2015 USRDS Annual Data Report
Volume 2: ESRD in the United States

Introduction to Volume 2: ESRD in the United States

Introduction

Volume 2 of the USRDS Annual Data Report (ADR) offers a source of detailed descriptive epidemiology of end-stage renal disease (ESRD) in the United States. Registration in the U.S. national ESRD database legally requires the completion of the ESRD Medical Evidence form (CMS 2728). This documentation of new ESRD patients must be submitted to the Centers for Medicare & Medicaid Services (CMS) within 45 days of onset of renal replacement therapy.

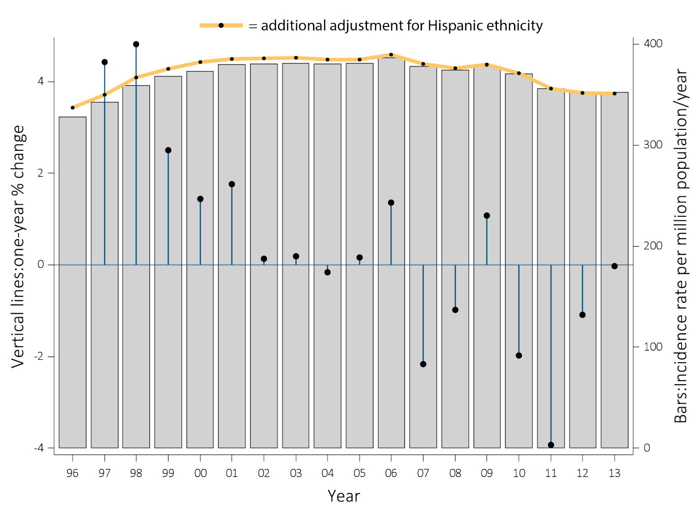
Data collection for many national projects administered by the CMS has been transitioning from paper-based data entry to a fully web-based system. These projects include data to create core metrics and measures, such as the assessment and reporting of provider performance through Dialysis Facility Reports (DFR) and Dialysis Facility Compare (DFC), as well as the Quality Incentive Program (QIP), which ties provider achievement of selected quality targets to Medicare reimbursement. This web-based system is known as the Consolidated Renal Operations in a Web-Enabled Network (CROWNWeb). For Volume 2 of the USRDS Annual Data Report (ADR), the coordinating center has previously relied on data from Medicare claims for its analyses, however, in 2015, data from CROWNWeb is included for the first time in several chapters.

Volume 2 of the 2015 USRDS ADR provides key statistics on ESRD in the United States and includes the following chapters: Incidence, Prevalence, Patient Characteristics, and Treatment Modalities (Chapter 1); Healthy People 2020 (Chapter 2); Clinical Indicators and Preventive Care (Chapter 3); Vascular Access (Chapter 4); Hospitalization (Chapter 5); Mortality (Chapter 6); Transplantation (Chapter 7); Pediatric ESRD (Chapter 8); Cardiovascular Disease in Patients With ESRD (Chapter 9); Dialysis Providers (Chapter 10); Medicare Expenditures for Persons With ESRD (Chapter 11); Medicare Part D Prescription Drug Coverage in Patients With ESRD (Chapter 12); International Comparisons (Chapter 13); USRDS Special Study Center on End-of-life Care for Patients With ESRD (Chapter 14).

Chapter 1: Incidence, Prevalence, Patient Characteristics, and Treatment Modalities

There were 117,162 new cases of ESRD reported by the end of 2013; the unadjusted incidence rate was 363 per million/year, representing no change compared to 2012. The adjusted incidence rate rose sharply in the 1980s and 1990s, but leveled off in the early 2000s, and has declined slightly since its peak in 2006 (Figure i.1). The rate of incident ESRD is roughly 3-fold higher for Black/African Americans than for other races, and 1.4-fold higher for Hispanics versus non-Hispanics.

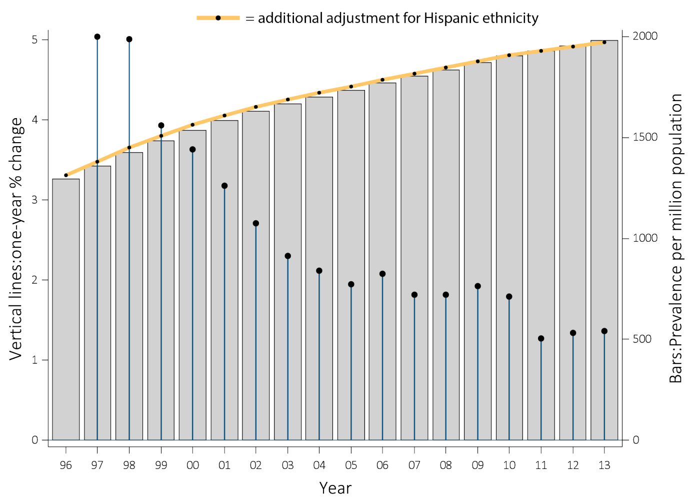
vol 2 Figure i.1 Trends in the adjusted* incidence rate (per million/year) of ESRD (bars; scale on right), and annual change (%) in the adjusted* incidence rate of ESRD (lines; scale on left) in the U.S. population, 1996-2013



*Data Source: Reference Table A.2(2), and special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease. This graphic is also presented as Figure 1.2.*

Despite this stability in ESRD incidence, at the end of 2013, there were 661,648 prevalent dialysis and transplant patients receiving treatment for ESRD—a 3.5% increase from 2012. The number of ESRD prevalent cases continues to rise (by about 21,000 cases per year), as does the adjusted prevalence (Figure i.2). Because the incidence of ESRD has plateaued, the ongoing rise in prevalence can be attributed to the decline in mortality rate among ESRD patients.

vol 2 Figure i.2 Trends in the adjusted* ESRD prevalence (per million) (bars; scale on left), and annual change (%) in adjusted* prevalence of ESRD (lines; scale on right), in the U.S. population, 1996-2013

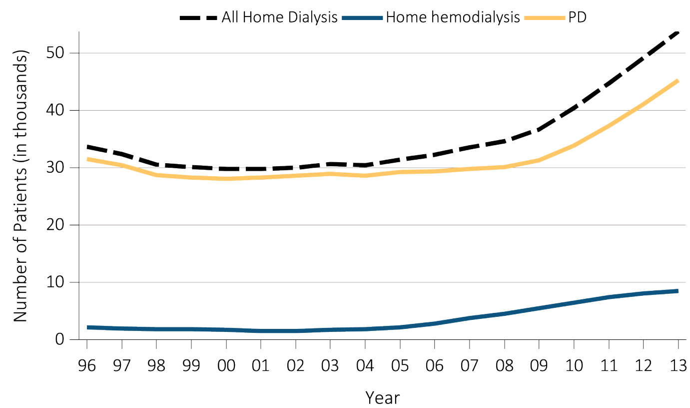


*Data Source: Reference Table B.2(2), and special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease. This graphic is also presented as Figure 1.11.*

The mean eGFR at initiation of dialysis has been stable or decreased slightly from 2010 to 2013 after increasing steadily from 1996 until 2009. However, the percentage of incident ESRD cases receiving little or no pre-ESRD nephrology care remains high, at 38% in 2013.

Among prevalent ESRD cases, the use of home dialysis (peritoneal dialysis or home hemodialysis, Figure i.3) has increased appreciably in recent years. Home dialysis accounted for 11.5% of all prevalent dialysis patients in 2013, up from a low of 8.9% in 2008. Among prevalent ESRD cases receiving home dialysis, the proportion using home hemodialysis was over 3-fold higher in 2013 (15.8%) than in 2001 (5.2%).

vol 2 Figure i.3 Trends in number of prevalent ESRD cases (in thousands) using home dialysis, by type of therapy, in the U.S. population, 1996-2013



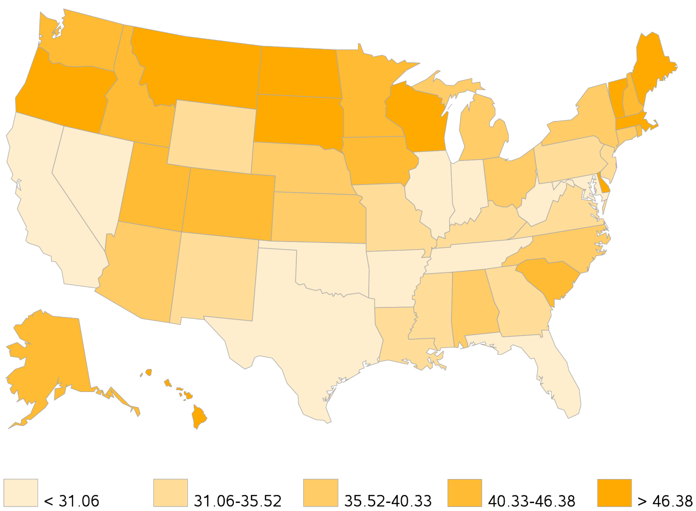
Data Source: Reference Table D.1. December 31 prevalent ESRD patients; PD consists of CAPD and CCPD only. Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycler peritoneal dialysis; ESRD, end-stage renal disease; PD, peritoneal dialysis. This graphic is also presented as Figure 1.23.

Chapter 2: Healthy People 2020

In 2015, we present data for 10 Healthy People (HP) 2020 Objectives, spanning 19 total indicators. As in previous years, we present data overall and stratified by race, gender, and age groups. In 2013, 11 of 19 indicators met HP2020 goals, and most of the remaining objectives continue to show improvement. We include maps for some of the indicators to illustrate geographic variation. Specifically, we present state-level comparison maps for HP2020 objectives CKD-10 (proportion of CKD patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy) and CKD-13.1 (proportion of patients receiving a kidney transplant within 3 years of end-stage renal disease) (Figure i.4). To update HP2020 objectives relating to vascular access, we present data from CROWNWeb for the first time. Previous USRDS annual reports have relied on data from the clinical performance measures project, which only collected information through 2007. Using CROWNWeb, this year we were able to present data from 2012 and 2013 for HP2020 objectives CKD 11-1 (proportion of adult hemodialysis patients who use an arteriovenous (AV) fistula as the primary mode of vascular access) and CKD 11-2 (proportion of adult hemodialysis patients who use a catheter as the only mode of vascular access).

We observed substantial geographic variation in the proportion of chronic kidney disease patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy, with percentages varying by more than 50% from the lowest quintile (30%) to the highest quintile (46%).

vol 2 **Figure i.4 HP2020 CKD-10 Geographic distribution of the adjusted proportion of chronic kidney disease patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy, by state, in the U.S. population, 2013: Target 29.8%**



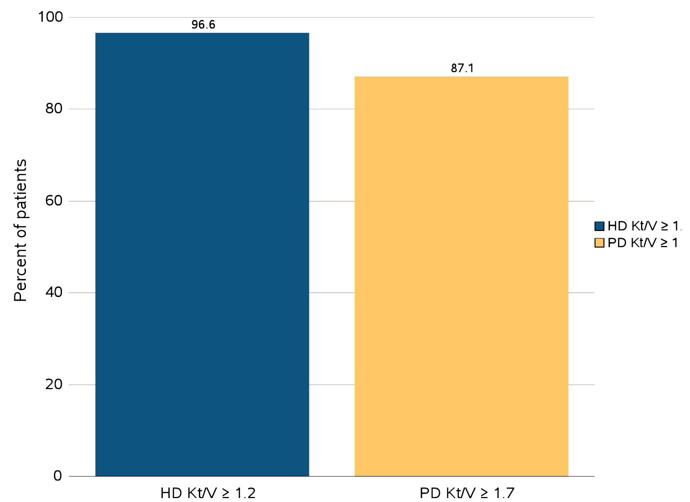
Data Source: Special analyses, Medicare 5 percent sample. Incident hemodialysis patients with a valid ESRD Medical Evidence CMS 2728 form; nephrologist care determined from Medical Evidence form. Adjusted for age, sex, and race. Abbreviations: CDC, Centers for Disease Control and Prevention; CKD, chronic kidney disease. Abbreviations: CDC, Centers for Disease Control and Prevention; CKD, chronic kidney disease; ESRD, end-stage renal disease. This graphic is also presented as Figure 2.1.

Chapter 3: Clinical Indicators and Preventive Care

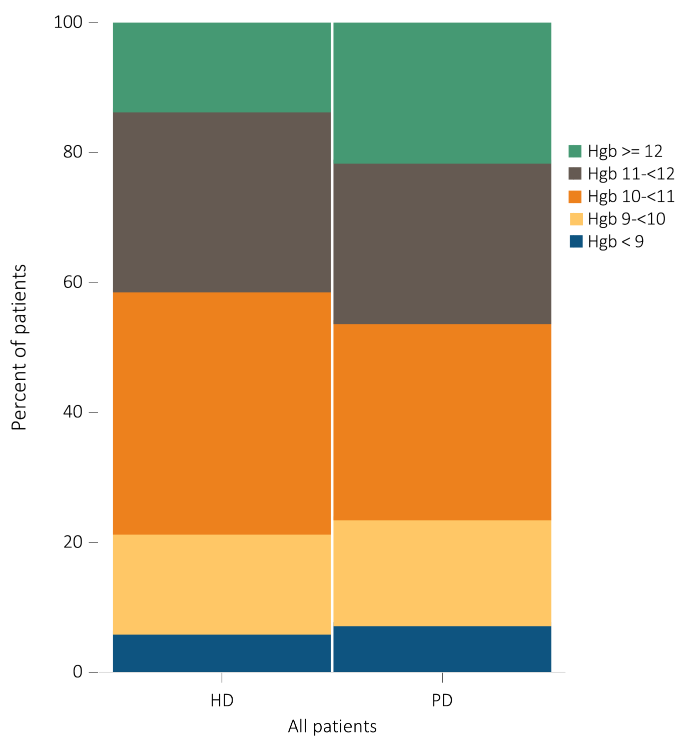
Given the high morbidity and mortality of the ESRD population receiving dialysis, quality improvement has long been a priority. For the first time, due to the recent availability of data from CROWNWeb, national trends in serum calcium, phosphorus, ferritin and transferrin saturation levels are reported in the ADR. For example, as of December 2014, 2.4% of hemodialysis patients and 2.3% of peritoneal dialysis patients had a serum calcium of >10.2 mg/dl (Figure i.5.c). Avoidance of this threshold is currently being utilized as a quality indicator in Centers for Medicare & Medicaid Services (CMS) programs such as Dialysis Facility Compare and the Quality Incentive Program given concerns about associations between hypercalcemia and vascular calcifications or cardiovascular events.

vol 2 **Figure i.5 ESRD clinical indicators: (a) Percentage of prevalent hemodialysis and peritoneal dialysis patients meeting clinical care guidelines for dialysis adequacy by modality, (b) percentage distribution of achieved mean Hgb among prevalent hemodialysis and peritoneal dialysis patients; and (c) percentage of patients with serum calcium >10.2 mg/dL by modality, CROWNWeb data, December 2014**

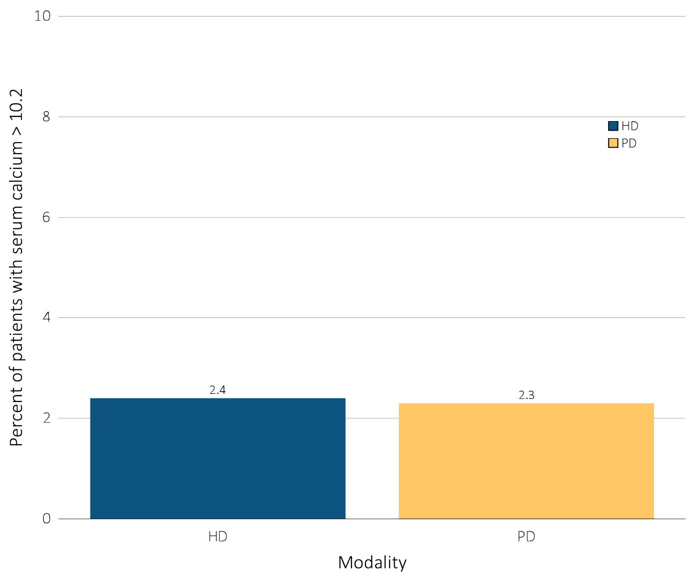
(a) Percentage of prevalent hemodialysis and peritoneal dialysis patients meeting clinical care guidelines for dialysis adequacy by modality



(b) Percentage distribution of achieved mean Hgb among prevalent hemodialysis and peritoneal dialysis patients



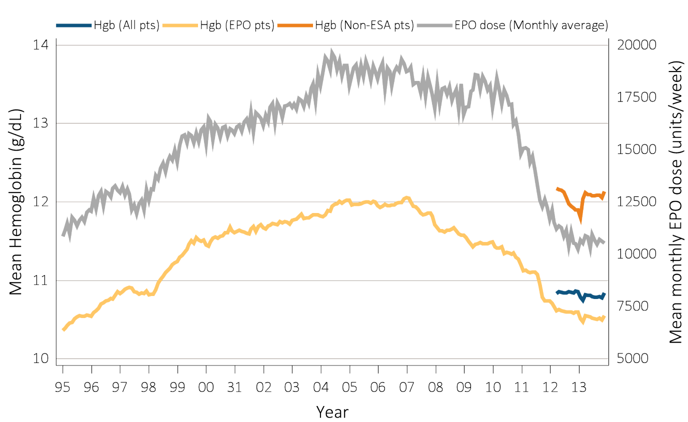
(c) Percentage of patients with serum calcium >10.2 mg/dL by modality



Data Source: Special analyses, USRDS ESRD Database. Results shown are for laboratory values reported to CROWNWeb for December 2014, restricted to patients as follows: Panel a: Dialysis patients initiating treatment for ESRD at least 1 year prior to December 1, 2014, and who were alive through December 31, 2014. Panel b: Dialysis patients initiating treatment for ESRD at least 90 days prior to December 1, 2014, who were ≥18 years old as of December 1, 2014, and who were alive through December 31, 2014. Panel c: Hemodialysis and peritoneal dialysis patients initiating treatment for ESRD at least 90 days prior to December 1, 2014, who were ≥18 years old as of December 1, 2014, and who were alive through December 31, 2014. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; Hgb, hemoglobin; Kt/V, see Glossary; PD, peritoneal dialysis. This graphic is also presented as Figure 3.1.

The decreasing trend in mean hemoglobin (Hgb) levels over the last several years following a peak near 12.0 g/dL in 2007 in erythropoiesis stimulating agent-treated hemodialysis patients appears to have finally plateaued. Mean Hgb levels were relatively stable in 2013, with only small changes in mean values across most months, with a mean monthly Hgb of 10.5 g/dL among ESA-treated hemodialysis patients (Figure i.6).

vol 2 Figure i.6 Mean monthly Hgb level and mean monthly EPO dose (expressed as units/week) in adult hemodialysis patients on dialysis ≥90 days, Medicare claims, 1995-2013

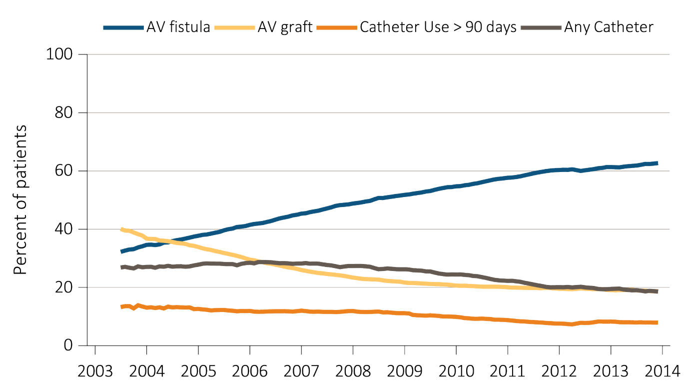


Data Source: Special analyses, USRDS ESRD Database. Mean monthly Hgb level among ESA-treated hemodialysis patients within a given month (1995 through 2013) or all hemodialysis patients (April 2012 to December 2013 only) who, within the given month, had a Hgb claim, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. Mean monthly EPO (epoetin alfa) dose is shown for hemodialysis patients within a given month who had an EPO claim, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. EPO dose is expressed as mean EPO units per week averaged over all EPO claims within a given month. Abbreviations: EPO, erythropoietin; ESA, erythropoiesis-stimulating agents; Hgb, hemoglobin. This graphic is also presented as Figure 3.2.

Chapter 4: Vascular Access

New for 2015, this Chapter outlines the patterns of vascular access for incident and prevalent hemodialysis patients in the United States. Figure i.7 displays trends in vascular access use among prevalent hemodialysis patients from 2003-2013. There has been a large rise in AV fistula use and AV fistula placement since 2003, with use increasing from 32% to nearly 63% and placement increasing from 38% to 66% of patients, respectively. In contrast, AV graft use has decreased from 40% to 19% over the same time period. Catheter use has also declined, albeit not as dramatically, decreasing from 27% to 19%. In 2013, only 8% of prevalent hemodialysis patients had been using a catheter for >90 days.

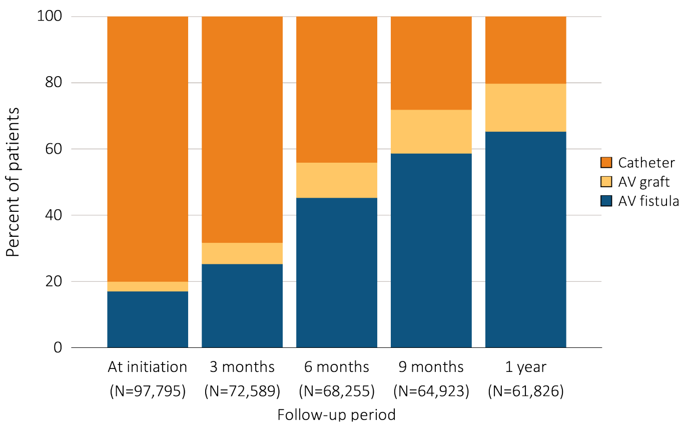
vol 2 Figure i.7 Trend in vascular access type use among ESRD prevalent patients, 2003-2014



Data Source: Special analyses, USRDS ESRD Database, and Fistula First data. Fistula First data reported from July 2003 through April 2012, CROWNWeb data are reported from June 2012 through December 2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease. This graphic is also presented as Figure 4.6.

Figure i.8 shows cross-sectional data from both the CMS Medical Evidence form (CMS 2728) (for vascular access information at initiation) and CROWNWeb (for follow-up data with respect to vascular access in use at 3, 6, 9 months and 1 year). At 90 days, most hemodialysis patients were still using a catheter, highlighting the importance of ongoing efforts to improve pre-dialysis access planning. The percentage of patients using an AV fistula exclusively at the end of 1 year on dialysis was 65%, up from 17% at initiation of hemodialysis. The proportion of patients with an AV graft for vascular access was 3% at initiation, and 15% at 1 year. Thus, at 1 year, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter.

vol 2 Figure i.8 Vascular access use during the first year of hemodialysis by time since initiation of ESRD treatment, among patients new to hemodialysis in 2013, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb data, 2013-2014



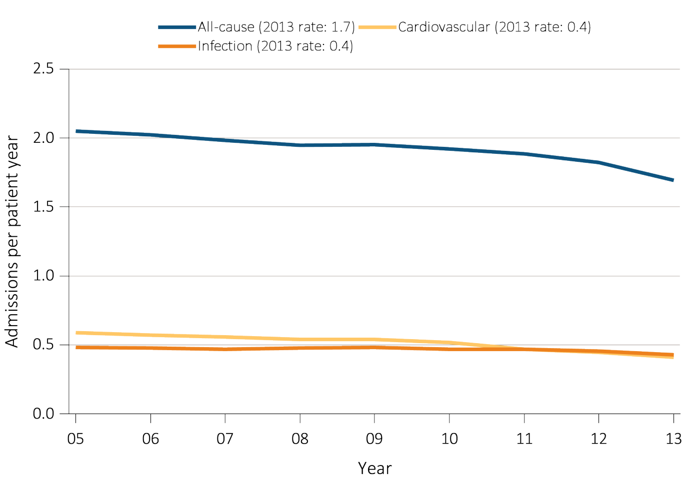
Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease. This graphic is also presented as Figure 4.7.

Chapter 5: Hospitalization

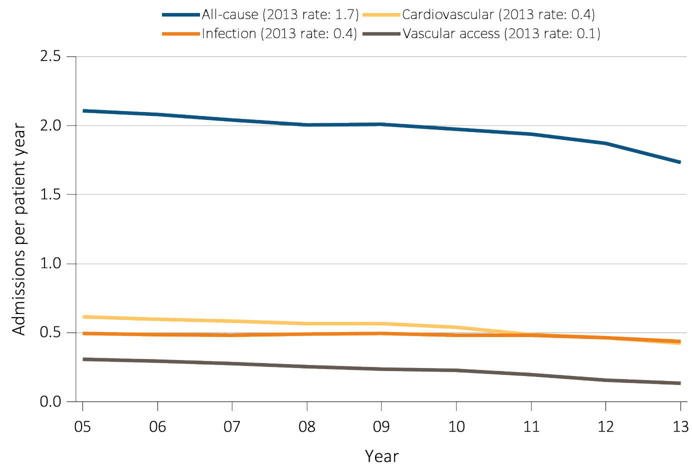
Among hemodialysis patients, the overall hospitalization rate in 2013 was 1.7 admissions per patient year—down from 2.1 in 2005 (Figure i.9).

vol 2 Figure i.9 Adjusted all-cause & cause-specific hospitalization rates for ESRD patients, by treatment modality, 2005-2013

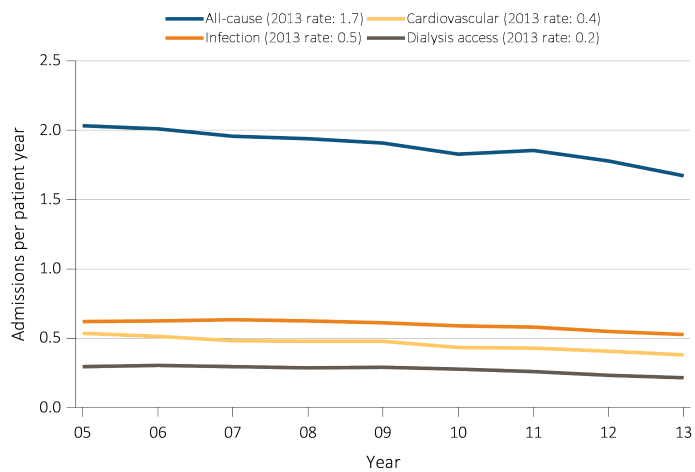
(a) All ESRD



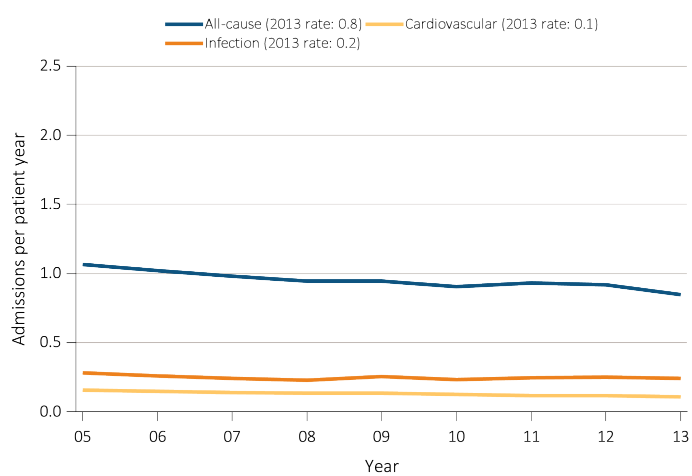
(b) Hemodialysis



(c) Peritoneal dialysis



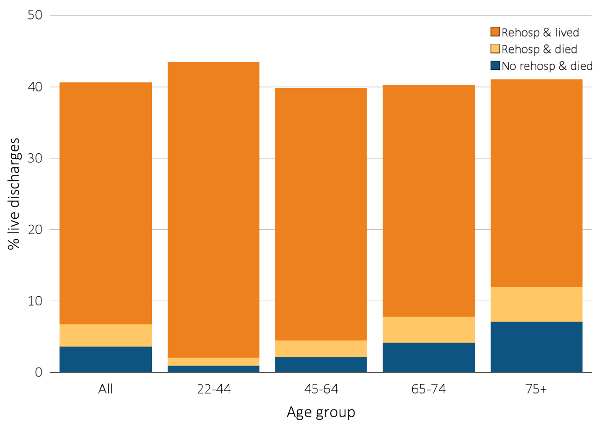
(d) Transplant



Data Source: Reference tables G.1, G.3, G.4, G.5, and special analyses, USRDS ESRD Database. Period prevalent ESRD patients; adjusted for age, sex, race, & primary diagnosis; ref: ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease. This graphic is also presented as Figure 5.2.

Rehospitalization has also been recognized as an important indicator of both morbidity and quality of life. It is also often costly, particularly among the ESRD patients being treated in dialysis facilities. Among hemodialysis patients prevalent in 2013, 37.0% of discharges from a hospitalization (for any cause) were followed by a rehospitalization within 30 days (Figure i.10).

vol 2 Figure i.10 Proportion of hemodialysis patients discharged alive from the hospital who either were rehospitalized or died within 30 days of discharge, by age, 2013



Data Source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients, all ages, 2013; unadjusted. Patients less than age 22 years are not represented as a group due to insufficient sample size. Includes live hospital discharges from January 1 to December 1, 2013. Cause-specific hospitalizations are defined by principal ICD-9-CM codes. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category. Abbreviations: ESRD, end-stage renal disease; rehosp, rehospitalization. This graphic is adapted from Figure 5.6.a.

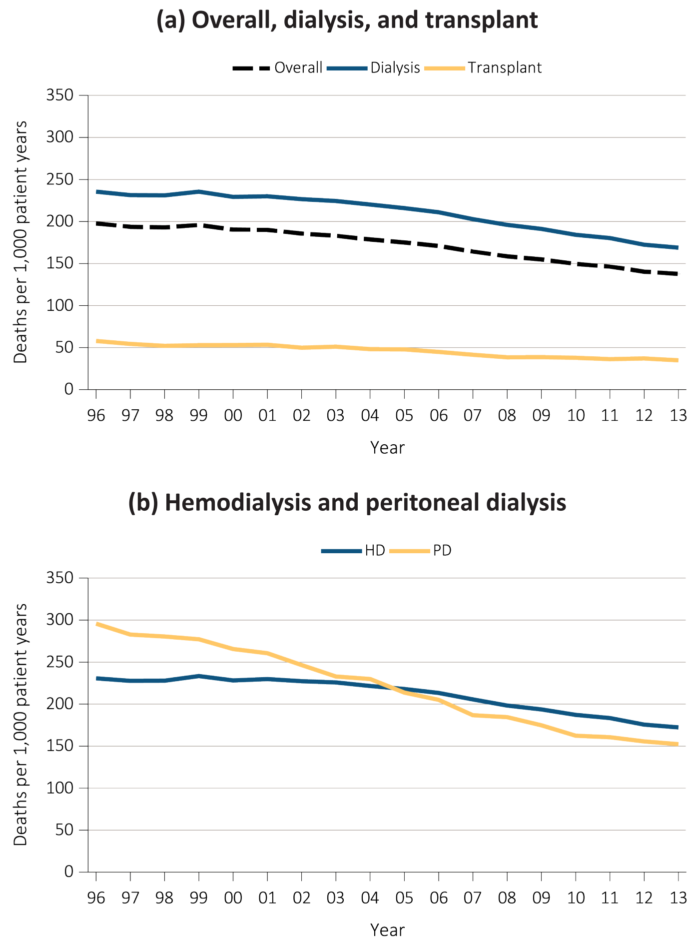
Chapter 6: Mortality

Overall mortality rates among ESRD (dialysis and transplant) patients continue to decline, with steeper declines in more recent years. Since 1996, the net reduction in mortality was 30% for all ESRD patients, including 28% for dialysis patients and 40% for transplant patients. The adjusted death rate fell by 7% from 1996 to 2003, and by 23% from 2004 to 2013 (Figure i.11.a). The trend was similar for dialysis (hemodialysis and peritoneal dialysis) patients, with the mortality rate falling by 5% from 1996 to 2003 and by 23% from 2004 to 2013. Among transplant patients, mortality fell by 12% from 1996 to 2003 and by 28% from 2004 to 2013.

Among hemodialysis patients the adjusted mortality rate fell by 2% from 1996 to 2003 and by 22% from 2004 to 2013. Among peritoneal dialysis patients, the mortality rate fell by 21% from 1996 to 2003 and by 34% from 2004 to 2013 (Figure i.11.b). The net reductions in mortality from 1996 to 2013 were 25% for hemodialysis patients and 49% for peritoneal patients.

Adjusted mortality rates in 2013 were 138, 169, and 35 per 1,000 patient-years for ESRD, dialysis, and transplant patients, respectively. By dialysis modality, mortality rates were 172 for hemodialysis patients and 152 for peritoneal dialysis patients, per 1,000 patient-years.

vol 2 Figure i.11 Adjusted all-cause mortality (deaths per 1,000 patient-years) by treatment modality (a) overall, dialysis, and transplant, and (b) hemodialysis and peritoneal dialysis, for period-prevalent patients, 1996-2013



Data Source: Reference Tables H.2_adj, H4_adj, H.8_adj, H.9_adj, and H.10_adj; and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, ethnicity, primary diagnosis and vintage. Ref: period prevalent ESRD patients, 2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis. This graphic is also presented as Figure 6.1.

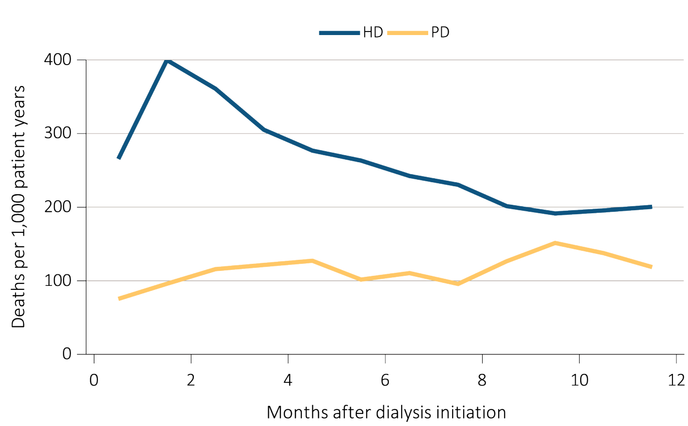
Among hemodialysis patients, from 1996-2011 the average yearly death rate was highest during the first year, then dropped to its lowest point during the second year, and then tended to rise for more than 5 years afterward (Figure i.12). Among peritoneal dialysis patients, mortality rates tended to increase over the first five years after starting dialysis. For both hemodialysis and peritoneal dialysis patients, mortality rates tended to be higher after 5 years than between 2-5 years on dialysis. The patterns of death rates according to time since dialysis initiation have been fairly similar over calendar time (comparing cohorts based on calendar year of initiation of treatment), within modality.

Among patients starting hemodialysis in 2012, reported all-cause mortality peaked at 400 deaths per 1,000 patient-years in month 2, and decreased thereafter to 200 per 1,000 patient-years in month 12. Note that the steep rise in hemodialysis mortality rates between months 1 and 2 may reflect data reporting issues; e.g., some patients who die soon after starting dialysis related to ESRD might not be registered as being ESRD and included in the CMS database (Foley et al., 2014). The extent to which this occurs is currently unknown.

Among patients with peritoneal dialysis as initial renal replacement modality, mortality does not peak early but instead tends to increase gradually during the first year on dialysis. Mortality at month 12 among these patients was 119 per 1,000 patient-years. Peritoneal dialysis patients may not experience an early peak in mortality, in part, because patients beginning ESRD via peritoneal dialysis are a highly selected group, in many cases being younger, healthier, and having undergone substantial pre-ESRD planning.

Post-transplant mortality among the <2% of patients who initiate ESRD treatment with a kidney transplant peaks in month 1, followed by a generally decreasing trend for the remainder of the first year (not shown).

vol 2 Figure i.12 Adjusted mortality (deaths per 1000 patient-years) by treatment modality and number of months after treatment initiation among ESRD patients, 2012



Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) mortality among 2012 incident ESRD patients during the first year of therapy. Ref: incident ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis. This graphic is also presented as Figure 6.3.

Mortality rates among ESRD patients increase with rising age, as expected. Mortality rates differ by race, but this difference is not constant within age groups or by modality. For example, White patients on dialysis had comparable mortality rates to Black/African American patients among those aged 0-44 years old, but higher mortality than Blacks at older ages (Table i.1).

vol 2 Table i.1 Adjusted all-cause mortality (deaths per 1,000 patient-years) by patient age and race among ESRD patients, 2012

Age	Race	ESRD	Dialysis	Transplant
0-21	White	12	31	4
	Black/African American	20	35	4
	Other	14	29	7
22-44	White	37	62	9
	Black/African American	48	60	10
	Other	24	38	6
45-64	White	99	143	30
	Black/African American	98	114	29
	Other	71	99	21
65-74	White	197	245	70
	Black/African American	167	183	71
	Other	137	171	61
75+	White	359	382	136
	Black/African American	275	283	132
	Other	239	254	112

Data Source: Special analyses, USRDS ESRD Database. Adjusted (sex and primary diagnosis) all-cause mortality among 2012 period prevalent patients. Ref: period prevalent ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease. This table is also presented as Table 6.1.

The differences in expected remaining lifetime between the ESRD and general populations are striking (Table i.2). Dialysis patients younger than 80 years old are expected to live less than one-third as long as their counterparts without ESRD, and dialysis patients aged 80 years and older are expected to live less than one-half as long as their counterparts without ESRD. Transplant patients fare considerably better, with expected remaining lifetimes for people under the age of 75 estimated at 67% to 84% of expected lifetimes in the general population.

vol 2 **Table i.2 Expected remaining lifetime (years) by age, sex, and treatment modality of prevalent dialysis patients, prevalent transplant patients, and the general U.S. population (2012), based on USRDS data and the National Vital Statistics Report (2013)**

	ESRD patients, 2013				General U.S. population, 2012	
	Dialysis		Transplant			
Age	Male	Female	Male	Female	Male	Female
0-14	24.1	22.4	59.2	61.2	70.7	75.4
15-19	20.9	19.3	46.8	48.6	59.7	64.4
20-24	18.1	16.5	42.5	44.2	55.0	59.5
25-29	15.8	14.3	38.6	40.2	50.3	54.6
30-34	14.1	13.0	34.7	36.4	45.7	49.7
35-39	12.5	11.7	30.8	32.4	41.0	45.0
40-44	10.8	10.3	26.9	28.6	36.4	40.3
45-49	9.1	8.8	23.2	24.8	31.9	35.6
50-54	7.7	7.7	19.8	21.3	27.7	31.1
55-59	6.5	6.6	16.6	18.1	23.7	26.8
60-64	5.5	5.7	13.8	15.2	19.8	22.6
65-69	4.5	4.8	11.4	12.7	16.2	18.5
70-74	3.8	4.0	9.4	10.4	*12.8*	*14.7*
75-79	3.2	3.5	7.7a	8.6a	9.8	11.3
80-84	2.6	2.9			7.1	8.4
85+	2.1	2.4			4.9	5.8

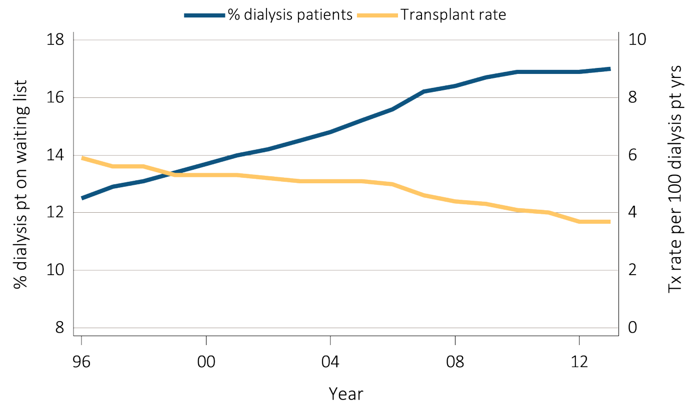
Data Source: Reference Table H.13; special analyses, USRDS ESRDS Database; and National Vital Statistics Report. "Table 7. Life expectancy at selected ages, by race, Hispanic origin, race for non-Hispanic population, and sex: United States, 2012 (2015)." Expected remaining lifetimes (years) of the general U.S. population and of period prevalent dialysis and transplant patients. [a]cell values combine ages 75+. Abbreviation: ESRD, end-stage renal disease. This table is also presented as Table 6.4.

Chapter 7: Transplantation

Kidney transplantation is the renal replacement therapy of choice for a majority of patients with ESRD. Successful kidney transplantation is associated with improved survival, improved quality of life and healthcare cost savings when compared to dialysis.

The unadjusted transplant rate per 100 dialysis patient years has been falling, while the percentage of prevalent dialysis patients wait-listed for a kidney has been rising (Figure i.13). Probable contributing causes include a growing prevalent dialysis population and a growing imbalance between donor supply and demand, which in turn leads to longer kidney transplant waiting times.

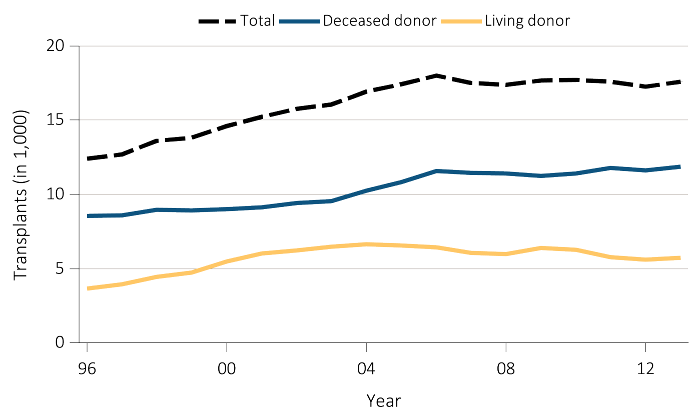
vol 2 **Figure i.13 Percentage of dialysis patients wait-listed and unadjusted kidney transplant rates, 1996-2013**



Data Source: Reference Tables E4 and E9. Percentage of dialysis patients on the kidney waiting list is for all dialysis patients. Unadjusted transplant rates are for all dialysis patients. This graphic is also presented as Figure 7.1.

The total number of kidney transplants has leveled off over the past decade (Figure i.14). During this period, a small overall increase in deceased donations has balanced a small decrease in living donations.

vol 2 **Figure i.14 Number of kidney transplants, 1996-2013**

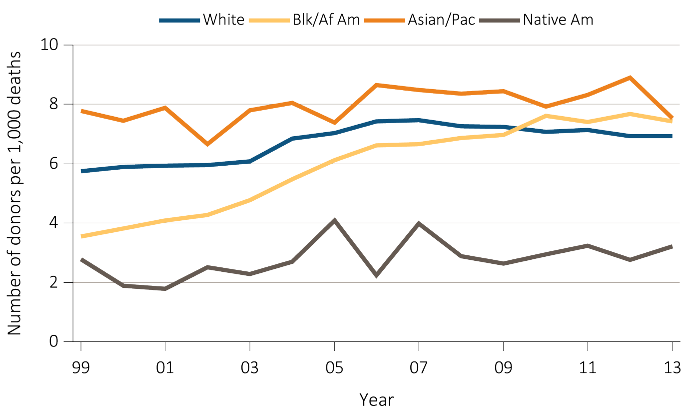


Data Source: Reference Tables E8, E8(2), and E8(3). Counts of transplants are for all dialysis patients. This graphic is also presented as Figure 7.3.

The number of deceased donors with at least one kidney retrieved has been increasing since 2003, reaching 8,021 in 2013 (Figure i.15).

In recent years (since 2010), Blacks have surpassed Whites in deceased donation rates. The rate of deceased donors per 1,000 deaths among Blacks more than doubled from 1999 to 2013. Notably, Asian or Pacific Islanders have had the highest donation rate, and Native Americans have had the lowest donation rates since 1999.

vol 2 Figure i.15 Unadjusted deceased donor kidney donation rates, by donor race, 1999-2013



Data Source: The U.S. death population data are obtained from Centers for Disease Control and Prevention; the deceased donor data are obtained from UNOS. Deceased donor kidney donation rates by donor race. Abbreviations: Asian/Pac, Asian/Pacific Islander; Blk/Af Am, Black/African American; Native Am, Native American. This graphic is also presented as Figure 7.17.b.

Among the recipients of deceased donor kidney transplants, the probability of all-cause graft failure in the first year following transplant decreased from 14% in 1996 to 8% in 2012, while the probability of death decreased from 6% in 1996 to 4% in 2012. Similarly, among those who received living donor kidney transplants, the probability of all-cause graft failure in the first year following transplant decreased from 7% in 1996 to 3% in 2012, while probability of death decreased from 2.3% to 1.5% over the same time period.

Improvements in patient survival probabilities have persisted for most of the five- and ten-year outcomes (Tables i.3 and i.4).

Chapter 8: Pediatric ESRD

A greatly expanded chapter on Pediatric ESRD is a notable feature of this year's ADR. Pediatric ESRD affects children of all ages. The majority of these children will depend on renal replacement therapies over many decades. Consequently, children with incident ESRD often traverse the entire ESRD modality continuum of hemodialysis, peritoneal dialysis, and transplantation. These children are subjected to frequent hospitalizations and have a risk of mortality far exceeding the general pediatric population in the United States. Children with ESRD are quite different in disease etiology, transplant opportunities, morbidity and mortality when compared to adults with ESRD. The chapter has been expanded to include information about vascular access in children as this can have far reaching implications into adulthood. Also, this year for the first time, the USRDS Annual Data Report pediatric chapter includes a section on young adults. This provides an opportunity to improve our understanding of the issues surrounding transitional ages and outcomes in these patients.

The leading causes of ESRD in children during 2009-2013 are as follows: cystic/ hereditary/congenital disorders (33.0%), glomerular disease (24.6%), and secondary causes of glomerulonephritis (GN) (12.9%). The most common individual diagnoses associated with ESRD include renal hypoplasia/dysplasia (N=703), congenital obstructive uropathies (N=659), focal glomerular sclerosis (N=911), and systemic lupus erythematosus (N=537). In children with ESRD, sickle cell nephropathy, human immunodeficiency virus (HIV) nephropathy, and systemic lupus erythematosus are more common among Blacks compared with other racial groups.

A total of 1,462 children in the United States began ESRD care in 2013, and 9,921 children were being treated for ESRD on December 31, 2013. The most common initial ESRD treatment modality among children overall is hemodialysis (56%). Peritoneal Dialysis is the most common initial treatment modality in children younger than 9 years and those who weigh less than 20 kg. 37% of children received a kidney transplant within the first year of ESRD care during 2009-2013. The number of children listed for incident and repeat kidney transplant was 1,277 in 2013. As of 2006, deceased donor transplants were more common than living donor transplants. All-cause hospitalization rates are 2 per patient year among children with ESRD. The five-year patient survival probability was 0.89 for children initiating ESRD care between 2004 and 2008. Since 2006, 81% of incident pediatric ESRD patients have started hemodialysis with a central venous catheter. In aggregate, children have initiated ESRD therapy with hemodialysis more frequently than peritoneal dialysis or transplantation. Data from 2013 demonstrate the same pattern with 816 (55.8%) initiating with hemodialysis, 367 (25.1%) peritoneal dialysis, and 267 (18.3%) transplant. When examined by age, peritoneal dialysis is the most common initial ESRD treatment modality for children age 9 years and younger (Figure i.16.a). Hemodialysis becomes the most common initial modality at patient age 10 and older. Kidney transplantation accounts for less than 40% of initial modality across all pediatric ages. Similarly, initial ESRD treatment modality is associated with

vol 2 Table i.3 Trend in 1-, 5-, & 10-year deceased donor kidney transplant outcomes, 1996-2012

	One year post-transplant			Five years post-transplant			Ten years post-transplant		
Year	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death
1996	14.3%	10.2%	5.8%	36.2%	25.7%	19.4%	59.1%	42.9%	39.3%
1997	12.9%	8.5%	6.2%	34.7%	23.7%	19.2%	58.1%	40.8%	39.6%
1998	12.8%	9.2%	5.5%	33.8%	24.0%	18.1%	56.8%	40.4%	38.1%
1999	13.7%	9.2%	5.9%	34.0%	23.1%	18.9%	56.8%	39.4%	38.4%
2000	13.2%	8.6%	6.4%	34.6%	23.1%	19.7%	57.3%	39.1%	39.3%
2001	12.2%	8.0%	5.7%	33.3%	21.4%	19.9%	55.8%	37.0%	38.7%
2002	12.3%	8.3%	5.8%	33.0%	22.2%	18.9%	54.1%	36.2%	37.4%
2003	12.1%	7.6%	5.7%	32.1%	20.6%	18.6%	54.9%	36.1%	37.9%
2004	11.5%	7.3%	5.5%	31.7%	20.8%	18.4%			
2005	11.4%	7.1%	6.0%	30.2%	19.3%	18.0%			
2006	10.8%	7.0%	5.2%	29.6%	18.9%	17.3%			
2007	9.7%	6.2%	4.7%	28.5%	17.9%	16.9%			
2008	9.5%	6.2%	4.4%	26.9%	16.2%	16.3%			
2009	9.5%	5.7%	5.0%						
2010	9.0%	5.6%	4.5%						
2011	7.6%	4.6%	3.9%						
2012	7.6%	4.6%	3.8%						

Data Source: Reference Tables F2, F14, I26; F5, F17, I29; F6, F18, I30. Outcomes among recipients of a first-time deceased donor kidney transplant; unadjusted. Abbreviations: Prob., probability. This table is also presented as Table 7.2.

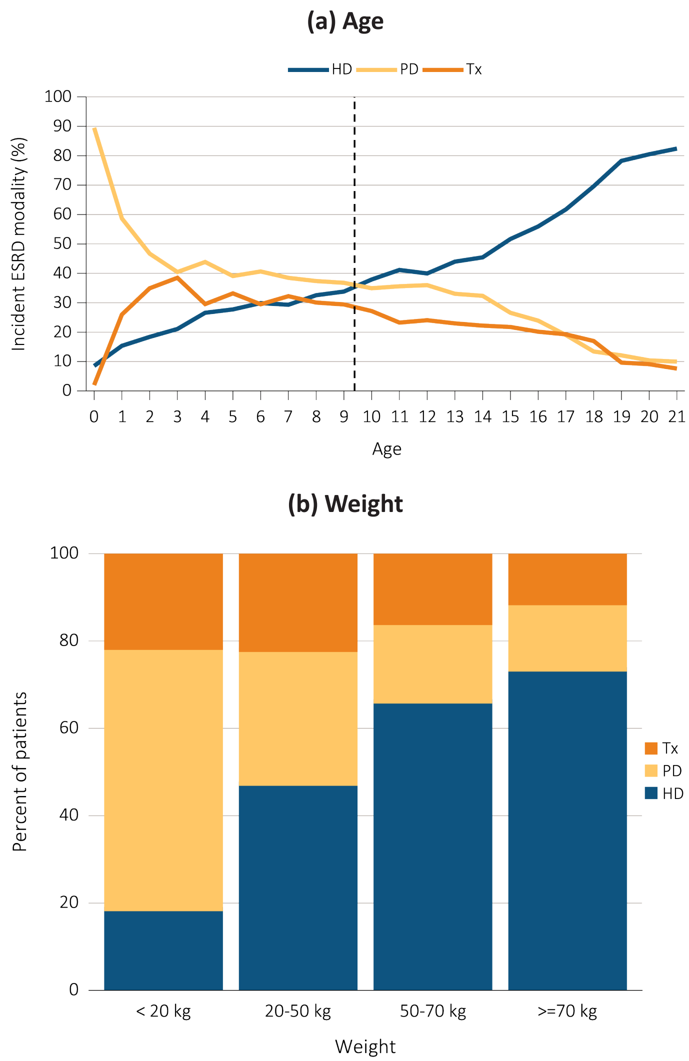
vol 2 Table i.4 Trend in 1-, 5-, & 10-year living donor kidney transplant outcomes, 1996-2012

	One year post-transplant			Five years post-transplant			Ten years post-transplant		
Year	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death
1996	6.9%	5.2%	2.3%	22.9%	16.8%	9.6%	43.3%	32.4%	22.7%
1997	6.7%	4.8%	2.7%	22.2%	15.8%	10.5%	43.2%	31.1%	24.4%
1998	6.0%	4.4%	2.3%	20.9%	14.6%	10.0%	42.4%	30.6%	23.4%
1999	6.1%	4.3%	2.2%	20.8%	14.7%	9.6%	41.2%	29.0%	22.7%
2000	6.6%	4.6%	2.6%	21.9%	14.9%	10.6%	42.2%	29.1%	24.0%
2001	6.2%	4.1%	2.5%	21.3%	14.3%	10.2%	41.2%	27.8%	24.0%
2002	5.8%	3.9%	2.5%	20.5%	13.6%	10.3%	40.0%	26.2%	24.6%
2003	5.4%	3.9%	1.9%	20.1%	13.8%	9.5%	39.6%	26.1%	23.3%
2004	5.2%	3.5%	2.1%	18.8%	12.7%	8.8%			
2005	5.3%	3.7%	2.0%	18.7%	12.6%	8.8%			
2006	4.4%	3.0%	1.7%	16.8%	11.1%	8.1%			
2007	3.8%	2.4%	1.4%	16.6%	10.5%	8.0%			
2008	4.1%	2.7%	1.6%	15.3%	9.9%	7.5%			
2009	3.9%	2.6%	1.4%						
2010	3.5%	2.2%	1.4%						
2011	3.4%	2.2%	1.9%						
2012	3.2%	1.9%	1.5%						

Data Source: Reference Tables F8, F20, I32; F11, F23, I35; F12, F24, I36. Outcomes among recipients of a first-time living donor kidney transplant; unadjusted. Abbreviations: Prob., probability. This table is also presented as Table 7.3.

patient weight. Peritoneal Dialysis is most commonly the initial modality in small children. Hemodialysis is the least common initiating modality in small children and increases in frequency with increasing patient weight (Figure i.16.b). Over time, transplant has become the most common prevalent ESRD treatment modality in children. Of the 9,921 children and adolescents between the ages of 0 and 21 years with prevalent ESRD as of December 31, 2013, kidney transplant was the most common modality (6,739[67.9%]), followed by hemodialysis (1,954 [19.7%]) and peritoneal dialysis (1,197 [12.1%]) (Figure i.16.b).

vol 2 Figure i.16 Trends in ESRD modality at initiation, by (a) patient age, and (b) weight, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Includes incident ESRD patients in the years 1996-2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant. This graphic is also presented as Figure 8.2.

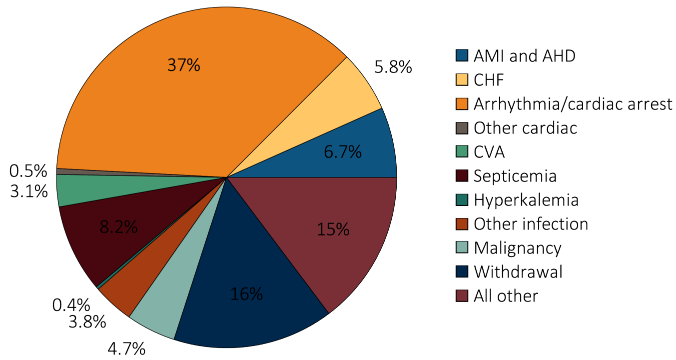
As a result of improvements in the care of pediatric patients with ESRD and kidney transplants, a larger percentage of these children are surviving into adulthood. The transition of these patients into adulthood represents a truly unique process and has resulted in the development of specific transition programs to improve health care for these individuals. For the first time in the USRDS Annual Data Report, we include a section in the pediatric chapter highlighting the young adult age group (defined in the USRDS as 22-29 years of age) that classically encompasses the transitional age groups. Despite their young age, cardiovascular disease remains the leading cause of mortality in this cohort, similar to older patients with ESRD. This section highlights the young adult population focusing on modality and the cardiovascular disease trends in this population.

Chapter 9: Cardiovascular Disease in ESRD Patients

This chapter has been reintroduced for the 2015 ADR, as the USRDS special study dealing with cardiovascular disease in CKD/ESRD ended at the beginning of 2014. Cardiovascular disease is a significant comorbidity for patients along the entire spectrum of chronic kidney disease and ESRD. ESRD patients are among the highest risk populations for a number of cardiovascular diseases. Presence of ESRD often complicates disease management and treatment, as it can influence both medical and procedural options, thereby adversely affecting a patient's prognosis. In this chapter, we focus on reporting the prevalence and outcomes of ESRD patients with diagnosed major cardiovascular conditions, stratifying by type of renal replacement therapy being received (hemodialysis, peritoneal dialysis, and kidney transplantation). For individual cardiovascular conditions, we compare the survival of patients with and without the condition. Given its role as the primary health care payer for ESRD patients, our analyses are based mostly on data from the national Medicare population.

As shown in Figure i.17, cardiovascular diseases are a major cause of death in ESRD patients, contributing to more than half of all deaths, among which the category of arrhythmias and cardiac arrest alone is responsible for 37% of the deaths.

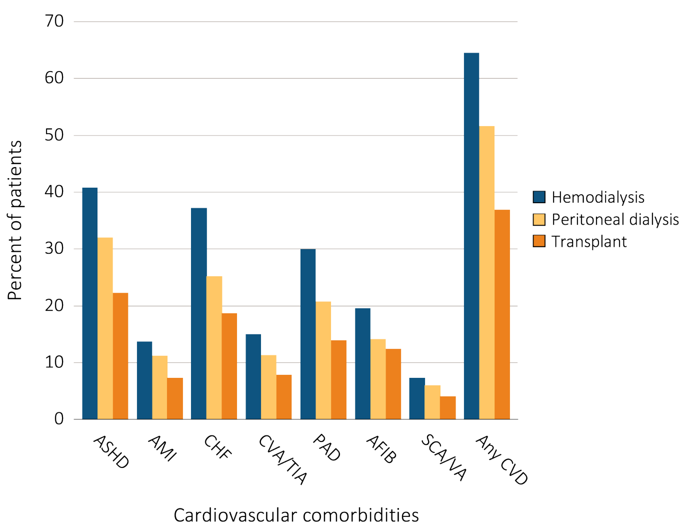
vol 2 Figure i.17 Causes of death in ESRD patients, 2013



Data Source: Reference Table H12. Abbreviations: AHD, atherosclerotic heart disease; AMI, acute myocardial infarction; CHF, congestive heart failure; CVA, cerebrovascular accident. This graphic is also presented as Figure 9.1.

ESRD patients have a high burden of cardiovascular disease across a wide range of conditions (Figure i.18).

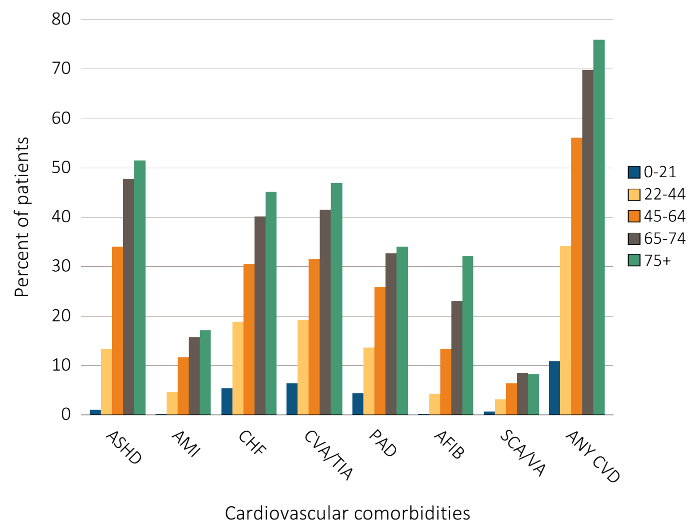
vol 2 Figure i.18 Prevalence of cardiovascular diseases in ESRD patients, by treatment modality, 2013



Data Source: Special analyses, USRDS ESRD database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias. This graphic is also presented as Figure 9.2.

Not surprisingly, older ESRD patients tend to have a higher prevalence of cardiovascular conditions (Figure i.19). It is notable, however, that the prevalence of these conditions is high even among those 20-44 years of age, although a much higher prevalence is observed among those 45 years or older. ASHD is the most common condition, with its prevalence exceeding 50% in ESRD patients aged 75 years or older, followed by CHF, PAD, AFIB and CVA/TIA.

vol 2 Figure i.19 Prevalence of cardiovascular diseases in ESRD patients, by age, 2013

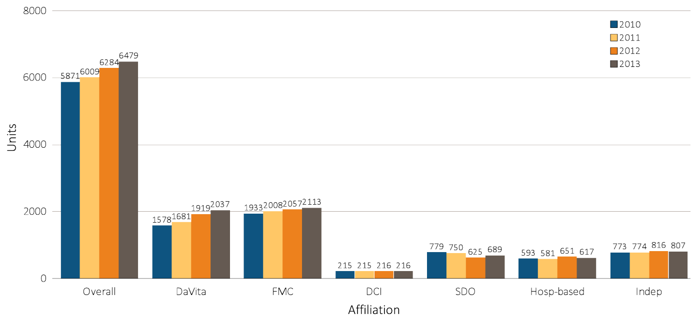


Data Source: Special analyses, USRDS ESRD database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012.Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias. This graphic is also presented as Figure 9.3.

Chapter 10: Dialysis Providers

The three large dialysis organizations (LDOs; DaVita, Fresenius [FMC] and Dialysis Clinic, Inc. [DCI]) treated 71% of all dialysis patients in the country at the end of 2013 (Figure i.20). Although DCI is considered a large dialysis organization for the purposes of this chapter, it is important to note that both DaVita and Fresenius are ten times as large. Nationwide, 608 dialysis units were added during the four-year period from 2010 to 2013, with most belonging to the LDOs; DaVita experienced the largest growth of all provider types in both facilities and patients. Small dialysis organizations experienced declines in the numbers of patients and units over the same period. Nearly 90% of all dialysis patients in 2013 received hemodialysis; hospital-based providers had the highest proportion of peritoneal dialysis patients at 21%, more than double the national average.

vol 2 Figure i.20 Dialysis unit counts, by unit affiliation, 2010-2013



Data source: Special analyses, USRDS ESRD Database. Abbreviations: DCI, Dialysis Clinic, Inc.; FMC, Fresenius; Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; SDO, small dialysis organizations. This graphic is also presented as Figure 10.1.

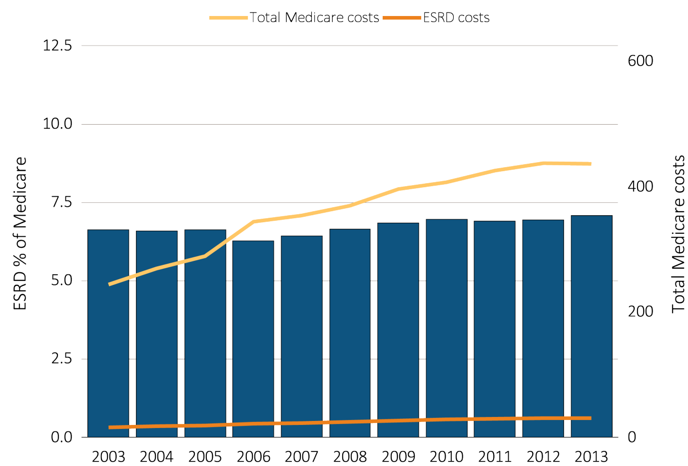
For the 2015 report, we introduce new tables illustrating one-year Standardized Mortality Ratios (Table i.5) and Standardized Hospitalization Ratios in 2013, to allow a simpler and more direct comparison of each facility-type's measure with the 2013 national norms.

Notably, hospital-based units continue to perform better than the national average on both measures. Dialysis providers of all types experienced an overall 5% decline in Standardized Mortality Ratios between 2010 and 2013. All provider types also experienced an overall decline in Standardized Hospitalization Ratios between 2010 and 2013, by 6%.

Chapter 11: Medicare Expenditures for Persons With ESRD

As illustrated in Figure i.21, total Medicare fee for service spending in the general Medicare population declined by 0.2 % in 2013 to $437.0 billion; spending for ESRD patients increased 1.6 %, to $30.9 billion, and accounted for 7.1% of the overall Medicare paid claims costs in the fee-for-service system.

vol 2 Figure i.21 Trends in costs of the Medicare & ESRD programs, 2003-1013



Data Source: Special analyses, USRDS ESRD Database; Reference Table K.1. Total Medicare expenditures obtained from Trustees Report, table II.B1 https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/TrusteesReports.html. Abbreviations: ESRD, end-stage renal disease. This graphic is also presented as Figure 11.2.

vol 2 Table i.5 All-cause standardized mortality ratio, by unit affiliation, 2013

Affiliation	All	White	Black/African American	Asian	Native American	Hispanic
Overall	1.00 (0.99-1.01)	1.13 (1.13-1.14)	0.83 (0.83-0.84)	0.66 (0.64-0.68)	0.83 (0.78-0.88)	0.76 (0.75-0.77)
LDO						
DaVita	1.02 (1.01-1.03)	1.15 (1.14-1.17)	0.85 (0.83-0.87)	0.66 (0.63-0.70)	0.74 (0.66-0.82)	0.76 (0.74-0.79)
Fresenius	1.00 (0.99-1.02)	1.14 (1.12-1.15)	0.83 (0.81-0.85)	0.72 (0.68-0.77)	0.90 (0.80-1.02)	0.76 (0.73-0.78)
DCI	0.94 (0.90-0.97)	1.09 (1.04-1.14)	0.76 (0.72-0.81)	0.71 (0.54-0.91)	0.78 (0.60-1.01)	0.84 (0.71-0.98)
SDO	1.02 (1.01-1.04)	1.15 (1.13-1.18)	0.84 (0.81-0.87)	0.73 (0.68-0.79)	1.08 (0.86-1.35)	0.81 (0.77-0.85)
Hospital-based	0.98 (0.95-1.01)	1.14 (1.10-1.18)	0.79 (0.74-0.84)	0.64 (0.54-0.76)	0.80 (0.64-0.99)	0.71 (0.63-0.79)
Independent	1.02 (1.01-1.04)	1.17 (1.14-1.19)	0.83 (0.80-0.86)	0.72 (0.67-0.77)	0.81 (0.71-0.92)	0.82 (0.79-0.86)

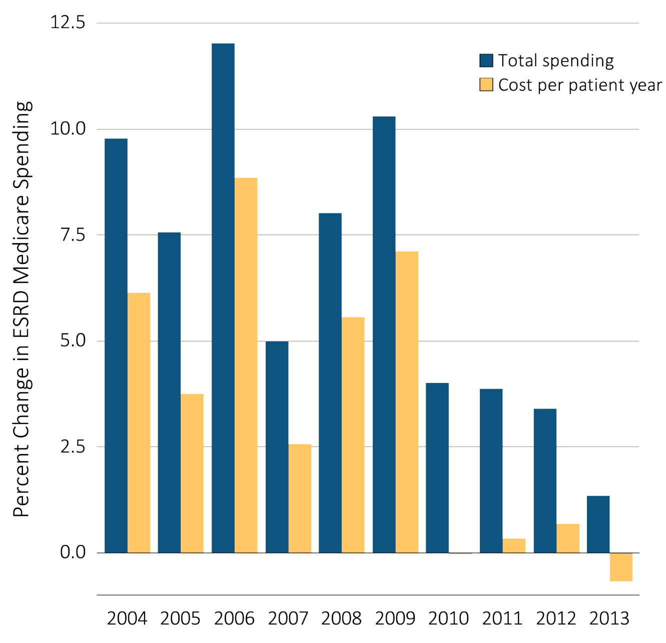
Data source: Special analyses, USRDS ESRD Database. Period prevalent dialysis patients; 95% confidence intervals are shown in parentheses. The overall measure is adjusted for patient age, race, ethnicity, sex, diabetes, duration of ESRD, nursing home status, patient comorbidities at incidence, body mass index (BMI) at incidence, and population death rates. The race-specific measures are adjusted for all the above characteristics except patient race. The Hispanic-specific measure is adjusted for all the above characteristics except patient ethnicity. Abbreviations: DCI, Dialysis Clinic, Inc.; LDO, large dialysis organizations; SDO, small dialysis organizations. This table is also presented as Table 10.2.

Figure i.22 displays the annual percentage change in Medicare ESRD spending for all ESRD patients for whom Medicare is the primary payer. Part D costs are included in these measures. However, as Part D is a voluntary component of the Medicare program; some recipients do not participate or have another source of pharmaceutical coverage (e.g., from an employer) and would not have medication claims represented in the Part D files.

For the fourth consecutive year, the annual increase in total Medicare ESRD spending for patients with primary payer status was less than 4%. In 2013, total Medicare paid claims for ESRD services and supplies increased by 1.3% to $29.7 billion (Figure i.23; for total and specific values see Reference Table K.4).

In 2013, ESRD spending per patient per year (PPPY) declined by 0.7%. Given that ESRD PPYY spending decreased or increased only slightly from 2009 to 2013, the growth in total ESRD costs during these years is almost entirely attributable to growth in the number of covered patients.

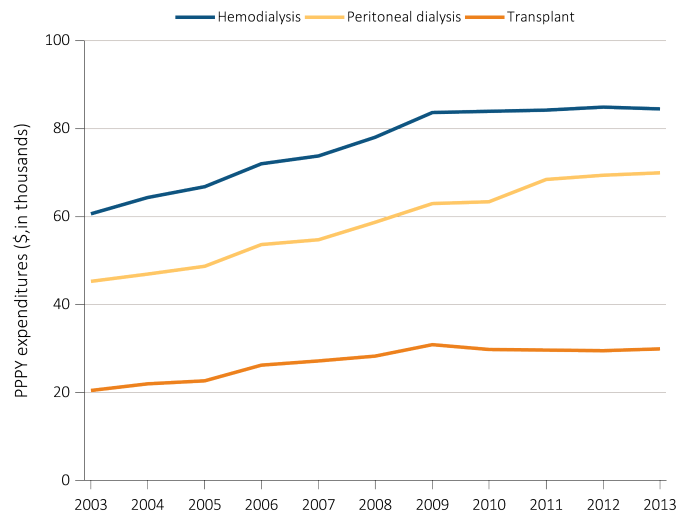
vol 2 Figure i.22 Annual percent change in Medicare ESRD spending



Data Source: Special analyses, USRDS ESRD Database; Reference Table K.4. Total Medicare ESRD costs from claims data; excludes claims with Medicare as secondary payer. Abbreviations: ESRD, end-stage renal disease. This graphic is also presented as Figure 11.4.

For hemodialysis, both total and PPPY spending were nearly flat between 2012 and 2013 (Figure i.23). Peritoneal dialysis total spending continued to grow, by 9.2% between 2012 and 2013 as the share of patients receiving peritoneal dialysis has continued to rise; peritoneal dialysis growth on a PPPY basis was moderate between 2012 and 2013 (0.8%), however, and peritoneal dialysis remains less costly on a per patient basis than hemodialysis. Finally, total and PPPY transplant spending has also remained consistent.

vol 2 Figure i.23 Total Medicare ESRD expenditures per person per year, by modality

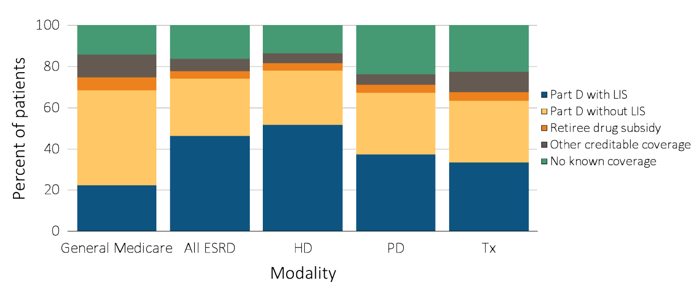


Data Source: Special analyses, USRDS ESRD Database; Reference Tables K.7, K.8, & K.9. Period prevalent ESRD patients; patients with Medicare as secondary payer are excluded. Abbreviations: ESRD, end-stage renal disease. This graphic is also presented as Figure 11.7.

Chapter 12: Part D Prescription Drug Coverage in Patients With ESRD

Overall, 74% of Medicare ESRD beneficiaries were enrolled in a Part D plan in 2013 (Figure i.24). By modality, enrollment is 78%, 67%, and 63% for hemodialysis, peritoneal dialysis and transplant patients, respectively, compared to 69% of general Medicare patients. Hemodialysis, peritoneal dialysis, and transplant patients with Part D receive the low-income subsidy (LIS) at a higher proportion, compared to general Medicare Part D enrollees, (66%, 56%, and 53% compared to 33%).

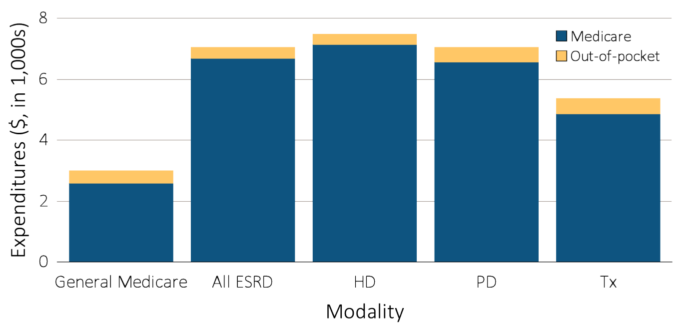
vol 2 Figure i.24 Sources of prescription drug coverage in Medicare ESRD enrollees, by population, 2013



Data source: Special analyses, USRDS ESRD Database. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; LIS, low-income subsidy; Part D, Medicare Part D Prescription drug coverage; PD, peritoneal dialysis; Tx, kidney transplant. This graphic is also presented as Figure 12.1.

In 2013, per patient per year Medicare Part D spending for ESRD patients was 2.6 times higher than for general Medicare patients, at $6,673 as compared to $2,592. By ESRD modality, hemodialysis patients had the highest per person per year (PPPY) Medicare costs in 2013, at $7,142, compared to $6,566 and $4,875 for peritoneal dialysis and transplant patients (Figure i.25).

vol 2 Figure i.25 Per person per year Medicare & out-of-pocket Part D spending for enrollees, 2013



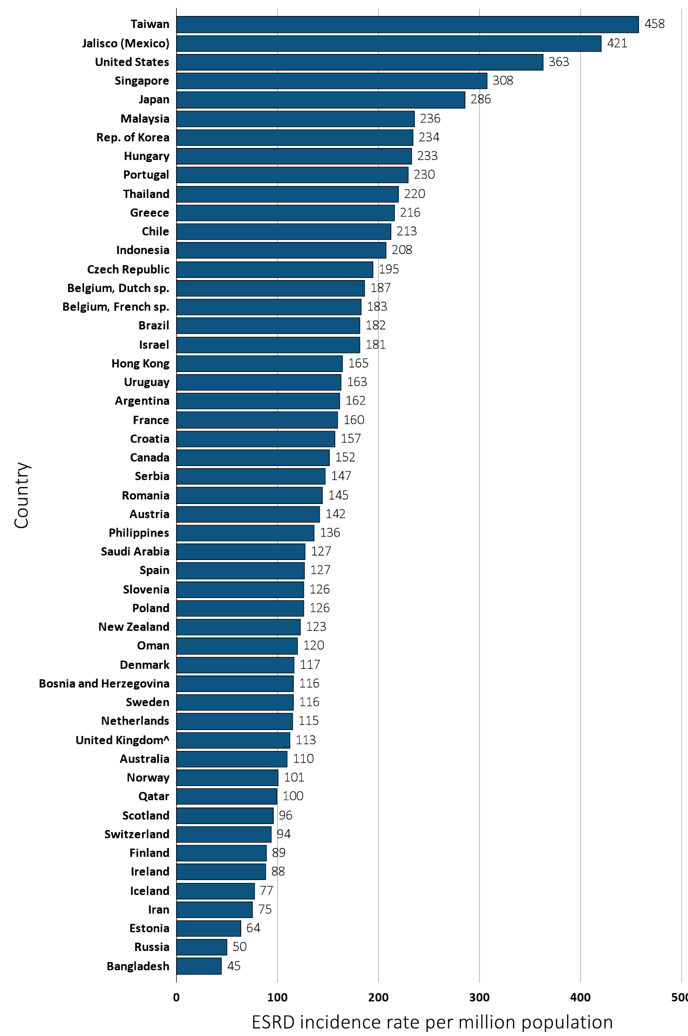
Data source: Special analyses, USRDS ESRD Database. Period prevalent Medicare enrollees alive on January 1, 2013, excluding those in Medicare Advantage Part D plans and Medicare secondary payer, using as-treated model (see method chapter for analytical methods). This graphic is also presented as Figure 12.5.a.

Chapter 13: International Comparisons

This chapter, expanded for 2015, examines treated ESRD from an international perspective. The number of countries and regions represented in this Annual Data Report has increased from 54 in 2014 to 57, with the addition of Estonia, Ireland, and Switzerland to this year's chapter. This work is made possible through the substantial efforts of many individuals from all participating countries, through collecting and contributing data for this international collaboration. The comparisons we present are intended to increase awareness of the international trends, similarities, and differences in key ESRD treatment measures. Data collection methods vary to some extent across countries, and therefore direct comparisons should be made with caution. Significant geographic variation in the incidence and prevalence of ESRD is seen by country (Figures i.26 and i.27).

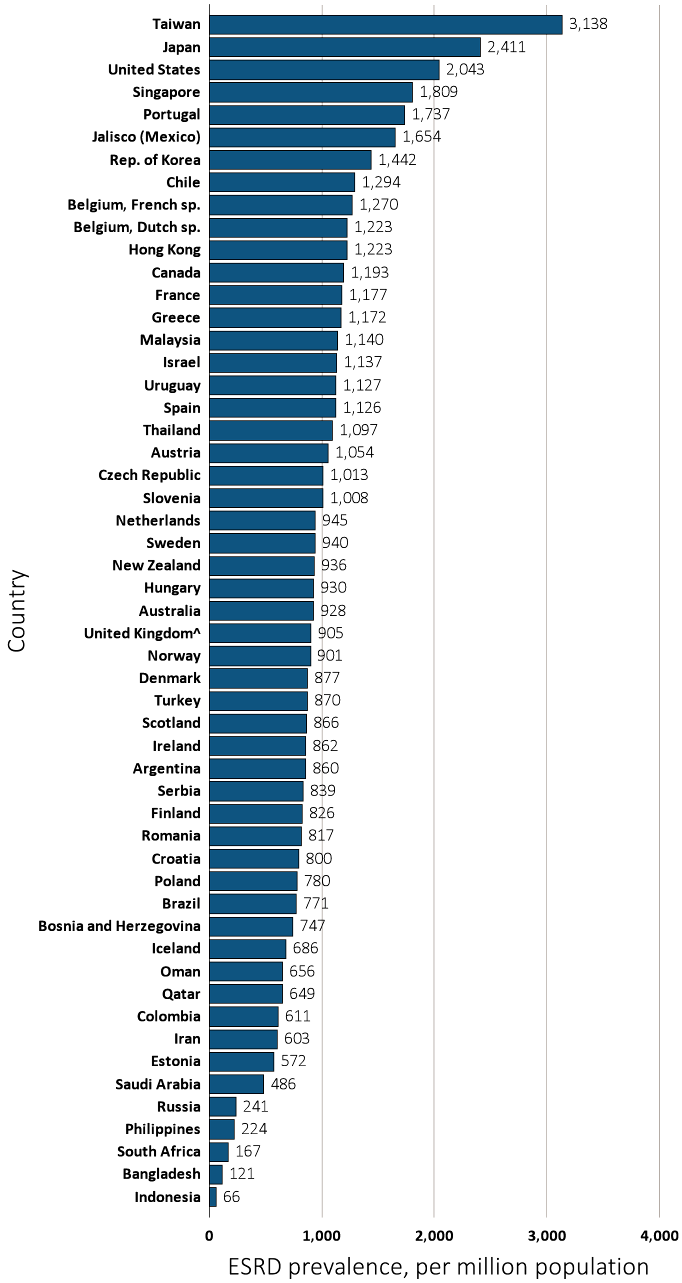
The chapter also covers variation in transplantation rates and living versus deceased kidney donations across countries. Finally, given the increasing diversity of countries represented in this International Comparisons chapter, this year we also introduce a comparison of a country's prevalence of treated ESRD with selected health and development indicators.

vol 2 Figure i.26 Incidence of treated ESRD, per million population, by country, 2013



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. ^United Kingdom: England, Wales, Northern Ireland (Scotland data reported separately). Data for Belgium do not include patients younger than 20. Data for Indonesia represent the West Java region. Data for France include 22 regions. Data for Spain include 18 of 19 regions. Abbreviations: ESRD, end-stage renal disease; sp., speaking. This graphic is also presented as Figure 13.2.

vol 2 **Figure i.27 Prevalence of treated ESRD per million population, by country, 2013**



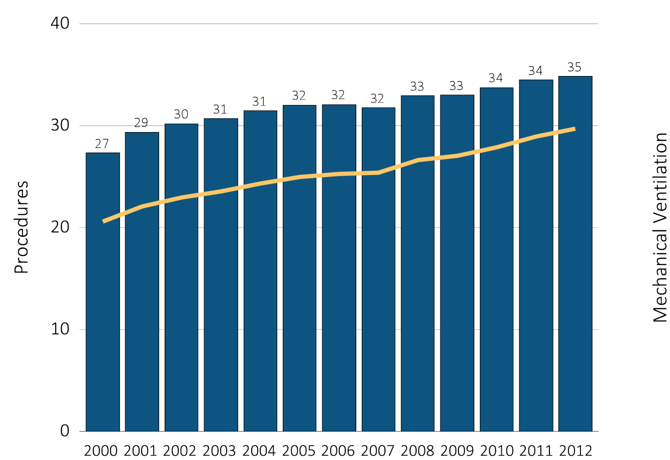
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. The prevalence is unadjusted and reflects prevalence at the end of 2013. ^United Kingdom: England, Wales, Northern Ireland (Scotland data reported separately). Japan and Taiwan include dialysis patients only. Data for Belgium do not include patients younger than 20. Data for Indonesia represent the West Java region. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Abbreviations: ESRD, end-stage renal disease; sp., speaking. This graphic is also presented as Figure 13.8.

Chapter 14: USRDS Special Study Center on Palliative and End-of-Life Care

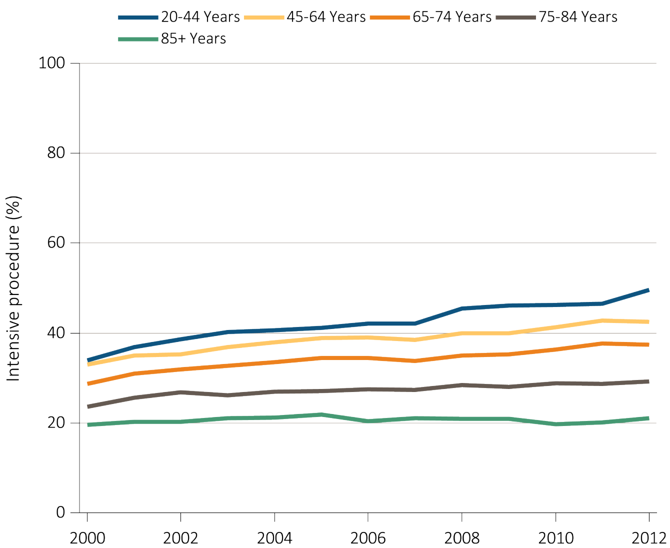
The limited survival of many patients with ESRD and their very high levels of disability, frailty, and functional impairment provide a strong rationale for efforts to integrate a more palliative and patient-centered approach to their care. The overarching goal of the USRDS Special Study Center (SSC) on Palliative and End-of-Life Care is to provide the nephrology community with innovative, rigorous, and nationally representative information about a domain of ESRD care for which little information is currently available to guide policy and practice. The percentage of Medicare beneficiaries with ESRD receiving an intensive procedure to prolong life during the last 90 days of life increased from 27% to 35% (Figure i.28). The percentage of Medicare beneficiaries with ESRD receiving hospice care at the time of death increased from 11% to 25% (Figure i.29). Most patients receive hospice services only after discontinuing dialysis treatments. From 2004-2012, hospice use prior to death increased from 59% to 80% among patients who discontinued dialysis treatments, but from only 5% to 7% among those who did not.

vol 2 **Figure i.28 Intensive procedures during the last 90 days of life among Medicare beneficiaries with ESRD overall, and by age, race, ethnicity, sex, and modality, 2000-2012**

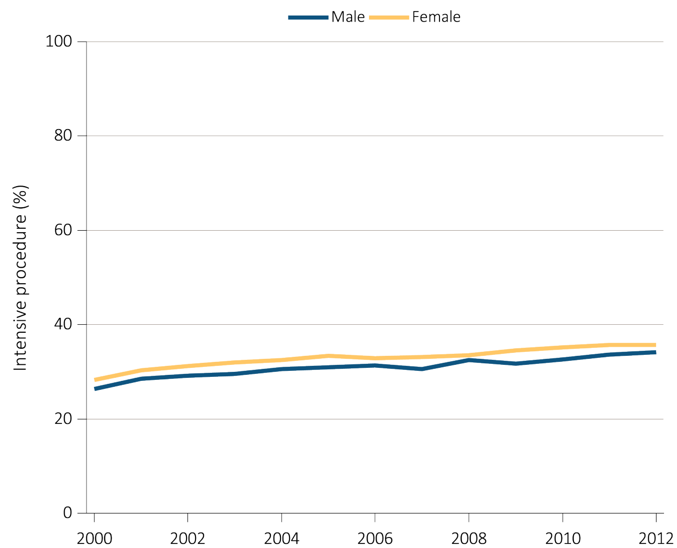
(a) Intensive procedures and mechanical ventilation by year, overall



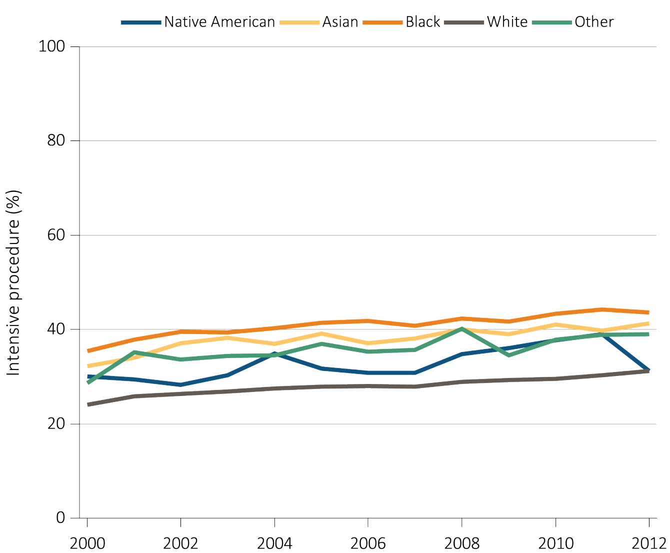
(b) Intensive procedures by age



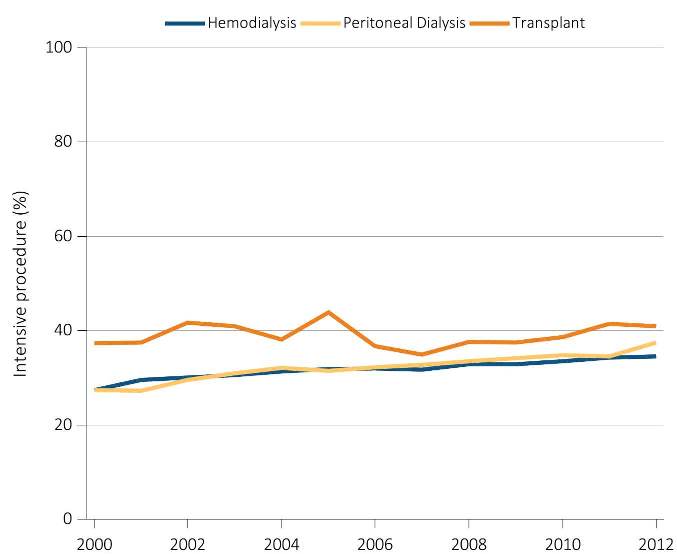
(e) Intensive procedures by sex



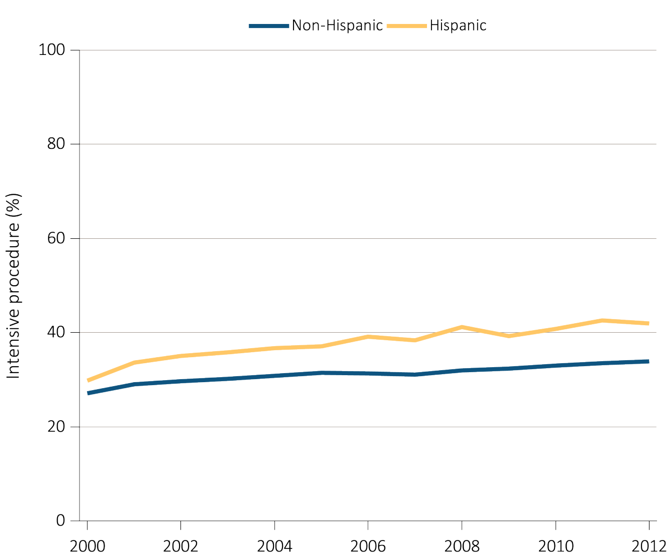
(c) Intensive procedures by race



(f) Intensive procedures by modality

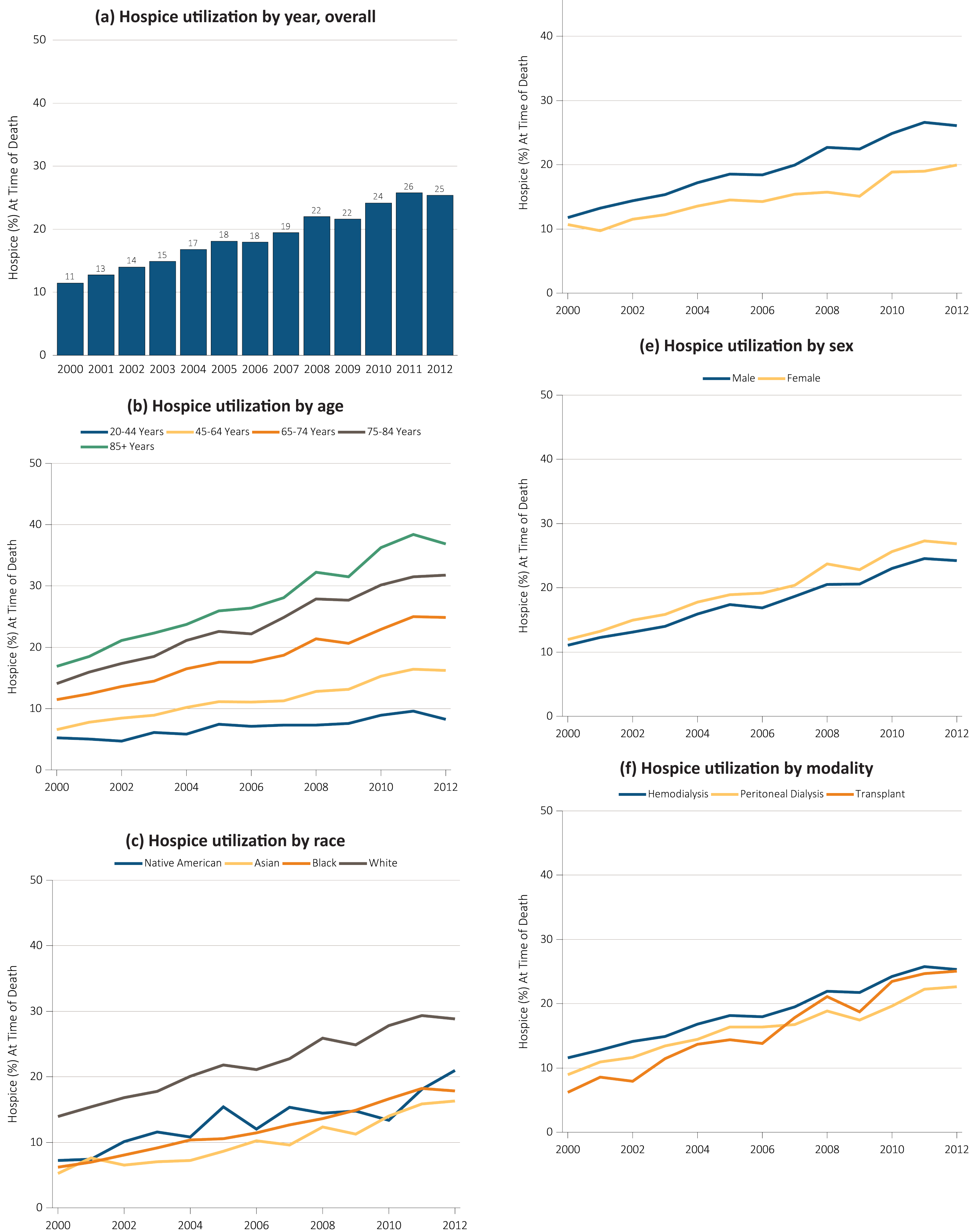


(d) Intensive procedures by ethnicity

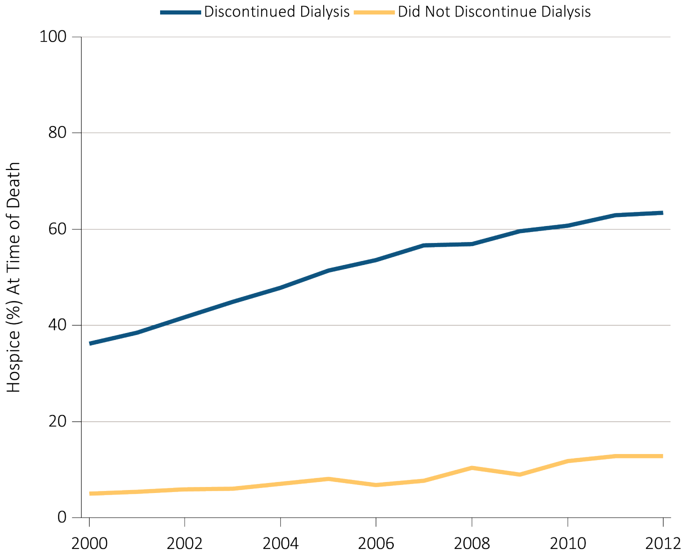


Data Source: Special analyses, USRDS ESRD Database (Medicare Institutional claims). Denominator population is all decedents with Medicare Parts A and B throughout the last 90 days of life. Intensive procedures were identified by ICD-9 procedure code search of Medicare Institutional claims from short and long stay hospitals. The yellow line in panel (a) denotes the percentage of patients who were intubated or received mechanical ventilation. This graphic is also presented as Figure 14.4.

vol 2 Figure i.29 Hospice utilization at the time of death among Medicare beneficiaries with ESRD overall, and by age, race, ethnicity, sex, modality, and whether dialysis was discontinued, 2000-2012



(g) Hospice utilization by whether patients discontinued dialysis before death



Data Source: Special analyses, USRDS ESRD Database. Denominator population is all decedents with Medicare Parts A and B throughout the last 90 days of life. Receipt of hospice care at the time of death was defined as having a claim in the Hospice SAF on or after the date of death or Discharge Status from hospice=40, 41, or 42. This graphic is also presented as Figure 14.7.

Notes

Chapter 1: Incidence, Prevalence, Patient Characteristics, and Treatment Modalities

Incidence

• The number of incident (newly reported) ESRD cases in 2013 was 117,162; the unadjusted incidence rate was 363 per million/year.

• The adjusted incidence rate of ESRD in the United States rose sharply in the 1980s and 1990s, leveled off in the early 2000s, and has declined slightly since its peak in 2006.

• In 2013, the adjusted ESRD incidence rate ratios for Black/African Americans, Native Americans, and Asians/Pacific Islanders, compared with Whites, were 3.0, 1.1 and 1.2; the rate ratio for Hispanics versus Non-Hispanics was 1.4.

Prevalence

• On December 31, 2013, there were 661,648 prevalent cases of ESRD; the unadjusted prevalence (proportion) was 2,034 per million in the U.S. population.

• While the number of ESRD incident cases plateaued in 2010, the number of ESRD prevalent cases continues to rise by about 21,000 cases per year.

• Compared to Whites, ESRD prevalence is about 3.7 times greater in Blacks, 1.4 times greater in Native Americans, and 1.5 times greater in Asians.

Characteristics of Incident ESRD Cases

• Up to 38% of incident ESRD cases in 2013 received little or no pre-ESRD nephrology care.

• Mean eGFR at initiation of dialysis in 2013 increased steadily from 1996 until 2009, but has been stable or decreased slightly from 2010 to 2013

Treatment Modalities

• In 2013, 88.2% of all incident cases began renal replacement therapy with hemodialysis, 9.0% started with peritoneal dialysis, and 2.6% received a preemptive kidney transplant.

• On December 31, 2013, 63.7% of all prevalent ESRD cases were receiving hemodialysis therapy, 6.8% were being treated with peritoneal dialysis, and 29.2% had a functioning kidney transplant.

Introduction

The focus of this chapter is the incidence and prevalence of end-stage renal disease (ESRD) in the U.S. population. Incidence refers to the occurrence or detection of new (incident) cases of ESRD during a given period. Incidence is expressed in this chapter as a count (number of incident cases) and as a rate (number of new cases in one year, divided by the amount of person-years at risk, which is approximated by the mid-year census for the population in that year). Rates are then expressed as per million population per year. For example, if 3,000 incident ESRD cases occurred in 2013 in a population of 10,000,000 adults, the incidence rate would be 0.000300 per year or 300 per million per year. Incidence rates are used to describe the occurrence of disease in populations, to identify risk factors for ESRD in etiologic studies, and to evaluate the impact of interventions for reducing ESRD risk in primary-prevention studies.

Prevalence refers to the presence of existing ESRD cases at a point in time (point prevalence) or during a specific period (period prevalence; not used in this chapter); it is expressed in this chapter as a count (number of prevalent cases) and as a proportion (number of prevalent cases, divided by the size of the population from which those cases were identified); prevalence at the end of each year is then expressed as per million population. Note that prevalence is not a rate; it is a proportion. Prevalence is used to describe the existing burden of disease in populations, to quantify the need for and to allocate health care resources.

Although prevalence is easier to estimate than incidence, prevalence findings are more difficult to interpret because the prevalence of a condition depends on both the incidence rate of that condition and how long ESRD patients live with the condition before recovering or dying. For example, if something favorable is done to improve survival among ESRD patients without changing the incidence rate, the prevalence of ESRD will increase. On the other hand, if something favorable is done to reduce the ESRD incidence rate without changing the survival of ESRD patients, the prevalence of ESRD will decrease.

This chapter examines trends in ESRD incidence and prevalence, patient characteristics, and treatment modalities from 1996 through 2013. While the prevalence of ESRD continues to rise, the trend over the past decade indicates that ESRD incidence has plateaued after increasing for many years. If these incidence and prevalence trends continue in the coming years, this would be good news indeed, as it implies likely improvements in prevention of ESRD as well as longer survival among patients who have reached ESRD.

Primary Cause of ESRD: A Cautionary Note

The "primary cause of renal failure," as assessed by individual physicians and reported on Form CMS-2728, has been used for many years in nephrology to compare populations and assess temporal trends. In the ADR, it allows us to estimate the ESRD incidence rate and prevalence for different disease subtypes, i.e., those with the primary cause listed as diabetes, hypertension, glomerulonephritis, or cystic kidney disease. It should be noted, however, that this approach is not the same as stratifying on comorbidity status, e.g., in this chapter we are not estimating adjusted incidence rates of ESRD among diabetics or non-diabetics in the U.S. population. Furthermore, the reliability of clinician assigned "primary-cause" of ESRD has not been well established; and because causation cannot be definitively established for all patients on the basis of clinical judgment or testing, and also because many patients arrive at ESRD without benefit of prior nephrology care, the validity of these etiologic subtypes of ESRD remains a challenge.

Adjustment of Incidence Rates and Prevalence

When comparing the incidence rate or prevalence of ESRD between different groups or years, the magnitude of the difference might be distorted (biased) if the groups or years differ in the distribution of one or more risk factors for ESRD. To control for those risk factors (potential confounders or covariates) in this chapter, we stratify on them in each group or year and calculate a weighted average of the stratum-specific rate or prevalence estimates, where the weights are the numbers of persons in each stratum of a standard population. This method is called standardization or "direct adjustment." To control for the potential confounders when comparing groups or years, we standardize all sets of rates or prevalences to the same standard population. In the 2015 ADR, standardization is used to adjust for age, sex, and race or ethnicity; and the standard population is the total U.S. population in 2011 (the same as in the 2014 ADR). Each standardized rate or prevalence for any specific group or year is interpreted as the rate or prevalence expected if that group or year had exhibited the covariate distribution of the standard population.

The major limitation of this adjustment method is that we are controlling for only a few demographic variables in this chapter. We are not controlling for other major ESRD risk factors such as CKD stage, diabetes status, hypertension status, or cardiovascular burden. Therefore, interpreting comparisons of incidence rates or prevalences between groups or years should be done with caution.

Analytical Methods

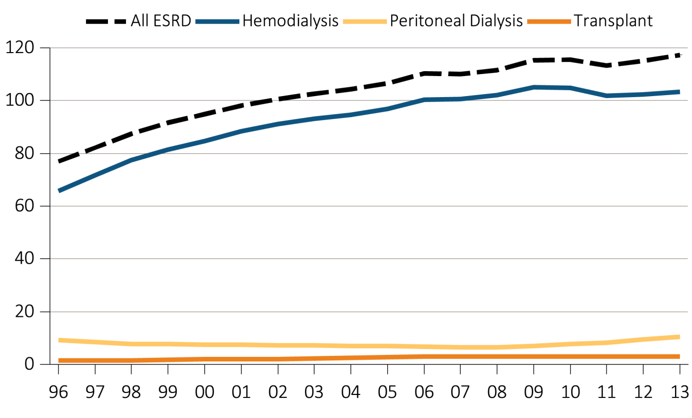
See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Incidence of ESRD: Counts, Rates, and Trends

Overall Incidence Rate

The number of incident (newly reported) ESRD cases in 2013 was 117,162 (Figure 1.1). The unadjusted incidence rate in 2013 was 363 per million/year. After a year-by-year rise in ESRD incidence over two decades from 1980 through 2000, it has been roughly stable from 2000 to 2013. The size of the incident dialysis population (hemodialysis and peritoneal dialysis) increased 1.9% from 2012 to 2013, reaching 113,944, and is now 24% larger than in 2000. The size of the pre-emptive transplant population rose 2.6% in 2013 to 3046 patients and is now 59.2% larger than in 2000.

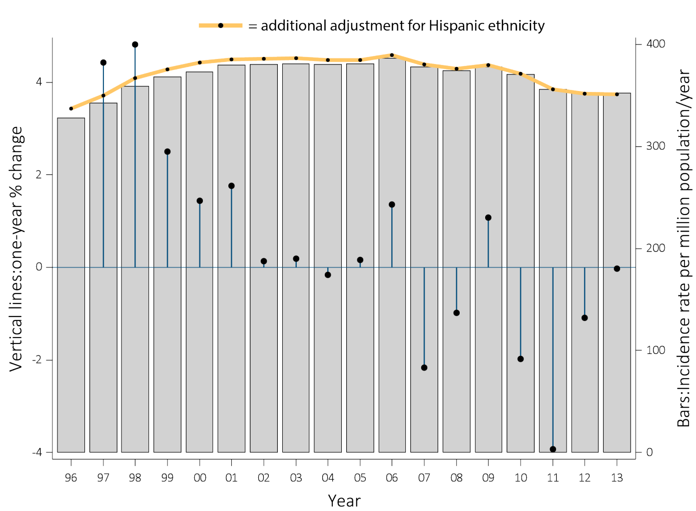
vol 2 Figure 1.1 Trends in the annual number of ESRD incident cases (in thousands) by modality, in the U.S. population, 1996-2013



Data Source: Reference Table D1. Abbreviation: ESRD, end-stage renal disease.

The incidence rate of ESRD virtually plateaued beginning in 2001, declined in all but one year between 2007 and 2012, and was essentially unchanged in 2013 (Figure 1.2). The adjusted incidence rate of 352 per million/year in 2013 was the lowest since 1997. These findings provide further indication that the sustained rise in ESRD incidence rate through the 1980s and 1990s has not continued.

vol 2 Figure 1.2 Trends in the adjusted* incidence rate (per million/year) of ESRD (bars; scale on right), and annual change (%) in the adjusted* incidence rate of ESRD (lines; scale on left) in the U.S. population, 1996-2013



*Data Source: Reference Table A.2(2) and special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

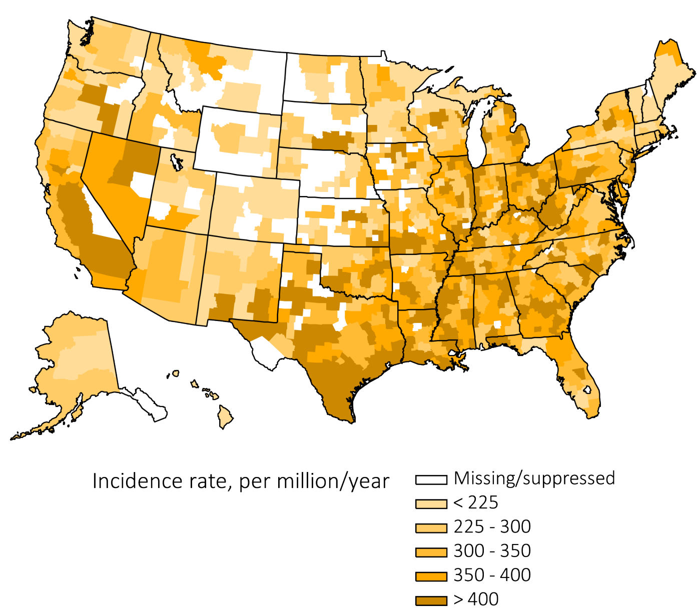
Incidence Rate: By Region

Variation in ESRD incidence rates among the 18 ESRD Networks remains substantial (Table 1.1). Adjusting for differences in age, sex, and race, the lowest rate was 244 per million/year in Network 1 (CT, MA, ME, NH, RI, VT), while the rate in Network 18 (S. CA) was 80% higher at 438 per million/year.

Among incident ESRD cases, mean age varied by over 4 years from 60.3 years in Network 6 to 64.7 years in Network 4. The distribution of race among incident cases continues to vary widely across networks. Black/African Americans constitute fewer than 10% of all incident cases in Networks 15 and 16, but nearly 50% in Networks 5 and 8 and 52% in Network 6. Hispanics constitute fewer than 5% of patients in eight networks, but approximately 40% in Networks 3, 14, and 18.

The adjusted incidence rate of ESRD in 2013 ranged across 677 Health Service Areas from a low of 48 per million/year to a high of 3,751 per million/year (interquartile range: 262 to 405 per million/year) (Figure 1.3). The rates were generally highest in parts of the Ohio and Mississippi River valleys, the Southeast, Texas, and California, and lowest in New England, the Northwest, and certain Upper Midwest and Rocky Mountain states.

vol 2 Figure 1.3 Map of the adjusted* incidence rate (per million/year) of ESRD, by Health Service Area, in the U.S. population, 2013



*Data Source: Special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

vol 2 Table 1.1 Adjusted* incidence rate (per million/year) of ESRD in the U.S. population, and distribution (%) of age, diabetes, sex, race, and ethnicity among incident ESRD cases by ESRD Network, 2013

Network	States in network	Rate per million / year	Total no. incident cases	% of incident cases	Mean age	% Diabetic	% Male	Race				Ethnicity
								% White	% Black / Af Am	% N Am	% Asian	% Hisp
1	CT, MA, ME, NH, RI, VT	244	3,600	3.1	64.3	41.6	61.1	83.4	13.3	0.1	3.1	8.8
16	AK, ID, MT, OR, WA	270	3,461	3.0	61.8	43.8	59.1	83.5	6.1	2.9	7.2	7.7
15	AZ, CO, NV, NM, UT, WY	294	5,519	4.7	61.3	47.0	58.3	81.5	6.8	7.5	3.8	24.5
7	FL	317	7,523	6.4	63.8	39.9	59.4	68.1	29.2	0.2	2.3	16.8
2	NY	323	7,005	6.0	64.0	43.9	60.0	63.5	29.5	0.2	6.4	14.5
5	MD, DC, VA, WV	326	6,508	5.6	62.7	37.6	57.3	52.5	43.9	0.0	3.3	2.8
6	NC, SC, GA	327	10,103	8.6	60.3	40.0	55.3	46.1	52.0	0.4	1.3	2.7
11	MI, MN, ND, SD, WI	335	7,329	6.3	63.5	39.2	58.4	73.4	21.5	2.5	2.4	3.3
12	IA, KS, MO, NE	336	4,358	3.7	63.3	41.2	56.9	77.7	20.4	0.4	1.4	4.3
17	N. CA, HI, GUAM, AS	344	5,665	4.8	62.4	50.6	57.7	56.8	11.5	0.4	30.9	20.4
4	DE, PA	353	5,403	4.6	64.7	41.8	58.5	74.2	24.3	0.0	1.3	3.9
8	AL, MS, TN	363	6,387	5.5	60.7	41.6	55.9	53.3	45.5	0.2	0.8	1.3
3	NJ, PR	374	5,091	4.3	64.1	48.4	59.6	72.4	23.7	0.0	3.6	36.1
13	AR, LA, OK	376	4,796	4.1	60.8	43.6	55.2	56.4	39.0	3.1	1.2	3.2
10	IL	389	5,211	4.4	63.8	40.2	56.6	68.6	28.3	0.0	2.6	10.4
9	IN, KY, OH	390	9,119	7.8	63.5	43.8	57.9	78.6	20.5	0.0	0.8	2.2
14	TX	436	10,336	8.8	60.4	53.3	57.0	74.5	22.8	0.1	2.4	39.9
18	S. CA	438	9,310	7.9	63.2	48.8	58.0	74.6	11.9	0.2	13.1	41.0
	All	352	117,162	100.0	62.5	43.9	57.8	67.7	26.2	0.9	4.9	14.8

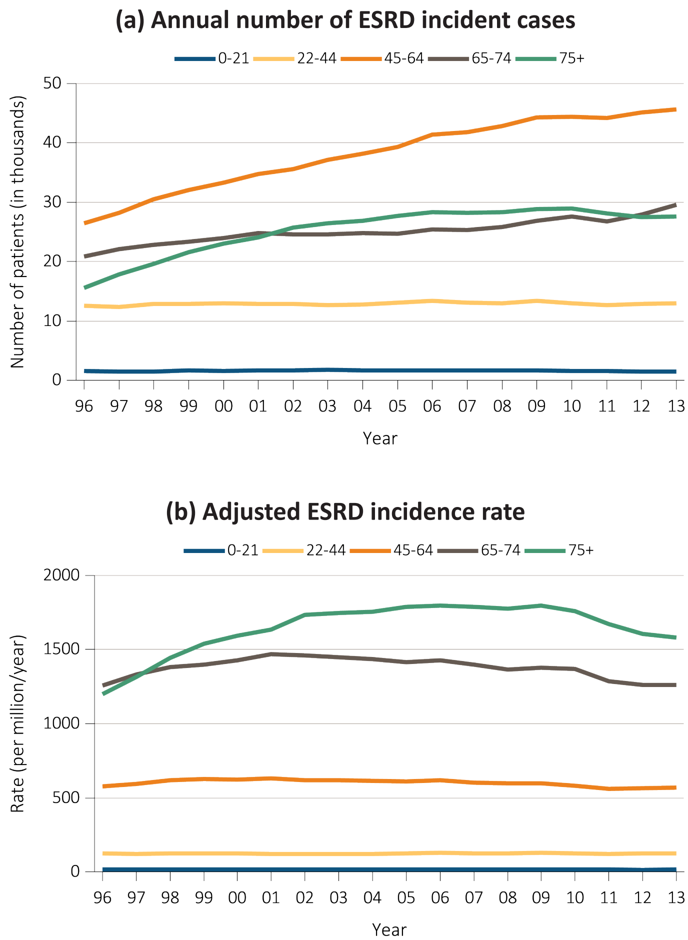
*Data Source: Reference Table A.10 and special analyses, USRDS ESRD Database. *Adjusted for age, sex, race, and ethnicity. The standard population was the U.S. population in 2011. Listed from lowest to highest rate per million/year. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; Hisp, Hispanic; N Am, Native American.*

Incidence Rate: By Age

The number of incident ESRD cases per year among those aged 0-21 and 22-44 years old has been generally stable for the past two decades (Figure 1.4.a.). By contrast, for ages 45 to 74, the number of incident ESRD cases per year has been rising for the past two decades, and continues to do so. For ages 75 and over, the number of incident ESRD cases had been rising steeply 10 to 20 years ago, but has been generally stable for the past decade.

Across age groups, adjusted ESRD incidence rates have been generally stable or fallen for a decade or more (Figure 1.4.b). Pronounced declines have been seen recently among ages 65 and over: among ages 65-74, the ESRD incidence rate is the lowest since 1996; and among ages 75 and over, the rate is the lowest since 1999.

vol 2 Figure 1.4 Trends in (a) annual number of ESRD incident cases (in thousands), and (b) adjusted* ESRD incidence rate (per million/year), by age group, in the U.S. population, 1996-2013



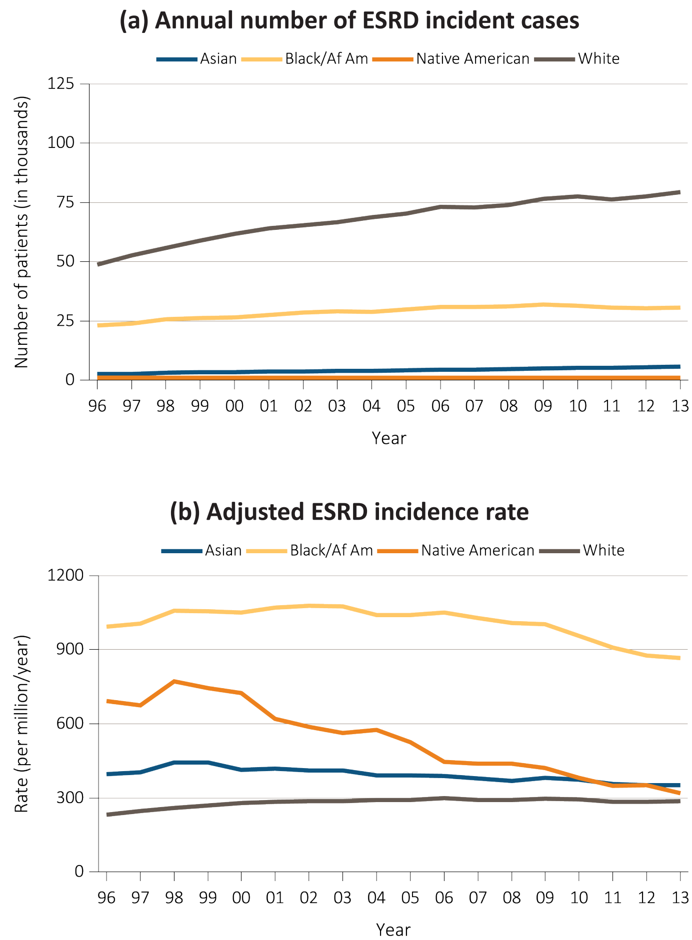
*Data Source: Reference Table A.1 and special analyses, USRDS ESRD Database. *Adjusted for sex and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

Incidence Rate: By Race and Ethnicity

The number of incident ESRD cases per year continues to rise slowly among Whites, although it appears to have plateaued among Blacks and Native Americans (Figure 1.5.a). The number of incident ESRD cases per year had been rising since 1996 across racial groups, but it has plateaued over the past two-to-five years among Whites, Blacks, and Native Americans (Figure 1.5.a). Among Asians, the number of incident ESRD cases appears still to be rising.

The ESRD incidence rates for Blacks, Native Americans, and Asians have declined over the nearly 20-year period shown in Figure 1.5.b. The decline has been greatest (over 2-fold) among Native Americans. Over the same period, the rate initially rose among Whites but has been generally stable since around 2000. The ratio of incidence rates for Blacks versus Whites decreased from 3.8 in 2000 to 3.0 in 2013. Similarly, the ratio of incidence rates for Asians versus Whites decreased from 1.5 to 1.2 during the same period; and the ratio of incidence rates for Native Americans versus Whites decreased from 2.6 to 1.1.

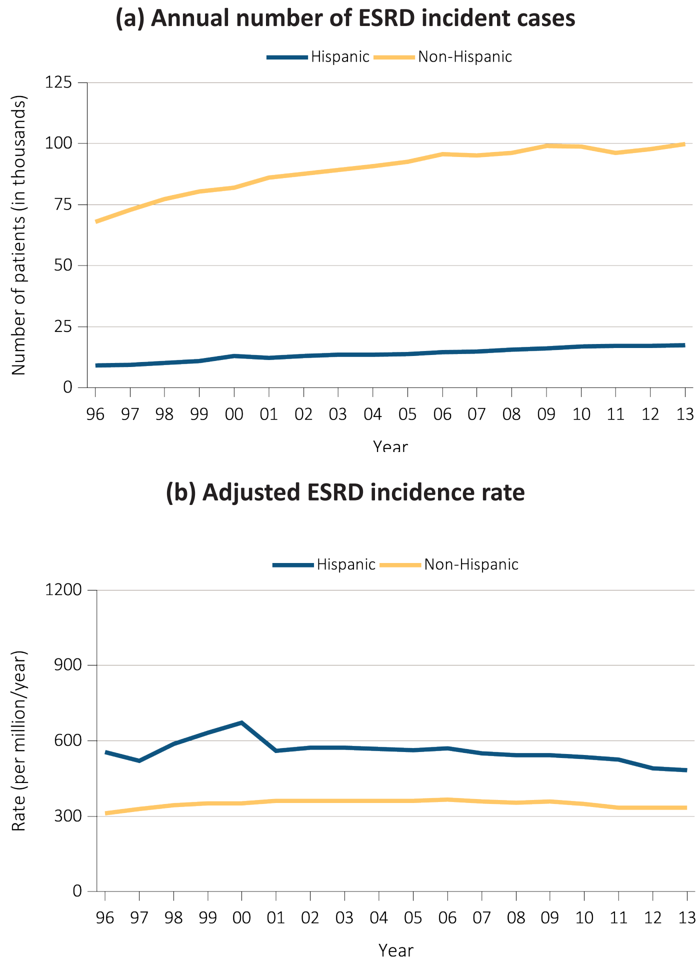
vol 2 Figure 1.5 Trends in (a) annual number of ESRD incident cases (in thousands), and (b) adjusted* ESRD incidence rate (per million/year), by *race*, in the U.S. population, 1996-2013



*Data Source: Reference Table A.1 and special analyses, USRDS ESRD Database. *Adjusted for age and sex. The standard population was the U.S. population in 2011. Abbreviations: Af Am, African American; ESRD, end-stage renal disease.*

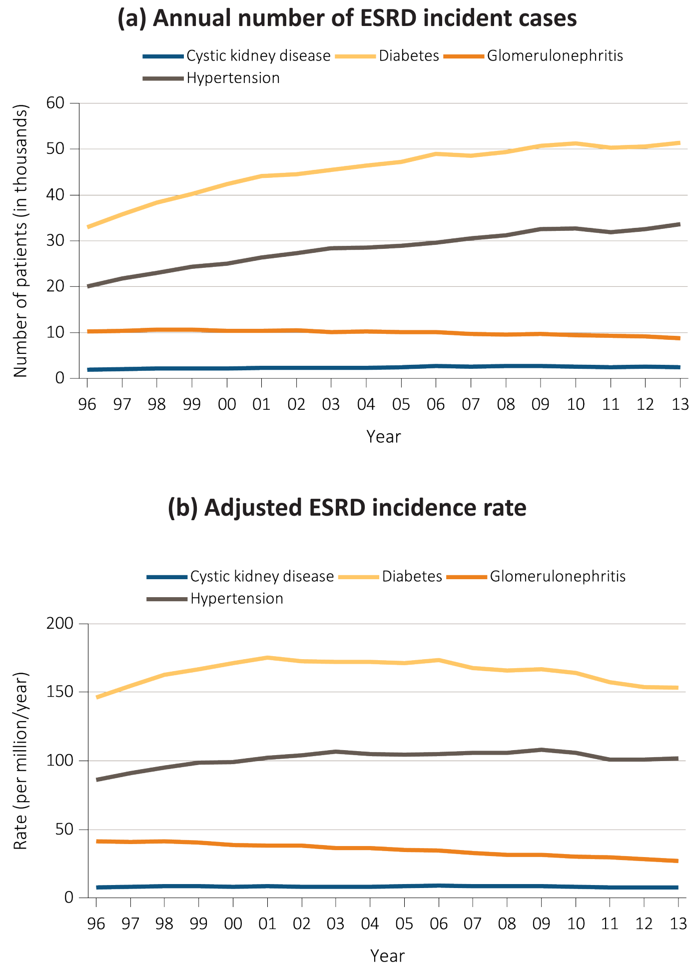
Among both Hispanic and non-Hispanic populations, the number of incident ESRD cases per year had been rising since data were first available in 1996, but this rise has been less evident over the past three to five years (Figure 1.6.a). For both groups, ESRD incidence rates have been stable or somewhat declining since 2001 (Figure 1.6.b). However, the ESRD incidence rate remains nearly 50% higher among Hispanics than non-Hispanics.

vol 2 **Figure 1.6 Trends in (a) annual number of ESRD incident cases (in thousands), and (b) adjusted* ESRD incidence rate (per million/year), by Hispanic ethnicity, in the U.S. population, 1996-2013**



*Data Source: Reference Tables A.1, A.2(2). *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

vol 2 **Figure 1.7 Trends in (a) annual number of ESRD incident cases (in thousands), and (b) adjusted* ESRD incidence rate (per million/year), by primary cause of ESRD, in the U.S. population, 1996-2013**



*Data Source: Reference Table A.1 and special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

Incidence Rate: By Primary Cause of ESRD

The number of incident ESRD cases per year with diabetes or hypertension listed as the primary cause had been rising rapidly, but they have been generally stable over the past five years (Figure 1.7.a). The number with glomerulonephritis listed as the primary cause of ESRD has declined since the 1990s, while the number with cystic kidney disease listed as the primary cause has been generally stable over this period.

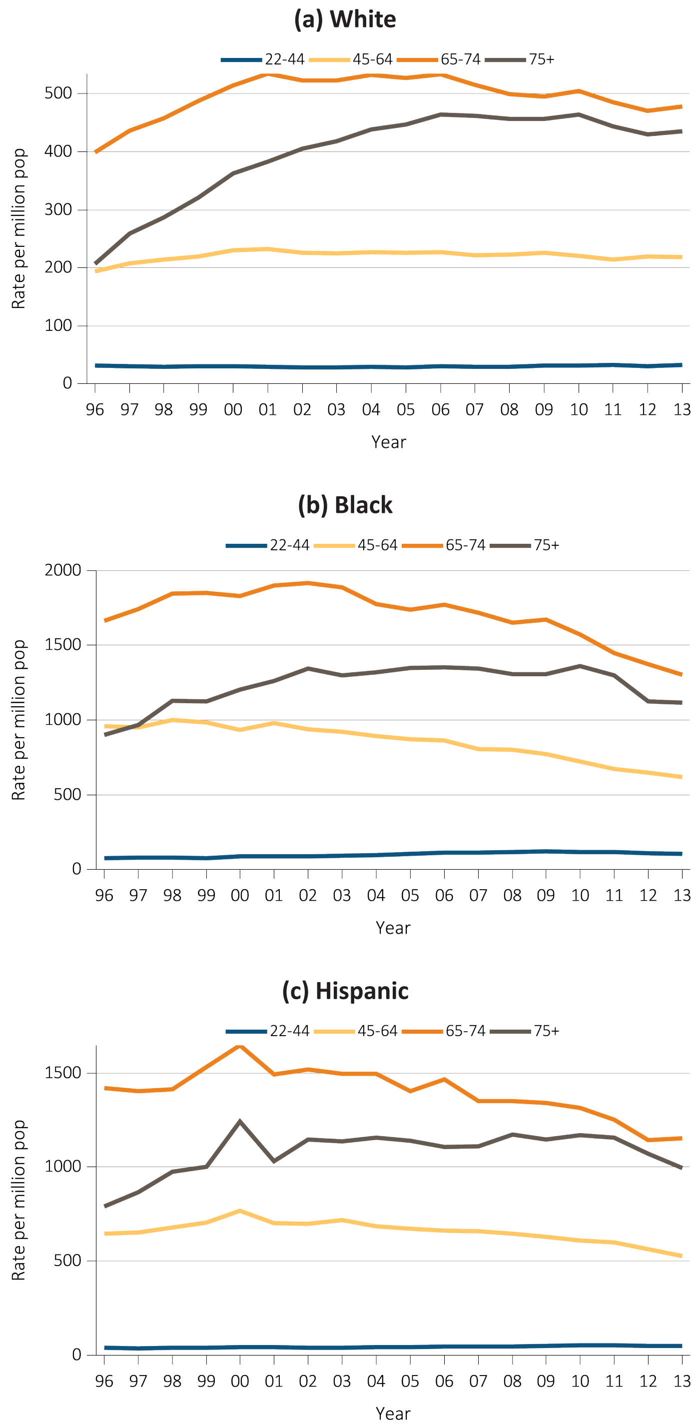
Since 1997, the rate of new ESRD cases with diabetes listed as the primary cause plateaued in 2001 and has declined in most subsequent years, with the lowest rate in 2013 (Figure 1.7.b). The rate with ESRD due to hypertension plateaued in 2003 and has been quite stable since then. The rate due to glomerulonephritis has fallen steadily since the 1990s, while the rate due to cystic disease has remained stable.

Diabetes as Primary Cause of ESRD, By Patient Characteristics

The incidence rate of ESRD due to diabetes as the primary cause is, as expected, higher for ages 65 and older than for younger age groups among Whites (Figure 1.8.a) and Blacks (Figure 1.8.b) and among Hispanics (Figure 1.8.c). Among individuals aged 20-44 years, these rates have been generally stable or slightly increased. In older individuals, rates have declined among White, Black, and Hispanic groups.

Incidence rates of ESRD due to diabetes were several-fold higher in Blacks, compared to Whites, within each age category. These racial differences in the incidence rate of ESRD due to diabetes are generally similar to those seen for overall ESRD incidence rates. Among Hispanics, the incidence rates of ESRD due to diabetes are comparable to Whites aged 22-44 years, but much higher than for Whites aged 44 and over. Across age categories, incidence rates in Hispanics are lower than the rates in Blacks.

vol 2 Figure 1.8 Trends in the sex-adjusted incidence rate (per million/year) of ESRD due to diabetes as the primary cause, by age and race (a & b), and by age and ethnicity (c), in the U.S. population, 1996-2013



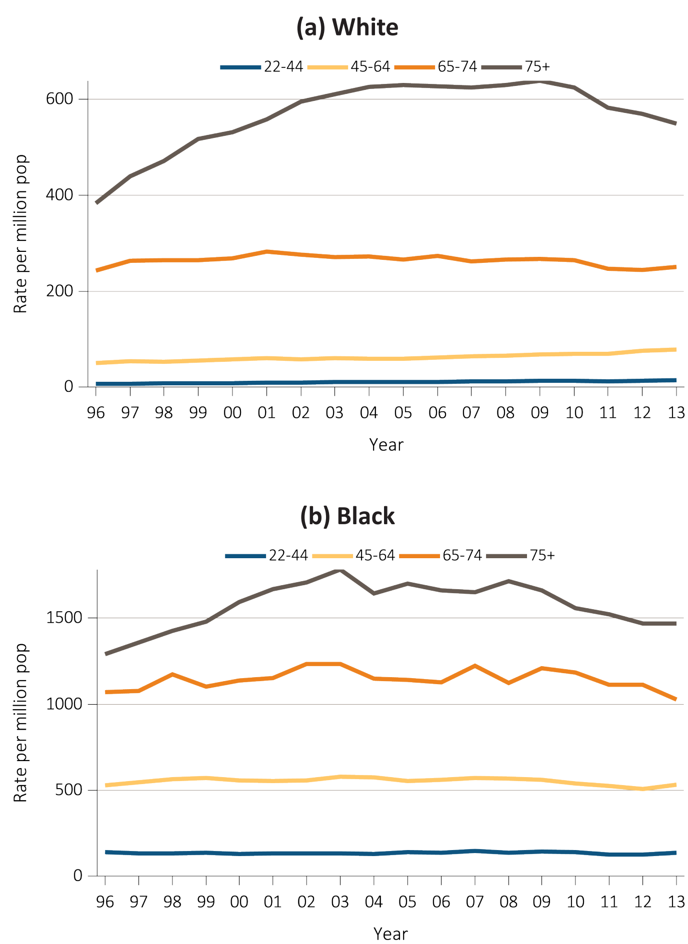
*Data Source: Special analyses, USRDS ESRD Database. *Adjusted for sex. The standard population was the U.S. population in 2011. Abbreviations: ESRD, end-stage renal disease.*

Hypertension as Primary Cause of ESRD, by Patient Characteristics

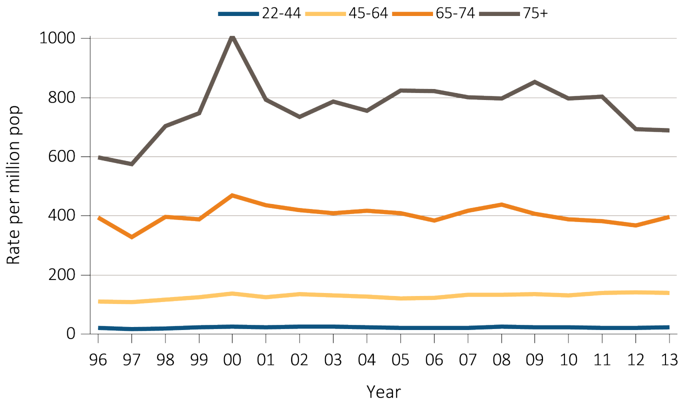
The incidence rate of ESRD with hypertension listed as the primary cause increases with age among White and Black racial groups and among Hispanics (Figure 1.9). In contrast to incidence rates of ESRD with diabetes listed as the primary cause, these rates are substantially higher at age 75 and older than at 65-74 years of age. Rates have been quite stable over the past two decades, with some decline in recent years in older age groups.

Within each age category, the incidence rate of ESRD with hypertension listed as the primary cause is dramatically higher among Blacks than among other racial/ethnic groups. Compared to Whites, incident rates among Blacks in 2013 were over 10-fold higher in younger age categories, 4-fold higher at ages 65-74, and nearly 3-fold higher at age 75 and over.

vol 2 Figure 1.9 Trends in the sex-adjusted incidence rate (per million/year) of ESRD due to hypertension as the primary cause, by (a & b) age and race, and by (c) age and ethnicity, in the U.S. population, 1996-2013



(c) Hispanic



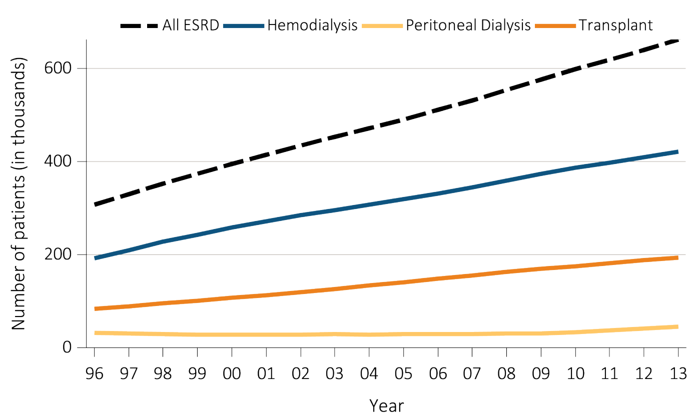
*Data Source: Special analyses, USRDS ESRD Database. *Adjusted for sex. The standard population was the U.S. population in 2011. Abbreviations: ESRD, end-stage renal disease.*

Prevalence of ESRD: Counts, Prevalence, and Trends

Overall Prevalence

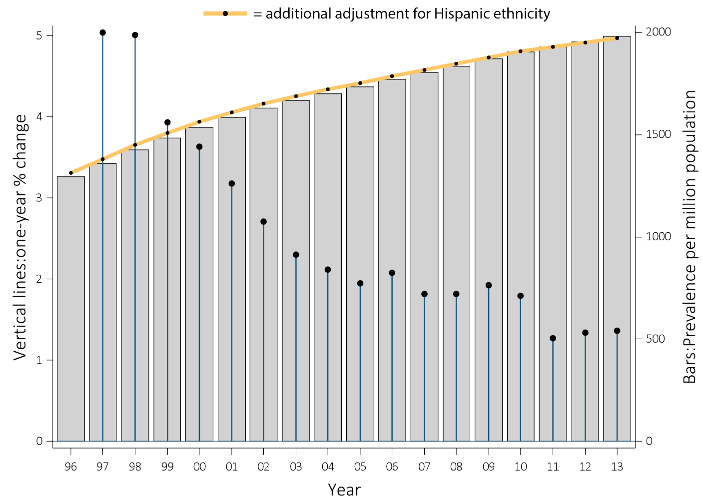
On December 31, 2013, there were 661,648 prevalent cases of ESRD in the United States, an increase of 3.5% since 2012 and an increase of 68% since 2000 (Figure 1.10). The ESRD prevalence reached 1,981 per million (~0.20%), an increase of 1.4% since 2012 and an increase of 29% since 2000 (Figure 1.11). The size of the prevalent dialysis population (hemodialysis and peritoneal dialysis) increased 4% in 2013, reaching 466,607, and is now 63.2% larger than in 2000. The size of the transplant population rose 3.1% in 2013 to 193,262 patients and is now 81.0% larger than in 2000.

vol 2 **Figure 1.10 Trends in the number of ESRD prevalent cases (in thousands) by modality, in the U.S. population, 1996-2013**



Data Source: Reference Table D.1. Abbreviation: ESRD, end-stage renal disease.

vol 2 **Figure 1.11 Trends in the adjusted* ESRD prevalence (per million) (bars; scale on left), and annual change (%) in adjusted* prevalence of ESRD (lines; scale on right), in the U.S. population, 1996-2013**



*Data Source: Reference Table B.2(2) and special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

Prevalence: By Region

There was a 2-fold variation in dialysis prevalence among the 18 ESRD Networks, from a low of 944 per million in Network 16 to a high of 1,855 per million in Network 8 (Table 1.2). Among prevalent dialysis cases, mean age varied by nearly 5 years, from 54.8 years in Network 6 to 59.2 years in Network 1. The distribution of patients by race continues to vary widely across Networks. Blacks/African Americans, for example, constitute just 8.4% percent of the prevalent dialysis population in Network 16 but 65.7 % of patients in Network 6. This variability probably reflects, to some extent but not entirely, the racial/ethnic distributions of the network populations.

vol 2 **Table 1.2 Adjusted* prevalence (per million) of dialysis in the U.S. population, and distribution (%) of age, diabetes, sex, race, and ethnicity among prevalent dialysis patients, by ESRD Network, 2013**

Network	States in network	Prevalence per million	Total no. prevalent dialysis cases	% of prevalent dialysis cases	Mean age	% Diabetic	% Male	Race				Ethnicity
								% White	% Black / Af Am	% N Am	% Asian	% Hisp
16	AK, ID, MT, OR, WA	944	13,373	2.9	56.5	43.1	57.1	79.1	8.4	3.2	9.1	11.2
1	CT, MA, ME, NH, RI VT	982	14,042	3.0	59.2	39.9	58.2	75.3	20.6	0.2	3.5	12.0
15	AZ, CO, NV, NM, UT, WY	1,095	22,233	4.7	56.6	50.6	57.3	73.8	10.1	11.5	4.5	31.0
12	IA, KS, MO, NE	1,128	15,683	3.3	57.7	40.7	56.4	68.7	29.0	0.6	1.6	5.8
11	MI, MN, ND, SD, WI	1,188	27,191	5.8	58.0	40.9	56.7	63.0	31.0	2.8	3.1	4.7
9	IN, KY, OH	1,415	32,196	6.9	57.6	43.7	56.2	66.3	32.6	0.1	0.9	2.9
4	DE, PA	1,420	19,325	4.1	58.6	40.5	57.7	63.4	34.7	0.1	1.7	5.2
7	FL	1,434	28,218	6.0	57.9	39.8	57.6	57.3	40.1	0.2	2.2	17.6
2	NY	1,485	29,272	6.2	58.1	40.7	57.5	53.4	38.1	0.4	7.1	16.4
10	IL	1,555	19,987	4.3	57.5	38.8	56.2	56.9	39.3	0.0	3.5	14.8
5	MD, DC, VA, WV	1,588	26,760	5.7	56.6	38.1	56.0	39.2	57.3	0.1	3.3	4.1
17	N. CA, HI, GUAM, AS	1,607	26,043	5.6	57.0	49.3	55.6	51.7	14.1	0.6	33.1	25.0
13	AR, LA, OK	1,620	18,543	4.0	55.0	42.3	53.8	43.4	51.4	3.8	1.3	3.9
14	TX	1,656	44,189	9.4	55.2	52.8	54.8	68.9	28.5	0.1	2.4	45.2
18	S. CA	1,672	40,522	8.7	57.0	48.8	57.9	70.9	14.7	0.3	13.8	48.1
3	NJ, PR	1,674	19,203	4.1	58.7	46.7	59.2	64.3	30.9	0.0	3.6	38.2
6	NC, SC, GA	1,780	44,475	9.5	54.8	39.3	54.5	32.5	65.7	0.5	1.3	3.0
8	AL, MS, TN	1,855	26,114	5.6	55.1	40.5	54.2	38.2	60.6	0.3	0.8	1.3
	All	1,425	468,386	100.0	56.9	43.6	56.3	57.8	35.2	1.2	5.5	17.9

*Data Source: Special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Listed from lowest to highest prevalence per million. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; Hisp, Hispanic; N Am, Native American.*

The adjusted prevalence of kidney transplant patients varied by nearly 45% among the ESRD Networks, from 512 per million in Network 13 and 14 to 737 per million in Network 11 (Table 1.3) Differences in the racial/ethnic distribution between transplant and dialysis patients by ESRD Network raise the possibility of disparities in access to kidney transplants or transplant care. For example, Blacks account for 65.7% of prevalent dialysis patients, but only 41.2% of prevalent transplant patients in Network 6.

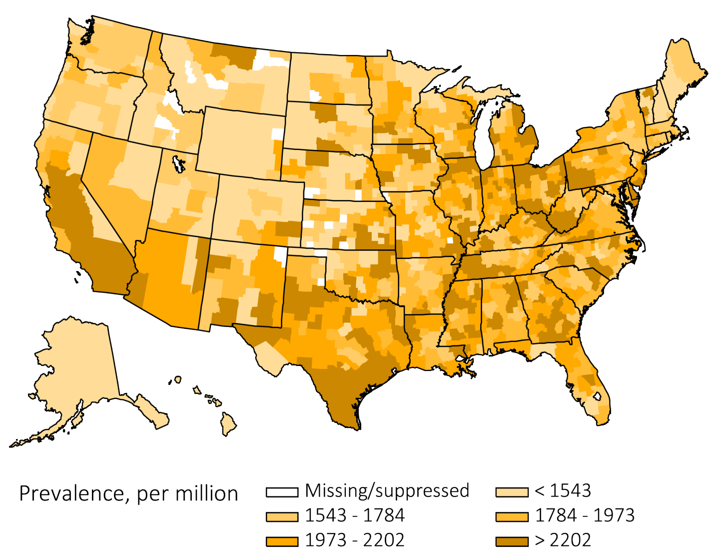
vol 2 Table 1.3 Adjusted* prevalence (per million) of kidney transplant patients in the U.S. population, and distribution (%) of age, diabetes, sex, race, and ethnicity among prevalent transplant patients, by ESRD Network, 2013

Network	States in network	Prevalence per million	Total no. prevalent kidney transplant cases	% of prevalent kidney transplant cases	Mean age	% Diabetic	% Male	Race				Ethnicity
								% White	% Black / Af Am	% N Am	% Asian	% Hisp
13	AR, LA, OK	512	5,779	3.0	41.4	23.6	60.2	65.5	30.1	2.2	2.0	3.6
14	TX	512	13,553	7.0	40.7	25.4	58.3	77.7	18.0	0.2	3.7	37.8
18	S. CA	521	12,319	6.4	40.3	20.8	59.0	75.7	10.4	0.3	13.0	41.1
6	NC, SC, GA	522	13,061	6.8	41.8	21.8	58.4	55.2	41.2	0.7	2.2	3.2
7	FL	535	10,578	5.5	43.9	21.3	59.1	72.1	23.1	0.3	3.6	19.5
16	AK, ID, MT, OR, WA	539	7,664	4.0	42.1	23.0	58.9	83.8	5.3	1.6	8.7	7.5
15	AZ, CO, NV, NM, UT, WY	552	11,101	5.7	42.5	28.4	58.8	84.4	5.7	5.1	4.4	23.6
8	AL, MS, TN	571	8,099	4.2	40.7	20.8	59.8	60.5	37.8	0.1	1.3	1.6
9	IN, KY, OH	579	13,151	6.8	41.9	24.0	60.5	80.2	17.7	0.1	1.4	2.6
1	CT, MA, ME, NH, RI VT	599	8,737	4.5	42.6	20.2	61.1	83.4	11.5	0.3	3.6	8.5
2	NY	618	12,519	6.5	42.7	21.1	59.5	65.8	23.5	0.7	7.0	18.5
12	IA, KS, MO, NE	618	8,547	4.4	42.0	23.0	60.6	83.2	13.9	0.4	2.1	5.2
17	N. CA, HI, GUAM, AS	652	10,489	5.4	41.8	22.1	58.9	63.5	9.2	0.6	24.6	24.9
4	DE, PA	662	9,049	4.7	43.3	22.6	60.2	75.4	21.1	0.2	2.5	4.3
3	NJ, PR	666	7,527	3.9	43.1	23.7	62.0	65.3	20.4	0.2	5.6	29.7
5	MD, DC, VA, WV	667	11,098	5.7	43.1	21.9	59.4	55.6	38.6	0.2	4.9	4.7
10	IL	725	9,317	4.8	42.0	23.2	59.5	71.0	23.0	0.3	4.3	14.9
11	MI, MN, ND, SD, WI	737	16,706	8.6	42.5	25.6	60.6	80.2	14.2	1.8	3.5	3.4
	All	582	193,262	100.0	42.0	22.6	59.7	71.3	19.8	0.9	5.8	14.5

*Data Source: Special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Listed from lowest to highest prevalence per million. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; Hisp, Hispanic; N Am, Native American.*

The adjusted prevalence of ESRD in 2013 ranged across 786 Health Service Areas from a low of 533 per million to a high of 7,717 per million (interquartile range: 1,640 to 2,217 per million) (Figure 1.12). ESRD prevalence in 2013 was generally highest in parts of the Ohio and Mississippi River valleys, the Southeast, Texas, and California, and was lowest in New England, the Northwest, and certain Upper Midwest and Rocky Mountain regions. These patterns were roughly similar to patterns of ESRD incidence shown earlier in this chapter in Figure 1.3.

vol 2 Figure 1.12 Map of the adjusted* prevalence (per million) of ESRD, by Health Service Area, in the U.S. population, 2013**



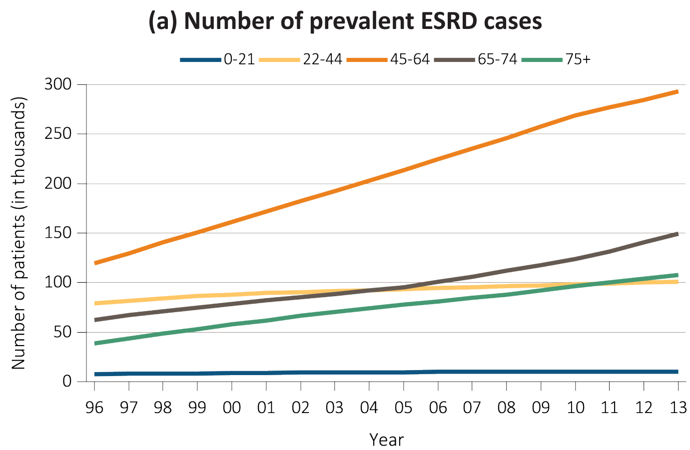
*Data Source: Special analyses, USRDS ESRD Database. *Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. **Three Health Service Areas were suppressed because the ratio of unadjusted rate to adjusted rate or adjusted rate to unadjusted rate was greater than 3. Abbreviation: ESRD, end-stage renal disease.*

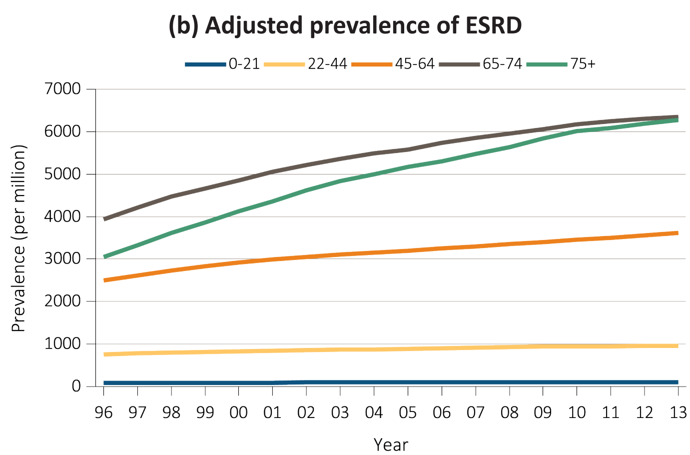
Prevalence: By Age

The number of prevalent ESRD cases continues to increase in all age groups, except among patients aged 0-21 years, with a steeper increase among patients aged 45-64 years (Figure 1.13.a). With the recent leveling off of the number of incident ESRD cases, the continuing rise in ESRD prevalence is due largely to longer survival among ESRD patients in recent years.

In 2013, the adjusted prevalence of ESRD per million was 104 for ages 0-21, 959 for ages 22-44, 3,624 for ages 45-64, 6,347 for ages 65-74, and 6,275 for ages 75 and over (Figure 1.13.b).

vol 2 **Figure 1.13 Trends in (a) number of prevalent ESRD cases (in thousands) and (b) the adjusted* prevalence (per million) of ESRD, by age group, in the U.S. population, 1996-2013**



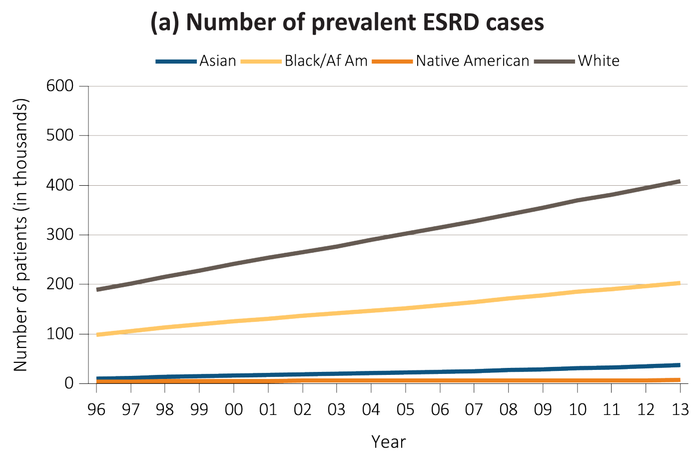


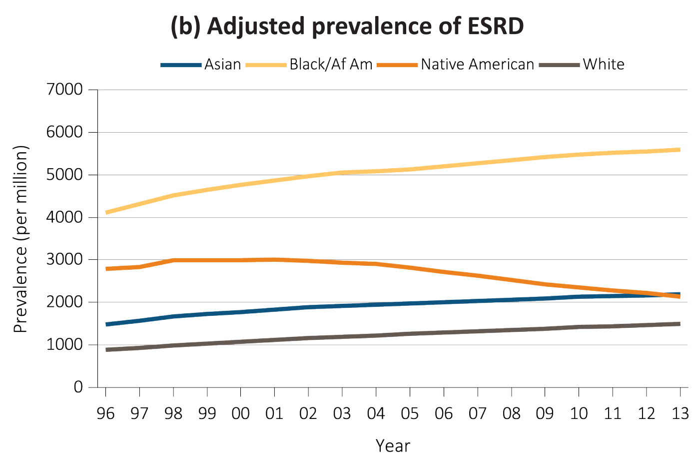
*Data Source: Reference Table B.1 and special analyses, USRDS ESRD Database. *Point prevalence on December 31 of each year. Adjusted for sex and race. The standard population was the U.S. population in 2011. Abbreviations: ESRD, end-stage renal disease.*

Prevalence: By Race and Ethnicity

The number of prevalent ESRD cases, as well as adjusted prevalence, continues to rise among Whites, Blacks, and Asian Americans (Figure 1.14.a and b). However, the remarkable decline in incidence rates among Native Americans has resulted in a 29% decline in the prevalence of ESRD in this population since 2000. This represents the only instance, since the beginning of ESRD care in 1973, of a decline in adjusted prevalence for a major racial group. In 2013, the prevalence per million was 5,584 among Black/African Americans, 2,133 among Native Americans, 2,196 among Asians, and 1,499 among Whites (Figure 1.14.b). The prevalence per million remains much higher in Blacks than in other racial groups, at nearly 2.6-fold higher than Native Americans and Asians, and nearly 4-fold higher than Whites.

vol 2 **Figure 1.14 Trends in (a) number of prevalent ESRD cases (in thousands) and (b) the adjusted* prevalence (per million) of ESRD, by race, in the U.S. population, 1996-2013**

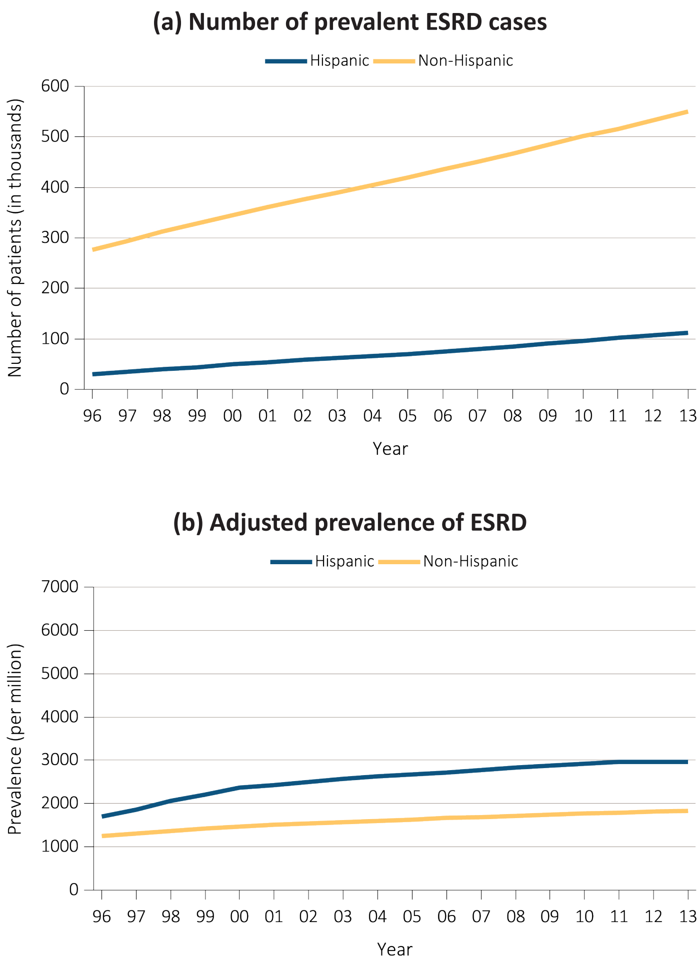




*Data Source: Reference Table B.1 and special analyses, USRDS ESRD Database. *Point prevalence on December 31 of each year. Adjusted for age and sex. The standard population was the U.S. population in 2011. Abbreviations: Af Am, African American; ESRD, end-stage renal disease.*

The number of prevalent ESRD cases, as well as adjusted prevalence, has continued to rise for both non-Hispanics and Hispanics (Figure 1.15). In 2013, the adjusted prevalence was 1,838 per million among non-Hispanics and nearly 62% higher, at 2,970 per million, among Hispanics.

vol 2 Figure 1.15 Trends in (a) number of prevalent ESRD cases (in thousands) and (b) the adjusted* prevalence (per million) of ESRD, by Hispanic ethnicity, in the U.S. population, 1996-2013

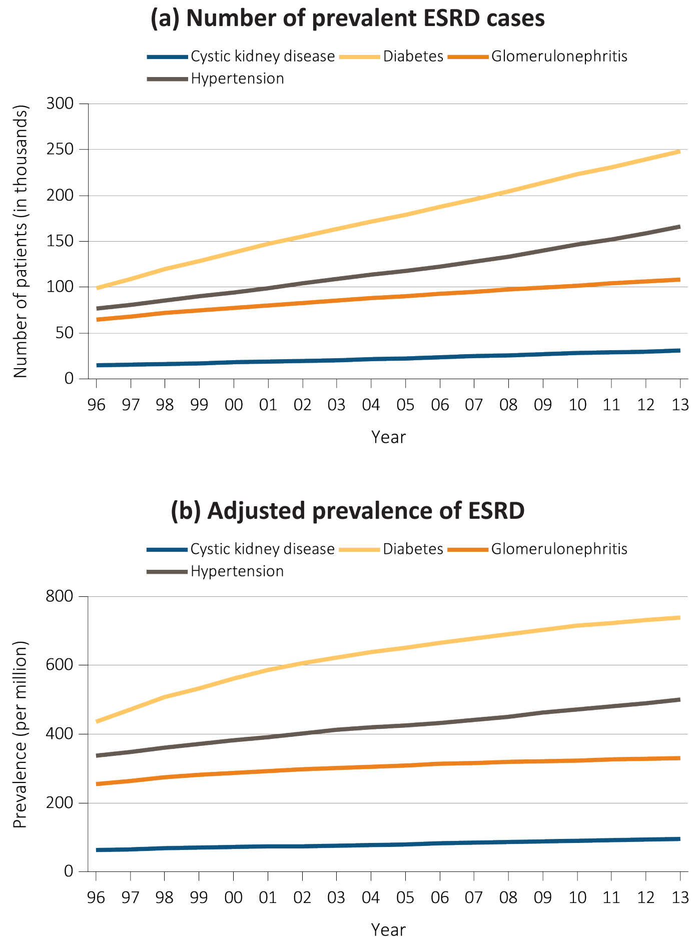


*Data Source: Reference Tables B.1, B.2(2). *Point prevalence on December 31 of each year. Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

Prevalence: By Primary Cause of ESRD

The number of prevalent ESRD cases with diabetes, hypertension, glomerulonephritis, or cystic kidney disease listed as the primary cause has continued to rise since 1996 (Figure 1.16.a), despite the recent stabilization of incidence rates. The prevalence also continues to rise for these causes of ESRD (Figure 1.16.b). For diabetes as the primary cause, the increase in prevalence was slower over approximately the last decade than it had been previously.

vol 2 Figure 1.16 Trends in (a) number of prevalent ESRD cases (in thousands) and (b) adjusted* prevalence (per million) of ESRD, by primary cause of ESRD, in the U.S. population, 1996-2013



*Data Source: Reference Table B.1 and special analyses, USRDS ESRD Database. *Point prevalence on December 31 of each year. Adjusted for age, sex, and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.*

Patient and Treatment Characteristics at ESRD Onset

Pre-ESRD Care

Twenty-five (25) percent of patients starting ESRD therapy in 2013 were reported on CMS Form 2728 as not having received nephrology care prior to ESRD start (Table 1.4). This reflects little decline from 26% in 2012. An additional 13% had unknown duration of pre-ESRD nephrology care. Because treatment characteristics (e.g., ESA use and dietary care) for this group were similar to those for no pre-ESRD nephrology care, one may assume that up to 38% of new ESRD cases received little or no pre-ESRD nephrology care (Table 1.4.a).

Several differences are notable in the distributions of pre-ESRD nephrology care by patient characteristics. Young patients (0-21) were most likely (43%), and adults aged 22-64 years were least likely (27%), to have had longer duration (12 months or more) of pre-ESRD nephrology care. African Americans were somewhat less likely to have had pre-ESRD care than were other racial groups, and Hispanics were less likely to have had pre-ESRD care than were non-Hispanics.

ESRD patients with a primary etiologic diagnosis of glomerulonephritis or cystic kidney disease were more likely to have had pre-ESRD nephrology care than were patients with a diagnosis of diabetes or hypertension. Having no nephrology care was most common for patients with hypertension as the primary cause of ESRD; one could surmise that some patients initially presenting at, or near, ESRD might be assigned this diagnosis in the absence of evidence of other possible etiologies.

Patients receiving longer pre-ESRD nephrology care were relatively more likely to use an ESA before ESRD, receive dietary care before ESRD, and start dialysis with an arteriovenous fistula (AV) fistula rather than a central venous catheter (Table 1.4.b). Patients receiving longer pre-ESRD nephrology care were less likely to start dialysis at either very low eGFR levels (<5 ml/min/1.73 m^2) or very high (≥15 ml/min/1.73 m^2)eGFR levels.

vol 2 Table 1.4 Distribution (%) of the reported duration of pre-ESRD nephrology care, by (a) demographic and (b) clinical characteristics, among incident ESRD cases in the U.S. population, 2013

(a) Demographic characteristics (% within row)

	n	>12 mo.	6-12 mo.	0-6 mo.	None	Unknown
Total	114,417	30.0	18.6	13.2	25.3	12.6
Age						
0-21	1,550	42.8	14.6	14.2	21.9	6.3
22-44	12,946	26.7	16.9	13.6	31.1	11.5
45-64	44,268	27.9	18.6	13.5	27.3	12.4
65-74	28,554	31.8	19.5	13.1	22.5	12.7
75+	27,099	32.4	18.6	12.7	22.3	13.7
Sex						
Female	48,833	30.1	18.8	13.3	24.6	12.9
Male	65,584	30.0	18.5	13.2	25.7	12.4
Race						
Native American	1,147	28.2	20.3	17.0	26.1	8.4
Asian	5,785	30.1	19.9	13.8	22.7	13.2
Black	31,202	25.9	18.5	12.9	28.0	14.5
White	76,271	31.8	18.6	13.3	24.3	11.9
Other/Unknown	12	*	*	*	*	*
Ethnicity						
Non-Hispanic	98,367	31.2	18.7	13.2	24.4	12.2
Hispanic	16,050	23.1	17.9	13.8	30.2	14.9
Primary Diagnosis						
Diabetes	52,354	30.9	20.7	13.7	22.2	12.3
Hypertension	34,104	26.6	18.2	13.1	26.8	15.2
Glomerulonephritis	9,016	39.8	17.5	12.7	22.5	7.4
Cystic kidney	2,557	57.9	16.5	9.8	9.5	6.0
Other/Unknown	16,386	24.5	13.6	12.8	35.8	12.3

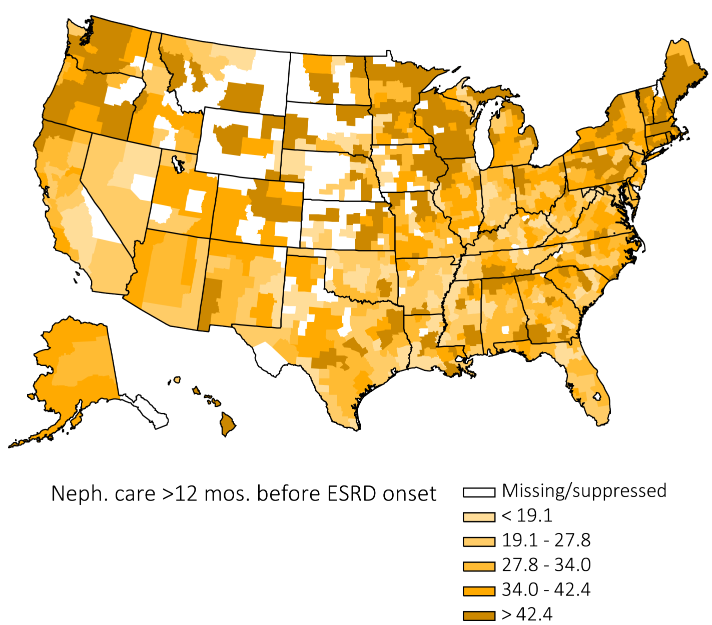
(b) Clinical characteristics (% within column)

	n	>12 mo.	6-12 mo.	0-6 mo.	None	Unknown
Total	114,417	100.0	100.0	100.0	100.0	100.0
Dietary care						
No	105,311	85.7	89.2	88.3	99.7	99.8
Yes	9,106	14.3	10.8	11.7	0.3	0.2
ESA use						
No	96,661	72.0	78.9	80.6	98.2	98.9
Yes	17,756	28.0	21.1	19.4	1.8	1.1
eGFR at RRT start						
<5	15,660	11.1	11.5	12.4	19.0	13.7
5-<10	52,610	48.8	47.6	45.8	43.2	42.9
10-<15	31,548	29.2	29.4	29.1	24.0	26.7
≥15	14,436	10.8	11.5	12.7	13.6	16.5
Vascular Access						
AV fistula	17,115	26.9	20.1	11.2	2.5	8.1
AV graft	2,884	3.7	3.2	2.4	1.0	1.8
CV Catheter only	60,908	32.2	41.6	55.4	77.4	70.3
CVC with maturing fistula/graft	20,233	18.1	20.7	19.3	15.2	15.6
Other/Unknown	13,277	19.1	14.4	11.7	3.8	4.2

*Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. *Count ≤10. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m²) for those aged ≥18 years and the Schwartz equation for those aged <18 years. Abbreviations: CKD-EPI, chronic kidney disease epidemiology calculation; eGFR, estimated glomerular filtration rate; ESA, erythropoiesis-stimulating agents; RRT, renal replacement therapy.*

The proportion of incident ESRD cases in 2013 with >12 months of pre-ESRD nephrology care was 30% in the US; it varied substantially across 677 Health Services Areas, ranging from a low of 0% to a high of 75% (interquartile range: 24 to 42%) (Figure 1.17). Health Service Areas with the greatest proportions of patients with >12 months of pre-ESRD care were clustered in the Northeast, Upper Midwest, and Northwest, where over 40 percent of patients were under a nephrologists care for more than one year prior to ESRD.

vol 2 **Figure 1.17 Percent of incident cases who had received >12 months of pre-ESRD nephrology care, by Health Service Area, 2013**

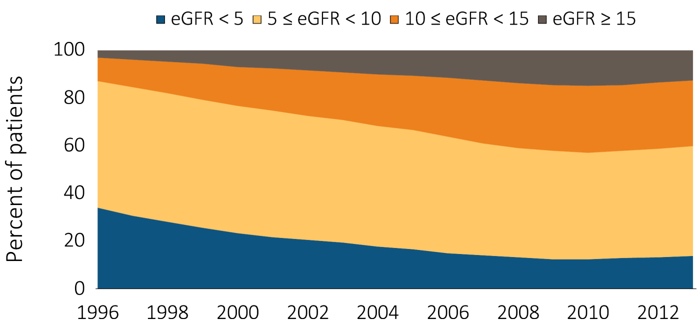


Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. Abbreviations: ESRD, end-stage renal disease; Neph., nephrology.

eGFR at ESRD Onset

Figure 1.18 shows that the percentage of incident ESRD cases who were initiated on renal replacement therapy at higher eGFR levels increased steadily from 1996 until 2009, but has been stable or decreased slightly from 2010 to 2013. For example, the percent of incident ESRD cases who started with eGFR at ≥10 ml/min/1.73 m² rose from 12.9% in 1996 to 43.0% in 2010, but decreased to 40.2% in 2013. In parallel, the percent of incident ESRD cases who started therapy at eGFR <5 ml/min/1.73 m² decreased from 33.9% in 1996 to 12.4% in 2010, then increased to 13.7% in 2013.

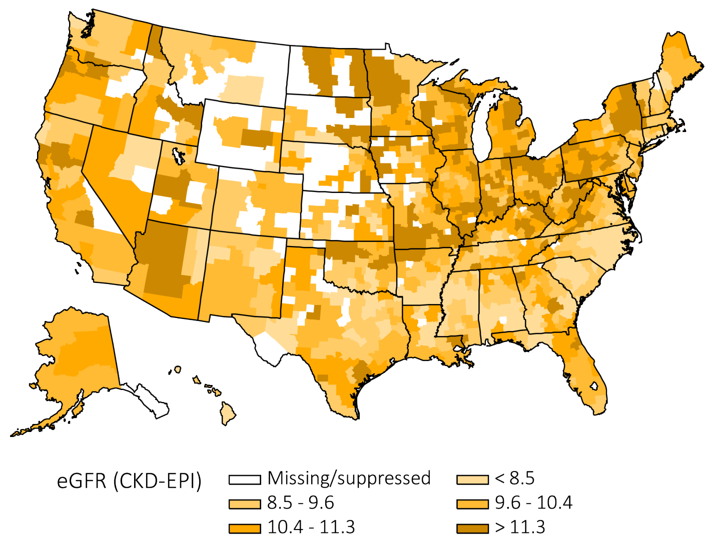
vol 2 Figure 1.18 Trends in the distribution (%) of eGFR (ml/min/1.73 m²) among incident ESRD patients, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m²) for those aged ≥18 and the Schwartz equation for those aged <18. Abbreviations: CKD-EPI; chronic kidney disease epidemiology calculation; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease.

Mean eGFR at ESRD start was higher among young patients (0-21), males, White, non-Hispanic, or with diabetes as the primary cause of ESRD (Table 1.5). Mean eGFR at ESRD start in 2013 varied substantially by Health Service Area (Figure 1.19). Perhaps the most striking geographic patterns are the prominence of Health Service Areas with higher average eGFRs at initiation of ESRD in the North and Midwest regions and Health Service Areas with lower average eGFRs at ESRD start in the South. Regional variation in eGFR at initiation does not seem to be related to length of time with pre-ESRD nephrology care (Table 1.6).

vol 2 Figure 1.19 Map of average eGFR at initiation of renal replacement therapy, by Health Service Area, 2013



Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m²) for those aged ≥18 and the Schwartz equation for those aged <18. Abbreviations: eGFR, estimated glomerular filtration rate; CKD-EPI, chronic kidney disease epidemiology calculation.

Anemia at ESRD Onset

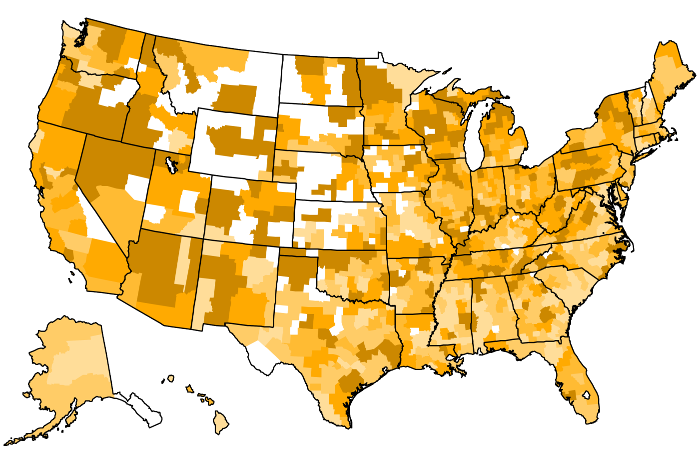
The overall mean hemoglobin level at ESRD onset in 2013 was 9.6 g/dL. Incident ESRD cases with cystic kidney disease as the primary cause had higher mean hemoglobin levels at ESRD onset than did other ESRD cases (Table 1.5). Figure 1.20 shows the distribution of mean hemoglobin levels by Health Service Area across the United States. There appears to be large Health Service Areas with higher average hemoglobin levels in the western half of the U.S., especially in the Rocky Mountain areas, with smaller areas of the higher hemoglobin at start of ESRD across the rest of the country.

vol 2 **Table 1.5 Distributions of laboratory values (mean) and treatment characteristics (%), by age, sex, race, ethnicity, and primary cause of ESRD, among incident ESRD cases, 2013**

	eGFR (ml/min / 1.73 m^2)	Anemia		Nutrition		Lipids		Diabetes
		Serum albumin (g/dL)	Dietary Care (%)	Hemoglobin (g/dL)	ESA Use (%)	Total Cholesterol (mg/dL)	LDL (mg/dL)	HbA1c (%)
Age								
0-21	13.15	3.4	36.4	9.7	27.6	184	107.1	5.35
22-44	9.48	3.2	7.2	9.5	10.9	173	102.1	6.95
45-64	10.12	3.2	7.8	9.6	12.7	161	93.0	6.85
65-74	10.44	3.3	7.8	9.7	15.9	147	81.8	6.68
75+	10.54	3.3	6.9	9.7	17.4	142	77.9	6.46
Sex								
Male	10.59	3.3	8.1	9.7	13.4	149	85.0	6.69
Female	9.84	3.2	7.5	9.5	16.3	165	92.9	6.79
Race								
White	10.53	3.3	8.2	9.7	14.9	152	85.9	6.76
Black	9.84	3.2	6.5	9.3	13.1	162	94.5	6.67
Native American	9.77	2.8	7.7	9.5	15.1	152	81.8	6.83
Asian	8.95	3.4	10.7	9.6	19.7	160	88.7	6.68
Ethnicity								
Hispanic	9.75	3.2	7.3	9.5	12.6	157	88.2	6.83
Non-Hispanic	10.35	3.3	7.9	9.7	15.0	155	88.2	6.71
Primary Cause of ESRD								
Diabetes	10.47	3.2	7.6	9.6	16.6	153	86.7	7.05
Hypertension	9.80	3.3	6.0	9.6	12.8	153	87.8	6.20
Glomerulonephritis	9.37	3.3	12.3	9.6	19.5	176	101.3	5.76
Cystic kidney	9.48	3.8	15.8	11.1	16.1	164	94.0	5.72
All	**10.27**	**3.3**	**7.9**	**9.6**	**14.6**	**155**	**88.2**	**6.73**

Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m^2) for those aged ≥18 years and the Schwartz equation for those aged <18 years. Abbreviations: CKD-EPI; chronic kidney disease epidemiology calculation; eGFR, estimated glomerular filtration rate; ESA, erythropoiesis-stimulating agents; ESRD, end-stage renal disease; HbA1c, glycosylated hemoglobin; Hgb, hemoglobin; LDL, low-density lipoprotein.

vol 2 **Figure 1.20 Map of average hemoglobin level at initiation of renal replacement therapy, by Health Service Area, 2013**



Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. Abbreviation: ESRD, end-stage renal disease.

Variation in Treatment Characteristics by ESRD Network

Geographic variation in pre-ESRD care is also evident by ESRD Network. Most pronounced was over 2-fold variation in the percentage of incident ESRD cases with pre-ESRD nephrology care >12 months, ranging from 19% in Network 18 to 45% in Network 1. Mean eGFR at ESRD start ranged from 9.0 ml/min/1.73 m^2 in Network 6 to 10.8 ml/min/1.73 m^2 in Networks 9. Mean Hgb at dialysis start was 9.4 to 9.9 g/dL in 16 of 18 Networks, but >10 g/dL in Networks 15 and 16, which include states at higher elevations (Table 1.6).

vol 2 **Table 1.6 Distribution (%) of mean duration of pre-ESRD nephrology care, mean hemoglobin level, eGFR, by ESRD Network, among incident ESRD cases, 2013**

Network	States in network	Mean duration of ore-ESRD nephrology care					eGFR (ml/min/1.73 m^2)	Hgb (g/dL)
		>12 months	6-12 months	0-6 months	None	Unknown		
18	S. CA	18.7	16.0	17.2	25.2	22.9	10.4	9.8
10	IL	24.1	17.2	13.1	22.7	22.8	10.3	9.7
14	TX	25.2	18.5	13.3	30.5	12.5	9.5	9.4
13	AR, LA, OK	25.6	20.1	11.9	28.4	14.0	9.7	9.6
5	MD, DC, VA, WV	25.8	21.7	13.3	26.7	12.4	9.7	9.4
7	FL	26.8	17.7	12.7	29.0	13.8	10.1	9.6
3	NJ, PR	28.6	19.2	9.4	35.6	7.2	9.8	9.7
9	IN, KY, OH	29.4	21.1	11.9	21.9	15.7	10.8	9.6
17	N. CA, HI, GUAM, AS	29.6	19.6	15.7	21.9	13.2	10.0	9.6
8	AL, MS, TN	29.9	18.6	13.4	27.8	10.3	9.2	9.5
2	NY	32.4	17.3	12.1	24.7	13.4	9.5	9.5
15	AZ, CO, NV, NM, UT, WY	32.8	19.0	15.7	22.1	10.4	10.5	10.2
6	NC, SC, GA	33.2	19.2	13.5	23.8	10.3	9.0	9.5
12	IA, KS, MO, NE	35.8	18.3	12.2	24.8	8.9	10.7	9.6
4	DE, PA	36.1	18.7	14.1	21.7	9.4	10.5	9.7
11	MI, MN, ND, SD, WI	38.6	16.1	12.2	24.6	8.5	10.7	9.6
16	AK, ID, MT, OR, WA	41.4	18.4	14.7	21.8	3.8	10.1	10.1
1	CT, MA, ME, NH, RI VT	45.3	20.5	10.3	15.9	8.0	9.4	9.5
All		30.1	18.7	13.3	25.3	12.6	10.0	9.6

Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with CMS form 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m^2) for those aged ≥18 and the Schwartz equation for those aged <18. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate; CKD-EPI, chronic kidney disease epidemiology calculation; Hgb, hemoglobin.

Modality of Renal Replacement Therapy: Distributions, Geographic Variation, and Trends

Among Incident Cases of ESRD in 2013

In 2013, 88.4% of all incident cases began renal replacement therapy with hemodialysis, 9.0% with peritoneal dialysis, and 2.6% received a preemptive kidney transplant (Table 1.7). Use of peritoneal dialysis and pre-emptive kidney transplant were relatively more common in younger groups and relatively less common among Black or Hispanic patients. Use of peritoneal dialysis and pre-emptive kidney transplant were more common among patients with glomerular or cystic kidney disease, versus diabetes or hypertension, as the primary cause of ESRD. This difference may be attributed in part to age, as both glomerular and cystic kidney disease are more common in younger patients.

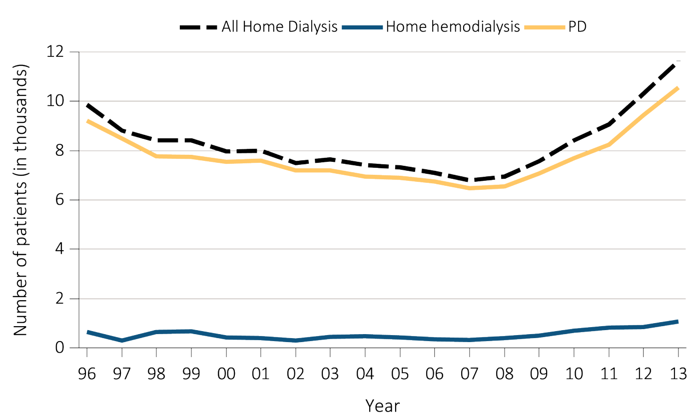
vol 2 Table 1.7 Number and percentage of incident cases of hemodialysis, peritoneal dialysis, and transplantation by age, sex, race, ethnicity, and primary cause of ESRD, in the U.S. population, 2013

	Total	HD		PD		Transplant	
		n	%	n	%	n	%
Age							
0-21	1,470	832	56.6	371	25.2	267	18.2
22-44	12,977	10,472	80.7	1,793	13.8	712	5.5
45-64	45,566	39,593	86.9	4,515	9.9	1,458	3.2
65-74	29,453	26,598	90.3	2,296	7.8	559	1.9
75+	27,524	25,887	94.1	1,587	5.8	50	0.2
Sex							
Male	67,580	59,865	88.6	5,992	8.9	1,723	2.5
Female	49,410	43,517	88.1	4,570	9.2	1,323	2.7
Race							
White	79,244	69,447	87.6	7,479	9.4	2,318	2.9
Black / African American	30,664	28,038	91.4	2,292	7.5	334	1.1
Native American	1,040	932	89.6	71	6.8	37	3.6
Asian	5,714	4,721	82.6	698	12.2	295	5.2
Other/Unknown	328	244	74.4	22	6.7	62	18.9
Ethnicity							
Hispanic	17,276	15,527	89.9	1,460	8.5	289	1.7
Non-Hispanic	99,714	87,855	88.1	9,102	9.1	2,757	2.8
Primary cause of ESRD							
Diabetes	51,339	46,502	90.6	4,392	8.6	445	0.9
Hypertension	33,585	30,459	90.7	2,850	8.5	276	0.8
Glomerulonephritis	8,802	6,801	77.3	1,444	16.4	557	6.3
Cystic kidney	2,482	1,547	62.3	485	19.5	450	18.1
Other/Unknown	20,782	18,073	87.0	1,391	6.7	1,318	6.3
All	116,990	103,382	88.4	10,562	9.0	3,046	2.6

Data Source: Special analyses, USRDS ESRD Database. The numbers in this table exclude "Other PD" and "Uncertain Dialysis." Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Use of home dialysis among incident ESRD patients has increased notably in recent years (Figure 1.21). Home dialysis use overall in 2013 was 52% higher than a decade ago in 2003 and 71% higher than at its nadir in 2007. Use of peritoneal dialysis and home hemodialysis in 2013 are 63% and 222% higher, respectively, than in 2007. Despite the large relative rise in home hemodialysis, its overall use among incident ESRD patients is low, as only 9.1% of home dialysis patients were treated with home hemodialysis in 2013.

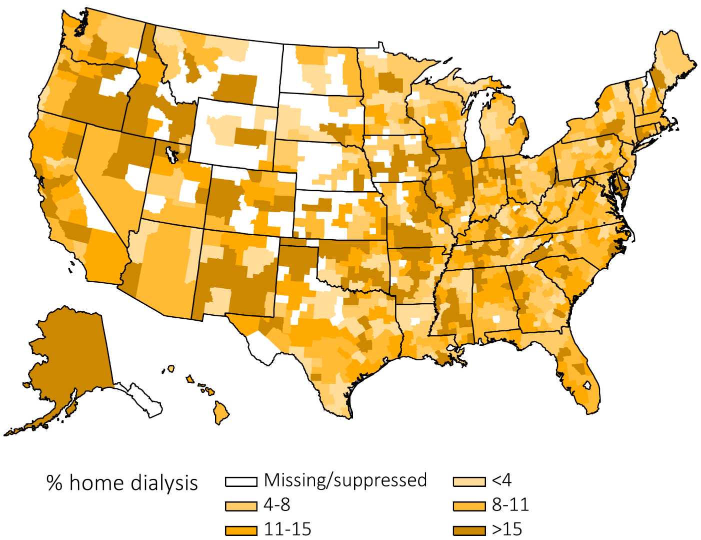
vol 2 Figure 1.21 Trends in the number of incident ESRD cases (in thousands) using home dialysis, by type of therapy, in the U.S. population, 1996-2013



Data Source: Reference Table D.1. Abbreviations: ESRD, end-stage renal disease; PD, peritoneal dialysis.

The proportion of incident dialysis cases using home dialysis was 10.2% in the US; it varied substantially across 677 Health Services Areas, ranging from a low of 0% to a high of 58% (interquartile range: 6.3 to 14.2%) (Figure 1.22). Geographic patterns are less apparent, supporting the likelihood that differences in home dialysis use are largely driven by differences among individual dialysis centers or groups of centers, rather than by large-scale regional effects.

vol 2 Figure 1.22 Map of the percentage of incident dialysis cases using home dialysis, by Health Service Area, 2013



Data Source: Special analyses, USRDS ESRD Database.

Among Prevalent Cases of ESRD in 2013

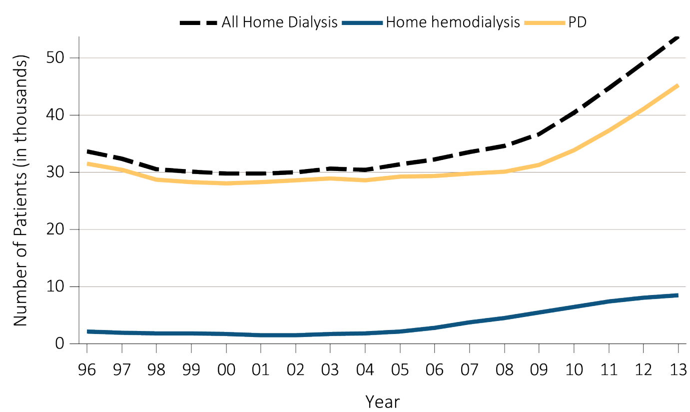
On December 31, 2013, 63.9% of all prevalent ESRD cases were receiving hemodialysis therapy, 6.9% were being treated with peritoneal dialysis, and 29.3% had a functioning kidney transplant (Table 1.8).

Distributions of modality use by patient characteristics generally mirror those for incident patients. Peritoneal dialysis and kidney transplant were more commonly used among patients who were younger and more likely White, non-Hispanic, and with glomerular disease or cystic kidney disease as the primary cause of ESRD.

The use of home dialysis (peritoneal dialysis or home hemodialysis, Figure 1.23) has increased appreciably in recent years. Home dialysis accounted for 11.5 percent of all prevalent dialysis patients in 2013, up from a low of 8.9 percent in 2008. Among home dialysis cases, the proportion using home hemodialysis was over 3-fold higher in 2013 (15.8%) than in 2001 (5.2%).

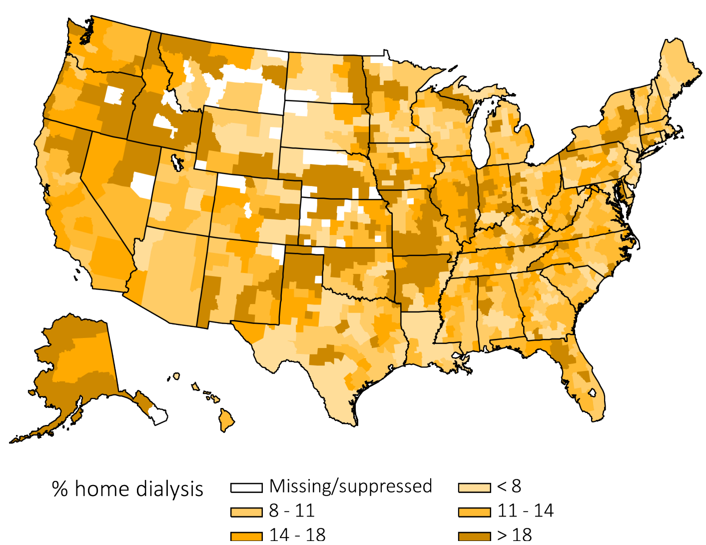
As observed for incident dialysis patients, there was substantial variation in home dialysis use by Health Service Area among prevalent dialysis cases in 2013. The percent of prevalent dialysis cases using home dialysis ranged across 763 Health Service Areas from a low of 0% to a high of 77% (interquartile range: 8.8 to 16.9%) (Figure 1.24). Scattered geographic patterns are apparent as in the case of incident utilization of home dialysis, further supporting the likelihood that differences in home dialysis use are largely being driven by preferences and availability of home dialysis at individual dialysis centers or groups of centers, rather than by large-scale regional influences, though this phenomenon requires further investigation.

vol 2 Figure 1.23 Trends in number of prevalent ESRD cases (in thousands) using home dialysis, by type of therapy, in the U.S. population, 1996-2013



Data Source: Reference Table D.1. December 31 prevalent ESRD patients; PD consists of CAPD and CCPD only. Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycler peritoneal dialysis; ESRD, end-stage renal disease; PD, peritoneal dialysis.

vol 2 Figure 1.24 Map of the percentage of prevalent dialysis cases using home dialysis, by Health Service Area, 2013



Data Source: Special analyses, USRDS ESRD Database.

vol 2 Table 1.8 Number and percentage of prevalent cases of hemodialysis, peritoneal dialysis, and transplantation by age, sex, race, ethnicity, and primary ESRD diagnosis, in the U.S. population, 2013

		HD		PD		Transplant	
	Total	n	%	n	%	n	%
Age							
0-21	9,979	1,993	20.0	1,206	12.1	6,780	67.9
22-44	100,836	50,973	50.6	8,751	8.7	41,112	40.8
45-64	292,344	174,610	59.7	20,051	6.9	97,683	33.4
65-74	149,225	102,609	68.8	9,368	6.3	37,248	25.0
75+	107,485	91,164	84.8	5,882	5.5	10,439	9.7
Sex							
Male	378,185	238,277	63.0	24,602	6.5	115,306	30.5
Female	281,604	183,009	65.0	20,651	7.3	77,944	27.7
Race							
White	407,377	239,192	58.7	30,323	7.4	137,862	33.8
Black / African American	202,843	153,406	75.6	11,169	5.5	38,268	18.9
Native American	7,188	5,000	69.6	438	6.1	1,750	24.3
Asian	36,882	22,548	61.1	3,195	8.7	11,139	30.2
Other/Unknown	5,579	1,203	21.6	133	2.4	4,243	76.1
Ethnicity							
Hispanic	111,622	76,790	68.8	6,901	6.2	27,931	25.0
Non-Hispanic	548,247	344,559	62.8	38,357	7.0	165,331	30.2
Primary cause of ESRD							
Diabetes	247,257	187,520	75.8	16,060	6.5	43,677	17.7
Hypertension	165,634	122,624	74.0	11,962	7.2	31,048	18.7
Glomerulonephritis	107,853	45,012	41.7	8,557	7.9	54,284	50.3
Cystic kidney	30,977	9,810	31.7	1,990	6.4	19,177	61.9
Other/Unknown	108,148	56,383	52.1	6,689	6.2	45,076	41.7
All	659,869	421,349	63.9	45,258	6.9	193,262	29.3

Data Source: Special analyses, USRDS ESRD Database. The numbers in this table exclude "Other PD" and "Uncertain Dialysis." Abbreviation: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Chapter 2: Healthy People 2020

- This year we examine data for ten HP 2020 Objectives, spanning 19 total indicators. As in previous ADRs, we present data overall and stratified by race, sex, and age groups.
- In 2013, 11 of 19 indicators met HP2020 goals, with most of the remaining objectives continuing to show improvement.
- This year, we introduce U.S maps to illustrate geographic variation for some of the indicators. Specifically, we present state-level comparison maps for HP2020 objectives CKD-10 (proportion of ESRD patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy) and CKD-13.1 (proportion of patients receiving a kidney transplant within three years of end-stage renal disease).
- To update HP2020 objectives relating to vascular access, we present data from CROWNWeb for the first time. Previous USRDS annual reports have relied on data from the Clinical Performance Measures Project (CMS, 2007), which only collected new information through 2007. By employing CROWNWeb data, this year we were able to present more recent findings from 2012 and 2013 for HP2020 objectives CKD 11-1 (proportion of adult hemodialysis patients who use arteriovenous fistulas as the primary mode of vascular access) and CKD 11-2 (proportion of adult hemodialysis patients who use catheters as the only mode of vascular access).

Introduction

For more than three decades, the Healthy People initiative has served as the nation's agenda for health promotion and disease prevention. Coordinated by the United States (U.S.) Department of Health and Human Services, the initiative provides a vision and strategy for improving the health of all Americans by setting priorities, identifying baseline data and 10-year targets for specific objectives, monitoring outcomes, and evaluating progress. Since its inaugural iteration in 1980, in each decade the program has released updated plans that reflect emerging health priorities, and have helped to align health promotion resources, strategies, and research.

Healthy People 2020 (HP2020) was launched on December 2, 2010. It represents the fourth-generation plan, and encompasses more than 1,000 health objectives organized into 42 different topic areas. Built on the success of the three previous initiatives, HP2020 seeks to achieve the following overarching goals:

- to assist all Americans in attaining high-quality, longer lives free of preventable disease, disability, injury, and premature death;
- to achieve health equity, eliminate disparities, and improve the health of all groups;
- to create social and physical environments that promote good health for all, and
- to promote quality of life, healthy development, and healthy behaviors across all life stages (HP2020, 2010).

One of the key priorities of the HP2020 initiative is to "reduce new cases of chronic kidney disease (CKD) and its complications, disability, death, and economic costs." The development of CKD and its progression to end-stage renal disease (ESRD) is a major source of reduced quality of life in the U.S., and is responsible for significant premature mortality. The HP2020 CKD objectives are designed to reduce the long-term burden of kidney disease, increase lifespan, and improve quality of life among those with this condition, and to eliminate health care disparities among patients. To accomplish these goals the HP2020 program developed 14 objectives (with 24 total indicators) related to CKD, accompanied by targets designed to evaluate the program's success. Herein, we provide data for nine of these objectives, as well as information on urine albumin testing in non-CKD patients diagnosed with diabetes mellitus (DM; 19 total indicators). Because we use the Medicare 5 percent data sample to evaluate objectives related to CKD patients who are not on dialysis, the results presented in this chapter are limited to those aged 65 and older.

Overall, the data continue to demonstrate both areas of improvement and of continued need. Encouraging trends were noted for nearly all objectives, with 11 out of 19 indicators meeting or exceeding their improvement targets. For example, with respect to provision of recommended care, both of the indicators related to the proportion of patients with DM and CKD receiving recommended medical evaluations have surpassed their objectives. Nearly all indicators related to reductions in mortality among ESRD patients have exceeded their targets. However, the data demonstrate that several indicators continue to fall short of their targets. The rates of new cases of ESRD (CKD Objective 8) and the rate of ESRD among patients with DM (CKD Objective 9.1) remain above target, but have continued to slowly trend downwards in both cases. Similarly, transplant wait-listing of dialysis patients (CKD Objective 12) and death rate among patients with a functioning kidney transplant (CKD Objective 14.4) have both improved, but both remain short of their HP2020 goals. The proportion of patients receiving a kidney transplant within three years of ESRD is one of the only objectives that has not improved; in 2000, 19.1% of patients met this objective, nearly meeting the target of 19.7%; by 2010 only 14.1% of patients met this objective.

It is important to highlight that one of the four overarching goals of HP2020 is to eliminate health care disparities. While much of the data show promising trends relevant to this goal, progress overall has not always translated into reduced differences across subgroups. To facilitate comparisons, data is presented overall and by racial, ethnic, sex, and age subgroups. In many cases, while an objective may be met by the overall population, one or more subgroups may fall well short. Primarily, however, trends are similar across different subgroups.

In this 2015 report, for the first time we have included maps to illustrate U.S. geographic differences in the achievement of two HP2020 objectives: the proportion of CKD patients receiving nephrology care for 12 months before starting renal replacement therapy (CKD Objective 10) and the proportion of patients receiving a kidney transplant within three years of ESRD (CKD Objective 13.1).

Below, the detailed findings and trends for each of the 10 objectives (with 19 total indicators) are presented separately. Additional information on the HP2020 program objectives can be found at www.healthypeople.gov.

Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Recommended Care

Acute kidney injury (AKI) is now recognized as an important risk factor for the subsequent development of CKD. The HP2020 program has been at the forefront of recognizing this risk, and this objective aims to promote improved renal follow-up after an episode of AKI. Post-AKI follow-up allows for early identification of development of CKD, and provides an opportunity to institute renoprotective measures early in the course of evolving disease. Over the past decade, the percentage of Medicare patients with AKI receiving follow-up renal evaluation has risen by greater than threefold, but the absolute levels remain low overall. In 2013, 16.1% of patients aged 65 and older who were hospitalized for AKI had a follow-up renal evaluation during the next six months (see Table 2.1). This is the third consecutive year that the HP2020 goal of 12.2% has been achieved.

vol 2 **Table 2.1 HP2020 CKD-3 Increase the proportion of hospital patients who incurred acute kidney injury who have followup renal evaluation in 6 months post discharge: Target 12.2%**

	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)
All	2.4	3.1	4.4	8.4	9.1	10.5	11.2	10.6	11.5	11.9	12.7	12.8	16.1
Race/Ethnicity													
American Indian or Alaskan Native only	0.0	0.0	2.9	16.7	4.8	13.2	12.0	15.2	6.9	11.0	16.7	9.5	7.8
Asian only	3.8	2.0	4.5	8.1	12.8	19.0	15.2	11.5	16.6	15.5	16.0	14.8	22.0
Black or African American only	2.9	2.5	4.0	7.8	9.7	9.2	11.2	10.3	12.1	11.3	12.1	13.3	16.2
White only	2.3	3.2	4.5	8.3	8.8	10.5	11.1	10.4	11.2	11.9	12.6	12.6	15.7
Hispanic or Latino	1.4	6.6	7.1	12.9	12.2	10.3	12.4	15.6	13.4	13.1	17.2	16.4	23.0
Sex													
Male	2.8	3.5	4.6	8.8	9.9	11.3	12.6	11.9	12.5	12.8	13.9	13.9	17.6
Female	2.0	2.8	4.3	8.0	8.3	9.7	10.0	9.4	10.6	11.1	11.7	11.9	14.7
Age													
65-74	3.7	4.2	6.2	11.6	12.8	14.7	16.1	14.8	16.0	16.5	17.6	17.3	21.0
75-84	2.0	3.2	4.2	8.5	8.6	10.4	11.1	10.8	11.3	12.4	13.2	13.0	16.8
85+	0.8	1.1	2.2	3.1	4.4	5.1	5.1	5.0	6.4	5.9	6.2	6.9	9.1

Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 65 & older with a hospitalized AKI event in a given year. Abbreviation: CKD, chronic kidney disease.

The proportion of patients receiving post-AKI renal evaluation decreased with older age. Among patients aged 65-74, 21.0% received follow-up evaluation. This declined to 16.8% in patients aged 75-84, and only 9.1% of those aged 85 and older received such care. In addition, men were more likely to receive follow-up renal evaluation as compared with women. A slightly higher proportion of Blacks/African Americans had post-AKI follow-up compared to Whites, at 16.2% and 15.7% respectively.

Over the past decade, there has been steady annual improvement in the proportion of patients with diagnosed diabetes who received an annual urine albumin measurement. In 2013, this proportion reached 45.0%, representing a greater than twofold increase from 2003. This is the fifth consecutive year that the HP2020 target of 37.0% has been achieved (see Table 2.2).

vol 2 **Table 2.2 HP2020 D-12 Increase the proportion of persons with diagnosed diabetes who obtain an annual urinary microalbumin measurement: Target 37.0%**

	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)
All	15.3	18.1	21.2	25.5	28.5	31.0	33.3	35.3	36.9	38.6	40.5	42.3	45.0
Race/Ethnicity													
American Indian or Alaskan Native only	11.4	12.0	13.0	15.5	18.9	20.2	20.9	21.2	24.0	22.9	24.5	24.0	27.2
Asian only	16.8	20.6	23.9	28.8	30.5	33.4	34.9	37.3	39.5	41.7	43.8	47.3	49.4
Black or African American only	13.1	15.6	18.5	23.5	26.4	29.0	31.5	33.3	35.3	36.9	39.0	40.5	43.1
White only	15.5	18.5	21.6	25.7	28.7	31.2	33.5	35.5	37.1	38.7	40.6	42.3	44.9
Hispanic or Latino	15.3	17.8	20.7	25.5	29.6	31.3	33.2	35.2	37.6	40.2	42.3	44.3	47.9
Sex													
Male	14.8	17.6	20.7	24.7	27.8	30.2	32.4	34.4	36.2	37.7	39.6	41.5	44.0
Female	15.9	18.8	21.9	26.5	29.4	32.0	34.5	36.4	37.9	39.5	41.6	43.3	46.1
Age													
65-74	18.1	21.2	24.7	29.4	32.6	35.1	37.7	39.9	41.8	43.3	45.3	47.2	49.7
75-84	13.7	16.7	19.6	23.8	26.8	29.6	31.8	33.7	35.3	37.1	39.1	41.0	44.4
85+	7.2	9.0	10.9	13.9	16.1	18.1	20.5	22.2	23.5	25.0	26.7	28.0	31.5

Data Source: Special analyses, Medicare 5 percent sample. Medicare patients with diabetes mellitus, aged 65 & older. Abbreviations: D, diabetes mellitus.

The proportion of patients with diabetes who had urine albumin measurements declined with age, falling from 49.7% in the 65-74 age group to 31.5% in patients older than 85 years. Proportions were relatively similar when examined by race, with the exception of Native Americans. While this group had a low rate of 27.2%, testing in Native Americans may have been under-reported because the Indian Health Service does not report claims through the Medicare system.

HP2020 CKD Objective 4.1 examines the proportion of patients with CKD who receive recommended medical testing, including serum creatinine, urine albumin, and lipids. Table 2.3 shows that in the Medicare population aged 65 and older, 33.1% of CKD patients underwent serum creatinine, lipid, and urine albumin testing in 2013, surpassing the HP2020 goal of 28.3% for the fourth consecutive year. Overall, this continues an improving trend and represents a greater than threefold increase over the past decade. As seen with other measures of recommended testing, the proportion of patients tested declined with rising age; testing occurred in 41.5, 33.7, and 18.6% of individuals in the 65-74, 75-84, and 85 years and older age groups, respectively.

vol 2 Table 2.3 HP2020 CKD-4.1 Increase the proportion of persons with chronic kidney disease who receive medical evaluation with serum creatinine, lipids, and microalbuminuria: Target 28.3%

	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)
All	7.3	9.1	10.6	19.8	22.1	23.4	25.7	26.7	28.1	29.0	30.2	31.1	33.1
Race/Ethnicity													
American Indian or Alaskan Native only	8.2	5.5	7.0	13.7	19.2	15.8	16.9	16.7	18.3	20.2	21.0	18.4	23.4
Asian only	8.4	14.4	14.1	27.6	27.9	32.5	35.3	34.0	37.5	36.9	39.5	41.2	43.9
Black or African American only	6.6	8.7	10.1	20.8	22.8	24.4	26.7	27.8	30.1	30.6	32.3	33.1	35.0
White only	7.1	8.8	10.4	19.3	21.6	22.9	25.1	26.3	27.4	28.3	29.4	30.3	32.2
Hispanic or Latino	13.1	17.3	17.7	26.8	30.4	31.1	33.1	32.1	36.1	36.7	38.9	41.2	44.2
Sex													
Male	7.0	8.9	10.0	18.6	20.9	22.4	24.4	25.2	26.7	27.6	28.6	29.5	31.4
Female	7.5	9.3	11.3	21.1	23.4	24.5	27.1	28.4	29.6	30.6	32.0	33.0	35.1
Age													
65-74	10.3	12.6	14.2	26.1	29.2	31.4	33.9	35.1	36.7	37.6	38.9	39.9	41.5
75-84	6.2	8.0	9.8	18.5	20.8	22.6	24.9	26.2	27.7	28.9	30.3	31.2	33.7
85+	2.3	3.1	4.0	8.2	10.0	10.1	12.1	13.1	14.0	14.8	16.2	17.0	18.6

Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 65 & older with CKD. Abbreviations: CKD, chronic kidney disease.

Patients with both type 1 or type 2 diabetes and CKD require comprehensive laboratory monitoring to assess for development of complications. The glycosylated hemoglobin (HgbA1c) test provides an assessment of blood glucose control over prolonged periods of time, while diabetic retinopathy can be detected through regular eye examinations. In the diabetic CKD population aged 65 and older, 29.9% of patients received serum creatinine, urine albumin, HgbA1c, and lipid testing, as well as an eye examination in 2013 (see Table 2.4). This again exceeded the HP2020 goal of 25.3%, although some populations remained below the goal (e.g. Native Americans, patients aged 85 years and older). Again, data for Native Americans may have been under-reported due to the separation of the Indian Health Services from Medicare reporting.

vol 2 Table 2.4 HP2020 CKD-4.2 Increase the proportion of persons with type 1 or type 2 diabetes and chronic kidney disease who receive medical evaluation with serum creatinine, microalbuminuria, A1c, lipids, and eye examinations: Target 25.3%

	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)
All	9.0	10.4	12.1	18.4	20.0	21.1	23.0	23.7	25.1	26.5	26.9	27.6	29.9
Race/Ethnicity													
American Indian or Alaskan Native only	7.3	2.4	5.7	5.6	15.8	12.5	10.2	10.9	10.9	15.1	14.2	11.2	16.3
Asian only	8.3	12.4	12.8	25.0	21.8	26.1	26.7	25.3	27.0	29.6	30.8	32.4	37.0
Black or African American only	6.7	7.2	9.9	16.3	17.9	18.8	19.7	21.1	22.4	23.8	25.1	25.3	27.1
White only	9.4	11.0	12.5	18.6	20.3	21.4	23.4	24.2	25.6	27.0	27.1	27.9	30.0
Hispanic or Latino	10.4	11.8	11.8	20.5	20.2	19.8	22.2	21.7	24.6	24.0	26.5	25.2	29.8
Sex													
Male	8.7	10.3	11.8	18.0	19.7	20.9	22.5	23.6	24.7	26.2	26.6	27.5	29.4
Female	9.3	10.6	12.4	18.8	20.3	21.4	23.5	23.7	25.6	26.8	27.3	27.8	30.3
Age													
65-74	10.9	12.3	14.3	22.0	23.4	24.6	26.6	27.2	28.5	30.0	30.1	30.7	32.7
75-84	8.1	9.9	11.6	16.9	18.9	20.7	22.6	23.3	25.2	26.7	27.4	28.4	30.8
85+	4.0	4.2	4.9	9.5	11.5	11.3	13.0	14.2	15.5	16.6	17.7	18.3	20.5

Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 65 & older with CKD & diabetes mellitus. Abbreviations: CKD, chronic kidney disease; A1c, glycosylated hemoglobin.

Incidence of End-stage Renal Disease

Since 2006, the rate of new cases of ESRD has been slowly declining, although at 354.5 new cases per million population it still remains above the target rate of 344.3. As shown in Table 2.5, the trend of wide variation in the rate of new ESRD cases by race continued to be observed. Rates were lowest among Whites (282.5 new cases per million) and Asians (325.0 new cases per million). Consistent with historical trends, higher rates were seen among Blacks (915.3 new cases per million) and Native Hawaiians/Pacific Islanders (2,523.9 new cases per million). However, whereas rates have been decreasing for Blacks, in the past two years we have seen increased rates among Native Hawaiians and Pacific Islanders. It should be noted that the extraordinarily high rates among Native Hawaiians and Pacific Islanders may have been due in part to differential race reporting between the Census Bureau and the ESRD Medical Evidence Report forms (CMS 2728; ME) data collections. Although in the Census, one-half of Native Hawaiians and Pacific Islanders self-identified as of multiple race, in the ME, it was only seven percent. The rate of incident ESRD among Hispanics (515.4 per million) continued to be nearly 50% greater than among non-Hispanics (354.9 per million).

While overall rates have declined, a difference between sexes continued, with a rate of 448.0 cases per million population among men and 278.4 new cases per million among women. This gap has increased from 2001, when males had a rate 42% higher than females, to 2013, where males exhibited a 61% higher rate.

vol 2 Table 2.5 HP2020 CKD-8 Reduce the rate of new cases of end-stage renal disease (ESRD): Target 344.3 new cases per million population

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	387.9	388.8	388.7	388.2	391.3	399.0	391.1	386.6	389.3	381.5	364.7	356.9	354.5
Race													
American Indian or Alaskan Native only	709.5	672.0	622.4	633.6	609.0	524.8	538.0	543.4	527.8	487.6	457.3	462.6	403.7
Asian only	319.5	312.7	304.2	281.9	336.5	354.5	356.3	354.6	363.6	353.0	345.0	332.4	325.0
Native Hawaiian or other Pacific Islander only~	3430.6	3547.7	3552.0	3716.5	2902.8	2830.5	2388.6	2175.3	2420.5	2578.2	2356.9	2465.1	2523.9
Black or African American only	1126.0	1134.1	1131.7	1093.8	1103.1	1113.9	1091.6	1072.7	1070.5	1031.1	989.1	939.6	915.3
White only	292.0	293.3	293.3	298.0	301.8	311.6	306.0	303.3	306.6	303.2	289.9	284.4	282.5
Two or more races	.	.	.	.	.	146.6	149.9	158.2	145.1	140.8	113.3	17.1	3.8
Ethnicity													
Hispanic or Latino	632.9	643.2	640.9	618.4	603.5	604.2	589.6	586.4	583.5	576.7	563.9	528.0	515.4
Not Hispanic or Latino	372.8	373.1	374.1	375.2	377.9	383.4	376.5	373.0	377.3	370.0	354.0	352.9	354.9
Black or African American only, not Hispanic or Latino	1143.9	1153.5	1152.0	1111.2	1122.6	1134.8	1114.3	1095.7	1093.6	1054.5	1011.0	962.9	939.9
White only, not Hispanic or Latino	268.9	268.1	268.2	274.2	276.2	281.9	276.2	272.5	275.3	270.9	256.7	254.4	253.4
Sex													
Male	463.7	470.2	469.3	477.3	483.6	494.4	486.7	483.8	488.3	480.1	459.6	448.9	448.0
Female	327.1	323.9	324.8	317.1	317.7	322.4	314.9	309.0	310.0	302.2	287.7	282.2	278.4
Age													
<18	11.6	11.9	12.0	12.5	12.3	11.3	12.1	11.9	11.7	11.3	11.4	11.3	10.8
0-4	8.9	7.8	9.2	10.9	10.0	8.8	10.9	10.1	10.4	10.7	10.8	11.4	10.5
5-11	7.6	8.9	7.6	7.9	7.8	6.5	6.9	7.5	7.1	7.0	6.7	7.2	7.5
12-17	18.4	18.7	19.6	19.4	19.6	18.9	19.2	18.7	18.1	16.7	17.3	16.1	14.9
18-44	112.5	111.8	110.8	112.0	116.9	120.8	119.2	118.4	121.8	118.1	114.5	112.6	113.0
18-24	43.6	41.9	41.9	39.4	41.9	43.3	42.4	41.0	40.1	39.0	39.2	35.6	36.3
25-44	136.6	136.3	134.9	137.4	143.2	147.9	146.1	145.5	150.4	145.8	140.8	139.5	139.9
45-64	615.1	605.7	606.8	600.3	600.9	612.2	597.6	592.9	592.2	574.8	554.4	551.3	546.2
45-54	388.8	388.1	390.1	388.1	386.3	403.2	390.2	386.2	388.2	372.9	370.4	365.5	375.4
55-64	841.4	823.3	823.5	812.5	815.6	821.3	805.0	799.6	796.2	776.8	738.3	737.0	716.9
65+	1580.1	1626.0	1614.8	1611.7	1628.7	1654.3	1622.4	1598.8	1608.2	1599.3	1517.8	1451.6	1438.7
65-74	1436.3	1426.7	1406.8	1397.6	1384.0	1413.2	1379.3	1351.7	1358.4	1351.8	1267.8	1230.7	1224.8
75-84	1756.0	1853.7	1843.7	1844.6	1889.8	1913.0	1876.8	1853.2	1864.0	1859.1	1783.0	1687.0	1674.4
85+	1259.2	1341.2	1406.0	1424.0	1463.6	1478.7	1508.6	1525.0	1547.8	1477.3	1365.0	1306.4	1221.2

Data Source: Special analyses, USRDS ESRD Database and CDC Bridged Race Intercensal Estimates Dataset, Incident ESRD patients. Rates adjusted for: overall, age/sex/race; rates by age adjusted for sex/race; rates by sex adjusted for age/race; rates by race/ethnicity adjusted for age/sex. Reference: 2012 patients. "." Zero values in this cell. ~Estimate shown is imprecise due to small sample size and may be unstable over time. Abbreviations: CDC, Centers for Disease Control and Prevention; CKD, chronic kidney disease; ESRD, end-stage renal disease.

Kidney Failure Due to Diabetes

There continues to be a favorable, decreasing trend in the overall rate of kidney failure due to DM. As shown in Table 2.6, the rate fell by 11% over the past decade, from 174.4 per million population in 2003 to 155.9 per million in 2013. These rates varied widely by race, with Whites having the lowest rate, at 130.0 per million, compared with 392.7 per million among Blacks. However, while the trend over the past decade stayed relatively flat for Whites, rates among Blacks have improved by 23%. As seen with overall ESRD incidence in the previous indicator (and with the same reporting caveats), Native Hawaiians and Pacific Islanders had the highest rate of kidney failure due to DM at 1626.3 per million. Males continued to have a higher rate of diabetic kidney failure than did females, at 190.5 compared with 126.6 per million population. While the overall rate remained short of the HP2020 goal of 154.6 per million, this target was achieved in some subgroups, including Whites, females, and patients aged 44 years and younger.

vol 2 **Table 2.6 HP2020 CKD-9.1 Reduce kidney failure due to diabetes: Target 150.6 per million population**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	177.9	175.2	174.4	174.2	174.2	177.6	171.7	169.1	169.6	166.9	159.5	156.4	155.9
Race													
American Indian or Alaskan Native only	526.0	494.4	469.3	478.9	431.1	366.4	378.8	391.1	384.3	347.5	321.5	320.9	291.6
Asian only	151.7	142.5	139.7	128.9	159.7	177.2	172.7	179.7	180.0	172.3	172.4	167.5	167.9
Native Hawaiian or other Pacific Islander only~	2190.5	2000.1	2019.7	2256.4	1699.7	1729.3	1490.5	1309.2	1537.5	1618.0	1446.7	1480.8	1626.3
Black or African American only	525.9	520.2	511.2	496.4	497.1	502.9	478.5	474.2	471.4	456.9	435.4	407.2	392.7
White only	133.3	132.0	132.2	134.2	135.1	139.6	136.3	134.0	135.0	134.4	129.1	128.8	130.0
Two or more races	.	.	.	.	.	74.7	80.8	78.6	77.1	69.4	58.2	7.8	*
Ethnicity													
Hispanic or Latino	404.5	407.4	407.5	393.8	377.7	375.5	366.2	367.7	359.8	355.8	346.1	320.5	308.2
Not Hispanic or Latino	164.7	161.9	161.3	162.1	162.0	164.4	158.9	156.5	157.8	155.2	148.1	146.4	146.8
Black or African American only, not Hispanic or Latino	533.8	528.2	518.7	503.3	504.9	510.5	487.0	482.7	480.4	465.6	443.4	416.6	402.3
White only, not Hispanic or Latino	114.8	112.5	112.2	114.6	114.6	116.7	113.2	109.5	110.4	109.2	103.5	105.0	107.0
Sex													
Male	194.2	195.1	195.0	200.5	202.0	206.9	202.3	200.9	203.1	200.7	193.1	189.3	190.5
Female	163.9	158.4	157.1	152.1	150.9	152.8	146.1	142.5	141.5	138.4	131.2	128.3	126.6
Age													
<18	0.1	0.1	*	0.1	0.1	*	*	*	0.1	0.1	*	0.1	0.1
0-4	*	*	*	*	*	*	*	*	*	*	*	*	*
5-11	.	*	.	.	*	.	.	*	.	.	.	*	.
12-17	*	*	*	*	0.2	*	*	*	*	*	*	*	*
18-44	33.6	32.7	33.4	34.4	35.2	38.4	37.9	37.6	40.0	39.6	39.7	37.7	38.6
18-24	3.6	2.9	2.9	2.1	3.1	3.1	2.7	2.4	2.6	2.5	2.3	2.5	2.4
25-44	44.1	43.1	44.0	45.7	46.4	50.7	50.2	49.9	53.1	52.6	52.8	50.1	51.2
45-64	343.7	333.7	329.4	323.9	323.2	324.0	310.5	308.8	306.9	295.2	281.1	281.3	275.1
45-54	190.9	188.8	187.2	185.1	183.0	189.7	179.2	178.9	180.2	175.6	173.1	173.8	178.4
55-64	496.6	478.7	471.7	462.6	463.4	458.3	441.7	438.7	433.7	414.9	389.1	388.8	371.8
65+	678.5	689.8	683.1	690.0	693.8	706.7	691.2	674.4	673.7	679.2	646.5	611.6	616.6
65-74	748.3	736.3	728.5	721.6	711.2	725.9	698.5	678.5	675.4	669.0	631.1	608.6	608.0
75-84	649.1	682.5	674.3	692.8	712.8	722.2	716.4	699.9	700.4	719.1	690.7	641.0	654.1
85+	274.5	297.8	317.8	344.5	328.8	359.1	366.7	378.6	389.5	383.2	358.3	348.2	327.0

*Data Source: Special analyses, USRDS ESRD Database and CDC Bridged Race Intercensal Estimates Dataset, Incident ESRD patients. Adjusted for age/sex/race; reference: 2012. "." Zero values in this cell. *Values for cells with 10 or fewer patients are suppressed. ~Estimate shown is imprecise due to small sample size and may be unstable over time. Abbreviations: CDC, Centers for Disease Control and Prevention; CKD, chronic kidney disease; ESRD, end-stage renal disease.*

In 2013, the adjusted rate of kidney failure due to DM among diabetic patients fell to 2,073 per million population, a 7.5% decrease from 2012 and a 20.8% decrease from 2007 (see Table 2.7). This rate fell below the HP2020 target of 2,380.5 for the fourth consecutive year. Rates varied among races, and remained highest in Black diabetics, at 3,181 per million in 2013; however, this reflected a 28.9% improvement from 2007, exceeded only by the 30.7% improvement seen in Native Americans. Male diabetics remained at higher risk for kidney failure as compared with females; in 2013, the rate in males fell below the HP2020 target for the first time.

vol 2 **Table 2.7 HP2020 CKD-9.2 Reduce kidney failure due to diabetes among persons with diabetes: Target 2,380.5 per million population**

	2007	2008	2009	2010	2011	2012	2013
All	2616	2486	2401	2344	2271	2242	2073
Race							
American Indian or Alaskan Native only	2559	2926	2931	2594	2246	2273	1774
Asian only	2067	2185	2207	2106	2070	2130	2079
Native Hawaiian or other Pacific Islander only~	.	.	.	.	.	.	.
Black or African American only	4476	4335	4242	3978	3820	3662	3181
White only	2276	2138	2047	2025	1971	1965	1845
Two or more races	610	553	517	484	463	59	*
Ethnicity							
Hispanic or Latino	3313	3177	2960	2898	2900	2770	2408
Not Hispanic or Latino	2518	2391	2321	2261	2179	2156	2015
Black or African American only, not Hispanic or Latino	4686	4528	4473	4191	4057	3865	3342
White only, not Hispanic or Latino	2049	1899	1822	1799	1729	1749	1676
Sex							
Male	2927	2744	2621	2541	2521	2514	2339
Female	2327	2235	2177	2139	2019	1971	1806
Age							
<18	*	*	30	35	*	54	56
0-4	.	.	.	.	.	.	.
5-11	*	.	.	.	.	*	.
12-17	*	*	*	*	*	*	*
18-44	1613	1531	1507	1461	1557	1494	1532
18-24	341	268	285	290	334	295	267
25-44	1748	1677	1642	1578	1665	1628	1682
45-64	2377	2257	2195	2134	2068	2093	2078
45-54	2005	1846	1854	1864	1875	1869	1919
55-64	2643	2571	2436	2308	2179	2231	2172
65+	3101	2939	2800	2720	2574	2487	2507
65-74	3186	2990	2894	2771	2619	2543	2565
75-84	3351	3156	2934	2873	2799	2695	2807
85+	1946	2073	1976	2073	1765	1691	1485

*Data Source: Special analyses, USRDS ESRD Database and CDC Bridged Race Intercensal Estimates Dataset, Incident ESRD patients. Adjusted for age/sex/race; Ref: 2012. National Health Interview Survey 2006–2013 used to estimate diabetes mellitus prevalence. "." Zero values in this cell; *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CDC, Centers for Disease Control and Prevention; CKD, chronic kidney disease; ESRD, end-stage renal disease; Ref, reference.*

Nephrologist Care

At 34.3% in 2013, the proportion of CKD patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy exceeded the HP2020 goal of 29.8%, and reflected nearly a nine percent increase from the level of 25.7% seen in 2005 (Table 2.8).

Variations by race continued to be observed, with Whites (35.9%) and Asians (35.5%) experiencing greater rates than Blacks (30.2%) and Native Hawaiians and Pacific Islanders (30.1%). While rates overall have increased, the gap between lowest and highest has remained fairly consistent, increasing slightly from 5.2% in 2005 to 5.7% in 2013. Rates by ethnicity were lowest among Hispanics/Latinos, at 27.1%.

Even broader variation was observed by age, with rates ranging from 27.6% among those aged 18-44 to 46.1% among those under age 18. In contrast to the differences seen by race and age, rates of pre-ESRD nephrologist care were nearly identical by sex, at 34.2% among males and 34.4% among females.

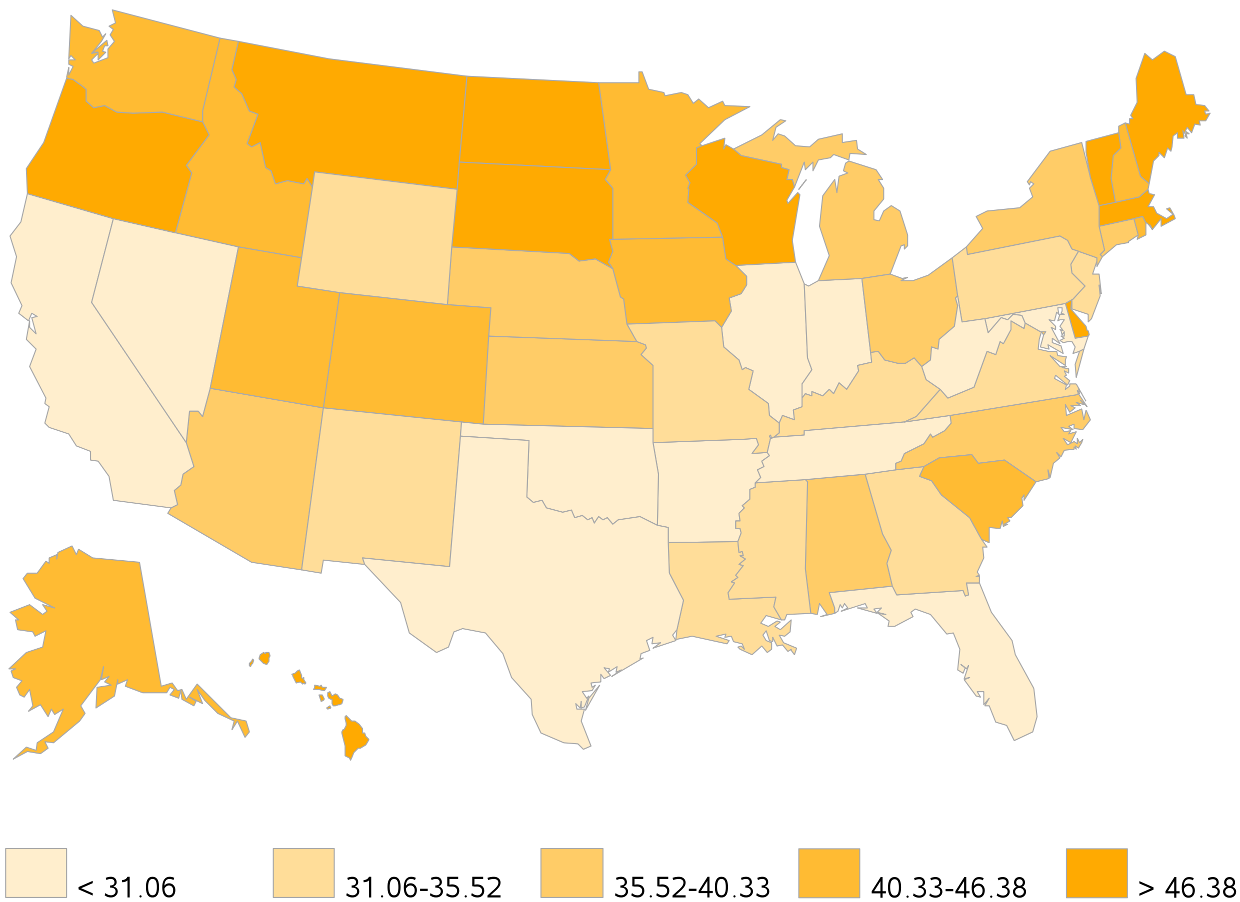
vol 2 **Table 2.8 HP2020 CKD-10 Increase the proportion of chronic kidney disease patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy: Target 29.8%**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	25.7	26.5	27.3	28.6	28.6	29.6	31.0	33.1	34.3
Race									
American Indian or Alaskan Native only	25.3	27.2	26.1	27.9	26.9	23.8	27.8	30.2	30.5
Asian only	25.9	23.8	26.6	27.6	29.1	29.8	31.4	31.9	35.5
Native Hawaiian or other Pacific Islander only~	23.5	25.2	23.9	22.5	24.0	25.4	27.0	27.5	30.1
Black or African American only	22.1	23.2	24.0	24.7	24.9	25.5	27.2	29.6	30.2
White only	27.3	28.0	28.8	30.4	30.2	31.3	32.7	34.7	35.9
Two or more races	23.0	22.7	24.6	29.1	28.6	31.4	31.5	33.3	45.5
Ethnicity									
Hispanic or Latino	20.0	21.3	21.3	22.3	22.6	23.7	25.1	25.8	27.1
Not Hispanic or Latino	26.6	27.2	28.2	29.6	29.5	30.5	32.1	34.3	35.5
Black or African American only, not Hispanic or Latino	22.2	23.2	24.1	24.7	25.0	25.6	27.2	29.7	30.3
White only, not Hispanic or Latino	28.8	29.4	30.5	32.2	32.0	33.3	34.7	37.0	38.2
Sex									
Male	26.1	26.5	27.3	28.4	28.4	29.6	30.8	33.1	34.2
Female	25.3	26.4	27.3	28.8	28.9	29.5	31.4	33.1	34.4
Age									
<18	39.8	36.0	35.2	40.0	39.5	37.6	44.7	40.8	46.1
0-4	25.0	20.3	25.7	26.7	23.5	22.7	25.0	27.3	29.2
5-11	50.5	48.6	41.1	53.1	48.0	48.8	59.4	51.5	57.7
12-17	41.4	36.8	36.9	40.3	42.4	39.5	47.5	42.7	48.4
18-44	23.3	23.0	23.6	24.4	23.9	24.3	25.7	27.8	27.6
18-24	24.6	23.2	24.9	23.9	24.7	25.4	27.6	26.6	28.0
25-44	23.1	23.0	23.5	24.4	23.8	24.2	25.5	27.9	27.6
45-64	25.7	26.1	26.7	27.3	27.4	27.9	29.5	31.1	32.1
45-54	24.0	25.0	25.5	25.3	25.8	26.2	28.4	29.5	30.6
55-64	26.8	26.9	27.4	28.6	28.5	29.0	30.1	32.1	33.0
65+	26.2	27.5	28.6	30.5	30.5	32.0	33.4	35.9	37.4
65-74	27.1	28.4	28.9	30.6	30.7	32.1	33.4	35.6	36.8
75-84	26.0	27.3	28.9	31.2	30.9	32.7	33.9	36.7	38.4
85+	22.9	24.2	26.7	27.6	28.3	29.7	31.5	34.1	36.4

Data Source: Special analyses, Medicare 5 percent sample. Incident hemodialysis patients with a valid ESRD Medical Evidence CMS 2728 form; nephrologist care determined from Medical Evidence form. Abbreviations: CMS, Centers for Medicare and Medicaid Services; CKD, chronic kidney disease; ESRD, end-stage renal disease.

Substantial geographic variation in the proportion of chronic kidney disease patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy was also observed (Figure 2.1). While more than 80% of U.S. states met or exceeded the HP2020 target of 29.8% in 2013, percentages varied by over 50% from the lowest quintile to the highest quintile. In general, the highest percentages were observed in the North Atlantic and Northern Plains regions, with the lowest occurring in the Mid-South and Southern Plains states.

vol 2 **Figure 2.1 HP2020 CKD-10 Geographic distribution of the adjusted proportion of chronic kidney disease patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy, by state, in the U.S. population, 2013: Target 29.8%**



Data Source: Special analyses, Medicare 5 percent sample. Incident hemodialysis patients with a valid ESRD Medical Evidence CMS 2728 form; nephrologist care determined from Medical Evidence form. Adjusted for age, sex, and race. Abbreviations: CDC, Centers for Disease Control and Prevention; CKD, chronic kidney disease; ESRD, end-stage renal disease.

Vascular Access

In this year's ADR, we introduce data from CROWNWeb, a dialysis data reporting system launched in 2012. Vascular access is an important aspect of hemodialysis care, and arteriovenous (AV) fistulas are established as the primary access of choice. The HP2020 CKD Objective 11.1 examines the use of AV fistulas among prevalent hemodialysis patients (see Table 2.9). Previous ADRs have reported data for this objective from the ESRD Clinical Performance Measures (CPM) Project, which only collected this information through 2007.

In 2013, 62.8% of prevalent adult hemodialysis patients were using an AV fistula as their primary access, more than double the proportion reported in ESRD CPM data for 2000 (29.9%) and well above the last available ESRD CPM data from 2007 (49.6%; USRDS, 2012). This overall prevalence achieved the previous HP2020 target of 50.6%, although comparisons should be made with caution as this target was derived from a different data source (ESRD CPM). Blacks have consistently shown the lowest use of AV fistulas, although this has improved steadily, and reached 57.8% in 2013. A higher proportion of males than females were using AV fistulas, 68.8% compared to 55.1%; steady improvement has been seen in both sexes. Use of an AV fistula declined with age, peaking at 66.3% in patients aged 18-44 and falling to 59.2% in patients aged 65 years and older.

vol 2 **Table 2.9 HP2020 CKD-11.1: Increase the proportion of adult hemodialysis patients who use arteriovenous fistulas as the primary mode of vascular access: Previous data source target 50.6%**

	2012	**2013**
All	61.4	62.8
Race		
American Indian or Alaskan Native only	71.8	74.2
Asian only	65.8	67.3
Native Hawaiian or other Pacific Islander only~	65.2	67.7
Black or African American only	56.4	57.8
White only	63.8	65.2
Two or more races	67.6	68.6
Ethnicity		
Hispanic or Latino	66.7	67.9
Not Hispanic or Latino	60.2	61.7
Black or African American only, not Hispanic or Latino	56.3	57.8
White only, not Hispanic or Latino	62.5	64.0
Sex		
Male	67.7	68.8
Female	53.2	55.1
Age		
18-44	65.3	66.3
18-24	64.5	66.1
25-44	65.4	66.3
45-64	63.4	64.9
45-54	65.1	66.4
55-64	62.3	63.8
65+	57.6	59.2
65-74	59.8	61.4
75-84	56.5	57.9
85+	47.5	48.9

Data Source: Special analyses, CROWNWeb. Prevalent hemodialysis patients with a valid ESRD Medical Evidence CMS 2728 form, vascular access type determined from CROWNWeb. Abbreviations: CMS, Centers for Medicare and Medicaid Services; CKD, chronic kidney disease; ESRD, end-stage renal disease.

In comparison to AV fistulas, use of a hemodialysis catheter is associated with increased morbidity and mortality. As such, reducing the proportion of hemodialysis patients that are dependent on catheters is another important CKD objective of HP2020. Data for this objective was also obtained from CROWNWeb and interpretation of target achievement may be limited, as the former HP2020 target was derived from a different data source (ESRD CPM Project).

In 2013, 15.1% of prevalent adult hemodialysis patients were using catheters as the primary mode of access, a 5.0% decrease from 2012 (Table 2.10). Notably, the most recent data from the ESRD CPM Project showed that 27.7% of hemodialysis patients were using a catheter in 2007.

A lower proportion of Blacks were using catheters in 2013 compared to Whites (14.3% versus 16.0%), while Native Americans and Asians reported even lower use (11.7% and 13.3%, respectively). A higher proportion of females than males were using catheters (17.5% compared to 13.3%). Use of catheters was similar in the 18-44 and 45-64 years age groups at 14.2% and 13.9% respectively, but rose to 16.9% in patients aged 65 years and older. Among patients aged 85 years and older, 26.7% were catheter-dependent.

vol 2 Table 2.10 HP2020 CKD-11.2: Reduce the proportion of adult hemodialysis patients who use catheters as the only mode of vascular access: Previous data source target 26.1%

	2012	2013
All	15.9	15.1
Race		
American Indian or Alaskan Native only	12.7	11.7
Asian only	13.9	13.3
Native Hawaiian or other Pacific Islander only~	14.7	14.2
Black or African American only	15.0	14.3
White only	16.7	16.0
Two or more races	11.4	10.0
Ethnicity		
Hispanic or Latino	13.9	13.4
Not Hispanic or Latino	16.3	15.5
Black or African American only, not Hispanic or Latino	14.9	14.2
White only, not Hispanic or Latino	17.8	17.1
Sex		
Male	13.8	13.3
Female	18.5	17.5
Age		
18-44	14.9	14.2
18-24	17.9	16.4
25-44	14.6	13.9
45-64	14.5	13.9
45-54	13.8	13.2
55-64	15.0	14.4
65+	17.6	16.9
65-74	15.7	15.2
75-84	18.4	17.7
85+	27.6	26.7

Data Source: Special analyses, CROWNWeb. Prevalent hemodialysis patients with a valid ESRD Medical Evidence CMS 2728 form, vascular access type determined from CROWNWeb. Abbreviations: CMS, Centers for Medicare and Medicaid Services; CKD, chronic kidney disease; ESRD, end-stage renal disease.

In 2013, 37.2% of incident hemodialysis patients had a maturing arteriovenous fistula or were using one as their primary vascular access, a 20% increase from 2005 (see Table 2.11). This marks the third consecutive year that the target for this objective was met. The proportions were higher in males than females (39.2% compared to 34.4%), and slightly higher in Whites than Blacks (37.5% compared to 35.6%). By age group, patients aged 65-74 had the highest proportion of arteriovenous fistula use or maturing fistula at 39.1%, compared to 28.1% in patients aged 18-24 and 33.5% in patients aged 25-44.

Programs such as HP2020 and the Fistula First Initiative continue to work to increase the use of fistulas, and to promote early placement prior to initiation of ESRD therapy.

vol 2 **Table 2.11 HP2020 CKD-11.3 Increase the proportion of adult hemodialysis patients who use arteriovenous fistulas or have a maturing fistula as the primary mode of vascular access at the start of renal replacement therapy: Target 34.5%**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	31.1	31.9	31.6	31.2	32.3	33.8	35.1	36.6	37.2
Race									
American Indian or Alaskan Native only	36.2	39.1	37.6	41.4	41.4	41.1	40.2	40.8	42.4
Asian only	36.0	37.5	35.2	35.9	35.5	37.4	37.1	38.0	41.3
Native Hawaiian or other Pacific Islander only~	41.0	34.7	35.4	32.9	32.4	32.4	36.0	37.7	39.5
Black or African American only	28.4	29.3	29.7	29.2	30.6	32.0	33.9	35.8	35.6
White only	31.9	32.7	32.1	31.7	32.7	34.3	35.3	36.8	37.5
Two or more races	25.8	36.4	33.2	28.9	36.1	37.8	39.1	42.9	33.3
Ethnicity									
Hispanic or Latino	31.4	32.3	29.9	29.7	31.0	32.8	33.4	34.2	34.8
Not Hispanic or Latino	31.0	31.9	31.9	31.4	32.5	34.0	35.4	37.1	37.6
Black or African American only, not Hispanic or Latino	28.3	29.2	29.7	29.1	30.6	31.9	33.9	35.8	35.6
White only, not Hispanic or Latino	32.0	32.9	32.7	32.3	33.1	34.8	36.0	37.7	38.4
Sex									
Male	34.9	35.1	34.8	33.9	34.9	36.4	37.8	39.1	39.2
Female	26.3	27.9	27.4	27.6	28.8	30.4	31.4	33.3	34.4
Age									
18-44	29.5	29.5	28.2	27.5	29.2	31.1	31.9	32.5	33.0
18-24	25.6	22.3	20.2	21.0	22.7	23.6	25.0	25.4	28.1
25-44	29.9	30.3	29.0	28.2	29.8	31.8	32.6	33.1	33.5
45-64	33.2	33.3	32.6	32.5	33.2	34.4	35.9	37.8	37.8
45-54	32.4	33.1	32.4	32.2	32.8	34.0	35.9	37.1	37.4
55-64	33.8	33.5	32.7	32.7	33.5	34.6	35.9	38.2	38.1
65+	29.9	31.4	31.6	31.0	32.2	34.0	35.1	36.6	37.6
65-74	31.7	33.5	34.0	32.9	34.3	35.9	37.0	38.7	39.1
75-84	29.4	30.6	30.5	30.7	31.8	33.7	34.8	36.0	37.7
85+	23.7	25.0	25.1	24.0	25.3	26.6	28.3	29.1	29.9

Data Source: Special analyses, Medicare 5 percent sample. Incident hemodialysis patients aged 18 & older. Abbreviations: CKD, chronic kidney disease.

Transplantation

The proportion of ESRD patients younger than age 70 who were wait-listed or received a deceased donor kidney transplant within one year of initiating dialysis therapy continues to increase, at 18.0% in 2013, although this level remained below the HP2020 target of 18.4% (Table 2.12).

The target was exceeded by Asians (34.1%), Whites (19.0%), those of two or more races (37.5%), females (18.9%), and those younger than age 18 (56.6%), aged 18-44 (27.4%), and aged 45-54 (19.1%). Groups furthest from the target included those aged 65-69, Blacks, and Native Americans. Gaps between groups with the highest and lowest percentages have remained fairly stable, showing only minor decreases over time.

vol 2 Table 2.12 HP2020 CKD-12 Increase the proportion of dialysis patients waitlisted and/or receiving a deceased donor kidney transplant within 1 year of end-stage renal disease (ESRD) start (among patients under 70 years of age): Target 18.4% of dialysis patients

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	15.2	14.5	14.5	14.5	15.3	15.8	16.9	17.0	16.7	17.2	16.9	17.5	17.7	18.0
Race														
American Indian or Alaskan Native only	12.9	9.7	10.1	9.5	10.3	10.9	10.4	11.4	10.5	11.5	11.4	11.3	12.3	12.4
Asian only	26.8	28.7	28.2	28.3	32.2	28.2	31.3	30.8	31.1	32.0	32.0	33.0	32.1	34.1
Native Hawaiian or other Pacific Islander only~	17.4	17.3	18.7	19.6	18.2	16.1	15.1	14.9	14.3	14.8	15.2	14.8	16.9	18.3
Black or African American only	11.2	10.5	10.7	10.5	11.6	12.0	13.1	13.3	13.2	13.9	13.8	14.4	14.8	15.0
White only	17.0	16.2	16.1	16.3	16.7	17.5	18.4	18.5	18.1	18.2	17.8	18.5	18.6	19.0
Two or more races						14.0	19.4	13.8	23.5	23.9	23.0	17.6	20.5	37.5
Ethnicity														
Hispanic or Latino	12.9	12.7	13.3	14.1	14.5	15.7	17.6	17.7	17.3	18.2	17.5	18.4	18.1	18.2
Not Hispanic or Latino	15.5	14.8	14.6	14.6	15.4	15.8	16.7	16.8	16.6	16.9	16.7	17.2	17.5	17.9
Black or African American only, not Hispanic or Latino	11.2	10.5	10.7	10.5	11.6	11.9	13.0	13.2	13.2	13.8	13.8	14.4	14.8	14.9
White only, not Hispanic or Latino	18.0	17.1	16.8	16.7	17.2	18.0	18.7	18.8	18.3	18.2	17.9	18.3	18.7	19.3
Sex														
Male	13.4	13.4	12.7	13.0	13.6	14.2	15.3	15.7	15.6	15.8	15.7	16.3	16.5	17.1
Female	16.4	15.2	15.7	15.5	16.4	16.8	17.9	17.8	17.4	18.0	17.7	18.3	18.7	18.9
Age														
<18	41.9	40.2	40.8	48.9	44.9	52.7	58.2	56.0	59.0	58.2	55.3	54.0	55.1	56.6
0-4	24.0	26.1	31.5	39.1	30.9	34.5	40.9	36.5	40.1	44.3	37.7	34.4	29.6	35.5
5-11	42.2	49.2	44.2	50.0	50.7	63.6	61.5	65.1	66.6	64.2	60.3	62.6	62.5	67.4
12-17	47.1	40.0	41.6	51.2	47.3	53.6	62.7	59.4	63.2	61.3	60.9	58.6	64.4	61.8
18-44	26.4	25.2	24.5	23.8	25.2	24.9	26.2	25.6	25.3	25.9	25.2	27.0	26.2	27.4
18-24	30.5	29.1	30.2	29.5	33.5	27.8	32.4	32.0	30.0	32.5	32.6	33.5	34.0	38.6
25-44	26.0	24.9	23.9	23.3	24.5	24.6	25.7	25.0	24.9	25.3	24.5	26.4	25.5	26.3
45-64	14.1	13.4	13.4	13.5	14.0	14.6	15.7	15.9	15.5	15.8	15.7	16.3	16.8	16.7
45-54	18.2	17.4	17.1	16.6	16.8	16.8	18.3	18.6	17.2	18.3	17.9	18.6	19.1	19.1
55-64	11.2	10.5	10.7	11.4	12.1	13.1	13.8	14.1	14.3	14.2	14.3	14.9	15.4	15.2
65+	5.0	5.3	6.0	6.2	7.4	8.0	8.9	9.4	9.9	10.9	10.9	10.8	10.9	12.1
65-69	5.0	5.3	6.0	6.2	7.4	8.0	8.9	9.4	9.9	10.9	10.9	10.8	10.9	12.1

Data Source: Special analyses, Medicare 5 percent sample. Incident ESRD patients younger than 70. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease.

At 14.1%, the proportion of 2010 patients younger than age 70 who received a kidney transplant within three years of starting ESRD therapy remained well below the HP2020 target of 19.7% (see Table 2.13). This continues the slow but consistent decrease observed since 1998, when 19.9% of patients received a transplant within three years of initiating ESRD therapy.

Such rates were highest among Asians (17.2%) and Whites (17.1%), and lowest among American Indians/Alaskan Natives (7.2%) and Native Hawaiians and Pacific Islanders (7.3%). Males (14.5%) were slightly more likely to receive a transplant as compared to females (13.5%). The percentage of patients receiving transplants decreased with age, from 73.2% in pediatric patients to 8.0% among those aged 65-69.

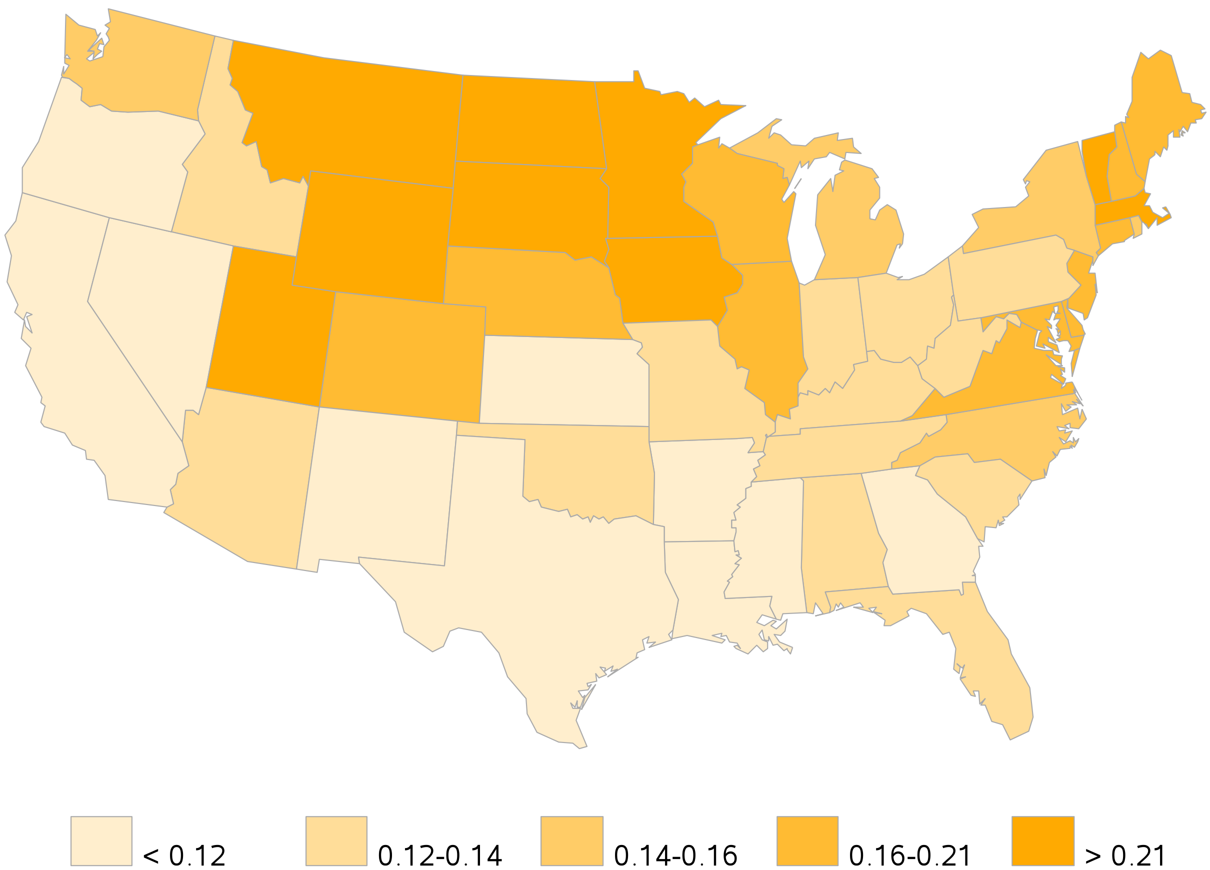
vol 2 Table 2.13 HP2020 CKD-13.1 Increase the proportion of patients receiving a kidney transplant within 3 years of end-stage renal disease (ESRD): Target 19.7%

	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)
All	19.9	19.4	19.1	18.3	18.3	18.0	18.2	17.6	17.1	16.6	15.6	14.6	14.1
Race													
American Indian or Alaskan Native only	11.3	10.0	15.4	8.7	11.6	8.8	9.1	8.7	10.0	10.1	6.7	7.2	7.2
Asian only	18.8	17.8	18.3	18.1	20.8	21.4	20.3	18.2	18.7	17.4	17.8	16.7	17.2
Native Hawaiian or other Pacific Islander only~	12.3	12.8	8.3	12.6	12.0	11.4	12.5	9.4	9.7	10.5	10.5	8.2	7.3
Black or African American only	9.8	9.5	9.8	8.8	9.5	9.2	9.9	9.5	8.9	9.0	8.6	7.7	7.6
White only	26.3	25.2	24.4	23.7	23.1	22.8	22.6	22.0	21.3	20.6	19.2	18.0	17.1
Two or more races								16.4	16.5	14.6	17.6	17.0	14.4
Ethnicity													
Hispanic or Latino	16.7	14.7	15.0	14.2	14.0	14.4	14.7	14.7	14.5	13.8	12.5	11.7	11.2
Not Hispanic or Latino	20.0	19.6	19.4	18.6	18.8	18.3	18.5	17.9	17.2	16.8	15.9	14.8	14.3
Black or African American only, not Hispanic or Latino	9.7	9.4	9.8	8.7	9.5	9.1	9.9	9.5	8.9	8.9	8.5	7.6	7.5
White only, not Hispanic or Latino	28.3	27.8	26.9	26.3	25.9	25.3	24.9	24.3	23.7	23.0	21.7	20.4	19.4
Sex													
Male	21.9	21.1	20.5	19.7	19.9	19.6	19.5	19.0	18.5	17.5	16.2	15.3	14.5
Female	17.5	17.3	17.3	16.5	16.2	15.9	16.4	15.8	15.3	15.3	14.8	13.7	13.5
Age													
<18	72.0	73.8	71.9	69.1	69.5	74.3	74.0	75.6	77.2	77.9	75.1	77.5	73.2
0-4	73.5	80.3	74.5	69.6	73.9	76.3	73.6	73.9	73.8	76.1	65.8	73.8	68.3
5-11	78.2	75.9	72.6	76.9	75.7	78.8	81.8	81.2	80.2	87.5	84.3	82.9	79.5
12-17	68.4	71.0	71.1	65.1	65.1	71.9	70.9	74.1	77.3	75.2	75.1	76.8	72.6
18-44	33.6	32.5	31.3	29.9	29.6	28.7	29.2	27.6	26.8	25.4	24.0	22.7	22.0
18-24	44.3	42.2	43.0	41.8	39.5	42.0	41.9	40.0	37.8	35.1	34.2	34.6	34.8
25-44	32.4	31.4	30.0	28.6	28.5	27.1	27.8	26.2	25.5	24.3	22.9	21.4	20.6
45-64	16.3	15.7	15.9	15.3	15.1	15.0	15.1	14.9	14.5	14.1	13.2	12.3	11.8
45-54	21.0	20.1	20.2	19.5	18.4	18.3	18.5	17.4	17.1	17.0	15.5	14.8	13.8
55-64	12.5	12.0	12.5	11.8	12.5	12.4	12.6	13.1	12.6	12.0	11.6	10.6	10.5
65+	5.3	5.9	6.2	6.5	7.3	7.6	8.0	7.8	8.3	8.3	8.2	7.8	8.0
65-69	5.3	5.9	6.2	6.5	7.3	7.6	8.0	7.8	8.3	8.3	8.2	7.8	8.0

Data Source: Special analyses, Medicare 5 percent sample. Incident ESRD patients younger than 70. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease.

Geographic variation in the proportion of patients receiving a kidney transplant within three years of end-stage renal disease was also observed (Figure 2.2). In 2010, just over 20% of U.S. states met or exceeded the HP2020 target of 19.7%; these were almost exclusively located in the North Atlantic and Northern Plains regions. Overall, the percentages of patients by state varied by 75% from the lowest quintile to the highest quintile. States with the lowest percentages were generally observed throughout the South and in the West.

vol 2 **Figure 2.2 HP2020 CKD-13.1 Geographic distribution of the adjusted proportion of patients receiving a kidney transplant within 3 years of end-stage renal disease (ESRD), by state, in the U.S. population, 2010: Target 19.7%**



Data Source: Special analyses, Medicare 5 percent sample. Incident ESRD patients younger than 70. Adjusted for age, sex, and race. Alaska and Hawaii are not reported due to small sample size. Abbreviations: CKD, chronic kidney disease.

In 2013 the percentage of patients receiving a preemptive transplant at the start of ESRD remained stable at 3.7%, maintaining a small increase observed over the past decade (see Table 2.14). Preemptive transplants were, by far, most common in pediatric patients, reaching 32.3% among those aged five to 11. Rates were slightly higher among females at 4.0%, compared to males at 3.6%. Substantial variation was observed by race, however, ranging from 1.0% among Blacks to 4.5% among Asians.

vol 2 **Table 2.14 HP2020 CKD-13.2 Increase the proportion of patients who receive a preemptive transplant at the start of ESRD: No applicable target**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	3.3	3.3	3.4	3.7	3.9	4.1	4.1	4.0	3.8	3.9	4.0	3.7	3.7
Race													
American Indian or Alaskan Native only	*	*	1.5	*	*	1.4	*	*	1.7	*	1.6	1.3	1.2
Asian only	2.0	2.8	2.6	2.5	2.7	3.0	3.1	3.5	3.1	3.4	3.8	3.1	4.5
Native Hawaiian or other Pacific Islander only~	*	*	*	*	1.0	*	1.9	2.6	2.0	*	*	*	*
Black or African American only	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.2	0.9	1.0
White only	4.1	4.2	4.1	4.6	4.9	5.1	5.2	5.0	4.7	4.7	4.8	4.3	4.2
Two or more races						*	*	*	*	*	*	*	*
Ethnicity													
Hispanic or Latino	1.4	1.5	1.5	1.8	1.9	2.3	2.3	2.2	2.2	2.2	2.4	2.2	2.2
Not Hispanic or Latino	3.2	3.3	3.3	3.6	3.8	3.9	4.1	3.9	3.7	3.8	3.8	3.4	3.5
Black or African American only, not Hispanic or Latino	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.2	0.9	1.0
White only, not Hispanic or Latino	4.8	4.9	4.8	5.4	5.7	6.0	6.3	6.0	5.5	5.6	5.7	5.1	4.9
Sex													
Male	3.5	3.4	3.5	3.6	3.9	4.2	4.2	3.9	3.8	3.9	4.0	3.6	3.6
Female	3.1	3.3	3.2	3.7	3.8	4.0	3.9	4.0	3.8	3.9	4.0	3.8	4.0
Age													
<18	20.8	19.4	21.2	19.7	23.8	25.4	22.2	22.6	26.9	24.1	26.3	25.3	25.0
0-4	18.6	14.1	18.8	18.7	17.8	17.4	19.5	11.9	19.6	16.7	19.1	17.6	19.5
5-11	22.8	27.2	28.7	22.0	28.8	33.5	31.3	32.9	36.5	32.9	29.9	30.6	32.3
12-17	20.7	17.0	18.7	19.2	23.9	25.1	19.7	22.8	25.7	23.6	28.1	26.7	24.0
18-44	6.0	5.9	5.5	6.1	5.9	6.4	6.1	6.1	5.8	5.7	6.1	5.7	5.6
18-24	8.8	8.6	9.0	9.5	9.2	10.6	8.4	9.2	9.3	9.7	9.4	9.6	8.2
25-44	5.6	5.6	5.2	5.8	5.5	6.0	5.9	5.8	5.5	5.3	5.7	5.3	5.3
45-64	2.7	2.7	2.8	3.1	3.3	3.5	3.6	3.4	3.2	3.4	3.4	3.1	3.2
45-54	3.7	3.7	3.7	4.0	4.3	4.3	4.6	4.2	4.0	4.3	4.0	3.8	3.8
55-64	1.9	2.0	2.1	2.4	2.7	2.9	3.0	2.9	2.8	2.9	3.0	2.7	2.9
65+	0.8	0.9	1.2	1.3	1.6	2.0	1.8	2.0	1.9	2.2	2.3	2.2	2.5
65-69	0.8	0.9	1.2	1.3	1.6	2.0	1.8	2.0	1.9	2.2	2.3	2.2	2.5

*Data Source: Special analyses, Medicare 5 percent sample. Incident ESRD patients younger than 70. *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease.*

Mortality

As demonstrated in Table 2.15, the total death rate among prevalent patients on dialysis has fallen by more than 25%, from 232.3 deaths per 1,000 patient years in 2001 to 174.1 in 2013, exceeding the HP2020 target of 190.0 for the fourth year in a row. With respect to race, rates among Whites were highest and continue to exceed the target at 198.7 deaths per 1,000 patient years. Rates were lowest among Native Hawaiians and Pacific Islanders (119.7 deaths per 1,000 patient years) and those of two or more races (116.2 deaths per 1,000). Mortality was slightly higher among females, at 176.5 deaths per 1,000 patient years, compared to males, at 172.3 deaths. Notably, significant reductions in rates since 2001 were observed across all age groups, with approximately 31% fewer deaths observed in 2013 for patients younger than 18 years (28.6 deaths per 1,000 patient years) compared with those in 2001 (41.6 deaths). Overall rates were highest among patients aged 65 and older (263.0 deaths per 1,000 patient years).

vol 2 Table 2.15 HP2020 CKD-14.1 Reduce the total number of deaths for persons on dialysis: Target 190.0 deaths per 1,000 patient years

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	232.3	229.9	228.4	224.2	220.5	216.3	207.8	200.6	195.5	188.6	184.9	177.6	174.1
Race													
American Indian or Alaskan Native only	202.0	194.6	188.2	182.4	177.8	170.1	162.6	167.5	171.6	151.3	146.1	146.6	144.2
Asian only	168.4	154.8	166.2	157.8	161.5	153.4	149.6	137.4	138.5	129.5	132.7	127.6	123.4
Native Hawaiian or other Pacific Islander only~	159.9	177.2	166.3	162.3	150.3	157.3	160.5	145.8	151.9	148.8	136.0	132.5	119.7
Black or African American only	185.1	181.3	181.8	181.2	176.7	171.3	164.8	158.4	153.9	146.7	141.6	136.4	134.4
White only	274.6	273.4	270.2	263.3	259.9	255.6	244.9	236.9	230.3	224.0	221.0	211.8	198.7
Two or more races					153.0	160.3	139.9	145.9	141.7	131.1	125.3	119.0	116.2
Ethnicity													
Hispanic or Latino	170.9	168.8	167.8	163.6	160.5	153.7	143.3	138.1	140.1	132.2	130.8	131.0	126.4
Not Hispanic or Latino	236.2	236.5	236.9	233.8	230.5	227.4	219.6	212.4	206.2	199.7	195.9	187.3	184.3
Black or African American only, not Hispanic or Latino	185.7	181.8	182.2	181.4	177.0	171.8	165.4	158.9	154.4	147.0	142.0	136.1	134.2
White only, not Hispanic or Latino	299.1	298.7	296.3	290.3	287.2	285.5	276.0	269.0	261.1	256.3	254.2	243.7	239.8
Sex													
Male	226.0	223.5	223.9	220.5	216.8	212.5	205.0	198.4	195.1	187.5	184.0	177.1	172.3
Female	239.4	237.2	233.6	228.4	224.8	220.8	211.1	203.4	196.0	190.0	186.0	178.2	176.5
Age													
<18	41.6	38.2	46.4	40.2	37.9	37.8	30.6	33.5	36.7	36.7	23.7	28.5	28.6
0-4	155.0	91.0	99.2	91.8	82.2	88.3	67.0	93.9	87.1	78.1	40.9	58.4	69.1
5-11	38.6	*	64.9	43.6	33.5	39.0	*	35.5	46.0	44.2	34.5	*	*
12-17	16.7	34.4	28.3	27.8	29.4	25.3	21.6	15.6	17.6	20.2	13.4	16.1	*
18-44	88.7	90.2	87.6	84.0	82.5	79.8	75.8	71.2	70.1	63.9	61.5	59.4	58.1
18-24	48.7	45.6	51.8	52.3	49.1	49.7	47.1	44.1	40.1	37.5	36.8	32.6	33.3
25-44	92.1	93.9	90.6	86.6	85.3	82.3	78.2	73.4	72.6	66.0	63.5	61.6	60.0
45-64	174.9	169.9	171.5	167.8	161.6	160.2	152.1	145.7	142.2	136.3	133.3	127.8	123.3
45-54	145.6	139.7	138.9	137.1	133.6	131.2	126.0	117.8	114.7	108.0	106.3	98.9	96.8
55-64	199.8	195.2	198.3	192.5	183.4	182.4	171.7	166.3	162.0	156.2	151.8	147.3	140.8
65+	349.0	345.6	339.7	334.3	332.0	324.1	313.3	304.0	295.0	285.9	280.5	268.0	263.0
65-74	287.8	284.0	278.3	272.3	268.5	257.1	246.6	240.4	235.7	226.6	220.9	212.1	210.1
75-84	404.2	395.4	386.8	381.5	377.9	371.5	357.8	346.6	333.0	323.0	317.7	302.2	296.4
85+	562.5	567.4	547.3	527.3	524.8	515.1	508.9	485.2	464.4	455.3	449.8	433.5	423.3

*Data Source: Special analyses, Medicare 5 percent sample. Period prevalent dialysis patients. *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD, chronic kidney disease.*

Since a peak in 2003 at 388.4 deaths per 1,000 patient years at risk, the rate of mortality among dialysis patients in the first three months after initiation has fallen more than 16%, to 321.2 in 2013. For the second year in a row the rate was below the HP2020 target of 328.7 deaths (see Table 2.16). Whites, however, still exceeded the target rate at 377.4 deaths per 1,000. Rates were lowest among Native Hawaiians and Pacific Islanders (158.3 deaths per 1,000) and Asians (189.3 deaths per 1,000), as well as among those with Hispanic/Latino ethnicity (188.7 deaths per 1,000). By sex, females had slightly higher rates than males, at 328.1 deaths per 1,000 patient years compared to 319.8 deaths per 1,000, respectively. Mortality rates were highest among those aged more than 85 years (871.7 deaths per 1,000 patient years).

vol 2 **Table 2.16 HP2020 CKD-14.2 Reduce the number of deaths in dialysis patients within the first 3 months of initiation of renal replacement therapy: Target 328.7 deaths per 1,000 patient years at risk**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	382.8	382.5	388.6	385.3	381.3	376.9	368.7	366.8	358.5	358.7	341.3	328.2	321.2
Race													
American Indian or Alaskan Native only	185.2	146.0	196.0	216.7	218.0	172.2	177.3	248.0	168.8	157.1	159.2	228.5	208.8
Asian only	232.4	227.8	234.7	234.5	257.1	213.8	244.7	203.8	214.7	219.5	179.9	189.7	189.3
Native Hawaiian or other Pacific Islander only~	210.2	180.6	186.5	185.0	173.4	222.7	172.8	153.9	194.5	162.8	179.2	122.2	158.3
Black or African American only	276.7	269.0	281.5	276.2	278.8	271.4	255.7	257.1	249.8	244.9	232.8	216.2	223.9
White only	449.2	454.8	457.7	451.8	442.3	439.6	434.3	432.4	423.9	426.0	407.6	392.5	377.4
Two or more races					301.9	303.7	280.9	295.6	209.6	262.1	260.4	247.2	237.9
Ethnicity													
Hispanic or Latino	247.1	227.4	243.6	229.6	242.0	219.6	220.8	212.9	207.3	209.7	205.3	198.7	188.7
Not Hispanic or Latino	400.0	403.7	407.7	405.9	399.5	397.7	389.9	387.9	379.9	381.4	363.5	347.3	341.9
Black or African American only, not Hispanic or Latino	277.6	268.8	281.9	277.3	278.6	271.7	257.5	257.9	250.4	245.8	234.4	214.8	224.2
White only, not Hispanic or Latino	484.5	498.0	498.4	495.1	484.1	489.9	483.4	486.2	478.0	482.1	462.9	444.6	427.3
Sex													
Male	384.3	377.0	387.8	385.4	375.8	373.0	370.5	368.9	363.7	356.2	340.1	323.6	319.8
Female	381.2	389.1	389.6	385.3	388.2	381.8	366.5	364.1	351.9	361.9	342.9	334.3	323.1
Age													
<18	*	*	*	59.3	*	*	*	.	*	*	*	*	*
0-4	*	*	*	.	*	.	*	*	*	.	*	*	*
5-11	*	*	*	*	*	*	*	*	*	*	*	*	*
12-17	*	*	*	*	*	*	.	*	*	*	*	*	*
18-44	102.0	104.3	106.1	107.5	107.5	105.8	101.4	101.8	108.3	94.8	94.8	76.1	82.2
18-24	72.5	54.5	63.1	76.1	65.4	93.7	69.9	59.7	45.6	68.0	62.2	*	52.1
25-44	105.1	109.7	110.7	110.7	111.9	107.1	104.8	106.2	114.5	97.5	98.3	81.1	85.3
45-64	219.3	215.1	224.4	217.4	221.1	214.3	205.4	214.9	210.2	213.7	200.7	193.3	192.5
45-54	162.4	168.3	171.6	172.9	177.7	163.4	160.3	175.3	161.7	167.0	158.6	144.3	143.8
55-64	261.5	250.1	263.6	249.6	251.6	250.4	236.2	241.3	242.1	243.3	227.6	223.3	222.9
65+	590.7	588.8	596.4	595.7	587.5	585.9	579.6	566.9	552.2	548.7	526.9	512.0	493.0
65-74	443.9	443.4	430.2	436.6	432.4	419.8	415.7	418.5	408.4	403.5	381.3	380.5	366.7
75-84	694.6	687.9	698.9	692.8	673.0	681.3	671.7	633.3	628.0	636.2	609.6	588.2	569.0
85+	1054.8	990.0	1070.9	1022.3	1008.7	1018.8	987.0	993.2	927.6	901.0	902.8	873.4	871.7

*Data Source: Special analyses, Medicare 5 percent sample. Incident dialysis patients, unadjusted. "." Zero values in this cell; *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD, chronic kidney disease.*

Since 2001, the rate of cardiovascular death among those on dialysis has fallen approximately 40% overall. In 2013, for the fourth consecutive year the HP2020 goal of 80.9 cardiovascular deaths per 1,000 patient years at risk was met, with a rate of 70.6 (see Table 2.17). Rates were lowest among American Indian/Alaskan Natives (55.0 deaths per 1,000) and those of two or more races (47.2 deaths per 1,000).

Cardiovascular death continued to be highest among Whites, at 81.9 deaths per 1,000 patient years. Rates were higher among males (72.2 deaths per 1,000) compared with females (68.4 deaths), although both were below the target. Large reductions in rates by age have been observed since 2001, with approximately 43% fewer deaths for patients older than 65 years occurring in 2013 (101.2 deaths per 1,000 patient years), compared with 2001 (178.5 deaths per 1,000).

vol 2 Table 2.17 HP2020 CKD-14.3 Reduce the number of cardiovascular deaths for persons on dialysis: Target 80.9 deaths per 1,000 patient years at risk

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	117.6	114.2	111.6	106.8	100.6	94.5	89.2	84.5	81.7	79.0	75.7	73.5	70.6
Race													
American Indian or Alaskan Native only	102.8	91.8	88.9	84.2	76.4	72.5	68.3	60.7	68.7	62.1	57.8	57.0	55.0
Asian only	94.6	84.8	91.3	81.6	83.1	69.4	67.8	65.1	65.9	59.8	60.8	57.6	55.6
Native Hawaiian or other Pacific Islander only~	99.7	110.5	102.1	88.0	76.4	86.2	80.4	72.0	79.8	79.3	66.4	65.3	61.9
Black or African American only	90.3	88.2	86.5	84.9	81.0	76.9	72.0	69.2	66.4	62.9	59.5	59.0	56.8
White only	140.4	136.2	132.6	125.9	117.7	109.8	103.7	97.4	94.0	91.9	88.8	85.4	81.9
Two or more races					69.5	71.7	63.7	67.4	61.7	64.4	57.1	49.4	47.2
Ethnicity													
Hispanic or Latino	91.0	87.5	83.7	80.7	77.8	70.9	65.2	62.9	64.4	60.9	59.1	59.0	57.6
Not Hispanic or Latino	119.1	116.9	115.5	110.9	104.4	98.8	93.6	88.6	85.2	82.6	79.2	76.6	73.4
Black or African American only, not Hispanic or Latino	90.6	88.3	86.8	85.0	81.0	77.0	72.3	69.3	66.5	63.1	59.6	58.9	56.7
White only, not Hispanic or Latino	152.2	148.1	145.2	138.1	128.6	121.1	115.5	108.6	104.0	102.7	99.5	95.7	91.4
Sex													
Male	116.9	113.6	111.9	107.7	101.3	95.6	90.2	86.2	83.9	80.8	77.5	75.5	72.2
Female	118.4	114.9	111.3	105.7	99.8	93.3	88.0	82.4	79.0	76.7	73.5	70.8	68.4
Age													
<18	14.1	11.9	9.1	13.0	15.5	16.6	*	9.4	15.9	8.5	*	9.7	*
0-4	*	*	*	*	*	*	*	*	45.4	*	*	*	*
5-11	*	*	*	*	*	*	*	*	*	*	*	.	*
12-17	*	11.8	*	*	15.7	13.7	*	*	*	*	*	*	*
18-44	40.1	40.6	39.0	38.0	37.2	34.9	32.3	30.5	30.6	28.9	26.6	26.9	25.9
18-24	19.9	19.3	24.3	24.2	23.6	18.7	18.1	16.1	17.9	18.5	17.9	13.2	14.1
25-44	41.8	42.4	40.3	39.1	38.3	36.3	33.5	31.7	31.7	29.7	27.3	27.9	26.9
45-64	88.9	85.7	83.9	80.4	75.3	72.8	67.8	64.7	63.0	60.4	58.4	56.9	54.7
45-54	72.3	68.9	66.0	63.6	60.7	59.2	56.3	52.7	51.4	47.2	47.6	44.8	43.4
55-64	103.1	99.8	98.6	94.0	86.6	83.3	76.5	73.6	71.5	69.7	65.8	65.1	62.1
65+	178.5	172.3	167.6	159.6	150.1	138.9	132.1	124.5	119.2	115.6	110.6	106.1	101.2
65-74	149.5	143.0	138.3	132.6	123.9	114.0	107.4	103.4	100.2	95.7	92.1	88.8	85.7
75-84	205.0	195.7	190.4	179.9	170.1	155.6	149.6	137.9	130.0	128.4	122.1	115.6	111.5
85+	277.5	278.8	265.6	244.6	225.4	214.3	199.6	187.2	178.6	171.8	163.1	161.0	146.5

*Data Source: Special analyses, Medicare 5 percent sample. Period prevalent dialysis patients; unadjusted. *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD, chronic kidney disease.*

The total death rate for patients with a functioning transplant has slowly declined since 2001, although in 2013 it still remained slightly above the HP2020 target at 31.8 deaths per 1,000 patient years at risk (Table 2.18). Rates were highest among American Indian/Alaskan Natives (36.6 per 1,000) and Whites (33.0 per 1,000), and lowest among Asians (18.8 per 1,000). With respect to sex, rates were higher among males (33.6 deaths per 1,000 patient years) compared with females (29.2 deaths per 1,000). Death rates for patients with functioning transplants were highest among those aged 65 and older, at 73.4 deaths per 1,000 patient years compared with those aged 18-44, at 7.6.

vol 2 **Table 2.18 HP2020 CKD-14.4 Reduce the total number of deaths for persons with a functioning kidney transplant: Target 29.3 deaths per 1,000 patient years at risk**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	34.2	32.2	33.4	32.0	32.5	31.9	31.5	30.3	31.7	31.7	31.8	31.9	31.8
Race													
American Indian or Alaskan Native only	40.5	36.6	42.1	41.1	40.8	45.0	37.8	38.7	57.0	48.3	44.4	43.5	36.6
Asian only	21.5	21.2	18.3	20.5	22.6	19.3	24.0	19.4	16.7	17.4	22.0	22.9	18.8
Native Hawaiian or other Pacific Islander only~	*	25.2	*	19.2	24.7	17.3	13.2	17.0	25.0	17.7	18.2	20.3	26.0
Black or African American only	38.6	36.3	37.6	34.0	34.7	34.1	30.5	31.2	30.8	30.5	31.3	30.7	30.4
White only	34.0	32.0	33.4	32.3	32.7	32.2	32.5	30.8	32.7	32.9	32.7	32.9	33.0
Two or more races					22.7	20.6	15.6	24.0	23.8	23.4	24.7	27.1	32.2
Ethnicity													
Hispanic or Latino	22.3	20.8	19.3	18.8	22.6	23.3	20.9	21.6	23.6	23.7	23.6	23.5	25.1
Not Hispanic or Latino	30.0	28.9	31.9	30.6	30.8	30.3	30.9	29.7	31.1	31.7	32.4	33.2	33.0
Black or African American only, not Hispanic or Latino	39.1	36.7	37.9	34.3	35.1	34.5	30.7	31.6	30.7	30.7	31.4	31.0	30.3
White only, not Hispanic or Latino	35.3	33.3	35.2	34.2	34.1	33.4	34.3	32.3	34.4	34.5	34.5	34.8	34.9
Sex													
Male	36.5	33.9	34.6	34.2	35.0	33.8	33.5	32.0	33.2	33.8	34.1	34.0	33.6
Female	30.8	29.8	31.7	28.9	29.0	29.2	28.4	27.8	29.5	28.6	28.5	29.0	29.2
Age													
<18	4.8	8.5	6.7	3.6	7.6	4.7	*	*	3.0	6.3	2.9	2.6	*
0-4	*	*	*	*	*	*	*	*	*	*	*	*	*
5-11	*	*	*	*	*	*	*	*	*	*	*	*	*
12-17	*	7.3	6.6	*	8.6	5.0	*	*	*	6.2	*	*	*
18-44	15.4	14.4	12.7	12.5	12.2	11.7	10.9	10.0	10.1	9.2	8.5	8.1	7.6
18-24	9.7	5.2	5.6	7.0	7.3	8.2	6.7	6.4	6.3	6.1	4.2	5.5	5.1
25-44	16.0	15.4	13.4	13.1	12.8	12.1	11.4	10.4	10.5	9.5	9.0	8.5	7.9
45-64	39.7	35.6	36.6	33.3	33.7	32.3	30.3	28.9	28.8	28.1	28.1	25.9	25.6
45-54	30.8	28.3	27.4	24.7	25.6	24.9	22.2	21.9	22.4	19.8	19.1	16.6	16.9
55-64	52.3	45.5	48.3	43.7	43.0	40.4	38.8	36.0	35.1	35.9	36.2	34.0	33.2
65+	91.7	85.9	91.0	87.1	83.6	79.8	80.0	73.3	77.0	75.4	74.2	76.7	73.4
65-74	85.9	80.5	82.2	78.9	76.4	70.5	71.3	63.8	66.9	65.7	63.4	64.7	61.2
75-84	137.7	126.5	153.2	138.0	124.2	130.3	122.0	117.0	121.3	113.6	115.3	120.0	117.3
85+	*	*	*	*	182.9	134.9	211.2	146.8	152.4	196.1	169.4	225.2	192.3

*Data Source: Special analyses, Medicare 5 percent sample. Period prevalent transplant patients, unadjusted. *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD, chronic kidney disease.*

The rate of cardiovascular mortality among transplant patients has fallen by 49% since 2001, and continued to meet the HP2020 target of 4.5 deaths per 1,000 patients, declining to three deaths per 1,000 in 2013 (see Table 2.19). Rates were lowest among Whites, at 2.9 deaths per 1,000 patients; and slightly lower among Hispanics/Latinos at 2.3. Rates were higher among males, at 3.3 deaths per 1,000 patients, compared to females, at 2.5, although both remained below the target.

vol 2 Table 2.19 HP2020 CKD-14.5 Reduce the number of cardiovascular deaths in persons with a functioning kidney transplant: Target 4.5 deaths per 1,000 patient years at risk

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All	5.9	5.3	5.4	5.8	5.7	5.4	5.3	4.3	4.4	4.4	3.7	3.5	3.0
Race													
American Indian or Alaskan Native only	*	9.4	*	*	*	*	*	*	*	*	*	*	*
Asian only	*	3.6	*	2.6	3.1	3.7	3.6	1.9	*	1.8	2.1	2.4	*
Native Hawaiian or other Pacific Islander only~	*	*	*	*	*	*	*	*	*	*	.	*	*
Black or African American only	7.2	6.3	6.5	6.3	6.1	6.2	5.5	5.1	5.2	5.0	4.4	4.0	3.4
White only	5.7	5.1	5.4	5.9	5.7	5.3	5.4	4.2	4.3	4.4	3.7	3.5	2.9
Two or more races					*	4.8	*	*	4.1	*	*	*	4.0
Ethnicity													
Hispanic or Latino	3.7	4.5	3.4	3.5	3.9	4.1	3.3	3.4	3.5	3.0	3.3	2.3	2.3
Not Hispanic or Latino	5.7	5.2	5.6	5.6	5.6	5.3	5.3	4.3	4.4	4.7	3.8	3.8	3.2
Black or African American only, not Hispanic or Latino	7.4	6.3	6.6	6.4	6.2	6.3	5.6	5.2	5.2	4.9	4.3	4.0	3.4
White only, not Hispanic or Latino	6.0	5.2	5.6	6.3	5.9	5.4	5.7	4.3	4.5	4.7	3.7	3.7	3.1
Sex													
Male	6.4	5.8	5.7	6.5	6.1	5.7	6.0	4.8	4.4	4.9	4.1	3.6	3.3
Female	5.1	4.7	5.0	4.9	5.1	4.9	4.2	3.6	4.3	3.7	3.0	3.3	2.5
Age													
<18	*	*	*	.	*	*	*	*	.	*	.	*	.
0-4	*	*	.	.	.	.	*	.	.	*	.	.	.
5-11	*	.	*	.	.	.	.	.	.	.	.	.	.
12-17	*	*	*	.	*	*	*	*	.	*	.	*	.
18-44	2.6	2.7	2.4	2.5	2.4	2.1	2.1	1.8	1.4	1.3	1.0	1.2	1.2
18-24	*	*	*	*	*	*	*	*	*	*	*	*	*
25-44	2.8	2.9	2.5	2.7	2.5	2.2	2.2	1.9	1.5	1.4	1.0	1.2	1.3
45-64	7.1	6.0	6.1	6.4	5.9	5.8	5.3	4.3	4.1	4.2	3.5	2.9	2.6
45-54	6.6	4.5	5.0	5.4	4.6	4.4	4.4	3.4	3.4	2.9	2.3	2.0	1.9
55-64	7.8	7.9	7.5	7.6	7.4	7.3	6.2	5.2	4.8	5.5	4.6	3.7	3.2
65+	13.9	12.9	13.2	14.1	13.9	12.1	12.2	8.9	10.2	9.6	8.0	7.8	5.9
65-74	13.7	11.6	11.7	13.3	13.4	10.4	10.9	8.3	8.9	8.9	7.6	6.7	5.4
75-84	15.1	22.5	24.2	19.4	16.2	22.0	18.4	11.9	16.5	12.2	9.1	12.3	8.1
85+	*	*	.	*	*	.	*	*	*	*	*	*	*

*Data Source: Special analyses, Medicare 5 percent sample. Period prevalent transplant patients, unadjusted. "." Zero values in this cell; *Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD, chronic kidney disease.*

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Notes

Chapter 3: Clinical Indicators and Preventive Care

Anemia

- The majority (65%) of hemodialysis patients in December 2014 had Hgb levels between 10-12 g/dL, while nearly 14% had Hgb ≥12 g/dL. 6% had Hgb less than 9 g/dL while 15% had Hgb between 9-10g/dL, with the mean Hgb being 10.8g/dL.
- The majority (55%) of peritoneal dialysis patients in December 2014 had Hgb levels of 10-12 g/dL, while 21%, had Hgb ≥12 g/dL. 7% had Hgb less than 9 g/dL while 16% had Hgb between 9-10g/dL, with the mean Hgb being 10.9g/dL.
- From December 2012 to December 2013, EPO doses declined by 5-7% in hemodialysis and peritoneal dialysis patients in the United States. In 2013, average monthly EPO doses were approximately 10,600 units/week and 9,500 units/week for hemodialysis and peritoneal dialysis patients, respectively.
- Little change was seen in IV iron use and IV iron dose from 2012 to 2013 in U.S. dialysis patients.
- Serum ferritin levels rose in all dialysis patients from 2012 to 2014, with 58% of hemodialysis patients and 39% of peritoneal dialysis patients having serum ferritin levels>800 ng/mL.

Mineral and Bone Disorder

- 56% of hemodialysis and 55% of peritoneal dialysis patients had calcium levels within a typical laboratory reference range (8.4-9.5 mg/dL); 4% had calcium levels >10.2 mg/dL, whereas 15% of hemodialysis patients and 21% of peritoneal dialysis patients had calcium levels <8.4 mg/dL.
- In December 2014, 37% of hemodialysis patients and 42% of peritoneal dialysis patients had serum phosphorus levels >5.5 mg/dL.

Preventive Care

- In 2013, only 33% of ESRD patients with diabetes received comprehensive diabetes monitoring (defined as at least one HbA1c test, one lipid test, and one dilated eye exam). This is a decline from 37% in 2010.
- 71% of patients received an influenza vaccination in the 2012-2013 flu season, which is still below the Healthy People 2020 (HP2020) target of 90%. However, it represents a steady increase from 58% in the 2003-2004 season.

Introduction

Given the high morbidity and mortality of individuals in the end-stage renal disease (ESRD) population on dialysis, initiatives aimed at quality improvement have long been a priority. Notable efforts from the Centers for Medicare & Medicaid Services (CMS) include assessment and reporting of provider performance through Dialysis Facility Reports (DFR) and Dialysis Facility Compare (DFC) (www.dialysisdata.org), as well as the Quality Incentive Program (QIP), which ties Medicare reimbursement to achievement of selected quality targets. Data collection for these projects has been undergoing a transition from paper-based data entry to web-based or electronic data entry, the Consolidated Renal Operations in a Web-Enabled Network (CROWNWeb). This system, which was implemented nationally in May 2012, allows for monthly submission of selected laboratory and clinical data from facilities for patients under their care though the system is still evolving and not all data are fully captured. CMS ESRD data for the Annual Data Report (ADR) have traditionally relied on Medicare claims, but last year, for the first time, CROWNWeb data were used for analyses in this chapter pertaining to dialysis adequacy, vascular access among prevalent hemodialysis patients, and selected anemia measures. This year, CROWNWeb data are used in this chapter for analyses on dialysis adequacy, bone and mineral disorders, and selected anemia measures. Reporting on vascular access has been moved to a new chapter this year: Chapter 4: Vascular Access.

Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Clinical Indicators

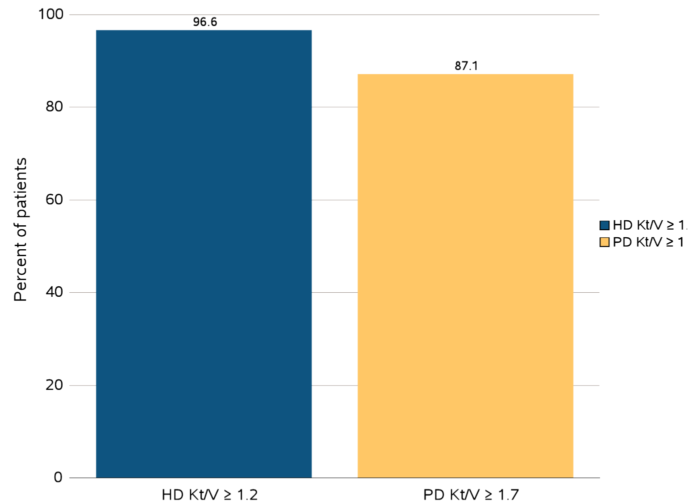
In Figure 3.1, we present CROWNWeb data from December 2014 on a selection of clinical indicators relating to dialysis adequacy, achieved hemoglobin (Hgb) level, and hypercalcemia. Figure 3.1.a shows that achievement of dialysis adequacy targets for hemodialysis is nearly universal, with 97% of patients obtaining a single pool Kt/V ≥1.2 (for more information about Kt/V see the Glossary). Achievement of the dialysis adequacy target for peritoneal dialysis (a weekly Kt/V ≥1.7) is somewhat lower at 87% (Figure 3.1.a).

Views on anemia treatment with srythropoiesis-stimulating agents (ESAs) have evolved in recent years, as safety concerns have emerged from clinical trials about maintaining Hgb levels greater than 11.5 to 13g/dL, with guidelines recommending Hgb correction to less than 11.5g/dL. This has resulted in generally lower Hgb levels among dialysis patients. Using CROWNWeb data, Figure 3.1.b presents a more representative view of Hgb levels for the dialysis population than was previously possible, as it includes data from both Medicare and non-Medicare insured patients. Among hemodialysis patients (both ESA-treated and non-treated), the majority (65%) have Hgb levels in the range of 10-12 g/dL, with 13.5% having Hgb ≥12 g/dL. The pattern is similar with peritoneal dialysis patients, though a somewhat higher percentage (21.4%) have Hgb ≥12 g/dL. Later in this chapter, Medicare claims (updated through 2013) are utilized for the anemia analyses in order to provide information on time trends. In addition, CROWNWeb data are used to describe iron indices (ferritin and transferrin saturation).

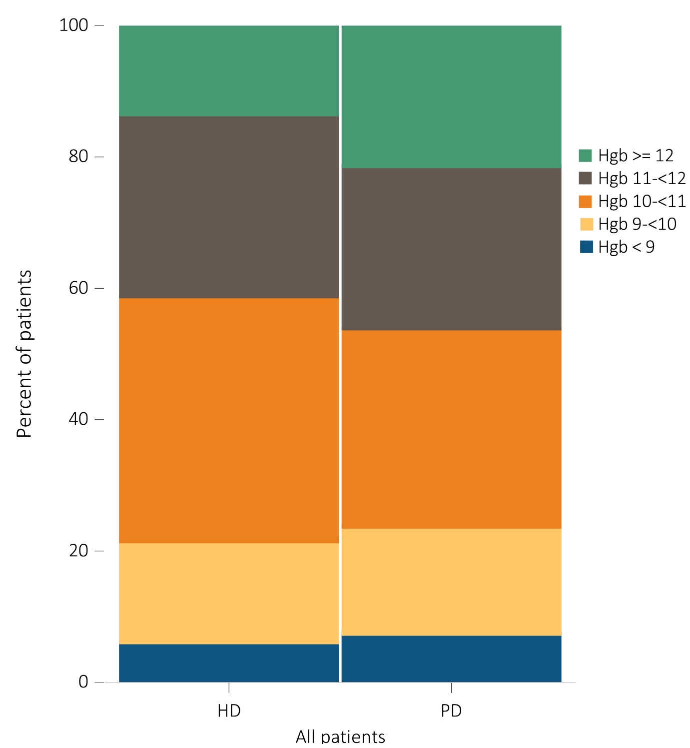
In Figure 3.1.c we present CROWNWeb data on the percentage of dialysis patients with serum calcium levels >10.2 mg/dL as of December 2014, calculated as a three-month rolling average, similar to methods utilized by the QIP. The rationale for this measure is to encourage avoidance of hypercalcemia given its associations with vascular calcifications and cardiovascular events. Later in the chapter we present additional CROWNWeb data on trends in serum calcium and phosphorus levels.

vol 2 Figure 3.1 ESRD clinical indicators: (a) percentage of prevalent hemodialysis and peritoneal dialysis patients meeting clinical care guidelines for dialysis adequacy by modality, (b) percentage distribution of achieved mean Hgb among prevalent hemodialysis and peritoneal dialysis patients; and (c) percentage of patients with serum calcium >10.2 mg/dL by modality, CROWNWeb data, December 2014

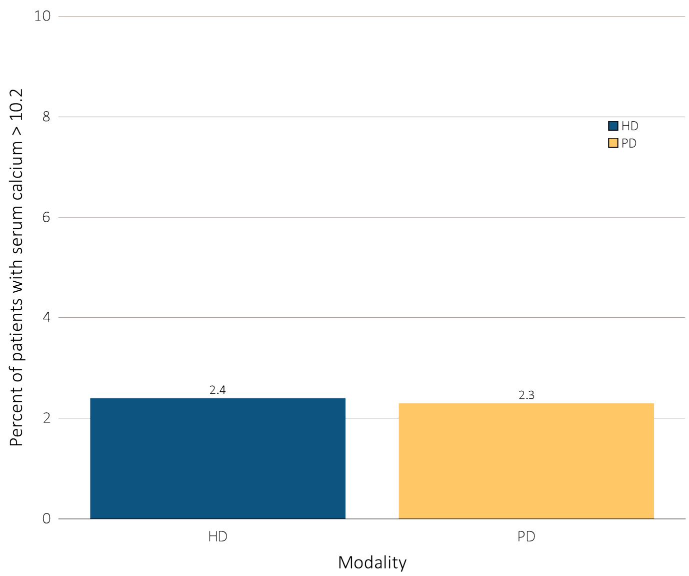
(a) Percentage of prevalent hemodialysis and peritoneal dialysis patients meeting clinical care guidelines for dialysis adequacy by modality



(b) percentage distribution of achieved mean Hgb among prevalent hemodialysis and peritoneal dialysis patients



(c) Percentage of patients with serum calcium >10.2 mg/dL by modality



Data Source: Special analyses, USRDS ESRD Database. Results shown are for laboratory values reported to CROWNWeb for December 2014, restricted to patients as follows: Panel a: Dialysis patients initiating treatment for ESRD at least 1 year prior to December 1, 2014, and who were alive through December 31, 2014. Panel b: Dialysis patients initiating treatment for ESRD at least 90 days prior to December 1, 2014, who were ≥18 years old as of December 1, 2014, and who were alive through December 31, 2014. Panel c: Hemodialysis and peritoneal dialysis patients initiating treatment for ESRD at least 90 days prior to December 1, 2014, who were ≥18 years old as of December 1, 2014, and who were alive through December 31, 2014. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; Hgb, hemoglobin; Kt/V, see Glossary; PD, peritoneal dialysis.

Anemia Treatment by Modality

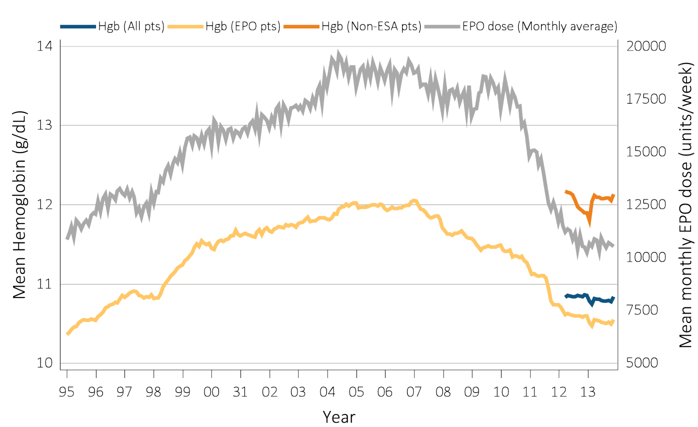
In this section, long-term trends in Hgb levels, ESA use, erythropoietin (EPO) dose, intravenous (IV) iron use, IV iron dose, levels of iron stores, and red blood cell transfusion rates are described through the year 2013 by dialysis modality in CMS claims data. New additions to this section in 2015 include the first description of serum ferritin and transferrin saturation (TSAT) levels as a result of the availability of these data from CROWNWeb for years 2012 to 2014. Furthermore, monthly mean IV iron doses are now provided for years 2005 to 2013 based on CMS claims data. Prior to 2012, to meet CMS billing requirements, Hgb values were only reported by dialysis providers when filing a claim for patients receiving an ESA during the given month. Consequently, Hgb values based on CMS claims data prior to 2012 were restricted to ESA-treated patients. Beginning in 2012, CMS required reporting of Hgb values for all patients, regardless of whether they received an ESA. This allows a comparison of Hgb values for ESA-treated patients to non-ESA treated patients and compared to *all* patients based upon CMS claims data beginning in April 2012.

Hgb Levels, ESA Use, and EPO Dose in Hemodialysis Patients

Claims data indicate that mean Hgb levels have declined substantially since they peaked near 12.0 g/dL in 2007 in ESA-treated hemodialysis patients (Figure 3.2). During 2011, the mean Hgb level for ESA-treated hemodialysis patients declined by 0.5 g/dL from 11.2 g/dL to 10.7 g/dL. Since then, Hgb levels have continued to decline to a mean monthly Hgb of 10.5 g/dL among ESA-treated hemodialysis patients in 2013. In contrast, mean monthly Hgb values in 2013 were 10.8 g/dL for *all* hemodialysis patients and 12.0 g/dL for non-ESA treated patients. Similarly, analyses of CROWNWeb data have indicated a similar mean Hgb level of 10.8 g/dL for *all* hemodialysis patients on December 31, 2013. Mean Hgb levels appeared to have stabilized in 2013, with only small changes in mean values across most months of 2013.

Typically, 79-80% of hemodialysis patients had a claim for ESA use during any single month in 2013. Among hemodialysis patients with an ESA claim in 2013, 96.5% of patients received EPO and 3.5% received darbepoetin. Between 2007 and 2013, mean monthly EPO doses (averaged over a month) have declined 42% in hemodialysis patients, with a nearly 5% decline from 2012 to 2013 (Figure 3.2). Throughout 2013, the mean monthly EPO dose (averaged over a month) was relatively stable, with a typical mean monthly EPO dose of 10,620 +/- 17.9 units/week.

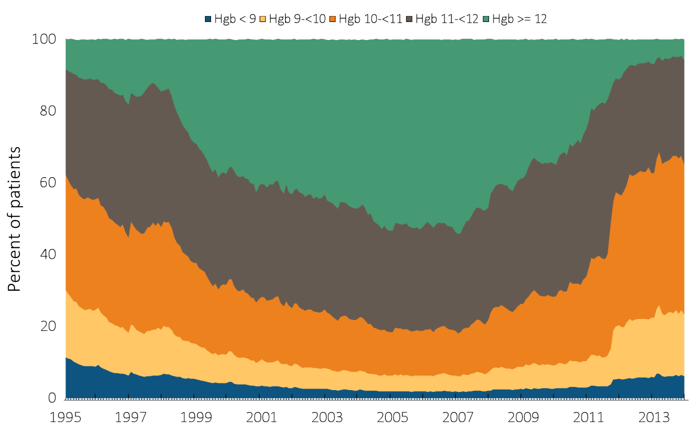
vol 2 Figure 3.2 Mean monthly Hgb level and mean monthly EPO dose (expressed as units/week) in adult hemodialysis patients on dialysis ≥90 days, Medicare claims, 1995-2013



Data Source: Special analyses, USRDS ESRD Database. Mean monthly Hgb level among ESA-treated hemodialysis patients within a given month (1995 through 2013) or all hemodialysis patients (April 2012 to December 2013 only) who, within the given month, had a Hgb claim, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. Mean monthly EPO (epoetin alfa) dose is shown for hemodialysis patients within a given month who had an EPO claim, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. EPO dose is expressed as mean EPO units per week averaged over all EPO claims within a given month. Abbreviations: EPO, erythropoietin; ESA, erythropoiesis-stimulating agents; Hgb, hemoglobin.

Between 2007 and 2013, a large shift was seen in the percentage of ESA-treated hemodialysis patients in the highest versus lowest categories of Hgb levels (Figure 3.3). The percentage with Hgb <10 g/dL increased from 7% in 2007 to 24% in 2013 among ESA-treated patients, while the percentage with Hgb ≥12 g/dL declined from 50% in 2007 to 5% in 2013. Among all hemodialysis patients in December 2013, 5.4% had Hgb <9g/dL, 14.7% had Hgb of 9.0 to <10g/dL, 65.3% had Hgb between 10-12g/dL, and 14.6% had Hgb ≥12 g/dL.

vol 2 Figure 3.3 Distribution of monthly Hgb (g/dL) levels in ESA-treated adult hemodialysis patients on dialysis ≥90 days, Medicare claims, 1995-2013

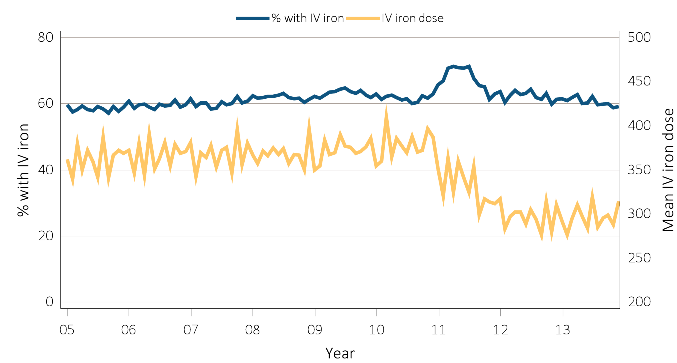


Data Source: Special analyses, USRDS ESRD Database. Distribution among hemodialysis patients within a given month who had claims for Hgb level and ESA use, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. Abbreviations: ESA, erythropoiesis-stimulating agents; Hgb, hemoglobin.

IV Iron Use, IV Iron Dose, and Measures of Iron Stores in Hemodialysis Patients

Trends in IV iron use for hemodialysis patients from 2005 to 2013 are shown in Figure 3.4. IV iron use increased sharply from 60% in August 2010 to 71% by April 2011. However, since July 2011, IV iron use has declined steadily to 59% by December 2013, essentially the pre-bundled payment level. This year for the first time, the trend in mean monthly IV iron dose is provided for 2005 through 2013, as calculated among patients with an IV iron dose claim during a month. The average mean monthly IV iron dose per year rose from 362 mg in 2005 to 378 mg in 2010. However, coincident with the 2011 implementation of the new CMS Prospective Payment System, IV iron doses declined from an average mean monthly IV iron dose of 332 mg in 2011, to 297 mg in 2012, and 296 mg in 2013. Thus, since 2011, both IV iron use and the average monthly IV iron dose have declined in the United States among hemodialysis patients.

vol 2 Figure 3.4 Monthly IV iron use and mean monthly IV iron dose in adult hemodialysis patients on dialysis ≥90 days, Medicare claims, 2005-2013

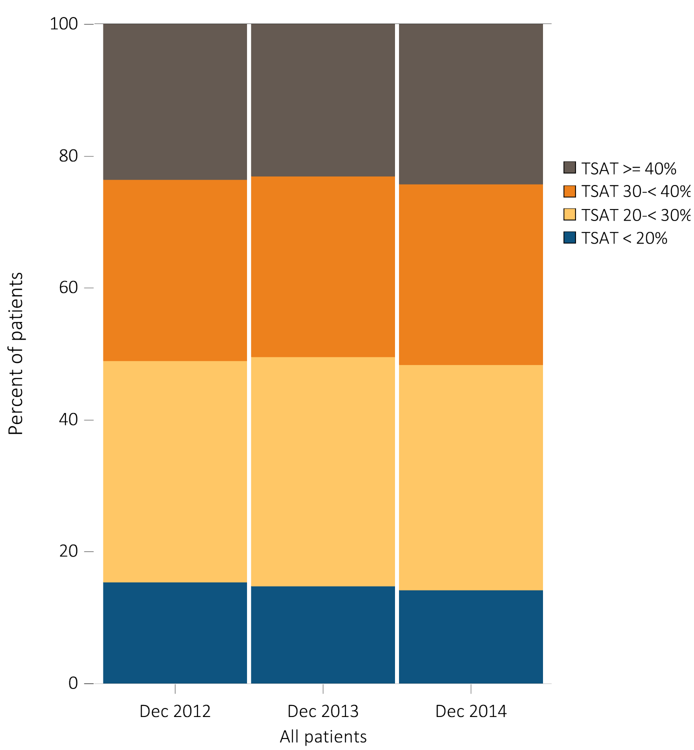


Data Source: Special analyses, USRDS ESRD Database. Monthly IV iron use is among hemodialysis patients on dialysis ≥90 days and ≥18 years old at the start of the given month. Mean IV iron dose was calculated as the average does of IV iron a patient received, among patients receiving iron during the month. Abbreviation: IV, intravenous.

The iron store measures, transferrin saturation (TSAT) and serum ferritin, are now reported by U.S. dialysis units as part of CROWNWeb data collection. This reporting has allowed, for the first time in the ADR, the presentation of distributions of TSAT and serum ferritin, for years 2012 through 2014. Reporting of these measures into CROWNWeb has increased over time. For example, when based upon the most recent serum ferritin value reported in the prior three months, serum ferritin was reported for N=280,870 hemodialysis patients in 2012 versus N=375,188 hemodialysis patients in 2014. Typically, reporting of TSAT levels in hemodialysis patients was 20-30% lower than for serum ferritin levels. Due to the changes in reporting of data from facilities over time, the trends noted below should be interpreted cautiously.

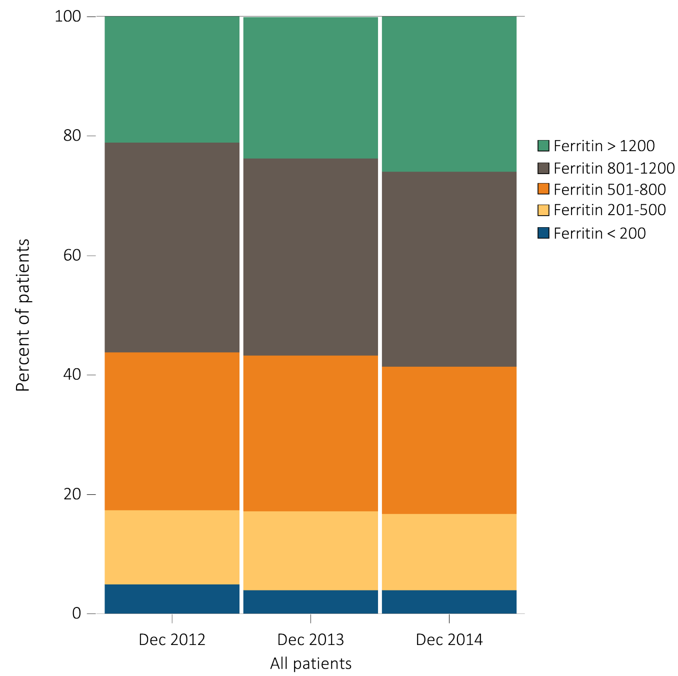
Across the three end-of-year TSAT cross-sections shown in Figure 3.5, 14.4% of patients had a TSAT <20%, with 34%, 27%, and 25% of patients having TSAT levels of 20 to <30%, 30% to <40%, and ≥40%, respectively. Over this three-year time period, the percentage of patients with TSAT<20% declined modestly from 15.1% to 13.8%, and the percentage of patients in the other TSAT categories remained relatively stable. Across the three end-of-year serum ferritin cross-sections shown in Figure 3.6, 4.3% of patients had serum ferritin ≤200 ng/mL, with 13%, 26%, 34%, and 24% of patients having serum ferritin levels of 201-500, 501-800, 801-1200, and >1200 ng/mL, respectively. Over this three-year time period, the percentage of patients with serum ferritin >1200 ng/mL gradually increased from 21% to 26%, accompanied with small declines in the percentage of patients with serum ferritin levels of 501-800 and 801-1200 ng/mL, suggesting a shift over time toward higher serum ferritin levels. Consistent with this, the mean serum ferritin level increased from 904 to 985 ng/mL from the December 2012 to December 2014 cross-section.

vol 2 **Figure 3.5 Distribution of TSAT levels (%) in adult hemodialysis patients on dialysis for at least 1 year, CROWNWeb data, December 2012, 2013, and 2014**



Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for December 2012, December 2013 and December 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of TSAT level for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year. Abbreviation: TSAT, transferrin saturation.

vol 2 **Figure 3.6 Distribution of the most recent value of serum ferritin (ng/mL) level taken between October and December in adult hemodialysis patients on dialysis for at least 1 year, CROWNWeb data, 2012-2014**



Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for October to December for years 2012, 2013 and 2014. Dialysis patients initiating treatment for ESRD at least 1 year at the time of measurement of serum ferritin for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year.

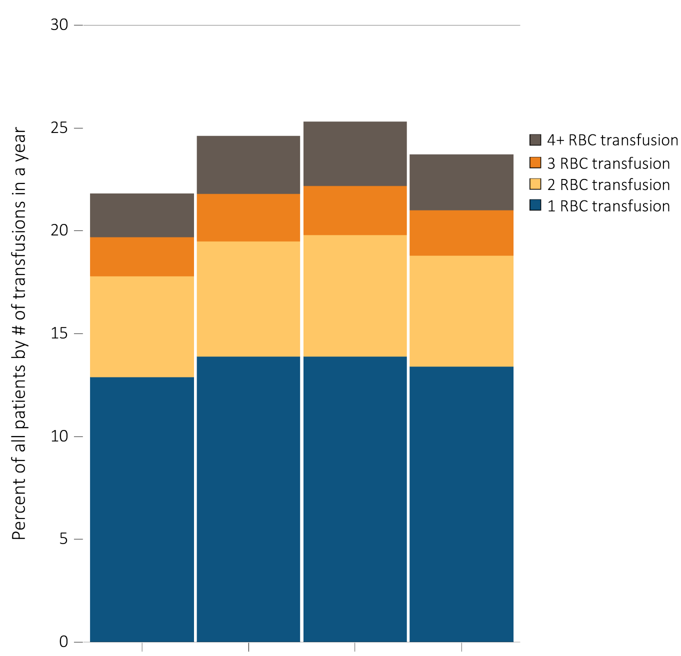
Red Blood Cell Transfusions in Hemodialysis Patients

The distribution of the number of red blood cell transfusions received by hemodialysis patients, by year, is shown in Figure 3.7.a, during 2010 through 2013, based on CMS claims data. The results shown are for all adults (≥18 years old) receiving at least one hemodialysis treatment during a given year, and represent the entire hemodialysis patient population. However, because some individuals did not receive hemodialysis therapy for the entire year, these results should be interpreted cautiously. The results indicate that 21.7% of hemodialysis patients received ≥1 red blood cell transfusion in year 2010, which increased to approximately 25% of patients in years 2011 and 2012, and decreased to 23.9% of hemodialysis patients in 2013. Across this four-year time period, typically 13-14% of patients received one red blood cell transfusion per year, 5-6% received two red blood cell transfusions per year, with 2.0-2.5% receiving 3 transfusions per year, and 2-3% receiving ≥4 red blood cell transfusions per year. Sensitivity analyses demonstrated that the percentage of hemodialysis patients receiving ≥1 red blood cell transfusion in a year was slightly higher when including any patient who received at least one hemodialysis treatment during the year compared to analyses requiring that patients receive hemodialysis for at least 30, 90, or 180 days within the indicated year for inclusion in the given analysis.

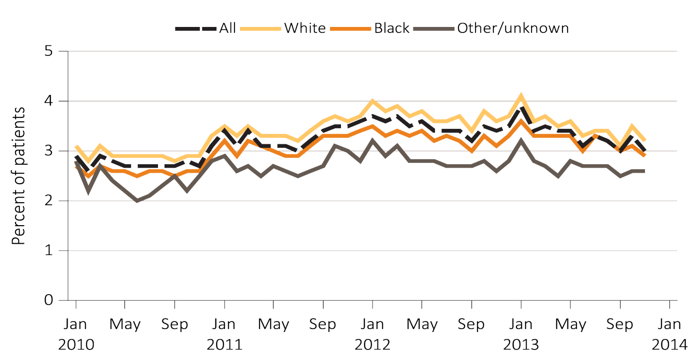
The percentage of hemodialysis patients with red blood cell transfusions within a month showed some variation by race (3.7.b). Among hemodialysis patients, from January to November 2013, on average, 3.5% of White patients had ≥1 red blood cell transfusions in a month compared to 3.2% of Black patients and 2.7% of patients of Other/Unknown race.

vol 2 **Figure 3.7 Percentage of all adult hemodialysis patients (a) by number of red blood cell transfusions received in a year, and (b) with ≥1 claims for a red blood cell transfusion in a month by race, from Medicare claims data, 2010-2013**

(a) Number of red blood cell transfusions in a year



(b) With ≥1 claims for a red blood cell transfusion in a month by race



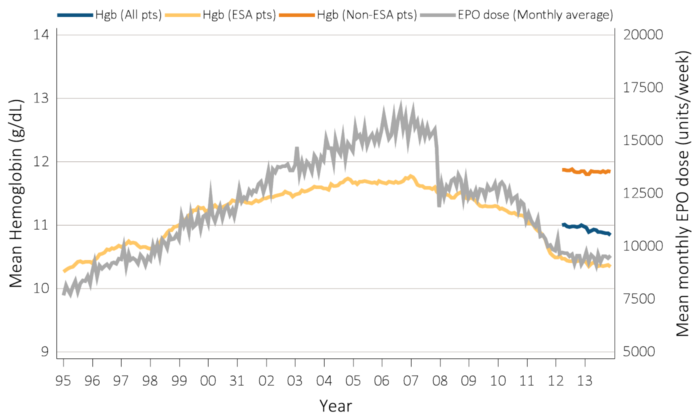
Data Source: Special analyses, USRDS ESRD Database. The percentage of hemodialysis patients ≥18 years old at the start of the month with ≥1 red blood cell transfusion claims in a given month among hemodialysis patients having a claim for at least one dialysis session during the month. Abbreviation: RBC, red blood cell.

Hgb Levels, ESA Use, and EPO Dose in Peritoneal Dialysis Patients

Claims data indicate that mean Hgb levels have declined substantially in ESA-treated peritoneal dialysis patients since peaking near 11.8 g/dL in January 2007 (Figure 3.8). During 2011, the mean Hgb level for ESA-treated peritoneal dialysis patients declined 0.6 g/dL from 11.1 g/dL to 10.5 g/dL. This was a larger decline, and the mean Hgb level achieved was lower than that seen for ESA-treated hemodialysis patients during 2011. Since then, Hgb levels have continued to decline to a mean monthly Hgb of 10.4 g/dL among ESA-treated peritoneal dialysis patients. In contrast, mean monthly Hgb values in 2013 of 10.9 g/dL were seen for *all* peritoneal dialysis patients and 11.8 g/dL for non-ESA treated patients. Similarly, analyses of CROWNWeb data have indicated a similar mean Hgb level of 10.9 g/dL for *all* peritoneal dialysis patients on December 31, 2013. Mean Hgb levels appear to have stabilized in 2013, with only small changes in mean values across most months of 2013.

The percentage of peritoneal dialysis patients with an ESA claim during any single month increased from 58% to 63% during 2013. Among peritoneal dialysis patients with an ESA claim in 2013, approximately 93% received EPO and 7% received darbepoetin. Mean monthly EPO dose (expressed as units per week) in peritoneal dialysis patients declined 18% from December 2010 to December 2011 (Figure 3.8). In 2012, mean monthly EPO doses declined by an additional 7%, from 9,857 units per week in December 2011 to 9,145 units per week in December 2012. Throughout 2013, the mean monthly EPO dose was relatively stable, with a typical mean monthly EPO dose of 9,453 +/- 15 units/week. The rapid, large decline in mean monthly EPO dose seen at the start of 2008 (Figure 3.8) is under further investigation since this change also coincides with a change in the reporting codes for EPO-related claims submission at that time.

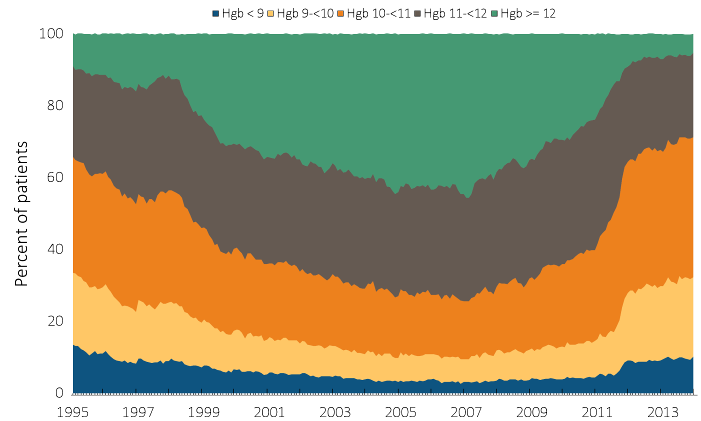
vol 2 Figure 3.8 Mean monthly Hgb level and mean monthly EPO dose (expressed as units/week) in adult peritoneal dialysis patients on dialysis ≥90 days, Medicare claims, 1995-2013



Data Source: Special analyses, USRDS ESRD Database. Mean monthly Hgb level among ESA-treated peritoneal dialysis patients within a given month (1995 through 2013) or all peritoneal dialysis patients (April 2012 to December 2013 only) who, within the given month, had an Hgb claim, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. Mean monthly EPO (epoetin alfa) dose is shown for peritoneal dialysis patients within a given month who had an EPO claim, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. EPO dose is expressed as mean EPO units per week averaged over all EPO claims within a given month. Abbreviations: EPO, erythropoietin; ESA, erythropoiesis-stimulating agents; Hgb, hemoglobin; Hgb (non-ESA), hemoglobin levels among patients not receiving an ESA during the month.

Between 2007 and 2013, a large shift was seen in the percentage of ESA-treated peritoneal dialysis patients in the highest versus lowest Hgb concentration categories (Figure 3.9). Among ESA-treated patients, the percentage with Hgb <10 g/dL increased from 11% in 2007 to 32% in 2013, while the percentage with Hgb ≥12 g/dL declined from 41% in 2007 to 6% in 2013. Among all peritoneal dialysis patients in December 2013, 8% had Hgb <9g/dL, 17% had Hgb of 9.0 to <10g/dL, 56% had Hgb between 10-12g/dL, and 19% had Hgb ≥12 g/dL.

vol 2 Figure 3.9 Distribution of monthly Hgb (g/dL) levels in ESA-treated adult (≥18 years old) peritoneal dialysis patients on dialysis ≥90 days, Medicare claims, 1995-2013

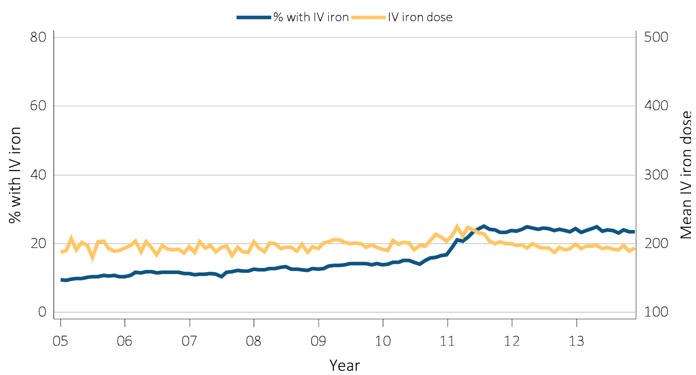


Data Source: Special analyses, USRDS ESRD Database. Distribution of Hgb levels among peritoneal dialysis patients within a given month who had claims for Hgb level and ESA use, were on dialysis ≥90 days, and were ≥18 years old at the start of the month. Abbreviations: ESA, erythropoiesis-stimulating agents; Hgb, hemoglobin.

IV Iron Use, IV Iron Dose, and Measures of Iron Stores in Peritoneal Dialysis Patients

Trends in IV iron use are shown from 2005 through 2013 for peritoneal dialysis patients (Figure 3.10). IV iron use increased sharply from 16% in November 2010 to 25% by August 2011. IV iron use has since declined slightly to 24% in December 2013. In the 2015 ADR, the trend in mean monthly IV iron dose is provided for the first time, covering the time period from 2005 through 2013, as calculated among patients with an IV iron dose claim during a month. The average of the mean monthly IV iron dose within a year steadily rose from 194 mg in 2005 to 211 mg in 2011. However, coincident with the 2011 implementation of the new CMS Prospective Payment System, IV iron doses declined to an average mean monthly IV iron dose of 195 mg in 2012. The average mean monthly IV iron dose in 2013 (194 mg) was nearly the same as that seen in 2012 (195 mg). Thus, since 2011, IV iron use has increased while the average monthly IV iron dose among patients given iron has declined in the United States among peritoneal dialysis patients.

vol 2 Figure 3.10 Monthly IV iron use and mean monthly IV iron dose in adult peritoneal dialysis patients on dialysis ≥90 days, Medicare claims, 2005-2013

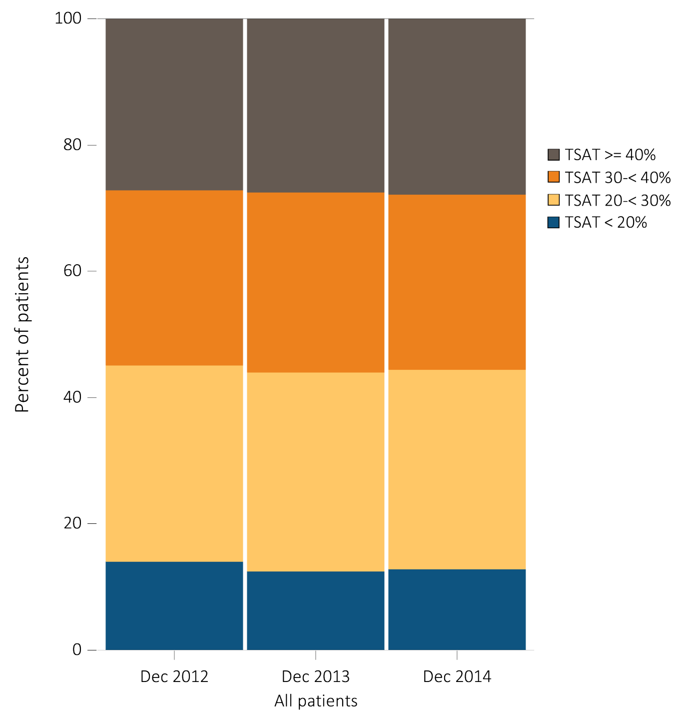


Data Source: Special analyses, USRDS ESRD Database. Monthly IV iron use is among peritoneal dialysis patients on dialysis ≥90 days and ≥18 years old at the start of the given month. Mean IV iron dose was calculated as the average does of IV iron a patient received, among patients receiving iron during the month. Abbreviation: IV, intravenous.

As mentioned previously, reporting of the iron store measures, transferrin saturation (TSAT) and serum ferritin, has gradually increased over time. For example, when based upon the most recent serum ferritin value reported in the prior three months, serum ferritin was reported for N=19,530 peritoneal dialysis patients in 2012 versus N=30,826 peritoneal dialysis patients in 2014. Typically, reporting of TSAT levels was 2-15% lower than for serum ferritin levels in peritoneal dialysis patients. Due to the changes in reporting of data from facilities over time, the trends noted below should be interpreted cautiously.

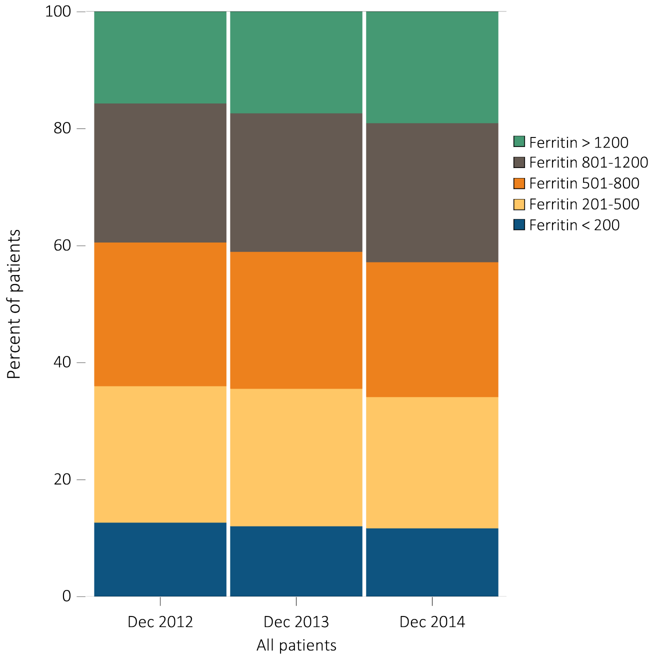
Across the three end-of-year TSAT cross-sections shown in Figure 3.11, 13% of patients had a TSAT<20%, with 31%, 28%, and 28% of patients having TSAT levels of 20 to <30%, 30% to <40%, and ≥40%, respectively. Over this three-year time period, the percentage of patients with a TSAT<20% gradually declined from 14% to 13% whereas the percentage of patients in the other TSAT categories remained relatively stable over this time period. Across the three end-of-year serum ferritin cross-sections shown in Figure 3.12, 12% of patients had a serum ferritin ≤200 ng/mL, with 23%, 24%, 24%, and 17% of patients having serum ferritin levels of 201-500, 501-800, 801-1200, and >1200 ng/mL. Over this three-year time period, the percentage of patients with a serum ferritin >1200 ng/mL gradually increased from 16% to 19%, accompanied with small declines in the percentage of patients with serum ferritin levels of 501-800 and 801-1200 ng/mL suggesting a gradual shift over time from lower to higher serum ferritin levels. Consistent with this, the mean serum ferritin level increased from 737 to 785 ng/mL from the December 2012 to December 2014 cross-section.

vol 2 Figure 3.11 Distribution of TSAT levels (%) in adult peritoneal dialysis patients on dialysis for at least 1 year, CROWNWeb data, December 2012, 2013, and 2014



Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for October to December for years 2012, 2013 and 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of TSAT level for that year, ≥18 years old as of December 1st of that year, and who were alive through December 31 of that year. Abbreviation: TSAT, transferrin saturation.

vol 2 Figure 3.12 Distribution of the most recent serum ferritin (ng/mL) level taken between October and December in adult peritoneal dialysis patients on dialysis for at least 1 year, CROWNWeb data, December 2012, 2013, and 2014



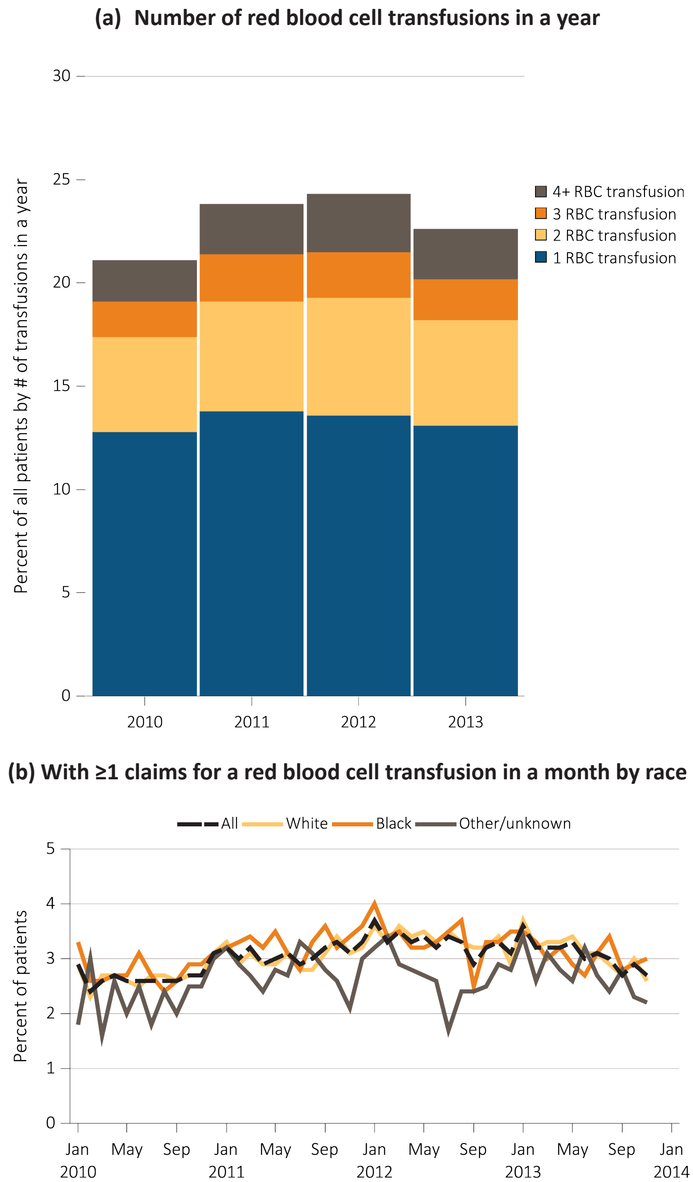
Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for October to December for years 2012, 2013 and 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of serum ferritin for that year, ≥18 years old as of December 1 of that year, and who were alive through December 31 of that year.

Red Blood Cell Transfusions in Peritoneal Dialysis Patients

The distribution of the number of red blood cell transfusions received by peritoneal dialysis patients, by year, is shown in Figure 3.13.a, for years 2010 through 2013. The results shown are for all adults (≥18 years old) receiving at least one peritoneal dialysis treatment during a given year. However, because some individuals did not receive hemodialysis therapy for the entire year, these results should be interpreted cautiously. The results indicate that 21.2% of peritoneal dialysis patients received ≥1 red blood cell transfusion in year 2010, which increased to approximately 24% of patients in years 2011 and 2012, and declined to 22.6% of peritoneal dialysis patients in 2013. Across this four-year time period, typically 13-14% of peritoneal dialysis patients received one red blood cell transfusion per year, 4.6-5.7% received two red blood cell transfusions per year, with approximately 2% receiving 3 transfusions per year, and 2-3% receiving ≥4 red blood cell transfusions per year.

In 2013, an average of 3.1% of peritoneal dialysis patients in a month received red blood cell transfusions both among Black and White peritoneal dialysis patients compared with 2.7% among patients of Other/Unknown race.

vol 2 Figure 3.13 Percentage of all adult peritoneal dialysis patients (a) by number of red blood cell transfusions received in a year, and (b) with ≥1 claims for a red blood cell transfusion in a month by race, from Medicare claims data, 2010-2013



Data Source: Special analyses, USRDS ESRD Database. The percentage of peritoneal dialysis patients with ≥1 red blood cell transfusion claims in a given month was among peritoneal dialysis patients having a claim for at least one dialysis session during the month, and who were ≥18 years old at the start of the month. Abbreviation: RBC, red blood cell.

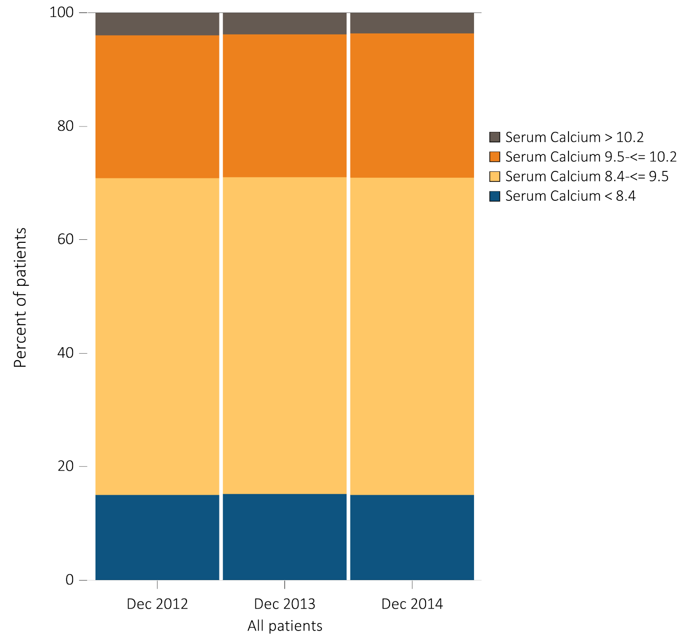
Mineral and Bone Disorder

Evidence from basic scientific and epidemiological studies supports the role of abnormalities in markers of mineral and bone metabolism in the pathogenesis of vascular calcifications and cardiovascular disease, which contributes to increased hospital admissions and mortality in the ESRD population. Specifically, elevated levels of calcium and phosphorus have been associated with increased cardiovascular events and mortality. Very low calcium and phosphorus levels have also been associated with poor outcomes, likely mediated in part by poor nutritional status. Finally, the possibility of inappropriate treatment should be considered when a patient on chronic dialysis presents with very low levels of calcium and phosphorus. Based on these observations, current Kidney Disease: Improving Global Outcomes (KDIGO) clinical practice guidelines (KDIGO, 2009) suggest maintaining calcium and phosphorus levels in the laboratory reference range among patients on chronic dialysis.

Calcium

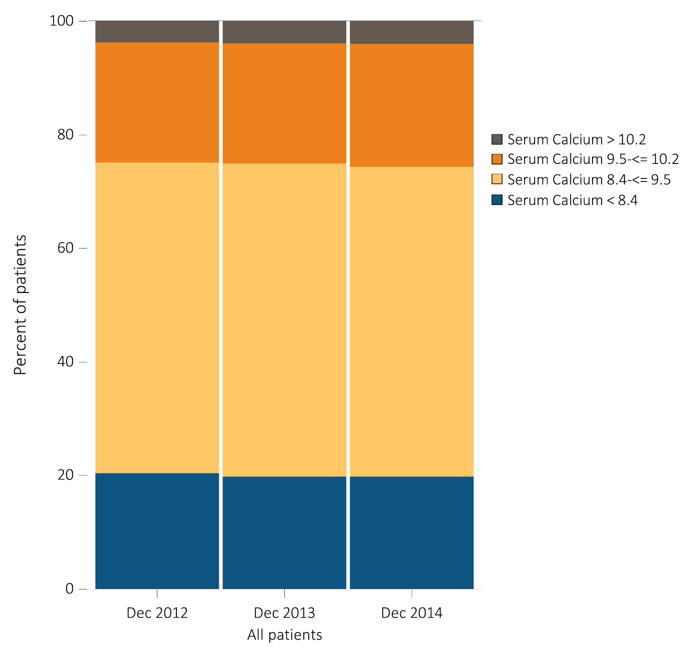
The distributions of calcium levels among adult hemodialysis and peritoneal dialysis patients are shown in Figures 3.14 and 3.15. Between 2012 and 2014, no substantial change in calcium distribution was observed. The majority of patients (hemodialysis: 56%, peritoneal dialysis: 55%) had calcium levels within a typical laboratory reference range (8.4-9.5 mg/dL), while a very small percentage (hemodialysis: 3.6%, peritoneal dialysis: 3.9%) had calcium levels >10.2 mg/dL. The 10.2 mg/dL cut point is particularly important since it approximates the one currently included in the QIP and DFC programs. The prevalence of very low calcium levels (< 8.4 mg/dL) was much higher in patients on peritoneal dialysis vs. hemodialysis (19.9 vs 15.1% in December 2014), likely due in large part to differences in dialytic treatment and serum albumin levels.

vol 2 Figure 3.14 Distribution of serum calcium levels in adult hemodialysis patients on dialysis for at least 1 year, CROWNWeb data, December 2012, 2013, and 2014



Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for October to December for years 2012, 2013 and 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of serum calcium for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year.

vol 2 Figure 3.15 Distribution of serum calcium levels in adult peritoneal dialysis patients on dialysis for at least 1 year, CROWNWeb data, December 2012, 2013, and 2014

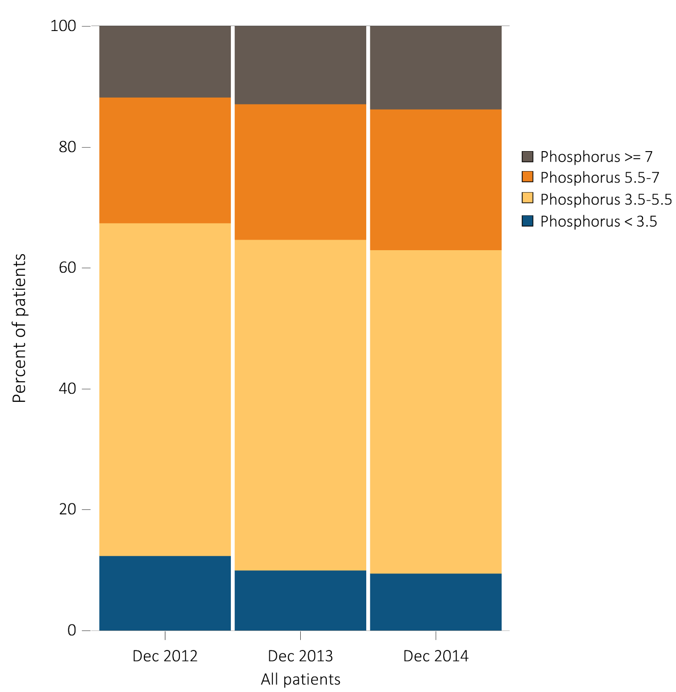


Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for October to December for years 2012, 2013 and 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of serum calcium for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year.

Phosphorus

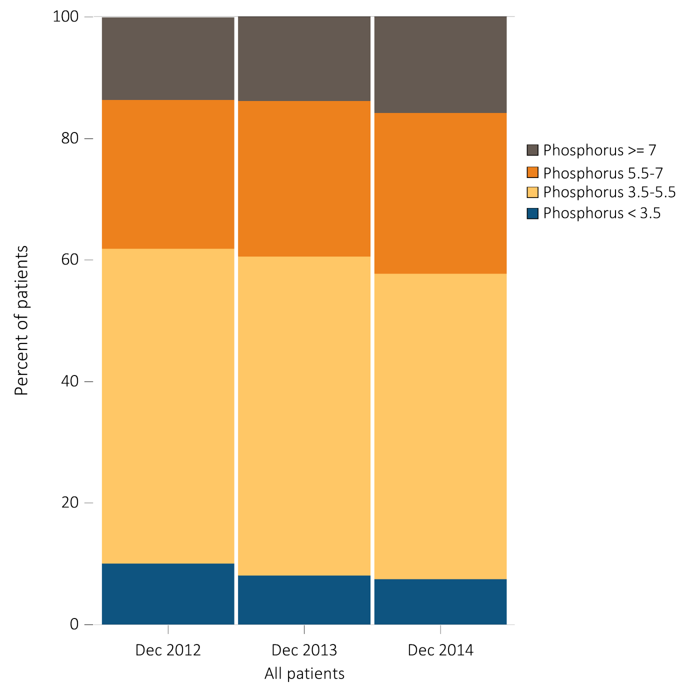
The distribution of serum phosphorus levels among adult hemodialysis and peritoneal dialysis patients are shown in Figures 3.16 and 3.17. Between 2012 and 2014, a slight increase in mean serum phosphorus was observed both in hemodialysis and peritoneal dialysis patients (hemodialysis: from 5.0 to 5.2 mg/dL; peritoneal dialysis: from 5.2 to 5.4 mg/dL). Among hemodialysis patients in December 2014, more than one-third (37%) had serum phosphorus >5.5 mg/dL, which has consistently been associated with adverse clinical outcomes. This percentage was even higher among patients on peritoneal dialysis (42%). It should be noted that 5.5 mg/dL is higher than the current KDIGO guidelines recommendation, which is to maintain phosphorus levels within the laboratory reference range (typically between 2.5 and 4.5 mg/dL). When using this more stringent criterion, 68% of hemodialysis and 71% of peritoneal dialysis patients had elevated phosphorus levels, indicating a clear opportunity for improvement. The prevalence of low phosphorus levels (<3.5 mg/dL) declined slightly over time, to 10% in hemodialysis patients and 8% in peritoneal dialysis patients in December 2014.

vol 2 Figure 3.16 Distribution of serum phosphorus (%) levels in adult hemodialysis patients on dialysis for at least 1 year, CROWNWeb data, December 2012, 2013, and 2014



Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for December 2012, December 2013, and December 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of serum phosphorus for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year.

vol 2 Figure 3.17 Distribution of serum phosphorus (%) levels in adult peritoneal dialysis patients on dialysis for at least 1 year, CROWNWEB data, December 2012, 2013, and 2014



Data Source: Special analyses, USRDS ESRD Database. CROWNWeb clinical extracts for December 2012, December 2013, and December 2014. Dialysis patients on treatment for ESRD at least 1 year at the time of measurement of serum phosphorus for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year.

Preventive Care

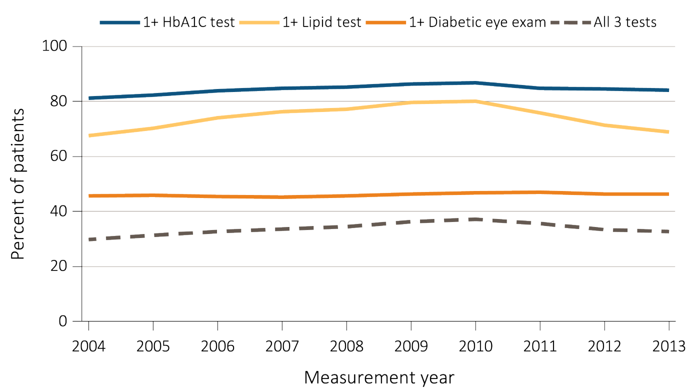
Diabetes Mellitus

Recommendations for glycemic and lipid monitoring, treatment, and target levels in diabetic patients with ESRD are controversial. The role of regular dilated eye exams and timely treatment in preventing vision loss is, however, well-established.

From 2003 to 2010, there was a steady increase in the percentage of ESRD patients with diabetes receiving at least one HbA1c test and at least one lipid test per year (86% with at least one HbA1c test and 80% with at least one lipid test in 2009) (Figure 3.18). The National Committee for Quality Assurance Comprehensive Diabetes Care data also show an increase in testing over this time period in the privately insured population with diabetes (89% with at least one HbA1c test and 85% with at least one lipid test in 2009) and in the Medicare population with diabetes (90% with at least one HbA1c test and 87% with at least one lipid test in 2009) compared to the data presented in this report (National Committee for Quality Assurance, 2010). Over the past three years, there has been a slight decrease in the percentage of patients with diabetes receiving at least one HbA1c test per year and a more substantial decrease in the percentage of patients receiving at least one lipid test per year (Figure 3.18). The decrease in HbA1c testing may reflect an increasing awareness of the limitations of HbA1c as an indicator of average glycemia in patients with ESRD. National Committee for Quality Assurance Comprehensive Diabetes Care data show a leveling off, but do not demonstrate similar decreases in HbA1c or LDL cholesterol testing rates since 2010 in the privately insured, Medicaid, or Medicare populations with diabetes (National Committee for Quality Assurance, 2014). The reason for the apparent decrease in lipid testing rates in the Medicare ESRD population with diabetes is unclear, but may possibly be related to the publication of two reports demonstrating a lack of effect of statin therapy on fatal and nonfatal cardiovascular outcomes in patients undergoing hemodialysis (Wanner et al., 2005; Fellstrom et al., 2009).

The percentage of patients with annual dilated eye exams has remained low but constant over the past decade (approximately 46%, which is lower than the Healthy People 2020 target of 58.7%), whereas the performance of all three tests (approximately 33% in the most recent year) has fallen slowly over the last three years, in line with the declines in HbA1c and lipid testing. There remains a substantial opportunity for quality improvement.

vol 2 **Figure 3.18 Diabetes-related care among ESRD patients with diabetes mellitus aged 18-75 years, Medicare claims, 2004-2013**



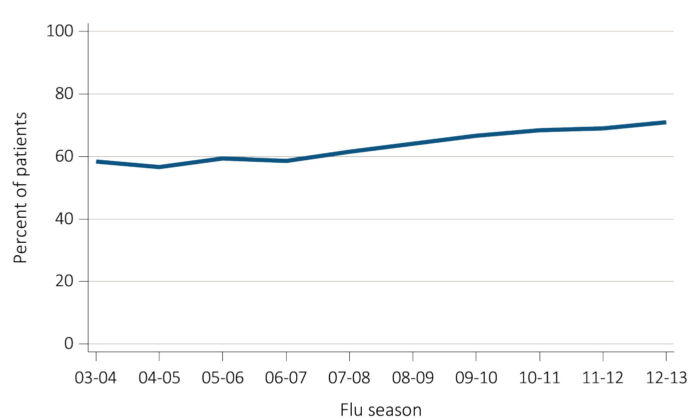
Data Source: Special analyses, USRDS ESRD Database. Point prevalent Medicare ESRD patients aged 18 to 75 years with a diagnosis claim for diabetes mellitus in the previous year; diabetes-related care in the measurement year. Abbreviations: ESRD, end-stage renal disease; HbA1C, glycosylated hemoglobin.

Vaccination

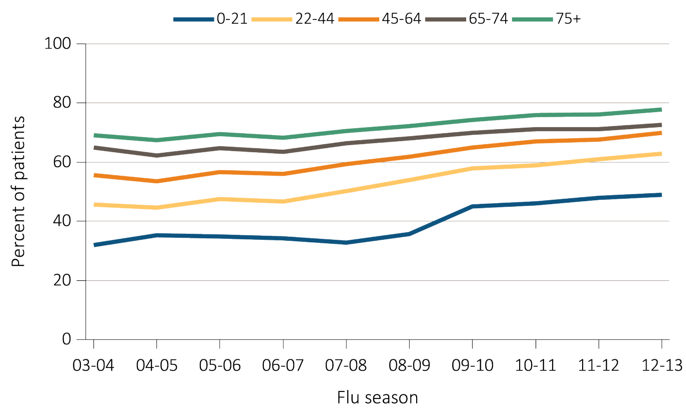
Yearly influenza vaccination is recommended for all ESRD patients. Seasonal influenza vaccination is defined here more broadly than the typical October through March influenza season, and covers the period of August 1 through April 30 to account for early or later vaccinations. Based on Medicare claims data, the percentage of ESRD patients receiving influenza vaccination has slowly improved over the past decade, rising from 58% in the 2003-2004 season to 71% in the 2012-2013 season (Figure 3.19.a); however, this is still below the Healthy People 2020 (HP2020) target of 90%. The percentage of patients vaccinated is highest in older age groups, with only 49% of ESRD patients aged 0-21 years vaccinated in the 2012-2013 season (Figure 3.19.b). The percentage of patients vaccinated is similar in the most recent years across race/ethnicity, though slightly lower among Blacks at 68% in the 2012-2013 season (Figure 3.19.c). By modality, hemodialysis patients were vaccinated at the highest frequency (75% in the most current data), compared with 72% in peritoneal dialysis patients, and 56% in kidney transplant patients (Figure 3.19.d). The higher percentage of vaccination in hemodialysis patients may relate to the greater frequency of medical contact, providing more opportunities for vaccination. The percentage vaccinated may also be lower in transplant patients in part because vaccination is often delayed for several months after a new transplant due to concerns about an ineffective immune response or the theoretical concern of triggering an acute rejection episode. The percentages vaccinated reported here may be underestimates, as they are derived from claims, which may not completely capture all vaccination events. Future analyses for the ADR will utilize CROWNWeb data, which should provide more complete information on vaccination, including status for other recommended vaccinations, such as for pneumococcus and hepatitis B.

vol 2 **Figure 3.19 Percentage of ESRD patients with a claim for seasonal influenza vaccination (August 1-April 30 of subsequent year), (a) overall, (b) by age, (c) by race/ethnicity, (d) by modality Medicare data, 2003-2013**

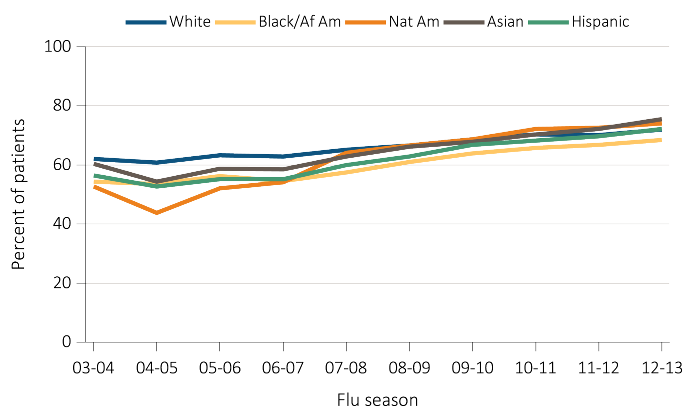
(a) Overall claims for seasonal influenza vaccination



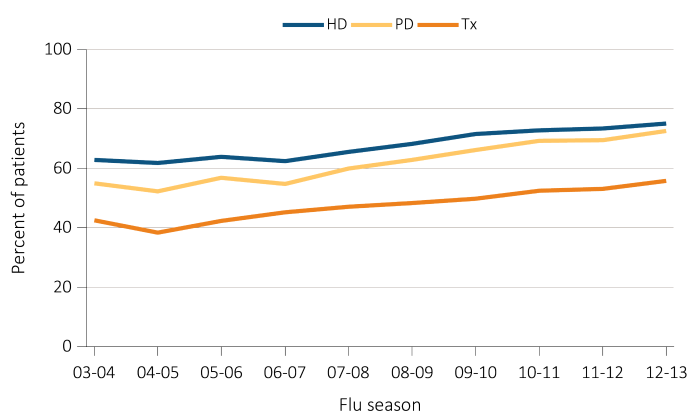
(b) Age



(c) Race/Ethnicity



(d) Modality



Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating treatment for ESRD at least 90 days before seasonal period: August 1-April 30 for influenza. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; HD, hemodialysis; Nat Am, Native American; PD, peritoneal dialysis; Tx, transplant.

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Notes

Chapter 4: Vascular Access

- 80.2% of patients were using a catheter at hemodialysis initiation in 2013, which has changed little since 2005.
- At 90 days after initiation of dialysis, 68.3% of hemodialysis patients were still using a catheter in 2013.
- Between 2005-2013, AV fistula use at hemodialysis initiation rose from 12% to 17.1%.
- The percentage of patients with either an AV fistula or a maturing AV fistula has increased from 28.9% to 35.1%, over the same period.
- By December 2013, 62.5 % of prevalent dialysis patients were using an AV fistula.
- The percentage of patients using an AV fistula exclusively at the end of 1 year on hemodialysis was 65%, up from 17% at initiation.
- The proportion of patients with an AV graft for vascular access was 3% at hemodialysis initiation, and 15% at 1 year after initiation.
- At 1 year after hemodialysis initiation, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter.
- Asians have the highest odds of successful AV fistula use at hemodialysis initiation. Both Asians and Blacks have the highest odds of AV fistula or AV graft use at hemodialysis initiation. Females are less likely than males to be using an AV fistula/AV graft at initiation.
- In 2013, 35.9% of AV fistulas placed failed to be in use following placement, with a mean of 135 days to first AV fistula use.
- Younger patients tended toward higher maturation rates, with patients over 75 years old displaying higher failure rates than the overall rate, with the oldest and youngest age categories having longer times to first AV fistula use.

Introduction

For the first time, the USRDS devotes an entire chapter of this year's ADR to the critically important topic of vascular access for hemodialysis patients, previously covered in *Chapter 3: Clinical Indicators and Preventive Care*. In addition, monthly CROWNWeb data on type of vascular access in use is being reported for the first time in the ADR for all dialysis patients in the United States; not just those with Medicare claims. For details on CROWNWeb, see the *ESRD Analytical Methods* chapter. Clinical practice guidelines recommend an autogenous arteriovenous (AV) fistula as the preferred vascular access for hemodialysis (National Kidney Foundation, 2006). A recent systematic review of 62 cohort studies with a total of 586,337 patients evaluated the association between type of vascular access and risk of mortality, infection, and major cardiovascular events. While recognizing the risk of selection bias inherent in observational studies, it concluded that central venous catheters (hereafter, catheter[s]) were associated with the highest risk of death, infection, and cardiovascular events, compared with other types of vascular access, and that patients who had a usable AV fistula were associated with the lowest risk (Ravani et al., 2013).

The international Dialysis Outcomes and Practice Patterns Study (DOPPS) brought much needed attention to vascular access practices around the world and highlighted the fact that U.S. dialysis practices with respect to vascular access lagged behind other industrialized countries of the world (Pisoni et al., 2002; Goodkin et al., 2010; Robinson et al., 2010). In large part, these international comparisons served as impetus for implementation by the Health Care

Financing Administration (HCFA) (now the Centers for Medicare & Medicaid [CMS]), which was later renamed the Fistula First Breakthrough Initiative (FFBI). A steady increase in AV fistula placement efforts followed in the United States over the next decade, such that the proportion of prevalent hemodialysis patients with AV fistula rose from 32% in 2003 to 62% by 2013.

A robust debate continues as to whether an AV fistula should remain the access of first choice in every dialysis patient. Although an AV fistula continues to be considered the optimal type of vascular access in many patients owing to its potential for durability, lower risk of infection and intervention to ensure patency, the focus has shifted somewhat toward creating the most appropriate access for the individual patient, based upon the clinical situation, patient characteristics, life expectancy, patient preference, and other factors. Whether this approach will indeed prove superior can only be determined by more robust prospective studies/clinical trials, which will most likely be challenging to conduct.

A landmark clinical trial where maturation of an AV fistula was a secondary outcome, revealed the high prevalence of failure of newly place fistulae ever coming to use (Dember et al., 2008). This topic remains of high interest to the nephrology community (Riella, et al., 2013) and led to the NIDDK funded Fistula Maturation Study (Dember et al., 2014) designed to study this phenomenon further. Between primary surgical failures and maturation failures, 30-50% of AV fistula placements in the United States are unsuccessful (Table 4.9). The many potential factors underlying this phenomenon need to be rigorously evaluated so that primary surgical success rates and subsequent optimal maturation of the AV fistula, could be ensured. In this regard, greater emphasis on AV fistula placement during surgical training may need to be prioritized (Saran et al., 2008; Goodkin et al., 2010) in the United States.

Interventional nephrology has gained prominence in the United States over the last decade or so, introducing a new class of specialists involved with vascular access procedures to a field previously dominated primarily by surgeons and interventional radiologists trained in vascular access procedures. The impact of this phenomenon on patient outcomes has yet to be systematically studied.

All of the above considerations make it imperative to comprehensively and carefully track vascular access placements and related practices and outcomes. In addition to patient characteristics, other factors such as technological advances, improved surgical and medical treatments, use of specific medications, payment reform and bundling, and improved pre-dialysis care can impact vascular access practice patterns and outcomes. Despite the emphasis on improving AV fistula success rates, at the time of initial dialysis 80% of patients are using a catheter. Improvements in pre-dialysis care during the critical transition period to ESRD may be the key to future improvements in this suboptimal practice pattern.

This chapter describes patterns of vascular access use among incident and prevalent dialysis patients by patient characteristics and geographic region over the last decade. In addition, we explore variation in time-to-first-use of AV fistula after placement as a surrogate of 'AV fistula maturation' across the country.

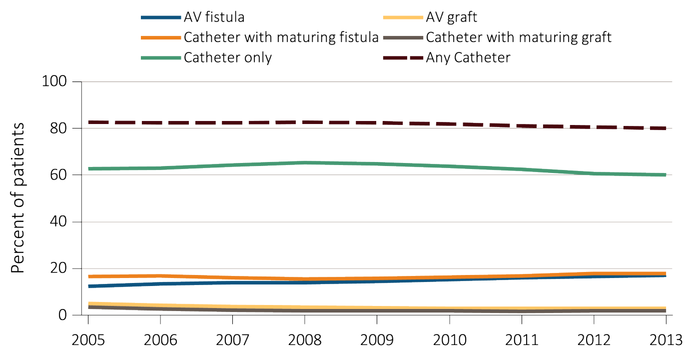
Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Vascular Access Use at Initiation of Hemodialysis

Figure 4.1 shows that, in 2013, at their first outpatient hemodialysis session, 60.2% of patients with incident ESRD used a catheter alone for vascular access. This peaked at 65.4%, earlier in 2008, and has been declining since then. However, if patients using a catheter who also had a maturing AV fistula or AV graft are included in this group, a total of 80.2% of patients were using a catheter at hemodialysis initiation in 2013, which has changed little since 2005. Over the last seven years, there has been an increase in AV fistula use at hemodialysis initiation, rising from 12% in 2005 to 17.1% in 2013. The percentage of patients with either an AV fistula or a maturing AV fistula has increased from 28.9% to 35.1%, over the same period.

vol 2 Figure 4.1 Vascular access use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2005-2013

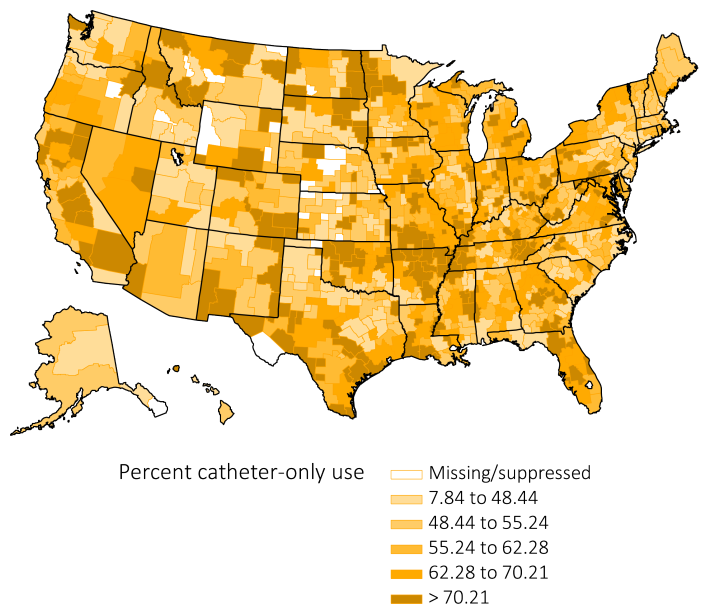


Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2005-2013. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Table 4.1 shows dialysis access use at hemodialysis initiation stratified by patient characteristics. The 0-21 year old age group has the highest percentage of catheter use at hemodialysis initiation (92%) and lowest percentage of AV fistula use/AV fistula maturing (17.5%). Many of these pediatric patients receive a renal transplant relatively quickly, with hemodialysis serving as a bridge to transplantation. Furthermore, patients in these youngest age groups often may not be suitable candidates for AV fistula creation due to anatomical challenges. The 65-74 year age group had the highest percentage of patients with AV fistula use/AV fistula maturing at hemodialysis initiation (37%) with slightly lower levels of 33% and 36% AV fistula use/AV fistula maturing seen for individuals >74 years old and 45-64 years old, respectively. Patients of Hispanic ethnicity displayed the lowest proportion with AV fistula being used or maturing (29%) at hemodialysis initiation and the highest catheter alone use (68%). Blacks/African Americans displayed the highest proportion of AV graft use/AV graft maturing at hemodialysis initiation (7%) compared with 2.6% to 4.7% for individuals of other races or of Hispanic ethnicity. Those with cystic kidney disease had higher rates of AV fistula use/AV fistula maturing at hemodialysis initiation (59%), perhaps related to younger age at disease detection, slower progression of underlying CKD, and relatively preserved vasculature.

Figures 4.2 and 4.3 illustrate the geographic variation in catheter use alone and AV fistula use, respectively, at hemodialysis initiation by Health Service Area. Considerable variation is seen in both of these categorizations, even within individual states. New England, the Northwest, and parts of the East coast tend to have a lower percentage of catheters use and a higher percentage of AV fistula use at initiation. Some of the Central and Western mountain states appear to have a lower prevalence of AV fistula use.

vol 2 Figure 4.2 Geographic variation in percentage of catheter-only use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2013



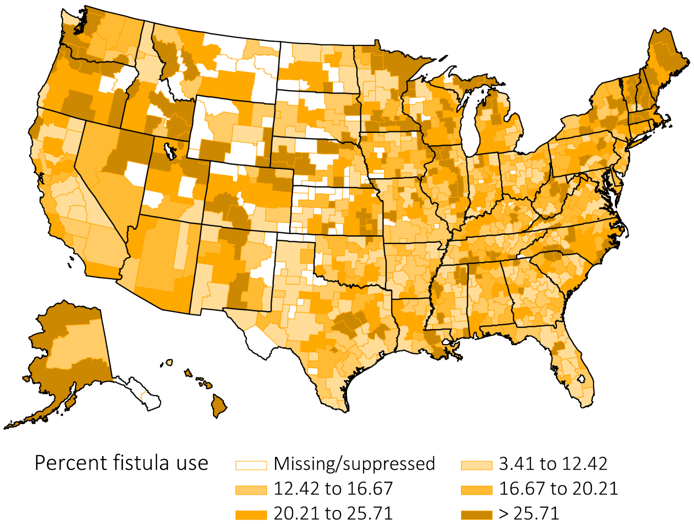
Data Source: Special analyses, USRDS ESRD Database. Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

vol 2 Table 4.1 Vascular access used at hemodialysis initiation by patient characteristics from the ESRD Medical Evidence form (CMS 2728), 2013

	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only
All	17.1	2.8	18.0	2.0	60.2
Age					
0-21	7.6	0.6	9.9	1.0	80.9
22-44	13.2	1.9	18.3	1.6	65.0
45-64	17.1	2.6	19	1.7	59.5
65-74	18.6	3.0	18.4	2.1	57.9
75+	17.3	3.5	16.1	2.3	60.8
Sex					
Male	18.7	2.1	18.4	1.6	59.2
Female	14.9	3.8	17.4	2.4	61.4
Race					
White	17.9	2.3	17.6	1.7	60.5
Black/African American	15.5	4.2	18.5	2.7	59.0
Native American	14.9	2.8	25	1.4	55.9
Asian	20.0	2.9	19.3	1.8	56.0
Ethnicity					
Hispanic	12.4	1.2	16.7	1.4	68.3
Primary Cause of ESRD					
Diabetes	17.7	2.9	20.9	2.0	56.4
Hypertension	17.5	3.2	16.6	2.0	60.6
Glomerulonephritis	18.6	2.3	16.5	1.8	60.7
Cystic Kidney	43.6	4.0	15.2	1.5	35.8
Other Urologic	14.2	3.3	14.4	2.1	66.0
Other Cause	9.2	1.8	11.5	1.7	75.9
Unknown/Missing	11.1	2.4	13.9	2.0	70.5
Comorbidities					
Diabetes	16.8	2.9	19.8	2.0	58.5
Congestive heart failure	13.3	2.4	19.3	2.2	62.8
Atherosclerotic heart disease	17	2.6	20.6	2.1	57.7
Cerebrovascular disease	15	3.4	18.9	2.5	60.2
Peripheral vascular disease	14.8	2.5	20.8	2.1	59.7
Hypertension	17.8	2.9	18.4	2.0	58.9
Other cardiac disease	14.5	2.4	17.9	2.1	63.1

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

vol 2 Figure 4.3 Geographic variation in percentage of AV fistula use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2013



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Vascular Access Use Among Prevalent Hemodialysis Patients

Table 4.2 shows patterns of access use among prevalent hemodialysis patients (those with ESRD for ≥90 days). By December 2013 62.5% of prevalent hemodialysis patients were using an AV fistula. In general, demographic variation was similar to the patterns observed among incident patients. Among prevalent hemodialysis patients, the 0-21 year old age group displays the highest catheter use, while the 45-64 year age group has the lowest catheter use, Black/African Americans displayed the lowest AV fistula utilization but highest utilization of an AV graft. Highest catheter use was reported for White, non-Hispanic hemodialysis patients. When examined among individuals by primary cause of ESRD, those with cystic kidney disease maintained the highest fistula usage, although the differences between patient categories were less compared with what was observed in patients new to dialysis (Table 4.1).

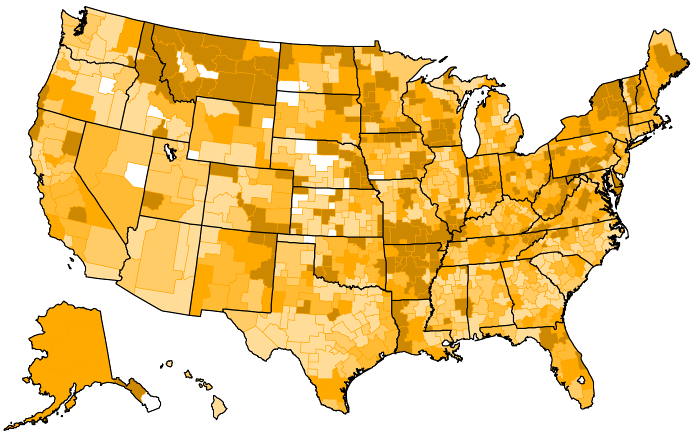
vol 2 Table 4.2 Distribution of type of vascular access in use among prevalent hemodialysis patients in 2013, from CROWNWeb data, December 2013

	AV fistula	AV graft	Catheter
All	62.5	18.4	19.2
Age			
0-21	47.0	6.8	46.1
22-44	64.8	15.7	19.6
45-64	64.2	17.7	18.1
65-74	61.9	19.3	18.8
75+	58.7	20.4	20.9
Sex			
Male	68.7	14.2	17.1
Female	54.5	23.7	21.8
Race			
White	64.3	13.6	22.1
Black/African American	56.9	25.4	17.7
Native American	73.3	12.1	14.6
Asian	67.2	16.7	16.1
Ethnicity			
Hispanic	67.5	15.4	17.1
Primary Cause of ESRD			
Diabetes	62.7	18.2	19.1
Hypertension	61.9	19.3	18.8
Glomerulonephritis	64.8	18.1	17.2
Cystic Kidney	69.5	16.9	13.7
Other Urologic	61.9	17.6	20.4
Other Cause	57.5	17.2	25.3
Unknown/Missing	61.4	17.6	21.0

Data Source: Special analyses, USRDS ESRD Database. CROWNWeb data catheter=any catheter use; fistula and graft use shown are without the use of a catheter. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

Figure 4.4, shows the geographic variation in proportion of patients using catheter among prevalent hemodialysis patients in the United States in 2013. Significant variation was observed across the country. Pockets of high catheter utilization are evident in most of Montana and upper Idaho (in contrast to the Pacific Northwest), and in southern Missouri, two-thirds of Arkansas, and northeastern upstate New York.

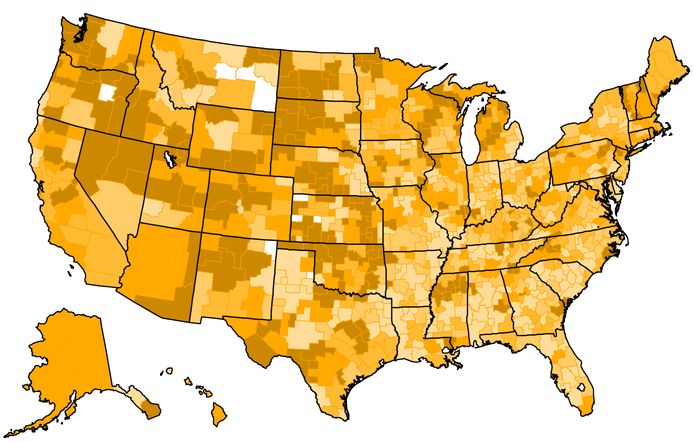
vol 2 Figure 4.4 Geographic variation in percentage catheter use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, December 2013



Data Source: Special analyses, USRDS ESRD Database. Abbreviation: ESRD, end-stage renal disease.

Figure 4.5 shows variation in fistula use among prevalent hemodialysis patients in the United States in 2013. While there are pockets where there is higher than 70% utilization of AV fistula among prevalent hemodialysis patients throughout the country, fistula use is more apparent in the western half of the country.

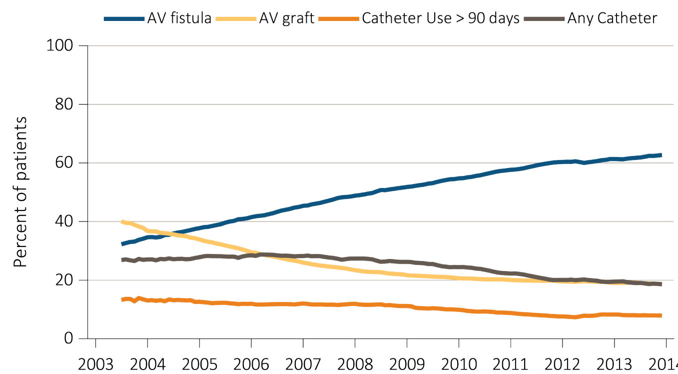
vol 2 Figure 4.5 Geographic variation in percentage AV fistula use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, December 2013



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

Figure 4.6 displays trends in vascular access use among prevalent hemodialysis patients from 2003-2013. There has been a large rise in AV fistula use and AV fistula placement since 2003, with use increasing from 32% to nearly 63% and placement increasing from 38% to 66% of patients, respectively. In contrast, AV graft use has decreased from 40% to 19% over the same time period. Catheter use has also declined, albeit not as dramatically, decreasing from 27% to 19%. In 2013, only 8% of prevalent hemodialysis patients had been using a catheter for >90 days.

vol 2 Figure 4.6 Trends in vascular access type use among ESRD prevalent patients, 2003-2014

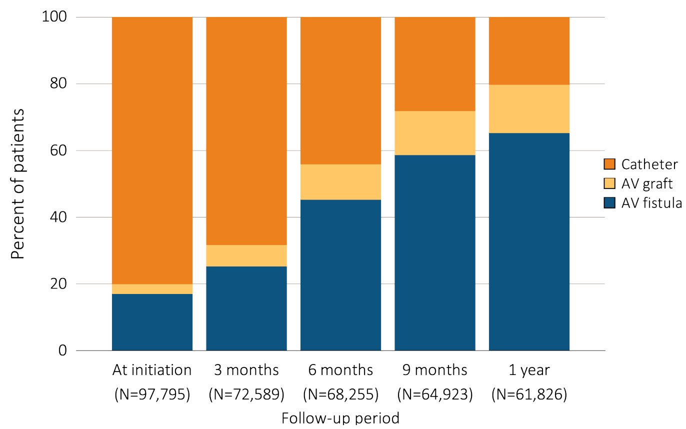


Data Source: Special analyses, USRDS ESRD Database, and Fistula First data. Fistula First data reported from July 2003 through April 2012, CROWNWeb data are reported from June 2012 through December 2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

Change in Type of Vascular Access During the First Year of Dialysis

Figure 4.7 shows cross-sectional data from both the CMS Medical Evidence form (CMS 2728) (for vascular access information at initiation) and CROWNWeb (for follow-up data with respect to vascular access in use at 3, 6, 9 months and 1 year). At 90 days, most hemodialysis patients were still using a catheter, highlighting the importance of ongoing efforts to improve pre-dialysis access planning. The percentage of patients using an AV fistula exclusively at the end of 1 year on dialysis was 65%, up from 17% at initiation of hemodialysis. The proportion of patients with an AV graft for vascular access was 3% at initiation, and 15% at 1 year. Thus, at 1 year, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter.

vol 2 Figure 4.7 Vascular access use during the first year of hemodialysis by time since initiation of ESRD treatment, among patients new to hemodialysis in 2013, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb data, 2013-2014



Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Tables 4.3 through 4.5 show cross-sectional distributions of vascular access use at several time points during the first year of hemodialysis therapy, stratified by age, race, and gender. Catheter use is most common at initiation and at the end of one year in the 0-21 year old age group for reasons discussed above (higher transplant rates, anatomical challenges). AV graft use is higher in the 75+ age group both at initiation and at the end of 1 year. At 1 year, catheter use of approximately 20% is seen in all age groups, except the 0-21 year old cohort, indicating barriers still remain in establishing surgical access, even after 1 year. Black patients have the highest proportion of AV graft in use, both at initiation and at 1 year. At one year, 19.8% of Black patients had an AV graft in use compared to 13.5% of Asians and 12.2% of whites. Females have a higher proportion of AV graft use and males a higher proportion of AV fistula use both at initiation and at one year. Catheter use was highest in patients of other/unknown race and females at 1 year. For most adult patient age groups, over 60% higher fistula prevalence is achieved by one year on hemodialysis. At one year, the highest proportions of AV fistula were seen among males, those of Native American or Asian race, and the lowest AV fistula proportion was observed among African Americans.

Predictors of AV Fistula Use at Hemodialysis Initiation

Programs such as "Fistula First" and "Fistula First Catheter Last" were created to inform and educate the medical community on the higher morbidity, mortality, and costs associated with catheter use, while encouraging greater AV fistula use. Although AV fistula use has increased greatly in prevalent patients, improvement in AV fistula use at initiation continues to lag behind. Many reasons can be postulated for these trends, such as access to primary and/or nephrology care, disparities in health-care access, difficulty in AV fistula maturation in certain patient groups, such as the elderly diabetic or those with limited transportation or financial incentives, and the wide variety of health care providers with differing expertise in creating AV fistula for dialysis patients. The following figures and tables examine associations between clinical and patient characteristics and successful surgical access use (AV fistula as well as AV fistula/AV graft use) at initiation of hemodialysis.

Table 4.6 examines patient characteristics as well as factors such as length of pre-ESRD care and CMS geographic regions (http://www.cms.gov/About-CMS/Agency-Information/RegionalOffices/RegionalMap.html). Asians have the highest odds of successful AV fistula use at hemodialysis initiation, while both Asians and Blacks have the highest odds of a surgical access (AV fistula or AV graft) in use at hemodialysis initiation, with females less likely to be using an AV fistula/AV graft at initiation. Region 10 (Northwest) displays the highest odds of patients using an AV fistula at initiation as well as higher odds of AV fistula or AV graft use at hemodialysis initiation. Patients with ESRD secondary to diabetes are less likely to use an AV fistula or AV graft at hemodialysis initiation compared with patients for whom the primary cause of ESRD was not diabetes.

vol 2 Table 4.3 Cross-sectional distributions of vascular access use during the first year of hemodialysis therapy among patients new to hemodialysis in 2013, by age group, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2013-2014

Age group	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
0-21	AV fistula	7.5	13.4	31.9	46.0	50.6
	AV graft	0.6	0.6	2.3	2.9	3.1
	Catheter	91.8	86.0	65.8	51.2	46.3
22-44	AV fistula	13.3	22.4	44.6	59.5	67.2
	AV graft	1.9	4.4	7.6	9.4	10.8
	Catheter	84.8	73.2	47.9	31.1	22.0
45-64	AV fistula	17.2	25.3	46.1	60.2	67.1
	AV graft	2.6	5.5	9.1	11.6	13.1
	Catheter	80.2	69.2	44.8	28.3	19.8
65-74	AV fistula	18.7	27.1	46.7	59.1	65.6
	AV graft	3.0	6.9	11.0	13.5	15.0
	Catheter	78.3	66.1	42.3	27.4	19.5
75+	AV fistula	17.4	24.9	43.6	56.1	61.5
	AV graft	3.5	8.5	14.0	16.9	18.5
	Catheter	79.1	66.6	42.4	27.1	20.0

Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

vol 2 Table 4.4 Cross-sectional distributions of vascular access use during the first year of hemodialysis therapy among patients new to hemodialysis in 2013, by race, from the ESRD Medical Evidence form (CMS-2728) and CROWNWeb, 2013-2014

Race	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
Native American	AV fistula	14.7	25.5	53.3	70.0	77.1
	AV graft	2.2	4.3	6.1	6.9	8.1
	Catheter	83.1	70.2	40.6	23.2	14.8
Asian	AV fistula	20.2	29.4	51.6	64.3	70.5
	AV graft	2.8	6.5	9.4	11.8	13.5
	Catheter	77.0	64.1	39.0	23.9	16.0
Black	AV fistula	15.4	22.5	40.1	52.8	58.8
	AV graft	4.2	8.9	14.7	17.9	19.8
	Catheter	80.4	68.5	45.3	29.3	21.4
White	AV fistula	17.7	26.2	47.2	61.0	67.8
	AV graft	2.3	5.4	8.9	11.0	12.2
	Catheter	80.0	68.4	43.9	28.0	20.0
Other/Unknown	AV fistula	16.5	12.3	39.5	57.3	62.5
	AV graft	4.1	6.2	2.6	4.0	5.6
	Catheter	79.3	81.5	57.9	38.7	31.9

Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

vol 2 **Table 4.5 Cross-sectional distributions of vascular access use during the first year of hemodialysis therapy among patients new to hemodialysis in 2013, by sex, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2013-2014**

Sex	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
Male	**AV fistula**	18.8	28.6	51.0	65.1	71.5
	AV graft	2.1	4.9	8.0	9.9	11.0
	Catheter	79.1	66.5	41.0	25.0	17.5
Female	**AV fistula**	15.0	20.8	37.9	50.2	56.9
	AV graft	3.8	8.6	14.0	17.4	19.3
	Catheter	81.2	70.6	48.1	32.4	23.7

Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Fistula Maturation

Timely fistula maturation is an area of central interest for the dialysis community. While AV fistula utilization among prevalent hemodialysis patients has improved (Figure 4.5), the proportion of patients using a dialysis catheter at incidence of ESRD remains stubbornly high (Figure 4.1). Limiting catheter exposure time is critical, as prolonged catheter use is often associated with bacteremia, sepsis, thrombosis and central stenoses (Morsy et al., 1998), which limits future access success, as well as poor long-term outcomes (Pisoni et al., 2009). "Observational data indicate catheter use is associated with higher mortality risk, compared to other access types, potentially through the greater risk for sepsis and as a source of inflammation due to the 'foreign body' in the bloodstream effect, biofilm formation and other mechanisms, which may cause persistent adverse outcomes even after catheter removal" (Foley et al., JASN 2004). While AV grafts are ready for use sooner and more reliably, their long-term primary and assisted primary patency are not as good and they are associated with a higher frequency of other complications that can significantly impact mortality and morbidity, including dialysis access-associated ischemia (also known as "dialysis hypoperfusion ischemic syndrome" and "steal syndrome") and infections (Churchill et al., 1992; Stevenson, 2002; Ravani, 2013), adding significant risk with this choice of conduit. These complications can also have a significant impact on quality of life as well. Furthermore, the premature use of an AV graft may limit access options in the future (National Kidney Foundation, 2006)—a significant concern for those with longer life expectancy. At the present time, it is currently unclear as to at what point considerations related to prolonged AV fistula maturation time, and the associated catheter exposure, warrant prioritizing placement of AV graft instead, although conversion from a catheter to permanent access of either type is beneficial (Bradbury et al., 2009).

In an effort to better understand which patients experience longer maturation times, data on prevalent hemodialysis patients was examined, as these patients are more likely to experience use of their AV fistula as soon as it is reasonable to do so. Fistula placement was identified through inpatient, outpatient and physician/supplier Medicare claims using the following ICD-9 procedure codes: 36818, 36819, 36820, 36821 and 36825. Subsequent first use of the placed fistula was determined by finding evidence of fistula use in CROWNWeb through the end of 2014. If the fistula was indicated as being used in CROWNWeb following its placement (and prior to any subsequent fistula placements), the fistula was considered to have successfully matured for use. If CROWNWeb did not indicate the fistula was used following placement, the fistula was assumed to have failed to mature. In order to be included in the analyses patients were required to have vascular access use data in CROWNWeb following the fistula placement. Time to maturation was determined using the date of fistula placement and the date of first use in CROWNWeb, given that the exact time of 'fistula maturity' is currently not determinable from CROWNWeb. The percentage of fistula placements that failed was calculated as the number of failed placements over the total number of placements in 2013 among patients with vascular access use data in CROWNWeb. Patients that died following the fistula placement were included in the analysis.

vol 2 **Table 4.6 Odds ratios and 95% confidence intervals from logistic regression models of fistula use at hemodialysis initiation and fistula or graft use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2013**

	AV fistula use at initiation			AV fistula or graft use at initiation		
Predictors	Odds ratio	95% confidence interval		Odds ratio	95% confidence interval	
		Lower bound	Upper bound		Lower bound	Upper bound
Pre-ESRD nephrology care						
0 months	0.05	0.05	0.06	0.06	0.06	0.07
>0 -<6 months	0.28	0.27	0.30	0.29	0.28	0.31
6-12 months	0.61	0.59	0.64	0.61	0.59	0.64
>12 months	Ref.			Ref.		
Unknown	0.19	0.17	0.20	0.19	0.18	0.20
Age						
0-21	0.33	0.25	0.43	0.30	0.23	0.39
22-44	0.84	0.78	0.89	0.80	0.75	0.86
45-64	Ref.			Ref.		
65-74	0.99	0.94	1.03	1.02	0.97	1.06
75+	0.86	0.82	0.90	0.94	0.90	0.98
Sex						
Female	0.74	0.71	0.77	0.86	0.83	0.89
Male	Ref.			Ref.		
Race						
Native American	0.81	0.67	0.99	0.83	0.69	1.01
Asian	1.13	1.04	1.23	1.15	1.06	1.24
Black/African American	0.99	0.94	1.03	1.16	1.12	1.21
White	Ref.			Ref.		
Other/Unknown	1.13	0.68	1.86	1.30	0.82	2.08
Diabetes as cause of ESRD	0.93	0.90	0.97	0.93	0.90	0.96
CMS Region						
1 (vs. average region)	1.08	0.99	1.17	1.09	1.01	1.18
2 (vs. average region)	0.97	0.92	1.02	0.96	0.92	1.01
3 (vs. average region)	0.92	0.87	0.97	0.91	0.86	0.96
4 (vs. average region)	0.91	0.87	0.94	0.91	0.87	0.94
5 (vs. average region)	0.94	0.89	0.98	0.94	0.90	0.98
6 (vs. average region)	0.90	0.85	0.94	0.91	0.86	0.95
7 (vs. average region)	0.88	0.80	0.96	0.89	0.82	0.96
8 (vs. average region)	1.11	1.00	1.25	1.05	0.95	1.18
9 (vs. average region)	1.09	1.04	1.14	1.09	1.04	1.14
10 (vs. average region)	1.30	1.19	1.41	1.33	1.22	1.44

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

In 2013, 35.9% of AV fistulas placed failed to be in use following placement, with a mean of 135 days to first AV fistula use (Table 4.7), among those that were used. Younger patients tended toward higher maturation rates, with patients over 75 displaying higher failure rates than the overall rate, with the oldest and youngest age categories having longer times to first AV fistula use. Males had a higher maturation rate compared to females, with a shorter time to first use. AV fistula placement failure rates among Native Americans and Asians were lower than the overall rate, while Blacks experienced higher failure rates. Time to first use did not necessarily correspond to maturation rates. While there was placement failure variability by ESRD etiology, those classified as having "unknown cause" were a clear outlier, with a 39.1% failure rate and longer median time to first use.

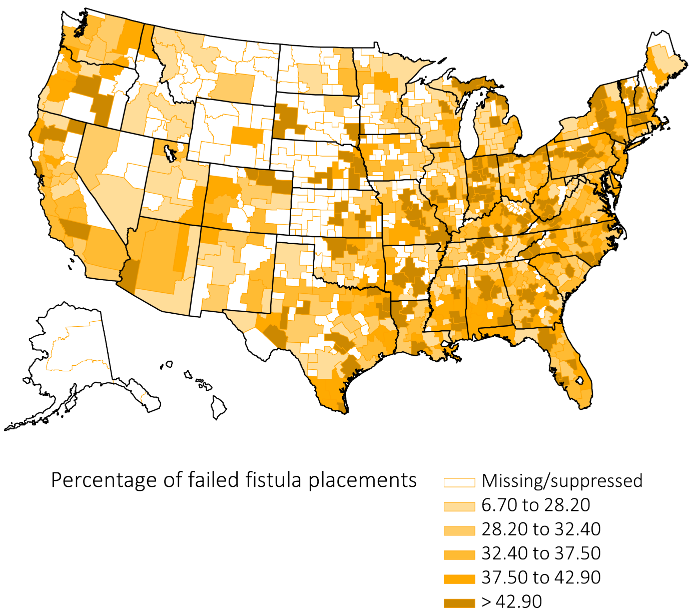
The percentage of failed fistula placements in 2013 for new AV fistulas created was mapped at the Health Service Area level in Figure 4.8. Within each state, there is typically a fair amount of variability in percentage of failed fistula. Many areas with a lower percentage of failed fistula appear to be concentrated in the Pacific Northwest and Southwest.

vol 2 Table 4.7 Distribution of number of days between AV fistula placement and first successful use*, overall and by patient characteristics, for new AV fistula created in 2013 (excludes patients not yet ESRD when fistula was placed), from Medicare claims and CROWNWeb, 2013-2014

	Total AV fistula placements	Percentage of failed placements	Number of days between AV fistula placement and first use			
			Average	Median	25th percentile	75th percentile
Overall	45,475	35.9	135	112	74	171
Age						
0-21	230	31.7	139	110	71	174
22-44	5,429	32.3	132	106	70	169
45-64	17,184	33.9	134	111	72	169
65-74	12,191	36.6	137	115	76	174
75+	10,441	40.6	137	115	78	171
Race						
Native American	485	26.6	135	117	76	165
Asian	1,857	27.8	128	106	67	168
Black/African American	14,582	38.8	136	113	71	175
White	28,501	35.2	135	112	76	170
Other/Unknown	50	34.0	122	113	71	146
Sex						
Male	25,693	31.8	129	108	73	161
Female	19,782	41.3	145	120	77	188
Primary Cause of ESRD						
Diabetes	21,303	36.2	137	115	76	174
Hypertension	13,681	35.3	133	111	73	169
Glomerulonephritis	4,037	33.4	130	104	68	167
Cystic kidney	739	36.7	135	111	66	173
Other urologic	687	34.6	128	109	71	161
Other cause	3,714	38.4	134	111	72	168
Unknown cause	1,314	39.1	153	120	78	195

*Data Source: Special analyses, USRDS ESRD Database. *With follow-up through the end of 2014; date of first use was the date the given access was first reported in CROWNWeb to be in use in a particular patient. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.*

vol 2 **Figure 4.8 Percentage of failed fistula placements, by Health Service Area, for new AV fistulas created in 2013 (excludes patients not yet ESRD when fistula was placed), from Medicare claims and CROWNWeb, 2013-2014**



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

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Notes

Chapter 5: Hospitalization

- On average, ESRD patients are admitted to the hospital nearly twice a year, and about 30% have an unplanned rehospitalization within the 30 days following discharge.
- Inpatient treatment represents a significant societal and financial burden, accounting for approximately 40% of total Medicare expenditures for dialysis patients.
- Over the past decade, the frequency of hospital admissions and resulting number of hospital days for ESRD patients have declined gradually, but fairly consistently. In 2013, the adjusted rate of admission for hemodialysis patients decreased to 1.7 per patient year, as compared to 2.1 in 2005, a reduction of 19.0%. During that same period, admission rates for peritoneal dialysis patients fell about 15.0% (to 1.7 in 2013, from 2.0 in 2005) and for transplant patients reduced by 18.2% (to 0.9 in 2013, from 1.1 in 2005).
- Hospitalizations due to cardiovascular events and those for vascular access infection fell by 29.0 and 61.0%, respectively.
- Patient groups with a higher risk of hospitalization (both overall and for most cause-specific diagnoses) included those aged 22–44 years or 75 years and older, females, Whites, Blacks/African Americans, and patients who had diabetes as their primary cause of kidney failure.
- Compared to older Medicare beneficiaries without a diagnosis of kidney disease (15.8%), patients with CKD and ESRD experienced rehospitalization rates of 22.3% and 34.8%, respectively.
- Among hemodialysis patients prevalent in 2013, 37.0% of discharges from a hospitalization for any cause were followed by a rehospitalization within 30 days.

Introduction

Admissions and readmissions to the hospital represent major burdens for patients with end-stage renal disease (ESRD). On average, ESRD patients are admitted to the hospital nearly twice a year, and about 30% have an unplanned rehospitalization within the 30 days following discharge (CMS, 2014). Given the disruption of everyday life stemming from dialysis treatment, hospital admissions and readmissions additionally compromise patients' well-being and quality of life, and are associated with adverse clinical outcomes for these patients. Furthermore, inpatient treatment represents a significant societal and financial burden, accounting for approximately 40% of total Medicare expenditures for dialysis patients (CMS, 2014).

Clinical studies in a broad range of settings have demonstrated that both improved health care and care coordination may reduce rates of unplanned or non-elective hospitalization and rehospitalization; some studies have suggested that a sizable portion of such readmissions may be preventable. Hence, monitoring trends in hospitalization and rehospitalization is a key to ensuring that quality of care is maintained, potential problems are identified, and cost-effective health care is provided. Informed care providers can respond with targeted strategies to prevent or minimize inappropriate admissions and reduce the incidence of rehospitalization.

Analytical Methods

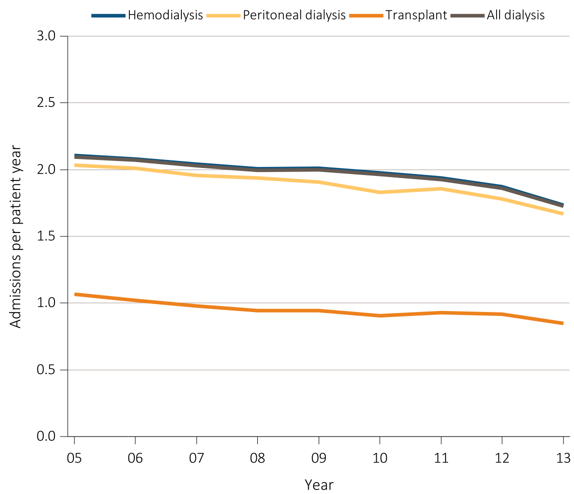
See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Trends in Hospitalization Rates

Over the past decade, the frequency of hospital admissions and resulting number of hospital days for ESRD patients have declined gradually, but fairly consistently. As shown in Figure 5.1, in 2013, the adjusted rate of admission for hemodialysis (HD) patients decreased to 1.7 per patient year (PPY), as compared to 2.1 in 2005, which is a reduction of 19.0%.

During that same period, rates for peritoneal dialysis (PD) patients fell about 15.0% (1.7 in 2013 from 2.0 in 2005) and for transplant patients reduced by 18.2% (0.9 in 2013 from 1.1 in 2005).

vol 2 Figure 5.1 Adjusted hospitalization rates for ESRD patients, by treatment modality, 2005-2013

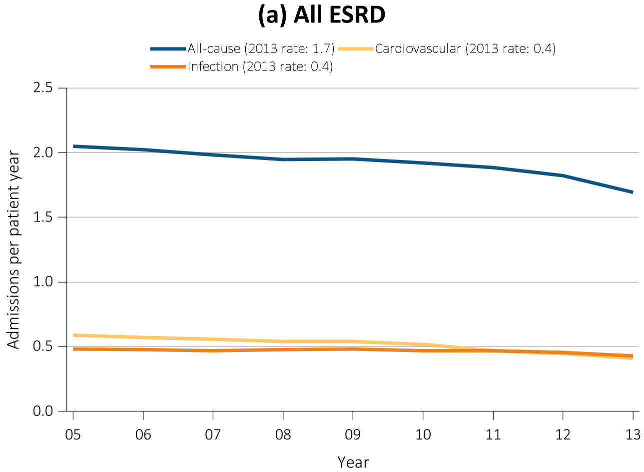


Data Source: Reference Tables G.1, G.3, G.4, G.5, G.6, G.8, G.9, G.10, and special analyses, USRDS ESRD Database. Period prevalent ESRD patients; adjusted for age, sex, race, & primary cause of kidney failure; reference group, ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

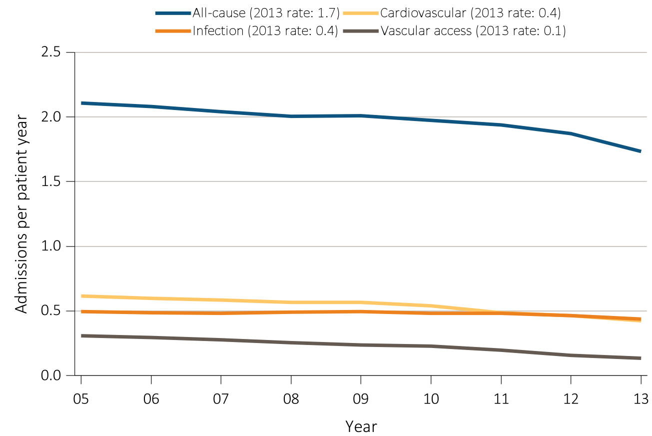
In recent years, the Annual Data Report has highlighted cause-specific hospitalization as an important morbidity surveillance issue. Between 2005 and 2013, rates of hospitalizations due to any cause among ESRD patients declined from 2.05 to 1.69. The decline in hospitalizations due to infection (11.4% overall) was more pronounced among patients on PD (15.4%), and those with a transplant (14.2%) compared to HD patients (11.7%; see Figure 5.2). These improvements likely reflect, at least in part, targeted interventions to prevent and reduce infection rates, especially among PD and transplant patients. Hospital admissions resulting from other causes have also decreased over the same time period (e.g., a 57.2% decrease in hospitalizations for vascular access procedures).

vol 2 Figure 5.2 Adjusted all-cause & cause-specific hospitalization rates for ESRD patients, by treatment modality, 2005-2013

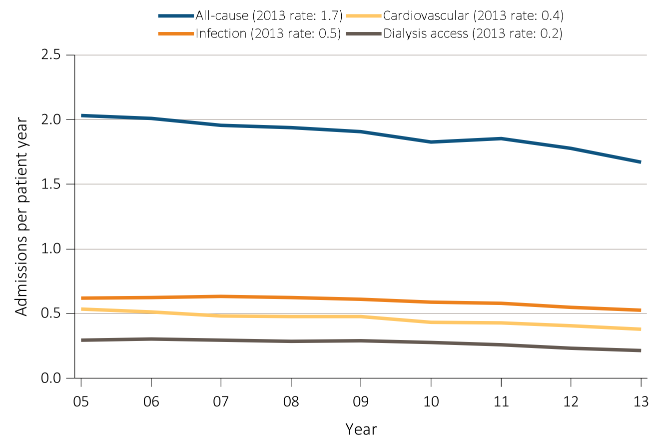
(a) All ESRD



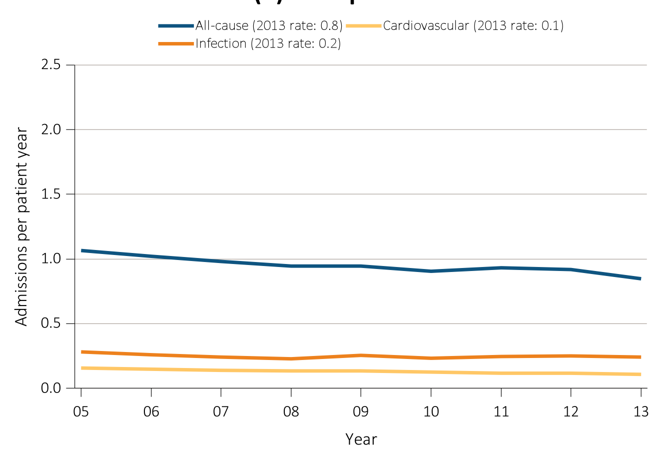
(b) Hemodialysis



(c) Peritoneal dialysis



(d) Transplant



Data Source: Reference Tables G.1, G.3, G.4, G.5, and special analyses, USRDS ESRD Database. Period prevalent ESRD patients; adjusted for age, sex, race, & primary cause of kidney failure; ref: ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

All-cause hospitalization rates among adult HD patients decreased by 14.8% from 2004-2005 to 2012-2013 (see Table 5.1). Hospitalizations due to cardiovascular events and those for vascular access infection fell 29.0 and 61.0%, respectively. Patient groups with higher risk of hospitalization (both overall and for most cause-specific diagnoses) included those aged 22–44 years or 75 years and older, females, Whites, Blacks/African Americans, and patients who had diabetes as their primary cause of kidney failure.

While the overall trends of decreasing hospitalization rates are encouraging, it is plausible that these global and cause-specific declines were influenced at least in part by changes in clinical care practices, CMS rules and terminology, and policies that emphasize greater utilization of ambulatory care services.

vol 2 **Table 5.1 Rates of all-cause & cause-specific hospitalization per patient year for adult hemodialysis patients, 2004-2013**

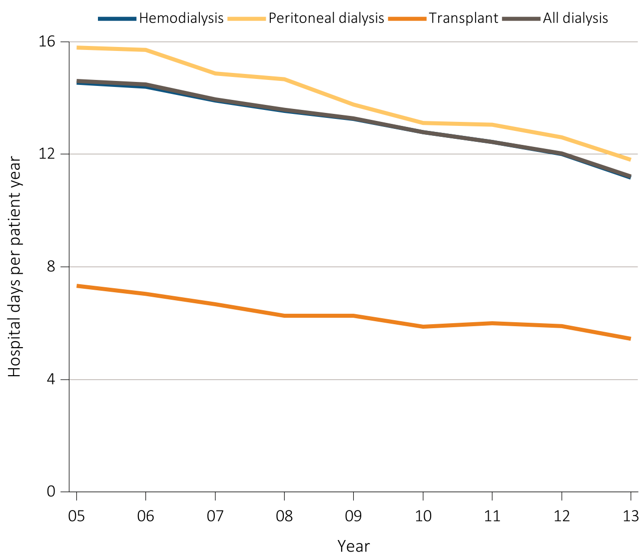
	All		Cardiovascular		Infection (any)		Vascular access infection	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
2004-2005	2.12	2.13	0.63	0.63	0.48	0.48	0.14	0.14
2006-2007	2.08	2.08	0.60	0.60	0.49	0.49	0.13	0.13
2008-2009	2.02	2.02	0.58	0.58	0.49	0.49	0.12	0.12
2010-2011	1.97	1.97	0.52	0.52	0.48	0.48	0.10	0.10
2012-2013	1.81	1.81	0.45	0.45	0.45	0.45	0.05	0.05
2012-2013								
Age								
22-44	1.79	1.96	0.36	0.37	0.42	0.46	0.07	0.08
45-64	1.76	1.76	0.42	0.42	0.43	0.43	0.05	0.06
65-74	1.86	1.82	0.49	0.48	0.46	0.45	0.05	0.05
75+	1.88	1.87	0.51	0.50	0.50	0.49	0.04	0.05
Sex								
Male	1.68	1.68	0.42	0.43	0.42	0.42	0.05	0.05
Female	1.99	1.98	0.48	0.48	0.49	0.49	0.06	0.06
Race								
White	1.86	1.85	0.46	0.45	0.49	0.48	0.05	0.05
Black/African American	1.80	1.83	0.45	0.46	0.41	0.43	0.06	0.06
Other race	1.43	1.40	0.35	0.34	0.39	0.38	0.04	0.04
Ethnicity								
Hispanic	1.70	1.70	0.41	0.41	0.44	0.44	0.05	0.05
Cause of Renal Failure								
Diabetes	2.00	2.03	0.49	0.49	0.50	0.50	0.05	0.06
Hypertension	1.68	1.68	0.46	0.46	0.40	0.40	0.05	0.05
Glomerulonephritis	1.55	1.56	0.36	0.38	0.39	0.39	0.05	0.05
Other	1.69	1.72	0.37	0.38	0.46	0.46	0.05	0.05

Data Source: Reference Tables G.3, G.13, and special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients aged 22 & older; adjusted for age, sex, race, ethnicity, & primary cause of kidney failure. Rates by one factor adjusted for the remaining three; reference group, hemodialysis patients, 2011. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category.

Hospital Days

Continuing a downward trend seen since 2005, the number of total hospital days per patient year among all dialysis patients has decreased, from 14.6 to 11.2 (Figure 5.3). From 2005 to 2013, hospital days PPY decreased to 11.1 for HD patients, 11.7 for PD patients, and to 5.4 days for those receiving a kidney transplant.

vol 2 **Figure 5.3 Adjusted hospital days for ESRD patients, by treatment modality, 2005-2013**

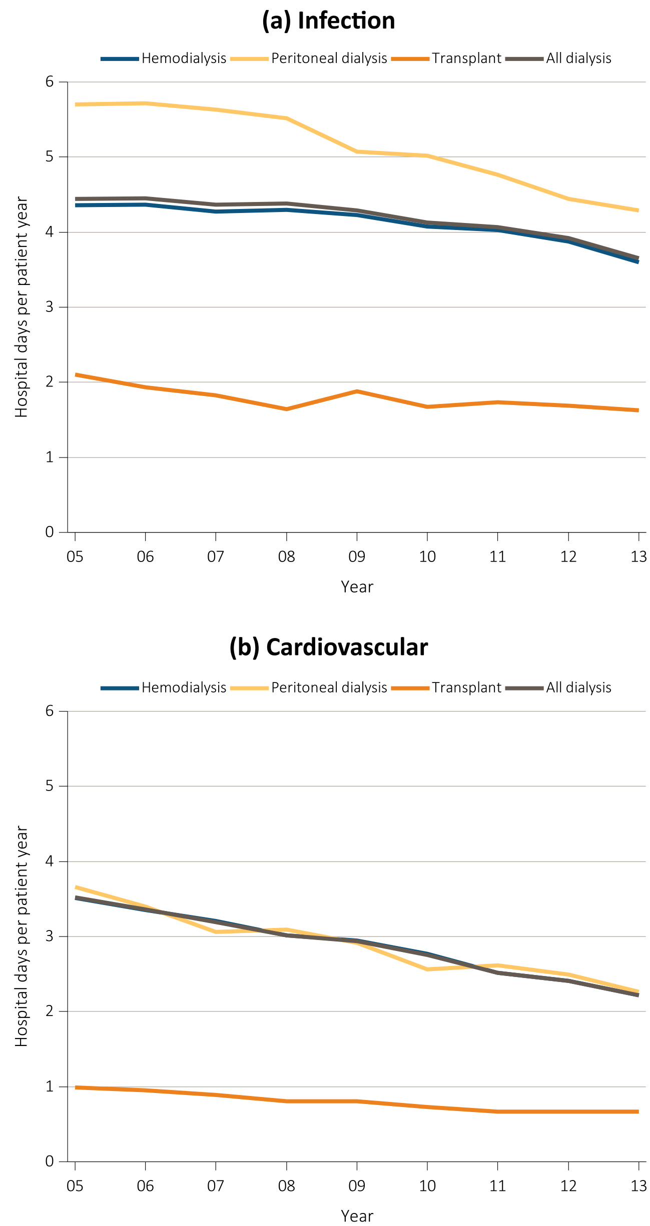


Data Source: Reference Tables G.1, G.3, G.4, G.5, G.6, G.8, G.9, G.10, and special analyses, USRDS ESRD Database. Period prevalent ESRD patients; adjusted for age, sex, race, & primary cause of kidney failure. Reference group: ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

With patient-specific adjustment, the number of infection-related hospital days per patient year decreased by 17.4% for HD patients, 24.8% for patients on PD, and 22.6% for patients with a kidney transplant. When restricted to cardiovascular hospitalizations, hospital days reduced by 37.0% for all dialysis patients, and 32.4% in those with a transplant.

Even after adjustment, the number of hospital days due to infections and cardiovascular events for patients on dialysis were more than twice that of those with a transplant. For HD and PD patients in 2013, infection-related hospital days were 3.6 and 4.3 PPY, respectively, compared to 1.6 PPY for those with a transplant. Among patients with a cardiovascular admission, hospital days were 2.2 and 2.3 PPY for HD and PD patients, as compared to 0.7 PPY for those with a transplant.

vol 2 **Figure 5.4 Adjusted hospital days for infection & cardiovascular causes, for ESRD patients by their treatment modality, 2005-2013**



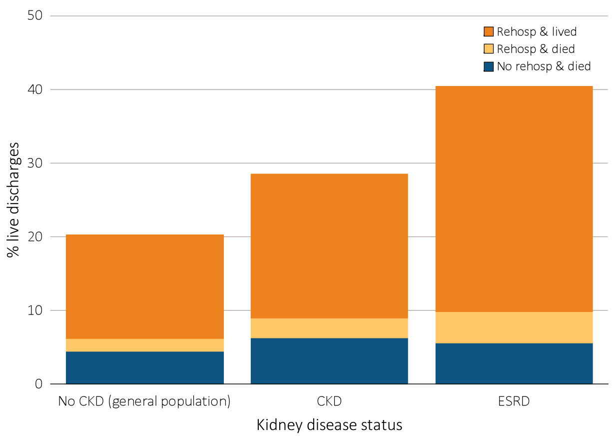
Data Source: Special analyses, USRDS ESRD Database. Period prevalent ESRD patients, adjusted for age, sex, race, & primary cause of kidney failure; reference group: ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

Rehospitalization

Readmissions to the hospital following a hospital discharge are an important predictor of subsequent adverse clinical events, both in the general and ESRD populations. Among dialysis patients, rehospitalizations are associated with morbidity, mortality, and reduced quality of life. Recurrent hospitalizations also pose a significant societal and financial burden, particularly for ESRD patients.

In this chapter rehospitalization/readmission is defined as a hospital admission occurring within 30 days of a hospital discharge. Hospital readmissions with associated death were more common among patients with chronic kidney disease (CKD) or ESRD than in the general population. Compared to older Medicare beneficiaries without a diagnosis of kidney disease (15.8%), patients with CKD and ESRD experienced rehospitalization rates of 22.3% and 34.8%, respectively (Figure 5.5). This held true for the combined outcomes of post-discharge death and/or rehospitalization—at 28.5 (CKD) and 40.5% (ESRD), versus only 20.3% for patients without diagnosed kidney disease.

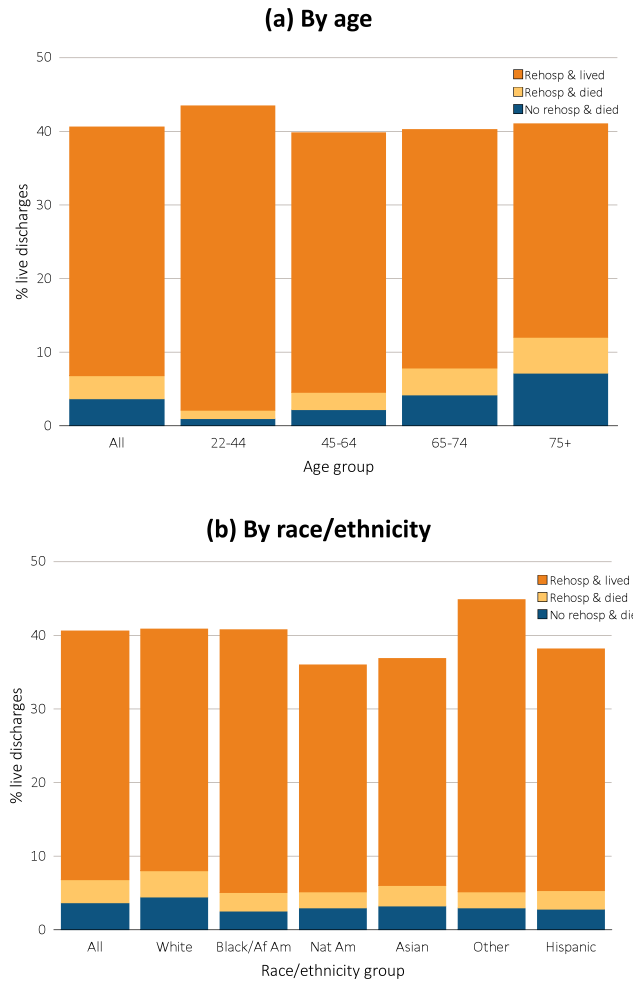
vol 2 **Figure 5.5 Proportion of patients aged 66 & older discharged alive from the hospital who either were rehospitalized or died within 30 days of discharge, by kidney disease status, 2013**



Data Source: Special analyses, USRDS ESRD Database and Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 & older on December 31, 2012. For general Medicare: January 1, 2013 point prevalent, Medicare patients aged 66 & older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013, unadjusted. CKD determined using claims for 2012. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; rehosp, rehospitalization.

Among HD patients prevalent in 2013, 37.0% of discharges from a hospitalization for any cause were followed by a rehospitalization within 30 days (see Figure 5.6a). For older patients, rehospitalization rates decreased as mortality increased, illustrating these competing risks, as death precluded the outcome of readmission. Rates of post-discharge death without rehospitalization, for example, were highest in patients aged 75 years and older, at 7.1%, while these patients had the lowest rehospitalization rates, at 33.9%.

vol 2 **Figure 5.6 Proportion of hemodialysis patients discharged alive from the hospital who either were rehospitalized or died within 30 days of discharge, by demographic characteristics, 2013**



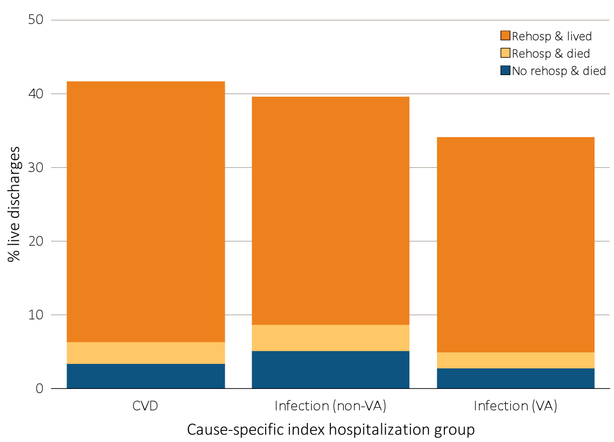
Data Source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients, all ages, 2013; unadjusted. Includes live hospital discharges from January 1 to December 1, 2013. Cause-specific hospitalizations are defined by principal ICD-9-CM codes. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; Nat Am, Native American; Other, other or unidentified race; rehosp, rehospitalization.

The highest rates of rehospitalization with survival occurred for adults aged 22 to 44 years—41.4% of their discharges were followed by a readmission within 30 days. For the two combined rehospitalization outcomes, the highest rates were again seen among patients aged 20–44 years, at 42.6%. The rate of survival following rehospitalization exceeded the two combined death outcomes for all age groups (33.9% vs. 6.7%), even in patients aged 75 and older, at 29.0% and 12.0%, respectively. These data showed that the observed, elevated rehospitalization rates among younger versus older groups was not fully due to the competing risk of mortality in the aged.

In examining the proportion of HD patients discharged alive who were either rehospitalized or died within 30 days of discharge, by their race & ethnicity, the highest rates were observed among the Other race group (39.6% vs. 41.9%), followed by Blacks (35.8% vs. 38.2%). The lowest such rates occurred among Native Americans, with 30.9% who were rehospitalized and lived, and 33.0% who were rehospitalized with the combined outcomes of either survival or death, respectively. The highest rate of post-discharge death occurred among White HD patients at 3.6%, possibly reflecting the older average age among White HD patients.

For all HD patients, the all-cause rehospitalization rate in 2013 was 37.0% (Figure 5.6a). For index hospitalizations due to cardiovascular, infection, and vascular access infections, patients' rehospitalization rates were 38.3, 34.5, and 31.3%, respectively (see Figure 5.7).

vol 2 Figure 5.7 Proportion of hemodialysis patients discharged alive that either were rehospitalized or died within 30 days of discharge, by cause of index hospitalization, 2013



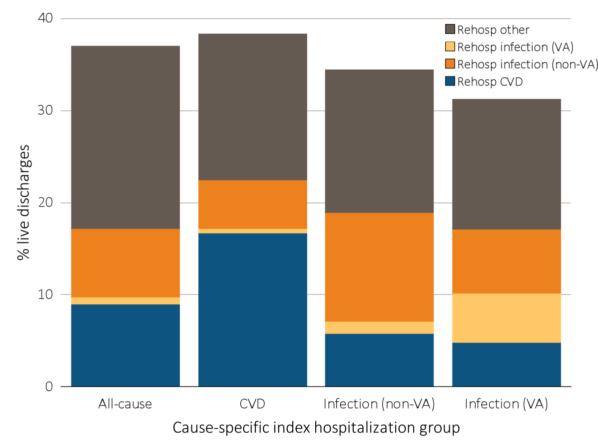
Data Source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients, all ages, 2013, unadjusted. Includes live hospital discharges from January 1 to December 1, 2013. Cause-specific hospitalizations are defined by principal ICD-9-CM codes. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category. Abbreviations: CVD, cardiovascular disease; ESRD, end-stage renal disease; rehosp, rehospitalization; VA, vascular access.

Figure 5.8 illustrates that rehospitalization in the 30 days following a hospital discharge doesn't always result from a similar diagnostic cause as the index hospitalization.

During 2013, of those admitted for treatment of cardiovascular issues and then soon rehospitalized, nearly half (43.6%) were admitted to treat the same or another cardiovascular condition. However, this pattern differed for those initially hospitalized to address vascular access infection (17.2%), and other types of infection (34.4%).The proportion of cause-specific readmission among those with an all-cause index hospitalization were also fairly low—with 24.2% returning for cardiovascular treatment, 2.1% with a vascular access infection, and 20.1% to address other types of infection.

The pattern of rehospitalization following an unrelated index hospitalization suggests the development of new conditions or complications of the original condition. These differences can in part be attributed to the nature of chronic conditions that typically do not resolve (i.e. CVD) versus acute conditions that are expected to resolve (i.e. infection).

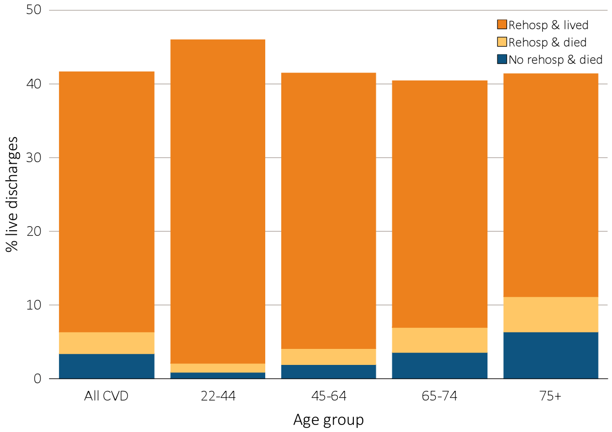
vol 2 Figure 5.8 Proportion of hemodialysis patients with cause-specific rehospitalizations within 30 days of discharge, by cause of index hospitalization, 2013



Data Source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients, all ages, 2013, unadjusted. Includes live hospital discharges from January 1 to December 1, 2013. Cause-specific hospitalizations are defined by principal ICD-9-CM codes. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category. Abbreviations: CVD, cardiovascular disease; ESRD, end-stage renal disease; rehosp, rehospitalization; VA, vascular access.

Rehospitalization rates following discharge from a cardiovascular index hospitalization were slightly higher among younger adults, compared with all other age groups in which rehospitalization rates appear similar. In those aged 20–44, for example, 45.1% of such discharges were followed by a rehospitalization within 30 days (Figure 5.9). In general, these rates mirrored those for all-cause index hospitalizations (seen in Figure 5.5), although the rates for those aged 22-44 in Figure 5.9 were slightly higher.

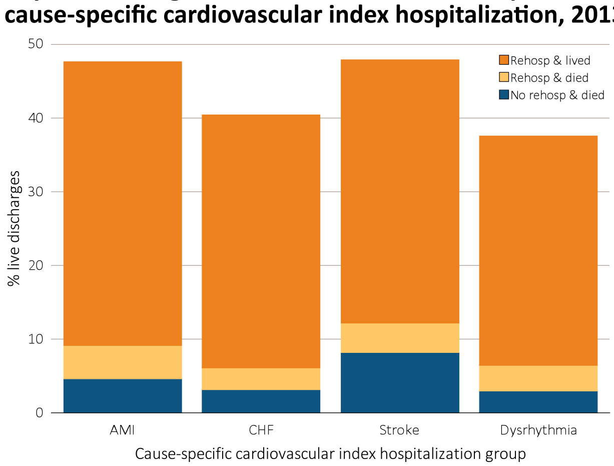
vol 2 Figure 5.9 Proportion of hemodialysis patients discharged alive that either were rehospitalized or died within 30 days of discharge for cardiovascular index hospitalization, by age, 2013



Data Source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients, all ages, 2013, unadjusted. Patients less than age 22 are not represented as a group due to insufficient sample size. Includes live hospital discharges from January 1 to December 1, 2013. Cause-specific hospitalizations are defined by principal ICD-9-CM codes. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category. Abbreviations: CVD, cardiovascular disease; ESRD, end-stage renal disease; rehosp, rehospitalization.

For cardiovascular index hospitalizations (Figure 5.10), rehospitalization occurred most frequently following discharge from treatment of acute myocardial infarction (AMI) and stroke, at 43.0 and 39.8%, respectively. The lowest rates occurred following discharge after dysrhythmia, at 34.6%. When not rehospitalized, stroke patients had the highest post-discharge mortality rate at 8.2%.

vol 2 Figure 5.10 Proportion of hemodialysis patients discharged alive that either were rehospitalized or died within 30 days of discharge for cardiovascular index hospitalization, by cause-specific cardiovascular index hospitalization, 2013



Data Source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients, all ages, 2013, unadjusted. Includes live hospital discharges from January 1 to December 1, 2013. Cause-specific hospitalizations are defined by principal ICD-9-CM codes. See Vol. 2, ESRD Analytical Methods for principal ICD-9-CM diagnosis codes included in each cause of hospitalization category. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; ESRD, end-stage renal disease; rehosp, rehospitalization.

As comorbid cardiovascular disease and its complications have a critical interaction with kidney disease of all types, this 2015 ADR features two chapters specifically addressing these issues—Volume1, Chapter 4 Cardiovascular Disease in Patients with CKD, and Volume 2, Chapter 9, Cardiovascular Disease in Patients with ESRD.

References

Center for Medicare and Medicaid Services (2014, June). Report for the Standardized Readmission Ratio. Retrieved October 23, 2015, from https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/ESRDQIP/Downloads/MeasureMethodology eMethodologyReportfortheProposedSRRMeasure.pdf

Notes

Chapter 6: Mortality

- Mortality rates continue to decrease for dialysis and transplant patients, having fallen by 28% and 40%, respectively, since 1996.
- Adjusted mortality rates in 2013 per 1,000 patient-years were 138, 169, and 35 for ESRD, dialysis, and transplant patients, respectively. By dialysis modality, mortality rates were 172 for hemodialysis patients and 152 for peritoneal dialysis patients, per 1,000 patient-years.
- Patterns of mortality during the first year of dialysis differ substantially by modality. For hemodialysis patients, reported mortality is very high in month 2, but declines thereafter. In contrast, mortality rises slightly over the course of the year for peritoneal dialysis patients.
- The relationship between race and mortality differs considerably by age among dialysis patients. White dialysis patients younger than age 45 have mortality rates comparable to Black patients, but experience higher mortality in older ages.
- Dialysis patients continue to have substantially higher mortality, and fewer expected remaining life years, compared to the general population and Medicare populations with cancer, diabetes, or cardiovascular disease. However, the relative and absolute decline in mortality for dialysis patients in the past 15 years has been greater than for these other diagnostic groups.

Introduction

Mortality analyses in this chapter are based on both end-stage renal disease (ESRD) data and general population data. ESRD data are from the USRDS ESRD Database. General population data are based on the Medicare 5 percent standard analytical files and U.S. Census mortality data. Note that universal reporting of ESRD patient deaths to the Centers for Medicare & Medicaid (CMS) is required via CMS form 2746 as a condition of coverage for dialysis units and transplant centers. In addition, mortality ascertainment is augmented by Social Security Death Master File data to the extent allowed by regulation.

For analyses in this chapter, the term "incident" refers to patients new to ESRD, while "prevalent" refers to patients receiving ESRD treatment on a specific date, and "period prevalent" includes patients treated for ESRD over a period of time. Modality is assigned as of the earliest date within the range used in the analysis, without use of the 60-day stable modality rule (i.e., the requirement of 60 days on a modality for change in modality assignment) or the 90-day rule for outcomes (attribution of outcomes for up to 90 days after a change in modality).

The decline in mortality shown in this chapter has important implications for both patients and resource allocation, as increasing ESRD patient lifespan is likely contributing to the ongoing increase in the size of the prevalent ESRD population.

Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

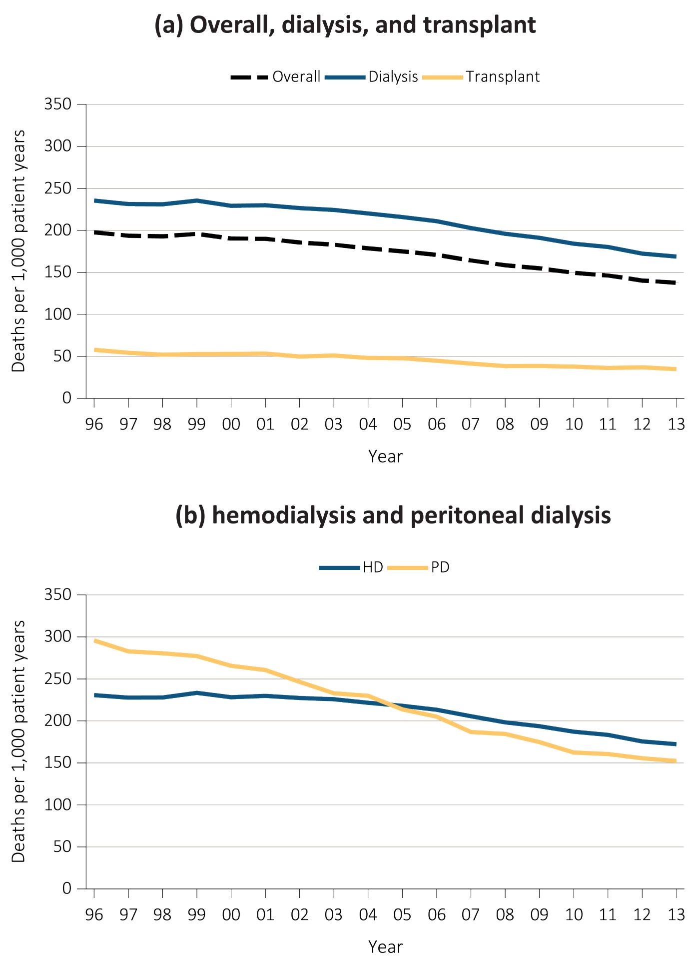
Mortality Among ESRD Patients, Overall and by Modality

Overall mortality rates among ESRD (dialysis and transplant) patients continue to decline, with steeper declines in more recent years. Over the last two decades, the adjusted death rate fell by 7% from 1996 to 2003, and by 23% from 2004 to 2013 (Figure 6.1.a). The trend was similar for dialysis (hemodialysis and peritoneal dialysis) patients, with the mortality rate falling by 5% from 1996 to 2003 and by 23% from 2004 to 2013. Among transplant patients, mortality fell by 12% from 1996 to 2003 and by 28% from 2004 to 2013. Since 1996, the net reduction in mortality was 30% for all ESRD patients, including 28% for dialysis patients and 40% for transplant patients.

By dialysis modality, among hemodialysis patients the adjusted mortality rate fell by 2% from 1996 to 2003 and by 22% from 2004 to 2013. Among peritoneal dialysis patients, the mortality rate fell by 21% from 1996 to 2003 and by 34% from 2004 to 2013 (Figure 6.1.b). The net reductions in mortality from 1996 to 2013 were 25% for hemodialysis patients and 49% for peritoneal patients.

Adjusted mortality rates in 2013 were 138, 169, and 35 per 1,000 patient-years for ESRD, dialysis, and transplant patients, respectively. By dialysis modality, mortality rates were 172 for hemodialysis patients and 152 for peritoneal dialysis patients, per 1,000 patient-years.

vol 2 Figure 6.1 Adjusted all-cause mortality (deaths per 1,000 patient-years) by treatment modality (a) overall, dialysis, and transplant, and (b) hemodialysis and peritoneal dialysis, for period-prevalent patients, 1996-2013

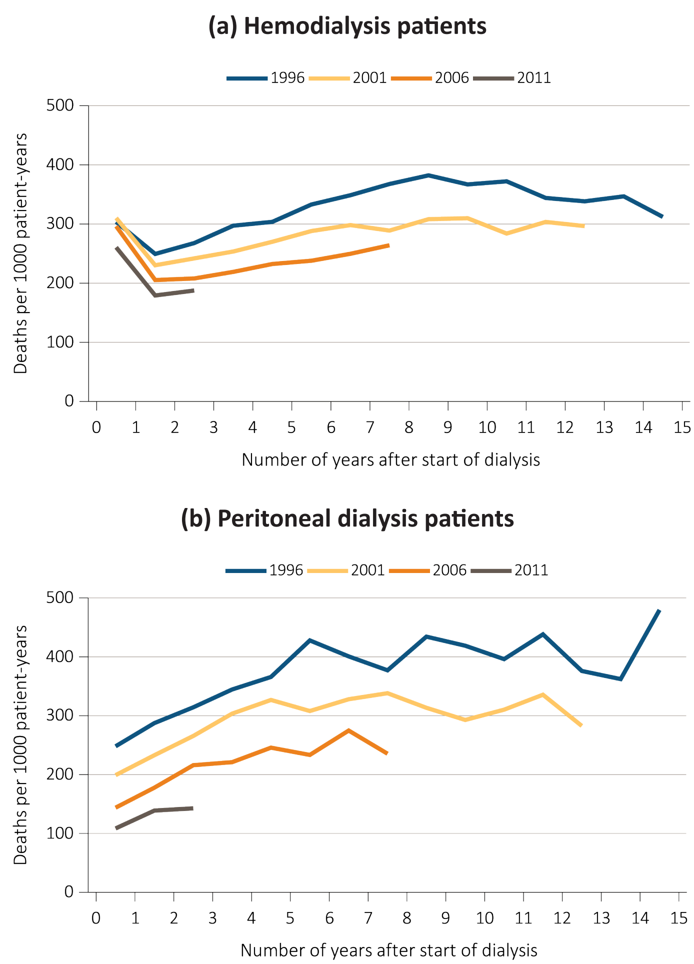


Data Source: Reference Tables H.2_adj, H4_adj, H.8_adj, H.9_adj, and H.10_adj; and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, ethnicity, primary diagnosis and vintage. Ref: period prevalent ESRD patients, 2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

Mortality by Duration of Dialysis, Including Trends Over Time

Among hemodialysis patients, from 1996-2011 the average yearly death rate was highest during the first year, then dropped to its lowest point during the second year, and then tended to rise for more than 5 years afterward (Figure 6.2). Among peritoneal dialysis patients, mortality rates tended to increase over the first five years after starting dialysis. For both hemodialysis and peritoneal dialysis patients, mortality rates tended to be higher after 5 years than between 2-5 years on dialysis. The patterns of death rates according to time since dialysis initiation have been fairly similar over calendar time (comparing cohorts based on calendar year of initiation of treatment), within modality.

vol 2 Figure 6.2 Adjusted all-cause mortality (deaths per 1,000 patient-years) by treatment modality, cohort (year of ESRD onset), and number of years after start of dialysis among incident (a) hemodialysis patients and (b) peritoneal dialysis patients, 1996, 2001, 2006, and 2011



Data Source: Special analyses, USRDS ESRD Database. Adjusted for age, sex, race, and primary diagnosis. Ref: period prevalent ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

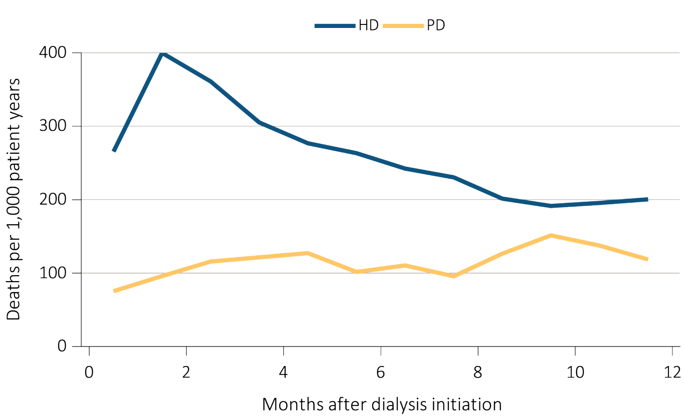
Mortality During the First Year of ESRD

Among patients starting hemodialysis in 2012, reported all-cause mortality peaked at 400 deaths per 1,000 patient-years in month 2, and decreased thereafter to 200 per 1,000 patient-years in month 12 (Figure 6.3). Note that the steep rise in hemodialysis mortality rates between months 1 and 2 may reflect 'data reporting issues'; e.g., some patients who die soon after starting dialysis related to ESRD might not be registered as being ESRD and included in the CMS database (Foley et al., 2014). The extent to which this occurs is currently unknown.

Among patients with peritoneal dialysis as initial renal replacement modality, mortality does not peak early but instead tends to increase gradually during the first year on dialysis. Mortality at month 12 among these patients was 119 per 1,000 patient-years. Peritoneal dialysis patients may not experience an early peak in mortality, in part, because patients beginning ESRD via peritoneal dialysis are a highly selected group, in many cases being younger, healthier, and having undergone substantial pre-ESRD planning.

Post-transplant mortality among the <2% of patients who initiate ESRD treatment with a kidney transplant peaks in month 1, followed by a generally decreasing trend for the remainder of the first year (not shown).

vol 2 Figure 6.3 Adjusted mortality (deaths per 1000 patient-years) by treatment modality and number of months after treatment initiation among ESRD patients, 2012



Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) mortality among 2012 incident ESRD patients during the first year of therapy. Ref: incident ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Mortality by Age and Race

Mortality rates among ESRD patients increase with rising age, as expected. Mortality rates differ by race, but this difference is not constant within age groups or by modality. For example, White patients on dialysis had comparable mortality rates to Black/African American patients among those aged 0-44 years old, but higher mortality than Blacks at older ages.

vol 2 Table 6.1 Adjusted all-cause mortality (deaths per 1,000 patient-years) by patient age and race among ESRD patients, 2012

Age	Race	ESRD	Dialysis	Transplant
0-21	White	12	31	4
	Black/African American	20	35	4
	Other	14	29	7
22-44	White	37	62	9
	Black/African American	48	60	10
	Other	24	38	6
45-64	White	99	143	30
	Black/African American	98	114	29
	Other	71	99	21
65-74	White	197	245	70
	Black/African American	167	183	71
	Other	137	171	61
75+	White	359	382	136
	Black/African American	275	283	132
	Other	239	254	112

Data Source: Special analyses, USRDS ESRD Database. Adjusted (sex and primary diagnosis) all-cause mortality among 2012 period prevalent patients. Ref: period prevalent ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

Cause-Specific Mortality Rates

The largest category of known cause-specific mortality for dialysis patients is deaths due to cardiovascular disease (CVD), which comprises 41% of the deaths and 53% of the deaths with known causes. The cause of death information (based on CMS 2746) is missing or unknown for 23% of dialysis patients and 68% of transplant patients.

vol 2 **Table 6.2 Unadjusted percentages of deaths due to cardiovascular disease (CVD), infection, other specified causes, and with missing data, by modality among ESRD patients, 2012**

	Cause-specific mortality			
	CVD	Infection	Other cause	Missing cause
Modality				
ESRD	39%	9%	26%	26%
Dialysis	41%	9%	27%	23%
Transplant	11%	6%	16%	68%

Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) all-cause mortality among 2012 prevalent patients. Ref: period prevalent ESRD patients, 2011. Abbreviations: CVD, cardiovascular disease; ESRD, end-stage renal disease.

Survival Probabilities for ESRD Patients

Despite improvements in survival on dialysis over the years, adjusted survival for hemodialysis patients who were incident in 2008 is only 55% at three years after ESRD onset (Table 6.3.a.). For peritoneal dialysis patients, adjusted survival is 66% at three years. These results illustrate the extreme vulnerability of these patients relative to the general population.

Survival has improved between the 2000 and 2008 incident ESRD cohorts for all modalities. For example, five-year survival rose from 35% to 40% among hemodialysis patients, from 37% to 50% among peritoneal dialysis patients, from 66% to 75% among deceased donor transplant patients, and from 75% to 87% among living donor transplant patients. Adjusted survival was consistently higher in the transplant population than in dialysis patients, and among living donor transplant recipients than deceased donor recipients.

In the 2008 incident ESRD cohort, adjusted survival was consistently higher (Table 6.3.b) among younger patients, among Asians and Blacks compared to other races, and patients among with primary cause of ESRD designated as glomerulonephritis compared to patients with diabetes or hypertension.

vol 2 **Table 6.3 Adjusted survival (%) by (a) treatment modality and incident cohort year (year of ESRD onset), and (b) age, sex, race, and primary cause of ESRD, for ESRD patients in the 2008 incident cohort (initiating ESRD treatment in 2008)**

(a) Treatment modality and incident cohort year (year of ESRD onset)

	3 months	12 months	24 months	36 months	60 months
Hemodialysis					
2000	91.0	74.4	60.6	50.1	34.5
2002	91.0	74.6	61.1	50.7	35.9
2004	91.0	74.8	61.9	51.8	37.3
2006	91.1	75.4	63.0	53.4	38.8
2008	91.4	76.3	64.4	54.7	40.2
Peritoneal dialysis					
2000	94.7	80.3	64.3	52.8	37.3
2002	95.8	82.9	68.4	57.0	41.6
2004	96.1	84.8	71.8	60.8	45.7
2006	96.9	86.4	73.7	62.4	47.1
2008	97.4	88.5	76.4	66.4	50.3
Deceased-donor transplant					
2000	94.5	88.1	82.7	77.9	65.8
2002	95.1	89.9	84.4	79.5	68.8
2004	96.1	90.4	85.5	79.8	69.7
2006	96.0	91.4	86.9	82.7	72.4
2008	96.8	92.8	88.7	84.6	74.6
Living donor transplant					
2000	97.0	93.2	88.7	84.9	74.8
2002	97.6	94.2	90.0	86.3	77.6
2004	98.2	95.3	92.4	88.9	81.8
2006	98.6	96.3	93.7	90.8	83.5
2008	98.7	97.1	94.9	92.2	86.9

Data Source: Reference Tables I.1_adj-I.36_adj. Adjusted survival probabilities, from day one, in the ESRD population. Ref: incident ESRD patients, 2011. Adjusted for age, sex, race, Hispanic ethnicity, and primary diagnosis. Abbreviation: ESRD, end-stage renal disease.

(b) Age, sex, race, and primary cause of ESRD

2008 cohort	3 months	12 months	24 months	36 months	60 months
Age					
0-21	98.5	95.3	93.2	91.8	88.7
22-44	97.6	91.8	86.4	81.7	73.8
45-64	95.3	85.6	76.4	68.3	54.5
65-74	91.1	75.0	61.8	50.9	34.1
75+	85.1	62.2	45.6	33.2	17.1
Sex					
Male	91.8	77.6	65.9	56.4	42.4
Female	92.0	77.9	66.5	57.2	42.8
Race					
White	91.2	76.3	64.2	54.6	40.2
Black/African American	93.1	79.7	69.1	60.1	46.1
Native American	92.5	78.6	65.8	55.9	42.4
Asian	95.3	85.1	75.4	67.0	53.9
Other	90.1	71.6	57.7	47.2	34.4
Primary cause of ESRD					
Diabetes	92.9	78.3	65.2	54.3	37.9
Hypertension	92.2	78.8	67.7	58.6	44.6
Glomerulonephritis	94.4	83.8	74.6	66.8	55.1
Other	90.1	71.6	57.7	47.2	34.4
All patients	91.9	77.7	66.2	56.8	42.6

Data Source: Reference Tables I.1-I.36. Adjusted survival probabilities, from day one, in the ESRD population. Ref: incident ESRD patients, 2011. Adjusted for age, sex, race, Hispanic ethnicity, and primary diagnosis. Abbreviation: ESRD, end-stage renal disease.

Expected Remaining Lifetime: Comparison of ESRD Patients to the General U.S. Population

The differences in expected remaining lifetime between the ESRD and general populations are striking (Table 6.4). Dialysis patients younger than 80 years old are expected to live less than one-third as long as their counterparts without ESRD, and dialysis patients aged 80 years and older are expected to live less than one-half as long as their counterparts without ESRD. Transplant patients fare considerably better, with expected remaining lifetimes for people under the age of 75 estimated at 67% to 84% of expected lifetimes in the general population.

vol 2 **Table 6.4 Expected remaining lifetime (years) by age, sex, and treatment modality of prevalent dialysis patients, prevalent transplant patients, and the general U.S. population (2012), based on USRDS data and the National Vital Statistics Report (2013)**

	ESRD patients, 2013				General U.S. population, 2012	
	Dialysis		Transplant			
Age	Male	Female	Male	Female	Male	Female
0-14	24.1	22.4	59.2	61.2	70.7	75.4
15-19	20.9	19.3	46.8	48.6	59.7	64.4
20-24	18.1	16.5	42.5	44.2	55.0	59.5
25-29	15.8	14.3	38.6	40.2	50.3	54.6
30-34	14.1	13.0	34.7	36.4	45.7	49.7
35-39	12.5	11.7	30.8	32.4	41.0	45.0
40-44	10.8	10.3	26.9	28.6	36.4	40.3
45-49	9.1	8.8	23.2	24.8	31.9	35.6
50-54	7.7	7.7	19.8	21.3	27.7	31.1
55-59	6.5	6.6	16.6	18.1	23.7	26.8
60-64	5.5	5.7	13.8	15.2	19.8	22.6
65-69	4.5	4.8	11.4	12.7	16.2	18.5
70-74	3.8	4.0	9.4	10.4	*12.8*	*14.7*
75-79	3.2	3.5	7.7a	8.6a	9.8	11.3
80-84	2.6	2.9			7.1	8.4
85+	2.1	2.4			4.9	5.8

Data Source: Reference Table H.13; special analyses, USRDS ESRD Database; and National Vital Statistics Report. "Table 7. Life expectancy at selected ages, by race, Hispanic origin, race for non-Hispanic population, and sex: United States, 2012 (2015)." Expected remaining lifetimes (years) of the general U.S. population and of period prevalent dialysis and transplant patients. [a]cell values combine ages 75+. Abbreviation: ESRD, end-stage renal disease.

Mortality Rates: Comparisons of ESRD Patients to the Broader Medicare Population

Comparison to the General Medicare Population

Dialysis patients over the age of 75 years experienced mortality rates 3.9 times higher for males and 3.8 times higher for females than for males and females in the general Medicare population (Table 6.5). Among kidney transplant patients, mortality rates were 2.5-3.3 times higher than for the general Medicare population aged 65-74, and 1.4 times higher at age 75 and older.

vol 2 **Table 6.5 Adjusted mortality (deaths per 1,000 patient-years) by age, sex, treatment modality, and Medicare comorbidity among ESRD patients and people covered by Medicare in 2013, based on USRDS and CMS data, 2013**

Age	Sex	Dialysis	Transplant	All Medicare	Cancer	Diabetes	CHF	CVA/TIA	AMI
65-74	Male	235	68	27	75	42	107	75	91
	Female	214	60	18	69	31	99	56	96
75+	Male	357	126	91	135	109	232	167	202
	Female	321	122	85	139	104	229	156	212

Data Source: Special analyses, USRDS ESRD Database and Medicare 5 percent sample. Adjusted for race. Medicare data limited to patients with at least one month of Medicare eligibility in 2013. Ref: Medicare patients, 2013. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CMS, Centers for Medicare & Medicaid; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.

Comparison to Comorbidity-Specific Medicare Patients

From 1996 to 2013, adjusted mortality among ESRD patients aged 65 years and older declined by 48%, from 338 to 174 per 1,000 patient-years (Table 6.6). Among dialysis patients, adjusted mortality fell 37%, from 349 to 219. Among transplant patients, adjusted mortality fell 9%, from 79 to 72. The decline in mortality for dialysis patients was greater than for other major diagnostic groups, including cancer, diabetes, CHF, CVS/TIA, and AMI. Adjusted mortality fell 34% for cancer and 32% for diabetes, but somewhat less for cardiovascular conditions, at 23% for heart failure, 27% for cerebrovascular accident/transient ischemic attack (CVA/TIA), and 20% for acute myocardial infarction (AMI).

In 2013, mortality rates among dialysis patients aged 65years and older ranged from 1.7 times higher than for heart failure patients to 4.0 times higher than for patients with diabetes. For transplant patients aged 65 and older, the mortality rate was within the range of mortality rates for Medicare patients with the other listed conditions.

vol 2 **Table 6.6 Adjusted mortality (deaths per 1,000 patient-years) by calendar year, treatment modality, and Medicare comorbidity among ESRD patients and comorbidity-specific Medicare populations aged 65 & older, 1996-2013**

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Decline 1996-2012
Modality																			
ESRD	338	357	382	390	375	382	380	391	406	335	280	271	261	266	257	265	222	174	48%
Dialysis	349	368	392	402	389	399	400	415	437	365	310	307	298	313	307	328	288	219	37%
Transplant	79	87	110	82	73	76	81	118	100	95	82	74	96	91	91	94	85	72	9%
Medicare data comorbidities	151	146	137	140	142	113	122	120	118	107	110	106	107	102	98	99	100	99	34%
Cancer	80	76	76	82	77	68	69	66	61	61	60	58	57	55	52	52	53	54	32%
Diabetes	170	155	154	155	154	141	143	138	132	131	130	134	131	128	125	120	128	131	23%
CHF	124	117	116	126	116	105	111	102	97	96	98	95	90	89	89	84	92	91	27%
CVA/TIA	157	132	126	148	142	118	128	119	109	106	118	113	117	109	121	117	127	125	20%
AMI	338	357	382	390	375	382	380	391	406	335	280	271	261	266	257	265	222	174	48%

Data Source: Special analyses, USRDS ESRD Database, and Medicare 5 percent sample. Unadjusted and adjusted (sex and race) mortality rates starting with the January 1 point prevalent sample in the ESRD and general populations, aged 65 and older (per 1,000 patient-years at risk). Ref: period prevalent ESRD patients, 2012. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.

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Foley RN, Chen SC, Solid CA, Gilbertson DT, Collins AJ. Early mortality in patients starting dialysis appears to go unregistered. *Kidney Int* 2014;86(2):392-398.

National Vital Statistics Report. Table 7. Life expectancy at selected ages, by race, Hispanic origin, race for non-Hispanic population, and sex: United States, 2012. 2015;63(9):29. http://www.cdc.gov/nchs/data/nvsr/nvsr63/nvsr63_09.pdf. Accessed October 2, 2015.

Notes

Chapter 7: Transplantation

- 17,600 kidney transplants were performed in the United States in 2013 (16,253 were kidney-alone).
- Less than one-third of kidneys transplanted were from living donors in 2013.
- From 2012 to 2013, there was a 3.1% increase in the cumulative number of recipients with a functioning kidney transplant.
- On December 31, 2013, the kidney transplant waiting list had 86,965 candidates (dialysis patients only) with 48,311 active candidates. 83% of all candidates were awaiting their first transplant.
- Among candidates newly wait-listed for either a first-time or repeat kidney-alone transplant in 2009, the median waiting time to transplant was 3.6 years.
- The number of deceased donors has increased significantly since 2003, reaching 8,021 in 2013.
- The rate of deceased donors among Blacks more than doubled from 1999 to 2013.
- 16% of kidneys recovered from deceased donors were discarded in 2013.
- In 2012, the probability of one-year graft survival was 92% and 97% for deceased and living donor kidney transplant recipients, respectively.
- The probability of patient survival within one year post-transplant was 95% and 98% in deceased and living donor kidney transplant recipients, respectively, in 2012.
- Since 1996, the probabilities of graft survival and patient survival have steadily improved among recipients of both living and deceased donor kidney transplants.
- The one-year graft survival and patient survival advantage experienced by living donor transplant recipients persists at five and ten years post-transplant.

Introduction

Kidney transplantation is the renal replacement therapy of choice for a majority of patients with end stage renal disease (ESRD). Successful kidney transplantation is associated with improved survival, improved quality of life and healthcare cost savings when compared to dialysis. This chapter reports on the trends of the kidney transplant waiting list, kidney transplants performed over the years, and the health outcomes of those who have received a transplant. In addition, to further enhance our understanding of the donor pool, this year we report the trends and epidemiology of deceased kidney donations over the years.

Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Overview

During the year 2013, 17,600 kidney transplants, including 16,253 kidney-alone and 1,347 kidney plus at least one additional organ, were performed in the United States. Of these transplants, 5,721 were identified as coming from living donors and 11,878 from deceased donors. Overall, there were 356 more kidney transplants in the United States in 2013 than in 2012. Although the number of kidney transplants has, in general, remained stable since 2005, ranging from a high of 18,018 in 2006, to a low of 17,244 in 2012, the cumulative number of recipients living with a functioning kidney transplant continues to grow, reaching 193,262 in 2013, a 3.1% increase over 2012.

As of December 31, 2013, the kidney transplant waiting list increased by 3% over the previous year to 86,965 candidates (dialysis patients only), 83% of which were awaiting their first kidney transplant. Fifty-six percent (48,311) of wait-listed candidates were in active status and 44% (38,654) were inactive. With less than 18,000 kidney transplants performed in 2013, the active waiting list was 2.7 times larger than the supply of donor kidneys, which presents a continuing challenge. An additional 14,541 (14%) patients not yet on dialysis were on the waiting list as of December 31, 2013.

Among incident ESRD patients who started their dialysis in 2012, 13% were added to the waiting list or received a deceased or living donor transplant within one year of ESRD initiation. Among candidates newly wait-listed for either a first-time or repeat kidney-alone transplant in 2009, the median waiting time to transplant was 3.6 years, i.e., by 3.6 years after being wait-listed for a transplant, 50% of patients had received a transplant.

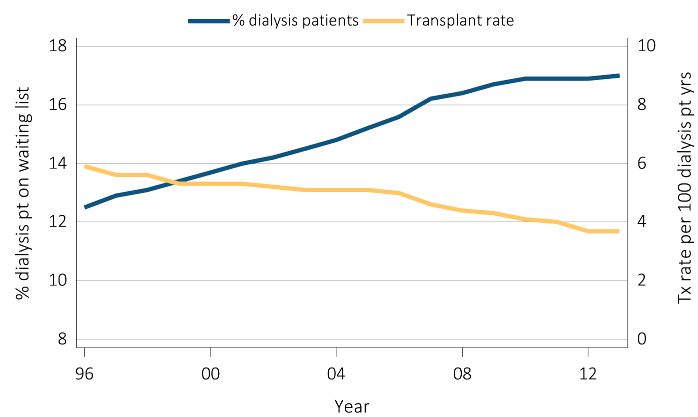
The probability of one-year graft survival for deceased donor kidney transplant recipients in 2012 was 92%, unchanged from 2011. Analyzing the separate components of graft failure, the probability of either returning to dialysis or undergoing repeat transplantation was 5%, while that of death was 4%. The probability of one-year graft survival for living donor transplant recipients was 97%, which was substantially higher than that for deceased donor transplant recipients. Analyzing the separate components of graft failure, the probability of either returning to dialysis or undergoing repeat transplantation was 2% and that of death was 2%.

For recipients of deceased donor transplants in 2008, the probability of five-year graft survival improved from 72% to 73% compared to the prior year. Five-year graft survival for living donor transplant recipients in 2008 also improved, from 83% to 85%.

The percentage of acute rejection during the first year was highest in 1996 among both deceased (51%) and living (52%) donor recipients. Subsequently, instances of acute rejection declined over the next decade.

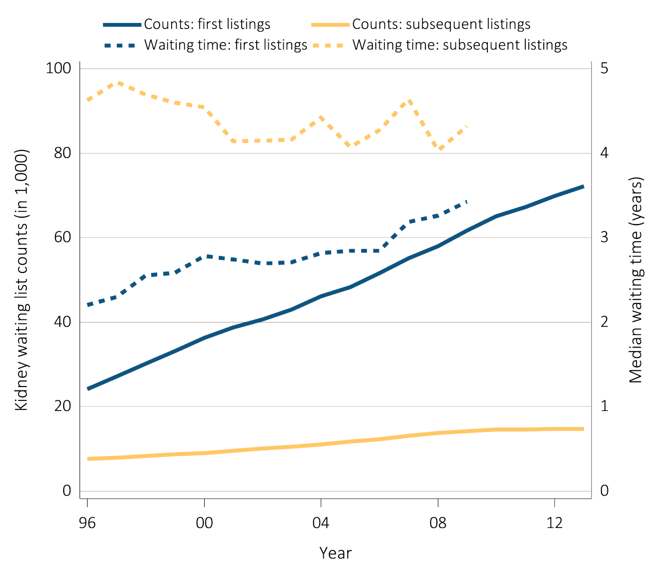
The unadjusted transplant rate per 100 dialysis patient years has been falling, while the percentage of prevalent dialysis patients wait-listed for a kidney has been rising (Figure 7.1). Probable contributing causes include a higher prevalent dialysis population, longer survival of ESRD patients on dialysis, and the growing imbalance between donor supply and demand, which in turn leads to longer kidney transplant waiting times. Waiting list counts and median waiting time to transplantation continue to grow (Figure 7.2). The number of candidates on the waiting list for repeat kidney transplant has plateaued at approximately 14,500 over the last four years. The median waiting time for first-time transplants was 3.4 years in 2009, 11 months shorter than that for repeat transplants. The total number of kidney transplants has leveled off over the past decade (Figure 7.3). During this period, a small overall increase in deceased donations has balanced a small decrease in living donations. The latter is driven in part by changes in the pediatric allocation policy that direct deceased donor kidneys from donors under the age of 35 years to children. Introduction of this policy has been associated with a decrease in living donations to children. As noted above, the total number of recipients with functioning kidney transplants continues to grow (Figure 7.4).

vol 2 Figure 7.1 Percentage of dialysis patients wait-listed and unadjusted kidney transplant rates, 1996-2013



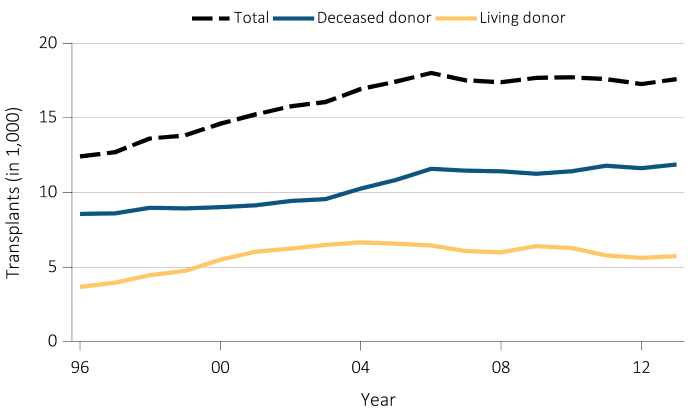
Data Source: Reference Tables E4 and E9. Percentage of dialysis patients on the kidney waiting list is for all dialysis patients. Unadjusted transplant rates are for all dialysis patients. Abbreviations: Tx, transplant; pt yrs, patient years.

vol 2 Figure 7.2 Number of patients wait-listed for kidney transplant, 1996-2013, and waiting time, 1996-2010



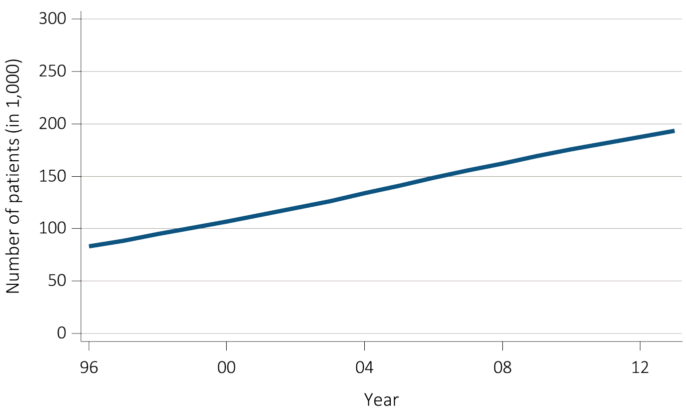
Data Source: Reference Tables E2 and E3. Waiting list counts include all candidates listed for a kidney transplant on December 31 of each year. Waiting time is calculated for all candidates enrolled on the waiting list in a given year.

vol 2 Figure 7.3 Number of kidney transplants, 1996-2013



Data Source: Reference Tables E8, E8(2), and E8(3). Counts of transplants are for all dialysis patients.

vol 2 Figure 7.4 Number of patients with a functioning kidney transplant, 1996-2013

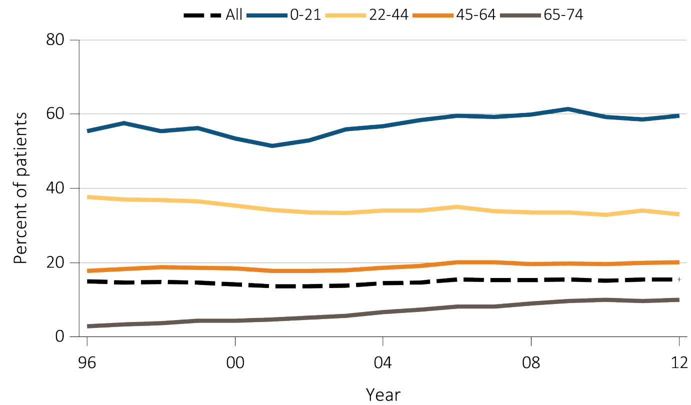


Data Source: Reference Table D9. Prevalent counts of patients with a functioning kidney transplant as of December 31 of each year.

Kidney Transplant Waiting List

The percentage of patients wait-listed or receiving a transplant in their first ESRD-year has declined for those between the ages of 22 and 44 years, but has increased slightly in recent years for those aged 45 years and older (Figure 7.5). Patients aged 0-21 and 65-74 years old experienced the greatest percentage increase of those being wait-listed or receiving a kidney transplant within one year of ESRD initiation, steadily rising from 5% in 2002 to 10% in 2012. Increasing age continues to be associated with a decreasing percentage of patients being wait-listed or transplanted within one year of ESRD initiation.

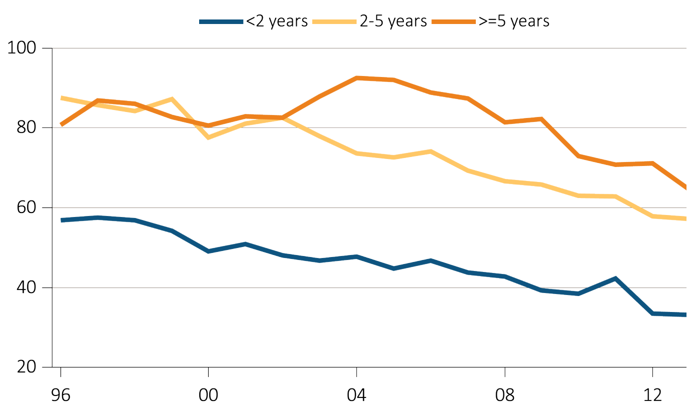
vol 2 Figure 7.5 Percentage of incident patients being wait-listed or receiving a kidney transplant within one year of ESRD initiation, by age, 1996-2012



Data Source: Reference Table E5(2). Waiting list or transplantation among incident ESRD patients by age (0-74 years).

There has been a 27% relative decline in the overall mortality rate for dialysis patients on the kidney transplant waiting list since 2004 (Figure 7.6).

vol 2 Figure 7.6 Annual mortality rates for dialysis patients on the kidney transplant waiting list by time on the list, 1996-2013



Data Source: Reference Table H6. Annual mortality rates of dialysis patients on the kidney transplant waiting list per 1,000 dialysis patient years at risk, by patient vintage. Abbreviation: pt yrs, patient years.

Transplant Counts and Rates

The number of annual kidney transplants has remained relatively stable since 2005, ranging from a high of 18,018 in 2006, to a low of 17,244 in 2012. However, the annual transplant rate has seen a continuous decline (Table 7.1). During 2004-2013, this trend was more pronounced in those aged 22-44 and 45-64 years. This decline is noticeable in both males and females, and across all racial groups and causes of ESRD.

vol 2 **Table 7.1 Unadjusted kidney transplant rates, all donor types, by age, sex, race, and primary cause of ESRD, per 100 dialysis patient years, 2004-2013**

Age	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
0-21	31.2	34.9	35.4	30.3	30.9	33.3	31.5	30.5	31.2	30.4
22-44	11.6	11.2	10.8	10.1	9.2	9.3	8.7	8.3	8.2	7.9
45-64	6.1	6.0	6.0	5.6	5.3	5.1	5.0	4.8	4.4	4.5
65-74	2.3	2.6	2.7	2.5	2.6	2.6	2.6	2.6	2.5	2.5
75 and up	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.3
Sex										
Male	5.6	5.6	5.6	5.1	4.9	4.7	4.5	4.3	4.1	4.0
Female	4.5	4.5	4.3	4.1	3.8	3.9	3.7	3.5	3.3	3.3
Race										
White	6.2	6.1	6.0	5.6	5.2	5.0	4.7	4.5	4.3	4.2
Black/African American	3.2	3.3	3.3	3.1	3.0	3.0	3.0	2.9	2.6	2.6
Native American	3.7	3.3	3.9	3.0	3.6	3.7	3.0	3.2	2.7	2.4
Asian	5.4	5.5	5.3	4.8	5.0	4.6	4.7	4.4	4.5	4.5
Primary Cause of ESRD										
Diabetes	3.4	3.4	3.2	3.0	2.9	2.8	2.6	2.5	2.3	2.3
Hypertension	3.1	3.2	3.2	3.1	2.9	2.9	2.8	2.6	2.6	2.5
Glomerulonephritis	10.2	9.7	9.9	9	8.7	8.7	8.8	8.3	7.9	7.7
All	5.1	5.1	5.0	4.7	4.4	4.3	4.1	4.0	3.7	3.7

Data Source: Reference Table E9.

Counts and Rates of Deceased Donor Transplants

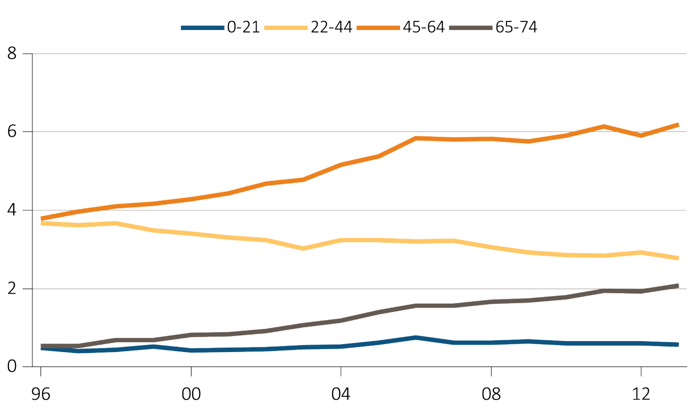
The overall number of deceased donor transplants has leveled off since 2007 (Figure 7.3). In this section, we review trends in counts and rates of deceased donor transplants by age, sex, race, and primary cause of ESRD (Figures 7.7-7.10).

For patients aged 45-64 and 65-74 years, the number of deceased donor transplant recipients has continued to increase throughout the past two decades, although less markedly since 2006. The counts were highest for recipients aged 45-64 years old, reaching 6,190 in 2013 (Figure 7.7.a, Number of transplants by age). In contrast, during this same time period, the number of deceased donor transplant recipients has decreased steadily to 2,781 for those aged 22-44 years.

Rates and counts of deceased donor transplantation per 100 dialysis patient years are presented in Figure 7.7 by age categories without statistical adjustment. The patterns for deceased donor transplant counts in Figure 7.7.a and rates in 7.7.b look very dissimilar, because the number of dialysis patients varies and increases markedly with age. Due to the small denominator for children on dialysis and the pediatric allocation priority for kidneys from deceased donors under the age of 35 years, deceased donor transplant rates are highest in children (<22 years old), and their rates increased in 2005-2007, stabilizing thereafter. While there has been a reduction in deceased donor kidney transplantation rates for those aged 22-44 and 45-64 years, the rates for those aged 65-74 years have stabilized at low levels.

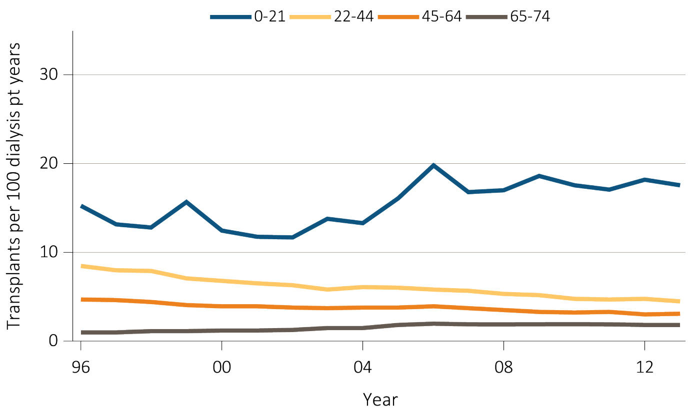
vol 2 **Figure 7.7 Number of deceased donor transplants and unadjusted transplant rates among deceased donor kidney recipients, by recipient age, 1996-2013**

(a) Number of transplants by age



Data Source: Reference Table E8(2). Deceased donor kidney transplant counts by recipient age.

(b) Transplant rates by age



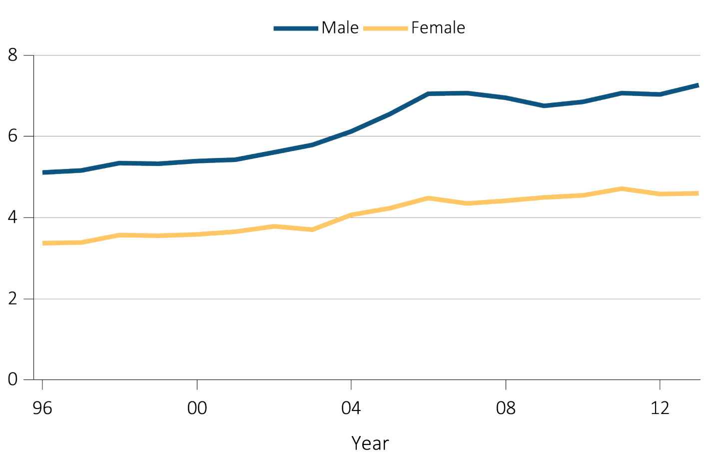
Data Source: Reference Table E9(2). Unadjusted deceased donor kidney transplant rates by recipient age. Abbreviation: pt, patient.

The trends for counts of deceased donor transplants by year are similar for males and females, rising over the past decade with some leveling off after 2006 (Figure 7.8.a, Number of transplants by sex). Males received substantially more transplants than females. This difference seems to be largely explained by the fact that males account for more than 60% of wait-listed candidates.

The rates of deceased donor kidney transplantation during 1996-2013 declined for both male and female dialysis patients (Figure 7.8.b, Transplant rates by sex). This is explained partly by the growing number of dialysis patients. The difference in transplantation rates between males and females has been narrowing in recent years.

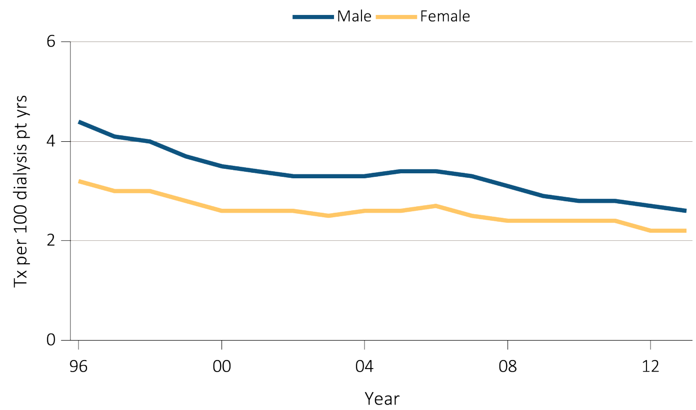
vol 2 **Figure 7.8 Number of deceased donor transplants and unadjusted transplant rates among deceased donor kidney recipients, by recipient sex, 1996-2013**

(a) Number of transplants by sex



Data Source: Reference Table E8(2). Deceased donor kidney transplant counts by recipient sex.

(b) Transplant rates by sex



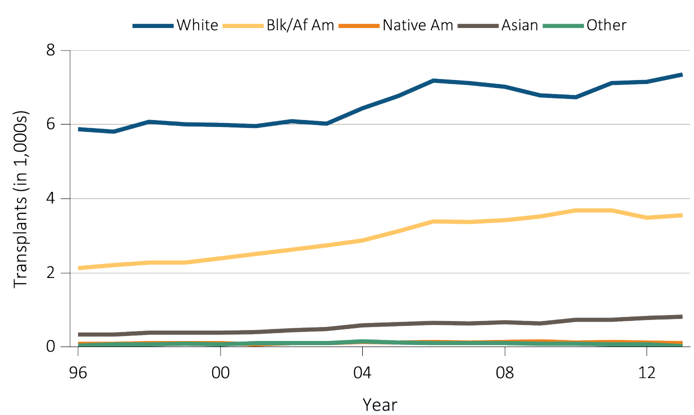
Data Source: Reference Table E9(2). Unadjusted deceased donor kidney transplant rates by recipient sex. Abbreviation: pt yrs, patient years.

Among Whites and Blacks/African Americans, the number of deceased donor transplants has grown substantially over the past decade, with smaller increases for Asians, and small decreases for Native American and Other races (Figure 7.9.a, Number of transplants by race).

Since 1996, deceased donor transplant rates for White dialysis patients have been declining. Since 2003, deceased donor transplant rates for Asians have surpassed and remain higher than for Whites (Figure 7.9.b, Transplant rates by race). The rates of deceased donor transplants for Blacks and Native Americans continue to remain low compared to Whites.

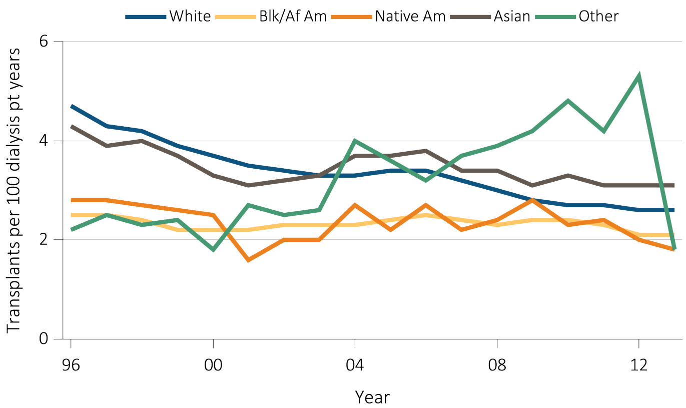
vol 2 **Figure 7.9 Number of deceased donor transplants and unadjusted transplant rates among deceased donor kidney recipients, by recipient race, 1996-2013**

(a) Number of transplants by race



Data Source: Reference Table E8(2). Deceased donor kidney transplant counts by recipient race. Abbreviations: Blk/Af Am, Black/African American; Native Am, Native American.

(b) Transplant rates by race



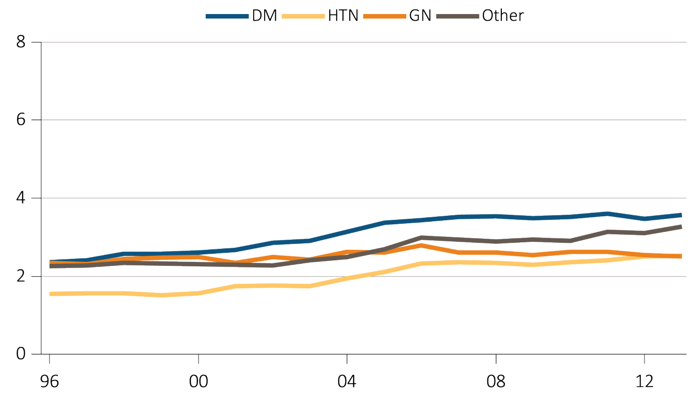
Data Source: Reference Table E9(2). Unadjusted deceased donor kidney transplant rates by recipient race. Abbreviations: Blk/Af Am, Black/ African American; Native Am, Native American; pt, patient.

The largest growth in deceased donor transplantation numbers has been among recipients with diabetes or hypertension. Diabetes was the most common disease among the major causes of ESRD (Figure 7.10.a, Number of transplants by primary cause).

The rates of deceased donor transplants for all diagnosis groups have been declining since 2006 (Figure 7.10.b, Transplant rates by primary cause of ESRD). Transplant rates among dialysis patients with glomerular disease by far exceeded those for any other causes, followed by the Other causes category (including cystic disease). Deceased donor transplant rates for candidates with ESRD attributed to hypertension and diabetes are similar to each other, but were lower than those observed for the glomerulonephritis and Other categories. This rank order is partly explained by differences in the number of patients with these diagnoses as the cause of ESRD.

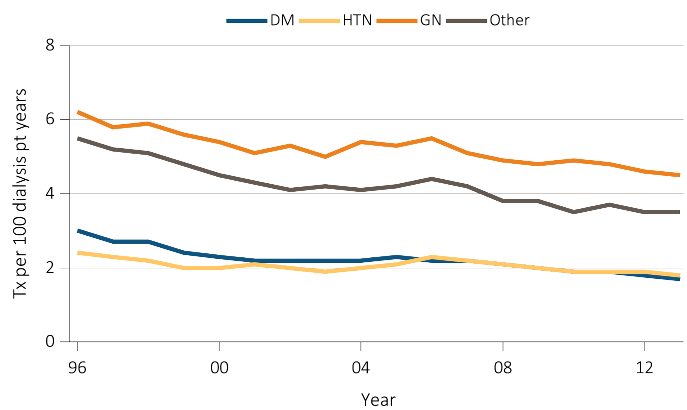
vol 2 Figure 7.10 Number of deceased donor transplants and unadjusted transplant rates among deceased donor kidney recipients, by recipient primary cause of ESRD, 1996-2013

(a) Number of transplants by primary cause of ESRD



Data Source: Reference Table E8(2). Deceased donor kidney transplant counts by recipient primary cause of ESRD. Abbreviations: DM, diabetes mellitus; ESRD, end-stage renal disease; GN, glomerulonephritis; HTN, hypertension.

(b) Transplant rates by primary cause of ESRD



Data Source: Reference Table E9(2). Unadjusted deceased donor kidney transplant rates by recipient primary cause of ESRD. Abbreviations: DM, diabetes mellitus; ESRD, end-stage renal disease; GN, glomerulonephritis; HTN, hypertension; pt, patient.

Counts and Rates of Living Donor Transplants

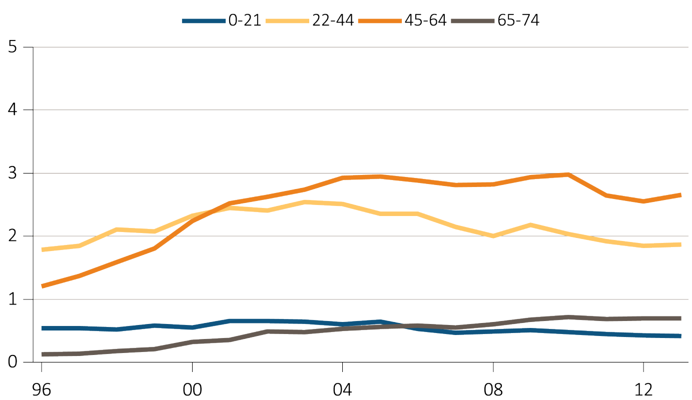
Though annual living donor kidney transplant counts rose steadily for adult recipients between 1996 and 2004, there has since been a steady decline. In this section, we review trends in annual counts and rates of living donor kidney transplants by age, sex, race, and primary cause of ESRD (Figures 7.11-7.14).

Counts for living donor transplants for those aged 22-44 years old decreased from 2,523 in 2004 to 1,866 in 2013. The number of living donor transplants for the group aged 45-64 years has shown a more recent decline, falling from 2,985 in 2010 to 2,658 in 2013 (Figure 7.11.a, Number of transplants by age). While transplant counts for those over 65 years old have shown an increase since 1996, from 2010 to 2013, they have remained stable at close to 800 per year.

Kidney transplantation rates from living donors per 100 dialysis patient years show that younger age groups have substantially higher annual rates and also a steeper decline in these rates since about 1999 (Figure 7.11.b, Transplant rates by age). Among adults, the 22-44 year old group has the highest transplantation rate. Only the very low rates for ages 65-74 years have remained stable over the past decade.

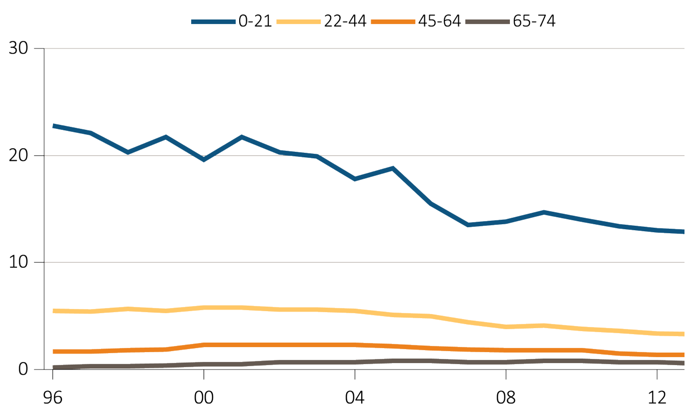
vol 2 Figure 7.11 Number of living donor transplants and unadjusted transplant rates among living donor kidney recipients, by recipient age, 1996-2013

(a) Number of transplants by age



Data Source: Reference Table E8(3). Living donor kidney transplant counts by recipient age.

(b) Transplant rates by age

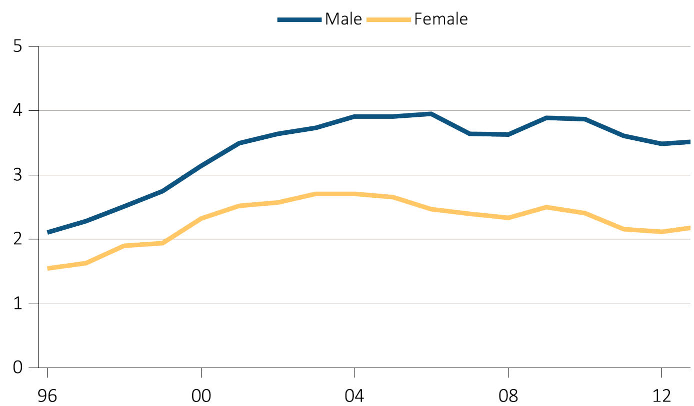


Data Source: Reference Table E9(3). Unadjusted living donor kidney transplant rates by recipient age. Abbreviation: pt, patient.

The annual counts of living donor kidney transplantation show consistently higher numbers of male compared to female recipients (Figure 7.12.a, Number of transplants by sex). However, since 2009, living donor kidney transplant counts have decreased for both males and females. The living donor transplant rates are higher for males than for females but the difference is relatively small (Figure 7.12.b, Transplant rates by sex).

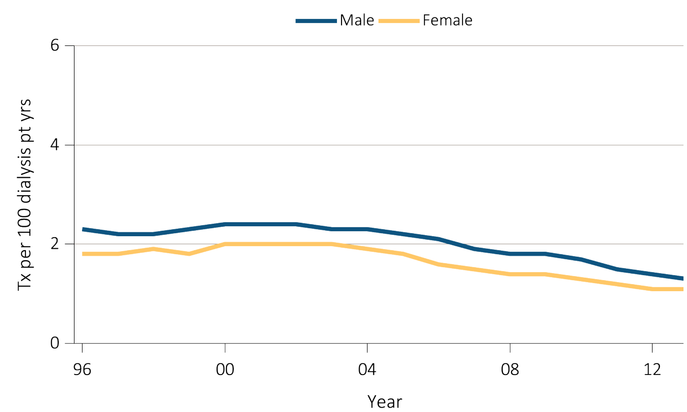
vol 2 Figure 7.12 Number of living donor transplants and unadjusted transplant rates among living donor kidney recipients, by recipient sex, 1996-2013

(a) Number of transplants by sex



Data Source: Reference Table E8(3). Living donor kidney transplant counts by recipient sex.

(b) Transplant rates by sex



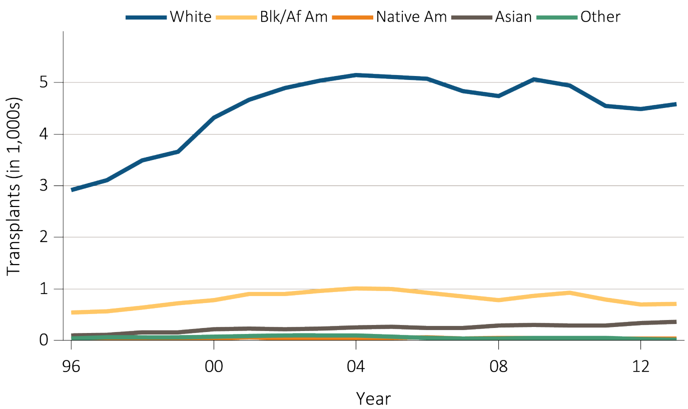
Data Source: Reference Table E9(3). Unadjusted living donor kidney transplant rates by recipient sex. Abbreviation: pt yrs, patient years.

Overall living donor kidney transplant counts had been steadily increasing until 2004 for all races (Figure 7.13.a, Number of transplants by race). Since then, the annual number of living donor kidney transplants has decreased for Whites and Blacks while the counts for Asians have shown a small increase.

Living donor transplant rates for Whites are the highest among all race groups, while rates among Native Americans are the lowest (Figure 7.13.b, Transplant rates by race). From 2012 to 2013, living donor transplant rates have increased slightly among Whites, Blacks, and Asians, while they have declined among Native Americans and Others.

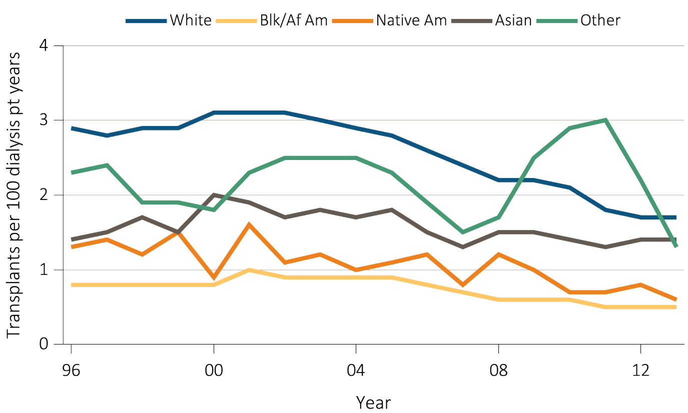
vol 2 **Figure 7.13 Number of living donor transplants and unadjusted transplant rates among living donor kidney recipients, by recipient race, 1996-2013**

(a) Number of transplants by race



Data Source: Reference Table E8(3). Living donor kidney transplant counts by recipient race. Abbreviations: Blk/Af Am, Black/African American; Native Am, Native American.

(b) Transplant rates by race



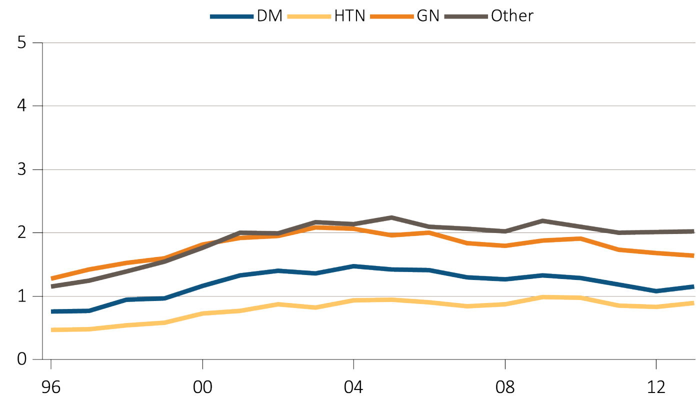
Data Source: Reference Table E9(3). Unadjusted living donor kidney transplant rates by recipient race. Abbreviations: Blk/Af Am, Black/African American; Native Am, Native American; pt, patient.

The ranking of living donor kidney transplantation counts by primary cause of ESRD has remained the same over the past decade, from highest to lowest frequency: other, glomerulonephritis, diabetes, and hypertension (Figure 7.14.a, Number of transplants by primary cause of ESRD). However, this contrasts with the pattern among deceased donor recipients, because the numbers with ESRD caused by hypertension and diabetes mellitus have grown steadily in comparison to other causes.

The rates of living donor transplantation for all diagnosis groups have been declining over the past decade (Figure 7.14.b, Transplant rates by primary cause of ESRD). The rates of living donor transplants among patients with glomerular disease by far exceed those for any other causes, followed by other causes (including cystic disease), and are lowest for those with hypertension and diabetes.

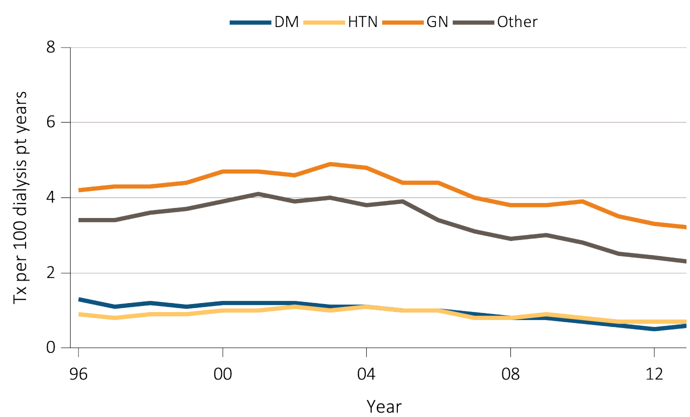
vol 2 **Figure 7.14 Number of living donor transplants and unadjusted transplant rates among living donor kidney recipients, by recipient primary cause of ESRD, 1996-2013**

(a) Number of transplants by primary cause of ESRD



Data Source: Reference Table E8(3). Living donor kidney transplant counts by recipient primary cause of ESRD. Abbreviations: DM, diabetes mellitus; ESRD, end-stage renal disease; GN, glomerulonephritis; HTN, hypertension.

(b) Transplant rates by primary cause of ESRD



Data Source: Reference Table E9(3). Unadjusted living donor kidney transplant rates by recipient primary cause of ESRD. Abbreviations: DM, diabetes mellitus; ESRD, end-stage renal disease; GN, glomerulonephritis; HTN, hypertension; pt, patient.

Deceased Donation Counts and Rates

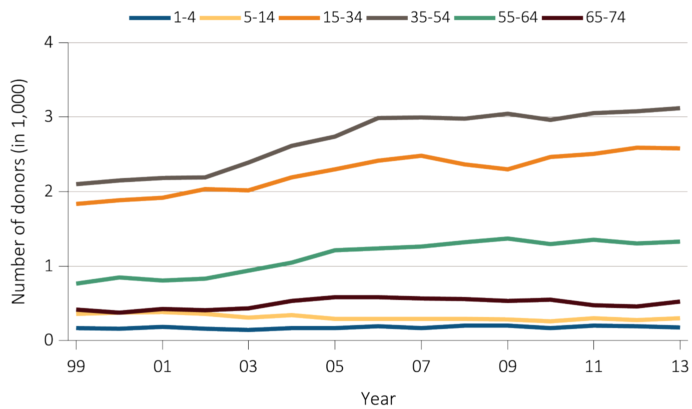
The number of deceased donors with at least one kidney retrieved has been increasing since 2003, reaching 8,021 in 2013 (Figure 7.15.a, Number of donors by age).

Since 2002, the number of donors among those aged 1-4, 5-14, and 65-74 years old has been relatively stable, but the number of donors among those aged 15-34, 35-54, and 55-64 years old has been increasing. Donors aged 35-54 years old have been the leading source of kidney donations during the past 15 years, with donors aged 15-34 years old being the second highest source, and those aged 55-64 years old being the third highest.

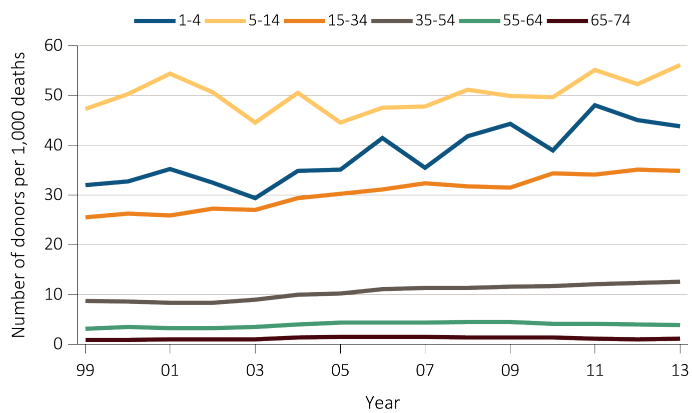
Annual donation rates were calculated as the number of deceased donors from whom at least one kidney was retrieved per 1,000 deaths in the U.S. population (Centers for Disease Control and Prevention, 2015). Donation rates among those aged younger than 55 have been increasing during 2003-2013 (Figure 7.15.b, Donation rates by age), with those aged 1-4 and 5-14 years old having the highest donation rates during 1999-2013.

vol 2 Figure 7.15 Number of deceased kidney donors and unadjusted kidney donation rates, by donor age, 1999-2013

(a) Number of donors by age



(b) Donation rates by age

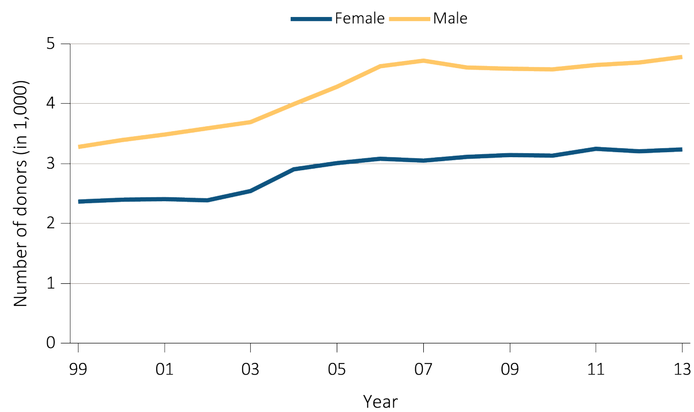


Data Source: Data on the annual number of deaths in the US population are obtained from the Centers for Disease Control and Prevention; the deceased donor data are obtained from UNOS. Deceased donor kidney donation rates by donor age.

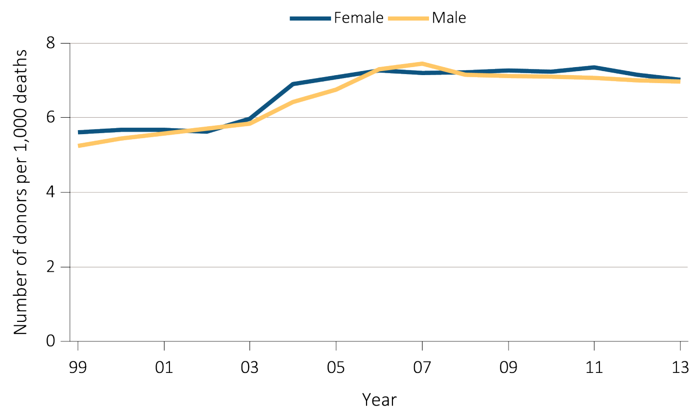
Deceased kidney donor counts of males have been consistently around 1.5 times greater than those of females (Figures 7.16.a Number of donors by sex, and 7.16.b Donation rates by sex), but the donation rates are similar between males and females. Both groups have demonstrated an increase in the donor number and rate since 2003, and have been stable since 2008.

vol 2 Figure 7.16 Number of deceased kidney donors and unadjusted kidney donation rates, by donor sex, 1999-2013

(a) Number of donors by sex



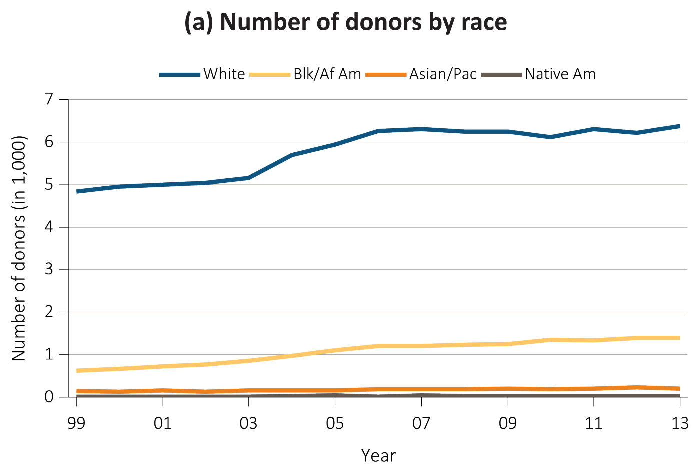
(b) Donation rates by sex

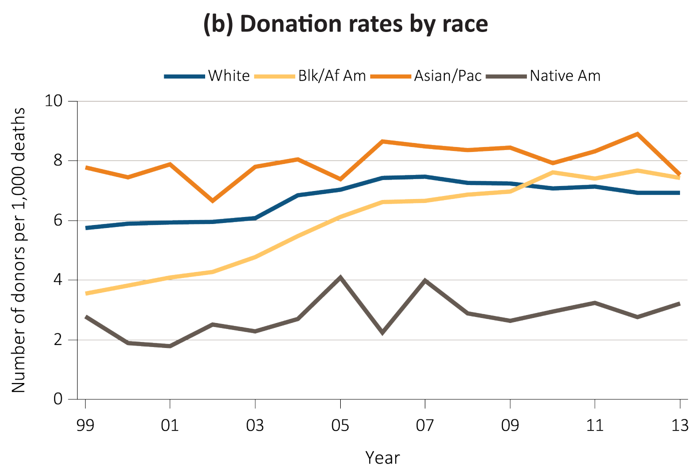


Data Source: Data on the annual number of deaths in the US population are obtained from the Centers for Disease Control and Prevention; the deceased donor data are obtained from UNOS. Deceased donor kidney donation rates by donor sex.

Whites have contributed the most to the number of deceased donors each year during 1999-2013 (Figure 7.17.a Number of donors by race), but Blacks have surpassed Whites in donation rates since 2000 (Figure 7.17.b Donation rates by race). The rate of deceased donors per 1,000 deaths among Blacks more than doubled from 1999 to 2013. Since 1999, Asian or Pacific Islanders have had the highest donation rate, and Native Americans have had the lowest donation rates.

vol 2 **Figure 7.17 Number of deceased kidney donors and unadjusted kidney donation rates, by donor race, 1999-2013**





Data Source: The US death population data are obtained from the Centers for Disease Control and Prevention; the deceased donor data are obtained from UNOS. Deceased donor kidney donation rates by donor race. Abbreviations: Asian/Pac, Asian/Pacific Islander; Blk/Af Am, Black/African American; Native Am, Native American.

In 2013, among 15,689 kidneys that were recovered from deceased donors, 2,551 (16%) were discarded due to various reasons.

Transplant Outcomes

There has been a progressive improvement in outcomes of kidney transplant recipients in the last few years. In this section, we review the trends in probability of all-cause graft failure, probability of returning to dialysis, and probability of death at one, five, and ten years post-transplant. We will also review the trends in acute rejection and hospitalization of patients who received a kidney transplant.

During 1996-2012, kidney transplant patients experienced improved health outcomes, with decreases in deaths and all-cause graft failure. Among the recipients of deceased donor kidney transplants, the probability of all-cause graft failure in the first year following transplant decreased from 14% in 1996 to 8% in 2012, while the probability of death decreased from 6% in 1996 to 4% in 2012. Similarly, among those who received living donor kidney transplants, the probability of all-cause graft failure in the first year following transplant decreased from 7% in 1996 to 3% in 2012, while probability of death decreased from 2.3% to 1.5% over the same time period.

Improvements in patient survival probabilities have persisted for most of the five- and ten-year outcomes. Among deceased donor kidney transplant recipients, the probability of all-cause graft failure by the fifth year improved, dropping from 36% in 1996 to 27% in 2008, and by the tenth year post-transplant it also decreased from 59% in 1996 to 55% in 2003. Probability of death by the fifth year post-transplant improved by dropping from 19% in 1996 to 16% in 2008, and for tenth year post transplant improved by decreasing from 39% in 1996 to 38% in 2003. Similarly, for living donor kidney transplant recipients, the probability of all-cause graft failure by the fifth year decreased from 23% in 1996 to 15% in 2008, while in the tenth year it decreased from 43% in 1996 to 40% in 2003. The probability for death by fifth year post-transplant also improved by falling from 10% in 1996 to 8% in 2008, but the probability of death by tenth year post-transplant remained unchanged at 23% from 1996 to 2003. Overall, the outcomes have been consistently more advantageous in living donor kidney transplant recipients in comparison to deceased donor transplant recipients (Tables 7.2 and 7.3).

vol 2 **Table 7.2 Trend in 1-, 5-, & 10-year deceased donor kidney transplant outcomes, 1996-2012**

Year	One year post-transplant			Five years post-transplant			Ten years post-transplant		
	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death
1996	14.3%	10.2%	5.8%	36.2%	25.7%	19.4%	59.1%	42.9%	39.3%
1997	12.9%	8.5%	6.2%	34.7%	23.7%	19.2%	58.1%	40.8%	39.6%
1998	12.8%	9.2%	5.5%	33.8%	24.0%	18.1%	56.8%	40.4%	38.1%
1999	13.7%	9.2%	5.9%	34.0%	23.1%	18.9%	56.8%	39.4%	38.4%
2000	13.2%	8.6%	6.4%	34.6%	23.1%	19.7%	57.3%	39.1%	39.3%
2001	12.2%	8.0%	5.7%	33.3%	21.4%	19.9%	55.8%	37.0%	38.7%
2002	12.3%	8.3%	5.8%	33.0%	22.2%	18.9%	54.1%	36.2%	37.4%
2003	12.1%	7.6%	5.7%	32.1%	20.6%	18.6%	54.9%	36.1%	37.9%
2004	11.5%	7.3%	5.5%	31.7%	20.8%	18.4%			
2005	11.4%	7.1%	6.0%	30.2%	19.3%	18.0%			
2006	10.8%	7.0%	5.2%	29.6%	18.9%	17.3%			
2007	9.7%	6.2%	4.7%	28.5%	17.9%	16.9%			
2008	9.5%	6.2%	4.4%	26.9%	16.2%	16.3%			
2009	9.5%	5.7%	5.0%						
2010	9.0%	5.6%	4.5%						
2011	7.6%	4.6%	3.9%						
2012	7.6%	4.6%	3.8%						

Data Source: Reference Tables F2, F14, I26; F5, F17, I29; F6, F18, I30. Outcomes among recipients of a first-time deceased donor kidney transplant; unadjusted. Abbreviations: Prob., probability.

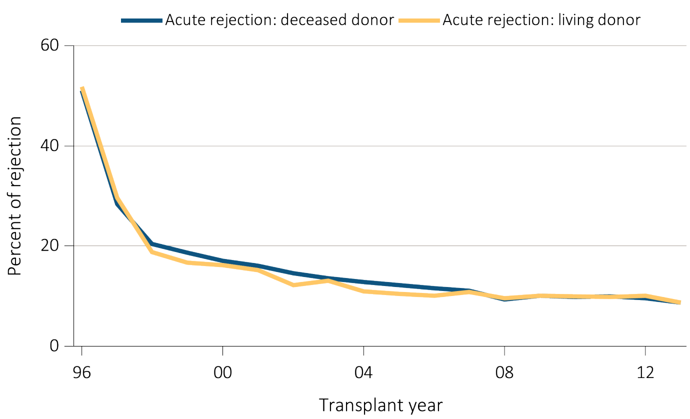
vol 2 **Table 7.3 Trend in 1-, 5-, & 10-year living donor kidney transplant outcomes, 1996-2012**

Year	One year post-transplant			Five years post-transplant			Ten years post-transplant		
	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death	Prob. of all-cause graft failure	Prob. of return to dialysis or repeat transplant	Prob. of death
1996	6.9%	5.2%	2.3%	22.9%	16.8%	9.6%	43.3%	32.4%	22.7%
1997	6.7%	4.8%	2.7%	22.2%	15.8%	10.5%	43.2%	31.1%	24.4%
1998	6.0%	4.4%	2.3%	20.9%	14.6%	10.0%	42.4%	30.6%	23.4%
1999	6.1%	4.3%	2.2%	20.8%	14.7%	9.6%	41.2%	29.0%	22.7%
2000	6.6%	4.6%	2.6%	21.9%	14.9%	10.6%	42.2%	29.1%	24.0%
2001	6.2%	4.1%	2.5%	21.3%	14.3%	10.2%	41.2%	27.8%	24.0%
2002	5.8%	3.9%	2.5%	20.5%	13.6%	10.3%	40.0%	26.2%	24.6%
2003	5.4%	3.9%	1.9%	20.1%	13.8%	9.5%	39.6%	26.1%	23.3%
2004	5.2%	3.5%	2.1%	18.8%	12.7%	8.8%			
2005	5.3%	3.7%	2.0%	18.7%	12.6%	8.8%			
2006	4.4%	3.0%	1.7%	16.8%	11.1%	8.1%			
2007	3.8%	2.4%	1.4%	16.6%	10.5%	8.0%			
2008	4.1%	2.7%	1.6%	15.3%	9.9%	7.5%			
2009	3.9%	2.6%	1.4%						
2010	3.5%	2.2%	1.4%						
2011	3.4%	2.2%	1.9%						
2012	3.2%	1.9%	1.5%						

Data Source: Reference Tables F8, F20, I32; F11, F23, I35; F12, F24, I36. Outcomes among recipients of a first-time living donor kidney transplant; unadjusted. Abbreviations: Prob., probability.

The percentage of kidney transplant recipients experiencing an acute rejection during the first year post-transplant has declined steadily since 1996 and has stabilized in recent years (Figure 7.18). In 2013, 7.3% of living donor transplant recipients and 7.5% of deceased donor transplant recipients experienced at least one acute rejection during the first year post-transplant. As of 2013, the risk of rejection is similar for living donor and deceased donor kidney transplants.

vol 2 Figure 7.18 Acute rejection within the first year post-transplant for kidney transplant recipients, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Acute rejection rates during the first year post-transplant for recipients age 18 and older with a functioning graft at discharge.

Hospitalization rates for all kidney transplant recipients have steadily declined from 954 hospitalizations per 1,000 patient years in 2004 to 788 in 2013 (Table 7.4). Hospitalization rates were higher in females and Blacks during this period.

vol 2 Table 7.4 Hospital admission rates (per 1,000 patient years), by age, sex, race, ethnicity, and primary cause of ESRD, among transplant patients, 2004-2013

Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0-21	1,145	1,143	1,302	1,129	1,121	1,254	1,274	1,198	1,226	1,137
22-29	897	947	873	893	966	889	846	1,007	952	897
30-39	957	1,009	925	842	867	862	880	875	853	788
40-49	892	866	850	818	789	808	748	758	728	704
50-59	914	897	855	876	839	822	806	829	776	722
60-64	985	971	944	861	919	879	881	817	850	786
65-69	1,039	1,077	963	917	891	898	842	867	896	812
70-74	1,086	1,003	1,091	995	898	902	878	918	915	864
75-79	1,038	1,065	988	980	863	911	850	960	897	901
80-84	999	1,113	1,370	1,195	990	876	844	751	861	957
85+	0	3,305	677	1,595	833	1,811	1,428	754	1,096	775
Sex										
Male	888	870	835	804	802	799	775	778	761	716
Female	1,049	1,080	1,056	1,011	986	985	958	981	962	898
Race										
White	925	920	902	860	836	836	835	843	825	789
Black/African American	1,090	1,100	1,031	1,000	1,002	1,015	935	945	920	842
Native American	1,222	1,224	1,161	1,004	964	825	752	942	1,016	816
Asian	553	612	605	620	672	577	548	561	572	487
Ethnicity										
Hispanic	899	922	922	839	843	844	849	845	850	769
Non-Hispanic	963	961	924	894	880	876	846	861	839	792
Primary Cause of ESRD										
Diabetes	1,285	1,289	1,245	1,146	1,136	1,127	1,092	1,141	1,078	1,016
Hypertension	878	833	798	811	797	773	767	744	759	677
Glomerulonephritis	803	773	793	741	754	726	714	692	710	675
Other cause	807	870	795	806	763	805	765	797	769	736
All	954	956	924	886	874	871	846	858	841	788

Data Source: Reference Table G5. All kidney transplant recipients. Abbreviation: ESRD, end-stage renal disease.

References

Centers for Disease Control and Prevention, National Center for Health Statistics. Underlying Cause of Death 1999-2013 on CDC WONDER Online Database, released 2015. Data are from the Multiple Cause of Death Files, 1999-2013, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. http://wonder.cdc.gov/ucd-icd10.html. Accessed June 30, 2015.

Chapter 8: Pediatric ESRD

- 1,462 children in the United States began end-stage renal disease (ESRD) care in 2013.
- 9,921 children were being treated for ESRD on December 31, 2013.
- The most common initial ESRD treatment modality among children overall is hemodialysis (56%).
- Peritoneal dialysis is the most common initial treatment modality in children younger than 9 years and those who weigh less than 20 kg.
- 37% of children received a kidney transplant within the first year of ESRD care during 2009-2013.
- All-cause hospitalization rates are 2 per patient year among children with ESRD.
- The number of children listed for incident and repeat kidney transplant was 1,277 in 2013.
- As of 2006, deceased donor transplants were more common than living donor transplants.
- The five-year patient survival probability was 0.89 for children initiating ESRD care between 2004-2008.
- Since 2006, 81% of incident pediatric ESRD patients have started hemodialysis with a central venous catheter.
- The five-year survival probability of young adults aged 22 to 29 years is 0.95 for transplant and 0.74 for hemodialysis dependent patients.

Introduction

Pediatric end-stage renal disease (ESRD) affects children of all ages. The majority of these children will depend on renal replacement therapies over many decades. Consequently, children with incident ESRD often traverse the entire ESRD modality continuum of hemodialysis, peritoneal dialysis, and transplantation. These children are subjected to frequent hospitalizations and have a risk of mortality far exceeding the general pediatric population in the United States Children with ESRD are quite different in disease etiology, transplant opportunities, morbidity and mortality when compared to adults with ESRD. The chapter has been expanded to include information about vascular access in children as this can have far reaching implications into adulthood. Also, this year for the first time, the *USRDS Annual Data Report* pediatric chapter includes a section on young adults. This provides an opportunity to improve our understanding of the issues surrounding transitional ages and outcomes in these patients. In the 2015 issue of the *United States Renal Data System (USRDS) Annual Data Report*, we continue to describe the full spectrum of renal replacement therapy from dialysis to transplant.

Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter, including a listing of ICD-9 codes used for classification of hospital and mortality associated events.

Epidemiology of End-Stage Renal Disease in Children

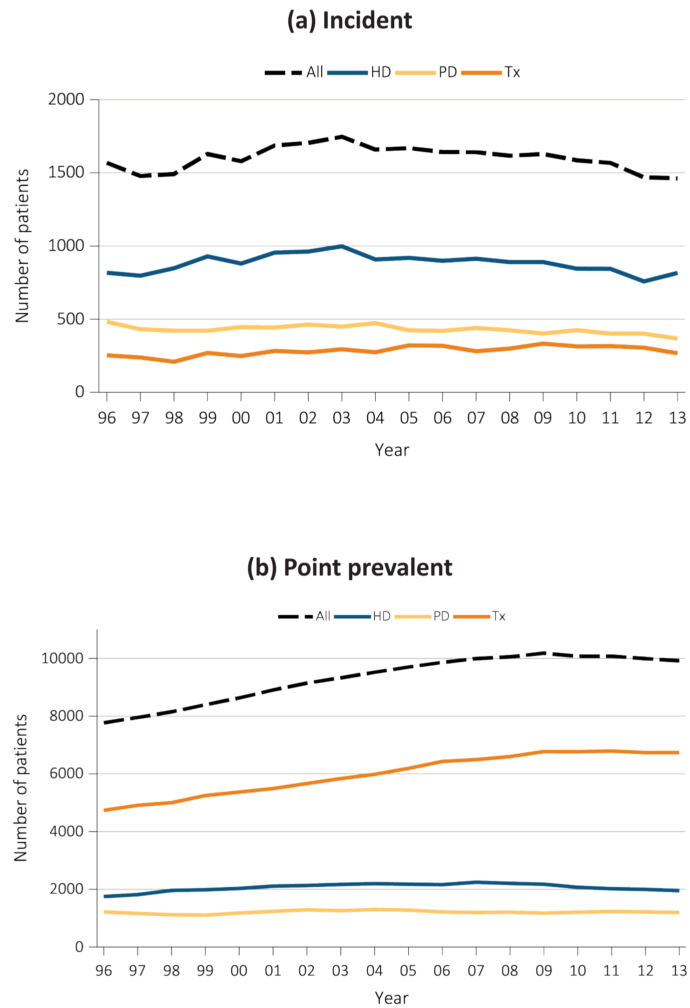
The incidence of ESRD in children has been decreasing annually in the United States between 2008 and 2012 (Figure 8.1.a). Between 2012 and 2013, a total of 1,462 children had new onset ESRD, which was only 7 fewer than the previous year. Similarly, as of December 31, 2013, the point prevalence of children with ESRD was 9,921, which represents a less than 1% decrease from the previous year (Figure 8.1.b).

Incidence and Prevalence by ESRD Modality

From the earliest reporting year, in aggregate, children have initiated ESRD therapy with hemodialysis more frequently than peritoneal dialysis or transplantation. Data from 2013 demonstrate the same pattern with 816 (55.8%) initiating with hemodialysis, 367 (25.1%) peritoneal dialysis, and 267 (18.3%) transplant (Figure 8.1.a). This equates to an incidence rate per million per year (per million/year) of 8.6 in hemodialysis, 3.9 in peritoneal dialysis, and 2.3 in transplant.

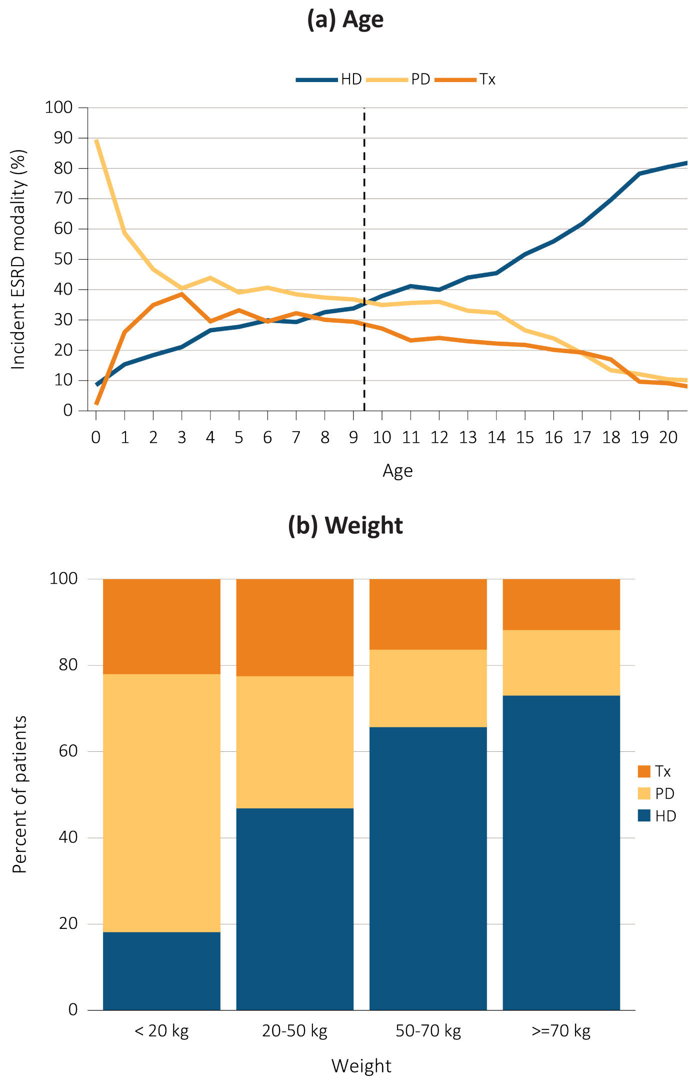
When examined by age, peritoneal dialysis is the most common initial ESRD treatment modality for children age 9 years and younger (Figure 8.2.a). Hemodialysis becomes the most common initial modality at patient age 10 and older. Kidney transplantation accounts for less than 40% of initial modality across all pediatric ages. Similarly, initial ESRD treatment modality is associated with patient weight. Peritoneal Dialysis is most commonly the initial modality in small children. Hemodialysis is the least common initiating modality in small children and increases in frequency with increasing patient weight (Figure 8.2.b). Over time, transplant has become the most common prevalent ESRD treatment modality in children. Of the 9,921 children and adolescents between the ages of 0 and 21 years with prevalent ESRD as of December 31, 2013, kidney transplant was the most common modality (6,739[67.9%]), followed by hemodialysis (1,954 [19.7%]) and peritoneal dialysis (1,197 [12.1%]) (Figure 8.1.b). This equates to a point prevalence per million population of 20.7 for hemodialysis, 12.6 for peritoneal dialysis, and 67.0 for transplant.

vol 2 Figure 8.1 Number of (a) incident and (b) December 31 point prevalent ESRD pediatric patients (aged 0–21 years), by modality, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Peritoneal dialysis consists of continuous ambulatory peritoneal dialysis and continuous cycling peritoneal dialysis. All consists of hemodialysis, peritoneal dialysis, uncertain dialysis, and transplant. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

vol 2 Figure 8.2 Trends in pediatric ESRD modality at initiation, by (a) patient age, and (b) weight, 1996-2013



Data Source: Special analyses, USRDS ESRD Database. Includes incident ESRD patients in the years 1996-2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Etiology

The underlying etiologies of ESRD are generated from the ESRD Medical Evidence Form (CMS 2728) and summarized in Table 8.1. Patients have been classified by diagnosis grouping consistent with previous years. The leading causes of ESRD in children during 2009-2013 are as follows: cystic/ hereditary/congenital disorders (33.0%), glomerular disease (24.6%), and secondary causes of glomerulonephritis (GN) (12.9%). The most common individual diagnoses associated with ESRD include renal hypoplasia/dysplasia (N=703), congenital obstructive uropathies (N=659), focal glomerular sclerosis (N=911), and systemic lupus erythematosus (N=537). In children with ESRD, sickle cell nephropathy, human immunodeficiency virus (HIV) nephropathy, and systemic lupus erythematosus are more common among Blacks compared with other racial groups.

vol 2 **Table 8.1 Distribution of reported incident pediatric ESRD patients by primary cause of ESRD (aged 0-21 years), and by demographic characteristics, 2004-2008 (period A) and 2009-2013 (period B)**

	Total		Incident		Age		Male		White		Black African Am		Other Race		Transplant first year		Died first year	
	Patients		%		Median		%		%		%		%		%		%	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
All ESRD (reference)	8,228	7,713	100.0	100.0	16	16	56.5	55.9	64.9	64.8	25.9	24.6	9.3	10.7	37.5	37.0	3.7	3.1
Diabetes	99	104	1.3	1.5	20	20	43.4	39.4	50.5	44.2	44.4	51.0	5.1	4.8	13.1	13.5	11.1	4.8
Glomerulonephritis (GN)	2,127	1,761	27.0	24.6	18	18	56.6	54.8	60.7	63.5	31.8	29.4	7.4	7.1	32.2	30.1	1.8	1.8
GN (histologically not examined)	405	303	5.1	4.2	19	19	62.0	60.4	64.7	68.6	25.4	21.1	9.9	10.2	23.5	19.1	3.0	1.7
Focal glomerular sclerosis	1,086	911	13.8	12.7	17	17	57.3	56.2	52.9	57.3	41.5	38.2	5.5	4.5	35.2	31.3	1.8	2.0
Membranous nephropathy	49	43	0.6	0.6	18	18	51.0	58.1	61.2	48.8	34.7	44.2	4.1	7.0	28.6	39.5	-	-
MPGN GN type 1, diffuse MPGN	106	91	1.3	1.3	17	17	49.1	42.9	75.5	70.3	16.0	20.9	8.5	8.8	40.6	45.1	0.9	2.2
Dense deposit disease, MPGN type 2	31	25	0.4	0.3	15	16	45.2	52.0	100.0	76.0	-	8.0	-	16.0	35.5	8.0	3.2	-
IgA nephropathy	224	205	2.8	2.9	19	19	61.6	60.0	70.1	74.6	17.4	12.2	12.5	13.2	37.9	36.6	0.4	2.0
IgM nephropathy	18	16	0.2	0.2	19	19	55.6	62.5	66.7	68.8	27.8	25.0	5.6	6.3	38.9	12.5	-	-
Rapidly progressive GN	75	58	1.0	0.8	15	16	41.3	22.4	70.7	74.1	14.7	19.0	14.7	6.9	17.3	22.4	2.7	1.7
Post infectious GN, SBE	23	25	0.3	0.3	15	19	65.2	44.0	56.5	80.0	39.1	16.0	4.3	4.0	17.4	16.0	-	4.0
Other proliferative GN	110	84	1.4	1.2	16	17	41.8	42.9	71.8	69.0	22.7	25.0	5.5	6.0	27.3	39.3	1.8	1.2
Secondary GN/vasculitis	1,022	922	13.0	12.9	18	18	30.2	26.5	53.5	57.8	38.4	34.8	8.1	7.4	12.6	14.3	6.5	3.7
Lupus nephritis	651	537	8.3	7.5	19	19	20.9	17.9	40.2	38.7	49.9	52.7	9.8	8.6	7.1	5.2	8.1	4.3
Henoch-Schonlein syndrome	26	33	0.3	0.5	17	14	69.2	54.5	88.5	87.9	7.7	3.0	3.8	9.1	42.3	36.4	-	3.0
Hemolytic uremic syndrome	144	115	1.8	1.6	7	9	44.4	35.7	77.1	82.6	18.1	13.0	4.9	4.3	27.1	39.1	2.8	3.5
Polyarteritis and other vasculitis	75	89	1.0	1.2	15	14	32.0	31.5	69.3	80.9	24.0	10.1	6.7	9.0	18.7	20.2	1.3	3.4
Wegeners granulomatosis	53	69	0.7	1.0	17	16	58.5	42.0	77.4	84.1	15.1	10.1	7.5	5.8	20.8	18.8	3.8	1.4
Goodpasture syndrome	40	54	0.5	0.8	20	19	45.0	40.7	87.5	98.1	10.0	-	2.5	1.9	7.5	18.5	5.0	1.9
Secondary GN, other	25	19	0.3	0.3	16	19	56.0	47.4	76.0	78.9	20.0	15.8	4.0	5.3	16.0	31.6	12.0	-
Interstitial nephritis/pyelonephritis	474	363	6.0	5.1	16	17	53.8	51.8	82.3	81.3	11.4	11.6	6.3	7.2	47.5	43.5	2.3	5.0
Nephropathy caused by other agents	44	47	0.6	0.7	16	16	52.3	59.6	86.4	83.0	13.6	10.6	-	6.4	47.7	25.5	11.4	12.8
Nephrolithiasis	15	19	0.2	0.3	18	17	40.0	26.3	80.0	89.5	13.3	5.3	6.7	5.3	66.7	68.4	-	10.5
Acquired obstructive uropathy	59	41	0.8	0.6	16	17	79.7	68.3	74.6	75.6	20.3	17.1	5.1	7.3	39.0	36.6	-	-
Chronic pyelonephritis, reflux nephropathy	249	161	3.2	2.2	16	17	46.2	46.0	87.6	87.0	4.8	6.8	7.6	6.2	50.2	49.7	1.6	3.7
Chronic interstitial nephritis	83	77	1.1	1.1	16	17	59.0	53.2	74.7	74.0	19.3	15.6	6.0	10.4	51.8	44.2	2.4	2.6
Hypertensive/large vessel disease	500	522	6.4	7.3	19	20	62.6	61.9	50.8	50.0	44.2	45.6	5.0	4.4	20.0	13.4	2.0	3.1

(Table 8.1 continued on next page)

vol 2 **Table 8.1 Distribution of reported incident pediatric ESRD patients by primary cause of ESRD (aged 0-21 years), and by demographic characteristics, 2004-2008 (period A) and 2009-2013 (period B)** *(Table 8.1 continued)*

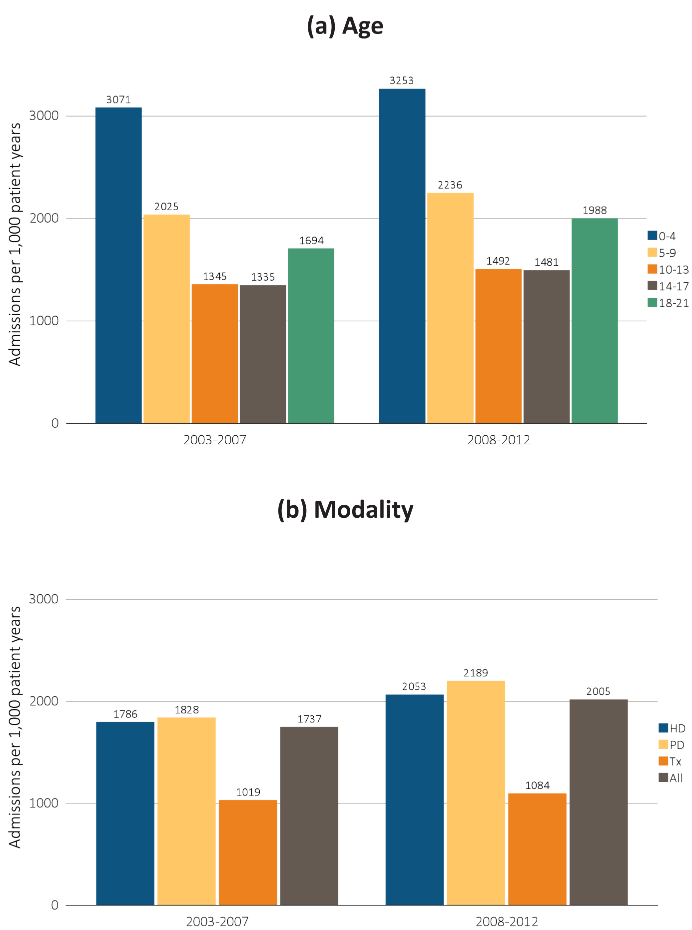
	Total		Incident		Age		Male		White		Black African Am		Other Race		Transplant first year		Died first year	
	Patients		%		Median		%		%		%		%		%		%	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Cystic/hereditary/congenital diseases	2,252	2,364	28.6	33.0	11	11	67.6	67.1	77.4	75.5	17.0	17.7	5.6	6.7	50.4	49.7	3.1	2.5
Polycystic kidneys, adult type (dominant)	46	51	0.6	0.7	18	18	45.7	47.1	80.4	76.5	17.4	23.5	2.2	-	47.8	49.0	2.2	2.0
Polycystic, infantile (recessive)	146	142	1.9	2.0	8	1	55.5	43.0	78.1	78.2	17.1	14.1	4.8	7.7	51.4	42.3	11.0	9.2
Medullary cystic disease, incl. nephronophthisis	105	112	1.3	1.6	12	13	39.0	46.4	88.6	82.1	3.8	11.6	7.6	6.3	65.7	71.4	1.0	0.9
Hereditary nephritis, Alport's syndrome	184	158	2.3	2.2	17	17	87.0	86.7	71.7	74.7	21.7	17.7	6.5	7.6	46.7	49.4	0.5	-
Cystinosis	65	45	0.8	0.6	12	13	49.2	62.2	95.4	84.4	4.6	13.3	-	2.2	76.9	75.6	-	-
Primary oxalosis	22	13	0.3	0.2	12	4	45.5	76.9	81.8	76.9	9.1	-	9.1	23.1	59.1	53.8	-	7.7
Congenital nephrotic syndrome	144	132	1.8	1.8	2	3	57.6	51.5	73.6	81.1	20.1	11.4	6.3	7.6	53.5	43.9	4.2	6.1
Drash syndrome, mesangial sclerosis	14	34	0.2	0.5	0	1	57.1	52.9	85.7	76.5	7.1	20.6	7.1	2.9	50.0	26.5	14.3	2.9
Congenital obstructive uropathy	610	659	7.8	9.2	12	12	82.3	81.0	73.8	72.2	21.0	21.9	5.2	5.9	45.2	47.3	2.8	0.8
Renal hypoplasia, dysplasia, oligonephronia	700	703	8.9	9.8	10	9	61.7	62.0	77.7	75.8	15.6	17.8	6.7	6.4	50.1	50.8	3.1	2.8
Prune belly syndrome	81	87	1.0	1.2	8	6	98.8	98.9	79.0	67.8	18.5	26.4	2.5	5.7	54.3	50.6	1.2	-
Other (congenital malformation syndromes)	126	219	1.6	3.1	16	13	54.8	58.9	84.1	79.0	11.9	9.6	4.0	11.4	49.2	49.3	1.6	4.1
Neoplasms/tumors	195	135	2.5	1.9	15	15	52.3	50.4	73.8	70.4	19.5	19.3	6.7	10.4	37.4	27.4	16.9	15.6
Renal tumor	40	40	0.5	0.6	6	5	42.5	42.5	57.5	72.5	32.5	17.5	10.0	10.0	12.5	20.0	25.0	12.5
Kidney transplant complication	51	*	0.6	0.1	16	19	54.9	50.0	74.5	100.0	19.6	-	5.9	-	66.7	50.0	-	-
Other transplant complication	87	75	1.1	1.0	15	17	57.5	56.0	80.5	66.7	14.9	24.0	4.6	9.3	33.3	28.0	20.7	17.3
Miscellaneous conditions	542	494	6.9	6.9	16	16	54.6	54.5	64.9	68.0	31.2	23.3	3.9	8.7	31.9	30.4	8.3	7.7
Sickle cell disease/anemia	26	19	0.3	0.3	19	20	69.2	63.2	3.8	5.3	92.3	94.7	3.8	-	7.7	15.8	23.1	10.5
AIDS nephropathy	64	31	0.8	0.4	19	20	50.0	54.8	9.4	3.2	90.6	96.8	-	-	-	-	18.8	19.4
Traumatic or surgical loss of kidney(s)	17	11	0.2	0.2	8	17	58.8	63.6	88.2	45.5	11.8	27.3	-	27.3	41.2	9.1	11.8	18.2
Tubular necrosis	163	143	2.1	2.0	15	15	50.9	61.5	79.1	74.8	16.6	17.5	4.3	7.7	16.0	16.8	6.7	12.6
Other renal disorders	266	282	3.4	3.9	15	14	56.8	49.6	74.4	77.3	20.7	13.5	4.9	9.2	51.9	41.8	4.5	3.2
Etiology uncertain	655	502	8.3	7.0	16	16	60.0	59.0	73.4	69.7	20.0	21.5	6.6	8.8	32.8	33.3	3.1	1.2
Missing	362	546	4.6	7.6	14	15	59.4	60.6	23.2	31.9	5.2	10.4	71.5	57.7	93.9	77.5	1.1	2.4

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: African Am, African American; AIDS, acquired-immune deficiency syndrome; Congenital obstructive uropathy, combination of congenital ureterpelvic junction obstruction, congenital uretrovesical junction obstruction, and other congenital anomalies; ESRD, end-stage renal disease; GN glomerulonephritis; IgA immunoglobulin A; IgM, immunoglobulin M; incl., including; MPGN, membranoproliferative glomerulonephritis; SBE, sub-acute bacterial endocarditis.

Hospitalizations

The one-year adjusted all-cause hospitalization rates by age (Figure 8.3.a) from 2003–2007 and 2008–2012 were highest in the youngest segment of children with ESRD (0-4 years of age). The rates of hospitalization rose in each group during this time frame. Those aged 18-21 years had substantially higher rates of hospitalization as compared to the 10-13 and 14-17 year old age groups. The one-year adjusted all-cause hospitalization rates in all children on renal replacement therapy (Figure 8.3.b) rose 15.4% from 1,737 to 2,005 admissions per 1,000 patient years. The one-year adjusted all-cause hospitalization rates rose for all modalities as follows: hemodialysis by 14.9%, peritoneal dialysis by 19.7%, and transplant by 6.4% from one period to the next.

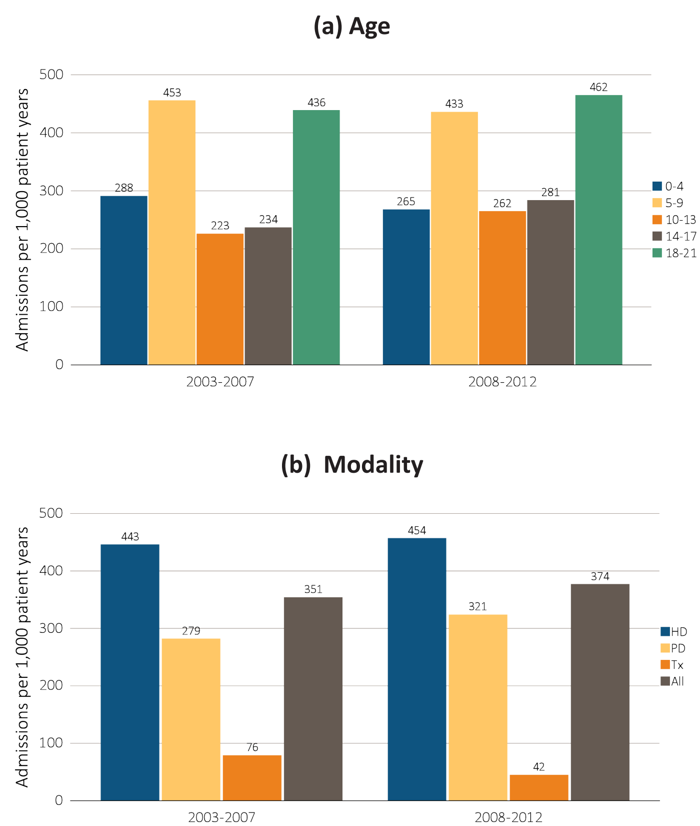
vol 2 Figure 8.3 One-year adjusted all-cause hospitalization rates in incident pediatric patients (aged 0-21 years), by (a) age and (b) modality, 2003-2007 and 2008-2012



Data Source: Special analyses, USRDS ESRD Database. Includes incident pediatric ESRD patients in the years 2003-2012, surviving the first 90 days after ESRD initiation and followed from day 90. Adjusted for sex, race, primary cause of ESRD, and Hispanic ethnicity. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

The overall cardiovascular hospitalization (for definition of terms, see the Pediatrics section of the ESRD Analytical Methods chapter) rate per 1,000 patient years from 2008-2012 was 374 admissions per 1,000 patients years, which is 6.6% higher than during 2003-2007 (Figure 8.4.b). Rates rose by 17.5% in ages 10-13, 20.1% in ages 14-17, and 6.0% in those 18-21 years old in the most recent reporting window (Figure 8.4.a). Children less than 4 and 5-9 years of age showed a decrease of 8.0% and 4.4% in cardiovascular hospitalizations during the same time period, respectively. In evaluating modality, the rate of cardiovascular hospitalizations remains highest in those on hemodialysis (Figure 8.4.b). There was a 2.5% and 15.1% rise in cardiovascular hospitalization rates in hemodialysis and peritoneal dialysis patients, respectively. While already somewhat low, the rate of cardiovascular hospitalization in transplant patients decreased by 44.7% between 2003-2007 and 2008-2012 and was markedly less than dialysis-associated cardiovascular hospitalizations.

vol 2 Figure 8.4 One-year adjusted cardiovascular hospitalization rates in incident pediatric patients (aged 0-21 years), by (a) age and (b) modality, 2003-2007 and 2008-2012

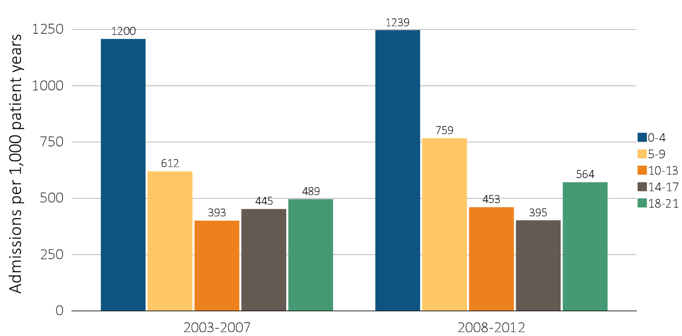


Data Source: Special analyses, USRDS ESRD Database. Includes incident pediatric ESRD patients in the years 2003-2012, surviving the first 90 days after ESRD initiation and followed from day 90. Adjusted for sex, race, primary cause of ESRD, and Hispanic ethnicity. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

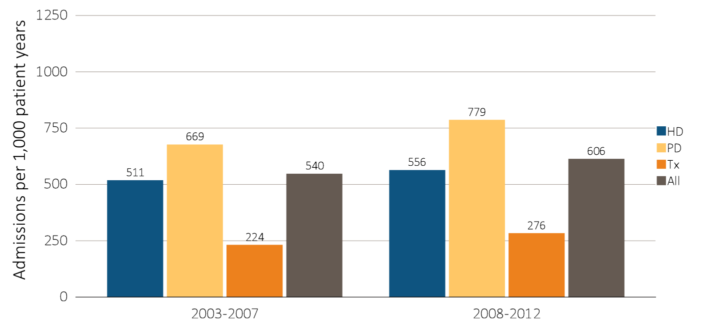
The overall rate of hospitalization for infection was 606 admissions per 1,000 patient years during 2008-2012, which is 12.2% higher than during 2003-2007 (Figure 8.5.b). The rates of infection-related hospitalizations rose by 3.3% in children 0-4 years of age, 24.0% in those 5-9 years of age, 15.3% in those 10-13 years of age, and 15.3% in those 18-21 years of age (Figure 8.5.a). Children between 14-17 years of age represented the only improvement in infection-related hospitalizations, decreasing 11.2% during the most recent time period (2008-2012) compared with 2003-2007. In examining modality, children on peritoneal dialysis had the highest rate of infection-related hospitalizations during 2003-2007 and 2008-2012 (Figure 8.5.b). During this time period, there was an increase in infection-related hospitalization rates in each modality of renal replacement therapy (hemodialysis 8.8%, peritoneal dialysis 16.4%, transplantation 23.2%). The rates of infection-related hospitalizations in transplant patients were much lower than for other ESRD modalities. Specifically, the rate of infection-related hospitalizations in transplant recipients was 276 per thousand patient years, compared with 556 per thousand patient years of hemodialysis and 779 per thousand patient years of peritoneal dialysis during 2008-2012.

vol 2 Figure 8.5 One-year adjusted hospitalization rates for infection in incident pediatric patients (aged 0-21 years), by (a) age and (b) modality, 2003-2007 and 2008-2012

(a) Age



(b) Modality



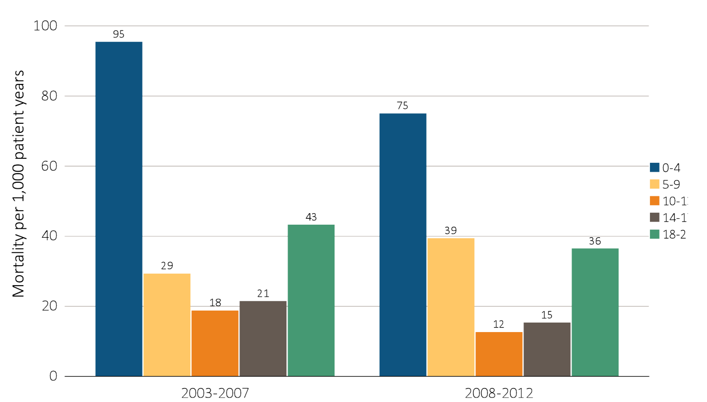
Data Source: Special analyses, USRDS ESRD Database. Includes incident pediatric ESRD patients in the years 2003-2012, surviving the first 90 days after ESRD initiation and followed from day 90. Adjusted for sex, race, primary cause of ESRD, and Hispanic ethnicity. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Mortality

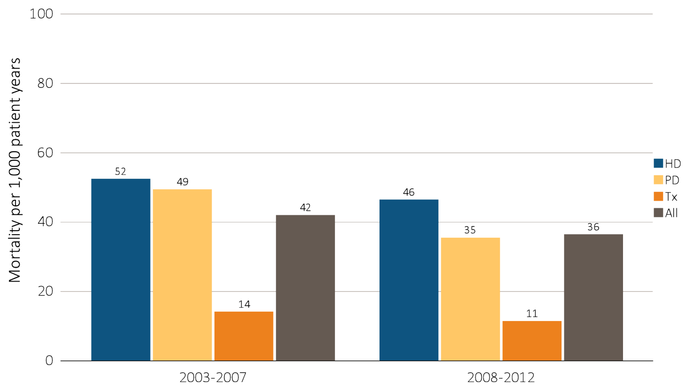
In 2008-2012, the one-year adjusted all-cause mortality was 36 per 1,000 patient years, which represents a decrease of 14.3% from 2003-2007 (Figure 8.6.b). The adjusted one-year all-cause mortality rates decreased in ages 0-4, 10-13, 14-17, and 18-21 years by 21.1%, 33.3%, 28.6% and 16.3% respectively (Figure 8.6.a). The adjusted one-year all-cause mortality rates rose by 34.5% in those ages 5-9 years. Adjusted one-year all-cause mortality rates by modality from 2003-2007 and 2008-2012 show decreases of 11.5% among hemodialysis patients, 28.6% among peritoneal dialysis patients, and 21.4% among transplant patients (Figure 8.6.b). Across all time windows, transplant-associated mortality remains a smaller fraction compared with other modalities.

vol 2 Figure 8.6 One-year adjusted all-cause mortality rates in incident pediatric patients with ESRD (aged 0-21 years), by (a) age and (b) modality, 2003-2007 and 2008-2012

(a) Age



(b) Modality

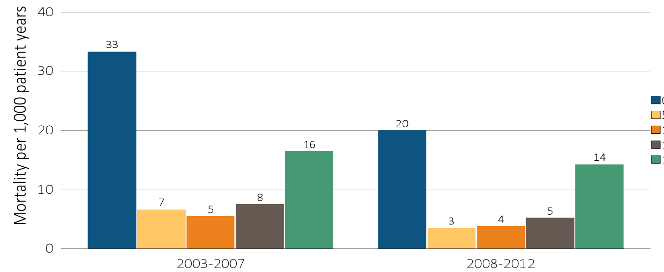


Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

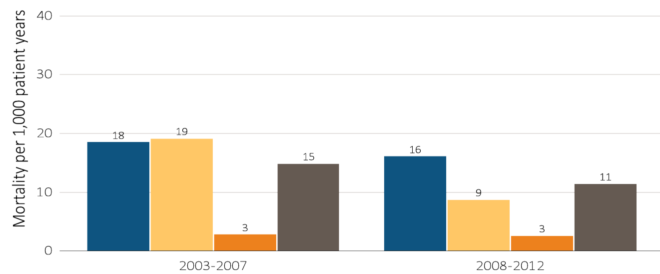
In 2008 to 2012, the one-year adjusted cardiovascular mortality was 11 per 1,000 patient years, which was a decrease of 26.7% from the 2003-2007 period (Figure 8.7.b). The adjusted one-year cardiovascular mortality decreased across all age groups: ages 0-4 years by 39.4%, ages 5-9 years by 57.1%, ages 10-13 years by 20%, ages 14-17 by 37.5%, and ages 19-21 by 12.5% (Figure 8.7.a). Compared to other pediatric age groups, children 0-4 years of age continued to have the highest adjusted one-year cardiovascular mortality. Examining adjusted one-year cardiovascular mortality across the periods 2003-2007 and 2008-2012 by modality, the rate decreased by 11.1% in hemodialysis, 52.6% in peritoneal dialysis, and was unchanged in transplant patients (Figure 8.7.b). During 2008-2012, one-year adjusted cardiovascular mortality rates in transplanted children were a fraction of the rates in dialysis-dependent children.

vol 2 **Figure 8.7 One-year adjusted cardiovascular mortality rates in incident pediatric patients with ESRD (aged 0-21 years), by (a) age and (b) modality, 2003-2007 and 2008-2012**

(a) Age



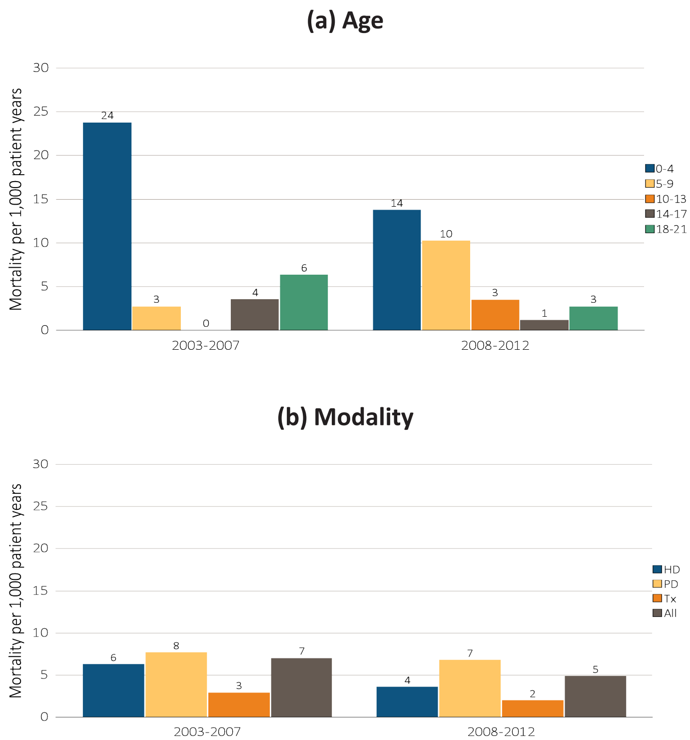
(b) Modality



Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

During 2008-2012, the one-year adjusted infection-related mortality rate decreased by 28.6% from that of the 2003-2007 period (Figure 8.8.b). The adjusted one-year infection-related mortality rate decreased in those 0-4 years of age by 41.7% (Figure 8.8.a). There was a rise in the rate of infection-related mortality in children ages 5-9 years, but the overall rates remained low in the remaining groups. Those 0-4 years of age continued to have the highest adjusted one-year infection-related mortality rate. Examining the adjusted one-year all infection-related mortality rates between the periods 2003-2007 and 2008-2012 by modality, the one-year infection-related mortality rate decreased from a range of 3 to 8 per 1,000 patient years during 2003-2007 to 2 to 7 per 1,000 patient years during 2008-2012 (Figure 8.8.b).

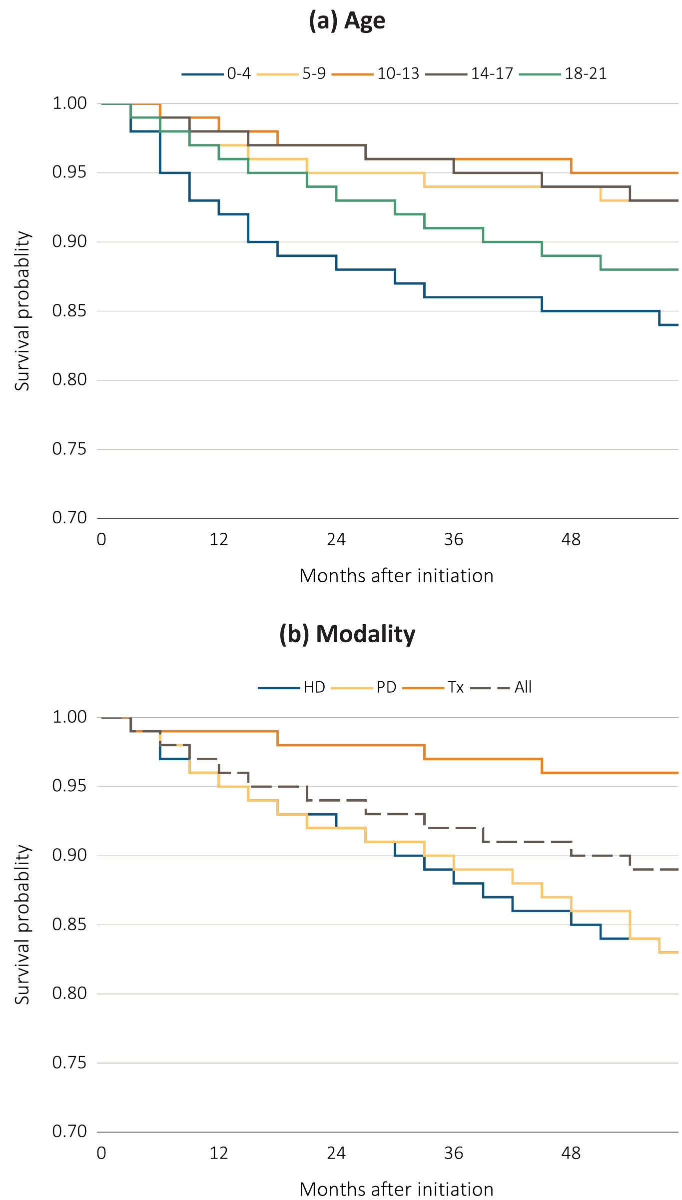
vol 2 Figure 8.8 One-year adjusted rates of mortality due to infection in incident pediatric patients with ESRD (aged 0-21 years), by (a) age and (b) modality, 2003-2007 and 2008-2012



Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

For patients beginning ESRD therapy during 2004-2008, the probability of five year survival was 0.89 (Figure 8.9.b). The probability of surviving five years by age was 0.84 for ages 0-4, 0.93 for ages 5-9, 0.95 for ages 10-13, 0.93 for ages 14-17, and 0.87 for ages 18-21 years (Figure 8.9.a). Transplant patients had the highest probability of surviving five years with a probability of 0.95, as compared to 0.82 in hemodialysis patients, and 0.82 in peritoneal dialysis patients (Figure 8.9.b).

vol 2 Figure 8.9 Adjusted five-year survival in incident pediatric patients (aged 0-21 years) from day 1, by (a) age and (b) modality, 2004-2008

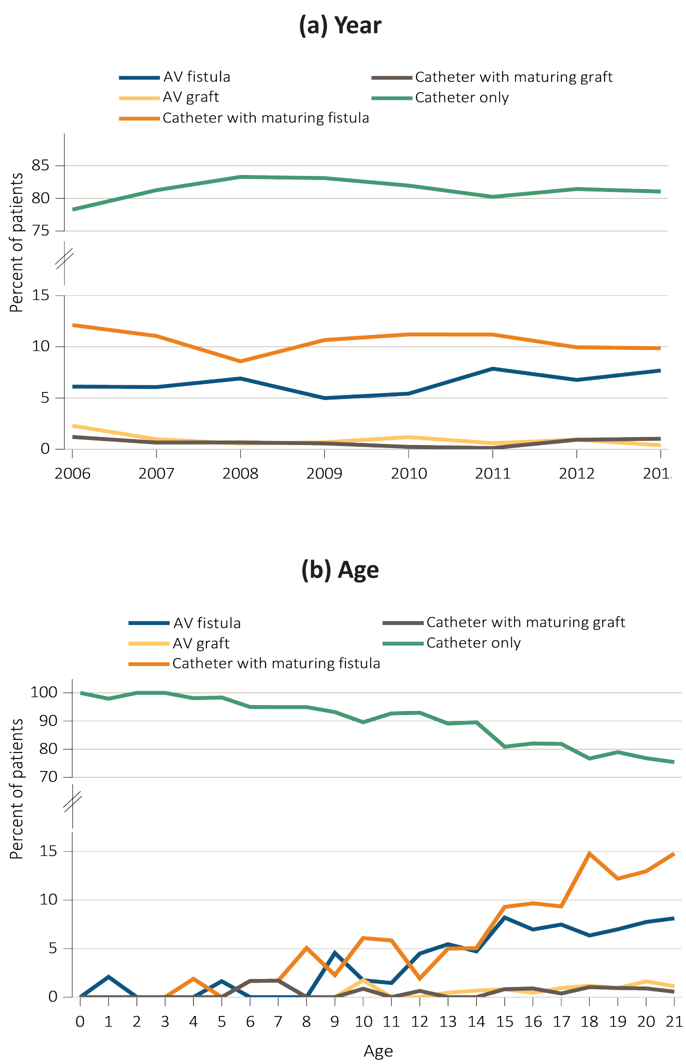


Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Vascular Access

The decisions and approach to vascular access in ESRD patients impact both immediate and future patient outcomes. Due to the potential short- and long-term consequences that central venous catheter (hereafter, catheter) use can have on future access, and the inevitability that pediatric patients will require multiple forms of vascular access during their lifetime, vascular access decisions are particularly important in pediatric patients. In this section, we will begin to comprehensively describe the vascular access practices in incident and prevalent hemodialysis patients. Vascular access in pediatric ESRD patients is approached differently than vascular access in adult ESRD patients due to factors such as anatomical differences, transplant waiting times, and transplant rates. The technical challenge of accessing vessels in small children and an expected short waiting time until a kidney transplant becomes available may influence the vascular access experience in children with ESRD. Since 2006 approximately 81% of incident pediatric ESRD patients started hemodialysis with a catheter (range 78.3% to 83.3%) (Figure 8.10).

vol 2 Figure 8.10 Vascular access type at initiation of incident pediatric hemodialysis patients (aged 0-21 years) by (a) year and (b) age, 2006-2013



Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2006-2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

With older ages, other forms of permanent access are increasingly utilized at initiation, such as arteriovenous (AV) fistula and AV graft (Table 8.2). When vascular access is examined in prevalent hemodialysis patients there are higher rates of arteriovenous fistula and arteriovenous graft utilization in children aged 10 to 21 years (Figure 8.11).

The trends in initial vascular access remain stable despite concerted efforts, such as 'Fistula First', to increase the utilization of arteriovenous fistulas in pediatric patients. The explanation for this dichotomy stems from an expected short waiting time for children on the transplant list.

During 2010-2013, the trends of demographic factors associated with the type of vascular access were similar to that of the 2006-2009 period (Table 8.2). Increasing patient age predicts a decreased likelihood of the utilization of a catheter alone for vascular access. This is likely reflective of multiple factors including anatomical consideration in the youngest patients, expected time until transplant, and the return to dialysis of adolescents with a failed transplant. In examining etiologies in both cohorts, patients with secondary glomerulonephritis were most likely to initiate dialysis with a catheter alone. In unadjusted analysis, Blacks and males were less likely to initiate hemodialysis with a catheter alone.

vol 2 Table 8.2 **Percent of vascular access type in incident pediatric hemodialysis patients (aged 0-21 years), by age, sex, race, ethnicity, and primary cause of ESRD, 2006-2009 and 2010-2013**

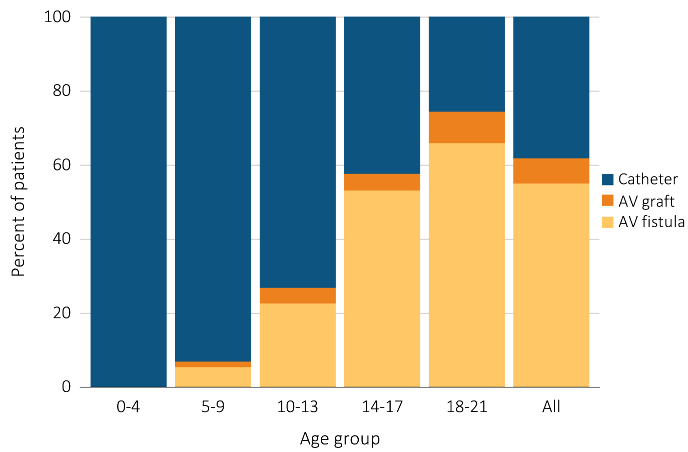
	2006-2009					2010-2013				
	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only
Age										
0-4	.	.	.	.	100.0	0.8	.	0.8	.	98.5
5-9	2.7	.	0.7	0.7	95.9	0.5	1.0	3.5	0.5	94.5
10-13	4.0	0.7	5.6	0.3	89.4	3.4	0.3	3.7	0.3	92.3
14-17	7.1	0.7	8.6	0.6	83.1	6.9	0.8	8.7	0.5	83.0
18-21	6.4	1.5	13.3	1.0	77.8	8.7	0.9	14.0	0.7	75.7
Sex										
Male	7.1	1.3	10.9	0.8	79.9	8.1	0.6	12.7	0.5	78.0
Female	4.7	0.9	10.2	0.8	83.4	5.5	1.0	8.0	0.6	84.9
Race										
White	6.7	1.4	9.7	0.7	81.5	7.3	0.7	9.6	0.4	82.0
Black/African American	5.3	0.9	12.8	1.1	79.9	6.7	0.7	12.8	1.0	78.9
Other	2.9	.	8.8	.	88.3	4.9	1.8	8.4	0.4	84.5
Ethnicity										
Hispanic	5.8	1.5	10.4	0.5	81.8	6.7	0.8	10.3	0.4	81.8
Non-Hispanic	6.1	1.0	10.7	0.9	81.3	7.0	0.8	10.7	0.6	80.9
Primary cause of ESRD										
Glomerulonephritis	5.9	1.2	13.1	0.9	78.9	7.5	0.8	12.4	0.4	78.9
Secondary GN	1.8	0.9	8.4	0.7	88.2	3.4	0.4	7.4	0.4	88.4
CHC	12.1	0.8	8.9	0.2	78.0	12.5	0.4	8.6	0.8	77.7
Other Cause	5.7	1.2	10.1	0.9	82.0	5.6	1.1	11.2	0.6	81.5

Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2006-2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease; GN, glomerulonephritis; CHC, Cystic/hereditary/ congenital diseases.

A cross-sectional analysis of prevalent ESRD patients aged 0-21 years in December 2014 shows that 62.4% of patients had arteriovenous fistula or arteriovenous graft as their type of vascular access (Figure 8.11). Age continues to strongly predict the type of vascular access. There is a stepwise increase in the utilization of AV fistula or AV graft for vascular access that parallels patient age, with the highest rates in older children, including 58.2% for those 14-17 and 75% for those 18-21 years old. Also when examining race and etiology of ESRD (figures not shown), there were subtle differences in vascular access in the prevalent patients in unadjusted analysis. Blacks had a higher proportion of AV graft use when compared to other races. Whites and Blacks had lower use of central venous catheters only when compared to other races (39.2%, 33.1%, vs. 50%, respectively). Overall, patients with primary and secondary glomerulonephritis as etiology of ESRD had a higher proportion of surgical access in place (arteriovenous fistula or graft) when compared to other etiologies in unadjusted analysis.

To provide context for the pediatric data we provide a brief description of adult trends in vascular access. Prevalent adult hemodialysis patients from December 2014 (data not shown) had a similar frequency of catheter use between races (13.8% White and 13.3% Black). Hispanic adults had a lower percentage of catheter use (11.5%) than non-Hispanics (13.9%). A higher percentage of AV graft use was observed in adults of Black compared with White race (26.2% vs 15.2% respectively).

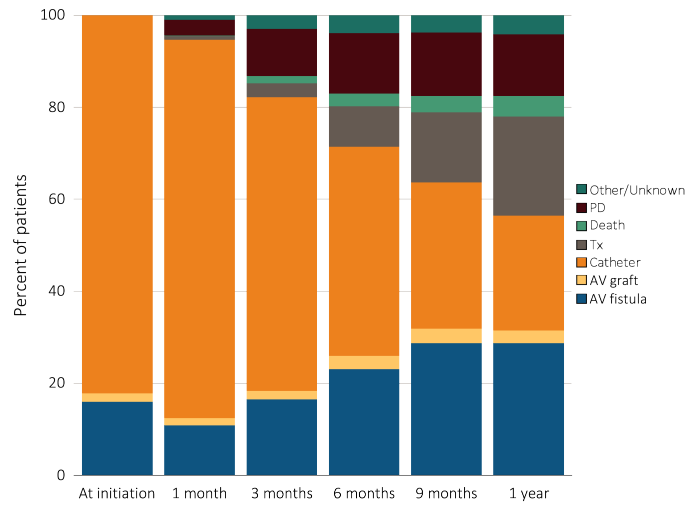
vol 2 Figure 8.11 Distribution of vascular access type in prevalent pediatric hemodialysis patients (aged 0-21 years* as of December 31, 2014), 2014



*Data Source: Special analyses, USRDS ESRD Database. Hemodialysis patients initiating treatment for ESRD at least 90 days prior to December 1, 2014, *who were <22 years old as December 1, 2014, and who were alive through December 31, 2014; Catheter=any catheter use; fistula and graft use shown are without the use of a catheter. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.*

Figure 8.12 examines the 12-month trend of vascular access and modality changes in pediatric ESRD patients who initiated ESRD care with hemodialysis between June 1, 2012 and December 31, 2012. In this seven-month hemodialysis initiation period, 82.1% of patients aged 0-21 years initiated hemodialysis with a central venous catheter in place. After 12 months of observation, 21.5% received a transplant, 31.5% had an arteriovenous graft or fistula in place, 13.4% transitioned to peritoneal dialysis, 24.9% of patients continued with a catheter, and 8.7% were other, unknown, or death. In examining age categories, 22.2% of patients aged 0-4 years (N=18) received a transplant and only 11.1% of patients aged 18-21 years (N=244) received a transplant.

vol 2 Figure 8.12 One-year longitudinal assessment of vascular access type in incident pediatric ESRD patients on hemodialysis (aged 0-21 years) in 2012



Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis from June 1, 2012 to December 31, 2012, who were <22 years of age at initiation. Patients with a maturing AV fistula / AV graft with a catheter in place were classified as having AV fistula or AV graft. The apparent decrease in arteriovenous fistula and arteriovenous graft use at 1 month is related to missing data due to the different data sources used for incident and prevalent patients. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Trends in Pediatric Kidney Transplantation

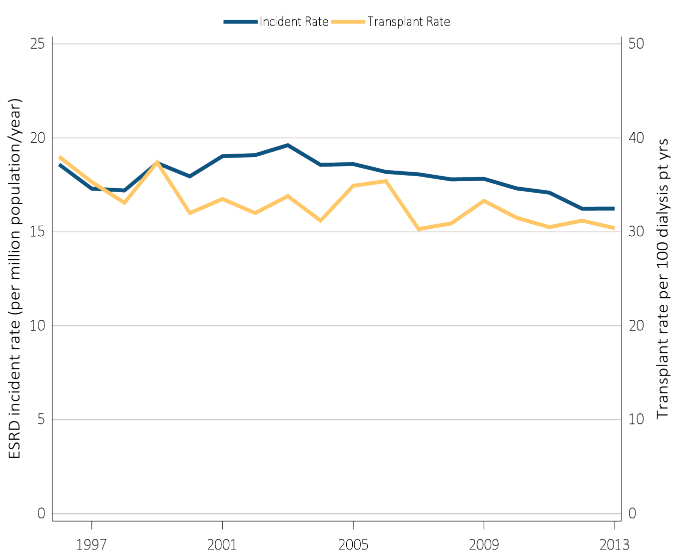
Overall, 37.0% of children received a kidney transplant within the first year of ESRD care during 2009-2013 (Table 8.1), including 36% of children with weight greater than 10 kg. The number of children receiving a transplant decreased 1.3% from 2004-2008. In 2013 the rate of transplants was 30.4 per 100 dialysis patient years, which has remained stable since 2007 (Figure 8.13.a).

A total of 1,277 children were listed for a kidney transplant in 2013, including 830 patients listed for the first time and 447 patients listed for repeat transplant. The number of patients awaiting a kidney transplant has ranged from 1,231 to 1,389 since 2006 (Figure 8.13.b). Since 1997 there has been a decrease in the median waiting time for those listed for their first transplant with a flattening of the curve in 2005, which coincides with the change in the Organ Procurement and Transplantation Network organ allocation policy. The median waiting time for patients receiving their first kidney transplant has remained at least 150-220 days. Over the same time period children receiving a repeat transplant have, on average, been on the waiting list at least 3-4 times longer than those awaiting their first transplant.

A total of 997 children received a kidney transplant in 2013 (Figure 8.13.c). Kidney grafts in pediatric transplant recipients were most commonly from living donors prior to 2005. There has been a decline in the number of pediatric patients with ESRD receiving living donor kidneys since 2009. In 2013, living donors accounted for 42.1% of kidney transplants.

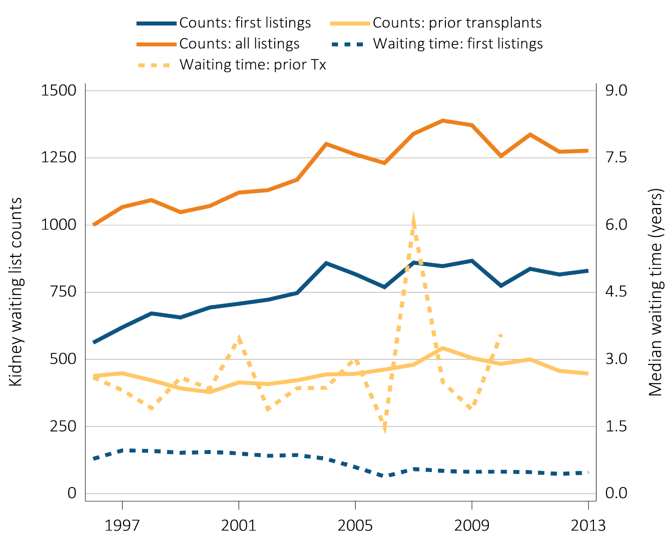
vol 2 Figure 8.13 Trends in pediatric transplantation (aged 0-21 years), by (a) ESRD incident and kidney transplant rates, (b) Pediatric patient transplant counts and kidney transplant waiting list times, and (c) kidney transplant counts, 1996-2013

(a) ESRD incident and kidney transplant rates



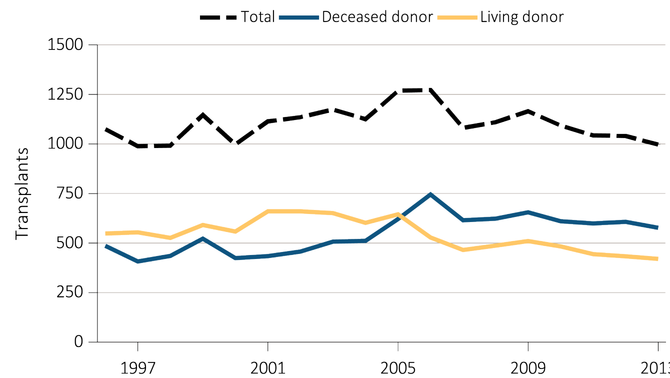
Data Source: Reference Tables A1, E9, M1, and special analyses, USRDS ESRD Database. The rate of ESRD per million among the U.S. population aged 0-21 years and the rate of transplantation in dialysis patients aged 0-21 years at the time of transplant, 1996–2013. Abbreviations: ESRD, end-stage renal disease.

(b) Pediatric patient transplant counts and kidney transplant waiting list times



Data Source: Reference Tables E2, E3, and special analyses, USRDS ESRD Database. The waiting list count provides the number of pediatric candidates aged 0-21 years on the Organ Procurement and Transplantation Network kidney transplant waiting list on December 31 of each year for first and subsequent kidney alone or kidney plus pancreas transplantation. Candidates listed at more than one center on December 31 are counted only once. There are no data available for median waiting list time for patients with prior transplants listed after 2010. Abbreviations: Tx, transplant.

(c) Kidney transplant counts



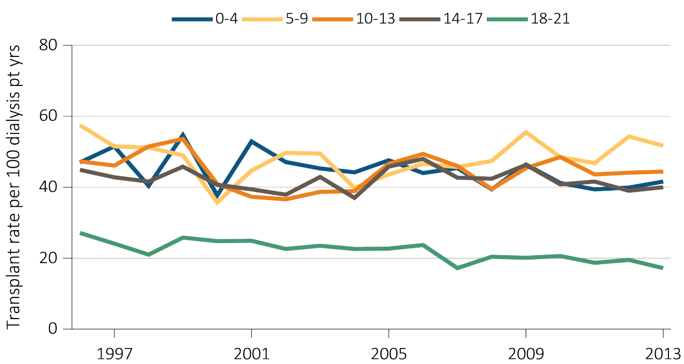
Data Source: Reference Tables E8, E8(2), E8(3), and special analyses, USRDS ESRD Database. This figure represents kidney alone and kidney plus pancreas transplant counts for all pediatric candidates.

Overall, the transplant rates in each of the age groups have remained stable during 1996-2013. In 2013, patients 5-9 years old had the highest rate of transplantation at 51.7 transplants per 100 dialysis patient years and those 18-21 years old had the lowest transplant rate at 17.2 transplants per 100 dialysis patient years. The transplant rate of those less than 18 years old was at least double that of those in the 18-21 year old group (Figure 8.14.a).

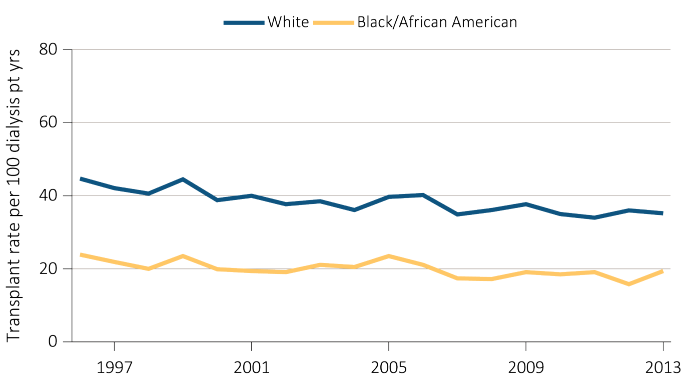
In 2013, males with ESRD are transplanted at a higher rate than females with ESRD, 32.3 versus 28.2 per 100 dialysis patient years, respectively. The transplant rate trends in Whites and Blacks have been parallel through the years (Figure 8.14.b). In 2013, White patients were transplanted at a rate of 35.2 per 100 dialysis patient years and Black patients at 19.4 per 100 dialysis patient years. Analyses for Native and Asian Americans were excluded due to the low number of transplants.

vol 2 Figure 8.14 Annual rates of live and deceased donor transplants in pediatric dialysis patients (aged 0-21 years), by (a) age and (b) race, 1996-2013

(a) Transplant rates by age



(b) Transplant rates in pediatric dialysis patients by race



Data Source: Reference Table E9, and special analyses, USRDS ESRD Database. Includes transplant year between 1996–2013.

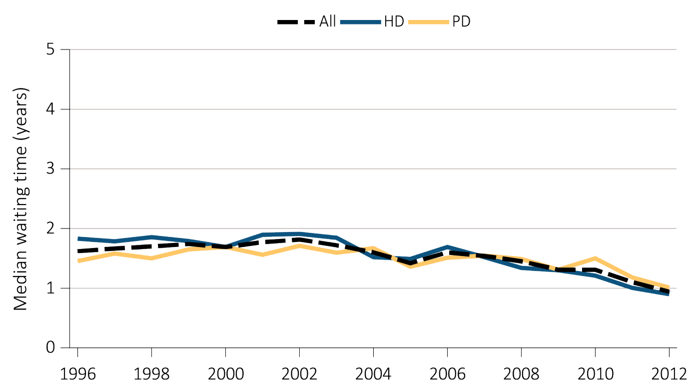
The median waiting time to transplant for incident patients on dialysis has been improving over time. In 2002, the median waiting time peaked at 1.82 years and began to decline with the most dramatic improvement occurring after 2005 (Figure 8.15.a), which coincides with the change in the Organ Procurement and Transplantation Network organ allocation policy. Since 2005, the median waiting time for incident dialysis patients has continued to decrease and was at its lowest in 2012 at 0.94 years. Since 2007, the waiting times for incident patients on dialysis have been similar for hemodialysis and peritoneal dialysis. In 2012, the median waiting time to transplant for hemodialysis patients was 0.9 years and for peritoneal dialysis patients it was 1.01 years.

Kidney transplant waiting times vary by age and ESRD etiology. The median time for incident dialysis to transplant has consistently improved from 1996 to 2012 in all age groups, with the exception of those 0-4 years old (Figure 8.15.b). Children 0-4 years have had stable waiting times, which likely reflect the surgical complexities in this age. Since 1996, patients ages 18-21 years old have shown the largest improvement with waiting times. Since 2009, children 0-4 years of age have the longest median waiting time, which was 1.36 years in 2012. Patients with secondary glomerulonephritis as the cause of their ESRD had the longest median waiting time to first transplant, with a median of 1.2 years in 2012 (Figure 8.15.c).

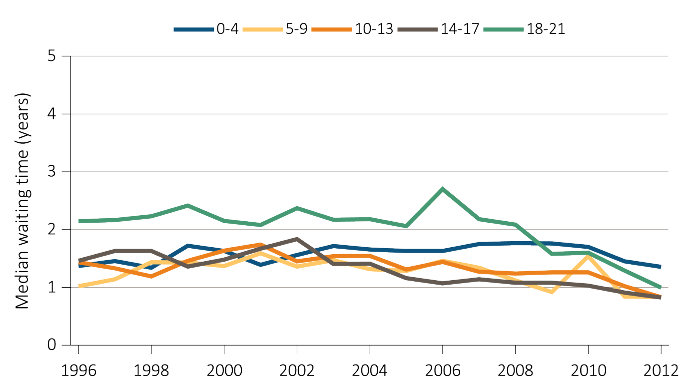
In 1996, White patients were on the wait list on average 50% shorter than Black patients awaiting a transplant (Figure 8.15.d). Since then, the average time on the transplant list has improved significantly for all patients and the gap between races has narrowed substantially so that median waiting times are now similar between groups (Whites 0.91 and Blacks 1.00 years).

vol 2 Figure 8.15 Median waiting time from incident hemodialysis (HD) or peritoneal dialysis (PD) to first transplant, by (a) modality, (b) age, (c) primary cause of ESRD, and (d) race, 1996-2012

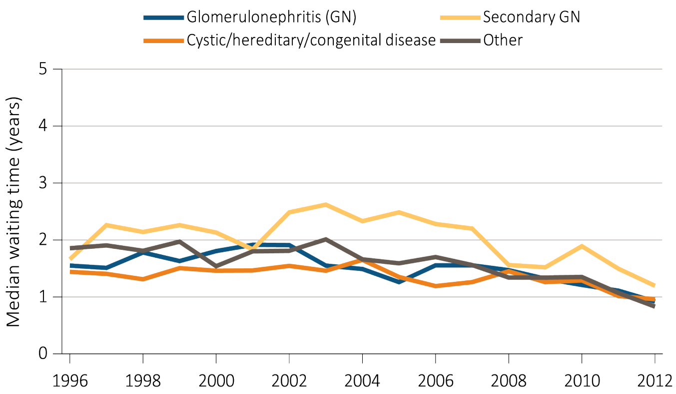
(a) Modality



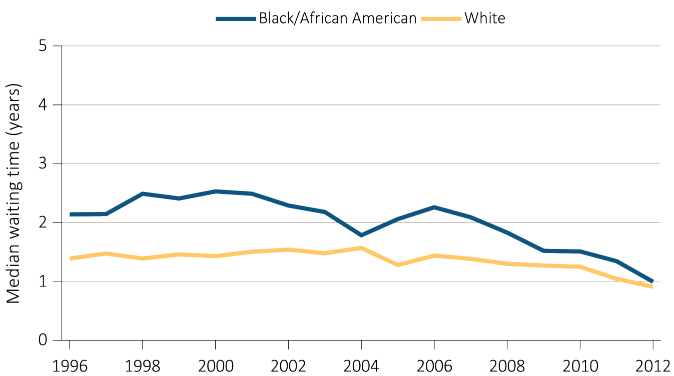
(b) Age



(c) Primary cause of ESRD



(d) Race



Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant with the 60-day rule. Includes pediatric patients (aged 0-21 years) starting initiation of HD or PD in 1996-2012 and having the first transplant before 12/31/2014. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

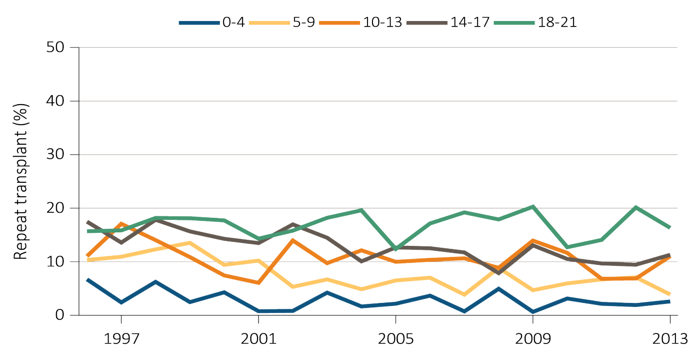
In 2013, there were 100 repeat transplants in pediatric patients, accounting for 10% of all transplants. Among the 100 repeat transplants, 94 received a second transplant and 6 received a third transplant. Repeat transplants have consistently represented 9%-13% of the total transplants since 2000. As might be expected, the rates of repeat transplant differed significantly by age, with older patients having a higher rate. The 18-21 year old group had the most repeat transplants at 16.3% in 2013 (Figure 8.16.a). This coincides with the expected half-life of organs transplanted during early childhood.

The ESRD diagnoses associated with the highest repeat transplant rate was cystic/hereditary/congenital causes of ESRD. (Figure 8.16.b) This diagnosis group's repeat transplant rate has been consistently between 13%-19%. This is an expected finding that may correlate with the increasing repeat transplantation rate that occurs with age. The cystic/hereditary/congenital diagnosis category represents the most common diagnosis to receive transplants early in childhood leading to an earlier need for repeat transplantation.

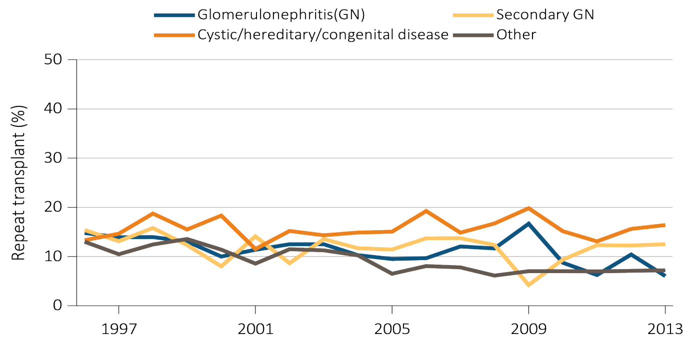
Time from first kidney graft loss to second transplant provides a perspective that is particularly relevant for children receiving the initial transplant before age 21 years. The time to repeat transplant is provided by age, race, and primary ESRD etiology for patients who had their repeat transplantation prior to 29 years of age and between 1996 and 2013. Patients who lost their first transplant between the ages of 18-21 years have a median waiting time of 26 months, the longest waiting time in all age groups. For patients in the other pediatric age groups, their median waiting times were the approximately the same (median 14 months for ages 0-4; 18 months for ages 5-9 and 13-17; 19 months for ages 10-13 years old). Black patients with failure of their first transplant had a median waiting time that was double that of White patients (median 35 months versus 16 months, respectively). Patients with primary glomerulonephritis as the cause of their ESRD had the longest median time to second transplant of 27 months, compared with secondary glomerulonephritis (24 months), cystic/congenital/hereditary causes (16 months) and all other causes of ESRD (19 months).

vol 2 **Figure 8.16 Percent of repeat transplantation in pediatric transplant patient population (aged 0-21 years), by (a) age and (b) primary cause of ESRD, 1996-2013**

(a) Age



(b) Primary cause of ESRD



Data Source: Special analyses, USRDS ESRD Database. Includes transplant year between 1996–2013. Numerator: Total number of kidney repeat transplants; Denominator: Total number of kidney transplants. Only includes patients who are 0-21 years old at the time of first transplant and repeat transplant.

Table 8.3 displays the one-year, five-year, and ten-year kidney transplant outcomes. The adjusted one-year outcomes in deceased donor kidney transplants have steadily improved from 1996–2012 (Table 8.3.a). While the adjusted one year outcomes in living donor kidney transplants also improved between 1996–2006, they have subsequently plateaued. In 2012, the one year outcomes in recipients of deceased donor transplants were comparable to those who had living donor transplants. While the adjusted five-year outcomes in deceased and living donor kidney transplants has steadily improved from 1996–2012, the five-year adjusted outcomes are consistently better for living donor kidney transplants (Table 8.3.b). In 2008 the five-year probability of poor outcomes was higher for deceased donor recipients including a 29.2% higher all-cause graft failure and 29.9% higher return to dialysis or repeat transplant. Overall probability of death at one and five years remains low irrespective of donor type. The ten-year outcomes improved in a similar manner to the five-year outcomes with decreasing probability of all cause graft loss and return to dialysis or repeat transplant for both deceased and living kidney transplants (Table 8.3.c). The ten-year outcomes show significantly better outcomes for patients receiving living donor kidney transplants when compared to deceased donor kidney transplants.

vol 2 Table 8.3 Outcomes for kidney transplants in pediatric patients (aged 0-21 years), by donor type and year, (a) adjusted one-year outcomes, (b) adjusted five-year outcomes, (c) adjusted ten-year outcomes, 1996-2012

(a) Adjusted one-year outcomes

Year	Deceased			Living		
	All-cause graft failure	Return to dialysis or retransplant	Death	All-cause graft failure	Return to dialysis or retransplant	Death
1996	0.160	0.139	0.016	0.096	0.083	0.025
1997	0.121	0.108	0.027	0.075	0.065	0.014
1998	0.155	0.143	0.022	0.069	0.061	0.010
1999	0.143	0.120	0.017	0.074	0.064	0.013
2000	0.121	0.105	0.015	0.081	0.073	0.021
2001	0.106	0.098	0.018	0.070	0.061	0.014
2002	0.091	0.082	0.009	0.061	0.050	0.022
2003	0.112	0.093	0.017	0.075	0.061	0.019
2004	0.092	0.072	0.015	0.062	0.052	0.014
2005	0.103	0.088	0.021	0.075	0.068	0.015
2006	0.096	0.085	0.014	0.043	0.040	0.004
2007	0.083	0.069	0.023	0.052	0.040	0.010
2008	0.096	0.079	0.015	0.053	0.045	0.020
2009	0.080	0.066	0.010	0.057	0.045	0.011
2010	0.069	0.058	0.011	0.040	0.034	0.004
2011	0.048	0.047	0.004	0.044	0.032	0.021
2012	0.056	0.043	0.010	0.060	0.048	0.021

Data Source: Deceased: Reference Tables F2, F14, I26. Live: Reference Tables F8, F20, I32. Probabilities for all-cause graft failure and return to dialysis or repeat transplant are adjusted for age, sex, race, primary cause of ESRD, and first versus subsequent transplant. All-cause graft failure includes repeat transplant, return to dialysis, and death. The death outcome is not censored at graft failure, and includes deaths that occur after repeat transplant or return to dialysis. Probabilities of death are adjusted for age, sex, race, ethnicity and primary cause of ESRD. The reference population for all-cause graft failure and return to dialysis or repeat transplantation is all pediatric patients receiving a kidney alone transplant in 2012. The reference population for death is incident pediatric ESRD patients in 2012.

(b) Adjusted five-year outcomes

Year	Deceased			Living		
	All-cause graft failure	Return to dialysis or retransplant	Death	All-cause graft failure	Return to dialysis or retransplant	Death
1996	0.431	0.402	0.068	0.311	0.287	0.082
1997	0.387	0.366	0.060	0.307	0.270	0.113
1998	0.395	0.377	0.059	0.263	0.252	0.026
1999	0.393	0.364	0.039	0.292	0.271	0.071
2000	0.426	0.400	0.053	0.287	0.270	0.086
2001	0.372	0.356	0.061	0.275	0.249	0.065
2002	0.358	0.334	0.038	0.269	0.247	0.090
2003	0.388	0.359	0.054	0.270	0.248	0.057
2004	0.396	0.368	0.048	0.279	0.253	0.044
2005	0.368	0.341	0.056	0.294	0.275	0.069
2006	0.341	0.325	0.038	0.227	0.212	0.027
2007	0.333	0.309	0.061	0.252	0.228	0.052
2008	0.292	0.261	0.038	0.226	0.201	0.067

Data Source: Deceased: Reference Tables F5, F17, I29. Live: Reference Tables F11, F23, I35. Probabilities for all-cause graft failure and return to dialysis or repeat transplant are adjusted for age, sex, race, primary cause of ESRD, and first versus subsequent transplant. All-cause graft failure includes repeat transplant, return to dialysis, and death. The death outcome is not censored at graft failure, and includes deaths that occur after repeat transplant or return to dialysis. Probabilities of death are adjusted for age, sex, race, ethnicity and primary cause of ESRD. The reference population for all-cause graft failure and return to dialysis or repeat transplantation is all pediatric patients receiving a kidney alone transplant in 2012. The reference population for death is incident pediatric ESRD patients in 2012. *(Table 8.3 continued on next page.)*

(c) Adjusted ten-year outcomes *(Table 8.3 continued)*

Year	Deceased			Living		
	All-cause graft failure	Return to dialysis or retransplant	Death	All-cause graft failure	Return to dialysis or retransplant	Death
1996	0.646	0.615	0.126	0.500	0.475	0.147
1997	0.629	0.598	0.152	0.489	0.454	0.169
1998	0.588	0.571	0.110	0.490	0.464	0.104
1999	0.613	0.585	0.121	0.502	0.471	0.149
2000	0.613	0.579	0.116	0.503	0.467	0.173
2001	0.590	0.561	0.125	0.490	0.454	0.154
2002	0.529	0.499	0.071	0.425	0.401	0.157
2003	0.570	0.542	0.112	0.440	0.409	0.116

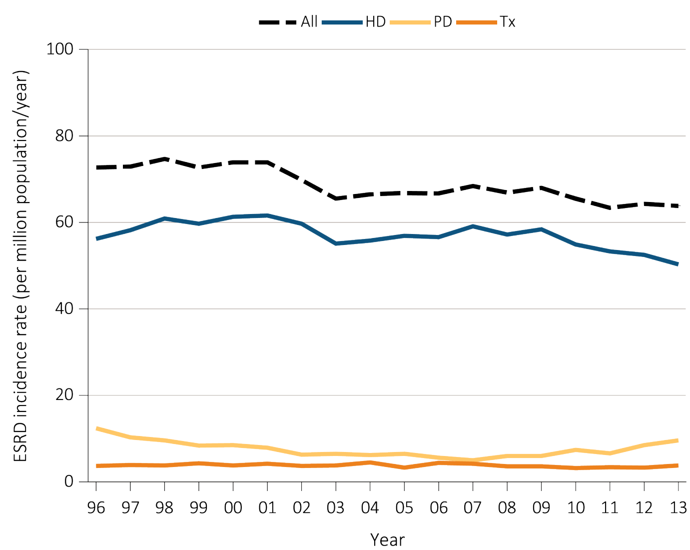
Data Source: Deceased: Reference Tables F6, F18, I30. Live: Reference Tables F12, F24, I36. Probabilities for all-cause graft failure and return to dialysis or repeat transplant are adjusted for age, sex, race, primary cause of ESRD, and first versus subsequent transplant. All-cause graft failure includes repeat transplant, return to dialysis, and death. The death outcome is not censored at graft failure, and includes deaths that occur after repeat transplant or return to dialysis. Probabilities of death are adjusted for age, sex, race, ethnicity and primary cause of ESRD. The reference population for all-cause graft failure and return to dialysis or repeat transplantation is all pediatric patients receiving a kidney alone transplant in 2012. The reference population for death is incident pediatric ESRD patients in 2012.

Young Adults

As a result of improvements in the care of pediatric patients with ESRD and kidney transplants, a larger percentage of these children are surviving into adulthood. The transition of these patients into adulthood represents a truly unique process and has resulted in the development of specific transition programs to improve health care for these individuals. For the first time in the USRDS Annual Data Report, we include a section in the pediatric chapter highlighting the young adult age group (defined in the USRDS as 22-29 years of age) that classically encompasses the transitional age groups. Despite their young age, cardiovascular disease remains the leading cause of mortality in this cohort, similar to older patients with ESRD. This section highlights the young adult population focusing on modality and the cardiovascular disease trends in this population.

The overall incident rate of ESRD in the young adult cohort has been stable from 2003-2013 (Figure 8.17). In 1996, the rate was 72.7 per million/year in the young adult census population while in 2013, the ESRD incident rate was 63.8 per million/year. In 2013, the rates of incident hemodialysis, peritoneal dialysis, and transplant were 50.3, 9.6, and 3.8 patients per million/year, respectively. Since 2008, there has been a trend in increased utilization of peritoneal dialysis as the incident ESRD modality. The point prevalence of young adults with ESRD (figure not shown) has fluctuated, but overall remains stable with 453.3 patients per million population in 2013. The 2013 point prevalence of hemodialysis, peritoneal dialysis, and transplant were 217.2, 45.3, and 189.7 patients per million population, respectively.

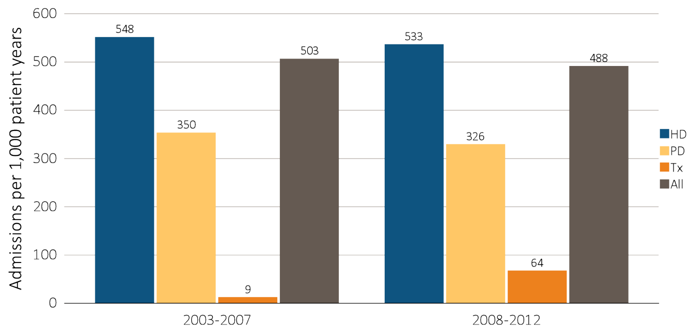
vol 2 **Figure 8.17 Trends in incident rates of ESRD in young adults (aged 22-29 years), by modality, 1996-2013**



Data Source: Special analyses, USRDS ESRD Database. Peritoneal dialysis consists of continuous ambulatory peritoneal dialysis and continuous cycling peritoneal dialysis. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

The overall cardiovascular hospitalization rate per 1,000 patient years during 2008-2012 was 488 admissions per 1,000 patient years, which is lower than the rate during 2003-2007 (Figure 8.18). In evaluating modality, the rate of cardiovascular hospitalizations remains highest in those on hemodialysis at 533 admissions per 1,000 patient years. There was a 2.7% decline in cardiovascular hospitalization rates in hemodialysis and a 6.9% decline in cardiovascular hospitalization rates in peritoneal dialysis patients in the most recent reporting years.

vol 2 Figure 8.18 One-year adjusted cardiovascular hospitalization rates in young adults with incident ESRD (aged 22-29 years), by modality, 2003-2007 and 2008-2012



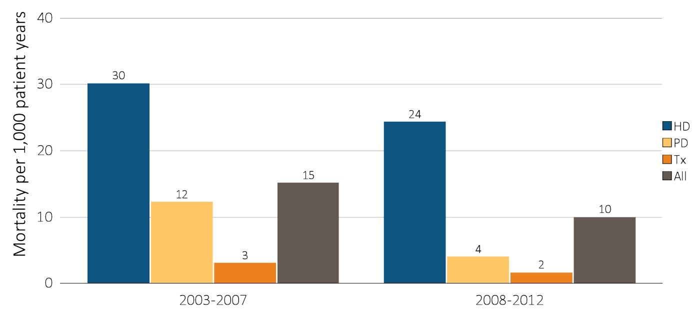
Data Source: Special analyses, USRDS ESRD Database. Includes incident pediatric ESRD patients in the years 2003-2012, surviving the first 90 days after ESRD initiation and followed from day 90. Adjusted for sex, race, primary cause of ESRD, and Hispanic ethnicity. Ref: incident ESRD patients aged 22-29, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Between 2008-2013, the one-year adjusted cardiovascular mortality was 10 per 1,000 patient years, which was a decrease of 33.3% from the 2003-2007 period (Figure 8.19). The adjusted one-year cardiovascular mortality rate decreased across all modalities: hemodialysis by 20%, peritoneal dialysis by 66.7%, and transplant by 33.3%. In this same time period, the one-year adjusted cardiovascular mortality rate for those on hemodialysis was 6 times higher than for those on peritoneal dialysis and 12 times higher than for transplanted patients.

Summary

This pediatric chapter of the USRDS Annual Data Report presents data on over 20 years of ESRD care in children. In the most recent reporting year, there was a 0.5% decrease in the incidence and a 0.7% decrease in the point prevalence of ESRD. Kidney transplantation remains the most common modality for treatment of prevalent ESRD. Pediatric kidney transplant recipients continue to have the best outcomes regarding hospitalization rates and mortality compared with other modalities. There are many opportunities to improve our understanding of the pediatric ESRD experience in future USRDS Annual Data Reports, special analyses and special studies including broad topics surrounding vascular access, acute kidney injury, and pre-ESRD chronic kidney disease.

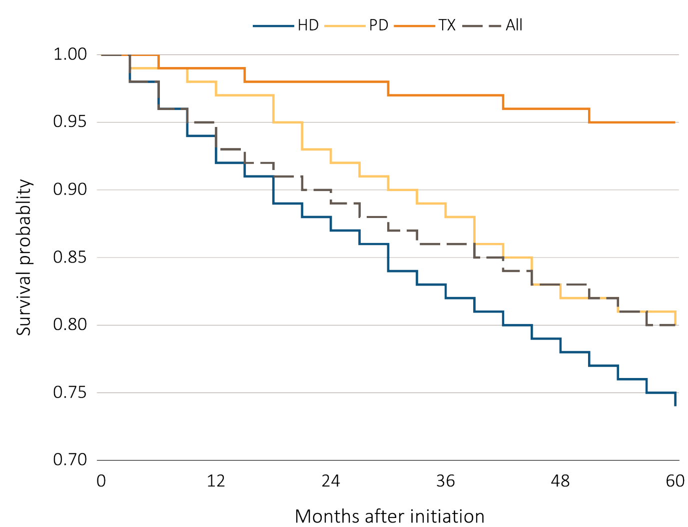
vol 2 Figure 8.19 One-year adjusted cardiovascular mortality rates in young adults with incident ESRD (aged 22-29 years), by modality, 2003-2007 and 2008-2012



Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 22-29, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

For young adults beginning ESRD therapy during the period 2004-2008, the probability of five-year survival was 0.80, which is lower than that of patients aged 0-21 years, which was 0.89 (Figure 8.20). Transplant patients had the highest probability of surviving five years with 0.95, as compared to 0.74 in hemodialysis patients, and 0.80 in peritoneal dialysis patients.

vol 2 Figure 8.20 Adjusted five-year survival probability of young adults with incident ESRD (aged 22-29 years), by modality and months after initiation, 2004–2008



Data Source: Special analyses, USRDS ESRD Database. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2013. Adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Ref: incident ESRD patients aged 22-29, 2010-2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Notes

Chapter 9: Cardiovascular Disease in Patients With ESRD

- Cardiovascular disease is common in ESRD patients, with atherosclerotic heart disease and congestive heart failure being the most common conditions.
- Cardiovascular diseases comprise the leading cause of death in ESRD patients.
- Even the relatively young population of dialysis patients (aged 22-44 and 45-64 years) experiences significant cardiovascular morbidity.
- Sudden death/cardiac arrhythmias account for 37% of all deaths in the Medicare ESRD population.
- Congestive heart failure (CHF) is a particularly common condition and its prevalence tends to be higher among ESRD patients who are older, White, male, and have diabetes mellitus.
- The presence of cardiovascular diseases worsens both short and long-term survival in ESRD patients.

Introduction

Cardiovascular disease is a significant comorbidity for patients along the entire spectrum of chronic kidney disease and end-stage renal disease (ESRD). ESRD patients are among the highest risk populations for a number of cardiovascular diseases. Presence of ESRD often complicates disease management and treatment, as it can influence both medical and procedural options, thereby adversely affecting a patient's prognosis. In this chapter, we focus on reporting the prevalence and outcomes of ESRD patients with diagnosed major cardiovascular conditions, stratifying by type of renal replacement therapy being received (hemodialysis, peritoneal dialysis, and kidney transplantation). For individual cardiovascular conditions, we compare the survival of patients with and without the condition. Given its role as the primary health care payer for ESRD patients, our analyses are based mostly on data from the national Medicare population.

Analytical Methods

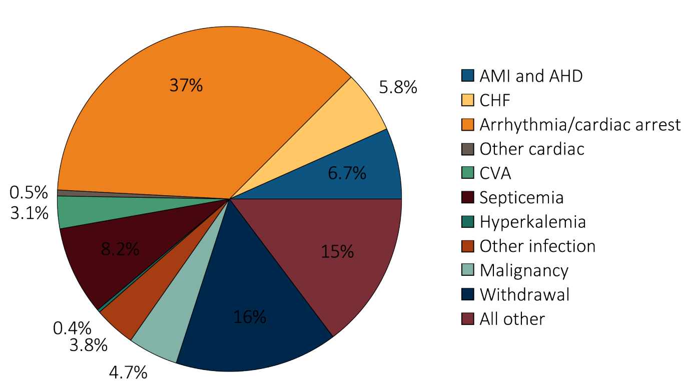
We used a previously validated method for Medicare claims to identify comorbid conditions. This method was developed in diabetic patients, wherein a patient was considered diabetic if, within a one-year observation period, he or she had a qualifying ICD-9-CM diagnosis code of diabetes mellitus (DM) on one or more Part A institutional claims (inpatient, skilled nursing facility, or home health agency), or two or more institutional outpatient claims and/or Part B physician/supplier claims (Herbert et al., 1999). With the same framework, we identified patients with comorbid conditions and procedures using the ICD-9-CM diagnosis codes over a one-year observation period. Specific ICD-9-CM codes used to define each condition are listed in the *ESRD Analytical Methods* chapter in the section on *Chapter 9: Cardiovascular Disease*.

Also, see the *ESRD Analytical Methods* chapter for a detailed explanation of analytical methods used to generate the figures and tables in this chapter.

Cardiovascular Disease Prevalence and Outcomes in ESRD Patients

As shown in Figure 9.1, cardiovascular diseases are a major cause of death in ESRD patients, contributing to more than half of all deaths, among which the category of arrhythmias and cardiac arrest alone is responsible for 37% of the deaths.

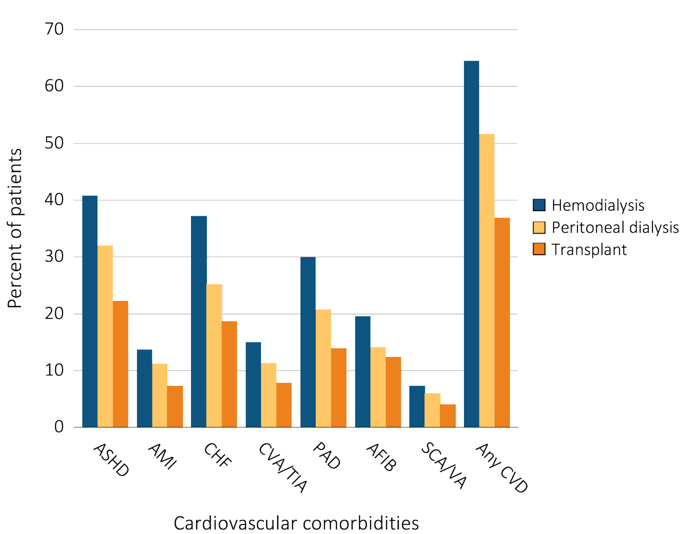
vol 2 Figure 9.1 Causes of death in ESRD patients, 2013



Data Source: Reference Table H12. Abbreviations: AHD, atherosclerotic heart disease; AMI, acute myocardial infarction; CHF, congestive heart failure; CVA, cerebrovascular accident.

ESRD patients have a high burden of cardiovascular disease across a wide range of conditions (Figure 9.2). Stable atherosclerotic heart disease (ASHD) and congestive heart failure (CHF) are the two major leading cardiovascular diseases present in ESRD patients. However, acute myocardial infarction (AMI), cerebrovascular accident/transient ischemic attack (CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AFIB), sudden cardiac arrest and ventricular arrhythmias (SCA/VA) are also common. The prevalence of these cardiovascular diseases is highest among ESRD patients who receive hemodialysis followed by peritoneal dialysis and those with a kidney transplant.

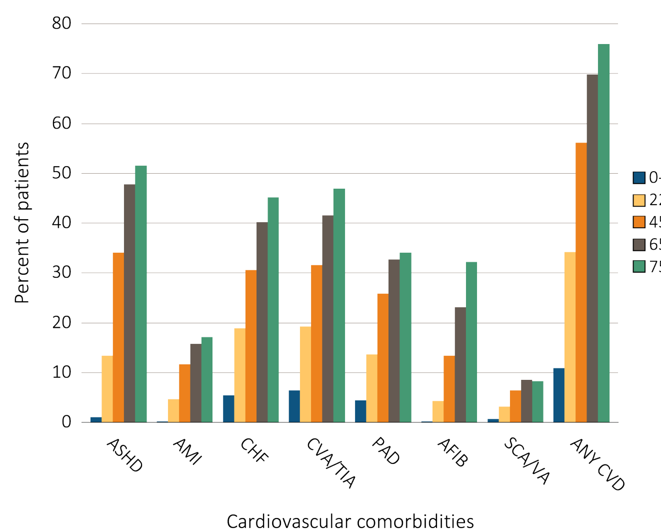
vol 2 Figure 9.2 Prevalence of cardiovascular diseases in ESRD patients, by treatment modality, 2013



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias.

Not surprisingly, older ESRD patients tend to have a higher prevalence of cardiovascular conditions (Figure 9.3). It is notable, however, that the prevalence of these conditions is high even among those 20-44 years of age, although a much higher prevalence is observed among those 45 years or older. ASHD is the most common condition, with its prevalence exceeding 50% in ESRD patients aged 75 years or older, followed by CHF, PAD, AFIB and CVA/TIA.

vol 2 Figure 9.3 Prevalence of cardiovascular diseases in ESRD patients, by age, 2013



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012.Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias.

The relationships between age, race or ethnicity, and sex with the prevalence of cardiovascular diseases in ESRD patients are displayed in Table 9.1. As noted earlier, aging is associated with higher prevalence of cardiovascular conditions. However, the relationships with race or ethnicity and sex are less definitive. The prevalence of major procedures for treating cardiovascular disease in ESRD patients is also reported in Table 9.1, including percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), and the placement of implantable cardioverter defibrillators (ICD).

vol 2 Table 9.1 Prevalence of cardiovascular diseases & procedures in ESRD patients, by treatment modality, age, race, & sex, 2013

	# Patients	% Patients										
		Overall	0-21	22-44	45-64	65-74	75+	White	Blk / Af Am	Other	Male	Female
Cardiovascular Comorbidities[a]												
Atherosclerotic heart disease (ASHD)												
Hemodialysis	147,373	40.8	2.5	15.6	36.8	49.7	52.1	45.1	36.0	38.4	40.9	40.7
Peritoneal dialysis	11,180	32.0	0.9	11.9	31.7	44.0	49.1	35.4	25.7	27.5	36.5	27.5
Transplant	23,465	22.3	0.4	6.1	19.3	36.8	43.2	24.0	19.0	18.3	24.0	19.7
Acute myocardial infarction (AMI)												
Hemodialysis	147,373	13.7	0.0	5.4	12.5	16.5	17.4	15.1	12.1	12.1	13.7	13.6
Peritoneal dialysis	11,180	11.2	0.5	4.1	11.1	15.6	17.2	12.6	9.0	8.1	12.8	9.6
Transplant	23,465	7.3	0.0	2.3	6.8	11.2	13.5	7.9	6.1	6.1	7.8	6.5
Congestive heart failure (CHF)												
Hemodialysis	147,373	37.2	10.7	22.4	33.7	42.2	45.9	37.8	37.1	32.0	35.4	39.4
Peritoneal dialysis	11,180	25.2	6.5	16.0	23.8	32.0	35.5	25.5	25.6	21.3	27.2	23.3
Transplant	23,465	18.7	2.2	6.9	15.5	29.1	39.5	19.1	18.8	13.8	18.9	18.4
Cerebrovascular accident/transient ischemic attack (CVA/TIA)												
Hemodialysis	147,373	15.0	2.8	5.5	12.5	19.0	20.3	15.0	15.4	13.0	13.5	16.9
Peritoneal dialysis	11,180	11.3	1.4	5.5	9.9	16.6	17.4	12.0	10.7	7.6	11.0	11.6
Transplant	23,465	7.8	0.6	2.4	6.2	13.0	17.5	8.2	7.5	5.2	7.6	8.1
Peripheral artery disease (PAD)												
Hemodialysis	147,373	30.0	10.3	16.3	28.5	34.6	34.9	31.2	29.3	23.9	29.9	30.0
Peritoneal dialysis	11,180	20.7	5.6	10.7	20.7	27.7	26.8	22.3	18.4	15.2	22.3	19.0
Transplant	23,465	13.9	0.7	5.0	12.7	21.3	25.0	14.6	13.0	10.2	15.0	12.3
Atrial fibrillation (AFIB)												
Hemodialysis	147,373	19.5	0.7	5.0	14.5	23.3	32.0	23.2	15.3	17.2	19.7	19.2
Peritoneal dialysis	11,180	14.1	0.0	3.8	10.4	21.0	32.1	16.4	9.8	11.2	16.8	11.5
Transplant	23,465	12.4	0.0	1.8	8.3	22.4	34.7	13.9	9.3	9.7	13.6	10.5
Cardiac arrest and ventricular arrhythmias (SCA/VA)												
Hemodialysis	147,373	7.3	0.4	3.8	6.9	8.8	8.1	7.2	7.5	6.0	7.5	6.9
Peritoneal dialysis	11,180	6.0	2.3	3.2	5.7	7.9	8.6	6.1	6.3	3.6	6.7	5.3
Transplant	23,465	4.0	0.2	1.0	3.2	7.0	8.8	4.2	3.8	3.5	4.5	3.4
Cardiovascular Procedures[b]												
Revascularization – percutaneous coronary interventions (PCI)												
Hemodialysis	60,125	5.3	0.0	4.8	6.3	5.4	4.0	5.6	4.7	6.3	5.4	5.2
Peritoneal dialysis	3,578	6.2	0.0	5.4	6.1	7.3	5.3	6.8	5.3	3.1	6.0	6.4
Transplant	5,228	5.2	0.0	5.6	7.0	4.4	2.6	5.4	4.5	5.5	5.4	4.8
Revascularization – coronary artery bypass graft (CABG)												
Hemodialysis	60,125	1.8	0.0	2.2	2.5	1.8	0.7	1.7	1.7	2.4	2.0	1.4
Peritoneal dialysis	3,578	2.6	0.0	2.9	2.8	2.8	2.0	2.7	2.5	2.2	3.4	1.6
Transplant	5,228	2.0	0.0	2.0	2.5	1.7	1.7	2.1	1.5	3.1	2.0	2.0
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)												
Hemodialysis	54,775	0.8	0.0	0.9	0.9	0.9	0.5	0.8	0.7	0.8	1.0	0.4
Peritoneal dialysis	2,818	1.0	0.0	0.3	1.0	1.1	1.2	0.9	1.2	0.6	1.1	0.8
Transplant	4,384	1.0	0.0	0.0	1.3	1.0	0.7	1.1	0.7	0.5	1.3	0.4

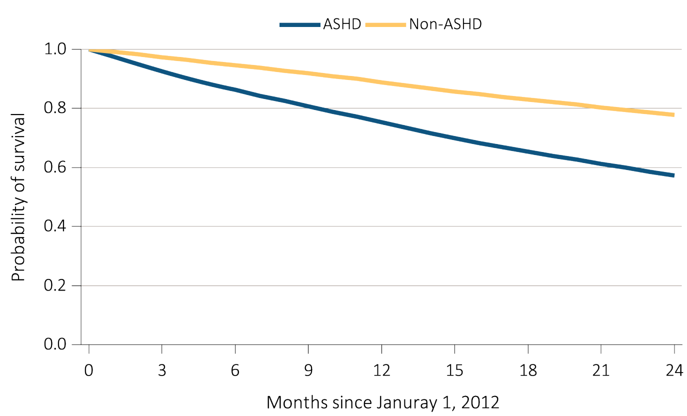
Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; Af Am, African American; Blk, black; CABG, coronary artery bypass grafting; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PAD, peripheral arterial disease; PCI, percutaneous coronary interventions; SCA/VA, sudden cardiac arrest and ventricular arrhythmias. [a]The denominators for all cardiovascular comorbidities are patients described above by modality. [b]The denominators for PCI and CABG are patients with ASHD by modality. The denominator for ICD/CRT-D is patient with CHF by modality.

The presence of cardiovascular diseases worsens short- and long-term prognoses for ESRD patients. Figures 9.4.a through 9.4.j illustrate two-year survival curves in ESRD patients with and without individual cardiovascular diseases.

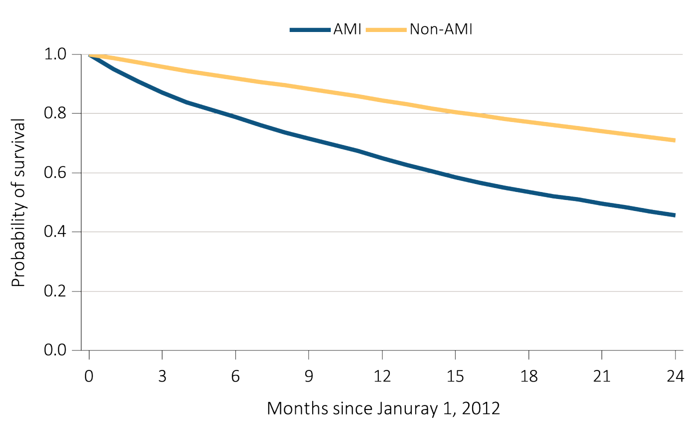
In general, ESRD patients have lower survival when cardiovascular disease conditions are present. A pattern of lower survival is observed in patients who undergo PCI and ICD/CRT-D placement, but survival appears similar between patients who undergo CABG procedures and those who do not. The ESRD patients who undergo these procedures are being compared both with those who have any cardiovascular conditions but do not undergo these procedures and those without any cardiovascular conditions. These descriptive results in the ESRD population may be the consequence of confounding-by-indication, and comparative effectiveness research with appropriate statistical adjustments would be necessary to evaluate whether these procedures improve patient prognoses when they are indicated.

vol 2 Figure 9.4 Probability of survival of ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, 2011-2013

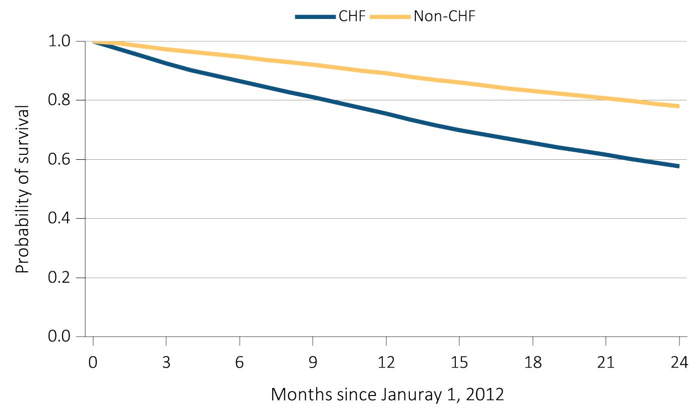
(a) ASHD



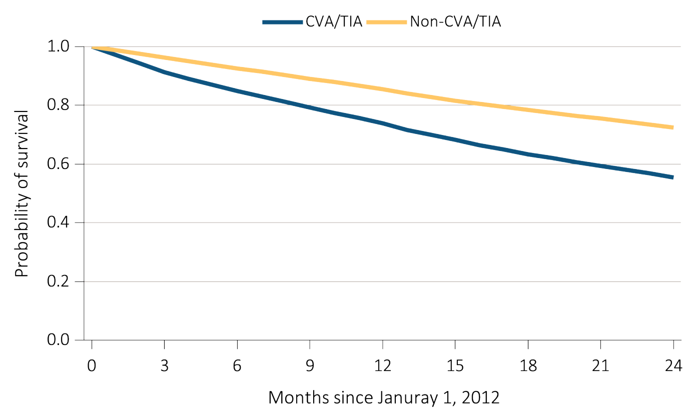
(b) AMI



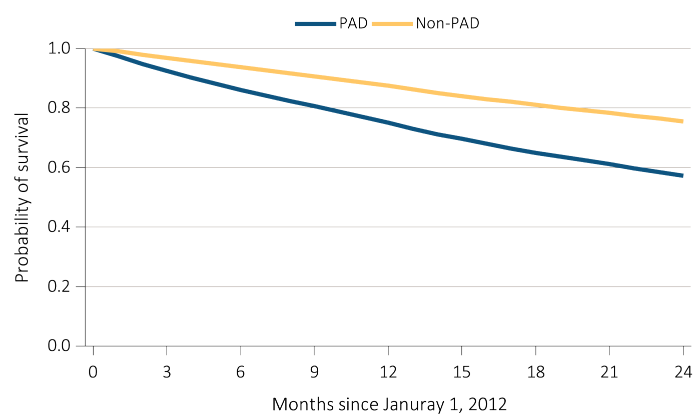
(c) CHF



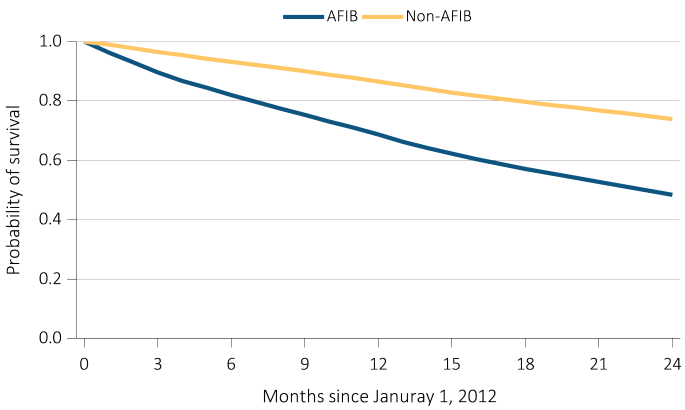
(d) CVA / TIA



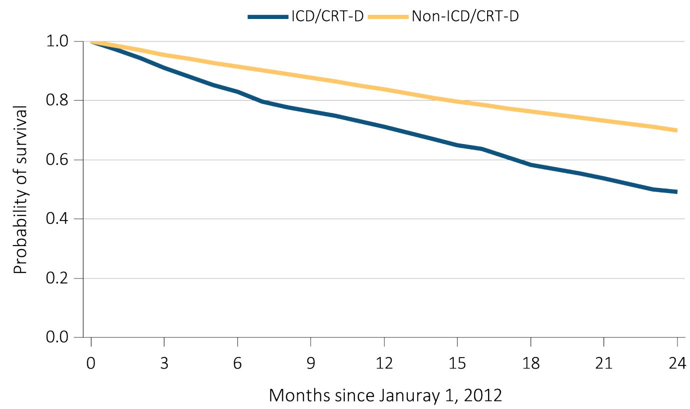
(e) PAD



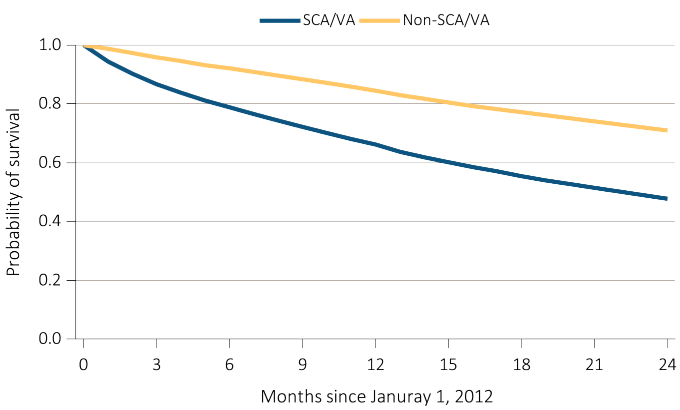
(f) AFIB



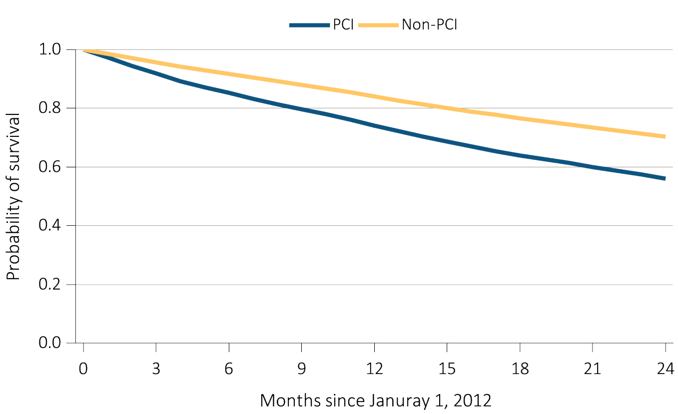
(j) ICD / CRT / D



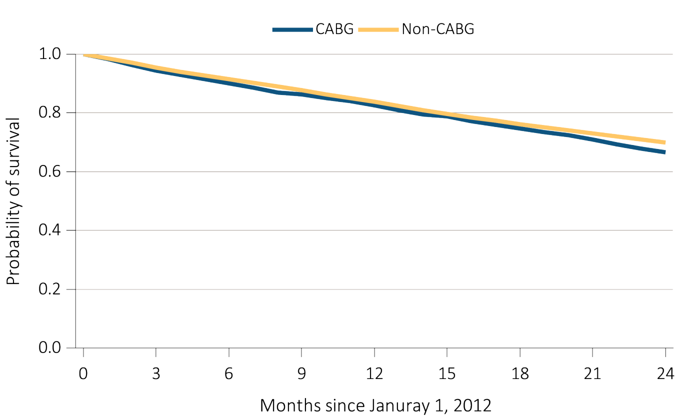
(g) SCA / VA



(h) PCI



(i) CABG



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, and whose first ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2011. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CABG, coronary artery bypass grafting; CHF, congestive heart failure; CVA/TIA, cerebrovascular accident/transient ischemic attack; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PAD, peripheral arterial disease; PCI, percutaneous coronary interventions; SCA/VA, sudden cardiac arrest and ventricular arrhythmias.

Congestive Heart Failure Among ESRD Patients

Congestive heart failure (CHF) is a highly prevalent cardiovascular disease among ESRD patients. Presence of CHF in the ESRD population adds further complexity to the vexing problem of fluid management in these patients, in the absence of renal function and lack of use of objective, validated methods for volume status assessment. Key characteristics of CHF in ESRD patients are further examined in Table 9.2 by stratifying CHF according to systolic dysfunction (i.e., heart failure with decreased ejection fraction), diastolic dysfunction (i.e., heart failure with preserved ejection fraction), or unspecified cardiac dysfunction. For ease of reporting and consistency in studying clinical approaches, systolic CHF includes patients with systolic dysfunction, regardless of the presence of concomitant diastolic dysfunction. Patients with isolated diastolic CHF are analyzed separately since treatments and prognoses are markedly different for this group. We analyze CHF using these categories of systolic dysfunction and diastolic dysfunction identified through ICD-9-CM diagnosis codes. For systolic heart failure, we use 428.2x; for diastolic heart failure, 428.3x; for both systolic and diastolic heart failure, 428.4x; and unspecified heart failure, 398.91, 428.xx (excluding 428.2x–428.4x), 402.x1, 404.x1, and 404.x3). The use of these codes has limitations and the separation of these different categories should be considered cautiously without further clinical data available.

In general, the prevalence of CHF increases with age, and peaks in those patients between the ages of 45 and 64 years old. Among younger age groups, the prevalence of CHF is more common for patients treated with peritoneal dialysis. The prevalence of CHF is higher among men than it is among women, and higher among Whites than other races. Finally, ESRD patients with diabetes mellitus experience an extremely high prevalence of CHF, with over 70% of patients having systolic dysfunction, diastolic dysfunction, or unspecified.

Summary

This chapter provides an overview of cardiovascular diseases primarily among Medicare ESRD patients, using claims data. The relationship between cardiovascular disease and kidney disease is complex and bidirectional, and close attention to cardiovascular comorbidity is vital to the care of these patients. The high prevalence of CHF and sudden death/cardiac arrhythmias should draw more attention of researchers and clinicians alike to improving outcomes in this complex patient population. The conventional paradigm of thrice-weekly hemodialysis, with wide fluctuations in fluid status, electrolytes and blood pressure, with frequent episodes of intradialytic hypotension and resultant 'myocardial stunning', have been highlighted in recent literature. High early-in-the-week mortality observed among patients on thrice weekly hemodialysis is also almost certainly the consequence of what has been referred to as the 'unphysiology' of intermittent hemodialysis, and should remain the concern of patients, providers, researchers, payers, and policy makers alike. Patients with ESRD bring unique challenges that should not detract health care practitioners from delivering the high quality cardiovascular care that they deserve.

References

Herbert PL, Geiss LS, Tierney EF, Engelgau MM, Yawn BP, McBean AM. Identifying persons with diabetes using Medicare claims data. *Am J Med Qual* 1999;14(6):270-277.

vol 2 Table 9.2 Characteristics of patients with heart failure, by treatment modality, 2013

	Systolic +/- Diastolic heart failure				Diastolic only heart failure				Heart failure, unspecified			
	HD		PD		HD		PD		HD		PD	
	N	%	N	%	N	%	N	%	N	%	N	%
Age												
0-21	7	0.0	1	0.1	1	0.0	0	0.0	11	0.0	6	0.5
22-44	887	6.3	100	12.4	774	6.2	63	11.2	1,852	7.5	156	13.2
45-64	5,047	35.7	303	37.5	4,413	35.1	231	41.2	9,295	37.7	474	40.1
65-74	4,034	28.5	241	29.8	3,565	28.4	142	25.3	6,643	26.9	307	26.0
75+	4,170	29.5	164	20.3	3,811	30.3	125	22.3	6,858	27.8	238	20.2
Sex												
Male	8,431	59.6	476	58.8	5,484	43.6	264	47.1	12,573	51.0	611	51.7
Female	5,714	40.4	333	41.2	7,080	56.4	297	52.9	12,086	49.0	570	48.3
Race												
White	7,708	54.5	555	68.6	6,547	52.1	344	61.3	12,720	51.6	755	63.9
Black/African American	5,756	40.7	216	26.7	5,386	42.9	187	33.3	10,683	43.3	344	29.1
Other	681	4.8	38	4.7	631	5.0	30	5.3	1,256	5.1	82	6.9
Diabetes												
No	4,029	28.5	323	39.9	3,505	27.9	203	36.2	7,095	28.8	439	37.2
Yes	10,116	71.5	486	60.1	9,059	72.1	358	63.8	17,564	71.2	742	62.8

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis and peritoneal dialysis patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

Chapter 10: Dialysis Providers

- In 2013, collectively the three large dialysis organizations treated 71% of patients in 67% of all dialysis units. In the Small Dialysis Organizations, the numbers of patients and units declined over the period from 2010 to 2013.
- Nearly 90% of all dialysis patients in 2013 received hemodialysis; hospital-based providers had the highest proportion of peritoneal dialysis patients at 21%, more than double the national average.
- Dialysis providers of all types experienced an overall 5% decline in Standardized Mortality Ratios between 2010 and 2013.
- All provider types also experienced an overall decline in Standardized Hospitalization Ratios between 2010 and 2013, by 6%.
- For this 2015 report, we introduce new tables illustrating one-year Standardized Mortality Ratios and Standardized Hospitalization Ratios, to allow a simpler and more direct comparison of each facility-type's measure with the 2013 national norms. Notably, hospital-based units continue to perform better than the national average on both measures.
- This year we have included sex-, race-, and ethnicity-specific breakdowns of patient outcomes for home-based dialysis modality, hemodialysis vascular access types, and kidney transplant waiting list participation to highlight the complex differences between demographic groups in these areas. For example, although Native American patients were more likely than the average patient to have a fistula as their first access type, they were less likely to be on a kidney transplant waiting list.

Introduction

As in previous years, this chapter focuses on the provider organizations involved in delivering care to dialysis patients. Particularly during the last two decades, there has been continued growth in the for-profit large dialysis organizations (LDOs). Two LDOs in particular, Fresenius Medical Care (Fresenius) and DaVita Healthcare Partners, Inc. (DaVita), now dominate as providers of dialysis services in the United States (U.S.), with nearly two-thirds of facilities; their industry dominance is also growing on an international level. In contrast, there has been little to no growth in the provision of dialysis services by small dialysis organizations (SDOs), not-for-profit organizations such as Dialysis Clinics, Inc. (DCI), or hospital-based dialysis facilities.

As in the 2014 Annual Data Report (ADR), this chapter begins with a description of growth in dialysis facilities by the type of provider organization, followed by updated coverage of three key areas of clinical practice related to care of patients on dialysis. These include (i) choice of dialysis modality, (ii) patterns of vascular access type for both incident and prevalent dialysis patients, and (iii) the proportion of patients younger than age 70 who are wait-listed for kidney transplantation. We conclude the chapter with an analysis of standardized mortality and hospitalization ratios (SMRs and SHRs) by provider type, namely, LDOs, SDOs, and independent and hospital-based providers.

In the 2014 ADR, we introduced a new approach to the methodology used to calculate and present the standardized measures of major dialysis clinical outcomes. This methodology constituted a departure from previous ADRs but was designed to facilitate comparison of the SMR and the SHR across years. We now report these measures with the year adjustment removed from the risk-adjustment model. That is, the measures are no longer standardized to a national norm annually, but instead are compared with the aggregated national population across the entire referenced reporting period (i.e., 4 years). This method facilitates identification of short-term trends in the standardized measures, while retaining the ability to compare these measures across different types of providers within a single year. To emphasize the variation that exists at the level of the individual dialysis facilities, this year the chapter also displays facility-level variation in some key clinical practices, including choice of dialysis modality, vascular access type, and wait-listing for a kidney transplant.

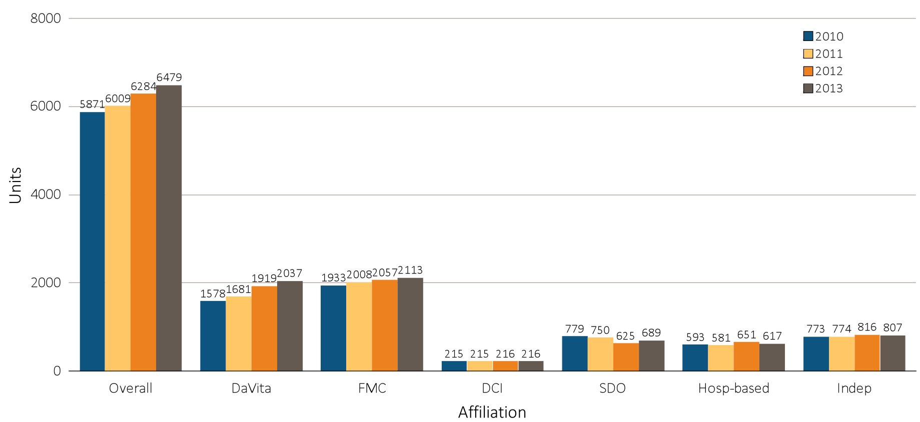
Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of methods used to generate the figures and tables in this chapter.

Provider Growth

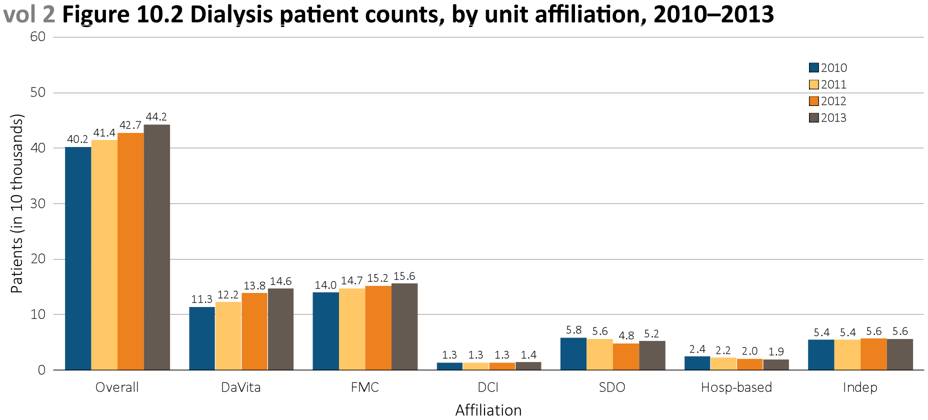
At the end of 2013, there were 6,479 dialysis units (Figure 10.1) and 442,218 dialysis patients (Figure 10.2) in the U.S. Together the three LDOs (DaVita, Fresenius, and DCI) treated 315,594 of these patients (71%) in 4,366 dialysis units (67%). SDOs treated 51,937 patients (12%) in 689 units (11%), and independent and hospital-based providers treated 55,637 (13%) and 19,050 (4%) patients, respectively, in 807 (12%) and 617 (10%) units. Nationwide, 608 dialysis units were added during the four-year period from 2010 to 2013, with most belonging to the LDOs; DaVita experienced the largest growth in both facilities and patients. In the SDOs, the numbers of patients and units declined over the same period.

vol 2 Figure 10.1 Dialysis unit counts, by unit affiliation, 2010–2013



Data source: Special analyses, USRDS ESRD Database. Abbreviations: DCI, Dialysis Clinic, Inc.; FMC, Fresenius; Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; SDO, small dialysis organizations.

vol 2 Figure 10.2 Dialysis patient counts, by unit affiliation, 2010–2013



Data source: Special analyses, USRDS ESRD Database. Abbreviations: DCI, Dialysis Clinic, Inc.; FMC, Fresenius; Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; SDO, small dialysis organizations.

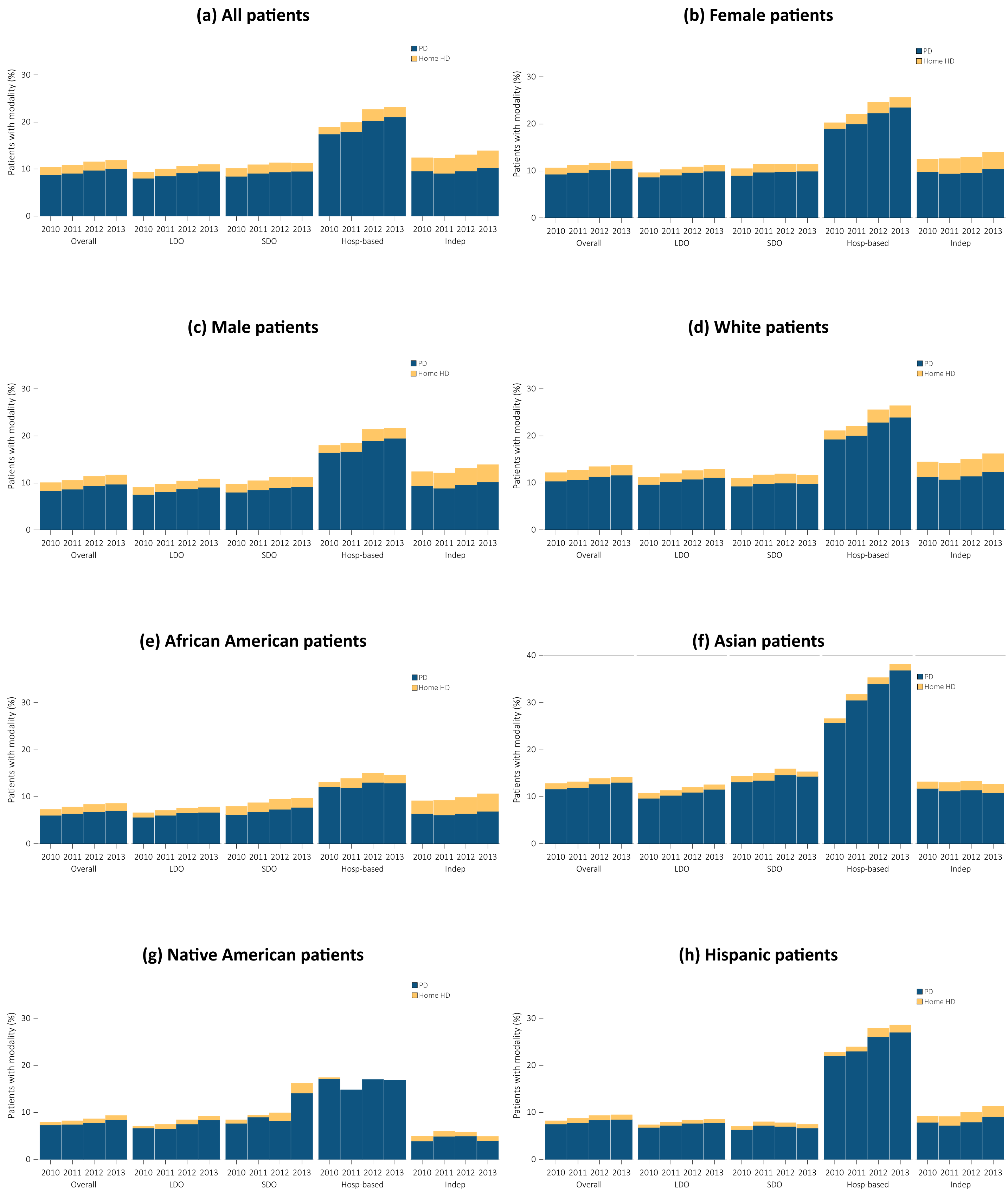
Key Dialysis Clinical Practices

Choice of Dialysis Modality

In 2013, nearly 90% of all dialysis patients received hemodialysis (HD) (Figures 10.3 a–h). This proportion was relatively consistent across provider types. However, hospital-based providers had the lowest proportion of patients on HD at 77% and the highest proportion of peritoneal dialysis (PD) patients at 21%, more than double the national average. Nationwide, the prevalence of PD increased from 9% in 2010 to 10% in 2013. (For additional information on trends in the modality of dialysis see Vol. 2, Chapter 1, Incidence, Prevalence, Patient Characteristics, and Modalities.) The largest increase in uptake of PD appeared to be among patients of Asian descent, particularly at hospital-based facilities. This trend may in part be due to lower rates of obesity or greater acceptance of PD by this patient subgroup, and requires further investigation.

Home dialysis therapies have been associated with greater patient independence and improved quality of life. Younger, more educated patients and those with fewer comorbid conditions and greater access to care tend to adopt these treatments more frequently, making comparisons of survival between in-center and home dialysis fraught with a high degree of confounding. Home hemodialysis remains uncommon in all racial and ethnic groups and types of facilities, representing fewer than 2% of all ESRD patients in 2013.

vol 2 Figure 10.3 Prevalence of dialysis modality, by unit affiliation, 2010–2013

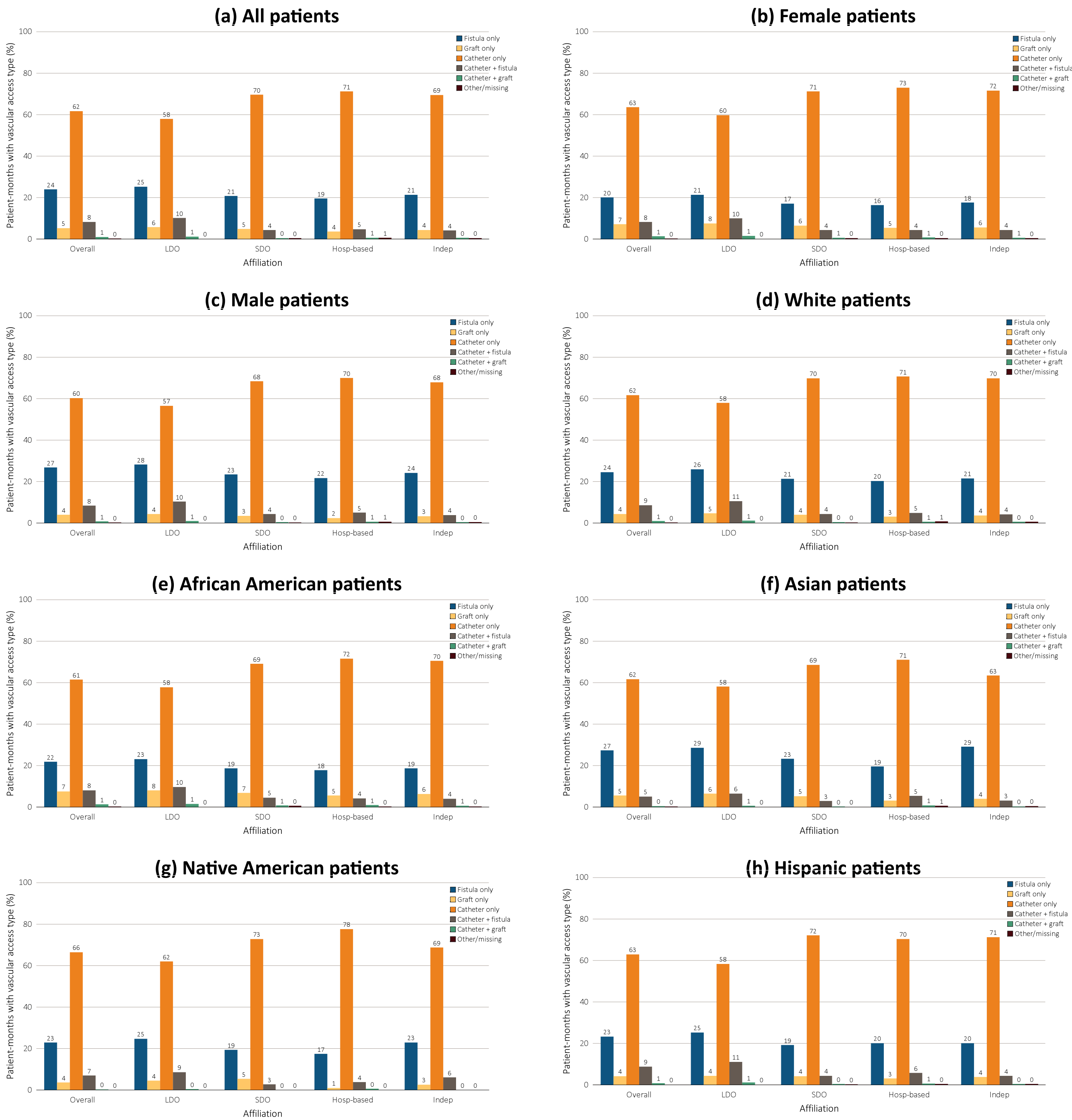


Data source: Special analyses, USRDS ESRD Database. Abbreviations: HD, hemodialysis; Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; LDO, large dialysis organizations; PD, peritoneal dialysis; SDO, small dialysis organizations.

Type of Vascular Access

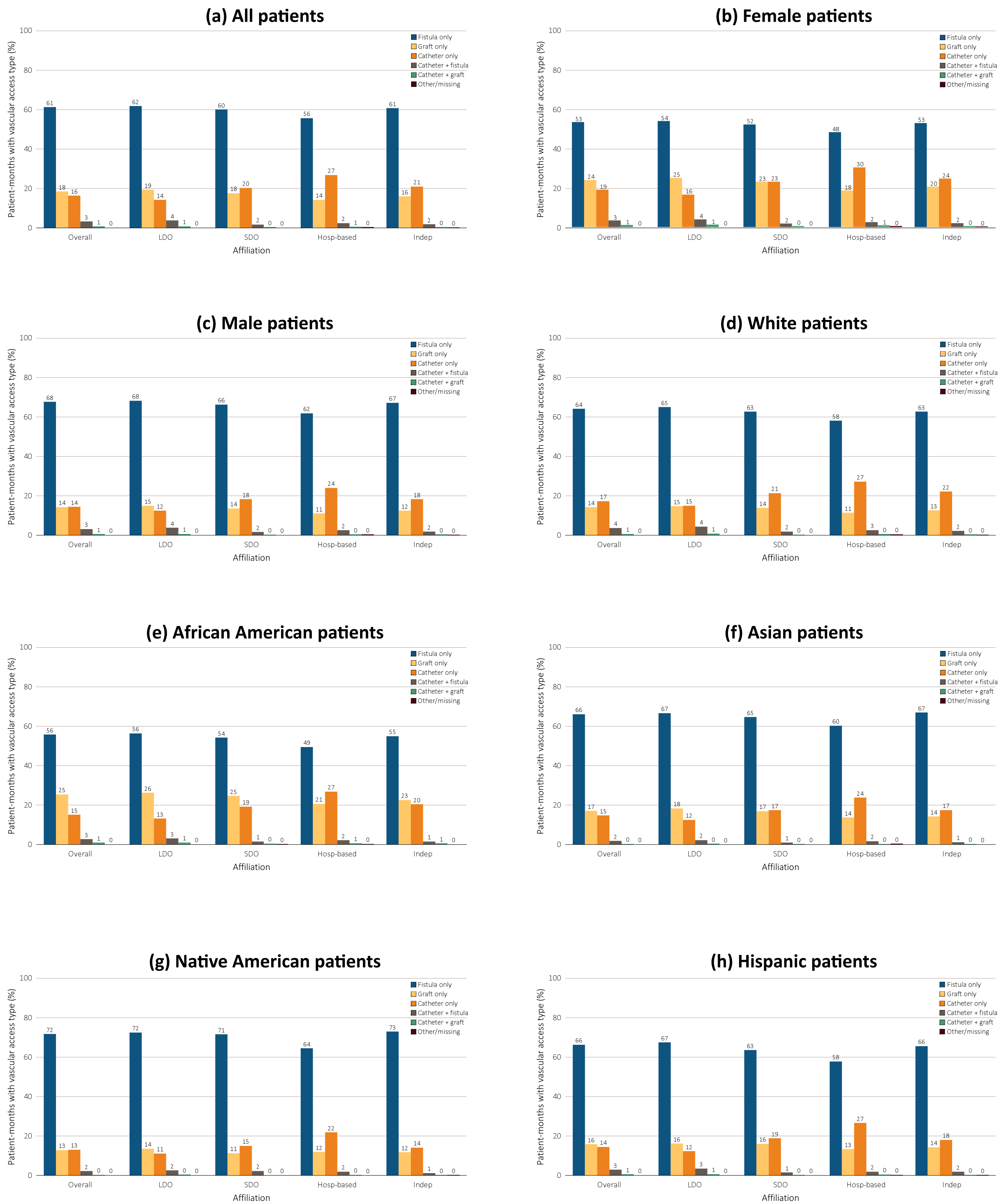
In 2013, 61% of prevalent HD patients in the U.S. received their treatment via an arteriovenous (AV) fistula and 16% via an indwelling catheter (Figures 10.5 a-h). Fistula use was highest among LDOs at 62%; catheter use was highest at 27% among hospital-based providers. During their first 30 days of ESRD, most incident patients (70%) received dialysis via a catheter; LDOs had the highest proportion of incident patients with a fistula alone (25%), compared with the 24% national average (Figure 10.4 a). The distribution of vascular access types (by provider) for both incident and prevalent patients are presented by sex, race, and ethnicity in Figures 10.4 a–h and 10.5 a-h, respectively.

vol 2 Figure 10.4 Prevalence of vascular access types among incident hemodialysis patients, by unit affiliation, 2013



Data source: Special analyses, USRDS ESRD Database. Abbreviations: Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; LDO, large dialysis organizations; SDO, small dialysis organizations.

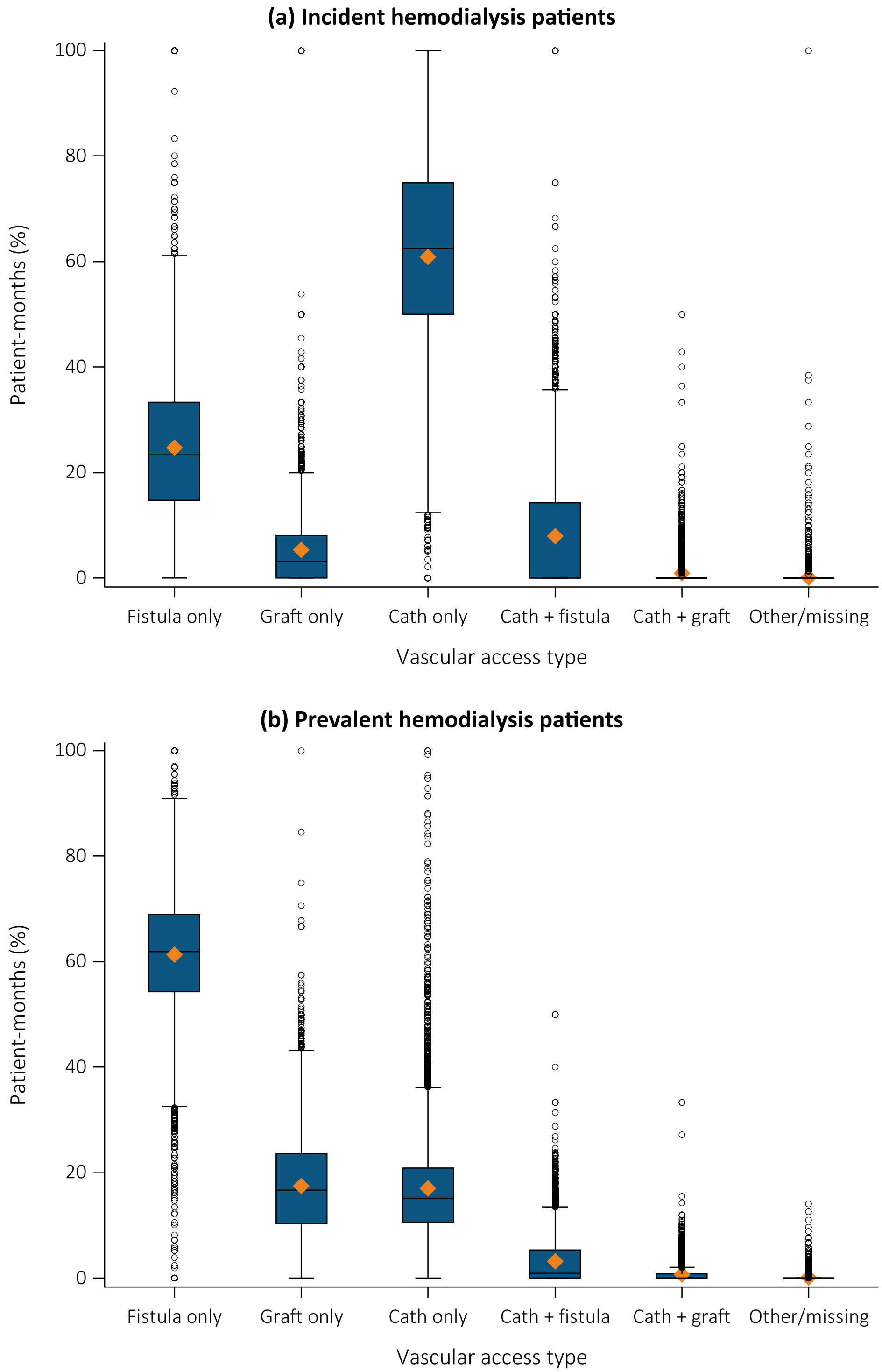
vol 2 **Figure 10.5 Prevalence of vascular access types among prevalent hemodialysis patients, by unit affiliation, 2013**



Data source: Special analyses, USRDS ESRD Database. Period prevalent hemodialysis patients. Abbreviations: Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; LDO, large dialysis organizations; SDO, small dialysis organizations.

In 2013, although catheter alone was the most common vascular access type among patients in their first 30 days of dialysis (Figure 10.6 a), considerable variation was observed with respect to the long-term distribution of the types in use at dialysis facilities. More than three-quarters of facilities successfully achieved the use of an AV fistula in the majority of their prevalent patients (Figure 10.6 b). More than 15% of facilities achieved at least 70% fistula prevalence, with the top 5% in the nation achieving AV fistula use in more than 90% of their patients. Conversely, 5% of facilities had 30% or fewer of their prevalent patients using a fistula.

vol 2 **Figure 10.6 Facility-level distribution of vascular access type among HD patients during the first 30 days of dialysis, 2013**



Data source: Special analyses, USRDS ESRD Database. The orange diamonds represent the average facility-level rate of each type of vascular access. The bars within each box represent the median. The boxes represent the interquartile range. The vertical lines are capped at the 5th and 95th percentile of these facility-level rates. Abbreviations: Cath, catheter.

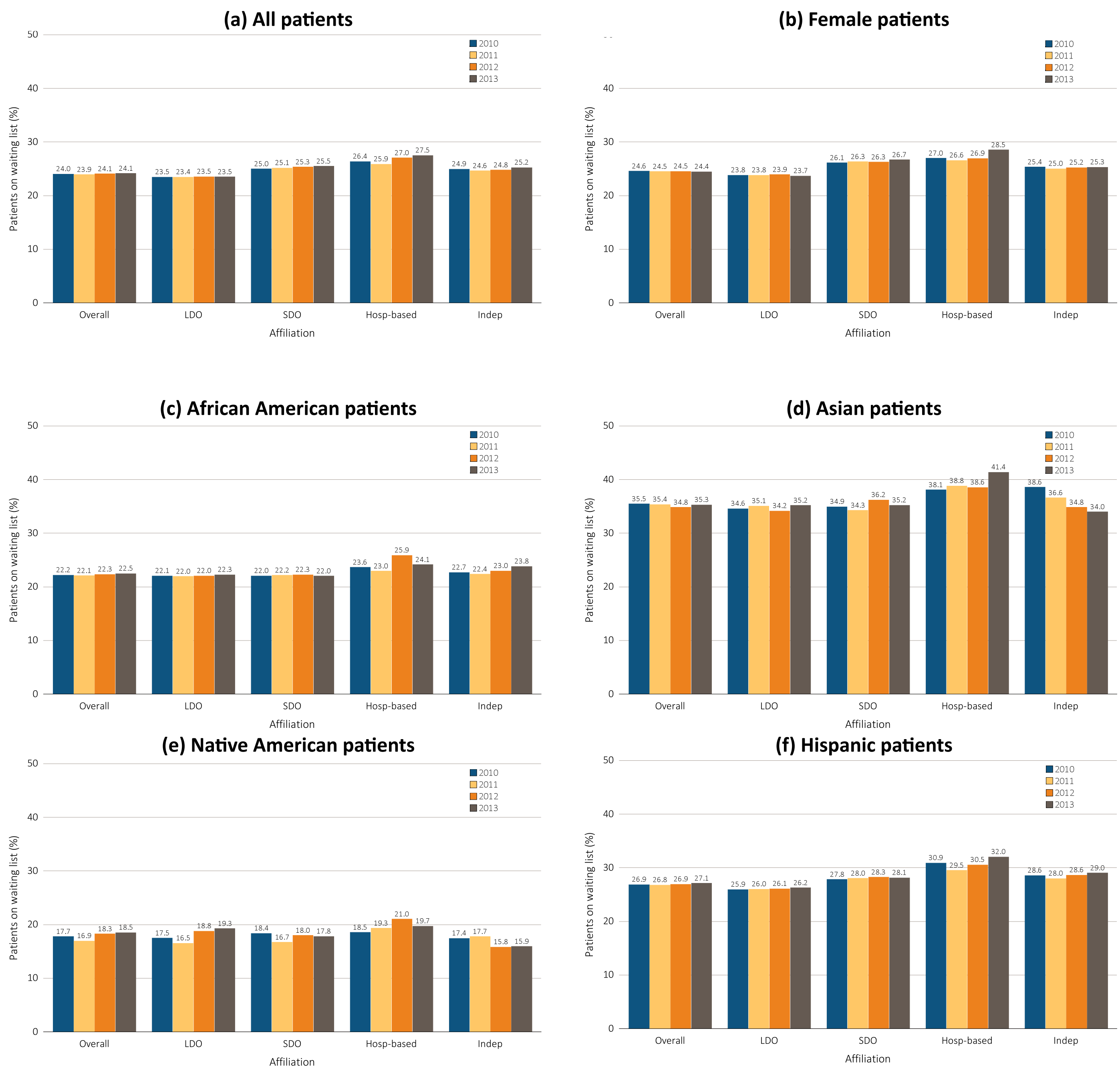
Wait-listing for Kidney Transplantation

Kidney transplantation is the modality of choice for most individuals with ESRD and is associated with the highest quality of life and survival. Nationally, the percentage of patients on a kidney transplant waiting list remained fairly consistent between 2010 and 2013, with 24% of patients younger than age 70 on a waiting list (Figure 10.7 a). This measure is limited to patients younger than age 70, to be comparable to the Healthy People 2020 goals (see Vol. 2, Chapter 2).

Hospital-based dialysis providers had the highest rates of wait-listed patients in 2013, at 27%.

The overall percentages of patients on a kidney transplant waiting list in 2013 varied substantially by race and ethnicity, ranging from 19% among Native American patients to 35% among Asian patients. Within each racial and ethnic group, hospital-based facilities again had the highest percentages of patients on a transplant waiting list.

vol 2 Figure 10.7 Percentage of patients younger than 70 on a kidney transplant waiting list, by unit affiliation, 2010–2013



Data source: Special analyses, USRDS ESRD Database. Dialysis patients younger than 70 years on December 31. Abbreviations: Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; LDO, large dialysis organizations; SDO, small dialysis organizations.

Standardized Measures of Clinical Outcomes

Standardized measures of the major clinical outcomes of dialysis treatment include assessments of mortality (SMR) and hospitalization (SHR). These measures were designed to reflect the number of observed events (i.e., deaths and hospitalizations) for patients of a provider or organization, relative to the number of events that would be expected to occur. Expected values were based on both the national rates during the reporting period and the characteristics of patients treated by a specific provider or organization. Specifically, the SMR and SHR are calculated as the ratio of two numbers: the numerator ("observed") is the actual number of events for the patients of a provider or organization over the specified period, and the denominator ("expected") is the number of events that would have been expected to occur for the same patients if they were with a provider or organization conforming to the national norm during the same reporting period (e.g., 2010–2013).

Standardized Mortality Ratios

All provider types experienced declines in SMRs (Table 10.1) between 2010 and 2013. Among the LDOs, DaVita experienced the greatest decline in SMR, from 1.05 in 2010 to 0.99 in 2013. DCI had the lowest SMR in 2013 at 0.92, compared with 0.99 and 0.98, respectively, for DaVita and Fresenius. In 2013, SDOs and independent providers had the highest SMRs at 1.00.

Between 2010 and 2013, White patients experienced lesser decreases in SMR compared with the overall population (Table 10.1). For White patients, SMR fell 3% overall in the 4-year period, compared with 5% for all patients.

Compared with the overall dialysis population, the decrease in SMR between 2010 and 2013 was of greater magnitude in the Black, Asian, and Hispanic cohorts (Table 10.1). Among Black patients, overall SMR decreased significantly by 9%; this outcome decreased significantly among all provider types, with hospital-based providers experiencing the greatest decrease at 14%. Among both Asian and Hispanic patients, overall SMR decreased significantly by 10% and 9%, respectively. SMRs for these groups decreased significantly among all provider types, except DCI, which experienced non-significant increases among Asian (17%) and Hispanic (6%) patients.

Native American patients experienced an average decrease in SMR of 5%, similar in magnitude to the overall population (Table 10.1). SMRs for Native American patients treated in SDO's increased substantially from 0.74 to 1.06, and to a lesser degree in units owned by DCI (from 0.67 to 0.77) and hospital-based units (from 0.75 to 0.79). Native American patients treated by all other provider types experienced decreases in SMR.

vol 2 **Table 10.1 All-cause standardized mortality ratio, by unit affiliation, 2010–2013**

	Affiliation		2010	2011	2012	2013
All patients	**Overall**		1.03 (1.02-1.04)	1.01 (1.00-1.02)	0.99 (0.98-0.99)	0.98 (0.97-0.98)
	LDO	DaVita	1.05 (1.04-1.06)	1.03 (1.02-1.04)	0.99 (0.98-1.00)	0.99 (0.98-1.00)
		Fresenius	1.04 (1.03-1.05)	1.03 (1.01-1.04)	1.00 (0.99-1.01)	0.98 (0.97-0.99)
		DCI	0.95 (0.92-0.99)	0.93 (0.90-0.96)	0.95 (0.92-0.99)	0.92 (0.88-0.95)
	SDO		1.03 (1.01-1.04)	1.03 (1.02-1.05)	1.01 (0.99-1.03)	1.00 (0.98-1.02)
	Hospital-based		0.98 (0.95-1.00)	0.93 (0.91-0.96)	0.95 (0.92-0.98)	0.95 (0.92-0.98)
	Independent		1.05 (1.03-1.06)	1.03 (1.01-1.05)	1.02 (1.00-1.04)	1.00 (0.98-1.01)
White patients	**Overall**		1.15 (1.14-1.16)	1.13 (1.12-1.14)	1.11 (1.11-1.12)	1.11 (1.10-1.12)
	LDO	DaVita	1.18 (1.16-1.19)	1.16 (1.14-1.18)	1.12 (1.10-1.13)	1.13 (1.11-1.14)
		Fresenius	1.16 (1.14-1.18)	1.16 (1.14-1.17)	1.13 (1.12-1.15)	1.11 (1.10-1.13)
		DCI	1.11 (1.06-1.15)	1.09 (1.05-1.14)	1.12 (1.08-1.17)	1.07 (1.02-1.12)
	SDO		1.15 (1.12-1.17)	1.14 (1.12-1.16)	1.11 (1.09-1.14)	1.12 (1.10-1.15)
	Hospital-based		1.09 (1.05-1.12)	1.04 (1.00-1.07)	1.06 (1.02-1.09)	1.11 (1.07-1.15)
	Independent		1.15 (1.13-1.18)	1.14 (1.12-1.16)	1.15 (1.12-1.17)	1.14 (1.11-1.16)
Black/African American patients	**Overall**		0.89 (0.88-0.90)	0.85 (0.84-0.86)	0.83 (0.82-0.84)	0.81 (0.80-0.82)
	LDO	DaVita	0.90 (0.88-0.92)	0.85 (0.83-0.87)	0.81 (0.79-0.83)	0.83 (0.81-0.84)
		Fresenius	0.88 (0.86-0.90)	0.85 (0.83-0.87)	0.82 (0.80-0.83)	0.81 (0.79-0.82)
		DCI	0.80 (0.75-0.85)	0.76 (0.71-0.81)	0.75 (0.71-0.80)	0.74 (0.70-0.79)
	SDO		0.88 (0.85-0.91)	0.89 (0.86-0.92)	0.87 (0.84-0.90)	0.81 (0.79-0.84)
	Hospital-based		0.88 (0.84-0.93)	0.80 (0.75-0.85)	0.89 (0.84-0.95)	0.76 (0.71-0.82)
	Independent		0.91 (0.88-0.94)	0.89 (0.86-0.92)	0.85 (0.83-0.88)	0.80 (0.78-0.83)
Asian patients	**Overall**		0.71 (0.69-0.74)	0.71 (0.69-0.73)	0.68 (0.66-0.70)	0.64 (0.62-0.66)
	LDO	DaVita	0.73 (0.69-0.78)	0.77 (0.73-0.82)	0.73 (0.69-0.78)	0.64 (0.61-0.68)
		Fresenius	0.74 (0.70-0.78)	0.71 (0.68-0.75)	0.70 (0.66-0.74)	0.70 (0.66-0.74)
		DCI	0.58 (0.42-0.78)	0.55 (0.40-0.73)	0.78 (0.61-1.00)	0.68 (0.52-0.88)
	SDO		0.77 (0.71-0.83)	0.84 (0.78-0.91)	0.69 (0.63-0.75)	0.71 (0.66-0.77)
	Hospital-based		0.74 (0.64-0.84)	0.78 (0.68-0.90)	0.55 (0.46-0.66)	0.62 (0.53-0.73)
	Independent		0.79 (0.72-0.85)	0.73 (0.67-0.79)	0.76 (0.71-0.82)	0.70 (0.65-0.75)
Native American patients	**Overall**		0.85 (0.80-0.90)	0.83 (0.78-0.88)	0.83 (0.78-0.88)	0.81 (0.76-0.86)
	LDO	DaVita	0.76 (0.67-0.86)	0.84 (0.74-0.94)	0.75 (0.67-0.84)	0.72 (0.64-0.80)
		Fresenius	0.99 (0.88-1.11)	0.92 (0.81-1.03)	1.01 (0.90-1.13)	0.88 (0.78-0.99)
		DCI	0.67 (0.50-0.88)	0.75 (0.57-0.98)	0.71 (0.54-0.92)	0.77 (0.58-0.99)
	SDO		0.74 (0.64-0.85)	0.65 (0.56-0.76)	1.20 (0.98-1.46)	1.06 (0.84-1.31)
	Hospital-based		0.75 (0.60-0.92)	0.80 (0.64-0.98)	0.78 (0.63-0.96)	0.79 (0.63-0.97)
	Independent		1.09 (0.95-1.25)	0.98 (0.84-1.13)	0.71 (0.62-0.82)	0.80 (0.70-0.90)
Hispanic patients	**Overall**		0.81 (0.79-0.82)	0.80 (0.79-0.82)	0.77 (0.75-0.78)	0.74 (0.72-0.75)
	LDO	DaVita	0.76 (0.73-0.79)	0.77 (0.75-0.80)	0.75 (0.72-0.77)	0.74 (0.72-0.76)
		Fresenius	0.85 (0.83-0.88)	0.84 (0.81-0.86)	0.79 (0.76-0.81)	0.74 (0.71-0.76)
		DCI	0.77 (0.65-0.91)	0.67 (0.57-0.80)	0.82 (0.70-0.96)	0.81 (0.69-0.95)
	SDO		0.85 (0.81-0.88)	0.85 (0.81-0.88)	0.82 (0.78-0.86)	0.79 (0.75-0.82)
	Hospital-based		0.83 (0.75-0.90)	0.80 (0.72-0.88)	0.76 (0.69-0.85)	0.68 (0.61-0.76)
	Independent		0.83 (0.79-0.87)	0.82 (0.79-0.86)	0.79 (0.76-0.83)	0.80 (0.76-0.83)

Data source: Special analyses, USRDS ESRD Database. Period prevalent dialysis patients; 95% confidence intervals are shown in parentheses. The overall measure is adjusted for patient age, race, ethnicity, sex, diabetes, duration of ESRD, nursing home status, patient comorbidities at incidence, body mass index (BMI) at incidence, and population death rates. The race-specific measures are adjusted for all the above characteristics except patient race. The Hispanic-specific measure is adjusted for all the above characteristics except patient ethnicity. Abbreviations: DCI, Dialysis Clinic, Inc.; LDO, large dialysis organizations; SDO, small dialysis organizations.

Table 10.1 presents data with which to compare a dialysis unit's performance on the SMR across multiple years. Table 10.2 provides an alternate perspective for 2013 only. This example is designed to provide a simpler and more direct comparison of a given provider type to other providers and to the national value in a single year.

vol 2 **Table 10.2 All-cause standardized mortality ratio, by unit affiliation, 2013**

Affiliation	All	White	Black/African American	Asian	Native American	Hispanic
Overall	1.00 (0.99-1.01)	1.13 (1.13-1.14)	0.83 (0.83-0.84)	0.66 (0.64-0.68)	0.83 (0.78-0.88)	0.76 (0.75-0.77)
LDO						
DaVita	1.02 (1.01-1.03)	1.15 (1.14-1.17)	0.85 (0.83-0.87)	0.66 (0.63-0.70)	0.74 (0.66-0.82)	0.76 (0.74-0.79)
Fresenius	1.00 (0.99-1.02)	1.14 (1.12-1.15)	0.83 (0.81-0.85)	0.72 (0.68-0.77)	0.90 (0.80-1.02)	0.76 (0.73-0.78)
DCI	0.94 (0.90-0.97)	1.09 (1.04-1.14)	0.76 (0.72-0.81)	0.71 (0.54-0.91)	0.78 (0.60-1.01)	0.84 (0.71-0.98)
SDO	1.02 (1.01-1.04)	1.15 (1.13-1.18)	0.84 (0.81-0.87)	0.73 (0.68-0.79)	1.08 (0.86-1.35)	0.81 (0.77-0.85)
Hospital-based	0.98 (0.95-1.01)	1.14 (1.10-1.18)	0.79 (0.74-0.84)	0.64 (0.54-0.76)	0.80 (0.64-0.99)	0.71 (0.63-0.79)
Independent	1.02 (1.01-1.04)	1.17 (1.14-1.19)	0.83 (0.80-0.86)	0.72 (0.67-0.77)	0.81 (0.71-0.92)	0.82 (0.79-0.86)

Data source: Special analyses, USRDS ESRD Database. Period prevalent dialysis patients; 95% confidence intervals are shown in parentheses. The overall measure is adjusted for patient age, race, ethnicity, sex, diabetes, duration of ESRD, nursing home status, patient comorbidities at incidence, body mass index (BMI) at incidence, and population death rates. The race-specific measures are adjusted for all the above characteristics except patient race. The Hispanic-specific measure is adjusted for all the above characteristics except patient ethnicity. Abbreviations: DCI, Dialysis Clinic, Inc.; LDO, large dialysis organizations; SDO, small dialysis organizations.

Standardized Hospitalization Ratios

All types of providers experienced significant declines in SHRs between 2010 and 2013 (Table 10.3). Of the three LDOs, DCI exhibited the lowest SHR, at 0.87, compared with 0.97 and 0.95 for DaVita and Fresenius, respectively. In 2013 only, units owned by DaVita had the highest SHRs at 0.97 (Table 10.4).

Between 2010 and 2013, White patients experienced decreases in SHR of similar magnitude as those in the overall population (Table 10.3). For these patients, SHR fell by 5%, as compared with 6% for all patients.

The decreases in SHR between 2010 and 2013 were of greater magnitude in the Black, Asian, Hispanic, and Native American populations (Table 10.3) as compared with the overall dialysis population. Reductions in SHR among these three groups were significant, declining by 8% among Black patients, 6% among Asian patients, 9% among Hispanic patients, and 8% among Native American patients.

All provider types experienced significant decreases in SHR among Black patients, with SDOs showing the greatest reduction at 11%. The SHR for Asian patients increased significantly in Fresenius facilities by 4%, but Asian patients treated by all other provider types experienced an SHR reduction. SHRs for Hispanic patients decreased significantly across all provider types, with hospital-based units and SDOs experiencing the greatest reductions at 12%. The SHR for Native American patients increased significantly by 10% in SDOs; Native American patients treated by all other provider types experienced decreases in SHR.

vol 2 **Table 10.3 All-cause standardized hospitalization ratio, by unit affiliation, 2010–2013**

	Affiliation		2010	2011	2012	2013
All patients	**Overall**		1.03 (1.03-1.03)	1.02 (1.02-1.02)	0.99 (0.99-0.99)	0.97 (0.96-0.97)
	LDO	DaVita	1.04 (1.03-1.04)	1.02 (1.02-1.02)	0.99 (0.99-0.99)	0.97 (0.97-0.97)
		Fresenius	1.02 (1.02-1.03)	1.01 (1.01-1.02)	0.98 (0.98-0.98)	0.95 (0.95-0.96)
		DCI	0.92 (0.91-0.93)	0.92 (0.91-0.93)	0.90 (0.89-0.91)	0.87 (0.86-0.88)
	SDO		1.03 (1.02-1.03)	1.03 (1.03-1.04)	1.00 (0.99-1.00)	0.95 (0.95-0.96)
	Hospital-based		0.97 (0.96-0.98)	0.94 (0.93-0.95)	0.95 (0.94-0.96)	0.91 (0.90-0.92)
	Independent		1.01 (1.00-1.02)	1.01 (1.00-1.01)	0.99 (0.98-0.99)	0.95 (0.94-0.95)
White patients	**Overall**		1.04 (1.04-1.05)	1.04 (1.03-1.04)	1.02 (1.01-1.02)	0.99 (0.99-0.99)
	LDO	DaVita	1.05 (1.05-1.06)	1.04 (1.04-1.05)	1.02 (1.01-1.02)	1.00 (0.99-1.00)
		Fresenius	1.06 (1.06-1.07)	1.05 (1.05-1.06)	1.02 (1.01-1.02)	0.99 (0.99-1.00)
		DCI	0.98 (0.96-1.00)	0.98 (0.96-1.00)	0.97 (0.96-0.99)	0.92 (0.90-0.94)
	SDO		1.02 (1.01-1.03)	1.03 (1.02-1.03)	0.99 (0.98-1.00)	0.96 (0.95-0.97)
	Hospital-based		0.95 (0.94-0.96)	0.92 (0.90-0.93)	0.93 (0.92-0.94)	0.91 (0.89-0.92)
	Independent		1.01 (1.01-1.02)	1.01 (1.00-1.02)	1.01 (1.00-1.01)	0.96 (0.96-0.97)
Black/African American patients	**Overall**		1.04 (1.04-1.04)	1.02 (1.02-1.03)	0.99 (0.99-0.99)	0.96 (0.96-0.96)
	LDO	DaVita	1.05 (1.04-1.06)	1.02 (1.01-1.02)	0.99 (0.98-1.00)	0.97 (0.96-0.98)
		Fresenius	1.01 (1.00-1.01)	0.99 (0.98-0.99)	0.95 (0.95-0.96)	0.92 (0.92-0.93)
		DCI	0.88 (0.87-0.90)	0.87 (0.85-0.89)	0.86 (0.84-0.88)	0.85 (0.83-0.86)
	SDO		1.10 (1.09-1.11)	1.11 (1.10-1.12)	1.04 (1.03-1.05)	0.99 (0.98-1.00)
	Hospital-based		1.04 (1.02-1.06)	1.05 (1.03-1.07)	1.04 (1.02-1.06)	0.97 (0.95-0.99)
	Independent		1.04 (1.03-1.05)	1.04 (1.03-1.05)	1.01 (1.00-1.02)	0.96 (0.95-0.97)
Asian patients	**Overall**		0.78 (0.77-0.79)	0.79 (0.78-0.80)	0.75 (0.74-0.76)	0.73 (0.72-0.74)
	LDO	DaVita	0.78 (0.76-0.80)	0.78 (0.76-0.80)	0.71 (0.70-0.73)	0.71 (0.69-0.72)
		Fresenius	0.74 (0.72-0.75)	0.78 (0.77-0.80)	0.79 (0.77-0.81)	0.76 (0.75-0.78)
		DCI	0.67 (0.61-0.74)	0.82 (0.75-0.89)	0.74 (0.67-0.81)	0.63 (0.57-0.69)
	SDO		0.76 (0.74-0.79)	0.79 (0.77-0.81)	0.69 (0.67-0.71)	0.67 (0.65-0.69)
	Hospital-based		0.81 (0.77-0.85)	0.70 (0.66-0.74)	0.68 (0.63-0.72)	0.74 (0.69-0.79)
	Independent		0.82 (0.80-0.85)	0.78 (0.75-0.80)	0.73 (0.71-0.75)	0.73 (0.71-0.75)
Native American patients	**Overall**		0.87 (0.85-0.88)	0.84 (0.83-0.86)	0.81 (0.80-0.83)	0.80 (0.78-0.81)
	LDO	DaVita	0.89 (0.86-0.93)	0.85 (0.82-0.88)	0.80 (0.78-0.83)	0.79 (0.77-0.82)
		Fresenius	0.91 (0.87-0.94)	0.91 (0.87-0.94)	0.84 (0.80-0.87)	0.83 (0.80-0.86)
		DCI	0.76 (0.70-0.83)	0.77 (0.71-0.84)	0.60 (0.55-0.66)	0.65 (0.59-0.71)
	SDO		0.71 (0.68-0.74)	0.71 (0.68-0.75)	0.92 (0.86-0.99)	0.78 (0.71-0.84)
	Hospital-based		1.03 (0.97-1.10)	0.96 (0.90-1.02)	0.95 (0.89-1.01)	0.84 (0.78-0.90)
	Independent		0.85 (0.81-0.90)	0.81 (0.76-0.86)	0.70 (0.67-0.74)	0.73 (0.70-0.76)
Hispanic patients	**Overall**		0.96 (0.96-0.97)	0.93 (0.92-0.93)	0.92 (0.92-0.93)	0.88 (0.87-0.88)
	LDO	DaVita	0.93 (0.92-0.94)	0.91 (0.90-0.92)	0.90 (0.89-0.91)	0.86 (0.85-0.87)
		Fresenius	0.98 (0.97-0.99)	0.92 (0.92-0.93)	0.92 (0.91-0.93)	0.87 (0.86-0.88)
		DCI	0.88 (0.83-0.93)	0.86 (0.82-0.91)	0.85 (0.81-0.90)	0.80 (0.76-0.85)
	SDO		0.94 (0.92-0.95)	0.90 (0.89-0.92)	0.88 (0.87-0.89)	0.83 (0.81-0.84)
	Hospital-based		0.97 (0.94-1.00)	0.92 (0.90-0.95)	0.94 (0.91-0.98)	0.85 (0.82-0.89)
	Independent		0.98 (0.97-1.00)	0.95 (0.93-0.96)	0.95 (0.94-0.97)	0.92 (0.90-0.93)

Data source: Special analyses, USRDS ESRD Database. Period prevalent dialysis patients with Medicare as primary payer; 95% confidence intervals are shown in parentheses. Adjusted for patient age, race, ethnicity, sex, diabetes, duration of ESRD, nursing home status, patient comorbidities at incidence, and body mass index (BMI) at incidence. The race-specific measures are adjusted for all the above characteristics except patient race. The Hispanic-specific measure is adjusted for all the above characteristics except patient ethnicity. Abbreviations: DCI, Dialysis Clinic, Inc.; LDO, large dialysis organizations; SDO, small dialysis organizations.

Similar to the SMR presentation, Table 10.4 displays the 2013-only SHR, which is constructed to provide a simpler and more direct comparison of a given provider type to the national value in a given year, versus comparing a provider type's performance on the SHR across years, as Table 10.3 is designed to facilitate.

vol 2 **Table 10.4 All-cause standardized hospitalization ratio, by unit affiliation, 2013**

Affiliation	All	White	Black/African American	Asian	Native American	Hispanic
Overall	1.00 (1.00-1.00)	1.03 (1.02-1.03)	1.00 (0.99-1.00)	0.75 (0.75-0.76)	0.82 (0.81-0.84)	0.91 (0.90-0.92)
LDO						
DaVita	1.01 (1.00-1.01)	1.03 (1.03-1.04)	1.01 (1.00-1.01)	0.73 (0.71-0.74)	0.82 (0.79-0.85)	0.89 (0.89-0.90)
Fresenius	0.99 (0.98-0.99)	1.03 (1.02-1.03)	0.96 (0.95-0.96)	0.79 (0.77-0.80)	0.86 (0.82-0.89)	0.91 (0.90-0.92)
DCI	0.90 (0.89-0.91)	0.95 (0.93-0.97)	0.88 (0.86-0.90)	0.64 (0.58-0.71)	0.67 (0.61-0.74)	0.83 (0.79-0.88)
SDO	0.99 (0.98-1.00)	1.00 (0.99-1.01)	1.02 (1.01-1.04)	0.69 (0.67-0.71)	0.80 (0.74-0.87)	0.86 (0.84-0.87)
Hospital-based	0.94 (0.93-0.95)	0.94 (0.92-0.95)	1.01 (0.99-1.03)	0.76 (0.72-0.81)	0.87 (0.81-0.93)	0.89 (0.85-0.92)
Independent	0.98 (0.98-0.99)	1.00 (0.99-1.01)	1.00 (0.99-1.01)	0.75 (0.73-0.77)	0.75 (0.72-0.79)	0.95 (0.93-0.96)

Data source: Special analyses, USRDS ESRD Database. Period prevalent dialysis patients with Medicare as primary payer; 95% confidence intervals are shown in parentheses. Adjusted for patient age, race, ethnicity, sex, diabetes, duration of ESRD, nursing home status, patient comorbidities at incidence, and body mass index (BMI) at incidence. The race-specific measures are adjusted for all the above characteristics except patient race. The Hispanic-specific measure is adjusted for all the above characteristics except patient ethnicity. Abbreviations: DCI, Dialysis Clinic, Inc.; LDO, large dialysis organizations; SDO, small dialysis organizations.

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Chapter 11: Medicare Expenditures for Persons With ESRD

- Medicare fee-for-service spending for ESRD beneficiaries rose by 1.6%, from 30.4 billion in 2012 to 30.9 billion in 2013, accounting for 7.1% of the overall Medicare paid claims costs. This marks the third year of modest growth relative to historical trends, and follows the implementation of the bundled payment system.
- In contrast to the increase in global expenditures for ESRD patients, total fee for service spending in the general Medicare population declined by 0.2% in 2013 to $437.0 billion.
- In 2013, ESRD spending per patient per year (PPPY) declined by 0.7%. Given that ESRD PPYY spending decreased or increased only slightly from 2009 to 2013, the rise in total ESRD costs during these years is almost entirely attributable to growth in the number of covered patients.
- For hemodialysis, both total and PPPY spending were nearly flat between 2012 and 2013. During this period, peritoneal dialysis total spending continued to grow by 9.2% as the share of patients receiving PD has continued to rise. PD growth on a PPPY basis was moderate between 2012 and 2013 (0.8%), however, and PD remains less costly on a per patient basis than HD. Finally, total and PPPY transplant spending has also remained consistent.

Introduction

The Medicare program for the elderly was enacted in 1965. Seven years later, in 1972, Medicare eligibility was extended to persons with irreversible kidney failure who required dialysis or transplantation. In 1972, only about 10,000 patients were receiving dialysis (Rettig, 2011), a number that has grown to over 469,950 in 2013. Even though the ESRD population remains at less than 1% of the total Medicare population, it has accounted for about 7% of Medicare fee for service spending in recent years (USRDS, 2014).

On January 1, 2011, The Centers for Medicare and Medicaid Services (CMS) implemented the ESRD Prospective Payment System (PPS). This program bundled Medicare's payment for renal dialysis services together with separately billable ESRD-related supplies (primarily erythropoiesis stimulating agents (ESAs), vitamin D, and iron) into a single, per treatment payment amount. The bundle payment supports up to three dialysis treatments per individual per week. The reimbursement to facilities is the same regardless of dialysis modality, but is adjusted for dialysis provider case-mix and geographic area health care wages. Early research linked the PPS with substantial declines in the utilization of expensive injectable medications, and increased use of in-home peritoneal dialysis (PD; Hirth et al., 2013; Civic Impulse, 2013).

Most of the savings from these changes have accrued to dialysis facilities, as CMS initially set the bundled payment rate at 98% of what spending would have been under the costlier utilization patterns observed prior to the PPS. In the American Taxpayer Relief Act of 2012, Congress authorized CMS to "re-base" the PPS bundled payment rate by an inflation-adjusted decrease of 9%. Re-basing the bundled payment rate would transfer the savings from dialysis facilities to Medicare and, ultimately, to taxpayers. Before the bundled payment rate reduction could be fully implemented, however, the Protecting Access to Medicare Act of 2014 required that it be phased in by limiting annual adjustments to the bundled payment rate. That legislation also delayed CMS's plans to include more oral medications (primarily phosphate binders) in the bundle in 2016, to no sooner than 2024.

This chapter presents recent patterns and longer-term trends in both total Medicare spending and spending by type of service. Data from 2013 is featured, the third full year under the expanded, bundled PPS.[1]

Analytical Methods

For this 2015 ADR, reported costs of ESRD include only those ESRD beneficiaries covered by Original Medicare (fee-for-service) for their Medicare Parts A and B benefits. Medicare expenditures can be calculated from the claims submitted for payment for health care provided to these individuals, but not for those enrolled in Medicare Advantage (managed care) plans. The Medicare program pays for services provided through Medicare Advantage plans on a risk-adjusted, per-capita basis, and not by specific claims for services. Methods of estimating Medicare expenditures for Medicare Advantage beneficiaries with ESRD will be explored for future ADRs.

Only a subset of ESRD patients is eligible to participate in a Medicare Advantage plan. If a person becomes eligible for Medicare solely due to ESRD, they are generally not allowed to enroll in a Medicare Advantage plan and must use fee-for-service Medicare. Current Medicare beneficiaries who develop ESRD are allowed to remain in their Medicare Advantage plan, but with a few rare exceptions, cannot switch to a Medicare Advantage plan if they were enrolled in fee-for-service Medicare at the time of ESRD.

Those who are newly entitled to Medicare due to ESRD and require dialysis have a three-month waiting period before Medicare coverage begins; an exception is for those initiating home dialysis training, where coverage may start as early as the first month of dialysis. If the new ESRD patient has private insurance through an employer or union, there are rules governing what Medicare will pay. During the first 30 months after the start of Medicare eligibility due to ESRD, the private insurance will be considered the primary payer of ESRD services. Medicare acts as the secondary payer and may reimburse some services not covered by the private insurance carrier. At month 31 the roles are reversed, and Medicare becomes the primary payer with the private insurance designated the secondary payer.

Additionally, Medicare eligibility based solely on ESRD ends for those ESRD patients who receive a kidney transplant or discontinue dialysis. Medicare coverage ends 12 months after the last dialysis treatment and 36 months after a successful transplant. However, if a transplant recipient also qualifies for disability or is over the age of 65, then Medicare entitlement will continue. If a transplant fails and the recipient returns to dialysis, Medicare eligibility is re-instated.

In this chapter, both data from the Medicare Enrollment Database (EDB) and dialysis claims information are used to categorize payer status as Medicare primary payer (MPP), Medicare secondary payer (MSP), or non-Medicare. Non-Medicare patients in the EDB include those who are pre- or post-Medicare entitlement, such as patients in the initial three-month waiting period.

A more accurate picture of total ESRD-related costs would take into account more than just expenditures by the Medicare program. It would include expenses such as those incurred by private insurance carriers when Medicare is the secondary payer, during the waiting period for initial Medicare coverage, and by insurance carriers of people living with a functioning kidney transplant following the termination of Medicare coverage. It would also include the patients' portion of the cost-sharing with Medicare, including the Parts B and D premiums of those enrolled in Medicare solely due to ESRD, the beneficiary's deductible, and their coinsurance amounts for ESRD services.

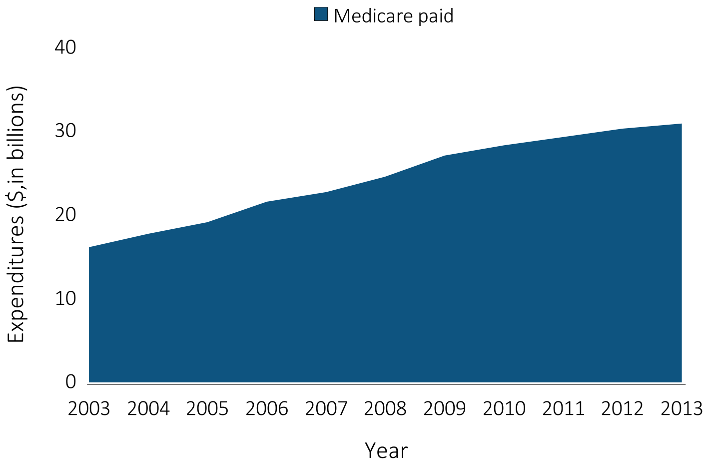
For additional detail see the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Overall & per Person per Year Costs of ESRD

Figure 11.1 displays Medicare's total annual paid claims for period prevalent ESRD patients from 2003-2013. These costs represent about three quarters of all spending for the care of U.S. ESRD patients (USRDS, 2013). Medicare fee for service ESRD spending rose by 1.6% from 2012 to 2013, marking the third year of modest growth relative to historical trends, and following the implementation of the bundled payment system.

[1] The reader may find information on Medicare Health Maintenance Organizations (HMO; managed care), and private insurer spending through 2011 in the 2013 Annual Data Report (USRDS, 2013).

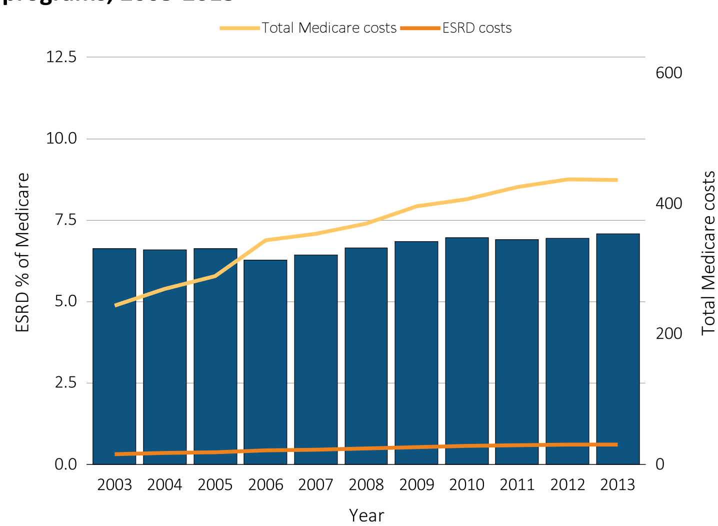
vol 2 Figure 11.1 Trends in ESRD expenditures, 2003-2013



Data Source: USRDS ESRD Database; Reference Table K.1. Abbreviations: ESRD, end-stage renal disease.

As illustrated in Figure 11.2, total Medicare fee for service spending in the general Medicare population declined by 0.2 % in 2013 to $437.0 billion; spending for ESRD patients increased 1.6 %, to $30.9 billion, and accounted for 7.1% of the overall Medicare paid claims costs in the fee-for-service system. Note that Medicare Advantage plans (private managed care) represented a larger share of general Medicare spending, while restrictions on new Medicare enrollment by beneficiaries with ESRD limited that growth in the ESRD population. This implies that the increasing fraction of Medicare fee-for-service spending accounted for by ESRD patients reflects both the growth in ESRD spending and the gradual shift away from fee-for-service in the general Medicare population.

vol 2 Figure 11.2 Trends in costs of the Medicare & ESRD programs, 2003-2013

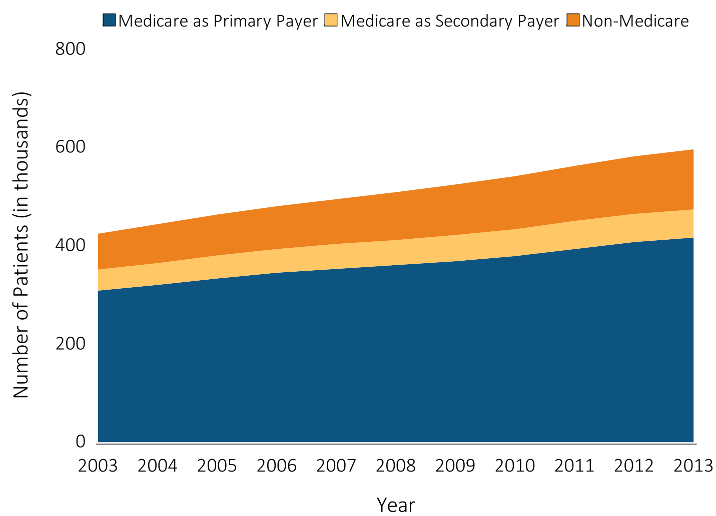


Data Source: Total ESRD costs obtained from USRDS ESRD Database; Reference Table K.1. Total Medicare expenditures obtained from Trustees Report, table B1 https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/TrusteesReports.html. Abbreviations: ESRD, end-stage renal disease.

Funding Sources for the ESRD Population

Figure 11.3 illustrates the annual number of prevalent ESRD patients by their Medicare status. Data from the Medicare Enrollment Database (EDB) and dialysis claims information were used to categorize payer status as Medicare primary payer (MPP), Medicare secondary payer (MSP), or non-Medicare. Non-Medicare patients in the EDB include those who are pre- or post-Medicare entitlement. The number of ESRD patients with MPP grew by 2.3 % from 2012 (407,432) to 2013 (416,808); the MSP ESRD population declined by 0.1% from 2012 (57,730) to 2013 (57,677), while the non-Medicare ESRD population rose 5.0 %, to 122,551.

vol 2 Figure 11.3 Trends in numbers of point prevalent ESRD patients, 2003-2013



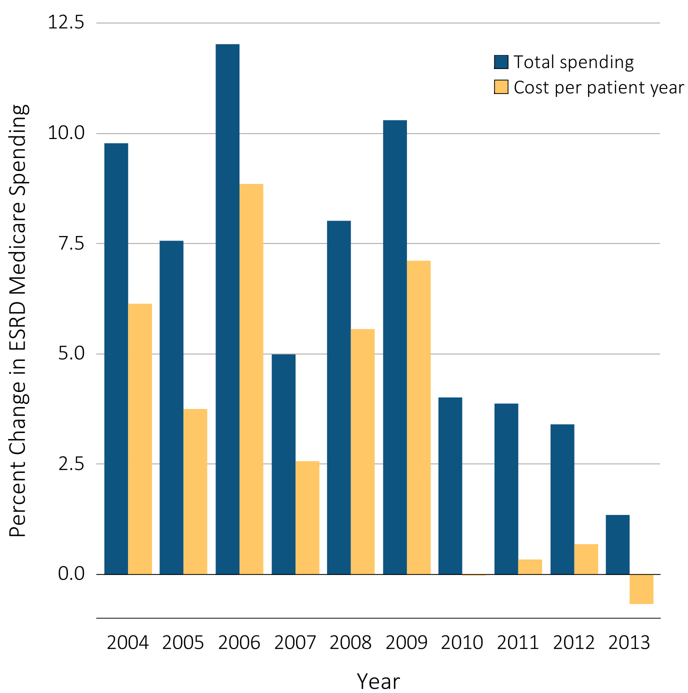
Data Source: USRDS ESRD Database. December 31 point prevalent ESRD patients. Abbreviations: ESRD, end-stage renal disease.

Figure 11.4 displays the annual percent change in Medicare ESRD fee for service spending for all ESRD patients for whom Medicare is the primary payer. Part D costs are included in these measures. However, as Part D is a voluntary component of the Medicare program, some recipients do not participate or have an alternate source of pharmaceutical coverage (e.g., from an employer) and would not have medication claims represented in the Part D records.

For the fourth consecutive year, the annual increase in total Medicare ESRD spending for patients with primary payer status was less than 4%. In 2013, total Medicare paid claims for ESRD services and supplies increased by 1.3% to $29.7 billion (Figure 11.4; for total and specific values see Reference Table K.4).

In 2013, ESRD PPPY spending declined by 0.7%. Given that these expenditures decreased or increased only minimally from 2009 to 2013, the growth in total ESRD costs during these years is almost entirely attributable to growth in the number of covered patients.

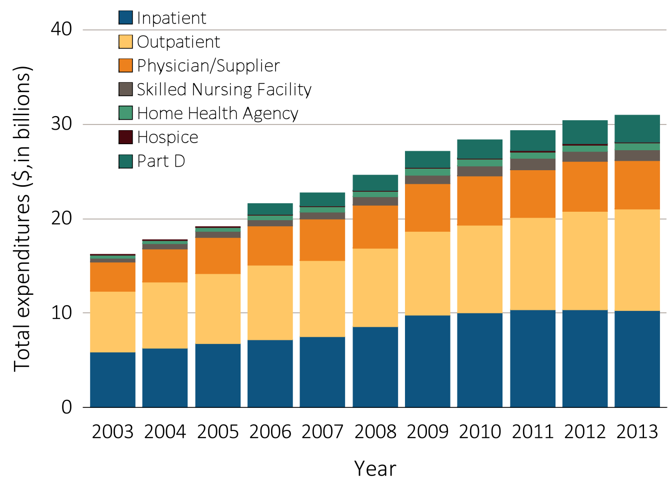
vol 2 **Figure 11.4 Annual percent change in Medicare ESRD spending**



Data Source: USRDS ESRD Database; Reference Table K.4. Total Medicare ESRD costs from claims data; excludes claims with Medicare as secondary payer. Abbreviations: ESRD, end-stage renal disease.

Total Medicare fee for service spending for ESRD patients by type of service is reported in Figure 11.5. Compared to 2012, the costs of Part D coverage and skilled nursing facility care grew at the fastest rates (14.9% and 5.1%, respectively). All other categories of spending rose by less than three percent. The smallest share of Medicare spending for ESRD patients was for hospice care; it should be noted, however, that hospice care had been experiencing the highest rate of growth of any category prior to 2013, when the growth rate decelerated to 0.6 %.

vol 2 **Figure 11.5 Trends in total Medicare fee for service spending for ESRD, by type of service, 2003-2013**

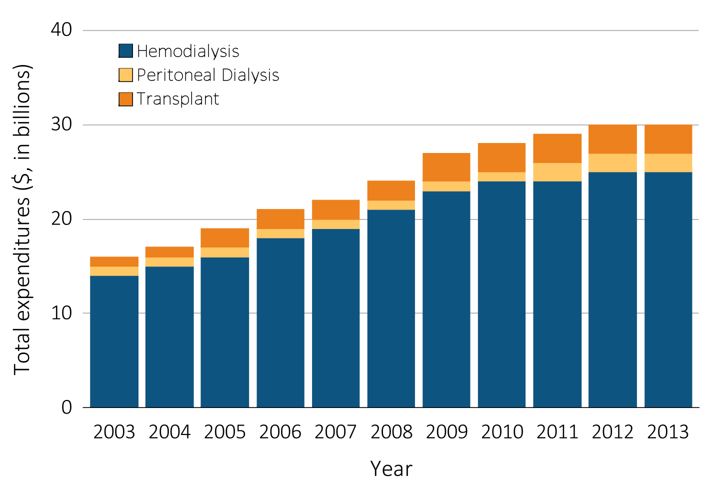


Data Source: USRDS ESRD Database; Reference Table K.1. Total Medicare costs from claims data; includes all claims with Medicare as primary payer. Abbreviations: ESRD, end-stage renal disease.

ESRD Spending by Modality

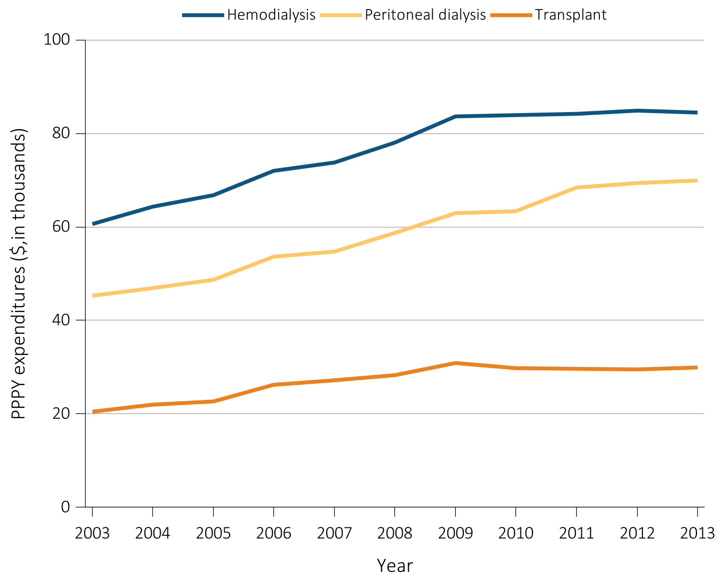
For hemodialysis, both total and PPPY fee for service spending were nearly flat between 2012 and 2013 (Figures 11.6 and 11.7). Peritoneal dialysis total spending continued to grow, by 9.2% between 2012 and 2013 as the share of patients receiving PD has continued to rise. PD growth on a PPPY basis was moderate between 2012 and 2013 (0.8%), however, and PD remains less costly ($69,919 in 2013) on a per patient basis than HD ($84,550). Finally, total and PPPY transplant spending has also remained consistent. In 2013 the PPPY cost for transplant patients was $29,920.

vol 2 **Figure 11.6 Total Medicare ESRD expenditures, by modality**



Data Source: USRDS ESRD Database. Total Medicare costs from claims data for period prevalent ESRD patients. Abbreviations: ESRD, end-stage renal disease.

vol 2 **Figure 11.7 Total Medicare ESRD expenditures per person per year, by modality**



Data Source: USRDS ESRD Database; Reference Tables K.7, K.8, & K.9. Period prevalent ESRD patients; patients with Medicare as secondary payer are excluded. Abbreviations: ESRD, end-stage renal disease.

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Notes

Chapter 12: Part D Prescription Drug Coverage in Patients With ESRD

- Among persons with part D enrollment, a higher proportion of hemodialysis (66%), peritoneal dialysis (56%), and transplant (53%) patients receive the low-income subsidy (LIS) than in the general Medicare population (33%).
- In 2013, per patient per year Medicare Part D spending for ESRD patients ($6,673) was 2.6 times higher than for general Medicare patients ($2,592). Hemodialysis patients had the highest per person per year (PPPY) Medicare costs in 2013, at $7,142, compared to $6,566 and $4,875 for peritoneal dialysis and transplant patients.
- Across general Medicare and ESRD populations, PPPY net Part D costs were 2.7-3.5 times greater for patients with LIS benefits than for those without. In addition, out-of-pocket costs represented only 1-2% of total expenditures in each of the LIS populations, compared to 28-32% in the non-LIS populations.
- Among the six most common drug classes used by dialysis patients during 2013, phosphate binders were the most frequently prescribed (72.5%), and also ranked first in terms of Medicare spending. Calcimimetic agents were the second most costly class of medications, although only 29.1% of dialysis patients had at least one such prescription filled.

Introduction

2016 will mark ten years of operation for the Medicare Part D prescription drug benefit. Over that time period, Part D has become an important component of Medicare as whole. Given the clinical and socioeconomic status of those in the ESRD population, this benefit has been particularly significant. In December 2013, more than 37 million Medicare recipients, representing 69% of the entire Medicare population, enrolled in a Medicare Part D prescription drug plan. With 74% participation, Medicare-covered ESRD patients exceed the Part D enrollment rate of the general Medicare population. When distinguished by renal replacement modality, 78, 67, and 63% of Medicare-enrolled hemodialysis, peritoneal dialysis, and kidney transplant patients, respectively, participated. Given that very few ESRD beneficiaries are enrolled in Medicare Advantage plans that provide both medical and prescription coverage, most obtain Part D benefits through a stand-alone prescription drug plan (PDP).

Prior to the initiation of this benefit on January 1, 2006, some Medicare beneficiaries were able to obtain drug coverage through various private insurance plans, state Medicaid programs, or the Department of Veterans Affairs. Others received partial support through pharmaceutical-assistance programs or free samples available from their physicians. However, many ESRD patients did not have reliable coverage, and incurred substantial out-of-pocket expenses for their medications.

Enrollment in Part D is not mandatory; non-Part D Medicare enrollees may choose to obtain outpatient medication benefits through other creditable coverage sources that provide benefits equivalent to or better than Part D. These include employer group health plans, retiree health plans, Veterans Administration benefits, and state kidney programs. Those without an alternative source of coverage pay for their prescriptions out-of-pocket. The proportion of Medicare-covered ESRD patients with no known source of drug coverage is highest in the peritoneal dialysis and transplant populations. Given that more of these patients are employed (relative to hemodialysis patients), it is likely that some have sources of prescription drug coverage not currently tracked by Medicare.

Patients dually-enrolled in Medicare and Medicaid are automatically eligible for Part D under the Low-income Subsidy (LIS) benefit. Non-Medicaid eligible patients can also qualify for the LIS based on limited assets and income. The LIS provides full or partial waivers for many out-of-pocket cost-sharing requirements, including premiums, deductibles, and copayments, and provides full or partial coverage during the coverage gap ("donut hole"). In 2013, 63% of Medicare-covered ESRD patients enrolled in Part D received the LIS benefit, compared to 33% of the general Medicare Part D population. By modality, 66, 56, and 53% of enrolled hemodialysis, peritoneal dialysis, and transplant patients, respectively, qualified for the LIS. Out-of-pocket costs are thus proportionally lower for Part D enrollees in the ESRD population than for their general Medicare counterparts ($375 vs $412). By race, White dialysis patients are the least likely to qualify for LIS benefits.

Phosphate binding agents are the most frequently prescribed of six common medication drug classes used by Part D dialysis patients, while cardiovascular agents (beta blockers, statins, and calcium channel blockers) account for three of the top four. Prescribed phosphate binding agents and calcimimetic agents incur the highest medication costs, as these are not available in generic form.

In 2013, total estimated net Medicare Part D costs for ESRD and general Medicare Part D enrollees were $2.3 billion and $52.8 billion, respectively. Between 2011 and 2013, total net costs increased by 27 and 41% for hemodialysis and peritoneal dialysis patients, compared to 13% for general Medicare patients; for transplant patients, costs rose by 26%. In 2013, regardless the LIS status, Medicare Part D costs for hemodialysis, peritoneal dialysis, and transplant patients were $7,142 and $6,566, and $4,875per person per year (PPPY), respectively, compared to $2,592for general Medicare patients. Out-of-pocket Part D costs for ESRD patients were slightly lower than for general Medicare patients, at $375 versus $412. This is not surprising, as among Part D enrollees, a higher percentage of ESRD patients enrolled in Part D received the LIS benefit (63% versus 33%). The Medicare Part D program functions in concert with Medicare Part B; this benefit covers medications administered in physician offices, some of those administered during hemodialysis (e.g. intravenous antibiotics that are not associated with dialysis-related infections), and most immunosuppressant medications required following a kidney transplant. Immunosuppression coverage continues as long as the transplant recipient maintains Medicare eligibility. Entitlement may end at three years post-transplant or be continued due to disability or age. Patients whose kidney transplant is not covered by Medicare, but who become Medicare-eligible due to age or disability can enroll in and receive their immunosuppressant medications through Part D. Prescription drugs not covered for beneficiaries under Part B may be covered by Part D, depending upon whether the drug is included on the plan formulary. Until January 2011, costs of erythropoietin stimulating agents, IV vitamin D, iron, and antibiotic agents administered during dialysis were separately reimbursable under Medicare Part B. Since 2011, coverage for these products has been included in the monthly bundled payment to dialysis providers. Part B costs are thus not displayed in chapter figures, as they have been in previous ADRs.

Analytical Methods

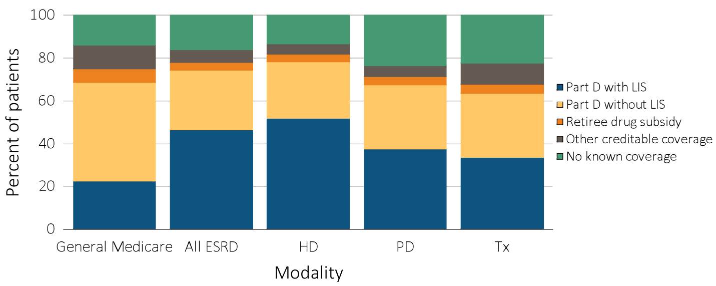
See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate thefigures and tables in this chapter.

Part D Enrollment Patterns

Patients with Medicare coverage have the option to enroll in Medicare Part D for prescription drug coverage; overall, 74% of Medicare ESRD beneficiaries were enrolled in a Part D plan in 2013. By modality, enrollment was 78, 67, and 63% for hemodialysis, peritoneal dialysis and transplant patients, respectively, compared to 69% of general Medicare patients.

Compared to general Medicare Part D enrollees, more hemodialysis, peritoneal dialysis, and transplant patients with Part D receive the Low-income Subsidy (LIS)—66, 56, and 53%, respectively, compared to 33% of the general Medicare population. About 16% of ESRD beneficiaries have no identified prescription drug coverage. By modality, peritoneal dialysis and transplant patients are least likely to have known coverage, but these groups are traditionally more likely to be employed than hemodialysis patients and thus may be more likely to have coverage that is not tracked by Medicare (see Figure 12.1).

vol 2 Figure 12.1 Sources of prescription drug coverage in Medicare ESRD enrollees, by population, 2013

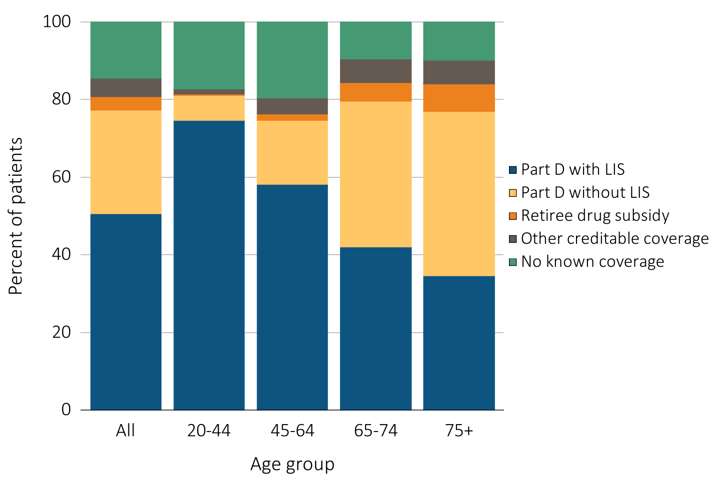


Data source: 2013 Medicare Data, point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; LIS, Low-income Subsidy; Part D, Medicare Part D prescription drug coverage; PD, peritoneal dialysis; Tx, kidney transplant.

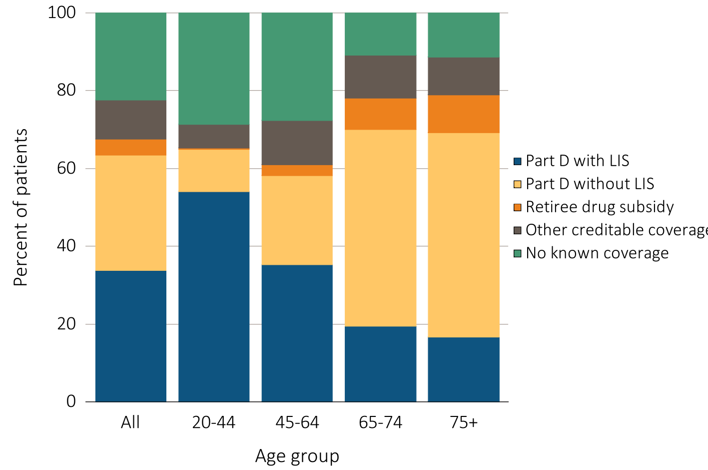
Sources of prescription drug coverage among ESRD patients vary widely by age (Figure 12.2). Dialysis patients aged 20-44 had the highest Part D enrollment in 2013, while transplant patients aged 65-74 had the highest Part D enrollment. In addition, receipt of the LIS decreases substantially with age—from 75 and 54% among dialysis and transplant patients aged 20–44 to just 35 and 17% among those aged 75 and older. In each age category, transplant patients are markedly less likely than those on dialysis to receive the LIS benefit.

vol 2 Figure 12.2 Sources of prescription drug coverage in Medicare ESRD enrollees, by age & modality, 2013

(a) Dialysis patients



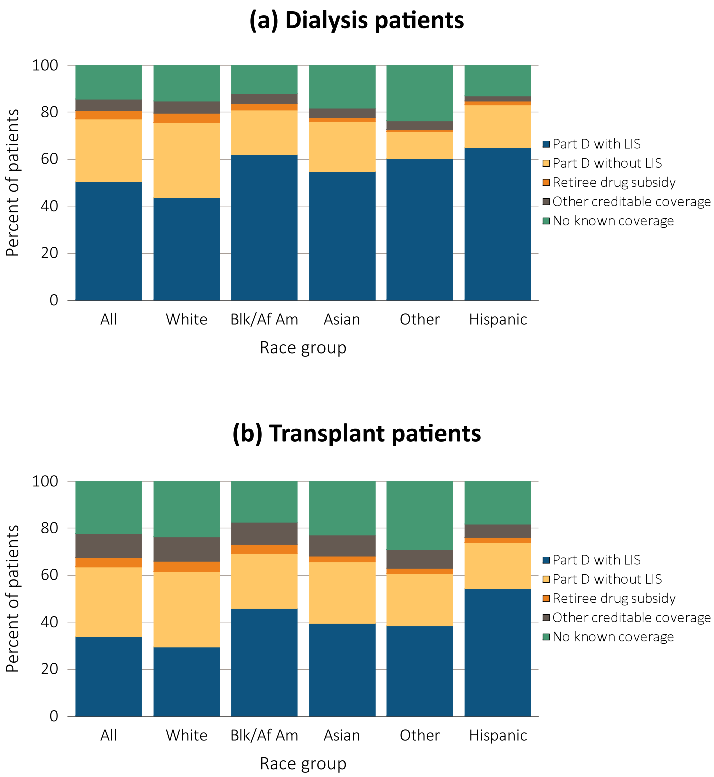
(b) Transplant patients



Data source: 2013 Medicare Data, point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: ESRD, end-stage renal disease; LIS, Low-income Subsidy; Part D, Medicare Part D prescription drug coverage.

The percentage of dialysis patients enrolled in Part D also varied by race, from 75% of Whites to 81 and 83% of Blacks/African Americans and Hispanics, respectively (Figure 12.3). Seventy-six percent of Blacks and 78% of Hispanics with Part D coverage qualified for the LIS benefit, compared to 58% of Whites; Blacks were the least likely to have no known prescription drug coverage. Overall and by race, Part D enrollment among transplant patients was lower than that of dialysis patients, with 62% of Whites, 69% of Blacks, and 73% of Hispanic transplant patients enrolled. Sixty-six percent of Blacks and 73% of Hispanics with Part D coverage have the LIS, compared to 48% of Whites and 60% of Asians (Figures 12.3).

vol 2 Figure 12.3 Sources of prescription drug coverage in Medicare ESRD enrollees, by race/ethnicity & modality, 2013

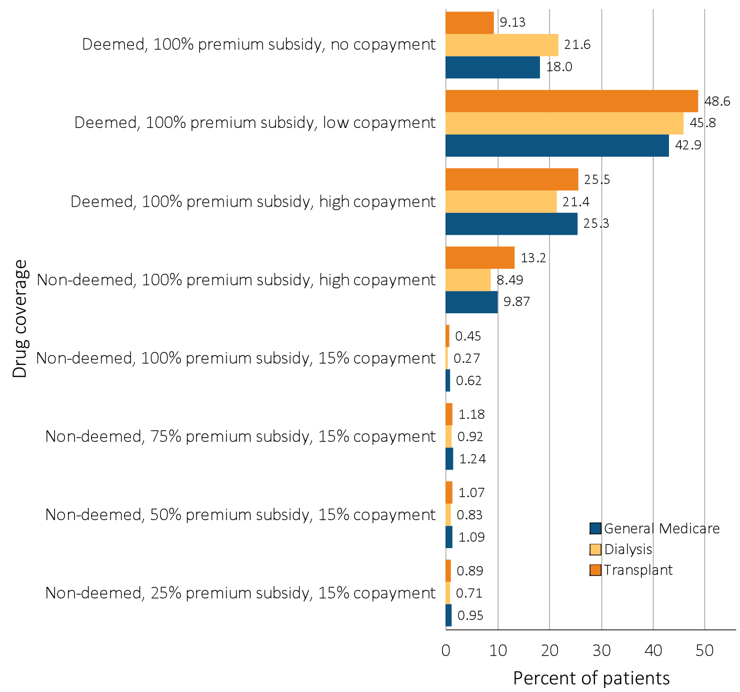


Data source: 2013 Medicare Data, point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: Blk/Af Am, Black or African American; ESRD, end-stage renal disease; LIS, Low-income Subsidy; Part D, Medicare Part D prescription drug coverage.

The LIS provides assistance for the premiums, deductibles, and co-payments of the Medicare Part D program. Some Medicare enrollees are automatically deemed eligible for LIS and do not need to file an application (deemed LIS beneficiaries). Such patients include persons dually eligible for both Medicaid and Medicare, those receiving supplemental security income, and those participating in Medicare savings programs (e.g., Qualified Medicare Beneficiaries (QMB) and Qualified Individuals (QI)). Dual-eligible ESRD patients who do not actively select a plan are automatically enrolled in a stand-alone Medicare Part D plan by the Center for Medicare and Medicaid Services (CMS). Other Medicare beneficiaries with limited incomes and resources who do not automatically qualify for LIS (non-deemed beneficiaries) can apply for the LIS and have their eligibility determined by their state Medicaid agency or the Social Security Administration.

In 2013, 89% of dialysis patients with Part D LIS coverage were deemed LIS beneficiaries, compared to 83% and 86%, respectively, of and transplant and general Medicare patients (Figure 12.4).

vol 2 Figure 12.4 Distribution of Low-income Subsidy categories in Part D general Medicare & ESRD patients, 2013



Data source: 2013 Medicare data, point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: ESRD, end-stage renal disease; Part D, Medicare Part D prescription drug coverage.

Within each race group, receipt of the LIS generally decreases with age. For those aged 75 and older, however, an uptick is seen for general Medicare patients across all races and several subsets of the ESRD population, including hemodialysis and peritoneal dialysis patients of other races, and Black transplant patients (see Table 12.1).

vol 2 **Table 12.1 Medicare Part D enrollees (%) with or without the Low-income Subsidy, by age & race, 2013**

	General Medicare		All ESRD		Hemodialysis		Peritoneal dialysis		Transplant	
	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS
White										
All ages	26.0	74.0	55.1	44.9	58.6	41.4	49.1	50.9	47.8	52.2
20-44	88.9	11.1	87.8	12.2	91.0	9.0	88.4	11.6	82.4	17.6
45-64	52.3	47.7	70.1	30.0	75.5	24.5	63.4	36.6	56.9	43.1
65-74	15.5	84.6	40.6	59.4	48.6	51.4	25.2	74.8	22.1	78.0
75+	20.4	79.6	34.8	65.2	37.6	62.4	17.3	82.7	18.6	81.4
Black/Af Am										
All ages	59.8	40.2	75.0	25.0	76.7	23.3	71.9	28.1	66.0	34.0
20-44	93.6	6.5	92.0	8.0	93.7	6.3	91.4	8.6	86.0	14.0
45-64	75.3	24.7	80.2	19.8	82.6	17.4	73.8	26.2	68.8	31.2
65-74	43.7	56.3	60.4	39.6	64.1	35.9	42.7	57.4	41.6	58.4
75+	52.0	48.0	61.1	38.9	62.7	37.4	36.7	63.3	41.7	58.3
Other race										
All ages	59.3	40.7	71.4	28.6	75.8	24.2	60.4	39.6	60.9	39.1
20-44	87.5	12.5	87.3	12.7	90.8	9.2	84.8	15.2	80.8	19.3
45-64	62.1	37.9	75.6	24.4	80.4	19.6	62.0	38.0	66.0	34.0
65-74	49.9	50.1	61.5	38.5	68.2	31.8	42.6	57.4	47.6	52.5
75+	63.6	36.4	68.3	31.7	71.8	28.2	54.8	45.2	44.9	55.2

Data source: 2013 Medicare data, point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; LIS, Low-income Subsidy; Part D, Medicare Part D prescription drug coverage.

Part D Coverage Plans

CMS provides participating prescription drug plans (PDPs) with guidance on structuring a "standard" Part D PDP. The upper portion of Table 12.2 illustrates the standard benefit design for PDPs in 2008 and 2013. In 2013, for example, beneficiaries shared costs with the PDP through co-insurance or copayments, until the combined total during the initial coverage period reached $2,970. After reaching this threshold, beneficiaries entered a coverage gap, or "donut hole," where they were then required to pay 100% of their prescription costs.

In each year since 2010, the U.S. government has been providing increasing assistance to those reaching this coverage gap. In 2013, patients received a 52.5% discount on brand name medications from drug manufacturers, and Part D plans paid 21% of generic drug costs for those in the gap (Q1 Medicare, 2013).

Beneficiaries who reached annual out-of-pocket drug costs of $4,750 entered the catastrophic coverage phase, in which they then paid only a small copayment for any additional prescriptions until the end of that year (Table 12.2).

PDPs have the latitude to structure their plans differently from the example presented, but companies offering non-standard plans must demonstrate that their coverage is at least actuarially equivalent to the standard plan. Many have developed plans featuring no deductibles, or with drug copayments instead of the 25% co-insurance, and some plans provide generic and/or brand name drug coverage during the coverage gap (Table 12.2; Q1 Medicare, 2013).

vol 2 **Table 12.2 Medicare Part D parameters for defined standard benefit, 2008 & 2013**

	2008	2013
Deductible After the deductible is met, the beneficiary pays 25% of total prescription costs up to the initial coverage limit.	$275	$325
Initial coverage limit The coverage gap ("donut hole") begins at this point. The beneficiary pays 100% of their prescription costs up to the out-of-pocket threshold	$2,510	$2,970
Out-of-pocket threshold The total out-of-pocket costs including the "donut hole"	$4,050	$4,750
Total covered Part D prescription out-of-pocket spending: (including the coverage gap). Catastrophic coverage begins after this point.	$5,726.25	$6,733.75
Catastrophic coverage benefit		
Generic/preferred multi-source drug	$2.25	$2.65[1]
Other drugs	$5.60	$6.60[1]
[1]plus a 52.50% brand name medication discount		
2013 Example:		
$325 (deductible)	$275	$325
+(($$2970-$325)*25%)(initial coverage)	$558.75	$652.50
+(($6733.75-$2970)*100%)(coverage gap)	$3,216.25	$3,763.75
Total (maximum out-of-pocket costs prior to catastrophic coverage, excluding plan premium)	$4,050.00	$4,750.00

The catastrophic coverage amount is the greater of 5% of medication cost or the values shown in the chart above. In 2013, beneficiaries were charged $2.65 for those generic or preferred multisource drugs with a retail price less than $53, and 5% for those with a retail price over $53. For brand name drugs, beneficiaries paid $6.60 for those drugs with a retail price less than $132, and 5% for those with a retail price over $132. Table adapted from http://www.q1medicare.com/PartD-The-2013-Medicare-Part-D-Outlook.php.

The catastrophic coverage amount is the greater of 5% of medication cost or the values shown in the chart above. In 2013, beneficiaries were charged $2.65 for those generic or preferred multisource drugs with a retail price less than $53 and 5% for those with a retail price over $53. For brand name drugs, beneficiaries paid $6.60 for those drugs with a retail price less than $132 and 5% for those with a retail price over $132.Table adapted from http://www.q1medicare.com/PartD-The-2013-Medicare-Part-D-Outlook.php.

Part D enrollment increased between 2011 and 2013 among Medicare-covered patients with ESRD. Enrollment growth was in the 7-11% range for all ESRD modalities compared to the 13% in the general Medicare population (Table 12.3).

vol 2 **Table 12.3 General Medicare & ESRD patients enrolled in Part D (%)**

	General Medicare	All ESRD	Hemodialysis	Peritoneal dialysis	Transplant
2011	61.01	68.93	73.17	61.83	57.15
2013	68.68	74.21	78.23	67.31	63.46

Data source: 2011 and 2013 Medicare data, point prevalent Medicare enrollees alive on January 1. Medicare data: general Medicare, 5% Medicare sample (ESRD, hemodialysis, peritoneal dialysis, and transplant, 100% ESRD population). Abbreviations: ESRD, end-stage renal disease; Part D, Medicare Part D prescription drug coverage.

Overall Costs of Part D Enrollment: Coverage Analysis

Total net Part D expenditures for ESRD patients increased from $1.80 billion in 2011 to $2.30 billion in 2013 (Table 12.4). These amounts do not include costs of medications subsumed under the ESRD prospective payment system (e.g. ESAs, IV vitamin D, and iron) or billed to Medicare Part B (e.g. immunosuppressants). Between 2011 and 2013, total estimated Part D costs increased by 27, 41, and 26% for hemodialysis, peritoneal dialysis, and kidney transplant patients, respectively.

By ESRD modality, hemodialysis patients had the highest per person per year (PPPY) Medicare costs in 2013, at $7,142, compared to $6,566 and $4,875 for peritoneal dialysis and transplant patients. PPPY net Part D costs in the overall ESRD population were 2.6 times greater than those for general Medicare patients, at $6,673 as compared to $2,592. As a proportion of total Part D costs, however, out-of-pocket costs were lower in ESRD patients, representing five, seven, and nine percent of PPPY costs for hemodialysis, peritoneal dialysis, and transplant patients, compared to 14% in the general Medicare population (Figure 12.5a).

vol 2 **Table 12.4 Total estimated Medicare Part D costs for enrollees, in billions, 2011 & 2013**

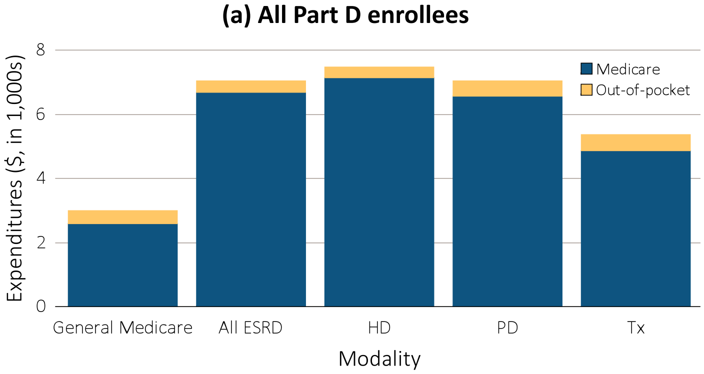
	General Medicare	All ESRD	Hemodialysis	Peritoneal dialysis	Transplant
2011	46.49	1.80	1.45	0.10	0.22
2013	52.75	2.30	1.83	0.14	0.27

Data source: 2011 and2013 Medicare data, period prevalent Medicare enrollees alive on January 1, excluding those in Medicare Advantage Part D plans and Medicare secondary payer, using as-treated model (see ESRD Methods chapter for analytical methods).

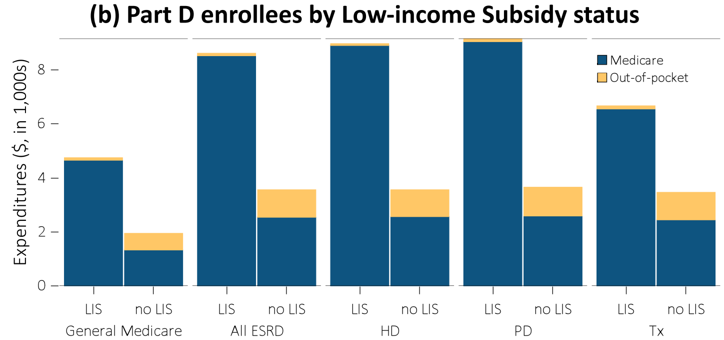
Across general Medicare and ESRD populations, PPPY net Part D costs are 2.7-3.5 times greater for patients with LIS benefits than in those without. In the LIS population, however, out-of-pocket costs represented only 1-2% of these total expenditures, compared to 28-32% in each of the non-LIS populations across general Medicare and ESRD populations. PPPY net Part D costs are 83% and 93% greater for patients with ESRD than for general Medicare patients in the LIS and non-LIS populations, respectively (Figure 12.5b).

vol 2 **Figure 12.5 Per person per year Medicare & out-of-pocket Part D costs for enrollees, 2013**

(a) All Part D enrollees



(b) Part D enrollees by Low-income Subsidy status



Data source: 2013 Medicare data, period prevalent Medicare enrollees alive on January 1, 2013, excluding those in Medicare Advantage Part D plans and Medicare secondary payer, using as-treated model (see ESRD Methods chapter for analytical methods).

Total per person per year (PPPY) Medicare Part D costs vary by age, sex, and race. Generally, younger patients, whose Medicare entitlement is based on disability, have higher costs than older patients. Costs varied only modestly by sex and race (Table 12.5).

vol 2 **Table 12.5 Per person per year Part D costs ($) for enrollees, by Low-income Subsidy status, 2013**

	General Medicare		All ESRD		Hemodialysis		Peritoneal dialysis		Transplant	
	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS	Part D with LIS	Part D without LIS
Age										
All	4,663	1,326	8,522	2,552	8,898	2,563	9,050	2,576	6,551	2,450
20-44	5,011	2,157	9,251	2,177	10,407	2,660	9,612	2,428	5,674	1,405
45-64	5,830	1,783	9,315	2,851	9,775	2,980	9,350	2,793	7,036	2,479
65-74	4,176	1,291	7,499	2,785	7,635	2,783	7,227	2,738	6,888	2,660
75+	3,588	1,256	5,889	2,049	5,999	2,051	5,064	2,094	5,300	2,132
Sex										
Male	4,788	1,400	8,554	2,548	8,958	2,536	9,346	2,522	6,529	2,521
Female	4,584	1,272	8,488	2,558	8,833	2,604	8,782	2,655	6,580	2,341
Race										
White	4,809	1,320	8,175	2,556	8,532	2,558	9,014	2,648	6,533	2,445
Black/ African American	4,470	1,456	9,039	2,539	9,408	2,572	9,014	2,058	6,445	2,520
Other race	4,256	1,279	8,132	2,548	8,301	2,600	9,500	3,114	7,066	2,306

Data source: 2013 Medicare data, period prevalent Medicare enrollees alive on January 1, 2013, excluding those in Medicare Advantage Part D plans and Medicare secondary payer, using as-treated model (see ESRD Methods chapter for analytical methods).

Among six common drug classes used by dialysis patients, phosphate binders were the most frequently prescribed during 2013, and also ranked first in in terms of costs. This is not surprising, as bone and mineral disorders are highly prevalent in dialysis patients and sevelamer (both hydrochloride and carbonate) is not yet available as a generic. Calcimimetic agents were the second most costly classes of medications, although only 29% of dialysis patients had at least one prescription filled (Table 12.6).

vol 2 **Table 12.6 Common drug classes used by Part D-enrolled dialysis patients, by percent of patients, drug class, and net cost, 2013**

Drug Class	Percent of patients (%)	Net costs ($)
Calcimimetic agents	29.1	407,140,771
Statins	46.0	21,788,139
Calcium channel blockers	46.2	15,096,030
Phosphate binder agents	72.5	692,085,189
Beta blockers	65.3	18,672,865
Renin-angiotensin-system (RAS)-acting agents	43.5	23,391,588

Data source: 2013 Medicare data, period prevalent Medicare enrollees alive on January 1, 2013, excluding those in Medicare Advantage Part D plans and Medicare secondary payer, using as-treated model (see ESRD Methods chapter for analytical methods). Renin-angiotensin-system (RAS)-acting agents contain three drug classes: angiotensin-receptor blockers (ARBs), angiotensin-converting enzyme inhibitors (ACE-inhibitors) and direct renin inhibitors.

References

Q1 Medicare. The 2013 Medicare Part D Prescription Drug Program. Website. Retrieved August 30, 2015 from http://www.q1medicare.com/PartD-The-2013-Medicare-Part-D-Outlook.php

Chapter 13: International Comparisons

- Taiwan, the Jalisco region of Mexico, and the United States continue to report the highest incidence of treated ESRD (458, 421 and 363 per million population (PMP) respectively; Fig 13.2), as they have done for the past decade.
- The greatest proportionate increases in the incidence of treated ESRD over the interval from 2000/2001 to 2012/2013 (Table 13.1) were reported for Thailand (1210%), Bangladesh (629%), Russia (249%), Philippines (185%), Malaysia (176%), the Jalisco region of Mexico (122%) and the Republic of Korea (120%).
- In contrast however, incidence rates have remained relatively stable since 2000/2001 in most high-income countries, and have declined by between 2 and 11% in Denmark, Sweden, Scotland, Finland and Canada (Table 13.1).
- In 2013, diabetes mellitus accounted for >50% of incident ESRD patients in Malaysia, Singapore and the Jalisco region of Mexico, but <20% of incident ESRD patients in Norway, the Netherlands, Iceland and Romania (Fig 13.4).
- The most rapid increases in diabetes-related ESRD over the interval from 2000/2001 to 2012/2013 have occurred in Thailand, Russia, Philippines, Malaysia, the Republic of Korea, the Jalisco region of Mexico, and Uruguay
- The highest prevalence of treated ESRD in 2013 was reported for Taiwan, Japan, and the United States (3138, 2411, and 2043 PMP respectively, Fig 13.8)
- The countries that have experienced the largest absolute increases in ESRD prevalence since 2000/2001 (Table 13.3) include the Jalisco region of Mexico (from 270 to 1654 PMP), the Republic of Korea (from 585 to 1442 PMP), Chile (from 612 to 1294 PMP), Malaysia (from 338 to 1140 PMP), and Thailand (98 to 1097 PMP).
- Internationally, in-center hemodialysis remains the most common form of treatment for ESRD, and constitutes greater than 80% of dialysis provision in the majority of countries represented in this report (Fig 13.17 and Table 13.6). The highest utilization of peritoneal dialysis is found in Hong Kong (72%), the Jalisco region of Mexico (45%), Iceland (34%), New Zealand (32%), Colombia (30%), and Thailand (25%).
- In 2013, the highest rates of kidney transplantation relative to population size were reported for Croatia (59 PMP), Jalisco (58 PMP), the Netherlands (56 PMP), the United States (56 PMP), and Spain (54 PMP; Fig 13.18(a)). When expressed relative to the size of the prevalent dialysis population, the highest rates of kidney transplantation were observed in Norway (210 kidney transplants per thousand dialysis patients), Estonia (158 per thousand), the Netherlands (146 per thousand), Scotland (129 per thousand) and the United Kingdom (117 per thousand; Fig 13.18(b).
- The countries that have experienced the largest absolute increases in their rate of kidney transplantation since 2000/2001 (Table 13.7) are Croatia (from 9 to 59 PMP), the Netherlands (from 36 to 56 PMP), the Republic of Korea (from 14 to 34 PMP), Scotland (from 36 to 51 PMP), Turkey (from 6 to 38 PMP) and Uruguay (from 17 to 32 PMP).

Introduction

This chapter examines treated end-stage renal disease (ESRD) from an international perspective. The number of countries and regions represented in this Annual Data Report has increased from 54 in 2014 to 57, with the addition of Estonia, Ireland, and Switzerland to this year's chapter. This work is made possible through the substantial efforts of many individuals from all participating countries, through collecting and contributing data for this international collaboration. We sincerely thank all of the registries and providers for their efforts, and have included a list of participants at the end of this chapter to further acknowledge their contributions.

The comparisons we present are intended to increase awareness of the international trends, similarities, and differences in key ESRD treatment measures. Data collection methods vary to some extent across countries, and therefore direct comparisons should be made with caution. We welcome any suggestions to further improve the content of this chapter for the benefit of the international community, and invite all renal registries to participate in this data collection and collaboration in the future. There are many countries not yet represented in this chapter. Therefore, efforts to increase international representation and enhance the comparisons presented will continue to be a focus of our work.

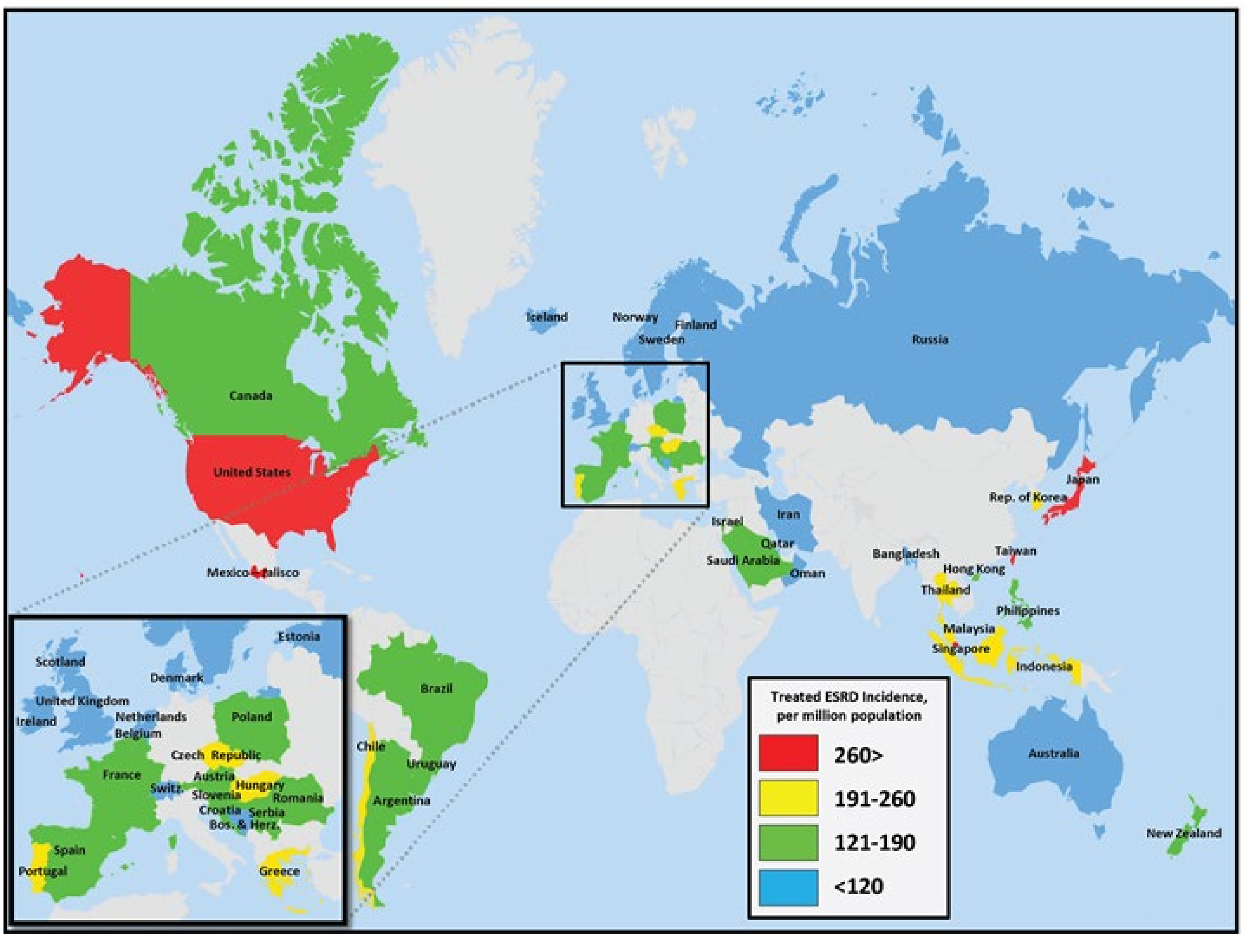
Analytical Methods

See the ESRD Analytical Methods chapter for the data collection form and for an explanation of analytical methods used to generate the figures and tables in this chapter.

Incidence of Treated End-stage Renal Disease

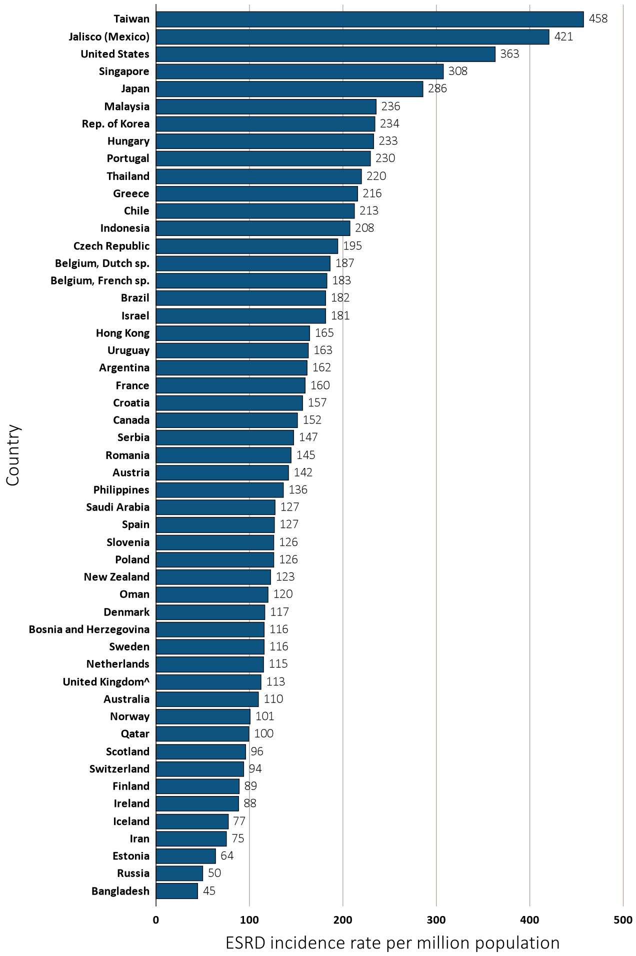
In 2013, reported incidence rates of treated ESRD varied greatly across countries (see Figures 13.1 and 13.2). Taiwan, the Jalisco region of Mexico, and the United States (U.S.) reported the highest incidence of treated ESRD, at 458, 421, and 363 individuals per million population, respectively. The next highest rates, ranging from 208–308 per million population, were reported for Singapore, Japan, Malaysia, Republic of Korea, Hungary, Portugal, Thailand, Greece, Chile, and Indonesia. The lowest treated ESRD incidence rates, ranging from 45 to 96 per million population, were reported by Bangladesh, Russia, Estonia, Iran, Iceland, Ireland, Finland, Switzerland, and Scotland.

vol 2 **Figure 13.1 Geographic variations in the incidence of treated ESRD, per million population, by country, 2013**



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. Data for Indonesia represent the West Java region. Data for France include 22 regions. Data for Spain include 18 of 19 regions. Abbreviations: ESRD, end-stage renal disease.

vol 2 Figure 13.2 Incidence of treated ESRD, per million population, by country, 2013

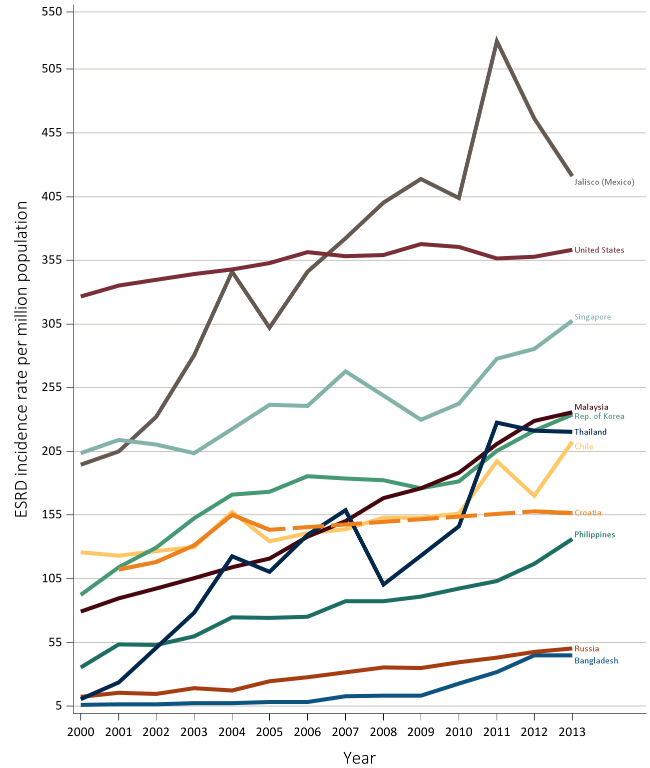


Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. Data for Belgium do not include patients younger than 20. Data for Indonesia represent the West Java region. Data for France include 22 regions. Data for Spain include 18 of 19 regions. Abbreviations: ESRD, end-stage renal disease.

Trends in the incidence of treated ESRD, by country, are shown in Figure 13.3 and Table 13.1. Large international variations are observed. Table 13.1, shows the percent change in averaged ESRD incidence rates in 2000/2001 versus that in 2012/2013. The greatest increases in the incidence of treated ESRD were reported for Thailand (1210%), Bangladesh (629%), Russia (249%), Philippines (185%), Malaysia (176%), the Jalisco region of Mexico (122%), and the Republic of Korea (121%). In contrast, the averaged ESRD incidence in 2012/13 was 2-11% lower than that in 2000/01 in Denmark, Sweden, Scotland, Finland, and Canada. However, the trend in the treated ESRD incidence rate was relatively stable in nearly half of all countries with reported data from 2000 to 2013, ranging from an overall 5% to 30% increase in the ESRD incidence rate in 2000/01 versus that in 2012/13. The U.S. displayed one of the more stable ESRD incidence rates over this time period, with an overall 9% increase from 2000/01 to that in 2012/13, with most of this change occurring prior to 2006 with essentially no meaningful change as of 2006 in the US in ESRD incidence rates.

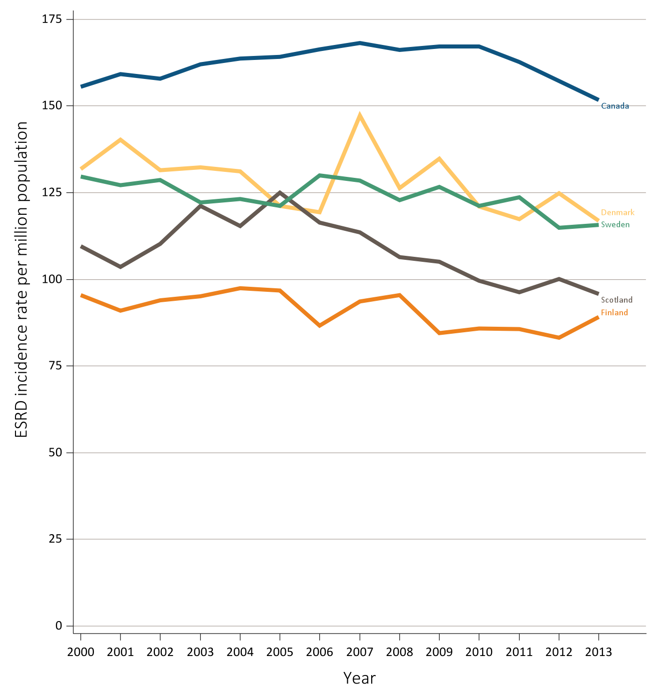
vol 2 Figure 13.3 Trends in the incidence of treated ESRD, per million population, by country, 2000-2013

(a) Ten countries having the highest % rise in ESRD incidence rate from 2000/01 to 2012/13, plus the U.S.



Data source: Special analyses, USRDS ESRD Database. All rates are unadjusted. Data for Croatia are missing from 2006-2011, indicated by the dashed line. Data for U.S. are shown for comparison purposes. Abbreviations: ESRD, end-stage renal disease.

(b) Five countries having the largest % decline in ESRD incidence rate from 2000/01 to 2012/13



Data source: Special analyses, USRDS ESRD Database. All rates are unadjusted. Only five countries had a decrease in incidence from 2000/01-2012/13. Abbreviations: ESRD, end-stage renal disease.

vol 2 **Table 13.1 Trends in the incidence of treated ESRD, per million population, by country, 2000-2013**

ESRD prevalence, per million population

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Argentina	.	.	.	.	137.4	140.3	141.0	151.1	144.4	152.6	151.5	151.9	156.0	162.0	**.**
Australia	91.6	98.4	96.7	99.7	96.9	112.8	117.4	113.3	120.2	112.1	106.0	112.4	113.2	110.0	**17.5**
Austria	132.3	137.6	135.3	140.2	160.8	153.8	159.5	154.0	149.7	150.9	139.8	141.4	143.0	141.7	**5.5**
Bahrain	.	.	.	.	.	.	.	.	206.1	205.4	219.5	207.5	.	.	**.**
Bangladesh	6.1	6.2	6.4	7.5	7.1	8.3	8.3	12.9	13.1	13.4	22.8	31.5	44.9	44.7	**628.5**
Belgium, Dutch sp.	149.3	159.8	174.0	174.8	181.4	183.1	192.4	189.8	192.6	208.8	198.4	185.3	189.6	186.5	**21.7**
Belgium, French sp.	.	176.5	172.9	160.5	186.5	176.8	187.0	187.0	191.8	195.8	191.1	186.3	190.4	182.7	**5.7**
Bosnia and Herzegovina	.	.	.	106.2	107.5	103.9	132.6	150.8	149.3	143.3	133.1	122.6	125.4	116.0	**.**
Brazil	.	.	.	.	.	177.4	184.9	140.1	145.4	98.0	146.7	174.1	171.5	181.8	**.**
Canada	155.6	159.2	157.8	162.0	163.6	164.1	166.3	168.2	166.1	167.2	167.1	162.6	157.1	151.7	**-1.9**
Chile	125.8	123.0	126.8	129.9	157.4	134.5	140.5	143.8	152.8	153.1	155.9	197.2	170.1	212.6	**53.8**
Colombia	.	.	.	.	96.7	100.7	125.9	146.4	107.4	103.4	122.9	92.8	.	.	**.**
Croatia	.	112.1	118.2	131.4	155.0	143.5	.	.	.	.	.	.	158.1	156.7	**40.4**
Czech Republic	150.1	162.8	159.0	167.0	166.0	174.5	185.7	184.6	181.9	180.5	197.8	171.9	.	194.5	**24.3**
Denmark	131.8	140.2	131.5	132.3	131.2	121.2	119.4	147.2	126.3	134.8	121.0	117.3	124.8	116.9	**-11.1**
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	63.7	**.**
Finland	95.4	91.0	94.0	95.1	97.4	96.8	86.6	93.6	95.4	84.5	85.8	85.6	83.1	89.2	**-7.6**
France	.	.	.	.	.	140.1	144.0	140.8	148.2	151.3	152.2	151.0	154.7	159.9	**.**
Greece	157.2	166.7	167.9	179.7	196.5	194.3	197.6	191.6	201.2	205.0	190.9	203.5	210.2	215.8	**31.5**
Hong Kong	.	130.8	128.8	128.2	141.2	145.1	148.9	147.4	148.2	138.5	151.2	157.7	165.6	164.5	**26.2**
Hungary	.	.	.	.	.	.	.	.	235.8	264.5	228.6	241.2	234.3	233.2	**.**
Iceland	56.9	77.2	73.0	72.5	78.7	67.4	69.1	83.7	72.5	87.9	106.9	103.4	59.2	77.2	**1.7**
Indonesia	.	.	.	.	.	.	.	.	.	100.8	128.4	176.1	194.6	207.9	**.**
Iran	.	.	.	.	.	.	.	.	99.2	70.2	73.7	73.5	73.6	75.2	**.**
Ireland	.	.	.	.	.	.	.	.	.	107.2	81.7	90.3	92.2	88.2	**.**
Israel	165.3	167.5	166.2	187.6	188.6	186.2	192.4	193.2	189.5	193.4	186.4	187.6	182.8	181.4	**9.4**
Italy	.	.	.	.	.	.	.	.	.	.	162.0	.	.	.	**.**
Jalisco (Mexico)	194.7	204.8	231.9	280.4	346.1	302.3	345.9	372.2	400.4	419.0	403.9	527.1	466.5	420.9	**122.1**
Japan	241.8	251.3	256.0	263.0	266.8	270.6	275.4	285.2	287.7	287.5	290.6	294.6	285.3	285.9	**15.8**

Table 13.1 continued on next page.

vol 2 **Table 13.1 Trends in the incidence of treated ESRD , per million population, by country, 2000-2013 (continued)**

Country	ESRD prevalence, per million population														% change from 2000/01 to 2012/13
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Rep. of Korea	92.5	113.9	129.5	152.4	170.8	173.4	185.3	183.5	182.1	175.9	181.5	205.3	221.1	234.0	**120.5**
Malaysia	79.1	89.5	97.4	105.6	114.0	121.0	137.8	150.3	168.2	176.0	188.2	210.7	228.8	235.7	**175.5**
Morelos (Mexico)	.	.	.	.	.	.	.	553.2	557.2	597.1	.	.	.	.	**.**
Netherlands	95.4	100.8	102.1	103.2	105.7	106.7	112.8	117.4	120.8	118.6	117.6	117.4	120.7	115.4	**20.3**
New Zealand	109.1	120.3	118.6	115.5	112.5	111.3	119.5	110.9	116.4	135.7	118.4	111.1	117.3	122.9	**4.7**
Norway	89.7	94.6	92.5	95.5	100.8	99.5	100.0	112.8	112.6	116.4	104.1	102.0	103.4	101.0	**10.9**
Oman	.	.	.	.	.	.	.	.	102.1	103.0	106.0	108.0	110.0	120.0	**.**
Philippines	35.2	53.5	53.1	59.8	74.8	74.2	75.3	87.5	87.2	91.1	97.3	103.0	116.8	136.2	**185.2**
Poland	.	.	.	.	.	.	.	.	129.9	134.2	134.3	131.9	133.1	126.2	**.**
Portugal	.	.	.	.	.	.	.	.	231.9	239.5	238.5	226.4	219.9	229.8	**.**
Qatar	.	.	.	.	.	.	.	.	.	.	132.9	136.8	98.7	99.6	**.**
Romania	.	.	.	.	.	94.2	74.9	89.9	96.7	120.8	137.8	140.5	150.6	144.7	**.**
Russia	12.5	15.5	14.7	19.2	17.3	24.3	27.7	.	35.5	34.9	39.5	43.1	47.7	50.1	**249.3**
Saudi Arabia	.	.	.	.	.	.	.	.	138.2	122.5	124.0	130.2	129.2	127.3	**.**
Scotland	109.5	103.5	110.2	121.2	115.4	125.0	116.3	113.5	106.4	105.1	99.6	96.3	100.1	95.7	**-8.1**
Serbia	.	.	.	.	.	.	.	.	.	.	.	150.5	136.1	147.3	**.**
Singapore	203.7	214.1	210.4	203.8	222.6	241.4	240.5	267.7	248.7	229.8	242.3	277.9	285.3	307.5	**41.9**
Slovenia	.	.	.	.	.	.	.	.	.	129.9	120.1	118.4	125.4	126.2	**.**
Spain	.	.	.	.	.	126.0	128.0	120.9	128.1	126.5	121.1	120.7	120.4	127.0	**.**
Sweden	129.7	127.2	128.7	122.1	123.1	121.2	129.9	128.4	122.8	126.7	121.2	123.6	114.8	115.7	**-10.3**
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	93.9	**.**
Taiwan	353.0	368.0	395.1	391.5	405.3	432.4	418.3	423.5	415.9	413.9	439.3	431.2	445.4	457.6	**25.2**
Thailand	10.3	23.4	.	78.4	122.8	110.2	139.4	158.9	100.3	123.2	146.0	227.4	221.1	220.2	**1209.5**
Turkey	114.8	141.1	117.9	111.6	121.4	178.7	191.8	228.9	261.1	256.7	252.2	238.0	.	.	**.**
Ukraine	.	.	.	.	.	.	.	.	.	.	.	.	24.8	.	**.**
United Kingdom^	.	.	.	.	99.7	110.6	114.8	112.4	112.2	111.3	108.6	110.8	110.8	112.5	**.**
United States	326.7	335.2	339.7	344.3	348.0	352.8	361.5	358.1	359.3	367.9	365.7	356.3	357.7	363.1	**8.9**
Uruguay	120.6	124.1	135.6	146.3	151.5	146.1	137.6	142.9	166.2	135.1	153.4	176.5	150.0	163.1	**28**

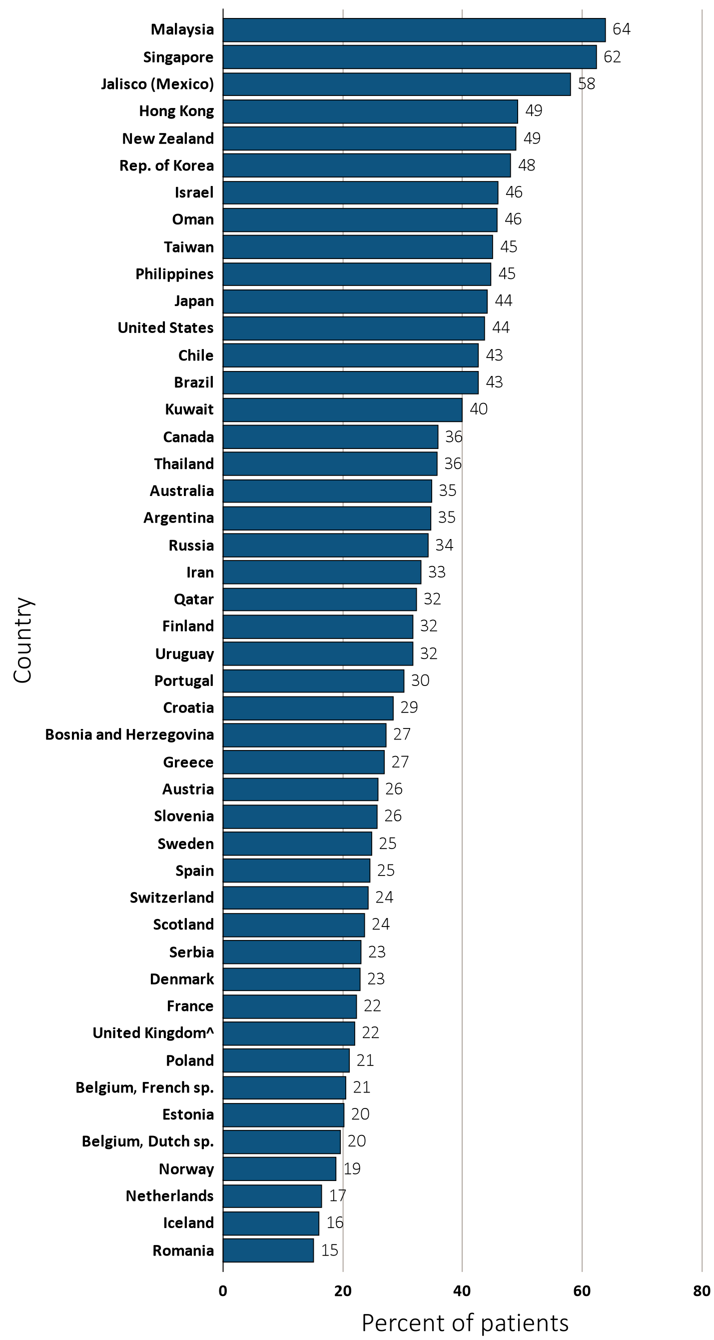
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Incidence is unadjusted. ^United Kingdom: England, Wales, Northern Ireland (Scotland data reported separately). Japan and Taiwan are dialysis only. Data for France include 15 regions in 2006, 18 regions in 2007, 20 regions in 2008, and 22 regions in 2009-2013. Data for Spain include 18 of 19 regions. Data for Belgium do not include patients younger than 20. Data for Indonesia represent the West Java region. [a] % change is calculated as the percent difference between the average incidence in 2012 and 2013 and the average in 2000 and 2001. Abbreviations: ESRD, end-stage renal disease; sp., speaking; . signifies data not reported.

Diabetes as Primary Cause of End-stage Renal Disease in Incident Patients

Data on the incidence of treated ESRD with a primary cause of diabetes mellitus (DM)—a key factor in the global burden of ESRD—were provided by nearly 80% of the countries participating in this report. In 2013, Singapore and Malaysia reported the highest proportions of patients with new ESRD due to DM, at 64 and 62%, respectively (Figure 13.4). Furthermore, DM was the primary cause of new ESRD for at least 40% of patients in Hong Kong, New Zealand, Republic of Korea, Israel, Oman, Taiwan, the Philippines, Japan, United States, Chile, Brazil, and Kuwait. In contrast, DM was the primary cause of ESRD for ≤20% of new ESRD patients in Estonia, Belgium (Dutch-speaking), Norway, Netherlands, Iceland, and Romania in 2013.

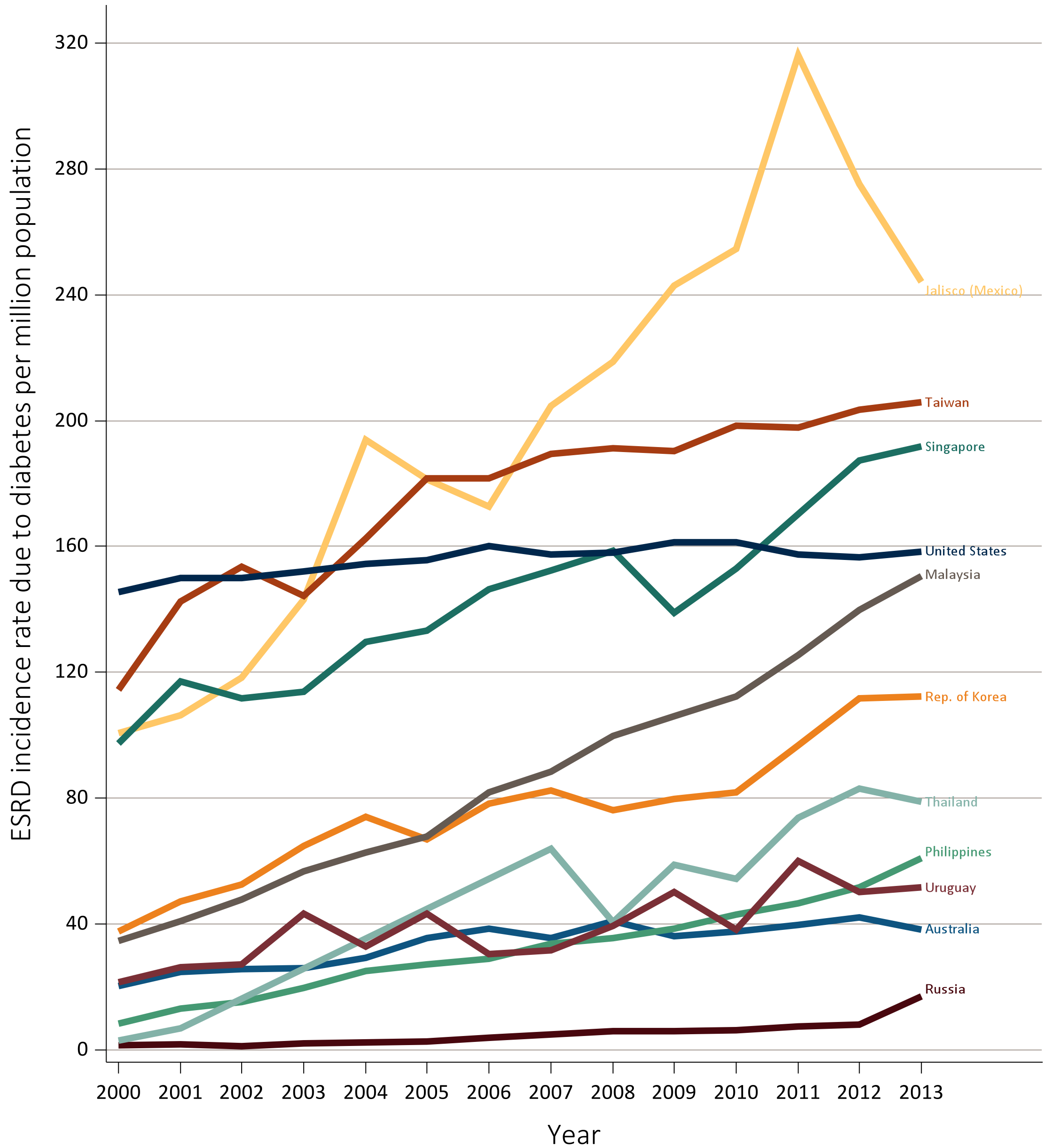
Twenty-one countries have provided rates of ESRD due to DM for the entire time period from 2000 to 2013. These data indicate an overall rise in the rate of treated ESRD due to DM in most, but not all, countries (Table 13.2) However, in some countries the increase in treated ESRD incidence due to DM has been especially large (Figure 13.5), such as in the Jalisco region of Mexico, the Republic of Korea, Malaysia, the Philippines, Singapore, Thailand, Russia, and Uruguay. In these countries, rates have more than doubled between 2000 and 2013. Among the countries shown, the Jalisco region of Mexico had the highest rate of treated ESRD incidence due to DM in 2013, at nearly 280 new ESRD patients per million population.

vol 2 Figure 13.4 Percentage of incident ESRD patients with diabetes as the primary cause of ESRD, by country, 2013



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Indonesia represent the West Java region. Data for Belgium do not include patients younger than 20. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

vol 2 Figure 13.5 Trends in the incidence of treated ESRD due to diabetes, per million population, 2000-2013: Ten countries having the highest % rise from 2000/01 to 2012/13, plus the U.S.



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Abbreviations: ESRD, end-stage renal disease.

vol 2 **Table 13.2 Trends in the incidence of treated ESRD due to diabetes, per million population, 2000-2013**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Argentina	.	.	.	.	43.1	48.7	47.6	50.1	51.1	52.1	53.5	54.9	56.2	56.2	**.**
Australia	20.4	24.9	25.8	25.9	29.3	35.6	38.5	35.7	40.9	36.1	37.7	39.9	42.1	38.4	**77.7**
Austria	43.6	44.5	46.6	47.0	51.9	51.5	52.7	48.8	47.8	44.9	42.1	40.6	37.1	36.7	**-16.2**
Bahrain	.	.	.	.	.	.	.	.	71.4	71.3	70.5	81.2	.	.	**.**
Belgium, Dutch sp.	31.3	38.1	38.9	42.0	44.3	44.4	42.8	44.5	44.5	48.3	41.6	38.4	35.3	36.6	**3.6**
Belgium, French sp.	.	36.5	38.9	40.1	39.6	41.9	42.0	42.6	44.2	49.3	40.7	38.6	41.7	37.4	**8.4**
Bosnia and Herzegovina	.	.	.	24.3	21.7	21.4	28.4	29.7	30.3	43.1	32.4	31.4	36.2	31.6	**.**
Brazil	.	.	.	.	.	.	.	.	50.2	.	.	.	.	77.4	**.**
Canada	49.8	53.3	53.1	55.4	56.2	57.2	56.9	58.4	57.6	57.4	59.5	58.1	60.8	54.5	**11.8**
Chile	.	.	.	.	.	.	.	.	.	.	.	.	.	90.6	**.**
Colombia	.	.	.	.	31.9	36.2	57.5	58.4	35.1	26.1	52.2	31.1	.	.	**.**
Croatia	.	.	.	.	.	.	.	.	.	.	.	.	37.5	44.6	**.**
Czech Republic	49.6	55.3	.	.	.	.	.	.	.	.	.	.	.	.	**.**
Denmark	28.5	31.7	34.6	29.9	28.2	29.4	28.0	34.6	28.8	30.1	27.7	30.6	34.9	26.8	**2.5**
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	12.9	**.**
Finland	30.3	30.8	36.7	33.2	32.3	33.5	31.0	33.5	31.8	27.9	29.1	30.4	28.3	28.3	**-7.4**
France	.	.	.	.	.	32.1	30.7	30.9	33.6	34.5	34.7	33.8	34.1	35.7	**.**
Greece	41.0	44.6	45.0	50.4	55.6	56.9	58.3	53.3	58.6	57.0	55.7	55.2	54.5	58.0	**31.4**
Hong Kong	.	.	60.5	51.2	57.2	59.7	59.9	66.6	62.7	65.4	69.3	72.5	79.0	81.0	**.**
Hungary	.	.	.	.	.	.	.	.	91.4	91.2	101.9	91.4	91.6	.	**.**
Iceland	3.6	14.0	7.0	.	3.4	3.4	19.8	9.7	12.6	15.7	15.7	40.8	.	12.4	**40.9**
Iran	.	.	.	.	.	.	.	.	22.1	23.2	24.6	24.6	24.8	24.9	**.**
Israel	.	.	65.3	73.3	79.6	75.8	80.7	80.8	78.4	83.4	83.7	90.5	89.2	83.3	**.**
Italy	.	.	.	.	.	.	.	.	.	.	34.0	.	.	.	**.**
Jalisco (Mexico)	100.6	106.5	118.2	143.0	193.8	181.4	172.7	204.7	218.8	243.0	254.5	316.2	275.2	244.1	**150.7**
Japan	87.9	95.7	99.1	106.8	109.1	112.6	117.1	123.3	124.2	128.1	127.7	131.3	126.8	126.0	**37.7**
Rep. of Korea	37.7	47.3	52.7	64.8	74.1	66.8	78.4	82.4	76.3	79.8	82.0	96.7	111.9	112.3	**163.8**
Malaysia	34.8	41.0	47.8	56.9	62.8	67.7	81.9	88.5	99.7	106.2	112.3	125.6	139.8	150.7	**283.2**

Table 13.2 continued on next page.

vol 2 **Table 13.2 Trends in the incidence of treated ESRD due to diabetes, per million population, 2000-2013 (continued)**

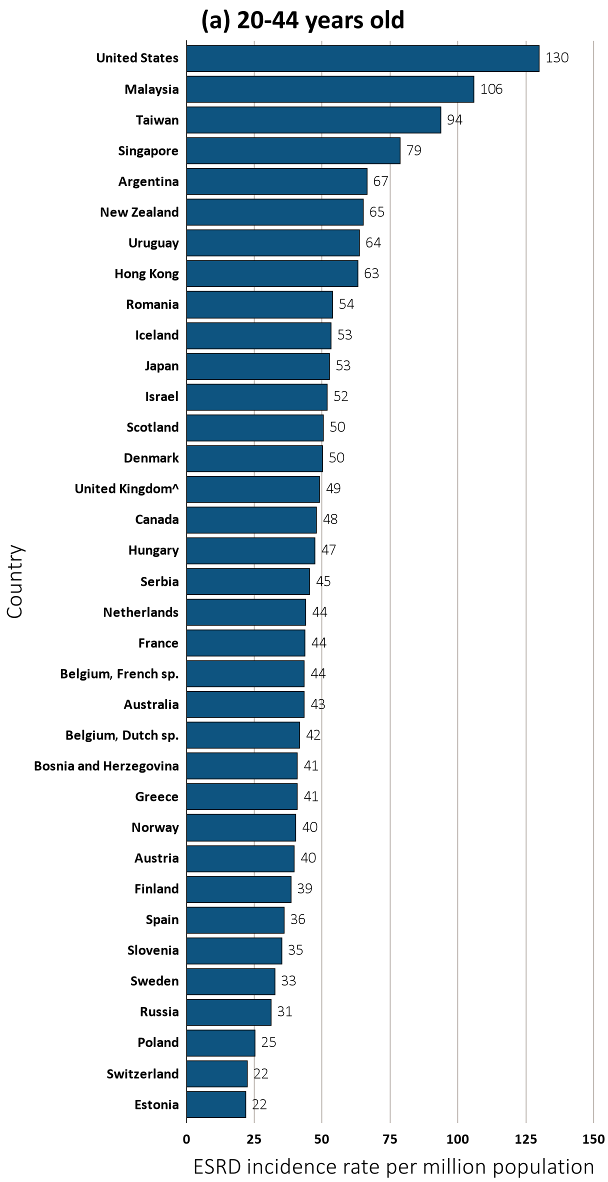
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Morelos (Mexico)	.	.	.	.	.	.	.	287.5	333.4	346.9	.	.	.	.	**.**
Netherlands	15.6	16.3	17.8	17.1	18.4	16.7	18.4	21.5	22.2	18.8	18.8	20.5	20.1	19.0	**22.6**
New Zealand	39.1	45.6	52.8	47.6	45.7	46.9	50.4	45.6	53.3	64.8	59.8	46.8	57.2	60.1	**38.5**
Norway	13.6	13.7	11.0	15.1	17.4	12.8	16.5	15.3	20.3	21.3	17.8	14.5	17.1	19.1	**32.6**
Oman	.	.	.	.	.	.	.	.	45.9	48.0	48.0	52.0	52.0	55.0	**.**
Philippines	8.4	13.3	15.2	19.7	25.1	27.1	29.0	33.8	35.5	38.7	43.0	46.5	51.8	60.9	**419.4**
Poland	.	.	.	.	.	.	.	.	31.2	28.7	26.3	30.0	30.7	26.7	**.**
Portugal	.	.	.	.	.	.	.	.	75.7	72.3	75.2	75.7	68.5	69.4	**.**
Qatar	.	.	.	.	.	.	.	.	.	.	32.1	32.9	32.9	32.3	**.**
Romania	.	.	.	.	.	10.1	9.2	10.5	12.1	15.7	19.6	18.4	19.7	21.9	**.**
Russia	1.6	1.8	1.3	2.1	.	2.7	3.8	.	6.1	5.9	6.2	7.4	8.1	17.2	**644.1**
Saudi Arabia	.	.	.	.	.	.	.	.	48.4	45.3	42.2	48.2	50.4	.	**.**
Scotland	19.9	18.8	20.4	22.9	20.7	27.7	25.8	23.1	23.4	25.4	23.2	22.3	28.0	22.7	**31**
Serbia	.	.	.	.	.	.	.	.	.	.	.	33.4	33.1	34.0	**.**
Singapore	97.4	117.2	111.7	113.8	129.8	133.2	146.4	152.4	158.7	139.0	153.0	170.2	187.3	191.7	**76.6**
Slovenia	.	.	.	.	.	.	.	.	.	31.9	30.3	31.7	35.0	32.5	**.**
Spain	.	.	.	.	30.6	29.3	29.9	26.0	28.9	25.6	29.8	29.3	29.9	31.3	**.**
Sweden	33.0	32.1	30.6	29.4	30.9	31.3	33.9	35.4	29.0	32.0	29.8	30.2	26.2	28.6	**-15.8**
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	22.8	**.**
Taiwan	114.4	142.5	153.6	144.2	162.6	181.8	181.8	189.5	191.1	190.2	198.4	197.8	203.4	205.8	**59.3**
Thailand	3.1	7.0	.	.	.	.	.	64.0	40.7	58.8	54.5	73.9	83.2	78.8	**1504**
Turkey	26.7	37.1	54.5	25.8	25.9	54.0	44.2	52.2	70.5	68.6	76.9	78.4	.	.	**.**
Ukraine	.	.	.	.	.	.	.	.	.	.	.	.	3.0	.	**.**
United Kingdom^	.	.	.	.	19.1	21.0	23.7	23.7	23.9	25.3	24.0	24.7	25.7	24.7	**.**
United States	145.6	150.0	150.1	152.2	154.5	155.8	160.2	157.4	158.0	161.4	161.4	157.6	156.6	158.5	**6.6**
Uruguay	21.4	26.3	27.1	43.3	33.0	43.3	30.5	31.6	39.6	50.2	38.4	60.0	50.2	51.7	**113.6**

Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for France include 15 regions in 2006, 18 regions in 2007, 20 regions in 2008, and 22 regions in 2009-2013. Data for Spain include 18 of 19 regions. Data for Belgium do not include patients younger than 20. [a] % change is calculated as the percent difference between the average incidence in 2012 and 2013 and the average in 2000 and 2001. Abbreviations: ESRD, end-stage renal disease.

Incidence of Treated End-stage Renal Disease by Age Group

The incidence of treated ESRD in 2013 is shown by age group in Figure 13.6. In the majority of countries, treated ESRD incidence was highest among patients aged 75 years or older. The highest ESRD incidence rates in the population aged 75 years and older were reported for Poland, Taiwan, and the U.S. (3166, 2720, and 1396 per million population, respectively). However, the oldest cohort did not display the highest incidence in all countries. In Hong Kong, Malaysia, New Zealand, Serbia, Romania, Russia, Estonia, and Finland, the incidence of treated ESRD was 20-50% lower in the population aged 75 years or older, as compared to those 65-74 years. The highest rate of ESRD incidence in younger adults (aged 20-44 years) was reported in the U.S., where 2013 rates were more than twice that of most other countries with available data.

vol 2 **Figure 13.6 Incidence of treated ESRD per million population, by age group and country, 2013**



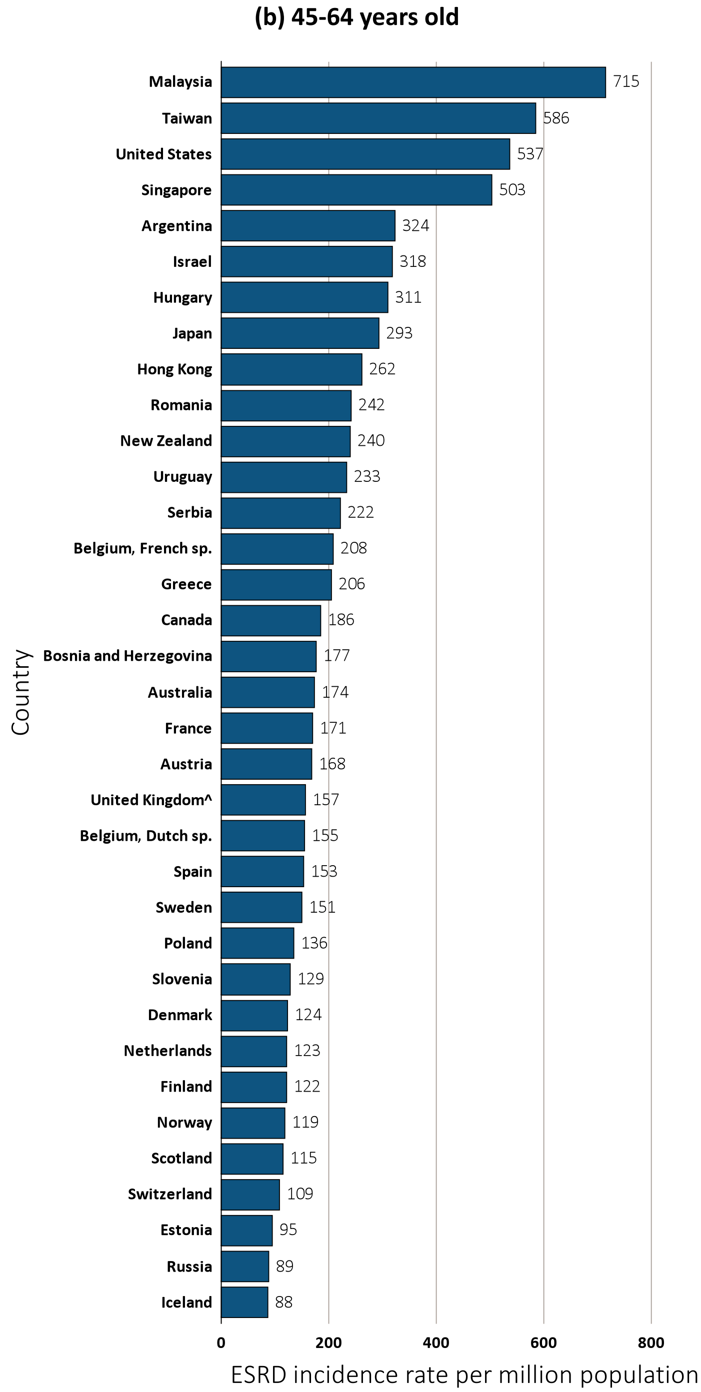
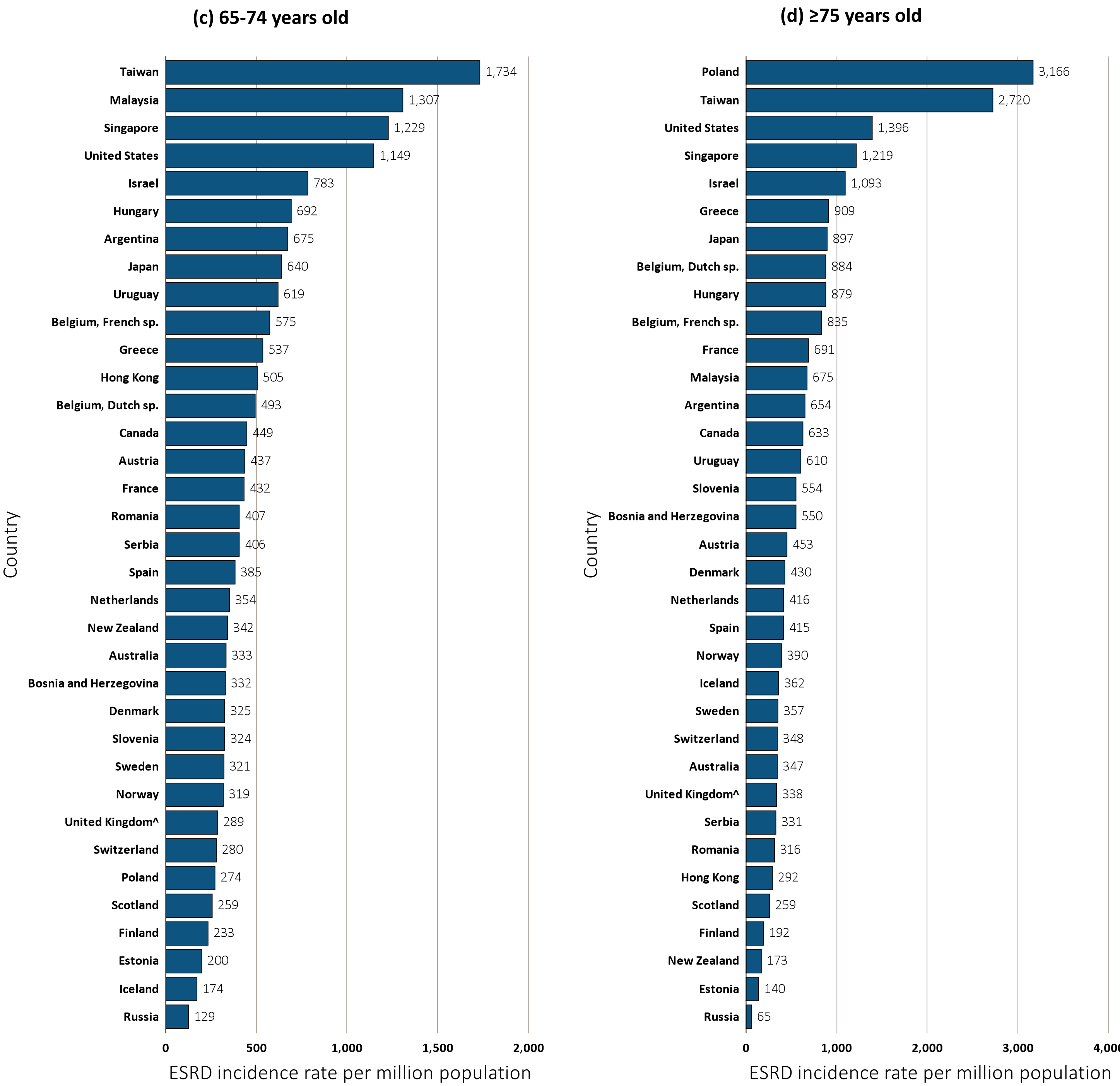


Figure 13.6 continued on next page.

vol 2 **Figure 13.6 Incidence of treated ESRD per million population, by age group and country, 2013 (continued)**



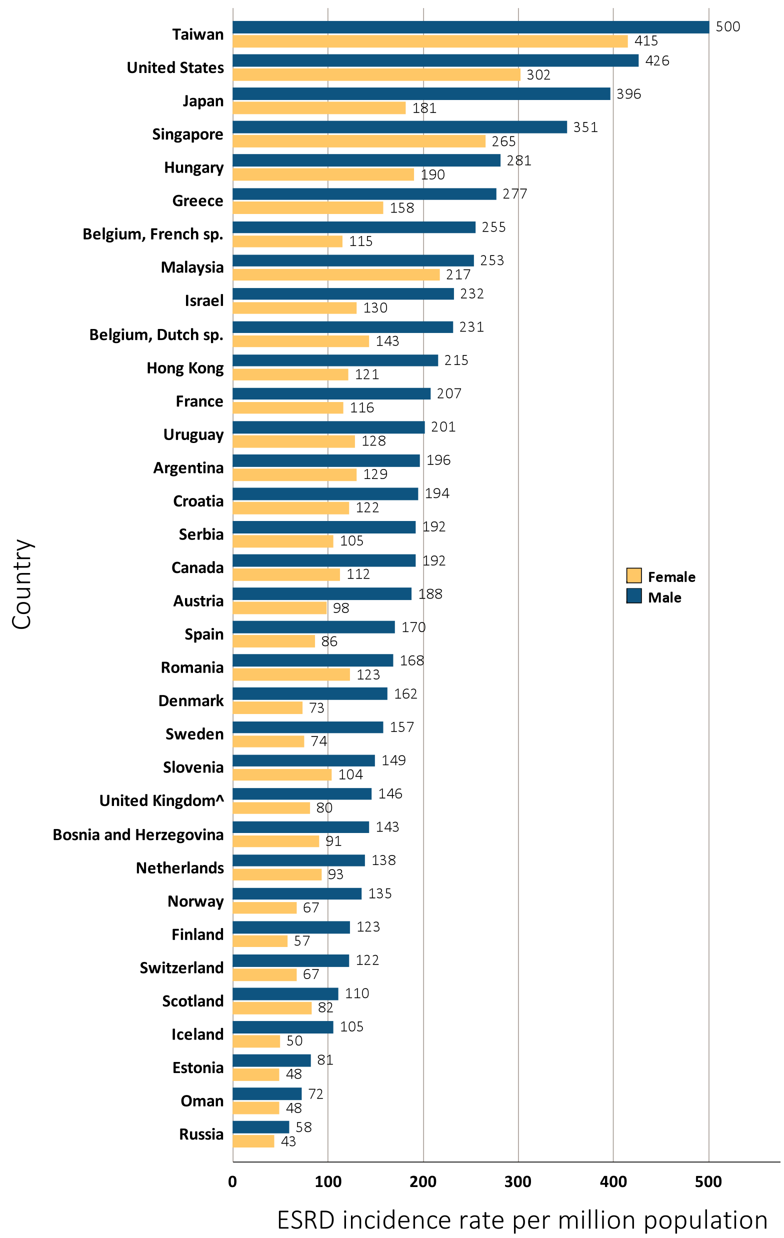
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Spain include 18 of 19 regions. Data for France include 22 regions. For graph (a), data for Spain include patients 15-44 years old, and data for the United States include patients 22-44 years old. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

Incidence of Treated End-stage Renal Disease by Sex

Comparisons of the incidence of treated ESRD by sex are shown in Figure 13.7. In every country the rate is substantially higher for males than for females. The incidence of treated ESRD was approximately 1.8 to 2 times higher for males in French-speaking Belgium, France, all of the Nordic countries shown, and Spain, and was 1.2 to 1.9 times higher for males versus females in most other countries. In contrast, Taiwan was the only country in which the incidence of treated ESRD was only slightly higher for males than for females.

The above indication of considerably lower ESRD incidence for females versus males in nearly all countries shown in Figure 13.7 is consistent with the recent paper by Hecking et al (2014) who observed that considerably fewer women than men were being treated with hemodialysis for end-stage renal disease in 12 countries participating in the Dialysis Outcomes and Practice Patterns Study (DOPPS) from 2002-2012. The current international findings regarding substantially lower ESRD incidence rates for females versus males in essentially all countries displayed in this current report in conjunction with the prior findings by Hecking et al (2014) lead to the broader question of what factors are responsible for this differential ESRD incidence in males versus females that is consistently being seen across this large number of countries.

vol 2 Figure 13.7 Incidence of treated ESRD per million population, by sex and country, 2013



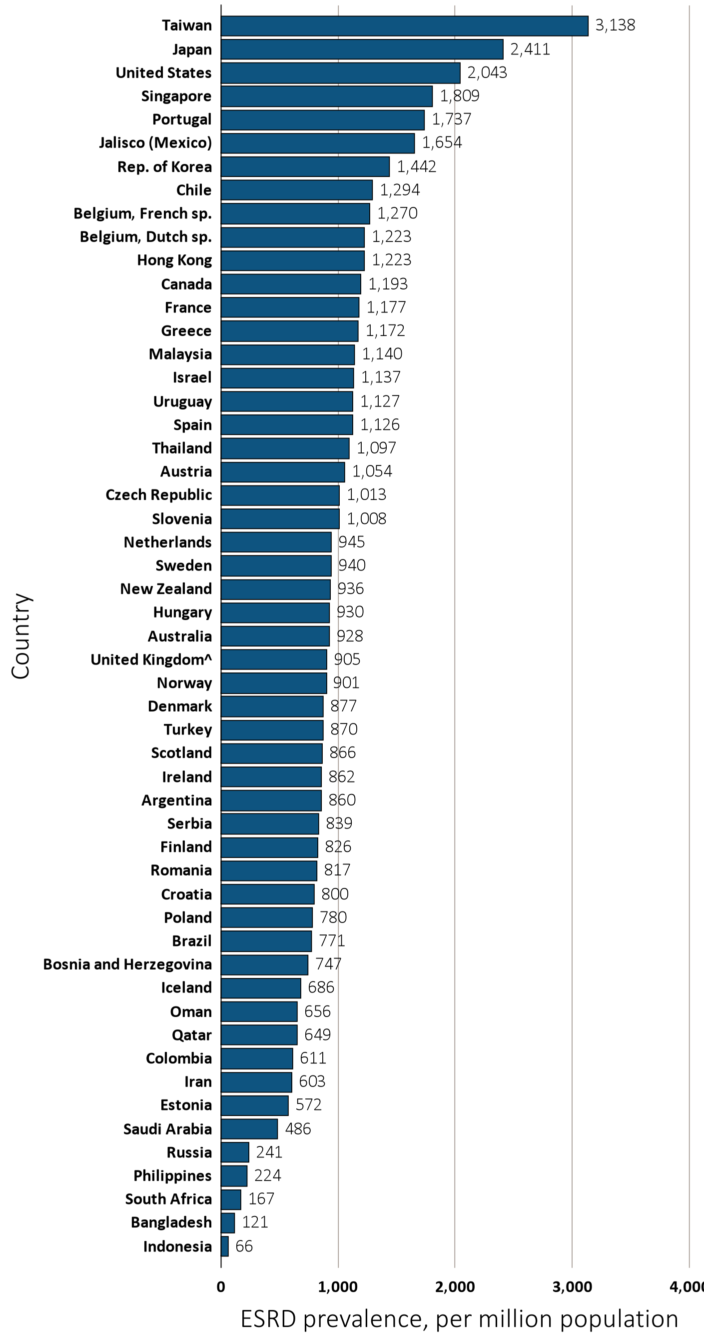
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Belgium do not include patients younger than 20. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Indonesia represent the West Java region. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

Prevalence of End-stage Renal Disease

In 2013, ESRD prevalence varied nearly 30-fold across represented countries (see Figure 13.8 and Table 13.3). Treated ESRD prevalence was highest, ranging from 1442 to 3138 per million population, in the Asian countries of Taiwan, Japan, Singapore, and the Republic of Korea, as well as in the US, Portugal, and Jalisco region of Mexico. In nearly 30% of countries, prevalence ranged from 1,000 to 1,300 per million population, while nearly 45% of countries reported a treated ESRD prevalence between 600 and 1000 patients per million population. These included many countries in the northern part of Western Europe and Central/Eastern Europe, Australia and New Zealand, the South American countries of Argentina, Brazil, and Colombia, and the Middle Eastern nations of Iran and Qatar. The lowest prevalence was reported in Indonesia, Bangladesh, South Africa, the Philippines, Russia, and Saudi Arabia, where ESRD prevalence ranged from 66 to 486 per million population.

In most countries, the prevalence of treated ESRD per million population was highest for individuals aged 65-74 years (Figure 13.9), whereas in Belgium, Bosnia and Herzegovina, Canada, France, Greece, Japan, Netherlands, Slovenia, and Taiwan, the prevalence was highest for those aged 75 years and older. Notably, in Malaysia, New Zealand, and Russia, the prevalence of treated ESRD was ~2 to 2.6 times lower for those 75 years and older versus those 65-74 years old. Among younger adults - 20 to 44 years old – the US displayed the highest ESRD prevalence across all countries. Similar to that seen for ESRD incidence rates, the prevalence of treated ESRD was substantially greater for males than females in all countries, except in Taiwan in which ESRD prevalence was similar for males and females (Figure 13.10).

vol 2 **Figure 13.8 Prevalence of treated ESRD per million population, by country, 2013**



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. The prevalence is unadjusted and reflects prevalence at the end of 2013. Japan and Indonesia includes dialysis patients only. Data for Belgium do not include patients younger than 20. Data for Indonesia represent the West Java region. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

vol 2 **Figure 13.9 Prevalence of treated ESRD per million population, by age group and country, 2013**

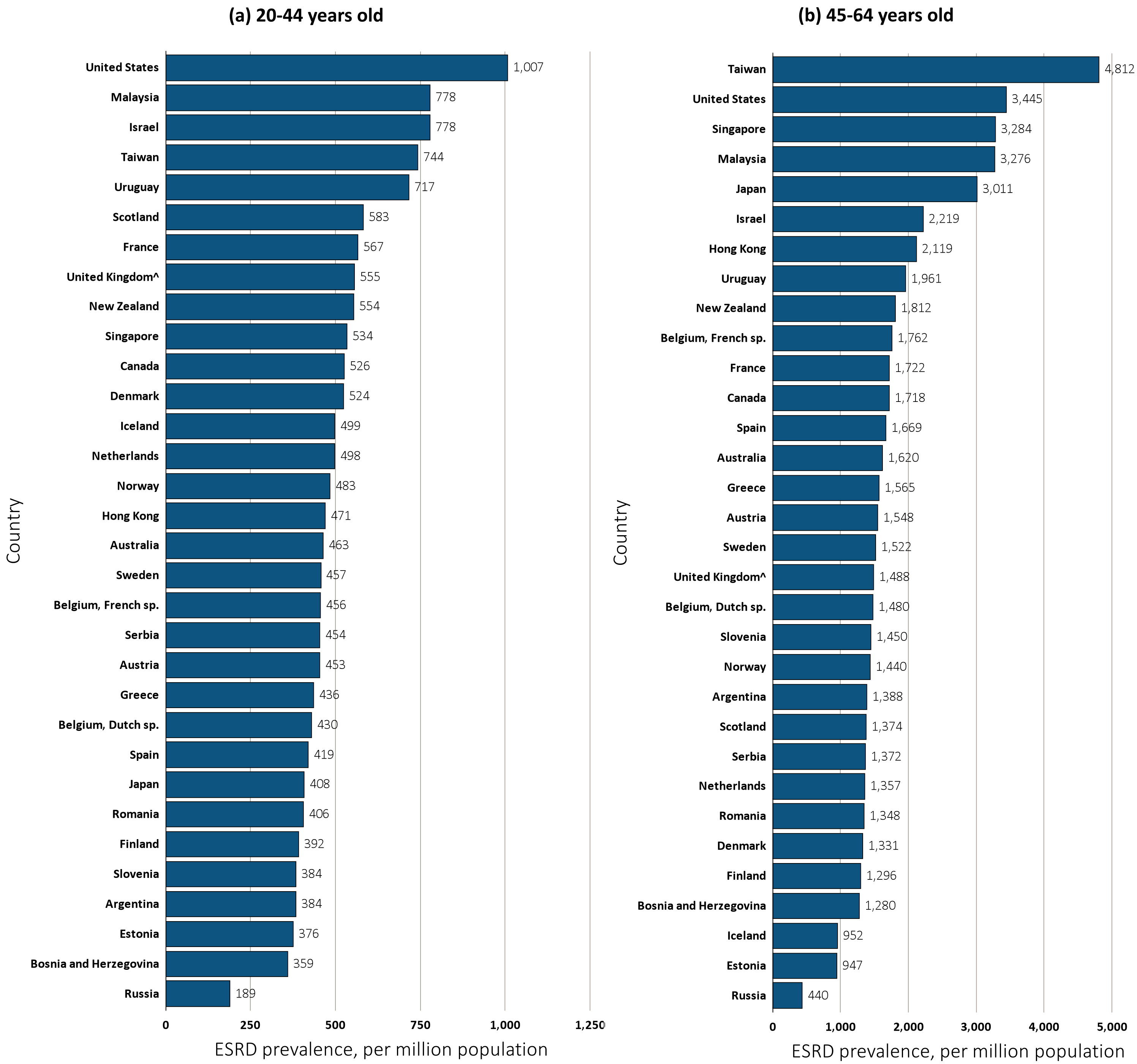
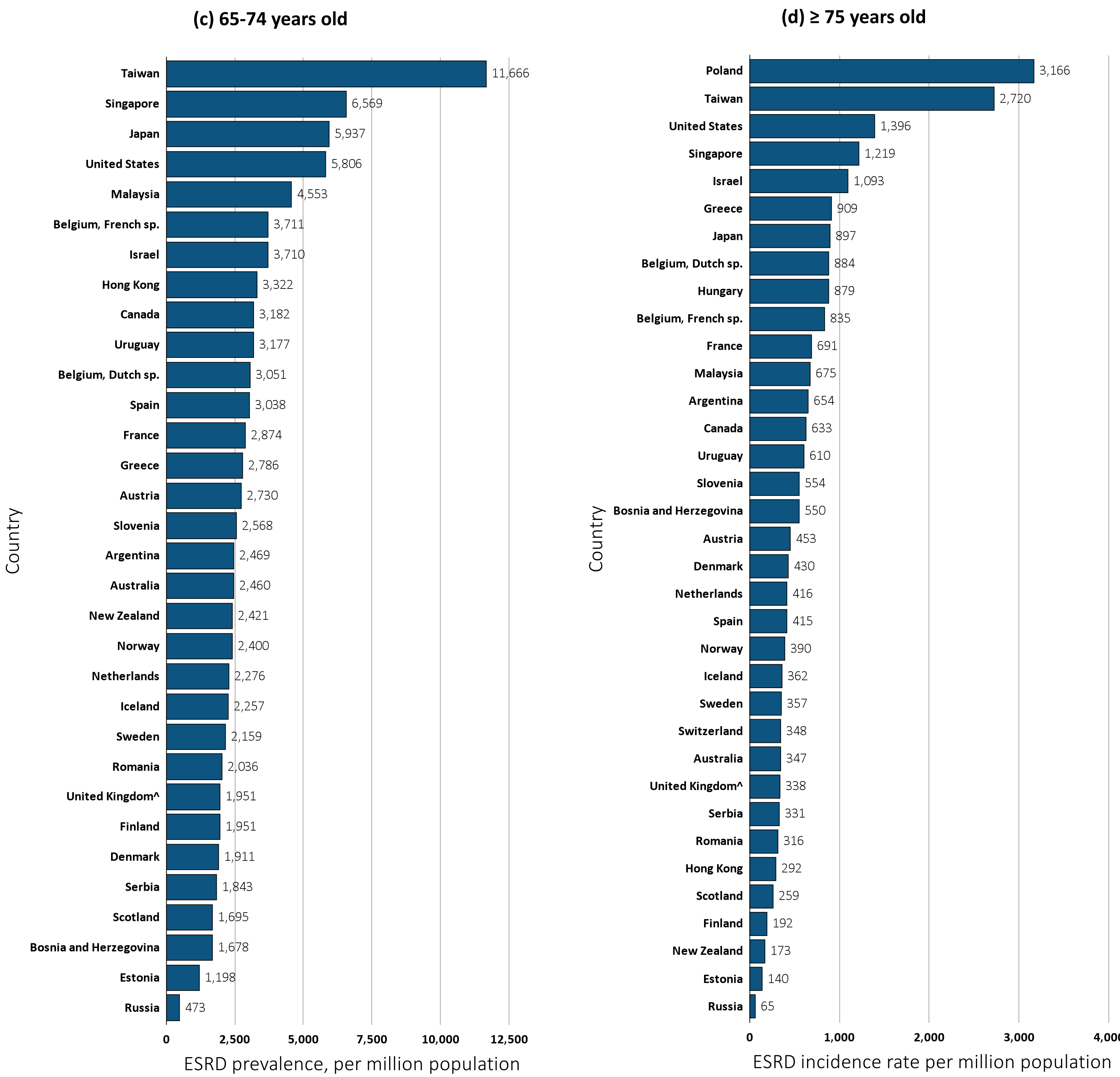


Figure 13.9 continued on next page.

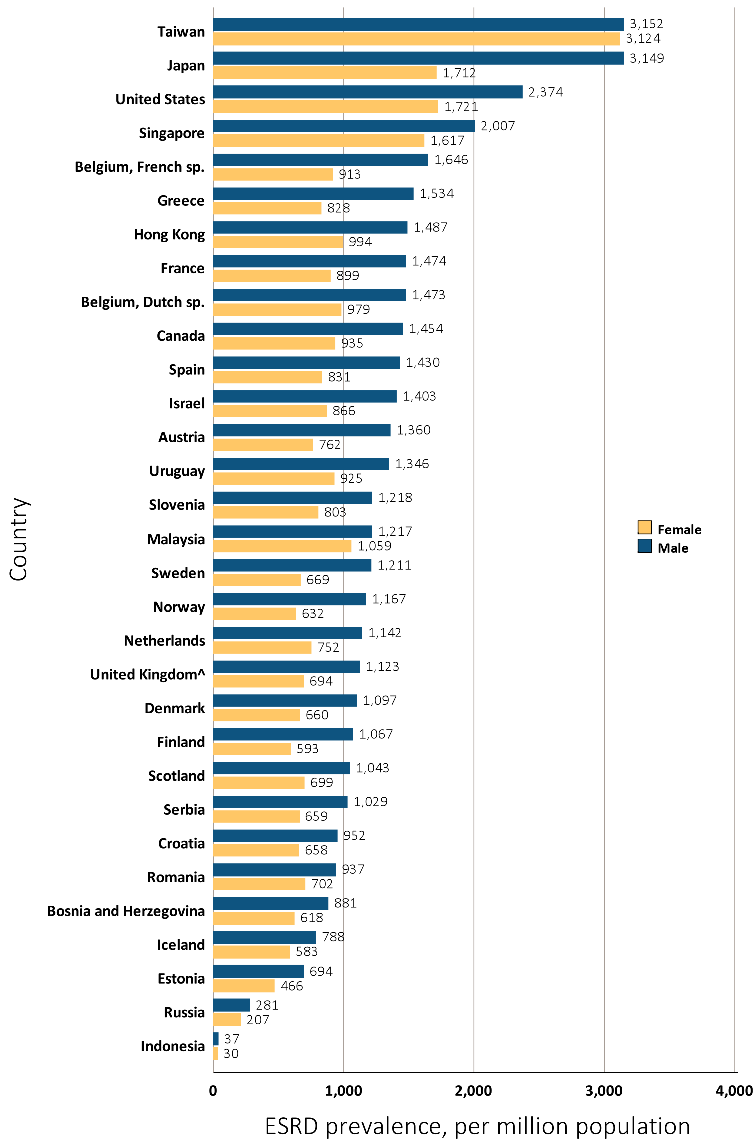
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Japan and Indonesia include dialysis patients only. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

vol 2 Figure 13.9 Prevalence of treated ESRD, per million population, by age group and country, in 2013 (continued)



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Japan and Indonesia include dialysis patients only. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

vol 2 **Figure 13.10 Prevalence of treated ESRD per million population, by sex and country, 2013**



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Japan and Indonesia include dialysis patients only. Data for Belgium do not include patients younger than 20. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

From 2006 to 2013 the prevalence of ESRD steadily increased in all countries that provided data for 2013. These trends are indicative of the increasing worldwide need for additional dialysis and kidney transplantation services to meet the health needs of individuals with ESRD. As shown in Figure 13.11 and Table 13.3, the largest proportionate increases in ESRD prevalence between 2000/01 and 2012/2013 were observed in Thailand, the Jalisco region of Mexico, and the Philippines (range: 323 to 839% increase), followed by rises of 99% to 227% in ESRD prevalence in Russia, Malaysia, Turkey, the Republic of Korea, Bangladesh, Israel, and Chile.

In 2013, the total number of patients treated for ESRD was by far the highest in the U.S. (Table 13.3), with nearly 650,000 treated patients, followed by Japan and Brazil with approximate cohorts of 307,000 and 155,000 patients, respectively. Spain, the United Kingdom, Turkey, France, Thailand, Taiwan, and the Republic of Korea reported between 50,000 to 75,000 treated ESRD patients in 2013, with all other countries indicating a smaller treated ESRD population, with approximately 9,000 treated ESRD patients in the median country.

vol 2 **Table 13.3 Number of prevalent treated ESRD patients and prevalence of ESRD, per million population, by country, 2000-2013**

ESRD prevalence, per million population

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Argentina	.	.	.	.	550.3	578.7	598.0	615.4	755.7	761.9	781.7	774.9	819.9	859.9	.
Australia	608.6	634.5	662.7	688.6	709.8	746.5	778.3	801.3	839.0	853.4	872.1	891.3	912.7	928.4	**48.1**
Austria	714.7	755.2	781.6	859.1	854.4	889.4	908.6	933.5	947.9	980.8	992.3	1001.0	1025.3	1053.7	**41.4**
Bahrain	.	.	.	.	.	.	.	.	291.0	300.4	280.3	339.7	.	.	.
Bangladesh	52.7	58.9	64.6	72.0	72.5	80.2	87.8	101.3	112.8	107.5	113.0	105.0	122.3	120.7	**117.7**
Belgium, Dutch sp.	790.4	834.4	879.0	909.8	950.0	993.7	1033.1	1063.8	1096.0	1138.6	1164.0	1184.6	1205.9	1223.1	**49.5**
Belgium, French sp.	.	828.6	885.3	933.0	987.1	1022.2	1071.5	1110.7	1145.7	1128.1	1165.0	1193.2	1232.6	1269.9	**51**
Bosnia and Herzegovina	.	.	.	477.3	487.2	524.2	551.9	601.8	637.0	646.4	675.1	709.8	718.9	746.9	.
Brazil	.	.	.	338.1	367.5	388.9	398.3	466.0	408.5	475.8	467.1	671.2	720.2	771.1	.
Canada	807.6	856.9	899.9	933.1	972.2	1006.1	1039.1	1071.1	1094.1	1118.6	1135.5	1158.3	1175.7	1192.6	**42.3**
Chile	611.5	671.6	725.8	772.8	840.9	865.8	929.6	985.7	1065.2	1108.8	1161.1	1235.7	1263.4	1293.8	**99.3**
Colombia	.	.	.	.	.	.	.	.	455.3	441.3	544.2	536.3	578.4	611.3	.
Croatia	621.5	657.0	699.1	789.7	806.8	835.5	.	.	.	.	.	.	1033.0	799.5	**43.3**
Czech Republic	620.9	662.2	695.1	707.7	757.6	452.4	461.9	499.9	538.1	907.6	970.1	974.4	.	1012.8	**57.9**
Denmark	639.6	685.3	716.5	743.2	755.8	770.4	781.8	832.2	832.1	842.6	846.3	856.7	871.6	876.9	**32**
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	572.1	.
Finland	582.3	613.0	635.5	663.9	688.8	715.8	727.1	747.4	769.2	783.5	798.6	807.5	811.8	825.9	**37**
France	.	.	.	.	.	916.9	962.6	953.9	993.1	1052.5	1089.2	1118.6	1142.9	1177.4	.
Greece	799.9	815.6	842.1	880.8	922.7	958.3	986.1	1013.4	1038.9	1069.7	1083.8	1104.1	1136.6	1172.1	**42.9**
Hong Kong	.	787.5	843.0	877.7	927.8	970.3	1003.0	1031.4	1067.4	1128.9	1145.8	1159.1	1194.9	1222.5	**53.5**
Hungary	.	.	.	.	.	.	.	.	578.1	868.6	889.9	904.7	919.8	929.6	.
Iceland	362.7	407.1	434.7	480.1	475.9	475.2	483.9	518.5	523.0	536.9	594.3	661.4	676.6	685.7	**77**
Indonesia	.	.	.	.	.	.	.	.	.	27.9	37.3	40.1	50.6	65.9	.
Iran	.	.	.	.	.	.	.	.	490.6	524.3	544.4	564.2	583.3	603.4	.
Ireland	.	.	.	.	.	.	.	.	.	769.2	801.6	825.2	845.3	862.2	.
Israel	526.0	542.0	577.7	896.3	934.7	973.6	1010.1	1040.7	1070.8	1086.6	1101.9	1120.2	1125.4	1136.7	**111.8**
Jalisco (Mexico)	270.3	337.9	389.5	394.4	507.6	807.9	928.9	986.2	1029.6	1314.3	1332.3	1381.5	1408.8	1653.5	**403.5**
Japan	1616.2	1640.3	1727.0	1795.2	1850.9	1879.8	1954.5	2058.1	2126.0	2205.4	2277.4	2313.8	2365.2	2411.1	**46.7**
Rep. of Korea	584.5	642.2	700.6	794.5	854.0	899.8	941.7	972.8	1031.7	1113.6	1144.4	1224.8	1353.3	1441.5	**127.8**
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	855.0	.	.

Table 13.3 continued on next page.

vol 2 **Table 13.3 Number of prevalent treated ESRD patients and prevalence of ESRD, per million population, by country, 2000-2013 (continued)**

ESRD prevalence, per million population

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Malaysia	338.4	382.3	429.4	476.8	526.9	577.4	626.3	692.5	769.4	828.1	903.1	974.8	1060.5	1140.4	**205.4**
Netherlands	617.1	636.2	656.0	678.4	703.7	733.5	772.2	802.5	820.2	850.4	873.2	894.1	918.2	945.4	**48.7**
New Zealand	610.6	652.2	689.2	719.1	733.9	754.0	775.5	793.2	812.0	857.2	880.8	884.6	904.7	935.6	**45.7**
Norway	581.2	611.9	642.8	667.9	708.9	732.4	753.1	784.0	816.9	844.1	859.2	875.0	887.9	900.5	**49.9**
Oman	.	.	.	.	.	.	.	.	463.5	499.7	618.7	663.2	713.9	655.8	**.**
Philippines	48.4	.	22.3	46.0	52.3	91.1	80.6	84.6	109.8	119.2	136.9	163.2	185.1	224.4	**323**
Poland	.	.	.	.	.	.	.	.	647.5	672.4	665.5	706.7	732.2	779.8	**.**
Portugal	.	.	.	.	.	.	.	.	1406.8	1505.1	1589.5	1662.0	1670.3	1736.9	**.**
Qatar	.	.	.	.	.	.	.	.	.	.	601.2	627.9	647.4	649.1	**.**
Romania	.	.	.	.	.	254.4	304.7	368.3	422.4	555.6	625.1	694.4	766.1	816.9	**.**
Russia	64.8	73.8	79.3	90.9	102.2	114.9	130.1	.	158.0	173.1	185.5	196.4	211.7	241.4	**226.9**
Saudi Arabia	.	.	.	.	.	.	.	.	797.5	474.5	465.5	492.2	499.4	485.5	**.**
Scotland	634.5	661.2	683.9	713.2	731.1	761.0	783.9	812.0	809.9	827.1	836.6	841.2	856.1	866.0	**32.9**
Serbia	.	.	.	.	.	.	.	.	.	.	.	765.5	799.7	839.1	**.**
Singapore	1103.0	1176.1	1225.7	1271.6	1301.9	1345.3	1400.1	1441.8	1494.8	1526.9	1578.6	1661.8	1741.4	1809.1	**55.8**
Slovenia	.	.	.	.	.	.	.	.	.	981.5	987.5	985.5	999.9	1008.3	**.**
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	163.7	166.8	**.**
Spain	.	.	.	.	1098.5	868.4	961.0	956.2	994.8	886.2	1045.5	1074.7	1075.6	1125.7	**.**
Sweden	716.4	739.8	764.5	778.3	808.9	820.4	850.7	866.7	875.7	891.6	910.0	929.2	931.3	939.5	**28.5**
Taiwan	1526.3	1643.7	1792.2	1899.8	1999.2	2101.4	2196.8	2285.1	2432.0	2667.3	2811.5	2923.1	3030.8	3137.7	**94.6**
Thailand	98.4	114.8	.	237.9	243.4	220.1	286.0	419.8	496.9	552.8	639.3	749.8	905.9	1096.6	**839.3**
Turkey	271.2	352.6	373.7	401.2	433.4	450.7	589.2	711.5	753.1	819.2	847.4	868.2	815.6	870.2	**170.2**
Ukraine	.	.	.	.	.	.	.	.	.	.	.	.	131.3	.	**.**
United Kingdom^	.	.	.	.	621.5	680.4	722.9	737.6	773.2	802.7	826.1	851.6	874.1	905.0	**.**
United States	1359.9	1415.7	1469.6	1520.5	1570.6	1619.7	1672.1	1722.5	1774.5	1831.5	1887.4	1936.2	1987.8	2042.5	**45.2**
Uruguay	737.1	762.9	807.3	845.5	893.2	849.1	927.1	963.9	1016.5	1018.6	1033.2	1074.9	1072.6	1127.1	**46.6**

Table 13.3 continued on next page.

vol 2 **Table 13.3 Number of prevalent ESRD patients and prevalence of ESRD, per million population, by country, 2000-2013 (continued)**

(a) Prevalent patients, counts

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina	.	.	.	.	21,034	22,333	23,306	24,218	30,035	30,580	31,885	31,975	34,218	36,290
Australia	11,657	12,318	13,017	13,691	14,275	15,175	16,112	16,842	17,826	18,510	19,212	19,909	20,742	21,470
Austria	5,770	6,091	6,303	6,940	6,925	7,232	7,512	7,731	7,898	8,195	8,325	8,432	8,657	8,906
Bahrain	.	.	.	.	.	.	.	.	322	354	346	406	410	.
Bangladesh	6,746	7,537	8,265	9,220	10,274	11,565	12,864	15,089	17,068	16,068	17,080	16,050	18,922	18,900
Belgium, Dutch sp.	4,700	4,975	5,260	5,464	5,728	6,023	6,300	6,531	6,779	7,094	7,309	7,497	7,677	7,823
Belgium, French sp.	.	3,583	3,850	4,068	4,335	4,516	4,768	4,983	5,184	5,151	5,378	5,566	5,795	6,005
Bosnia and Herzegovina	.	.	.	1,829	1,867	2,009	2,115	2,306	2,441	2,477	2,587	2,490	2,522	2,620
Brazil	.	.	.	59,153	65,121	70,872	73,605	87,044	77,589	92,091	91,314	132,491	143,497	155,011
Canada	24,784	26,581	28,222	29,542	31,057	32,467	33,898	35,274	36,465	37,742	38,749	39,942	41,009	41,931
Chile	9,301	10,344	11,314	12,190	13,450	14,160	15,353	16,360	17,856	18,849	19,854	21,007	21,730	22,512
Colombia	.	.	.	.	.	.	.	.	20,239	19,846	24,760	24,692	26,942	28,807
Croatia	2,755	2,913	3,100	3,504	3,582	3,708	3,799	3,932	4,009	4,124	4,257	4,348	4,410	2,740
Czech Republic	6,374	6,759	7,092	7,227	7,743	4,638	4,752	5,190	5,633	9,536	10,218	10,236	.	10,647
Denmark	3,415	3,670	3,851	4,004	4,125	4,219	4,295	4,592	4,619	4,701	4,743	4,821	4,923	4,973
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	754
Finland	3,014	3,180	3,305	3,461	3,601	3,755	3,829	3,953	4,087	4,183	4,283	4,351	4,395	4,492
France	.	.	.	.	.	31,151	34,835	49,679	54,627	62,019	64,197	66,243	68,448	70,792
Greece	8,480	8,942	9,266	9,705	10,207	10,641	10,994	11,343	11,674	12,069	12,255	12,477	12,608	12,832
Hong Kong	.	5,300	5,670	5,937	6,307	6,635	6,930	7,171	7,460	7,580	7,857	8,197	8,549	8,787
Hungary	.	.	.	.	.	.	.	.	5,807	8,713	8,912	9,034	9,135	9,211
Iceland	102	116	125	139	139	141	147	161	166	171	189	211	217	222
Indonesia	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iran	.	.	.	.	.	.	.	.	35,248	38,250	40,300	42,370	44,450	46,640
Ireland	.	.	.	.	.	.	.	.	.	3,487	3,651	3,775	3,876	3,960
Israel	3,350	3,528	3,796	5,995	6,364	6,747	7,125	7,472	7,826	8,134	8,400	8,699	8,902	9,161
Jalisco (Mexico)	1,688	2,110	2,432	2,463	3,170	5,455	6,357	6,865	7,218	9,222	9,916	10,421	10,769	12,802
Japan	205,139	208,791	220,196	229,110	236,334	240,170	249,718	262,968	271,471	281,212	289,415	295,706	301,545	306,925
Rep. of Korea	28,046	31,014	33,993	38,790	41,891	44,333	46,730	48,675	51,989	56,396	58,860	63,341	70,211	75,042
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	4,100	.

Table 13.3 continued on next page.

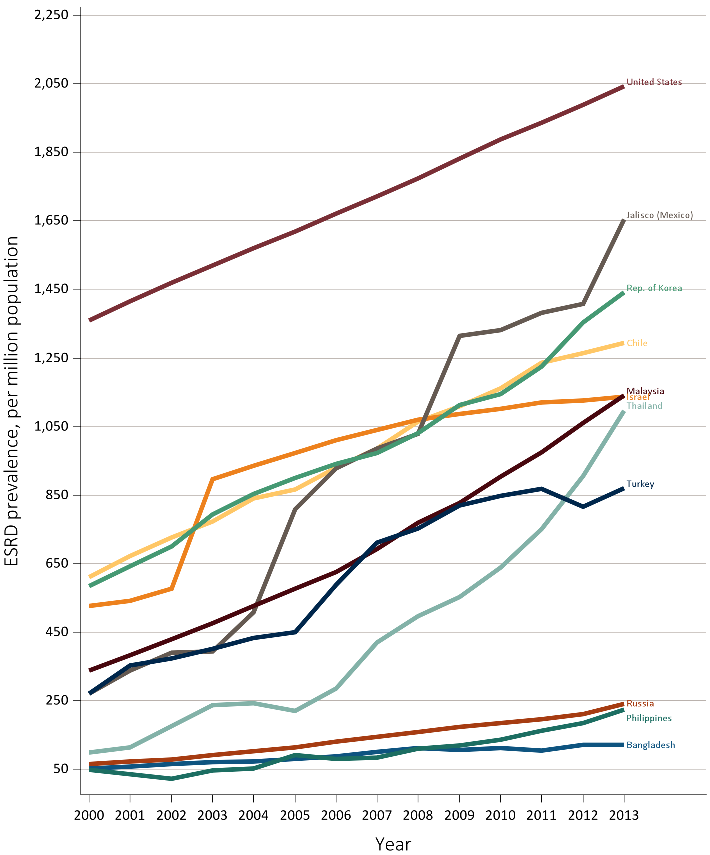
vol 2 **Table 13.3 Number of prevalent ESRD patients and prevalence of ESRD, per million population, by country, 2000-2013**

(a) Prevalent patients, counts

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Malaysia	7,951	9,180	10,531	11,943	13,479	15,086	16,805	18,825	21,191	23,442	25,589	28,234	31,113	33,887
Morelos (Mexico)	.	.	.	.	.	.	.	1,447	1,561	1,638	.	.	.	.
Netherlands	9,827	10,209	10,594	11,008	11,457	11,970	12,623	13,146	13,488	14,057	14,508	14,926	15,384	15,887
New Zealand	2,356	2,531	2,715	2,883	3,000	3,117	3,245	3,354	3,459	3,688	3,832	3,878	3,988	4,156
Norway	2,610	2,762	2,917	3,049	3,255	3,386	3,510	3,692	3,895	4,076	4,201	4,334	4,456	4,574
Oman	.	.	.	.	.	.	.	.	1,535	1,708	1,836	2,008	2,206	2,382
Philippines	3,861	.	1,853	3,922	4,375	7,676	7,437	7,967	10,552	11,683	13,674	16,619	19,210	23,727
Poland	.	.	.	.	.	.	.	.	24,783	25,665	25,635	27,236	28,226	30,131
Portugal	.	.	.	.	.	.	.	.	14,965	16,011	16,788	17,553	17,641	18,345
Qatar	.	.	.	.	.	.	.	.	.	.	1,031	1,088	1,181	1,408
Romania	.	.	.	.	.	5,504	6,578	7,935	9,088	10,863	12,150	13,414	14,752	16,162
Russia	9,508	10,770	11,517	13,175	14,720	16,483	18,486	.	22,234	24,246	26,327	27,989	30,349	34,680
Saudi Arabia	.	.	.	.	.	.	.	.	19,334	12,040	12,633	13,356	14,171	14,562
Scotland	3,245	3,347	3,457	3,607	3,713	3,877	4,011	4,177	4,186	4,296	4,369	4,419	4,549	4,614
Serbia	.	.	.	.	.	.	.	.	.	.	.	5,223	5,412	5,651
Singapore	3,611	3,912	4,147	4,281	4,444	4,665	4,936	5,165	5,445	5,701	5,954	6,297	6,648	6,955
Slovenia	.	.	.	.	.	.	.	.	.	2,002	2,023	2,023	2,057	2,077
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	8,559	8,840
Spain	.	.	.	.	39,578	28,366	35,462	41,546	44,067	39,708	47,632	50,614	50,837	50,565
Sweden	6,356	6,581	6,823	6,972	7,275	7,408	7,725	7,929	8,074	8,291	8,534	8,780	8,865	9,020
Taiwan	34,001	36,828	40,362	42,945	45,360	47,849	50,255	52,462	56,025	61,668	65,120	67,889	70,666	73,339
Thailand	5,963	7,225	.	15,004	15,083	13,741	17,967	26,457	31,496	35,112	40,845	47,987	58,385	71,037
Turkey	18,390	24,348	26,268	28,549	31,251	33,014	42,992	50,221	53,859	59,443	62,471	64,877	61,677	66,711
Ukraine	.	.	.	.	.	.	.	.	.	.	.	.	5,985	.
United Kingdom^	.	.	.	.	34,022	37,502	40,101	41,188	43,478	45,775	47,499	49,383	51,042	53,196
United States	383,716	403,431	422,696	441,103	459,875	478,651	498,928	518,883	539,620	561,848	583,817	603,287	623,916	645,697
Uruguay		2,551	2,715	2,675	2,895	2,807	3,073	3,204	3,389	3,407	3,468	3,532	3,525	3,704

Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. ESRD prevalence is unadjusted and reflects prevalence at the end of each year. ^United Kingdom: England, Wales, Northern Ireland (Scotland data reported separately). Japan and Indonesia include dialysis only; Israel includes dialysis patients only for 2000-2002. Taiwan includes dialysis patients only for 2000-2012. Data for France include 15 regions in 2006, 18 regions in 2007, 20 regions in 2008, and 22 regions in 2009-2013. Data for Spain include 18 of 19 regions. Data for Belgium do not include patients younger than 20. Data for Indonesia represent the West Java region. [a] % change is calculated as the percent difference between the average prevalence in 2012 and 2013 and the average in 2000 and 2001. Abbreviations: ESRD, end-stage renal disease; sp., speaking; . signifies data not reported.

vol 2 Figure 13.11 Trends in the prevalence of treated ESRD per million population, by country, 2000-2013: Ten countries having the highest % rise in ESRD prevalence from 2000/01 to 2012/13, plus the U.S.



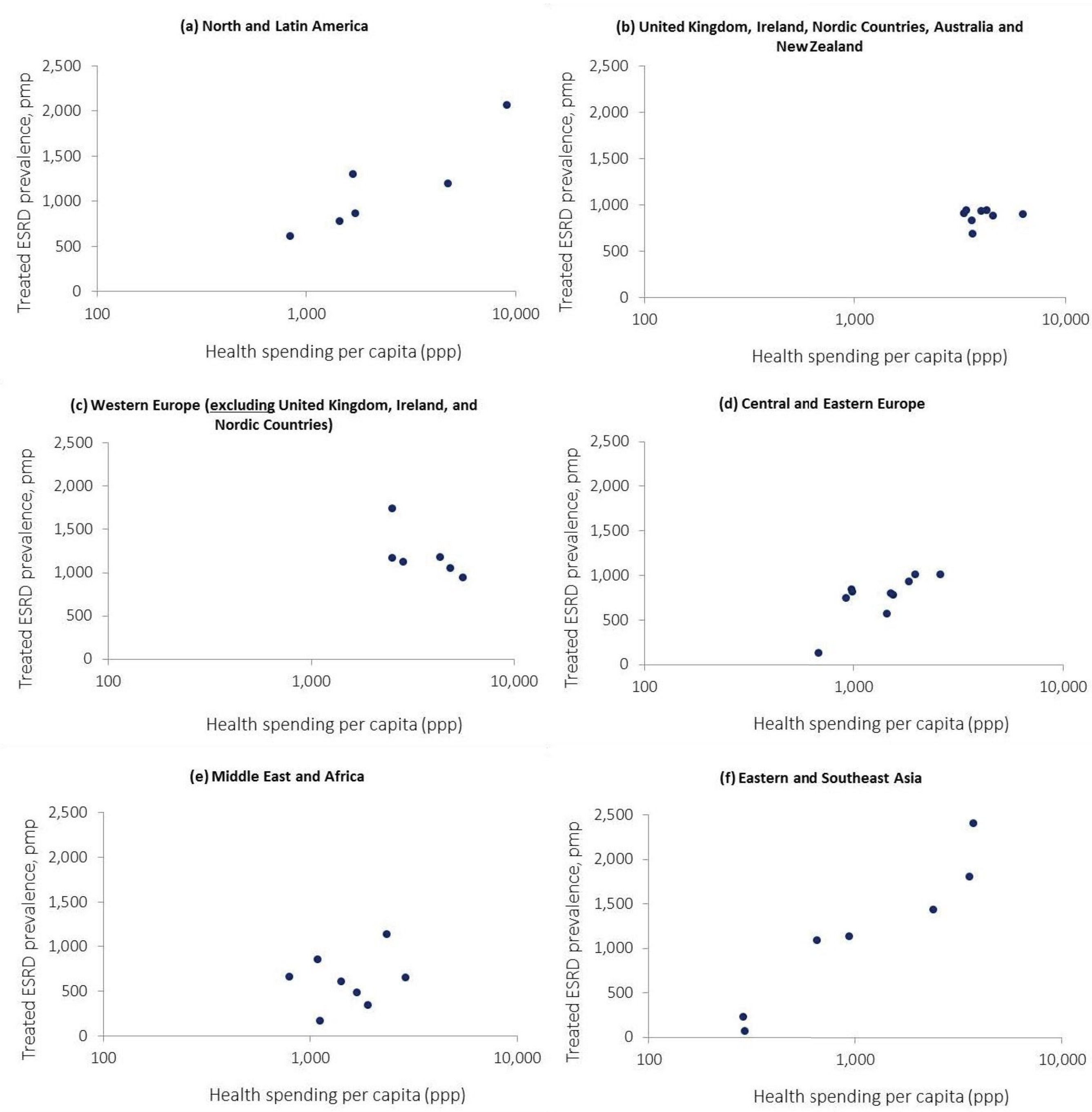
Data source: Special analyses, USRDS ESRD Database. ESRD prevalence is unadjusted. Israel includes dialysis patients only from 2000-2002. U.S. is shown for comparison purposes. Abbreviations: ESRD, end-stage renal disease.

Relationships between Health and Development Indicators and the Prevalence of Treated ESRD across Countries

Given the increasing diversity of countries represented in this International Comparisons chapter, this year we introduce a comparison of a country's prevalence of treated ESRD with selected health and development indicators. International variation in treated ESRD prevalence reflects interactions between the underlying burden of disease, historical access to treatment, and treatment outcomes in different countries. Indicators such as the human development index (HDI), health spending per capita, and diabetes prevalence may therefore explain some of the observed international variation in treated ESRD prevalence. While it would also be relevant to examine the correlations between these indicators and ESRD incidence, such an analysis is partially confounded by "catch-up" growth of dialysis programs in countries that are transitioning away from historically limited access to renal replacement therapy. For this reason, we present analyses of ESRD prevalence only. Correlations are presented within discrete global regions that reflect genetic, health system, economic, and/or geographical similarities. As with ESRD data collection methods varying across countries to some extent, the manner by which HDI, health spending, and diabetes prevalence are ascertained for individual countries likely differ across countries, and thus direct comparisons should be made with caution.

Figure 13.12 presents the correlations between prevalence of treated ESRD and health spending per capita (in constant 2011 international dollars, reflecting purchasing power parity—PPP) for all countries represented in this chapter, by region. Trends towards higher prevalence of ESRD with higher health spending per capita were observed for North & Latin America, and Eastern & Southeast Asia. There was also some indication of similar, though weaker, trends in Central and Eastern Europe and the Middle East and Africa. In Australasia, Ireland, Nordic countries and the United Kingdom, ESRD prevalence clustered between 686 and 940 cases per million population, with health spending ranging from 3,311 to 6,308 international dollars per capita. By comparison, prevalence of ESRD was higher in the rest of Western Europe, ranging from 945 to 1,737 per million population, whereas health spending was slightly lower (range of 2,508 to 4,885 international dollars per capita).

vol 2 **Figure 13.12 Prevalence of treated ESRD per million population, and health spending per capita (PPP), by region, 2013**

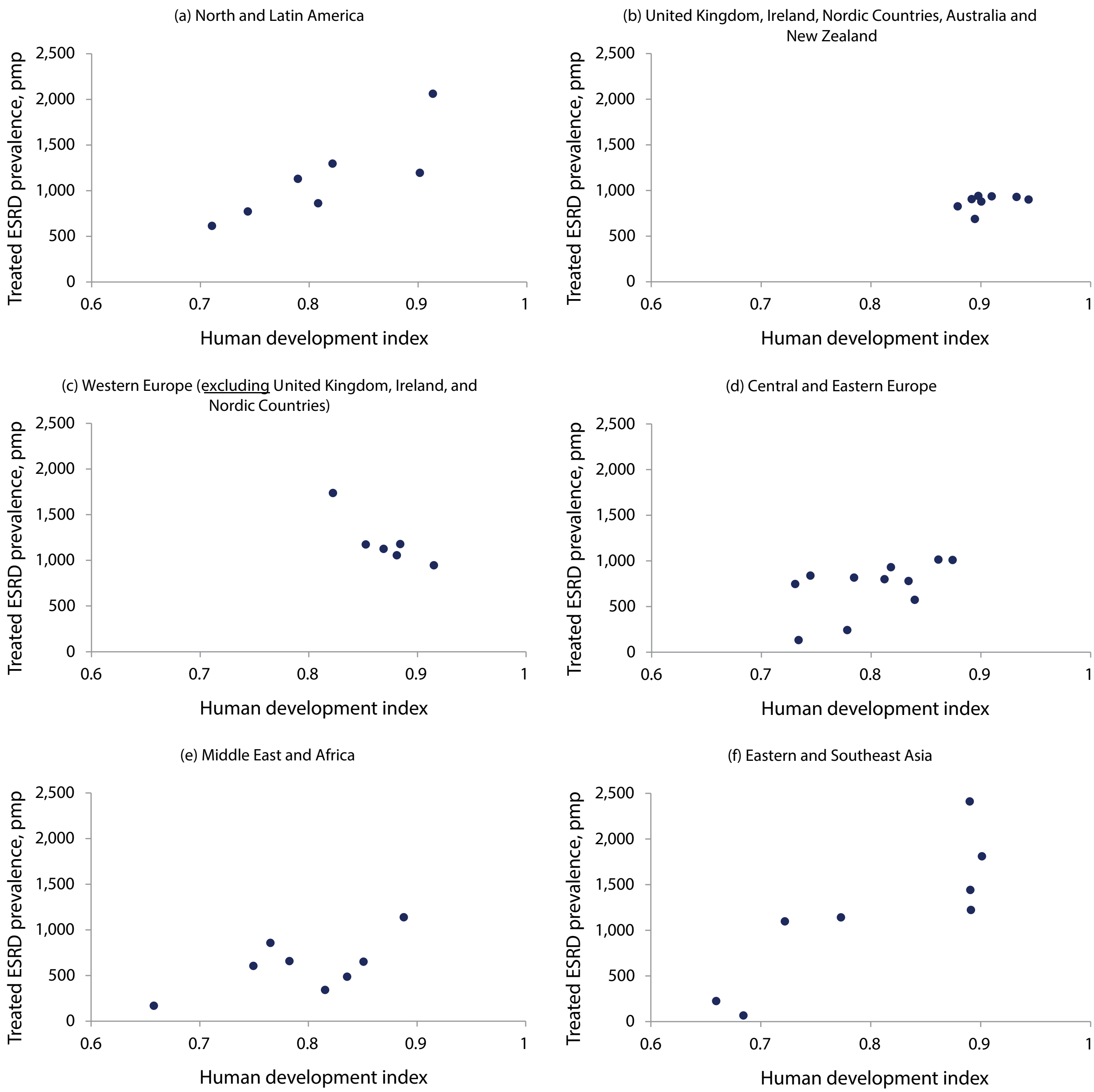


Data source: Special analyses, USRDS ESRD Database & World Health Organization Global Health Expenditure database. Data presented only for countries from which relevant information was available. ESRD prevalence is unadjusted and reflects the most recent available prevalence since 2010. aCentral & Eastern Europe: Hungary, Romania, Czech Republic, Poland, Bosnia and Herzegovina, Serbia, Slovenia, Russian Federation, Turkey; Western Europe (except. United Kingdom, Ireland, & Nordic countries): France, Belgium (French-speaking), Belgium (Dutch-speaking), Spain, Portugal, Greece, Austria, Netherlands; United Kingdom, Ireland, Nordic Countries & ANZ: United Kingdom, Ireland, Sweden, Norway, Finland, Denmark, Iceland, Australia, New Zealand; North & Latin America: Argentina, Uruguay, Colombia, Brazil, Mexico (Jalisco), United States, Canada; Eastern & Southeast Asia: South Korea, Malaysia, Singapore, Thailand, Indonesia, Philippines, Japan; Middle East & Africa: Bahrain, Israel, Iran, Qatar, Saudi Arabia, South Africa. Abbreviations: ESRD, end-stage renal disease; PPP, purchasing power parity; pmp, per million population.

Figure 13.13 shows the relationship between ESRD prevalence with values of the human development index (HDI), for countries in the dataset. The HDI is a summary measure of averaged achievement in 3 key dimensions of human development: life expectancy at birth, mean years of schooling, and standard of living (based on gross national income per capita expressed in purchasing power parity international dollars). Longer life expectancies and higher living standards may result in higher rates of treated ESRD, but also potentially to more effective disease prevention. Trends towards higher prevalence of ESRD with a higher HDI were observed for North and

Latin America, the Middle East and Africa, and Eastern and Southeast Asia. There was also evidence of a similar, though weaker, trend in Central and Eastern Europe. In the group of countries including in Australasia, Ireland, the Nordic countries, and the United Kingdom, ESRD prevalence ranged from 686 to 940 cases per million population, with HDI clustered between 0.88 and 0.94. By comparison, prevalence of ESRD was higher in the rest of Western Europe (range 945 to 1,737 per million population), where HDI values were on average slightly lower. Among countries with the highest HDI (>0.90), ESRD prevalence ranged from 877 cases per million population (Denmark) to 2043 cases per million population (United States). Among countries with the lowest HDI in this dataset (<0.75), ESRD prevalence ranged from 70 cases per million population (Indonesia), to 1097 cases per million population (Thailand).

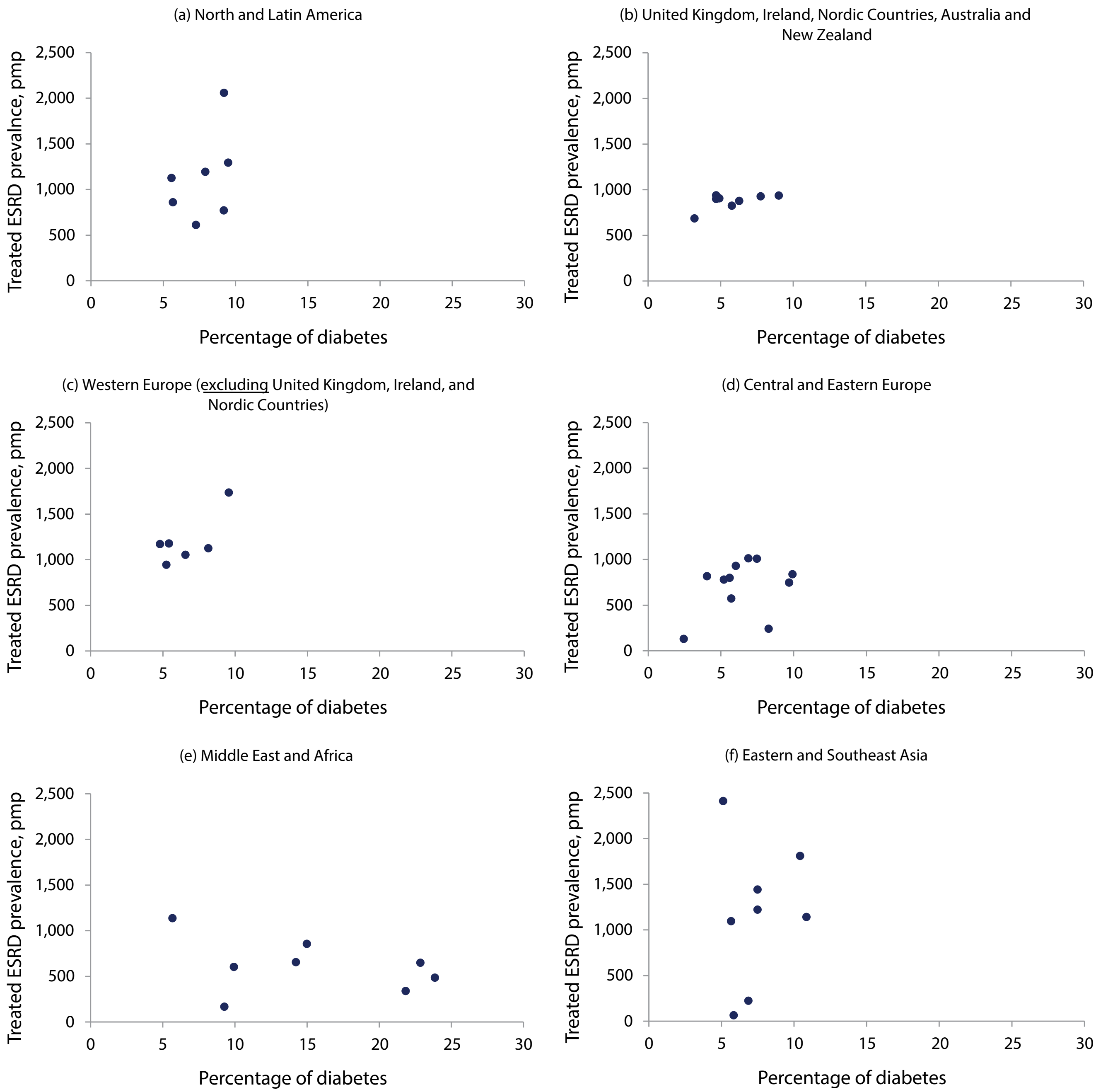
vol 2 **Figure 13.13 Prevalence of treated ESRD per million population, and Human Development Index, by region, 2013**



Data source: Special analyses, USRDS ESRD Database &United Nations Development Programme. Data presented only for countries from which relevant information was available. ESRD prevalence is unadjusted and was from 2013 for all countries except Bahrain for which it was from 2011 and Ukraine for which it was from 2012. aCentral & Eastern Europe: Hungary, Romania, Czech Republic, Poland, Bosnia and Herzegovina, Serbia, Slovenia, Russian Federation, Turkey; Western Europe (except. United Kingdom, Ireland, & Nordic countries): France, Belgium (French-speaking), Belgium (Dutch-speaking), Spain, Portugal, Greece, Austria, Netherlands; United Kingdom, Ireland, Nordic Countries & ANZ: United Kingdom, Ireland, Sweden, Norway, Finland, Denmark, Iceland, Australia, New Zealand; North & Latin America: Argentina, Uruguay, Colombia, Brazil, Mexico (Jalisco), United States, Canada; Eastern & Southeast Asia: South Korea, Malaysia, Singapore, Thailand, Indonesia, Philippines, Japan; Middle East & Africa: Bahrain, Israel, Iran, Qatar, Saudi Arabia, South Africa. Abbreviations: ESRD, end-stage renal disease; pmp, per million population.

Figure 13.14 illustrates the relationship between population prevalence of treated ESRD and crude prevalence of diabetes in the population aged 20-79 years. Overall, poor correlation was observed between the burden of diabetes in the adult population and rates of treatment for ESRD. This overall poor correlation may be indicative of multiple factors—in particular the relative impact of secondary prevention in different settings, rates of mortality in the diabetes population, variation in rates of detection of kidney disease in diabetic individuals, and access to dialysis and transplantation. The very high estimated prevalence of diabetes, but relatively low prevalence of treated ESRD, in North Africa and the Middle Eastern region are particularly noteworthy.

vol 2 **Figure 13.14 Prevalence of treated ESRD per million population, and percentage of diabetes, by region, 2013**



Data source: Special analyses, USRDS ESRD Database & International Diabetes Federation, Diabetes Atlas. Data presented only for countries from which relevant information was available. ESRD prevalence is unadjusted and was from 2013 for all countries except Bahrain for which it was from 2011 and Ukraine for which it was from 2012. Diabetes percentage refers to the percentage of people ages 20-79 who have type 1 or type 2 diabetes. aCentral & Eastern Europe: Hungary, Romania, Czech Republic, Poland, Bosnia and Herzegovina, Serbia, Slovenia, Russian Federation, Turkey; Western Europe (except. United Kingdom, Ireland, & Nordic countries): France, Belgium (French-speaking), Belgium (Dutch-speaking), Spain, Portugal, Greece, Austria, Netherlands; United Kingdom, Ireland, Nordic Countries & ANZ: United Kingdom, Ireland, Sweden, Norway, Finland, Denmark, Iceland, Australia, New Zealand; North & Latin America: Argentina, Uruguay, Colombia, Brazil, Mexico (Jalisco), United States, Canada; Eastern & Southeast Asia: South Korea, Malaysia, Singapore, Thailand, Indonesia, Philippines, Japan; Middle East & Africa: Bahrain, Israel, Iran, Qatar, Saudi Arabia, South Africa. Abbreviations: ESRD, end-stage renal disease; pmp, per million population.

vol 2 **Table 13.4 Health and development indicators and the prevalence of treated ESRD, across countries, 2013**

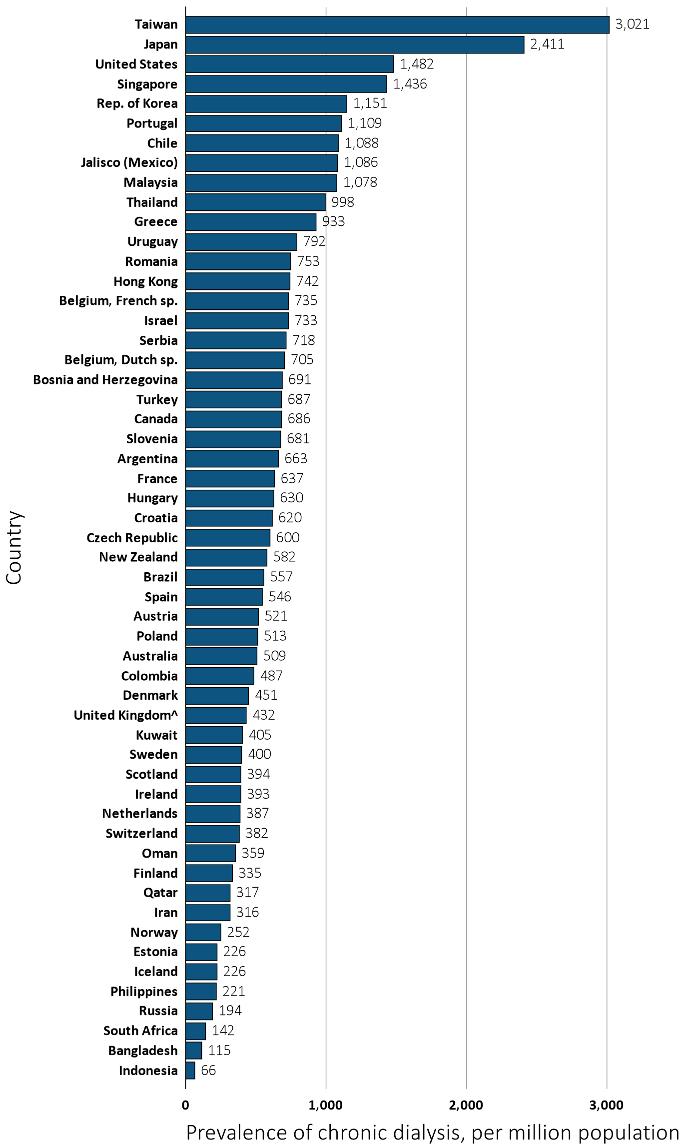
Region	Country	Health spending per capita	Human Development Index	Percentage of diabetes	Prevalence of treated ESRD, pmp
Central & Eastern Europe	Bosnia and Herzegovina	928	0.73	9.7	747
	Croatia	1517	0.81	5.6	800
	Czech Republic	1982	0.86	6.9	1013
	Estonia	1453	0.84	5.7	572
	Hungary	1839	0.82	6.0	930
	Poland	1551	0.83	5.2	780
	Romania	988	0.78	4.0	817
	Russia	NA	0.78	8.3	241
	Serbia	987	0.74	9.9	839
	Slovenia	2595	0.87	7.5	1008
	Ukraine	687	0.73	2.5	131
Eastern & Southeast Asia	Hong Kong	NA	0.89	7.5	1223
	Indonesia	293	0.68	5.8	66
	Japan	3741	0.89	5.1	2411
	Republic of Korea	2398	0.89	7.5	1442
	Malaysia	938	0.77	10.9	1140
	Philippines	287	0.66	6.9	224
	Singapore	3578	0.90	10.4	1809
	Thailand	658	0.72	5.7	1097
Middle East & Africa	Bahrain	1900	0.82	21.8	340
	Iran	1414	0.75	9.9	603
	Israel	2357	0.89	5.7	1137
	Lebanon	1092	0.77	15.0	855
	Oman	796	0.78	14.2	656
	Qatar	2882	0.85	22.9	649
	Saudi Arabia	1681	0.84	23.9	486
	South Africa	1121	0.66	9.3	167
North & Latin America	Argentina	1725	0.81	5.7	860
	Brazil	1452	0.74	9.2	771
	Canada	4759	0.90	7.9	1193
	Chile	1678	0.82	9.5	1294
	Colombia	843	0.71	7.3	611
	United States	9146	0.91	9.2	2043
	Uruguay	1715	0.79	5.6	1127
UK, Ireland, Nordic European Union Countries, & Australia /New Zealand	Australia	3997	0.93	7.8	928
	Denmark	4552	0.90	6.3	877
	Finland	3604	0.88	5.8	826
	Iceland	3646	0.89	3.2	686
	New Zealand	3405	0.91	9.0	936
	Norway	6308	0.94	4.7	901
	Sweden	4244	0.90	4.7	940
	United Kingdom	3311	0.89	4.9	905
Western Europe	Austria	4885	0.88	6.6	1054
	France	4334	0.88	5.4	1177
	Greece	2513	0.85	4.8	1172
	Netherlands	5601	0.92	5.2	945
	Portugal	2508	0.82	9.6	1737
	Spain	2846	0.87	8.2	1126

Data source: Special analyses, USRDS ESRD Database & World Health Organization Global Health Expenditure database, United Nations Development Programme, International Diabetes Federation, Diabetes Atlas. Data presented only for countries from which relevant information was available. ESRD prevalence is unadjusted and reflects the most recent available prevalence since 2010. Diabetes percentage refers to the percentage of people ages 20-79 who have type 1 or type 2 diabetes. Abbreviations: ESRD, end-stage renal disease; PPP, purchasing power parity; pmp, per million population.

Dialysis Therapy for ESRD

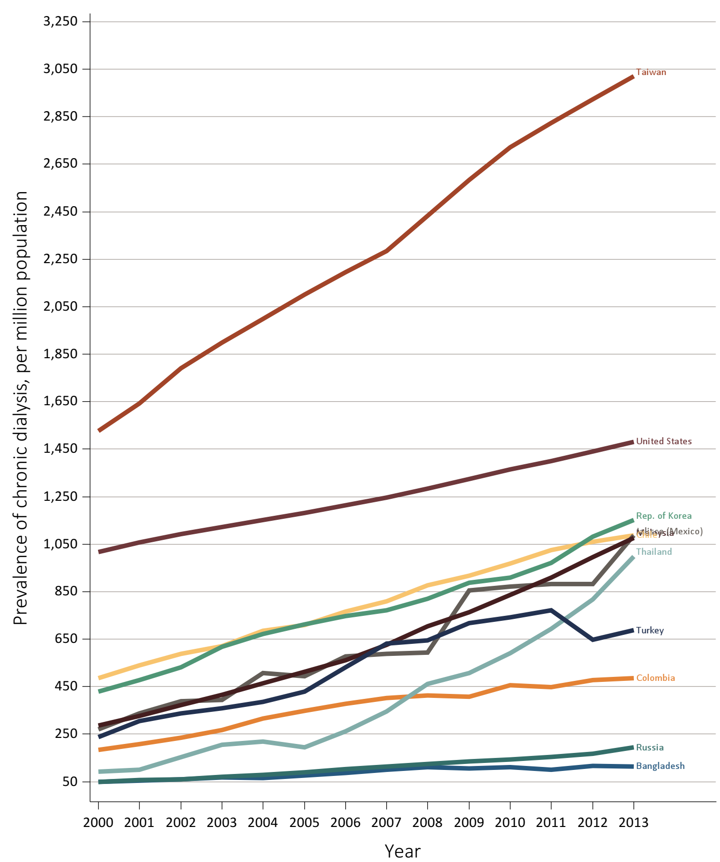
Dialysis is the most commonly utilized therapeutic approach for treatment of ESRD, followed by kidney transplantation. The number of ESRD patients receiving chronic dialysis per million population in 2013 varied more than 40-fold across countries, from 3021 in Taiwan to a range of 66 to 194 in Indonesia, Bangladesh, South Africa, and Russia, (see Figure 13.15). Some countries have experienced very large rises in the prevalence of dialysis during recent years, with a 179% increase in Romania since 2005, and a 200% nearly 850% increase in Thailand since year 2000, to 250% rise in the prevalence of dialysis in Russia, Malaysia, and the Jalisco region of Mexico since year 2000 (Table 13.4). However, a plateauing or decline in the prevalence of dialysis patients receiving chronic dialysis is beginning to be seen in nearly a quarter of all countries reporting several years of data (Table 13.5). These countries include Denmark, Finland, Netherlands, Norway, Scotland, Slovenia, Spain, Sweden, and Turkey.

vol 2 **Figure 13.15 Prevalence of dialysis per million population, by country, 2013**



Data source: Special analyses, USRDS ESRD Database. ESRD prevalence is unadjusted and reflects prevalence at the end of 2013. Data for Indonesia represent the West Java region. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Belgium do not include patients younger than 20. Abbreviations: sp., speaking.

vol 2 **Figure 13.16 Trends in the prevalence of dialysis per million population, by country, 2000-2013: Ten countries having the highest % rise in dialysis prevalence from 2000/01 to 2012/13, plus the U.S.**



Data source: Special analyses, USRDS ESRD Database. The prevalence is unadjusted and reflects prevalence of dialysis at the end of each year. Abbreviations: ESRD, end-stage renal disease.

vol 2 Table 13.5 Trends in the prevalence of dialysis per million population, by country, 2000-2013

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Argentina	.	.	.	.	550.3	578.7	598.0	615.4	623.4	634.1	636.9	644.0	655.1	662.7	.
Australia	334.7	353.0	370.3	388.5	398.2	424.9	447.1	462.9	478.8	482.6	486.3	494.9	505.1	509.1	47.5
Austria	372.3	386.2	394.2	412.1	441.8	461.4	469.6	477.7	487.9	505.9	507.8	503.2	510.2	521.1	36
Bahrain	.	.	.	.	.	.	.	.	212.4	221.5	196.8	250.2	.	.	.
Bangladesh	48.6	54.6	60.9	68.0	64.7	75.7	87.3	99.3	112.1	104.7	109.7	101.0	117.5	114.7	125
Belgium, Dutch sp.	440.6	467.9	501.3	518.7	549.3	589.0	609.9	624.3	644.4	674.6	689.2	694.8	699.8	705.4	54.7
Belgium, French sp.	.	506.3	523.4	555.2	594.3	611.8	637.8	657.6	673.0	663.6	682.8	689.6	713.2	735.1	43
Bosnia and Herzegovina	.	.	.	450.7	455.6	490.8	521.1	569.9	596.5	602.8	630.7	662.2	666.8	690.7	.
Brazil	.	.	.	338.1	367.5	388.9	398.3	466.0	408.5	475.8	467.1	494.4	503.9	556.7	.
Canada	487.9	521.9	551.5	565.4	591.1	613.2	629.9	643.1	652.4	667.2	670.6	680.3	684.1	685.9	35.7
Chile	484.4	540.5	587.1	621.2	684.6	708.4	764.9	810.2	876.3	917.9	969.6	1025.6	1059.9	1088.2	109.6
Colombia	184.4	208.8	236.2	267.4	315.5	348.6	377.6	403.1	412.7	408.2	455.4	447.9	478.7	486.5	145.5
Croatia	529.7	556.9	581.2	655.4	652.9	669.2	.	.	.	.	.	.	651.7	620.3	17.1
Czech Republic	382.4	409.5	428.4	424.6	440.7	452.3	461.9	499.9	538.1	548.7	599.8	584.1	.	600.3	51.6
Denmark	385.8	423.7	440.8	452.5	457.7	460.9	463.8	498.4	490.0	486.8	470.0	461.0	461.0	451.4	12.7
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	226.1	.
Finland	230.3	243.4	257.3	272.6	280.0	297.6	292.4	302.0	319.8	323.3	329.3	331.5	327.9	335.0	39.9
France	.	.	.	.	.	526.9	554.0	546.7	567.4	572.1	590.4	605.2	616.9	637.2	.
Greece	660.0	674.1	691.3	718.9	752.4	776.7	793.6	811.1	824.0	851.5	867.7	882.4	904.9	933.1	37.8
Hong Kong	.	.	556.1	563.3	566.4	582.9	593.2	611.0	624.6	647.3	661.6	681.5	709.5	742.4	.
Hungary	.	.	.	.	.	.	.	.	578.1	605.3	620.0	626.2	632.8	630.4	.
Iceland	138.7	175.5	198.2	234.9	229.4	195.5	167.9	199.7	201.6	191.5	223.2	250.8	237.0	225.5	47.2
Indonesia	.	.	.	.	.	.	.	.	.	27.9	37.3	40.1	50.6	65.9	.
Iran	.	.	.	.	.	.	.	.	245.0	282.1	290.7	299.2	307.3	316.4	.
Ireland	.	.	.	.	.	.	.	.	.	366.8	386.4	386.5	391.9	392.8	.
Israel	526.0	542.0	577.7	599.1	621.8	636.7	652.4	668.4	684.8	703.8	721.2	728.3	730.2	732.6	37
Italy	.	.	.	.	.	.	.	.	.	.	792.7	.	.	.	.
Jalisco (Mexico)	270.3	337.9	389.5	394.4	507.6	493.2	576.9	586.9	593.4	856.1	872.1	881.1	883.0	1086.1	223.8
Japan	1616.2	1640.3	1727.0	1795.2	1850.9	1879.8	1954.5	2058.1	2126.0	2205.4	2277.4	2313.8	2365.2	2411.1	46.7
Rep. of Korea	427.8	477.5	530.2	617.6	670.8	711.7	746.0	770.6	818.9	888.7	910.2	972.4	1081.0	1151.0	146.5
Kuwait	.	.	.	.	.	.	.	.	.	.	.	.	346.6	404.8	.
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	665.4	.	.
Malaysia	285.4	326.9	371.3	416.7	464.6	513.0	560.8	627.1	703.8	762.7	836.7	908.9	996.1	1077.5	238.7

Table 13.5 continued on next page.

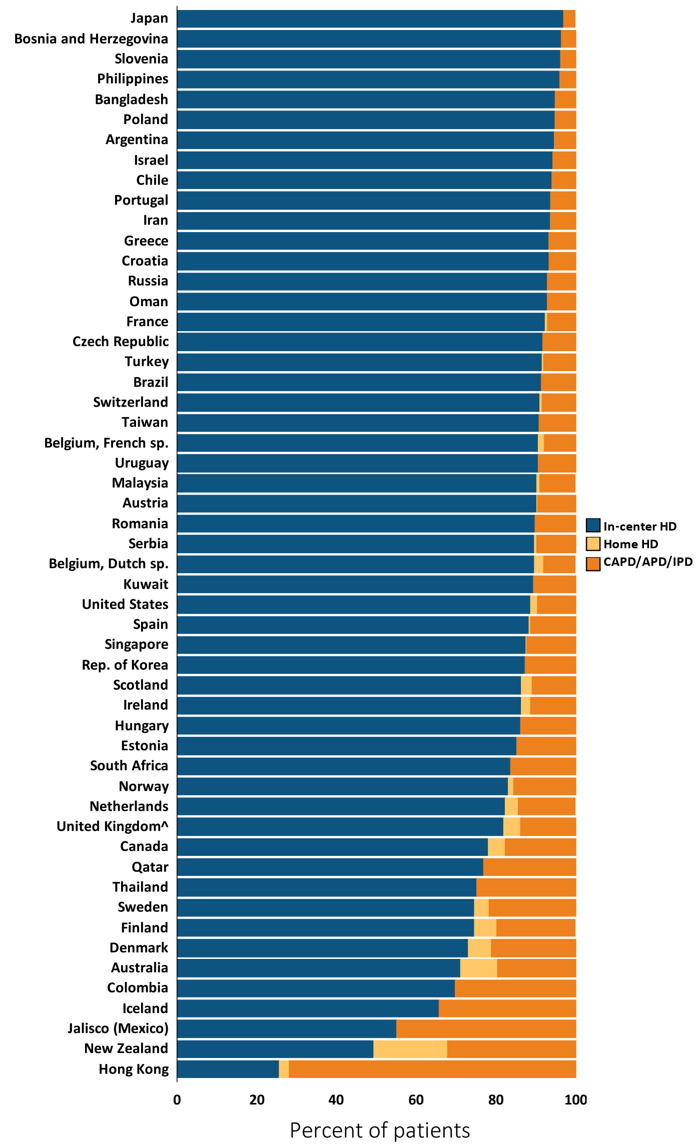
vol 2 **Table 13.5 Trends in the prevalence of dialysis per million population, by country, 2000-2013 (continued)**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Morelos (Mexico)	.	.	.	.	.	.	.	835.9	905.0	946.4	.	.	.	.	.
Netherlands	302.5	310.4	315.0	320.5	326.7	336.3	353.4	356.3	369.5	385.0	385.1	385.2	385.1	387.2	26
New Zealand	346.0	378.3	406.2	427.8	435.2	454.3	477.5	489.8	494.4	530.1	548.9	545.6	559.7	581.7	57.6
Norway	143.6	160.2	172.5	179.4	195.6	207.9	216.5	232.3	243.7	252.0	249.9	246.1	248.9	251.8	64.8
Oman	.	.	.	.	.	.	.	.	231.0	258.3	322.1	347.8	382.8	358.5	.
Philippines	.	.	20.1	46.0	61.2	86.5	75.8	79.4	104.6	114.0	132.9	159.4	181.8	221.0	.
Poland	.	.	.	.	.	.	.	.	417.5	432.8	446.3	466.1	483.2	513.2	.
Portugal	.	.	.	.	.	.	.	.	922.6	960.5	1023.7	1052.2	1068.2	1108.6	.
Qatar	.	.	.	.	.	.	.	.	.	.	246.6	254.5	271.9	316.7	.
Romania	.	.	.	.	.	239.5	285.0	346.2	393.8	518.0	581.1	642.3	708.0	752.5	.
Russia	48.3	55.7	60.6	69.0	79.1	90.4	101.6	.	124.4	135.4	144.3	154.8	168.3	193.6	248
Saudi Arabia	.	.	.	.	.	.	.	.	460.7	474.5	465.5	492.2	499.4	.	.
Scotland	326.9	334.8	354.3	367.2	379.5	399.0	414.1	424.4	415.2	418.2	418.8	410.6	407.4	393.8	21.1
Serbia	.	.	.	.	.	.	.	.	.	.	.	657.8	688.3	718.1	.
Singapore	841.9	897.1	944.9	979.6	998.1	1028.1	1070.5	1101.0	1145.9	1173.6	1218.5	1291.8	1373.6	1436.1	61.6
Slovenia	.	.	.	.	.	.	.	.	.	716.3	703.9	689.3	689.8	681.1	.
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	132.9	142.2	.
Spain	.	.	.	.	576.9	545.6	515.6	503.6	489.8	461.5	579.9	537.1	529.6	545.9	.
Sweden	338.9	353.1	367.3	367.0	378.5	381.3	396.1	397.1	388.6	392.8	403.1	409.7	402.1	400.0	15.9
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	381.6	.
Taiwan	1526.3	1643.7	1792.2	1899.8	1999.2	2101.4	2196.8	2285.1	2432.0	2585.1	2720.5	2823.1	2923.1	3020.5	87.5
Thailand	93.0	98.9	.	205.9	218.5	195.4	261.2	346.5	460.7	506.8	589.5	693.8	817.0	998.2	845.9
Turkey	237.9	306.1	337.1	359.6	386.3	430.0	530.8	631.5	643.7	717.6	742.9	772.8	646.6	687.1	145.2
United Kingdom^	.	.	.	.	335.2	329.0	352.7	391.8	402.8	415.9	419.3	426.7	430.4	432.2	.
United States	1018.3	1056.4	1091.6	1123.1	1151.6	1181.3	1214.7	1247.5	1283.2	1324.5	1365.5	1399.4	1439.1	1481.6	40.8
Uruguay	644.1	662.4	687.2	711.2	723.2	717.2	716.9	729.3	760.9	745.9	749.0	762.0	757.1	791.8	18.6

Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. The prevalence is unadjusted. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for France include 15 regions in 2006, 18 in 2007, 20 in 2008, and 22 in 2009-2013. Data for Belgium do not include patients younger than 20. Data for Spain include 18 of 19 regions. [a] % change is calculated as the percent difference between the average prevalence in 2012 and 2013 and the average in 2000 and 2001. Abbreviations: sp., speaking; . signifies data not reported.

Hemodialysis (HD) continues to be the most common form of dialysis therapy in nearly all countries. In nearly three-fourths of reporting countries, at least 80% of chronic dialysis patients were receiving in-center HD in 2013 (Figure 13.17). However, in 2013, peritoneal dialysis (PD) was used by 72% of dialysis patients in Hong Kong, and 45% in Jalisco (Mexico). Furthermore, 30-34% PD use was reported in Colombia, New Zealand, and Iceland, respectively, with 16% to 25% in Australia, Canada, Denmark, Finland, Qatar, South Africa, Sweden, and Thailand. As seen in Table 10.6, since 2006, an overall trend of increasing PD use as a percentage of all chronic dialysis has been seen in the countries of Argentina, Bangladesh, Hungary, Spain, Taiwan, Thailand, the U.S., and Uruguay. In contrast, PD use has declined over this same time period in countries such as Australia, Belgium, Bosnia and Herzogovina, Colombia, Croatia, Denmark, Finland, France, Greece, Hong Kong, Israel, Jalisco (Mexico), Republic of Korea, Netherlands, New Zealand, Norway, Romania, Russia, Scotland, Singapore, Turkey, and the United Kingdom Home HD therapy was provided to 18.4% and 9.3% of dialysis patients, respectively, in New Zealand and Australia in 2013. Home HD was also used by 3.0 to 5.9% of dialysis patients in Canada, Denmark, Finland, the Netherlands, Sweden, and the United Kingdom. However, in all other countries, home HD was either not provided, or used by fewer than three percent of dialysis patients.

vol 2 Figure 13.17 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or peritoneal dialysis (CAPD/APD/IPD), 2013



Data source: Special analyses, USRDS ESRD Database. Denominator is calculated as the sum of patients receiving HD, PD, or Home HD; does not include patients with other/unknown modality. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Belgium do not include patients younger than 20. Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; APD, automated peritoneal dialysis; IPD, intermittent peritoneal dialysis; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; sp., speaking.

vol 2 **Table 13.6 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or peritoneal dialysis (CAPD/APD/IPD), 2000-2013**

(a) In-center HD

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina	.	.	.	.	95.6	96.0	96.0	96.1	96.0	96.0	95.8	95.1	94.8	94.6
Australia	61.3	62.3	64.7	66.1	67.6	68.9	68.2	68.3	68.6	69.6	71.3	72.2	71.1	71.1
Austria	91.6	91.7	92.0	92.0	92.3	92.1	90.8	91.2	91.0	91.0	91.1	91.6	90.9	90.3
Bahrain	.	.	.	.	.	.	.	.	95.7	95.8	95.5	95.3	88.4	.
Bangladesh	99.1	99.1	99.1	99.0	98.8	98.6	99.6	98.4	98.3	98.2	97.5	96.2	95.9	94.9
Belgium, Dutch sp.	91.9	90.1	89.7	89.5	88.5	88.8	89.1	89.2	89.7	88.9	89.5	89.2	89.2	89.7
Belgium, French sp.	.	90.6	90.3	90.3	89.8	89.5	89.2	90.5	90.7	90.4	89.9	90.2	90.4	90.7
Bosnia and Herzegovina	.	.	.	96.6	96.2	95.7	95.3	95.2	95.1	94.9	95.2	96.0	96.5	96.5
Brazil	.	.	.	89.2	89.0	90.7	90.8	89.4	89.6	92.3	90.6	91.6	90.8	91.4
Canada	76.3	77.6	78.7	79.4	79.1	78.9	78.9	78.6	78.4	78.4	78.5	78.9	78.4	78.1
Chile	96.3	96.0	95.3	94.3	94.0	94.3	95.0	95.2	95.3	95.3	95.1	94.6	94.5	94.0
Colombia	.	.	.	.	63.3	62.4	63.9	63.4	68.0	68.2	68.7	69.1	69.4	69.9
Croatia	94.7	93.3	91.5	92.0	91.1	90.8	91.6	92.8	91.8	91.0	91.5	92.1	93.5	93.3
Czech Republic	93.3	92.4	92.8	92.6	92.5	92.5	92.4	92.3	91.8	92.0	92.1	91.7	.	91.8
Denmark	73.4	72.8	74.3	72.8	73.0	72.2	72.0	71.8	72.9	73.4	73.7	75.0	74.7	73.0
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	85.2
Finland	75.8	77.8	78.2	75.5	75.6	75.5	76.0	75.8	74.3	75.0	77.1	77.4	76.2	74.6
France	.	.	.	.	.	85.2	85.4	87.4	87.8	91.9	92.1	92.5	92.5	92.3
Greece	89.4	89.9	90.0	90.3	90.6	91.0	91.5	91.7	91.7	92.0	92.3	92.7	93.4	93.4
Hong Kong	.	.	17.9	17.4	17.9	17.7	18.8	19.8	20.4	21.5	23.5	24.4	25.0	25.6
Hungary	.	.	.	.	.	.	.	.	88.3	87.2	86.5	85.8	85.7	86.1
Iceland	71.8	70.0	66.7	66.2	58.8	65.5	70.6	72.1	76.6	86.9	83.1	80.0	72.4	65.8
Iran	.	.	.	.	.	.	.	.	93.8	94.5	93.5	93.1	93.4	93.7
Ireland	.	.	.	.	.	.	.	.	.	88.6	88.3	88.1	86.8	86.3
Israel	87.5	88.8	84.7	88.5	89.0	90.9	91.9	92.9	93.6	93.3	93.8	94.1	94.3	94.3
Italy	.	.	.	.	.	.	.	.	.	.	90.0	.	.	.
Jalisco (Mexico)	17.0	17.0	18.0	20.0	30.1	28.3	29.5	34.2	40.4	41.5	48.7	50.6	49.8	55.2
Japan	95.9	96.1	96.2	96.5	96.6	96.6	96.8	96.7	96.8	96.7	96.7	96.8	96.9	96.9

Table 13.6 continued on next page.

vol 2 **Table 13.6 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or CAPD/APD/IPD, 2000-2013 (continued)**

(a) In-center HD

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rep. of Korea	77.2	76.2	77.8	77.4	77.0	77.7	78.4	80.2	81.0	83.1	84.4	84.7	86.5	87.4
Kuwait	.	.	.	.	.	.	.	.	.	.	.	.	89.7	89.5
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	96.0	.
Malaysia	86.7	87.3	87.5	88.1	89.2	90.1	90.2	89.9	90.0	90.3	90.6	90.8	90.4	90.3
Morelos (Mexico)	.	.	.	.	.	.	.	40.6	43.2	42.4	.	.	.	.
Netherlands	67.6	66.9	68.3	69.5	72.2	73.4	74.8	76.0	77.4	79.1	79.5	81.4	81.6	82.4
New Zealand	34.9	37.6	37.5	41.2	43.3	45.9	45.5	48.2	48.1	48.4	47.4	48.6	49.3	49.4
Norway	81.2	86.2	84.0	83.6	82.9	83.2	80.5	80.6	83.4	80.7	81.3	84.2	83.2	83.2
Oman	.	.	.	.	.	.	.	.	95.7	97.1	95.9	96.0	95.0	92.9
Philippines	.	.	91.2	100.0	85.5	87.9	94.5	87.3	93.3	95.6	95.9	96.4	96.4	96.1
Poland	.	.	.	.	.	.	.	.	93.1	93.3	93.5	94.1	94.0	94.8
Portugal	.	.	.	.	.	.	.	.	94.8	94.4	93.9	93.7	93.4	93.7
Qatar	.	.	.	.	.	.	.	.	.	.	70.9	73.5	77.4	77.0
Romania	.	.	.	.	.	81.9	80.6	81.8	82.8	84.5	86.4	87.7	88.8	89.9
Russia	93.1	93.4	93.5	92.5	91.9	91.5	91.0	.	91.0	91.3	91.4	91.6	92.3	92.9
Saudi Arabia	.	.	.	.	.	.	.	.	92.2	90.6	90.5	90.7	90.6	.
Scotland	68.7	73.0	75.6	77.4	77.4	77.8	79.0	80.7	82.6	83.7	84.8	85.3	85.6	86.4
Serbia	.	.	.	.	.	.	.	.	.	.	.	90.1	90.5	89.7
Singapore	84.3	83.5	79.4	79.6	79.2	80.3	81.1	82.5	85.6	86.3	87.4	87.2	87.9	87.6
Slovenia	.	.	.	.	.	.	.	.	.	95.6	96.5	96.6	96.8	96.3
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	82.7	83.6
Spain	.	.	.	.	88.6	90.6	90.1	89.4	90.6	90.6	89.8	89.2	88.7	88.3
Sweden	72.7	73.0	73.5	74.2	74.6	75.8	75.5	73.0	73.3	73.7	74.7	75.6	76.0	74.6
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	91.1
Taiwan	94.2	93.7	93.9	93.5	93.5	93.0	92.4	91.5	90.7	90.7	90.6	90.5	90.7	90.8
Thailand	82.9	84.5	.	92.3	93.2	93.9	95.8	94.5	90.5	84.1	81.9	78.6	76.9	75.2
Turkey	87.3	89.0	86.9	87.5	88.2	87.9	88.7	88.1	87.4	89.6	90.4	91.8	90.4	91.6
United Kingdom^	.	.	.	.	73.8	76.3	78.6	78.9	81.1	81.6	81.9	81.9	81.5	82.0
United States	89.7	90.2	90.5	90.7	91.1	91.1	91.3	91.4	91.5	91.3	90.9	90.3	89.3	88.7
Uruguay	94.4	94.9	93.7	93.0	92.3	92.3	92.6	90.6	91.1	90.8	90.1	90.1	90.3	90.6

Table 13.6 continued on next page.

vol 2 **Table 13.6 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or CAPD/APD/IPD, 2000-2013**

(b) CAPD/APD/IPD

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina	.	.	.	.	4.4	4.0	4.0	3.9	4.0	4.0	4.2	4.9	5.2	5.4
Australia	27.1	26.4	24.6	23.9	22.4	21.5	22.1	22.0	22.0	21.0	19.5	18.8	19.5	19.6
Austria	8.2	8.0	7.7	7.8	7.5	7.7	9.0	8.7	8.9	8.9	8.9	8.4	9.0	9.6
Bahrain	.	.	.	.	.	.	.	.	4.3	4.2	4.5	4.7	11.6	.
Bangladesh	0.9	0.9	0.9	1.0	1.2	1.4	0.4	1.6	1.7	1.8	2.5	3.8	4.1	5.1
Belgium, Dutch sp.	7.8	9.7	10.2	10.4	11.3	11.0	10.7	10.6	10.1	9.9	9.2	9.1	8.4	8.0
Belgium, French sp.	.	8.3	8.7	8.5	9.0	9.3	9.5	8.3	8.0	8.4	8.7	8.2	8.1	7.8
Bosnia and Herzegovina	.	.	.	3.4	3.8	4.3	4.7	4.7	4.9	5.0	4.8	4.0	3.5	3.5
Brazil	.	.	.	10.8	11.0	9.3	9.2	10.6	10.4	7.7	9.4	8.4	9.2	8.6
Canada	22.2	21.0	19.8	18.9	18.9	18.7	18.4	18.4	18.4	18.1	17.9	17.2	17.5	17.6
Chile	3.7	4.0	4.7	5.7	6.0	5.6	5.0	4.8	4.7	4.7	4.9	5.4	5.5	6.0
Colombia	.	.	.	.	36.7	37.6	36.1	36.6	32.0	31.8	31.3	30.9	30.6	30.1
Croatia	5.3	6.7	8.5	8.0	8.9	9.2	8.4	7.2	8.2	9.0	8.5	7.9	6.5	6.7
Czech Republic	6.7	7.5	7.2	7.4	7.5	7.5	7.6	7.7	8.2	8.0	7.9	8.3	.	8.2
Denmark	26.1	26.5	24.7	25.7	24.7	24.8	23.9	24.5	22.9	21.6	20.8	19.5	19.7	21.2
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	14.8
Finland	22.7	20.3	18.9	21.3	21.0	21.3	21.2	20.4	21.7	21.3	18.9	18.5	18.4	19.6
France	.	.	.	.	.	12.2	12.6	11.1	10.9	7.3	7.2	6.9	6.9	7.1
Greece	10.6	10.1	10.0	9.7	9.4	9.0	8.4	8.3	8.3	7.9	7.7	7.2	6.6	6.6
Hong Kong	.	.	81.9	82.5	82.1	82.2	81.1	80.0	79.2	77.9	75.6	74.1	72.9	71.8
Hungary	.	.	.	.	.	.	.	.	11.7	12.8	13.5	14.2	14.3	13.9
Iceland	28.2	30.0	33.3	33.8	39.7	34.5	29.4	26.2	21.9	13.1	16.9	20.0	27.6	34.2
Iran	.	.	.	.	.	.	.	.	6.2	5.5	6.5	6.9	6.6	6.3
Ireland	.	.	.	.	.	.	.	.	.	11.3	11.1	10.8	11.6	11.3
Israel	12.5	11.2	15.3	11.5	11.0	9.1	8.1	7.1	6.4	6.7	6.2	5.9	5.7	5.7
Italy	.	.	.	.	.	.	.	.	.	.	10.0	.	.	.
Jalisco (Mexico)	83.0	83.0	82.0	80.0	69.9	71.7	70.5	65.8	59.6	58.5	51.3	49.4	50.2	44.8
Japan	4.1	3.9	3.8	3.4	3.4	3.4	3.2	3.3	3.1	3.2	3.2	3.1	3.0	2.9

Table 13.6 continued on next page.

vol 2 **Table 13.6 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or CAPD/APD/IPD, 2000-2013 (continued)**

(b) CAPD/APD/IPD

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rep. of Korea	22.8	23.8	22.2	22.6	23.0	22.3	21.6	19.8	19.0	16.9	15.6	15.3	13.5	12.6
Kuwait	.	.	.	.	.	.	.	.	.	.	.	.	10.3	10.5
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	4.0	.
Malaysia	9.9	9.8	10.1	10.1	9.4	8.7	8.7	9.1	9.0	8.7	8.4	8.3	8.8	8.8
Morelos (Mexico)	.	.	.	.	.	.	.	59.4	56.8	57.6	.	.	.	.
Netherlands	30.6	31.4	29.9	28.5	25.7	24.5	22.9	21.7	20.1	18.5	17.8	15.9	15.3	14.2
New Zealand	51.0	48.7	48.1	44.8	41.9	38.3	38.3	36.0	36.2	35.1	34.8	33.2	31.5	32.2
Norway	18.4	13.6	15.7	16.1	16.9	16.2	19.1	19.1	16.4	18.8	18.0	15.3	15.8	15.5
Oman	.	.	.	.	.	.	.	.	4.3	2.9	4.1	4.0	5.0	7.1
Philippines	.	.	8.8	0.0	14.5	12.1	5.5	12.7	6.7	4.4	4.1	3.6	3.6	3.9
Poland	.	.	.	.	.	.	.	.	6.9	6.7	6.5	5.9	6.0	5.2
Portugal	.	.	.	.	.	.	.	.	5.2	5.6	6.1	6.3	6.6	6.3
Qatar	.	.	.	.	.	.	.	.	.	.	29.1	26.5	22.6	23.0
Romania	.	.	.	.	.	18.1	19.4	18.2	17.1	15.5	13.5	12.2	11.1	10.1
Russia	6.9	6.6	6.5	7.5	8.1	8.5	9.0	.	9.0	8.7	8.6	8.4	7.7	7.1
Saudi Arabia	.	.	.	.	.	.	.	.	7.8	9.4	9.5	9.3	9.4	.
Scotland	28.2	24.2	21.9	20.2	20.4	20.1	19.3	17.5	15.1	13.7	12.8	12.1	11.3	11.0
Serbia	.	.	.	.	.	.	.	.	.	.	.	9.2	8.8	9.7
Singapore	15.6	16.4	20.5	20.3	20.8	19.7	18.8	17.4	14.4	13.6	12.5	12.8	12.0	12.3
Slovenia	.	.	.	.	.	.	.	.	.	4.4	3.5	3.4	3.2	3.7
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	17.3	16.4
Spain	.	.	.	.	11.4	9.4	9.7	10.5	9.2	9.2	10.0	10.6	11.1	11.4
Sweden	25.4	25.0	24.2	23.5	22.4	21.1	21.9	24.2	23.9	23.5	22.5	21.3	20.6	21.7
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	8.4
Taiwan	5.8	6.3	6.1	6.5	6.5	7.0	7.6	8.5	9.3	9.3	9.4	9.5	9.3	9.2
Thailand	17.1	15.5	.	7.7	6.8	6.1	4.2	5.5	9.5	15.9	18.1	21.4	23.1	24.8
Turkey	12.7	11.0	13.1	12.5	11.8	12.1	11.3	11.9	12.5	10.4	9.6	8.2	9.2	8.1
United Kingdom^	.	.	.	.	24.0	21.6	19.4	19.1	16.8	16.0	15.2	14.7	14.4	13.8
United States	9.8	9.4	9.1	8.9	8.5	8.4	8.1	7.9	7.7	7.6	8.0	8.5	9.0	9.5
Uruguay	5.6	5.1	6.3	7.0	7.7	7.7	7.4	9.4	8.9	9.2	9.9	9.9	9.7	9.4

Table 13.6 continued on next page.

vol 2 **Table 13.6 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or CAPD/APD/IPD, 2000-2013**

(c) Home HD

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina	.	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australia	11.6	11.3	10.7	10.1	10.0	9.5	9.6	9.8	9.4	9.4	9.2	9.0	9.4	9.3
Austria	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.1
Bahrain	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	0.0	.
Bangladesh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	.
Belgium, Dutch sp.	0.3	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.3	1.2	1.4	1.7	2.4	2.2
Belgium, French sp.	.	1.1	1.0	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.4	1.6	1.5	1.5
Bosnia and Herzegovina	.	.	.	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Brazil	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	.
Canada	1.5	1.4	1.5	1.7	2.0	2.5	2.8	3.0	3.3	3.5	3.7	3.9	4.1	4.3
Chile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colombia	.	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	.
Czech Republic	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0
Denmark	0.5	0.7	1.1	1.6	2.3	3.1	4.1	3.7	4.2	5.1	5.5	5.5	5.7	5.9
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Finland	1.6	1.9	2.9	3.2	3.4	3.1	2.9	3.8	3.9	3.7	4.0	4.1	5.4	5.7
France	.	.	.	.	.	2.6	2.0	1.6	1.4	0.8	0.7	0.6	0.6	0.6
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hong Kong	.	.	0.2	0.1	0.0	0.0	0.0	0.2	0.4	0.6	0.9	1.5	2.1	2.6
Hungary	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	0.0	.
Iceland	0.0	0.0	0.0	0.0	1.5	0.0	0.0	1.6	1.6	0.0	0.0	0.0	.	.
Iran	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	.	.	.	.	.	.	.	.	.	0.1	0.6	1.1	1.6	2.4
Israel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italy	.	.	.	.	.	.	.	.	.	.	10.0	.	.	.
Jalisco (Mexico)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 13.6 continued on next page.

vol 2 **Table 13.6 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or CAPD/APD/IPD, 2000-2013 (continued)**

(c) Home HD

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rep. of Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kuwait	.	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Malaysia	3.4	2.9	2.4	1.7	1.4	1.2	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.8
Morelos (Mexico)	.	.	.	.	.	.	.	0.0	0.0	0.0	.	.	.	.
Netherlands	1.8	1.7	1.8	2.0	2.1	2.1	2.3	2.3	2.5	2.5	2.7	2.7	3.1	3.3
New Zealand	14.1	13.7	14.4	14.0	14.8	15.8	16.1	15.8	15.7	16.6	17.8	18.1	19.2	18.4
Norway	0.3	0.3	0.3	0.2	0.2	0.5	0.4	0.3	0.3	0.5	0.7	0.6	1.0	1.3
Oman	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0
Philippines	.	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	.
Poland	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	.	.
Qatar	.	.	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0
Romania	.	.	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0
Saudi Arabia	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scotland	3.1	2.8	2.5	2.4	2.2	2.1	1.7	1.9	2.2	2.5	2.4	2.7	3.1	2.6
Serbia	.	.	.	.	.	.	.	.	.	.	.	0.7	0.7	0.6
Singapore	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Slovenia	.	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	.
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	.	0.2	0.1	0.3	0.2	0.2	0.2	0.2	0.3
Sweden	1.9	2.0	2.3	2.3	2.9	3.1	2.6	2.9	2.8	2.8	2.8	3.1	3.4	3.7
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5
Taiwan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	.	.
Thailand	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turkey	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3
United Kingdom^	.	.	.	.	2.2	2.1	2.0	2.0	2.1	2.5	2.8	3.4	4.0	4.2
United States	0.6	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.3	1.7	1.8
Uruguay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Data source: Special analyses, USRDS ESRD Database. Denominator is calculated as the sum of patients receiving HD, PD, or Home HD; does not include patients with other/unknown modality. Data prior to 2013 represents information on CAPD/CCPD. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Belgium do not include patients younger than 20. Abbreviations: APD, automated peritoneal dialysis; CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycling peritoneal dialysis; ESRD, end-stage renal disease; HD, hemodialysis; IPD, intermittent peritoneal dialysis; PD, peritoneal dialysis; sp., speaking.

Kidney Transplantation

Kidney transplantation rates vary greatly across countries, which may reflect not only geographic variations in ESRD incidence and prevalence but also differences in national health care systems, infrastructure, organ availability, and cultural beliefs. Kidney transplantation rates when expressed per million population serve to help standardize rates according to the size of a country's population and thus account for potential kidney donor pool size to some extent. However, it is also of interest to understand kidney transplantation rates in relationship to the size of the population in need of a kidney transplant. Towards this purpose, we now display kidney transplantation rates per 1000 dialysis patients in a country (Fig. 13.18b). A comparison of kidney transplantation rates per million population (Fig. 13.18a) with transplant rates per 1000 dialysis patients (Fig. 13.18b) indicates that the relative rates by country differ considerably between the two approaches for expressing kidney transplantation rates.

Among the countries represented in this chapter, kidney transplant rates when expressed per million population varied >30-fold across countries, from 1 to 59 kidney transplants per million population in 2013 (Figure 13.18a). The highest kidney transplant rates were reported in Croatia, the Jalisco region of Mexico, Netherlands, Norway, Spain, and the U.S., with 53–59 kidney transplants per million population. Kidney transplantation rates ranged from 30–51 per million population for 42% percent of countries, 11–29 per million population for 31% of countries, and 1–9 kidney transplants per million population for the remaining 15%. Countries reporting these lowest rates of kidney transplantation included Bangladesh, Bosnia and Herzegovina, the Philippines, Malaysia, Romania, Russia, South Africa, and Thailand.

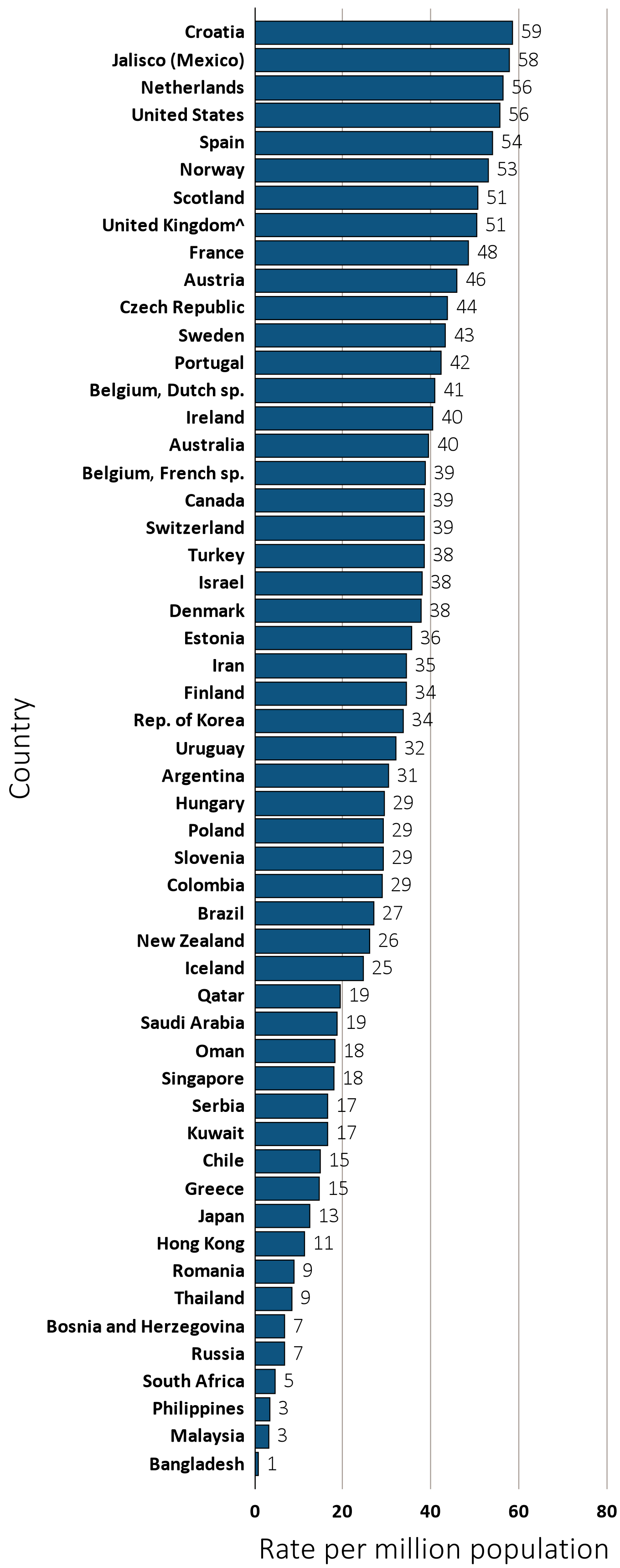
Kidney transplant rates when expressed per 1000 dialysis patients are seen to greatly vary across countries, from 3 to 210 kidney transplants per 1000 dialysis patients in 2013 (Figure 13.18b). The highest kidney transplant rates per 1000 dialysis patients in 2013 occurred in Norway (210), Estonia (158), the Netherlands (146), Scotland (129), and the United Kingdom (117, not including Scotland). Furthermore transplant rates of 101 to 110 per 1000 dialysis patients were reported in Finland, Iceland, Iran, Ireland, Spain, Sweden, and Switzerland. Nearly 30% of countries reported kidney transplant rates of 50 to 99 transplants per 1000 dialysis patients, 25% of countries with rates of 20-49 per 1000 dialysis patients, and 22% of countries with rates of <20 transplants per 1000 dialysis patients. The lowest rates of 3 to 9 transplants per 1000 dialysis patients are seen in the countries of Bangladesh, Japan, Malaysia, and Thailand. In the US, 38 kidney transplants were reported per 1000 dialysis patients, in 2013.

Since 2000, a substantial increase has been seen in kidney transplant rates per million population in some countries (Table 13.6, Figure 13.19) – particularly in Bangladesh, Croatia, the Netherlands, the Republic of Korea, Russia, Thailand, Turkey, and Uruguay, which have demonstrated the largest increases (66% to 519%) in kidney transplantation rates per million population over this time period. Furthermore, during this time period since 2000, kidney transplantation rates per million population rose 26-41% in Australia, French-speaking Belgium, the Czech Republic, Colombia, Denmark, Scotland, and Sweden.

Great variation is seen in the types of kidney donors, ranging from 80-100% living donor kidney transplantation in Bangladesh, Japan, Iceland, the Philippines, Qatar, Saudi Arabia, and Turkey, to 0% in Slovenia (Figure 13.20). In approximately 60% of countries, donation from deceased individuals was the predominant form of kidney donation for transplantation reported in 2013.

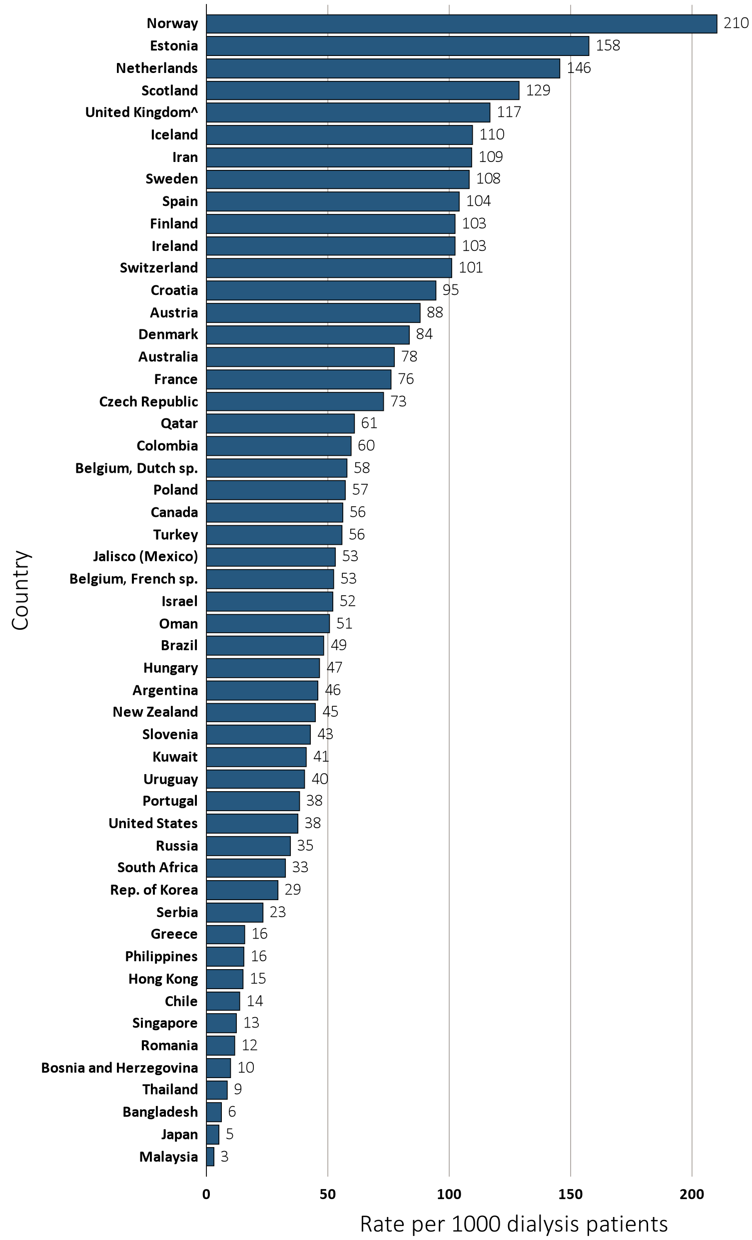
vol 2 **Figure 13.18 Kidney transplantation rate, by country, 2013**

(a) per million population



vol 2 **Figure 13.18 Kidney transplantation rate, by country, 2013**

(b) per 1000 dialysis patients



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for Belgium do not include patients younger than 20. Data for France include 22 regions. Transplant data for Romania are limited to that available in dialysis center reports, and include only non-preemptive transplants. Data for Spain include all regions. Abbreviations: sp., speaking.

vol 2 **Table 13.7 Kidney transplantation rates per million population, by country, 2000-2013**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Argentina	.	.	.	.	.	19.1	21.7	23.0	25.1	26.4	27.9	28.3	30.3	30.5	.
Australia	27.7	27.9	30.8	27.3	32.3	30.6	31.0	29.3	38.5	35.7	38.8	38.1	37.7	39.5	38.8
Austria	43.6	48.2	45.1	43.6	43.6	45.9	47.9	43.7	39.5	47.4	44.6	45.0	47.3	45.9	1.5
Bahrain	.	.	.	.	.	.	.	.	10.8	18.7	11.3	6.7	.	.	.
Bangladesh	0.4	0.2	0.4	0.4	0.4	0.4	0.2	0.5	0.5	0.6	0.6	0.8	0.5	0.7	100
Belgium, Dutch sp.	50.8	36.7	31.1	37.3	31.3	28.4	39.7	43.3	40.3	39.6	38.7	41.2	44.6	41.0	-2.2
Belgium, French sp.	.	29.4	32.2	36.5	29.8	37.6	39.3	40.8	37.4	37.9	37.0	43.1	40.6	38.7	34.9
Bosnia and Herzegovina	.	.	.	6.5	7.6	11.5	6.8	8.4	9.1	7.0	6.0	4.6	6.8	6.8	.
Brazil	.	.	.	17.9	18.8	18.4	17.8	18.5	20.1	22.1	23.8	25.2	27.2	27.0	.
Canada	37.9	35.4	34.6	33.4	32.1	32.7	38.4	39.5	38.3	37.7	38.0	37.7	38.4	38.6	5
Chile	17.9	17.3	16.6	19.8	16.9	17.2	18.5	17.1	16.8	15.1	13.5	15.6	16.7	14.9	-10.2
Colombia	21.7	22.7	19.7	19.2	11.0	11.9	29.8	29.5	16.1	18.9	38.9	34.9	33.3	29.0	40.3
Croatia	9.0	16.2	18.3	18.0	26.4	22.3	.	.	.	.	.	.	54.3	58.6	348
Czech Republic	33.2	30.6	32.5	40.4	41.6	38.0	41.6	38.0	31.9	34.0	27.2	31.6	.	43.8	37.3
Denmark	28.7	30.4	31.8	32.7	34.8	32.7	30.8	31.4	34.9	40.7	41.2	44.6	37.9	37.7	27.9
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	35.7	.
Finland	37.7	32.4	32.9	31.3	37.1	31.8	39.7	32.3	28.0	33.2	32.8	33.0	36.4	34.4	1
France	.	.	.	.	.	36.6	39.9	45.1	44.9	44.6	45.5	46.3	47.0	48.4	.
Greece	12.5	16.9	20.0	21.7	19.1	23.7	22.2	21.9	24.0	15.1	11.1	17.9	17.0	14.7	7.8
Hong Kong	.	.	12.0	7.5	7.4	8.6	9.6	9.5	11.0	14.0	11.7	9.3	13.8	11.3	.
Hungary	.	.	.	.	.	.	.	.	25.7	27.1	30.7	25.1	27.8	29.4	.
Iceland	24.9	17.5	0.0	3.5	10.3	33.7	26.3	22.5	25.2	31.4	31.4	50.2	18.7	24.7	2.4
Iran	.	.	.	.	.	.	.	.	26.7	29.3	30.1	30.3	31.8	34.5	.
Ireland	.	.	.	.	.	.	.	.	.	37.9	26.8	42.0	35.8	40.3	.
Israel	29.5	24.9	23.9	36.8	37.0	43.4	43.2	37.7	33.1	28.6	23.7	36.7	19.5	38.1	5.9
Jalisco (Mexico)	50.6	49.3	44.5	46.6	56.5	55.7	52.2	59.3	54.3	58.1	60.1	62.2	58.7	57.7	16.5
Japan	.	.	.	.	.	.	.	.	.	10.3	11.7	12.5	12.6	12.5	.
Rep. of Korea	14.2	17.6	15.2	16.5	17.4	15.5	18.8	18.5	22.7	24.5	25.1	31.7	34.4	33.8	114.5
Kuwait	.	.	.	.	.	.	.	.	.	.	.	.	18.3	16.6	.
Lebanon	.	.	.	.	.	.	.	.	.	.	.	.	19.0	.	.
Malaysia	6.1	6.6	6.7	6.4	7.4	6.2	11.1	8.2	4.7	5.0	4.5	4.4	3.6	3.3	-45.7

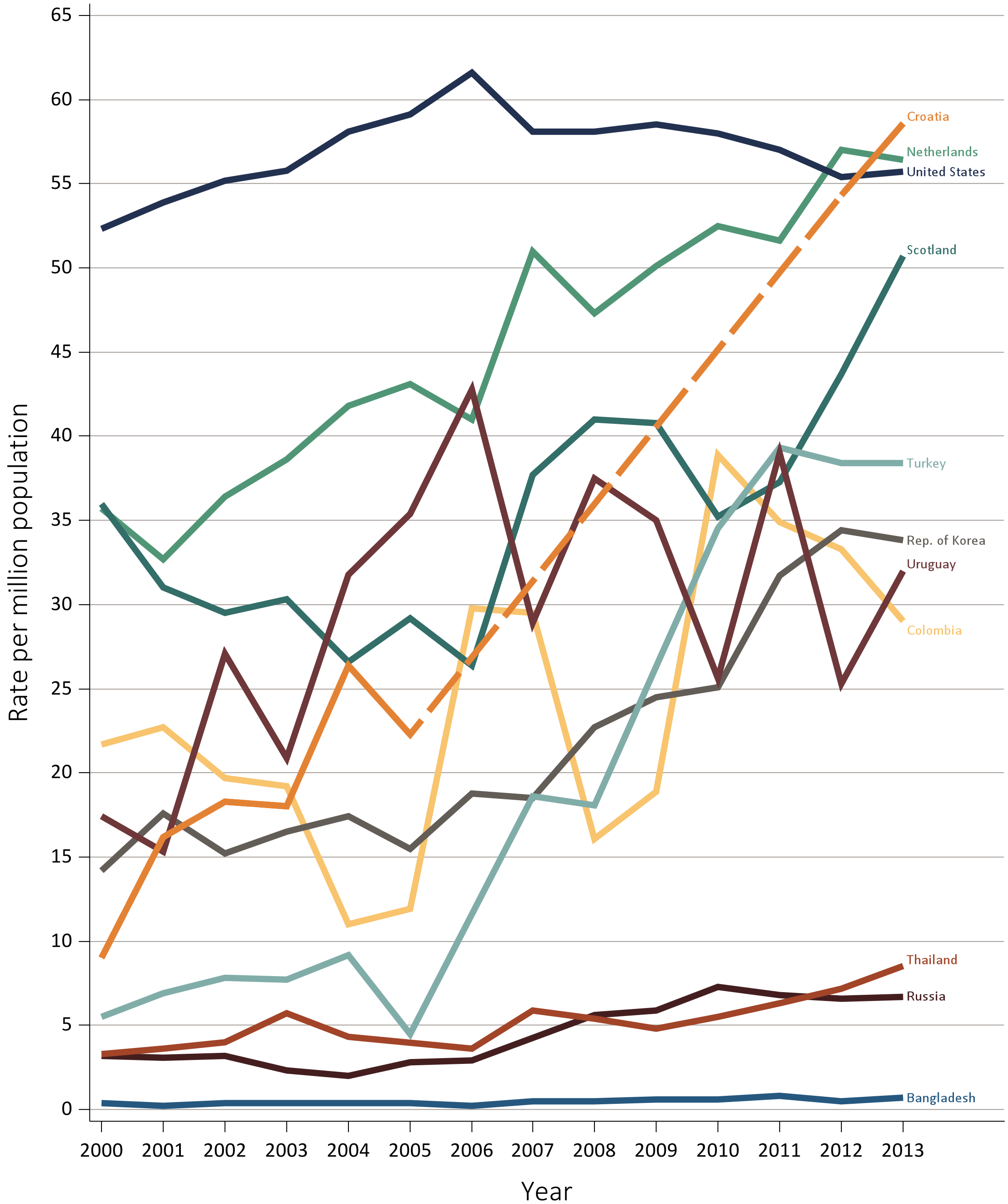
Table 13.7 continued on next page.

vol 2 **Table 13.7 Kidney transplantation rates, per million population, by country, 2000-2013 (continued)**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Morelos (Mexico)	.	.	.	.	.	.	.	54.6	44.5	41.8	.	.	.	.	**.**
Netherlands	35.7	32.7	36.4	38.6	41.8	43.1	41.0	51.0	47.3	50.1	52.5	51.6	57.0	56.4	**65.8**
New Zealand	27.5	28.3	29.7	27.7	25.7	22.5	21.5	29.1	28.6	28.1	25.3	27.4	25.0	26.1	**-8.4**
Norway	46.1	46.7	46.9	52.8	57.7	49.5	45.5	55.2	58.3	60.5	53.8	61.0	59.6	53.0	**21.3**
Oman	.	.	.	.	.	.	.	.	14.8	18.4	16.8	22.1	21.4	18.2	**.**
Philippines	3.5	3.0	3.7	4.9	5.6	7.5	7.5	11.1	7.1	5.2	4.0	3.8	3.3	3.4	**3.1**
Poland	.	.	.	.	.	.	.	.	21.2	20.6	25.9	27.0	29.7	29.3	**.**
Portugal	.	.	.	.	.	.	.	.	49.4	55.7	54.3	50.2	40.6	42.4	**.**
Qatar	.	.	.	.	.	.	.	.	2.1	1.2	15.2	19.6	15.3	19.4	**.**
Romania	.	.	.	.	.	4.7	5.3	2.8	7.3	6.9	6.8	9.0	7.1	8.9	**.**
Russia	3.2	3.1	3.2	2.3	2.0	2.8	2.9	.	5.6	5.9	7.3	6.8	6.6	6.7	**111.1**
Saudi Arabia	.	.	.	.	.	.	.	.	16.3	15.1	18.6	20.4	19.6	18.6	**.**
Scotland	36.0	31.0	29.5	30.3	26.6	29.2	26.4	37.7	41.0	40.8	35.2	37.3	43.7	50.7	**40.9**
Serbia	.	.	.	.	.	.	.	.	.	.	.	14.5	13.0	16.6	**.**
Singapore	16.5	21.0	14.2	10.1	17.6	19.6	24.1	23.2	20.0	18.5	16.2	17.7	13.4	17.9	**-16.5**
Slovenia	.	.	.	.	.	.	.	.	.	22.6	31.7	23.9	30.6	29.1	**.**
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	4.7	4.6	**.**
Spain	.	.	.	.	.	.	.	.	.	49.8	47.3	52.9	54.0	54.1	**.**
Sweden	31.9	34.8	34.6	39.0	41.7	43.2	40.5	42.3	45.6	42.4	39.5	45.2	41.3	43.2	**26.7**
Switzerland	.	.	.	.	.	.	.	.	.	.	.	.	.	38.5	**.**
Taiwan	12.0	16.0	17.2	.	.	.	.	.	12.5	13.6	12.1	14.0	11.2	.	**-20**
Thailand	3.3	3.6	4.0	5.7	4.3	.	3.6	5.9	5.4	4.8	5.5	6.3	7.2	8.5	**127.5**
Turkey	5.5	6.9	7.8	7.7	9.2	4.5	11.6	18.6	18.1	26.3	34.5	39.3	38.4	38.4	**519.4**
Ukraine	.	.	.	.	.	.	.	.	.	.	.	.	2.1	.	**.**
United Kingdom^	.	.	.	.	34.8	30.0	34.1	38.3	40.3	42.1	44.0	44.3	45.9	50.5	**.**
United States	52.3	53.9	55.2	55.8	58.1	59.1	61.6	58.1	58.1	58.5	58.0	57.0	55.4	55.7	**4.6**
Uruguay	17.4	15.3	27.1	20.9	31.8	35.4	42.8	28.9	37.5	35.0	25.6	39.0	25.3	32.0	**75.2**

Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for France include 15 regions in 2006, 18 in 2007, 20 in 2008, and 22 in 2009-2013. Transplant data for Romania are limited to that available in dialysis center reports, and include only non-preemptive transplants. Data for Belgium do not include patients younger than 20. There is underreporting of prevalent transplant patients in Turkey. a % change is calculated as the percent difference between the average rate in 2012 and 2013 and the average in 2000 and 2001. Abbreviations: sp., speaking; . signifies data not reported.

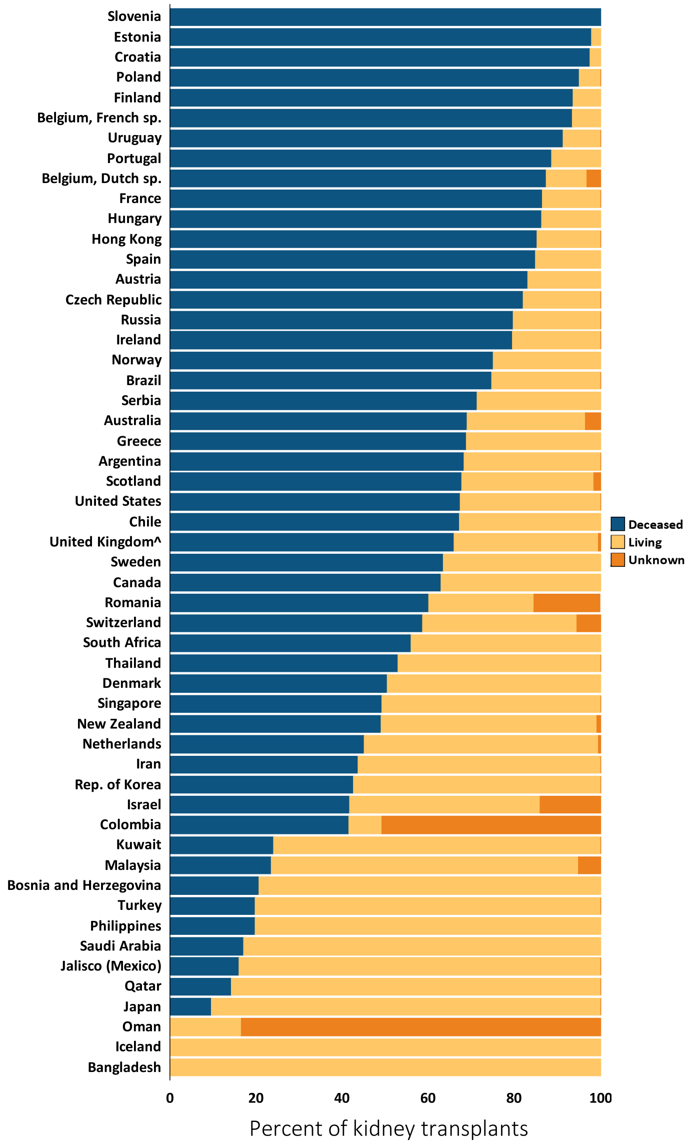
vol 2 **Figure 13.19 Trends in kidney transplantation rates per million population, by country: Ten countries having the highest % rise in kidney transplantation rate from 2000/01 to 2012/13, plus the U.S.**



Data source: Special analyses, USRDS ESRD Database. All rates are unadjusted. Data for Croatia are missing from 2006-2011. Abbreviations: ESRD, end-stage renal disease.

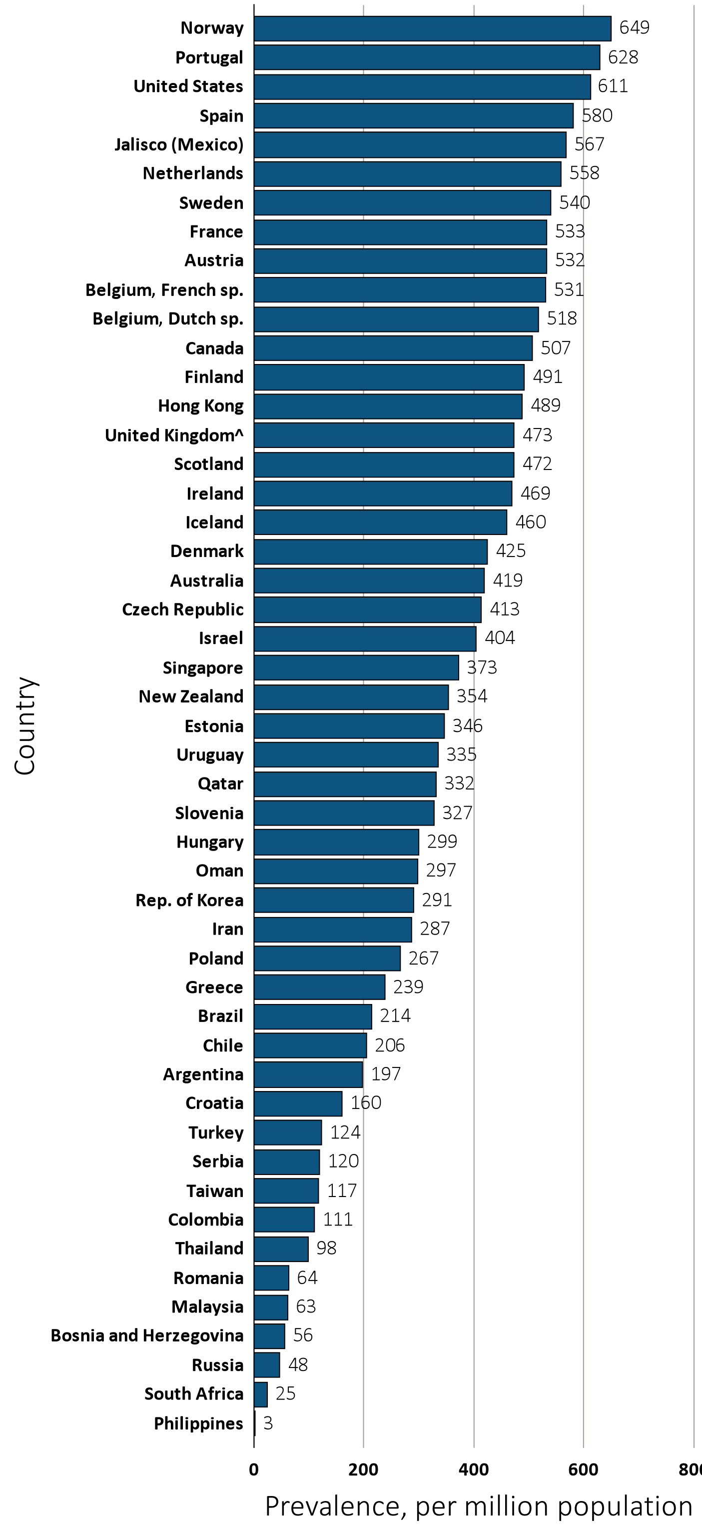
In 2013, Norway, Portugal, and the U.S. reported the highest prevalence of ESRD patients living with a kidney transplant, at 611 to 649 per million population (Figure 13.21 and Table 13.8). Forty percent of countries indicated 400 to 599 prevalent ESRD patients living with a kidney transplant per million population, with the remaining 54% of countries evenly divided between having <200 and having 200-399 ESRD patients living with a kidney transplant per million population. From 2000 to 2013, the prevalence of ESRD patients living with a kidney transplant hasc ontinued to increase in every country with available data - increasing 60% to nearly 500% in one-half of all countries, while rising 18-52% in the remaining countries. The largest increases (160% to 490%) in the prevalence of ESRD patients living with a kidney transplant from 2000 to 2013 were seen in Croatia, Russia, Thailand, Turkey, and Uruguay.

vol 2 Figure 13.20 Distribution of the percentage of kidney transplantations by kidney donor type and country, 2013



Data source: Special analyses, USRDS ESRD Database. Denominator is calculated as the sum of deceased, living donor, and unknown transplants. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for France include 22 regions. Abbreviations: ESRD, end-stage renal disease.

vol 2 Figure 13.21 Prevalence of treated ESRD patients with a functioning kidney transplant, per million population, by country, 2013



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. The prevalence is unadjusted. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Belgium do not include patients younger than 20. Abbreviations: ESRD, end-stage renal disease; sp., speaking.

vol 2 **Table 13.8 Trends in the prevalence of treated ESRD patients with a functioning kidney transplant, per million population, by country, 2000-2013**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Argentina	.	.	.	.	.	.	.	.	132.3	127.9	144.8	130.9	164.8	197.2	**.**
Australia	274.1	280.9	292.4	300.1	311.6	321.6	331.2	338.4	360.2	370.8	385.9	396.4	407.7	419.3	**49**
Austria	342.3	369.0	387.4	447.0	412.6	428.0	438.9	455.8	460.0	474.9	484.5	497.6	515.1	532.4	**47.3**
Bahrain	.	.	.	.	.	.	.	.	62.4	57.7	53.5	52.7	.	.	**.**
Bangladesh	2.6	2.7	3.1	3.3	3.2	3.4	3.5	.	.	.	.	.	.	.	**.**
Belgium, Dutch sp.	349.8	366.4	377.3	391.1	400.7	404.7	423.3	439.4	451.6	464.0	474.7	489.8	506.1	517.6	**42.9**
Belgium, French sp.	.	322.4	349.5	377.3	392.8	410.4	433.7	453.2	471.4	463.0	480.5	501.0	516.2	530.6	**62.3**
Bosnia and Herzegovina	.	.	.	26.6	31.6	33.4	31.6	31.8	40.4	43.6	42.3	47.3	51.9	56.2	**.**
Brazil	.	.	.	.	.	.	.	.	.	.	.	176.8	193.2	214.4	**.**
Canada	319.7	335.0	348.4	367.7	381.0	392.9	409.2	428.1	441.7	451.4	464.9	478.1	491.6	506.8	**52.5**
Chile	126.9	131.3	138.7	151.6	156.2	157.5	164.8	175.4	188.9	190.8	191.5	210.1	203.4	205.6	**58.4**
Colombia	.	.	.	.	.	.	.	.	60.6	59.8	88.8	88.3	99.7	111.1	**.**
Croatia	91.8	100.1	117.9	134.3	153.8	166.3	.	.	.	.	.	.	381.3	159.9	**182**
Czech Republic	238.4	252.7	266.7	276.3	316.9	.	.	.	.	358.9	370.3	390.3	.	412.5	**68**
Denmark	253.8	261.6	273.3	288.4	297.4	266.8	318.0	333.6	341.6	355.1	375.8	395.0	409.8	424.6	**61.9**
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	346.0	**.**
Finland	352.0	369.5	378.2	391.3	408.6	418.0	434.5	445.5	449.4	460.2	469.3	476.0	483.9	490.9	**35.1**
France	.	.	.	.	.	390.0	408.6	407.3	425.7	464.4	483.2	500.5	514.6	532.6	**.**
Greece	139.9	141.5	150.8	161.9	170.3	181.6	192.5	202.3	214.8	218.2	216.1	221.8	231.7	239.0	**67.3**
Hong Kong	.	.	312.5	314.4	361.4	387.4	409.7	420.4	442.8	481.7	484.2	477.7	485.4	488.5	**.**
Hungary	.	.	.	.	.	.	.	.	.	263.3	269.9	278.5	287.0	299.1	**.**
Iceland	224.0	231.6	236.5	241.8	246.5	276.3	316.0	318.8	321.3	345.4	371.0	410.6	439.6	460.2	**97.5**
Iran	.	.	.	.	.	.	.	.	245.7	242.2	253.7	265.0	276.0	286.9	**.**
Ireland	.	.	.	.	.	.	.	.	.	402.3	415.2	438.7	453.4	469.4	**.**
Israel	.	.	.	297.2	312.8	336.8	357.5	372.1	386.0	382.9	380.7	391.9	395.2	404.1	**.**
Jalisco (Mexico)	.	.	.	.	.	314.7	352.0	399.4	436.2	458.2	460.2	500.4	525.8	567.4	**.**
Japan	.	.	.	.	.	.	.	.	.	85.0	83.3	.	.	.	**.**
Rep. of Korea	156.8	164.8	170.5	176.9	183.2	188.2	195.7	202.2	212.8	224.8	234.1	252.4	272.3	290.5	**75**
Malaysia	53.0	55.4	58.1	60.1	62.4	64.4	65.6	65.3	65.6	65.4	66.4	65.8	64.5	62.9	**17.5**

Table 13.8 continued on next page.

vol 2 **Table 13.8 Trends in the prevalence of ESRD patients with a functioning kidney transplant, per million population, by country, 2000-2013 (continued)**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% change from 2000/01 to 2012/13
Morelos (Mexico)	.	.	.	.	.	.	.	41.9	34.3	31.6	.	.	.	.	**.**
Netherlands	314.6	325.9	341.0	357.6	376.7	396.9	418.9	446.1	450.5	465.1	487.9	508.8	532.9	558.2	**70.4**
New Zealand	264.6	273.9	283.1	291.3	298.7	299.7	298.0	303.4	317.6	327.0	331.9	339.0	345.1	353.9	**29.8**
Norway	437.5	451.7	466.0	488.5	513.3	524.5	536.6	551.7	573.2	592.1	609.3	628.9	639.0	648.7	**44.8**
Oman	.	.	.	.	.	.	.	.	232.5	241.4	296.5	315.4	331.1	297.4	**.**
Philippines	.	.	2.2	.	.	4.6	4.8	5.3	5.2	5.2	4.0	3.8	3.3	3.4	**.**
Poland	.	.	.	.	.	.	.	.	240.8	210.4	208.9	240.6	249.0	266.6	**.**
Portugal	.	.	.	.	.	.	.	.	484.2	544.7	565.8	609.8	602.1	628.3	**.**
Qatar	.	.	.	.	.	.	.	.	2.1	1.2	354.5	373.4	375.5	332.4	**.**
Romania	.	.	.	.	.	14.9	19.7	22.0	28.6	37.5	44.0	51.9	57.9	64.1	**.**
Russia	16.5	18.1	18.7	21.9	23.1	24.5	28.5	.	33.7	37.7	41.2	41.6	43.4	47.8	**163.6**
Saudi Arabia	.	.	.	.	.	.	.	.	336.8	318.2	298.4	273.0	252.0	.	**.**
Scotland	307.6	326.4	329.6	345.4	351.3	361.2	369.0	386.5	394.7	408.9	417.8	430.6	448.7	471.9	**45.2**
Serbia	.	.	.	.	.	.	.	.	.	.	.	107.3	111.1	120.4	**.**
Singapore	261.2	279.0	280.8	292.0	303.8	317.2	329.6	340.8	348.9	353.3	360.0	370.0	367.8	373.0	**37.1**
Slovenia	.	.	.	.	.	.	.	.	.	265.2	283.6	296.2	310.1	327.2	**.**
South Africa	.	.	.	.	.	.	.	.	.	.	.	.	30.7	24.7	**.**
Spain	.	.	.	.	521.6	386.3	445.4	452.7	505.0	424.7	516.1	537.6	545.9	579.9	**.**
Sweden	377.5	386.7	396.8	411.2	430.4	438.9	454.5	469.5	487.1	498.8	506.8	519.4	529.0	539.5	**39.8**
Taiwan	.	.	.	.	.	.	.	.	.	82.2	91.0	100.0	107.7	117.2	**.**
Thailand	.	15.9	23.8	33.8	24.9	24.7	20.5	57.4	36.3	46.0	49.8	56.0	88.9	98.4	**489**
Turkey	21.0	26.7	36.6	41.1	47.1	20.7	58.4	80.0	109.4	101.6	104.4	95.4	105.8	123.9	**381.6**
Ukraine	.	.	.	.	.	.	.	.	.	.	.	.	2.1	.	**.**
United Kingdom^	.	.	.	.	286.3	271.3	287.5	345.8	370.4	386.7	406.9	425.0	443.8	472.8	**.**
United States	378.4	397.1	416.7	435.7	456.2	476.5	497.2	516.1	533.7	550.7	567.2	583.1	597.1	611.3	**55.8**
Uruguay	87.5	100.8	120.1	134.3	151.5	131.9	210.3	234.7	255.5	272.7	284.2	312.9	315.6	335.3	**245.7**

Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Prevalence is unadjusted. ^United Kingdom: England, Wales, & Northern Ireland (Scotland data reported separately). Data for France include 15 regions in 2006, 18 in 2007, 20 in 2008, and 22 in 2009-2013. Data for Belgium do not include patients younger than 20. There is underreporting of prevalent transplant patients in Turkey. [a] % change is calculated as the percent difference between the average prevalence in 2012 and 2013 and the average in 2000 and 2001. Abbreviations: ESRD, end-stage renal disease; sp., speaking; . signifies data not reported.

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Chapter 14: End-of-life Care for Patients With End-Stage Renal Disease: 2000-2012

- Between 2000 and 2012:
  - The percentage of Medicare beneficiaries with ESRD admitted to an intensive or coronary care unit during the last 90 days of life increased from 50% to 63%.
  - The percentage of Medicare beneficiaries with ESRD receiving an intensive procedure to prolong life during the last 90 days of life increased from 27% to 35%.
  - The percentage of Medicare beneficiaries with ESRD who died in the hospital decreased from 47% to 41%.
  - The percentage of patients who discontinued maintenance dialysis treatments before death increased from 19% to 25%.
  - The percentage of Medicare beneficiaries with ESRD receiving hospice care at the time of death increased from 11% to 25%.
- Most patients receive hospice services only after discontinuing dialysis treatments. From 2004-2012, hospice use prior to death increased from 59% to 80% among patients who discontinued dialysis treatments, but from only 5% to 7% among those who did not.
- Median per person costs under Medicare Parts A and B in 2012 were $116,416 over the last year of life, $21,121 over the last 30 days of life, and $8,538 over the last 7 days of life.
- Costs during the final weeks of life were progressively lower for ESRD patients referred earlier to hospice. Median per person Medicare costs during the last 7 days of life ranged from $1,649 for those referred to hospice more than 2 weeks before death to $11,123 for those not referred until the last 2 days of life.

Introduction

The 2014 report from the Institute of Medicine (IOM) “Dying in America: Improving Quality and Honoring Individual Preferences near the End of Life” summarizes contemporary patterns of end-of-life care for the U.S. population. The report references recent work by Teno et al. (2013) describing trends in health care utilization at the end of life among older fee-for-service Medicare beneficiaries from 2000-2009. Some of the trends described by these authors seem to reflect a move toward less aggressive end-of-life treatment practices over time: the percentage of patients dying during an acute hospital stay declined from 33.0% to 25.0% and the percentage receiving hospice at the end of life increased from 21.6% to 42.2%. However, other trends seem to suggest a move toward more intensive inpatient-oriented patterns of care: the percentage of all patients with an acute hospital admission increased from 62.9% in 2000 to 69.3% in 2009; the percentage admitted to the intensive care unit (ICU) in the last month of life increased from 24.3% to 29.2%; the percentage who received mechanical ventilation during the last month of life increased from 8.3% to 9.3%; and the average time spent in the ICU during the last 90 days of life increased from 2.3 to 2.9 days. Teno et al. also noted an increase in the proportion of patients experiencing potentially burdensome health care transitions at the end of life. For example, the percentage of patients changing care settings during the last 3 days of life increased from 10.3% to 14.2%, the percentage admitted to the hospital 3 or more times during the last 90 days of life increased from 10.3% to 11.5%, and the percentage referred to hospice within 3 days of death increased from 4.6% to 9.8% (Teno, 2013).

The IOM report includes almost no information on patients with ESRD. Prior publications have described low rates of hospice referral, high rates of dialysis discontinuation before death, and high levels of health care utilization toward the end of life among patients receiving maintenance dialysis (Murray et al., 2006; Wong et al., 2012; Gessert et al., 2013; Murtagh et al., 2007; O'Hare et al., 2010). However, relatively little is known about national trends over time in patterns of end-of-life care in this population. In this chapter, we examine treatment practices, patterns of health care utilization, and costs during the final months of life among decedents with ESRD over the 13-year period from 2000 through 2012. The chapter is divided into the following five sections: 1) Characteristics of Decedents With ESRD; 2) Patterns of Inpatient Utilization During the Last 90 Days of Life Among Medicare Beneficiaries With ESRD; 3) Patterns of Dialysis Discontinuation Before Death; 4) Patterns of Hospice Utilization Before Death; and 5) End-of-life Costs for Services Under Medicare Parts A and B.

Analytical Methods

Data supporting these analyses were derived from the 2014 version of the public-use Standard Analysis Files (SAFs) supplied by the USRDS Coordinating Center at the University of Michigan. These include the Patients file, the MEDEVID file, the RXHIST file, the PAYHIST file, the Death file, and linked Medicare Institutional and Physician Supplier claims.

Because complete information on Medicare utilization and costs are only available for patients with fee-for-service Medicare Parts A and B, analyses that rely on these measures were restricted to patients with Medicare Parts A and B as the primary payer throughout the relevant time period and whose care was not covered by a health maintenance organization (HMO). We used the PAYHIST file to track primary payer for each patient over time, and to identify denominator populations of fee-for-service Medicare beneficiaries with Medicare Parts A and B as primary payer throughout time periods relevant to each analysis (e.g., last 90 days of life). Because Medicare Parts A and B were listed as the primary payer for only a minority of patients aged 19 years or less at the time of death, we do not report stratified results for this age group, but these patients are included in the denominator for all calculations.

We used the Patients file to ascertain information on age at death, sex, race, and ethnicity. The RXHIST, MEDEVID and Patients files were used in combination to ascertain each patient's most recent ESRD treatment modality before death. We used the most recent modality listed in the RXHIST file when available. If missing, we used transplant dates in the Patients file to identify those who had received a kidney transplant. For all other patients, we used treatment modality at initiation recorded in the MEDEVID file.

We used Medicare Institutional claims to ascertain dates of hospital admission (which included admissions to long and short stay hospitals), dates of hospice utilization (HCFASAF=H), and receipt of hospice care at the time of death (HCFASAF=H on or after the date of death or Discharge Status from hospice=40, 41, or 42). Episodes of ICU utilization were captured using intensive and coronary care unit revenue center codes in Medicare Institutional claims (020x and 021x). We used an ICD-9 procedure code search of Medicare Institutional claims for time periods when patients were hospitalized to capture inpatient intensive procedures. These included intubation and mechanical ventilation (ICD-9 codes 96.04, 96.05, 96.7x), tracheostomy (ICD-9 codes 31.1, 31.21, 31.29), gastrostomy tube insertion (ICD-9 codes 43.2, 43.11, 43.19, 43.2, 44.32), enteral or parenteral nutrition (ICD-9 codes 96.6 and 99.15), and cardiopulmonary resuscitation (CPR, ICD-9 codes 99.60, 99.63) (Barnato et al., 2009).

The CMS Death Notification form (CMS 2746) reports provider responses to questions about whether renal replacement therapy was discontinued before death, the date of the last dialysis treatment before death, and whether the patient was receiving hospice care prior to death. Analyses based on the CMS Death Notification form were conducted among those with complete information for the relevant data element. Analyses of hospice use and date of last dialysis treatment from the Death Notification form are available for most decedents from 2004 onward. Information on treatment discontinuation before death was available throughout the period of study. Analyses of discontinuation were restricted to patients for whom dialysis was listed as the most recent modality. While most measures of utilization at the end of life reported in this chapter were obtained from Medicare claims, these are supplemented with information on place of death, hospice utilization, and date of last dialysis treatment from the Death Notification form. Results for measures that are available in both Medicare claims and the CMS Death Notification form are not expected to be identical because there are differences in how measures are defined, in the denominator populations with complete information for each measure, and in the time periods and methods of ascertainment.

Costs for Medicare Part A and B services were calculated using payments to Medicare recorded in both Institutional (CLM_AMT) and Physician Supplier (PMTAMT) claims. Patients for whom Medicare Parts A and B were listed as primary payer in the PAYHIST file but had zero or negative costs during the last year of life (or last 30 days of life when calculating costs for the last 7 and 30 days of life) were excluded from cost analyses. Medicare Part A payments for hospital stays were calculated by adding the CLM_AMT to the pass-through payments for each stay (PER_DIEM*CVR_DCNT). Costs for hospital and skilled nursing facility admissions spanning the time period of interest (e.g., 90 days before death) were pro-rated. Cost calculations do not include Medicare Part D costs, Medicaid costs, Medicare copayments, or other health care costs for Medicare beneficiaries.

Characteristics of Decedents With ESRD

As shown in Table 14.1, we identified a total of 1,110,597 patients listed in USRDS who initiated dialysis in 1995 or later and died between calendar years 2000 and 2012 (Table 14.1). The mean age (± standard deviation) of decedents was 68.4 (±13.7) years. Patients aged 75-84 years comprised the largest group of decedents and more than 80% of decedents were between the ages of 45 and 84 years at the time of death. Overall, 66.8% of decedents were White, 27.6% were Black, 3.3% were Asian, 1.1% were Native American, and 1.1% were of Other race. The most recent modality prior to death was hemodialysis in 88.3% of patients, peritoneal dialysis in 5.2%, and transplant in 5.0% (1.5% were missing information on modality). During 2000-2012, the mean age of decedents increased from 67.5 (±13.7) years to 69.1 (±13.4) years, and the percentage of patients aged 85 years and older at the time of death

vol 2 Table 14.1 Characteristics of decedents with ESRD by death year, 2000-2012

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
n	72,926	77,124	79,804	82,696	84,347	86,107	87,853	87,967	88,838	90,355	91,107	91,962	89,511	1,110,597
%	6.6	6.9	7.2	7.4	7.6	7.8	7.9	7.9	8.0	8.1	8.2	8.3	8.1	100.0
Age (mean)	67.5 (13.7)	67.5 (13.8)	67.8 (13.9)	67.9 (13.8)	68.1 (13.8)	68.4 (13.8)	68.4 (13.8)	68.5 (13.8)	68.75 13.7)	68.6 (13.7)	68.9 (13.6)	69.0 (13.5)	69.1 (13.4)	68.4 (13.7)
Age Category														
0-19	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2
20-44	6.8	6.6	6.6	6.2	5.9	5.8	5.6	5.5	5.2	5.1	4.7	4.6	4.5	5.6
45-64	28.8	29.2	29.0	29.6	29.7	29.5	30.1	30.0	29.9	30.3	30.1	30.2	30.0	29.7
65-74	29.1	28.4	27.9	27.3	27.0	26.6	25.9	25.9	26.4	26.6	26.7	26.7	27.7	27.1
75-84	27.6	27.8	28.1	28.1	28.3	28.4	28.2	28.0	27.5	26.9	26.7	26.6	26.1	27.5
≥85	7.4	7.8	8.3	8.7	8.9	9.6	10.1	10.6	10.9	11.1	11.6	11.8	11.8	10.0
Race														
Native American	1.2	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.1
Asian	2.8	2.8	2.9	3.0	3.0	3.2	3.3	3.4	3.3	3.5	3.5	3.7	3.7	3.3
Black	28.2	28.3	28.0	28.2	28.4	28.1	27.7	27.5	27.4	27.2	26.8	26.5	26.5	27.6
White	65.9	65.9	66.1	65.7	65.4	66.1	66.9	67.1	67.3	67.4	68.0	68.2	68.3	66.8
Unknown	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2
Other	1.7	1.7	1.7	1.8	1.8	1.2	0.9	0.8	0.7	0.7	0.6	0.6	0.4	1.1
Hispanic														
No	71.2	75.1	78.1	79.8	81.3	82.4	83.3	84.1	84.4	84.4	84.6	84.5	84.3	81.6
Yes	8.3	9.0	9.4	9.8	10.0	10.3	10.4	10.4	10.7	11.0	11.1	11.6	11.7	10.4
Unknown	1.5	1.1	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.5
Missing	19.0	14.8	11.6	9.6	8.0	6.8	5.9	5.1	4.7	4.4	4.1	3.8	3.9	7.5
Sex														
Male	52.2	52.4	52.6	53.0	53.7	54.0	54.2	54.7	55.1	55.7	55.8	56.2	56.3	54.4
Female	47.8	47.6	47.4	47.0	46.3	46.0	45.8	45.3	44.8	44.2	44.2	43.8	43.7	45.6
Last Treatment Modality														
Hemodialysis	86.3	87.1	88.0	88.3	88.5	88.6	88.8	89.1	89.0	88.9	88.8	88.2	87.8	88.3
Peritoneal Dialysis	7.3	6.7	6.1	5.8	5.6	5.1	4.9	4.4	4.4	4.2	4.3	4.6	5.0	5.2
Transplant	4.6	4.5	4.5	4.5	4.4	4.7	4.8	5.0	5.0	5.4	5.4	5.7	5.8	5.0
Missing	1.9	1.7	1.5	1.5	1.5	1.5	1.6	1.5	1.6	1.6	1.5	1.5	1.4	1.5
Medicare Parts A&B as primary payer during last 3 months of life														
Yes	57.4	60.6	64.3	66.6	67.8	68.5	68.1	67.1	65.8	65.2	65.0	65.1	65.5	65.3

Data Source: Special analyses, USRDS ESRD Database. Denominator is all decedents.

increased from 7.4% to 11.8%. There was little change in racial and ethnic composition and a slight increase in the preponderance of male patients over time. The percentage of decedents with peritoneal dialysis as their most recent modality decreased over time and the percentage with transplant and hemodialysis increased. The percentage of patients with Medicare Parts A and B as primary payer during the last 90 days of life ranged between 57.4% and 68.5% over the period of study, peaking in 2005.

Inpatient Utilization During the Last 90 Days of Life Among Medicare Beneficiaries With ESRD

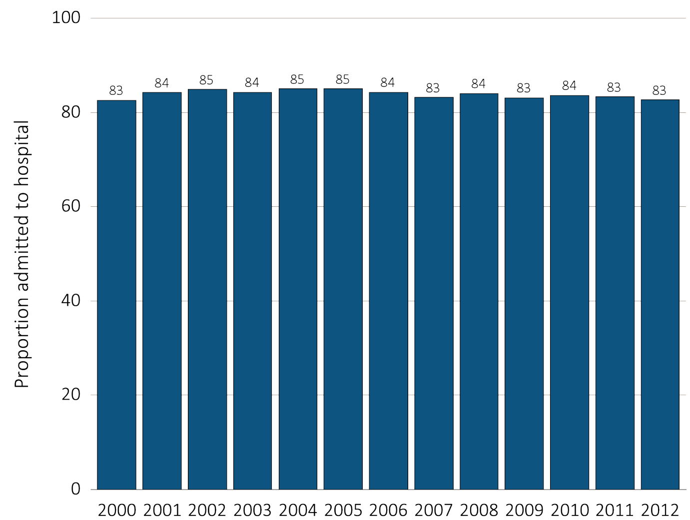
In this section, we describe the following measures of inpatient utilization during the last 90 days of life among fee-for-service Medicare beneficiaries from 2000-2012: (1) hospital admission; (2) days spent in the hospital; (3) ICU admission; (4) receipt of intensive procedures; and (5) inpatient deaths.

Hospital admission

Figure 14.1 shows that, overall, 83.9% of patients were hospitalized during the last 90 days of life. The percentage of patients admitted to the hospital was highest for those aged 75-84 years (85.1%) and lowest for those aged 45-64 years (81.4%). Hospital admission was most common in Blacks (84.7%) and least common in those of Other race (83.9%), was more common in Hispanics vs. non-Hispanics (84.9% vs. 83.9%), in women vs. men (86.2% vs. 81.9%), and in those whose most recent modality was hemodialysis vs. peritoneal dialysis vs. transplant (84.1% vs. 82.8% vs. 78.9%). The proportion of patients admitted to the hospital during the last 90 days of life either remained the same or decreased slightly in all subgroups examined.

Overall, 27.1% of decedents were admitted to and/or discharged from the hospital within 3 days of death. The percentage of patients admitted or discharged within 3 days of death did not vary greatly by age, race, ethnicity, gender, or most recent modality. Over time, the frequency of these potentially burdensome transitions increased slightly from 26.0% in 2000 to 27.8% in 2012.

vol 2 Figure 14.1 Hospital admission during the last 90 days of life among Medicare beneficiaries with ESRD, 2000-2012

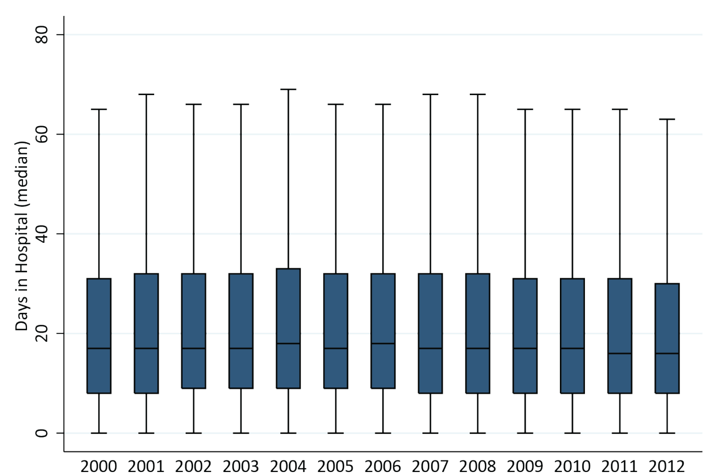


Data Source: Special analyses, USRDS ESRD Database. Denominator is all decedents with Medicare Parts A and B throughout the last 90 days of life. Includes hospital stays in both short and long stay hospitals.

Days spent in the hospital

Patients with Medicare Parts A and B who were admitted to the hospital at least once during the last 90 days of life had a median of 2 admissions during this time (interquartile range [IQR], 1, 3) and 28.2% had 3 or more admissions. The percentage of patients admitted to the hospital and the median number of admissions were stable over time and similar in all subgroups. Figure 14.2 shows that those admitted to the hospital during the last 90 days of life spent a median of 17 days in the hospital (IQR, 8, 31). The median number of days spent in the hospital during the last 90 days of life changed very little from 2000 through 2012.

vol 2 Figure 14.2 Days spent in the hospital during the last 90 days of life among Medicare beneficiaries with ESRD, 2000-2012



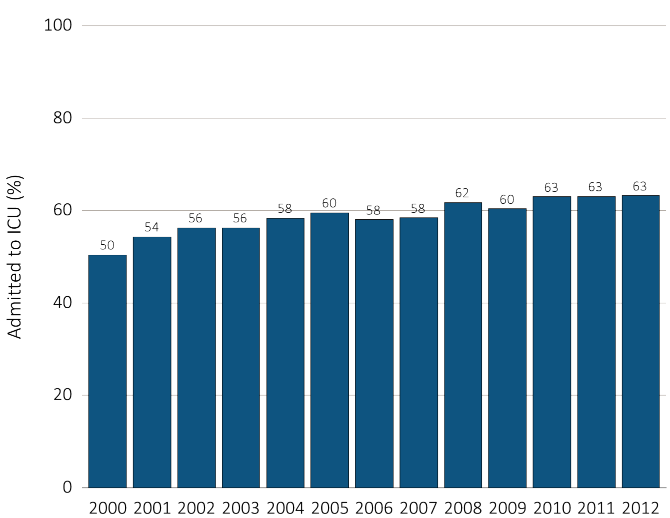
Data Source: Special analyses, USRDS ESRD Database. Denominator is all decedents with Medicare Parts A and B throughout the last 90 days of life who were admitted to the hospital at least once. Includes *hospital stays in both short and long stay hospitals. Explanation of box plot: The lower border of the box is the first quartile and the upper border is the third quartile of the distribution, the length of the box is the interquartile range and the line in the middle of the box is the median value. The whiskers (vertical lines above and below each box) extend from the lowest value of the distribution that is ≥ the first quartile minus 1.5 times the interquartile range at the bottom to the highest value of the distribution that is ≤ the third quartile plus 1.5 times the interquartile range at the top. Values outside this range (outliers) are not plotted.*

ICU admission

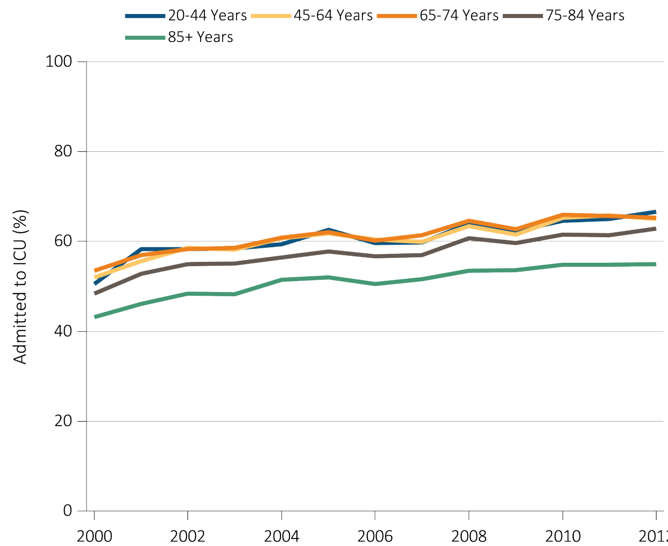
Overall, 59.0% of patients were admitted to an ICU during the last 90 days of life. As shown in Figure 14.3, the percentage admitted to the ICU was highest for those aged 65-74 years (61.4%) and lowest for those aged 85 years and older (51.7%), was highest for Asians (62.3%) and lowest for patients of Other race (46.7%), was higher for Hispanics vs. non-Hispanics (63.3% vs. 58.7%), was slightly higher for women vs. men (60.5% vs. 57.8%), and was similar in patients whose most recent modality was hemodialysis vs. peritoneal dialysis vs. transplant (59.1% vs. 58.6% vs. 58.1%). Over time, the percentage of patients admitted to the ICU during the last 90 days of life increased from 50.4% in 2000 to 63.3% in 2012. There was an increase in the percentage of patients admitted to the ICU over time among all subgroups examined.

vol 2 Figure 14.3 ICU admission during the last 90 days of life among Medicare beneficiaries with ESRD overall, and by age, race, ethnicity, sex, and modality, 2000-2012

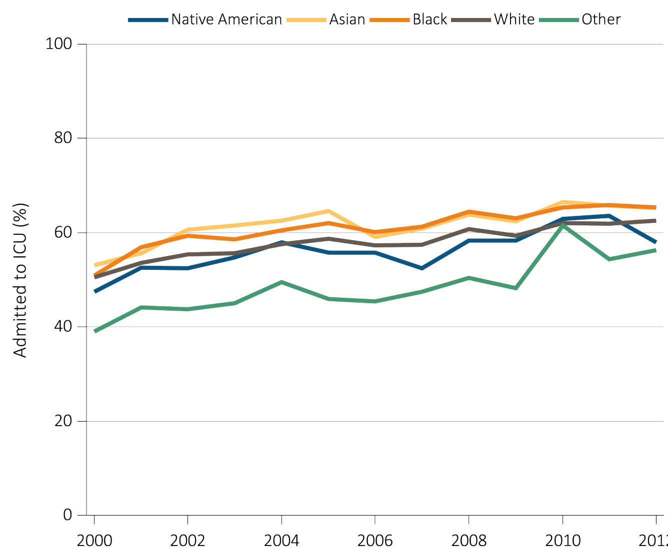
(a) ICU admission by year, overall



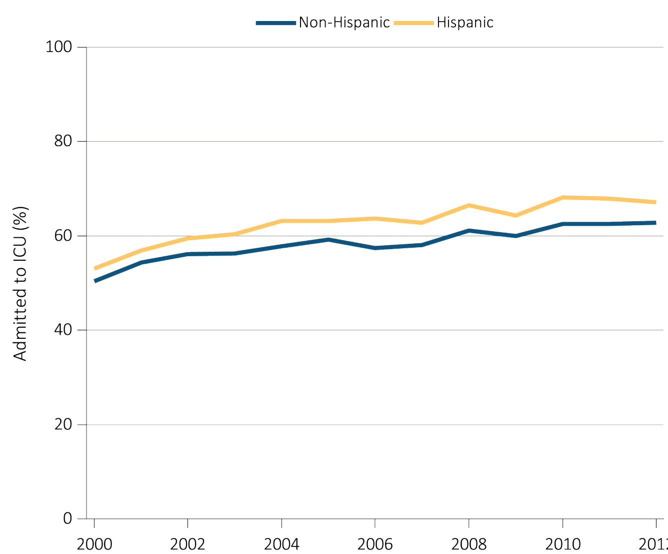
(b) ICU admission by age



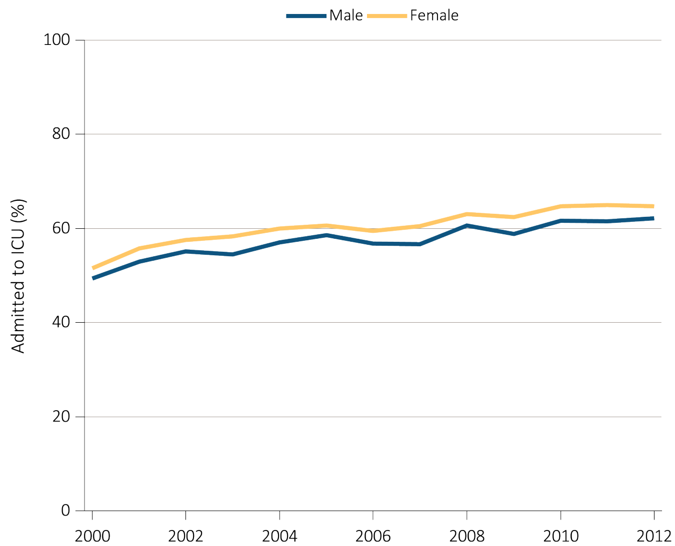
(c) ICU admission by race



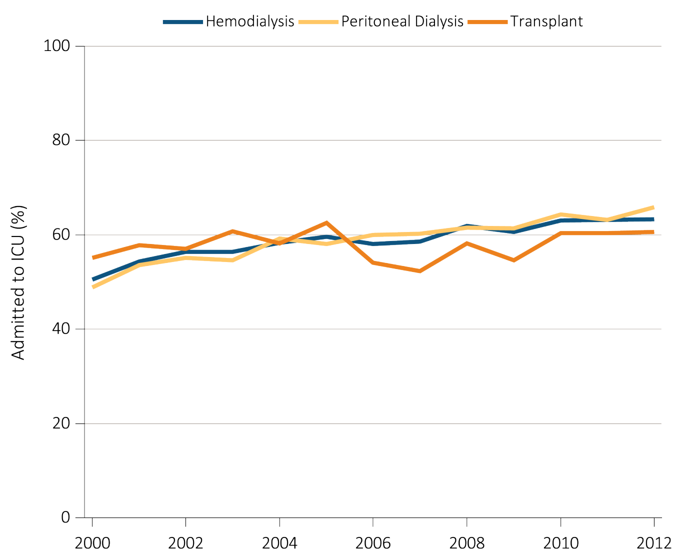
(d) ICU admission by ethnicity



(e) ICU admission by sex



(f) ICU admission by modality



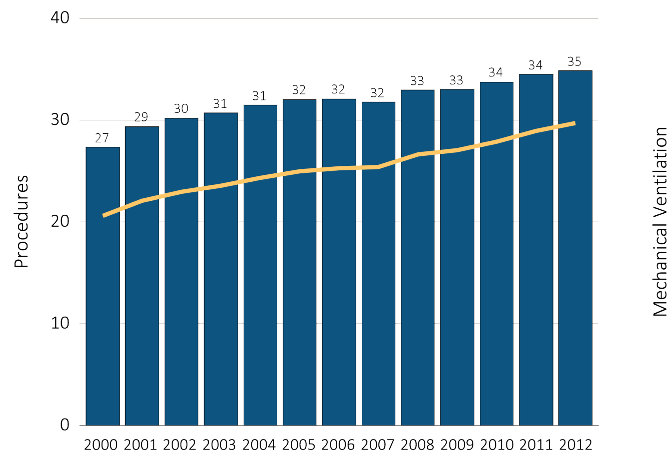
Data Source: Special analyses, USRDS ESRD Database. Denominator is all decedents with Medicare Parts A and B throughout the last 90 days of life. ICU admission was identified using ICU revenue center codes in Medicare Institutional claims.

Intensive procedures

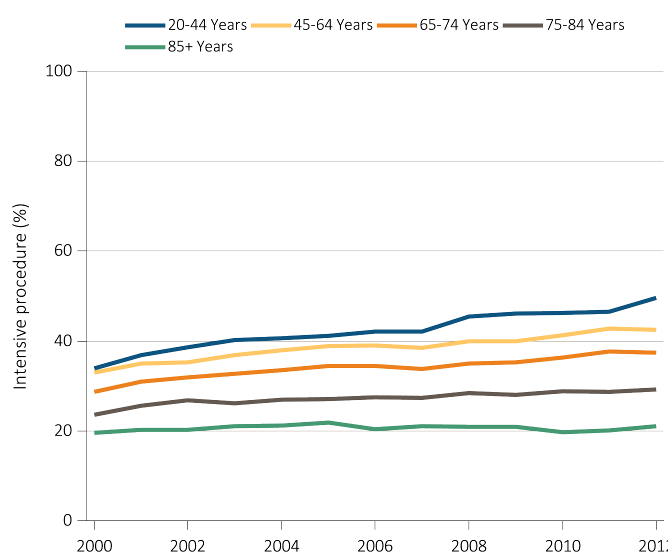
Overall, 32.0% of decedents had an inpatient intensive procedure during the last 90 days of life and 25.4% of patients were intubated or received mechanical ventilation. As shown in Figure 14.4, the percentage of patients receiving intensive procedures during the last 90 days of life was highest for those aged 20-44 years (42.4%) and lowest for those aged 85 years and older (20.7%), was highest for Blacks (41.1%) and lowest for Whites (28.1%), was higher for Hispanics vs. non-Hispanics (38.2% vs. 31.3%), was slightly higher for women vs. men (33.1% vs. 31.1%), and was higher for those with transplant vs. peritoneal dialysis vs. hemodialysis as the most recent modality (39.1% vs. 32.0% vs. 31.9%). Over time, the percentage of patients who received an intensive procedure increased from 27.3% in 2000 to 34.8% in 2012. The percentage of patients who were intubated or received mechanical ventilation during the last 90 days of life increased from 20.6% to 29.7% over the same time period. The percentage of patients receiving an intensive procedure increased over time for most subgroups examined.

vol 2 Figure 14.4 Intensive procedures during the last 90 days of life among Medicare beneficiaries with ESRD overall, and by age, race, ethnicity, sex, and modality, 2000-2012

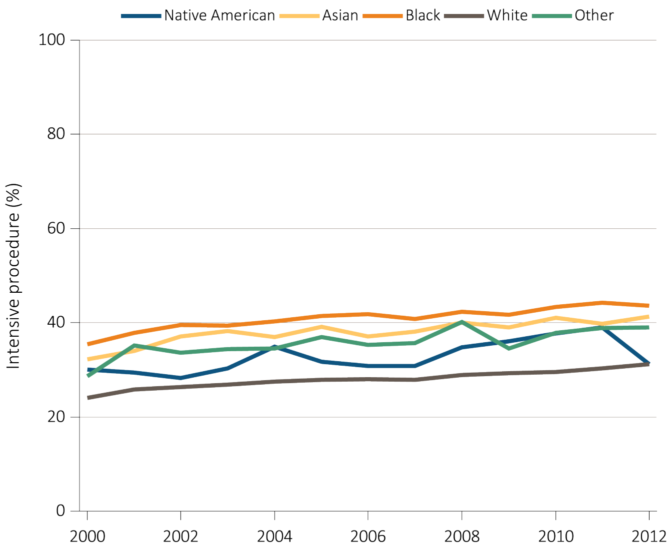
(a) Intensive procedures and mechanical ventilation by year, overall



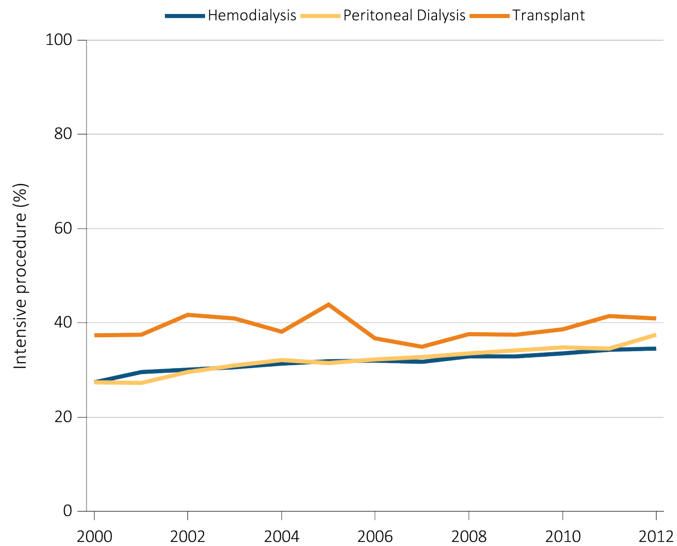
(b) Intensive procedures by age



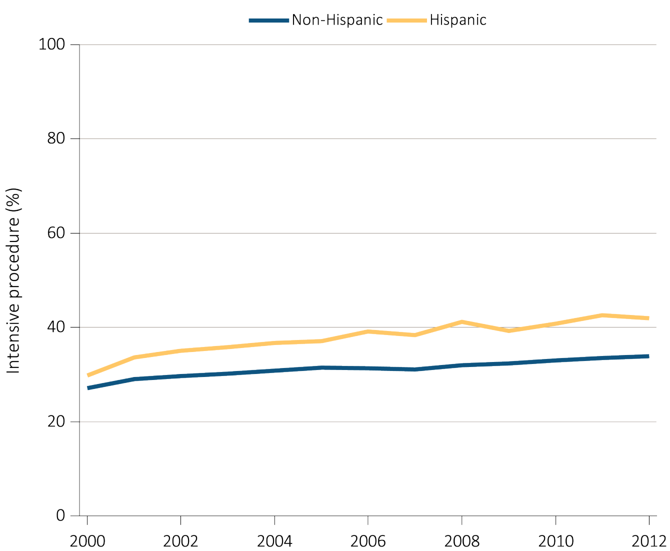
(c) Intensive procedures by race



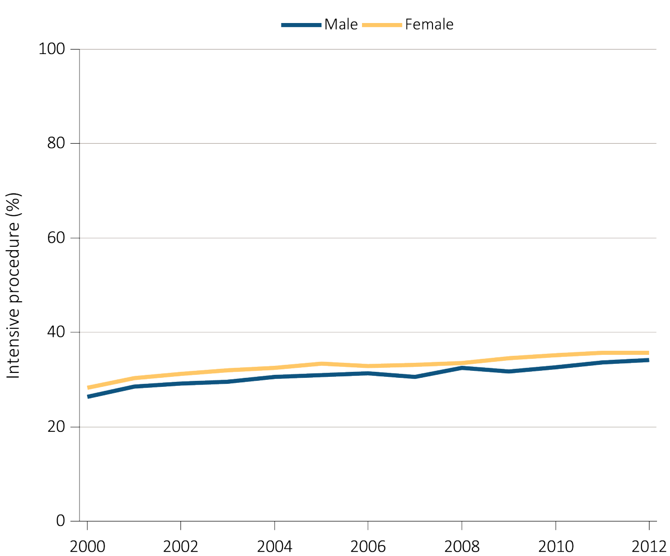
(f) Intensive procedures by modality



(d) Intensive procedures by ethnicity



(e) Intensive procedures by sex



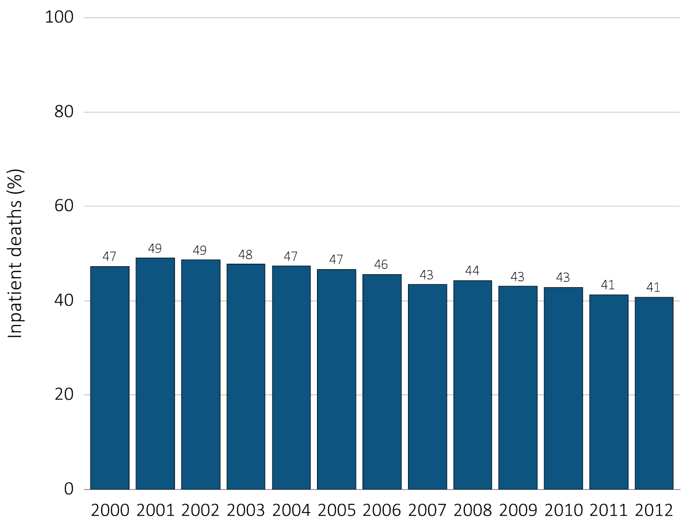
Data Source: Special analyses, USRDS ESRD Database. Denominator population is all decedents with Medicare Parts A and B throughout the last 90 days of life. Intensive procedures were identified by ICD-9 procedure code search of Medicare Institutional claims from short and long stay hospitals. The yellow line in panel (a) denotes the percentage of patients who were intubated or received mechanical ventilation.

Inpatient deaths

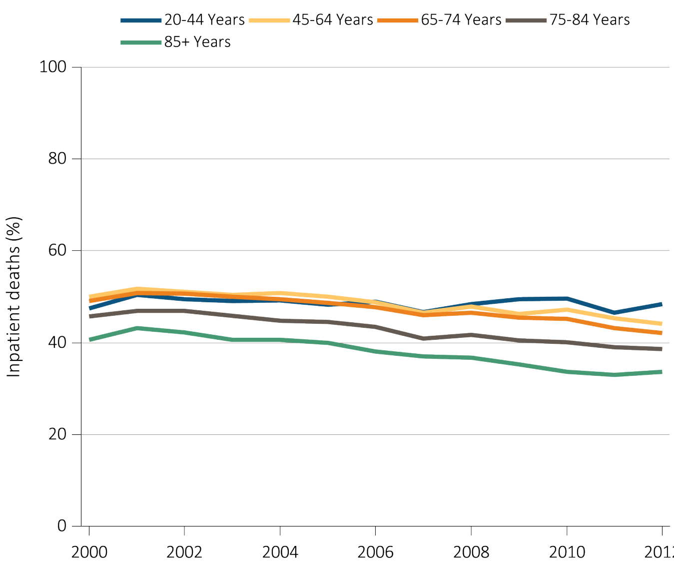
Based on Medicare Institutional claims, 45.1% of patients died in the hospital. As shown in Figure 14.5, the proportion of inpatient deaths was highest for those aged 20-44 years (48.6%) and lowest for those aged 85 years and older (37.5%). Death in the hospital was most common in those of Other race (53.7%) and least common in Whites (43.1%), was more common in Hispanics vs. non-Hispanics (51.0% vs. 44.4%), was more common in women vs. men (46.7% vs. 43.7%), and was more common in patients whose most recent modality was peritoneal dialysis vs. transplant vs. hemodialysis (50.1% vs. 49.0% vs. 44.8%). Over time, the percentage of inpatient deaths decreased from 47.3% in 2000 to 40.8% in 2012; the percentage of inpatient deaths decreased over time for most subgroups examined. When we used information from the CMS Death Notification form, 63.2% of decedents for whom this information was available were reported to have died in the hospital, declining from 68.9% in 2000 to 59.0% in 2012. The sensitivity and specificity of the CMS Death Notification form for detecting inpatient deaths based on Medicare claims were 94% and 63%, respectively, among patients with complete information from both sources.

vol 2 Figure 14.5 Inpatient deaths among Medicare beneficiaries with ESRD overall, and by age, race, ethnicity, sex, and modality, 2000-2012

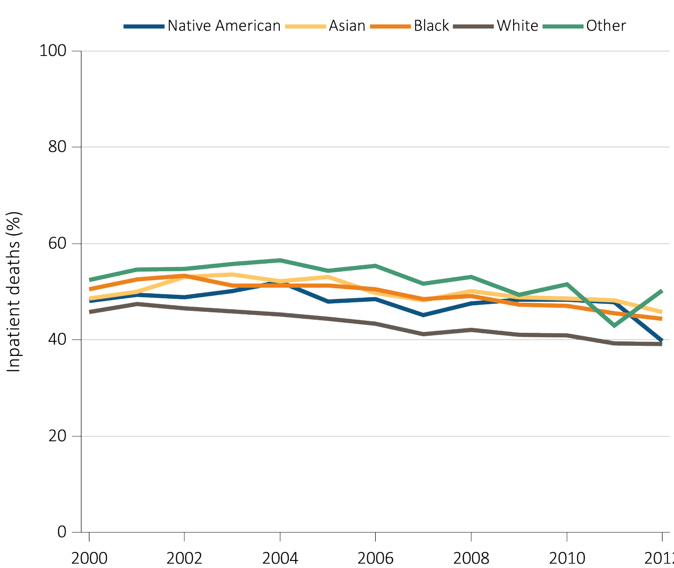
(a) Inpatient deaths by year, overall



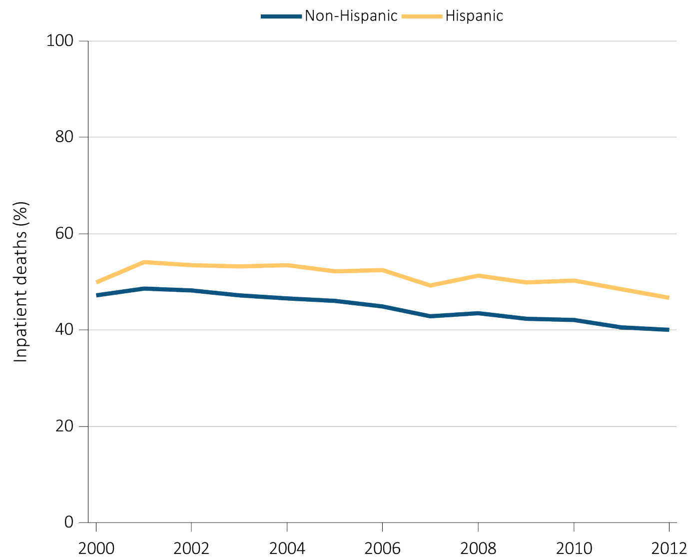
(b) Inpatient deaths by age



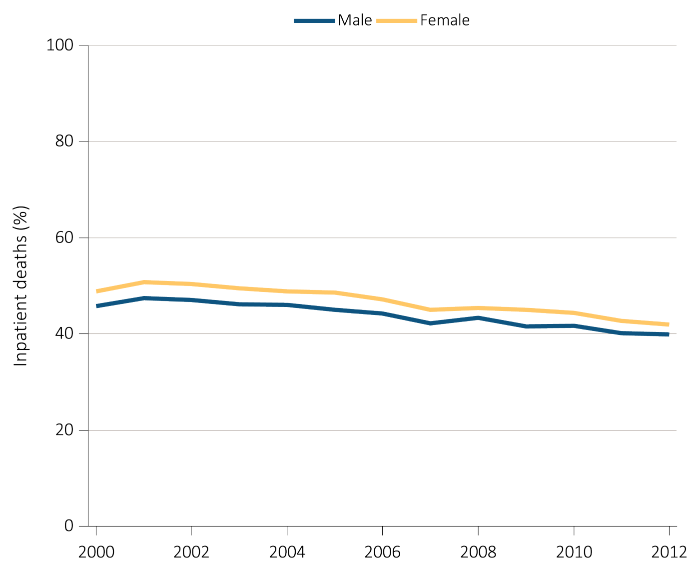
(c) Inpatient deaths by race



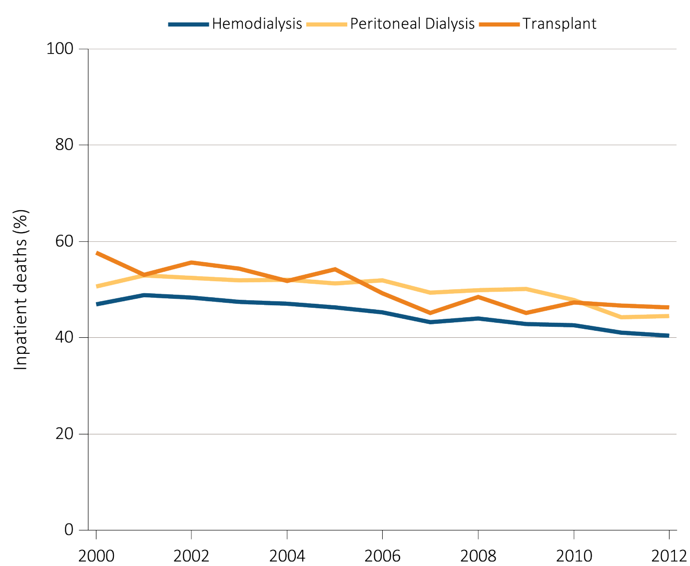
(d) Inpatient deaths by ethnicity



(e) Inpatient deaths by sex



(f) Inpatient deaths by modality



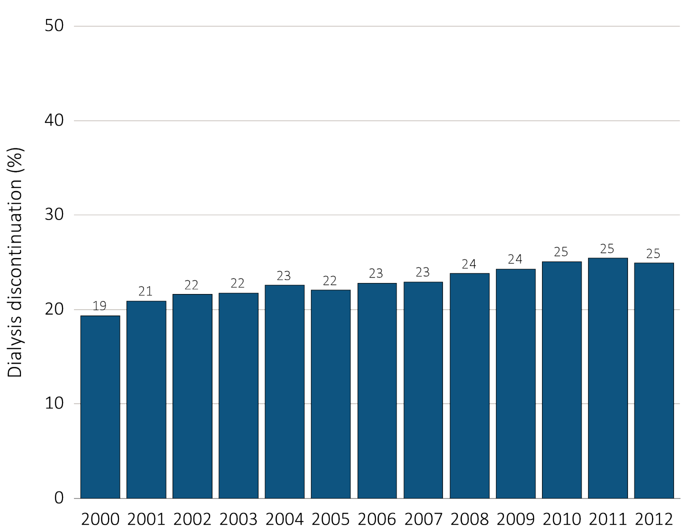
Data Source: Special analyses, USRDS ESRD Database. Denominator population is all decedents with Medicare Parts A and B throughout the last 90 days of life. Includes deaths occurring in short and long stay hospitals.

Dialysis Discontinuation Before Death

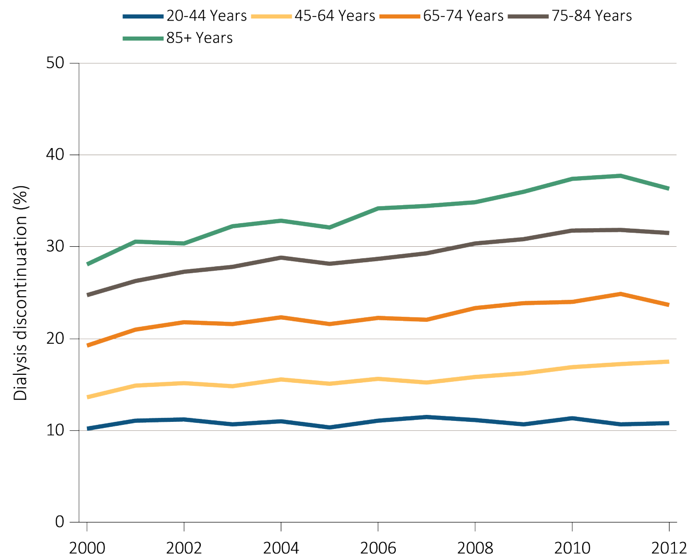
Overall, 23.0% of patients with either hemodialysis or peritoneal dialysis listed as their most recent modality were reported to have discontinued dialysis treatments before death on the CMS Death Notification Form. As shown in Figure 14.6, the frequency of dialysis discontinuation before death was highest for patients aged 85 years and older (34.2%) and lowest for those aged 20-44 years (10.9%), was highest for Whites (27.3%) and lowest for patients of Other race (10.2%), was higher for non-Hispanics vs. Hispanics (24.2% vs. 17.8%), was higher for women vs. men (24.6% vs. 21.6%), and for those whose most recent modality was hemodialysis vs. peritoneal dialysis (23.3% vs. 18.6%). The median time from discontinuation to death as reported on the CMS Death Notification form was 6 days (IQR, 3, 12 days). This interval was slightly shorter for those treated with peritoneal dialysis (3 days, IQR, 2, 7 days) vs. hemodialysis (6 days, IQR, 3, 12 days), and slightly longer for those who received hospice (7 days, IQR, 4, 13 days) vs. those who did not (4 days, IQR, 2, 8 days). Over time, there was an increase in the percentage of decedents who discontinued dialysis before death from 19.3% in 2000 to 24.9% in 2012. The percentage of decedents who discontinued dialysis increased over time for most subgroups examined.

vol 2 Figure 14.6 Dialysis discontinuation before death among decedents overall, and by age, race, ethnicity, sex, and modality, 2000-2012

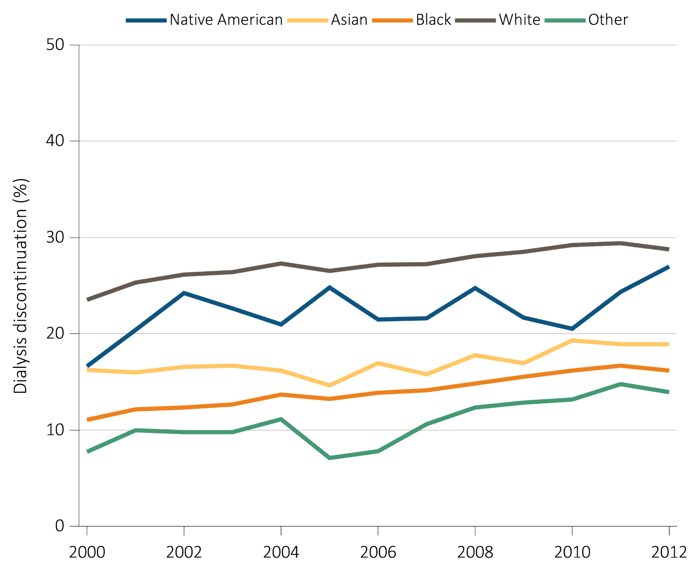
(a) Dialysis discontinuation by year, overall



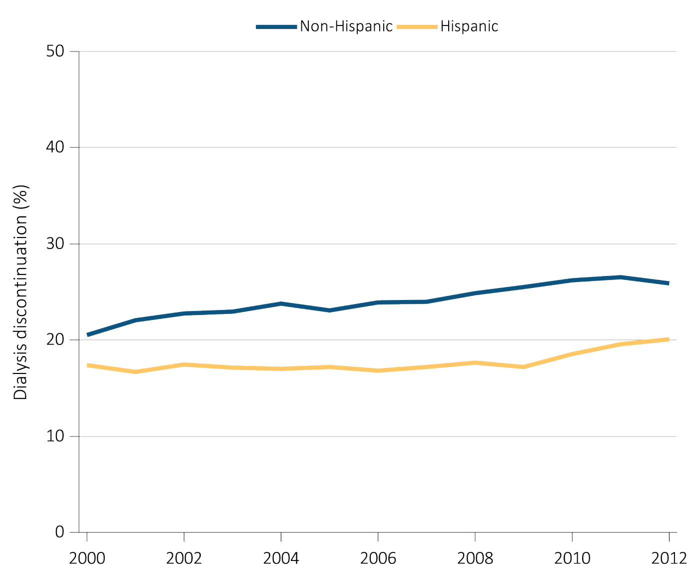
(b) Dialysis discontinuation by age



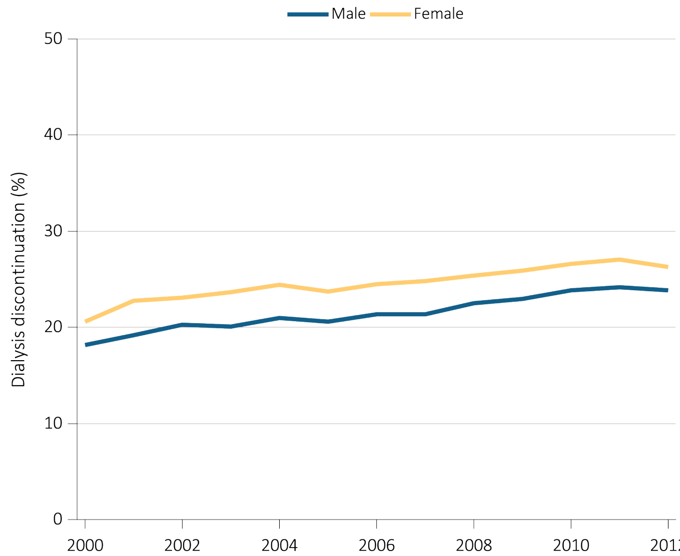
(c) Dialysis discontinuation by race



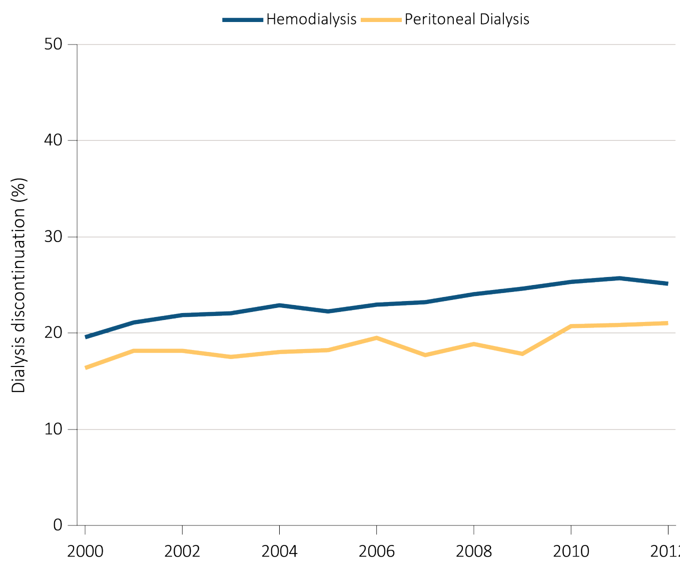
(d) Dialysis discontinuation by ethnicity



(e) Dialysis discontinuation by sex



(f) Dialysis discontinuation by modality



Data Source: Special analyses, USRDS ESRD Database. Denominator population is all patients with complete data on dialysis discontinuation from the CMS Death Notification form (CMS 2746).

Patterns of Hospice Utilization Before Death

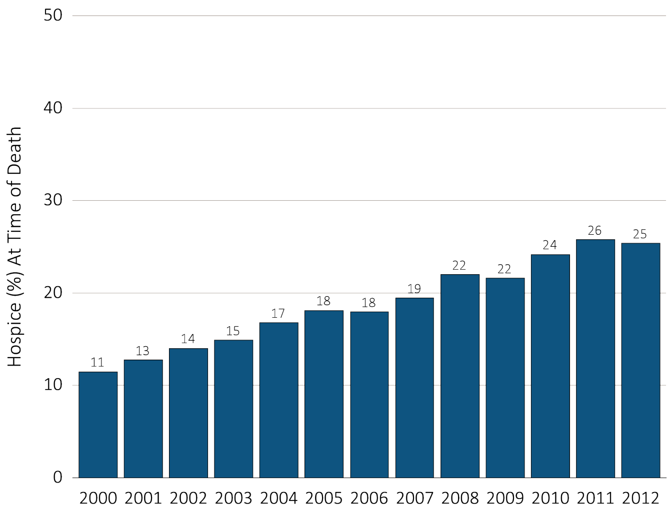
Overall, 19.2% of patients with Medicare Parts A and B as primary payer were receiving hospice at the time of death based on Medicare Institutional claims. As shown in Figure 14.7, use of hospice services was highest for patients aged 85 years and older (28.9%) and lowest for those aged 20-44 years (7.0%), was highest for Whites (22.4%) and lowest for those of Other race (7.5%), was higher for non-Hispanics vs. Hispanics (19.7% vs. 15.0%), was higher for women vs. men (20.1% vs. 18.3%), and was higher for those whose most recent modality was hemodialysis vs. transplant vs. peritoneal dialysis (19.2% vs. 18.3% vs. 15.9%). The percentage of patients receiving hospice services at the time of death differed markedly according to whether patients did vs. did not discontinue dialysis (53.1% vs. 8.5%), most likely reflecting both the intertwined nature of these two treatment decisions and regulatory barriers to concurrent receipt of dialysis and hospice services for many patients with ESRD (Murray et al., 2006). The percentage of patients receiving hospice services at the time of death increased from 11.4% in 2000 to 25.4% in 2012; hospice utilization increased over time for most subgroups.

Overall, 21.1% of patients with Medicare Parts A and B as primary payer had an institutional claim for hospice in the last 90 days of life. Among these, the median interval between the first claim for hospice within this time frame and death was 5 days (IQR, 2, 13 days) and 39.8% of patients had their first claim for hospice ≤ 3 days before death.

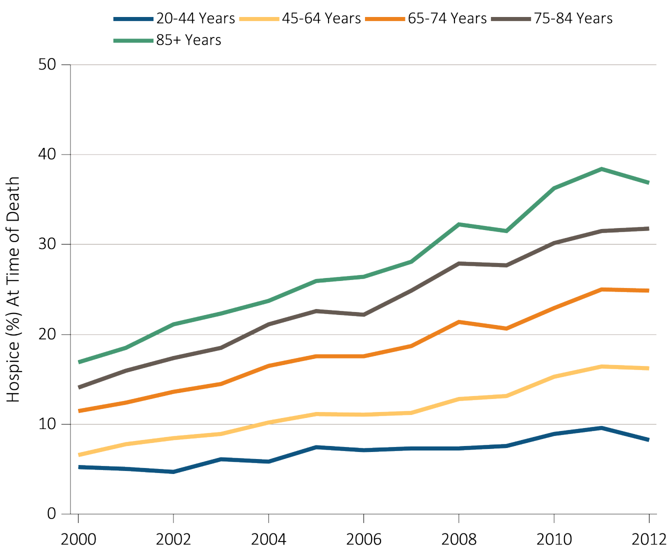
When we used information on hospice referral before death from the CMS Death Notification form, 23.6% of decedents for whom this information was available were reported to have received hospice care before death (data available only from 2004-2012). The sensitivity and specificity of the CMS Death Notification form for detecting hospice at the time of death based on Medicare claims were 83% and 92%, respectively among patients with complete information from both sources. The percentage of patients who received hospice care before death based on the CMS Death Notification form was highly correlated with dialysis discontinuation before death: 73.4% of those who had discontinued dialysis before death received hospice as compared with 6.5% of those who had not discontinued dialysis. From 2004-2012, the percentage of patients who received hospice prior to death based on the CMS Death Notification form increased from 17.5% to 27.3% in the overall population for whom this was reported, from 59.3% to 80.1% for those who discontinued dialysis treatments before death, and from 5.4% to 7.4% for those who did not.

vol 2 Figure 14.7 Hospice utilization at the time of death among Medicare beneficiaries with ESRD overall, and by age, race, ethnicity, sex, modality, and whether dialysis was discontinued, 2000-2012

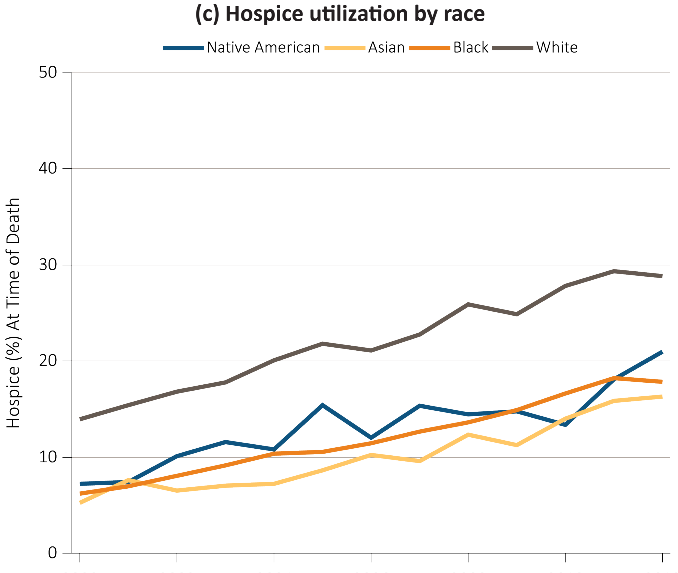
(a) Hospice utilization by year, overall



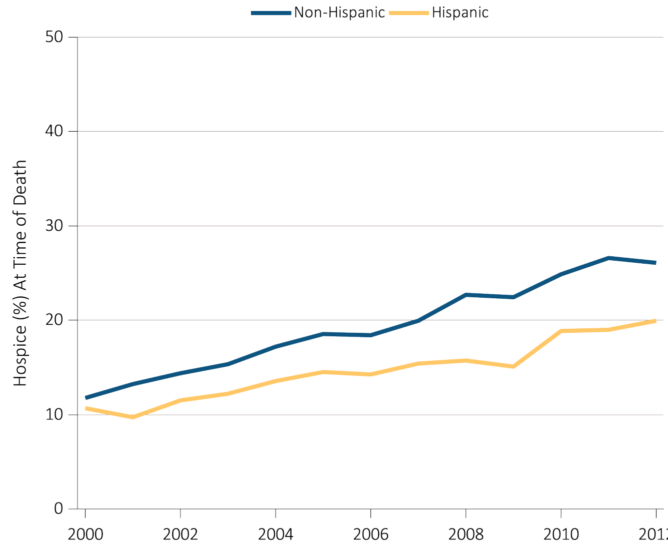
(b) Hospice utilization by age



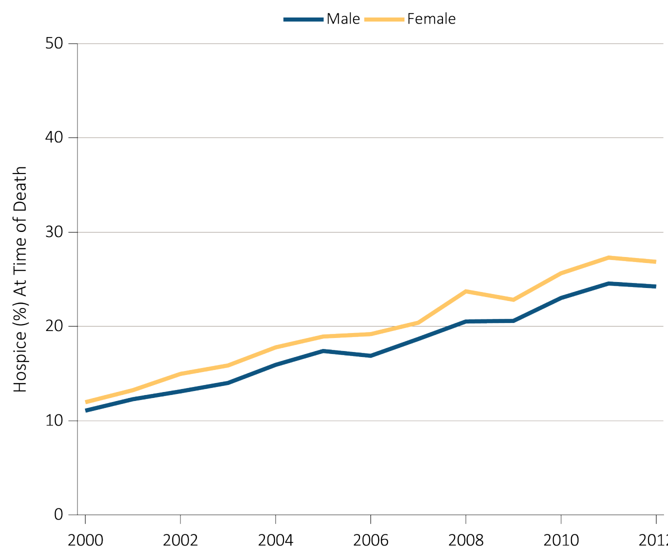
(c) Hospice utilization by race



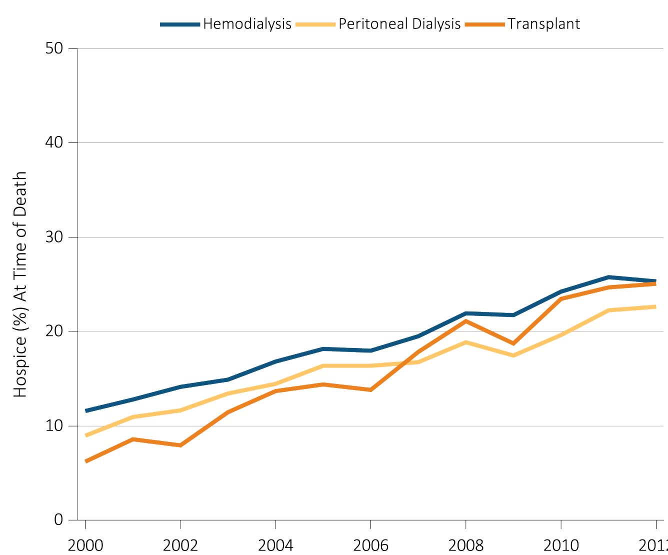
(d) Hospice utilization by ethnicity



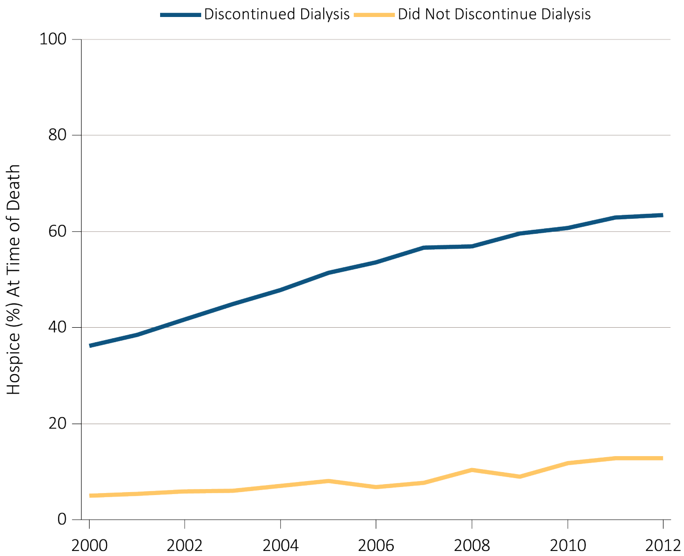
(e) Hospice utilization by sex



(f) Hospice utilization by modality



(g) Hospice utilization by whether patients discontinued dialysis before death



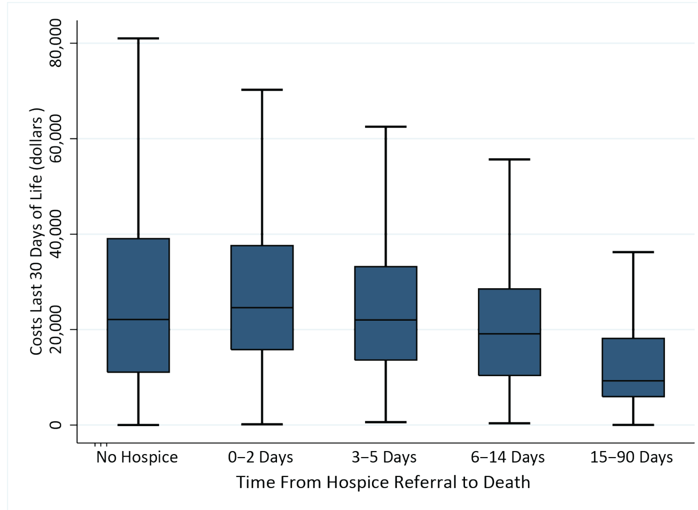
Data Source: Special analyses, USRDS ESRD Database. Denominator population is all decedents with Medicare Parts A and B throughout the last 90 days of life. Receipt of hospice care at the time of death was defined as having a claim in the Hospice SAF on or after the date of death or Discharge Status from hospice=40, 41, or 42.

End-of-life Costs for Services Under Medicare Parts A and B

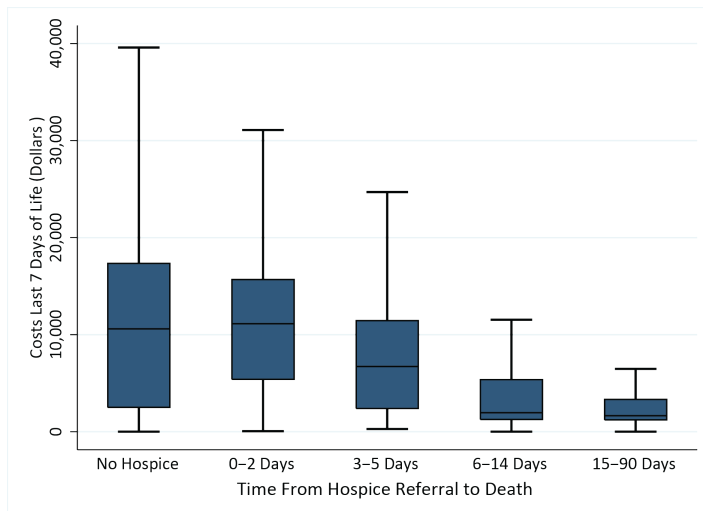
For ESRD patients who died in 2012, median per person costs under Medicare Parts A and B were $116,416 (IQR $72,258, $180,181) over the last year of life, $21,121 (IQR, $10,567, $36,389) over the last 30 days of life, and $8,538 (IQR, $2,004, $15,608) over the last 7 days of life (Figure 14.8). Median costs over the last 30 days of life were progressively lower for patients with a longer time interval between the first claim for hospice and death, ranging from $9,264 for those referred to hospice more than 2 weeks before death (IQR, $5,945, $18,150) to $24,590 for those first referred to hospice 2 days or less before death (IQR, $15,804, $37,597), as compared with the referent group without a claim for hospice during the last 90 days of life ($22,122; IQR, $11,080, $39,055). Median costs during the last 7 days of life were also lower for those referred earlier to hospice, ranging from $1,649 (IQR, $1,219, $3,334) for those referred more than 2 weeks before death to $11,123 (IQR, $5,320, $15,651) for those not referred until the last 2 days of life, as compared with the referent group without a claim for hospice during the last 90 days of life ($10,598; IQR, $2,528, $17,356).

vol 2 Figure 14.8 Costs in the (a) last 30 days of life, and (b) last 7 days of life in relation to timing of hospice care, 2012

(a) Last 30 days of life



(b) Last 7 days of life



Data Source: Special analyses, USRDS ESRD Database. Denominator population is all decedents with Medicare Parts A and B throughout the last 90 days of life exclusive of those patients without any costs during the last 30 days of life and those with negative costs. Date of the first claim in the Hospice SAF (HCFASAF=H) within the last 90 days of life is taken as the date of first receipt of hospice services. Timing of hospice referral in relation to death was categorized by quartile (1st quartile 0-2 days, 2nd quartile 3-5 days, 3rd quartile 6-14 days and 4th quartile 15-90 days). Explanation of box plot: the lower border of the box is the first quartile and the upper border is the third quartile of the distribution, the length of the box is the interquartile range, and the line in the middle of the box is the median value. The whiskers extend from the lowest value of the distribution that is ≥ the first quartile minus 1.5 times the interquartile range at the bottom to the highest value of the distribution that is ≤ the third quartile plus 1.5 times the interquartile range at the top. Values outside this range (outliers) are not plotted.

Summary

From 2000-2012, there were marked increases in the intensity of inpatient care during the final months of life for patients with ESRD. Over the same time period, there was a decline in inpatient deaths, an increase in dialysis discontinuation and an increase in hospice utilization. Receipt of hospice services occurred less than a week before death in most cases, was closely tied to dialysis discontinuation, and was associated with lower costs during the last days and weeks of life. In summary, while there has been a trend toward greater use of hospice services in this population, referral to hospice still tends to occur very late in the course of illness only after all other options have been exhausted.

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Notes

Volume 2: ESRD Analytical Methods

Contents

Introduction

In the ESRD Methods chapter, we present details on the United States Renal Data System (USRDS) database, its standardized working datasets and specialized code definitions, and the common data processing practices applied to the data used in the production of this Annual Data Report (ADR). We also describe the statistical methods used in the ADR. The *Researcher's Guide to the USRDS Database*, available through www.usrds.org, provides additional information about the database and standard analysis files (SAFs). For this ADR, data are reported through December 31, 2013.

Data Sources

The USRDS maintains a relational database of diagnostic and demographic characteristics of end-stage renal disease (ESRD) patients including information on the incidence, prevalence, morbidity, and mortality of this population as well as biochemical lab results, dialysis and other institutional claims, physician/supplier services, treatment and payer histories, hospitalization and modality events, and details regarding providers. As the ESRD population are typically Medicare beneficiaries, the main data source for this database is the Centers for Medicare & Medicaid Services (CMS).

In 2003, the USRDS was expanded to include information on persons with chronic kidney disease (CKD). The data for CKD patients come from the National Health and Nutrition Examination Survey (NHANES) and billing data sources such as Medicare. In 2009 acute kidney injury (AKI) was added to the USRDS ADR in order to cover all stages of kidney disease.

This introduction traces the history of data collection for ESRD patients, and discusses the systems that have evolved to house the data. Detailed discussions about the data and analytical methods that are used in each chapter are found in the section titled *Analytical Methods Used in the ESRD Volume*.

In October 1972, by Public Law 92-603, which expanded the Social Security Act,[1] ESRD patients were included as beneficiaries in the Medicare Program. With the provision of insurance coverage for end-stage renal care now provided, a means of collecting and utilizing data about that care was sought. The government made efforts to contract out a project to implement a national data collection system, or ESRD registry, between 1974 and 1977, but the effort was not successful. Meanwhile, Medicare expenditures and the number of ESRD beneficiaries began to grow significantly, and both government and the renal community became more concerned with the development of such a national registry.[2]

In accordance with the Privacy Act of 1974, which established a formal System of Records (SOR) for the protection of collected personal information such as name and Social Security number, a SOR was created for the ESRD program titled the "End Stage Renal Disease (ESRD) Program Management and Medical Information System (PMMIS) – SOR system number 09-70-0520.[3] This progress toward a data collection system, along with the 1975 and 1976 legislative amendments to the Social Security Act expanding Medicare coverage to ESRD patients, furthered the push for the development of a national ESRD Registry.

In 1977, the Health Care Financing Administration (HCFA), an agency that oversaw Medicare's financing (later renamed the Centers for Medicare & Medicaid Services (CMS)), was established under the department of Health Education and Welfare (HEW), which was renamed Health and Human Services (HHS) in 1979. CMS handles payment and administrative functions for all Medicare recipients on a regional (e.g., state) level. Originally, this was done through contracted intermediaries (Part A services) and carriers (Part B services). In recent years, the Parts A and B bill processing function has been combined into Medicare Administrative Contractors (MACs). Furthermore, CMS contracts with 18 regional ESRD Network offices that perform research and data collection activities, assure quality of medical care, and adjudicate patient grievances.

In June of 1978, Public Law 95-292 addressed the need for significant improvements to ensure cost-effective quality of care in the ESRD program. This finally led to the development of a comprehensive Medicare-based data system for the ESRD program within the

[1] Public Law 92-603, Approved October 30, 1972. *www.gpo.gov/fdsys/pkg/STATUTE-86/pdf/STATUTE-86-Pg1329.pdf*

[2] Blagg CR, Bovbjerg RR, Fitzsimmons SC. Here are (almost all) the data: The evolution of the U.S. Renal Data System. *Am J Kidney Dis* 1989;14(5): 347–353.

[3] *http://www.cms.gov/Research-Statistics-Data-and-Systems/Computer-Data-and-Systems/Privacy/CMS-Systems-of-Records.html*

HCFA.[4,5] Thus, the original data storage system was created and it was known by the same name as the official SOR title, the ESRD Program Management and Medical Information System (PMMIS). It was established to provide medical and cost information for ESRD program analysis, policy development, and epidemiologic research.[5]

The PMMIS gathered information on Medicare ESRD patients and Medicare-approved ESRD hospital-based and independent dialysis facilities. Data was compiled via Medicare claims and data forms that were collected through the Medicare intermediaries. The forms included the Medical Evidence form (CMS 2728), the Death Notification form (CMS 2746), and the Facility Survey form (CMS 2744). Other files maintained in the system included the Patient Identification File, the Transplant File, the Transplant Follow-up File, the Quarterly Dialysis File, and the Hospital Inpatient Stay Record File. There was no mandatory compliance for data collection, so early data is quite incomplete. In 1981, reporting on the incidence of ESRD was mandated as a requirement for Medicare Entitlement and a new Medical Evidence Form was introduced. Since that time there has been continuous improvement in the completeness of the data.[5] The PMMIS was maintained on HCFA computers, and was a batch-oriented Model 204 (M204 IBM Mainframe) data system.

Initially, HCFA was required to submit an annual report to Congress on the ESRD program and three reports were published (HCFA 1979, 1980, 1982). Due to the burden for HCFA of compiling many related reports, Congress rescinded the requirement for a separate report and the agency was permitted to include the ESRD program in its annual report on the whole Medicare program.[5] This level of reporting did not, however, adequately meet the needs of the renal community for reliable data collection and reporting on outcomes and quality of care. Throughout the 1980s, efforts continued to create a comprehensive ESRD registry with reporting beyond that which the PMMIS provided. This need was recognized politically as well as among researchers, and Congress, in 1986, called for the DHHS to establish a "national end-stage renal disease registry."[6] An interagency committee was formed between HHS and the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) and an RFP was shortly thereafter issued for the development of the United States Renal Data System (USRDS) to establish a complete ESRD Registry, which was to be built upon and surpass the HCFA data collected by the PMMIS. The contract was awarded by NIDDK in May 1988 to the Urban Institute, with a subcontract to the University of Michigan, and the first USRDS Annual Data Report on the ESRD population was released in 1989.

The specific data systems utilized by CMS to manage the ESRD database have evolved over the years as technology has changed and the need for improvements was identified. In 1995, CMS transitioned from the way data were stored in the original PMMIS, replacing its Medicare ESRD Support Subsystem (MESS) with an enhanced online M204 data system known as the Renal Beneficiary and Utilization System (REBUS). Also in 1995, non-Medicare patients began to be included in the database as the ESRD Medical Evidence Report form (CMS 2728) was again revised and made mandatory for all ESRD patients.

Renal Management Information System

In 2003, the REBUS database was converted into an Oracle relational database known as the Renal Management Information System (REMIS), and the Standard Information Management System (SIMS) database of the ESRD networks was also established. SIMS collected the CMS Medical Evidence, Death Notification, and Facility Survey forms mentioned above, and also included information to track patient movement in and out of ESRD facilities, and their transitions from one treatment modality to another. REMIS calculates Medicare ESRD coverage periods for renal patients and includes operational interfaces to the SIMS Central Repository and the Medicare Enrollment Database (EDB). REMIS also includes sophisticated data quality problem resolution support.[7]

CROWNWeb and Standard Information Management System Database

The Standard Information Management System (SIMS) database of the ESRD networks was established in 2003. It included information to track patient movement in and out of ESRD facilities, and their transitions from one treatment modality to

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4 Kidney Failure and the Federal Government, Richard A. Rettig and Norman G. Levinsky, Editors. National Academies of Sciences, 1991.

5 *http://www.cms.gov/Medicare/End-Stage-Renal-Disease/ESRDNetworkOrganizations/Downloads/ESRDNWBackgrounder-Jun12.pdf*

6 Omnibus Budget Reconciliation Act of 1986 – PL 99-509

7 *http://www.cms.gov/Research-Statistics-Data-and-Systems/Files-for-Order/IdentifiableDataFiles/RenalManagementInformationSystem.html*

another. With the integration of the SIMS events data into the USRDS Database, it became possible to better track patients beyond the initiation of treatment. The SIMS events data, along with the mandate for the Medical Evidence form beginning in 1995, allowed for inclusion of patients for whom there previously were no data on initial modality or death. SIMS was replaced by CROWNWeb in 2012. CROWNWeb is a web-based data collection system that captures clinical and administrative data from Medicare-certified dialysis facilities, and allows authorized users to securely submit, update, and verify data provided to Medicare. This system was rolled out nationally in June 2012. In addition to replacing the patient tracking functionality of SIMS, CROWNWeb also collects new data to support calculation of clinical measures (e.g., Kt/V, hemoglobin, and calcium), and integrates these data with the REMIS system.

Thus, the USRDS Database contains demographic, diagnostic, and treatment history information for all patients with ESRD, regardless of whether they are Medicare beneficiaries. The data are updated on a regular basis using the Medicare EDB, ESRD Medical Evidence and Death Notification Report forms (CMS 2728 and 2746), Medicare Institutional and Carrier claims, and the Organ Procurement and Transplantation Network (OPTN) transplant database. CMS has also established data-integrity rules to ensure accurate identification of patients in the CMS databases.

CMS Medicare Enrollment Database

The Medicare EDB is the designated repository of all Medicare beneficiary enrollment and entitlement data, including current and historical information on beneficiary residence, Medicare as secondary payer (MSP) and employer group health plan (EGHP) status, and Health Insurance Claim/Beneficiary Identification Code cross-referencing. About 8% of persons in the USRDS database never qualify for Medicare benefits and thus do not enter the Medicare EDB. Information on these patients comes from CROWNWeb, OPTN, and the Social Security Administration (SSA) mortality database.

ESRD Medical Evidence Form (CMS 2728)

The CMS ESRD Medical Evidence Report form (CMS 2728) is used to register patients at the onset of ESRD, and must be submitted by dialysis or transplant providers within 45 days of treatment initiation. The form establishes Medicare eligibility for individuals previously not Medicare beneficiaries, reclassifies previously eligible beneficiaries as ESRD patients, and provides demographic and diagnostic information on all new patients. The CMS, USRDS, and renal research communities rely on the form to ascertain patient demographics, primary cause of ESRD, comorbidities, and biochemical test results at the time of ESRD initiation. Prior to 1995, providers were required to file the Medical Evidence form only for Medicare-eligible patients. Since the 1995 revision, however, providers are required to complete the form for all new ESRD patients regardless of Medicare eligibility status.

The third major revision of the Medical Evidence form, in May 2005, remedied several shortcomings of the 1995 form and its earlier versions. Key additions target pre-ESRD care and vascular access use, and additional new fields collect information on glycosylated hemoglobin (HgbA1c) and lipid testing, on the frequency of hemodialysis (HD) sessions, and on whether patients are informed of transplant options.

ESRD Death Notification Form (CMS 2746)

The ESRD Death Notification form (CMS 2746) is used to report the death of ESRD patients. According to CMS policy, this form must be submitted by dialysis or transplant providers within 30 days of a patient's death, and provides the date and causes of death (primary and secondary), reasons for discontinuation of renal replacement therapy, if applicable, and evidence of hospice care prior to death. It is the primary source of death information for CMS and the USRDS, identifying more than 92% of deaths. The USRDS also utilizes several supplemental data sources for ascertaining death (see the *Death Date Determination* section below for more details).

Annual Facility Survey (CMS 2744)

Independent ESRD patient counts are available from the CMS Annual Facility Survey (AFS) (CMS 2744), which all Medicare-certified dialysis facilities must complete. The AFS reports the counts of patients being treated at the end of the year, new ESRD patients starting treatment during the year, and patients who die during the year. Both Medicare and non-Medicare end-of-year patients are counted. While AFS files do not carry patient-specific demographic and diagnosis data, they provide independent patient counts used to complement the CMS patient-specific records. In addition, CMS 2744 includes facility level information such as ownership, services offered, number of stations, and detailed staffing data. Starting with the 2005 AFS, CMS stopped posting data from these surveys on the Internet. Beginning with the 2007 ADR, the USRDS extracted the relevant facility survey data directly from the SIMS database. Beginning in 2012, when SIMS was replaced by CROWNWeb, the USRDS received the facility survey data directly from CROWNWeb.

Organ Procurement and Transplantation Network Database

In the early 1980s CMS began collecting data on all Medicare kidney transplants in the PMMIS data system. In 1984, the National Organ Transplant Act established the Organ Procurement and Transplant Network (OPTN) to collect data and maintain a registry for organ matching and transplantation. These two efforts were consolidated in 1994, and only OPTN continued to collect data on transplant donors and recipients. In addition to these sources, transplants are also identified from Medical Evidence forms that indicate transplant as the initial modality, from CROWNWeb transplant events, and from institutional inpatient claims.

CMS Standard Analytical Files

The CMS Standard Analytical files (SAFs) contain billing data from final action claims submitted by Medicare beneficiaries with ESRD in which all adjustments have been resolved. The USRDS uses these SAFs to obtain data from institutional claims (Part A), including inpatient, outpatient, home health agency, hospice, and skilled nursing facility (SNF) claims as well as Physician/Supplier and Durable Medical Equipment (DME) (Part B) claims.

CMS SAFs are updated quarterly with a six month lag in complete data. Annual SAF files are completed each June for services incurred in the prior calendar year and processed through June of the current year (an 18-month window for each calendar year). The most current full year SAF that is released in June of each year is therefore complete through the end of the prior year. Files of claims occurring in the current year are created 6 months into the year, and are then updated quarterly. Claims also provide an additional source of data to those listed above, which is useful for determining important dates, such as first service dates, death dates, transplant dates, and transplant failure dates. The accuracy of patient and graft survival statistics is enhanced by considering all possible sources of these events.

CMS Prescription Drug Event File

In December 2003, Congress passed the Medicare Prescription Drug, Improvement, and Modernization Act (MMA), amending the Social Security Act by adding Part D under Title XVIII. With this new Part D coverage, health plans must submit a summary record called the prescription drug event (PDE) record to CMS whenever a Medicare beneficiary fills a prescription. Each drug is identified by a National Drug Index (NDC) code. The record also contains prescription dosage information, drug costs above and below the out-of-pocket threshold, other true out-of-pocket (TrOOP) amounts, plan paid amounts, and low-income cost sharing subsidy amounts. Due to delays in availability of more recent data, the USRDS 2015 ADR includes 2006–2011 PDE data.

CMS 5 Percent Standard Analytical Files

The CMS 5 percent general Medicare SAFs are a random sample of 5% of the entire Medicare population, and contain billing data from final action claims submitted for Medicare beneficiaries in which all adjustments have been resolved. CMS and its contractors produce the Medicare 5 percent datasets by selecting all final action claims for Medicare beneficiaries whose CMS Health Insurance Claim (HIC) number ends in 05, 20, 45, 70, or 95. These five two-digit pairs were randomly selected to create a sample containing 5% of the total number of Medicare beneficiaries (Merriman and Asper, 2007). The sample design has the effect of creating a built-in longitudinal panel dataset. Once in the sample, a beneficiary will remain a part of all future year data files until death or a change in HIC number. Since 2012, the USRDS has received the Master Beneficiary Summary File (formerly the Denominator file), containing demographic information on each beneficiary in the sample, as well as dates of enrollment in the various Medicare programs (Hospital Insurance [Part A], Supplemental Medical Insurance [Part B], Medicare Advantage managed care plans [Part C] and Prescription Drug Benefit [Part D]). Institutional claims for beneficiaries in the Medicare 5 percent sample are received in five files, based on type of medical service: inpatient, outpatient, home health agency, hospice, and skilled nursing facility (SNF). Physician and supplier claims (also referred to as Carrier Claims) are comprised of one file for durable medical equipment and another file for all other Part B covered services. These files collectively are referred to as the Medicare 5 percent files in the ADR. The 5 percent files are used to construct CKD, diabetes, and congestive heart disease cohorts based on billing data. The total Medicare 5 percent sample is used to develop total Medicare cost and utilization data for comparison purposes.

CMS Dialysis Facility Compare Data

The USRDS uses the CMS Dialysis Facility Compare data to define corporation name and ownership type for each renal facility. Prior to the 2003 ADR, similar data were extracted from the Independent Renal Facility Cost Report (CMS 265-94).

CDC Surveillance

The CDC used its National Surveillance of Dialysis-Associated Diseases to collect data from the United States dialysis facilities on patient and staff counts, membrane types, reuse practices, water treatment, therapy, vascular access use, antibiotic use, hepatitis vaccination and conversion rates, and the incidence of HIV, AIDS, and tuberculosis. No data are patient-specific. CDC survey data are available for the years 1993 through 1997 and 1999 through 2002. The CDC did not conduct a survey in 1998, and terminated this program after 2002.

United States Census

In rate calculations throughout this year's ADR we use data from the 2000 and 2010 U.S. Census, and also incorporate CDC population estimates by race. Estimates for 1990–1999 were back-calculated based on the actual 2000 census. Later data, however, include racial groups that do not coincide with those in the ESRD data. For rate calculations throughout the ADR, we use the CDC's Bridged Race Intercensal and Postcensal Population Estimates Dataset, which estimates White, Black/African American, Native American, and Asian populations. The data and methods for these estimates are available at *http://www.cdc.gov/nchs/nvss/bridged_race.htm*. For state and network rates, we use Vintage 2013 Bridged-Race Postcensal Population Estimates. Both CDC Bridged-Race Intercensal and Postcensal Population Estimates Datasets are available at *http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm*.

Database Definitions

ESRD Patient Determination

A person is identified as having ESRD when a physician certifies the disease on the Medical Evidence form (CMS 2728), or when there is other evidence of chronic dialysis or a kidney transplant. Patients with acute kidney failure who are on dialysis for days or weeks, but who subsequently recover kidney function, are excluded from the database if their Medical Evidence forms have not been submitted.

The ESRD first service date is the single most important data element in the USRDS Database, and each patient must, at a minimum, have a valid first service date. This date is used to determine the incident year of each patient and the first year in which the patient is counted as prevalent.

In most cases, the first service date is derived by identifying the earliest date of any of the following potential indicators:

- The start of dialysis for chronic kidney failure as reported on the Medical Evidence form
- The first CROWNWeb event
- A kidney transplant as reported on a CMS or OPTN transplant form, a Medical Evidence form, or a hospital inpatient claim
- The first Medicare dialysis claim

There are two exceptions to the first ESRD service date determination:

- If the CROWNWeb event and Medical Evidence form agree (within 30 days of each other) and are more than 90 days after the first Medicare dialysis claim, and, if there is no transplant event between the first dialysis claim and the earlier of either the CROWNWeb event date or Medical Evidence form date, then first service date is defined as the earlier of the CROWNWeb event date or the Medical Evidence form date.
- If the Medical Evidence form date is one year earlier than the first CROWNWeb event date, and if the first claim date or first transplant date agrees with the first CROWNWeb event date, then the CROWNWeb first event date is used as the first service date.

Death Date Determination

After the ESRD first service date, the date of death is the most critical piece of information in the ESRD database. Death dates are obtained from several sources, including the CMS Medicare EDB, CMS forms 2746 and 2728, the OPTN transplant follow-up form, CROWNWeb database, inpatient claims, and, where allowed by regulation, the Social Security Death Master File. Because multiple sources report death information for the same patient, one patient may have several reported dates. For these patients, we primarily use the median of the various death dates reported. However, in the small number of cases where there are only two death dates and they are more than 70 days apart, we use, instead, the most recent of the two dates.

Transplant Dates

The CMS and OPTN transplant data files overlap for 1988–1993, and transplants can also be identified from Medical Evidence forms that indicate transplant as the initial modality, from CROWNWeb transplant events, and from institutional inpatient claims. To resolve any conflicts among these sources, and create a complete list of unique transplant events, the USRDS has adopted the following procedure.

We start with the complete list of transplant events according to a single source (CMS before 1988 and OPTN after 1988). We then supplement this list using other data sources, only adding an event if we are reasonably certain the event is not already included. Specifically, we only add an event if there is no existing event within 30 days of the potential new event. We supplement first with CMS REMIS/REBUS/PMMIS data after 1988 (available until 1994), followed (in order) by Medical Evidence forms, inpatient Medicare claims records, and CROWNWeb patient events. Currently, more than 99% of transplant dates come from the OPTN data.

Graft Failure

We assume a graft failure date reported in the OPTN transplant follow-up or REMIS identification file is correct unless death or a new transplant occurs before this date. A graft failure date may not be recorded in either file. In this case, we use the earliest of the following events:

- Death
- Subsequent transplant
- Return to regular dialysis, indicated by a continuous period of dialysis billing records covering a minimum of 60 days with at least 22 reported treatments
- Return to dialysis reported on the Medical Evidence form
- Date of graft nephrectomy from the OPTN follow-up record or a Medicare claim

Medicare and Non-Medicare Patients

Beneficiaries are enrolled in Medicare based on criteria defined in Title XVIII of the Social Security Act of 1965, and in subsequent amendments to the act. A person who meets one of these four criteria is eligible to apply for Medicare: aged 65 and over, who has certain disabilities and illnesses, who has ESRD, or who is eligible for services of the Railroad Retirement Board.

Most ESRD patients are eligible to apply for Medicare as their primary insurance payer. Some, however, are not immediately eligible for Medicare coverage because of their employment status and pre-existing primary insurance benefits. These patients are usually covered by employer group health plans (EGHPs) and typically must wait 30–33 months before becoming eligible to have Medicare as their primary payer. Some of these patients, particularly new patients since 1995, have first service dates established by Medical Evidence forms or CROWNWeb events, but have no dialysis claims or hospitalization events in the CMS claims database. In the REMIS database, all non-Medicare ESRD patients are assigned a code of 'ZZ' in the two-character Beneficiary Identification Code field. CMS does not generally include these patients in the datasets released to researchers.

The USRDS recognizes that these non-Medicare patients are true ESRD patients and should be included in patient counts for incidence, prevalence, and modality, as well as mortality and transplant rate calculations. Calculations of hospitalization statistics, as well as expenditure rates, should not include these patients because of the small number of claims available in the first 30–33 months after their first ESRD service.

The USRDS, in working with CMS, has been able to resolve most of the non-Medicare ESRD patients since the release of the ESRD Patient Database, REMIS, in the fall of 2003. According to our most recent assessment—performed during production of the 2007 ADR—we have determined that at least 99% of these patients have been resolved due to significant advancements in the REMIS database system.

Integration of the CROWNWeb and CMS Claims Databases

The USRDS uses all available data to create a treatment history for each patient in the database, including all modality events, their duration, and the renal providers involved in each patient's care. The CROWNWeb event database is the primary source of the modality sequence file, and the dialysis claims are used as a way of confirming placements and identifying problem cases. As described in previous sections, we use all available sources to determine first service dates, deaths, transplants, and graft failures.

For patients who either do not appear in the CROWNWeb events file or for whom the only event is "New ESRD Patient," and patients who have gaps in treatment history after transferring out of a facility, the Medicare dialysis claim file is used. For "Transfer Out" and "Transfer Out for a Transplant" events followed by large gaps in treatment history (seven days or more), claims falling in gaps are included, with the exception that no claims data are included if the "Transfer Out for a Transplant" event has a corresponding transplant/transplant failure event that occurred within 30 days (either before or after the event). Claims data are also included for the periods after "Transplant Failure" events and "Discontinued Dialysis" modality if the periods are longer than seven days.

Because the claims data capture the modality "Center Self-Hemodialysis" more accurately than the CROWNWeb data, this claims-based designation overrides other dialysis modalities from CROWNWeb. Any CROWNWeb dialysis event that falls into a "Center Self-Hemodialysis" period as determined by claims is recoded as "Center Self-Hemodialysis."

Some events that do not make sense are removed. These include events that occur before a patient's first service date, those falling between "Transplant" and "Transplant Failure," and "Transfer Out for A Transplant" events that occur 60 days or less after the corresponding "Transplant."

We have identified errors in the CROWNWeb data modality conversion that cause the wrong coding for peritoneal dialysis (PD) subcategories, including continuous ambulatory PD (CAPD), continuous cycling PD (CCPD), and intermittent PD (IPD). To correct this problem, we employ historical data (pre-CROWNWeb conversion) for years prior to 2012, and a combination of historical data and more complete CROWNWeb data for 2012. CROWNWeb data is used exclusively for years 2013 and beyond.

Lost-to-follow-up Methodology

Gaps frequently exist in the CROWNWeb and billing data upon which modality periods are based. The USRDS assumes that a modality continues until death or the next modality-determining event. A patient with a functioning transplant is assumed to maintain it until graft failure, as defined in the *Graft Failure* section above, occurs. A dialysis modality, in contrast, is assumed to continue for only 365 days from the date of the last claim, in the absence of a new CROWNWeb event, a transplant date, a death date, or dialysis claims. After this period, the patient is declared lost-to-follow-up, until the occurrence of a new CROWNWeb event, dialysis claim, or transplant event.

Patients are considered lost-to-follow-up beginning 365 days after a "Transplant Failure" event or "Discontinued Dialysis" modality with no subsequent events. Patients for whom the only event is a first service date, and who do not exist in any other files were also treated as lost-to-follow-up, beginning one year after the first service date. A number of events can result in a lack of dialysis data and eventual reclassification of a patient as lost-to-follow-up:

- The patient may have recovered renal function (RRF) and no longer have ESRD. For a valid patient classification, this event must occur within 180 days of the first service date, and the RRF period must persist for at least 90 days.
- The patient may no longer reside in the United States.
- The patient's death may not have been reported to the Social Security Administration or to CMS.

60-day Stable Modality Rule: Treatment History

The 60-day stable modality rule requires that a modality continue for at least 60 days before it is considered a primary or switched modality. The rule is used to construct a second modality sequence, or treatment history, for each patient and assigns the patient a modality only if it is a stable or established modality. The hospitalization statistics shown by modality in the ADR use the 60-day rule to define a stable modality. Most of the other data reported in the ADR do not apply this rule.

90-day Rule: Outcomes Analyses

This rule defines each patient's start date for data analyses as day 91 of ESRD and is used primarily to calculate hospitalization rates.

Serum Albumin Data

The Medical Evidence form reports patient albumin levels along with the test's lower limit, which indicates the testing method: bromcresol purple or bromcresol green, with lower limits of 3.2 and 3.5 g/dL, respectively.

In producing the 2004 ADR, USRDS found that in 1995–2003, almost 50% of patient forms contained lower limit values equal to "zero," while another 25% reported values other than the expected 3.2 and 3.5 g/dL. Only 25% (n=173,000) of incident patients had legitimate lower limit values. Further analyses, however, showed that these patients form a representative cohort sample, with demographic distributions by age, sex, race, and cause of ESRD similar to those of the overall ESRD population. For all figures in the 2005 and subsequent ADRs that present serum albumin data from the Medical Evidence form, the USRDS ESRD Database includes only those incident patients with both an albumin lower limit of 3.2 or 3.5 g/dL and an albumin value.

Modalities

USRDS and CMS have worked extensively on methods of categorizing patients by ESRD treatment modality. The initial modality for a patient is determined using an algorithm based on a hierarchy of data sources. The hierarchy of sources is evaluated in the following order: CROWNWeb data, Medical Evidence form, claims data, and transplant data. The modality indicated in Medical Evidence form may be temporary, as patients often change to a new one during the first 90 days of treatment, and it can be difficult to track modality during this time. Patients aged 65 and older have Medicare claims in the first 90 days that contain revenue codes designating modality. Patients younger than 65 and in EGHPs or Medicare risk programs, however, have no such early claims. Thus, modality may not be determined until Medicare becomes the primary payer at day 91 or, for EGHP patients, at 30–33 months after the ESRD first service date. These limitations influence our ability to determine a patient's modality at any one point in time.

Of note are patients categorized as having an unstable modality (i.e., on a modality for fewer than 60 consecutive days) in the first 90 days of treatment. Because these patients tend to have higher death and hospitalization rates, interpretations of modality-specific outcome data including them should be viewed with caution. These patients are not recognized as being either stable HD or stable PD patients in analyses of patients with stable modality (e.g., hospitalization rates in this ADR). When the 60-day stable modality rule is used, these patients are included in the "all ESRD" category, which provides a more complete view of outcomes with the least biasing of the data.

As mentioned earlier, a new modality/event—recovered renal function (RRF)—was introduced in the 2007 ADR. This event can be established only if it occurs within the first 180 days following the first service date, and if the RRF period persists for at least 90 days. The RRF event is similar to the lost-to-follow-up event in that patients will not be included in the prevalent populations for outcomes analyses. However, as with lost-to-follow-up events, we retain them in the modality sequence so that subsequent renal failure episodes can be tracked closely and in a timely manner.

ESRD treatment modalities may be categorized in different ways within the analyses in each chapter; these are defined in the chapter-specific analytical methods sections that follow this section.

Payers

Information on payers is obtained from the Medicare EDB. We also examine Medicare outpatient claims to identify patients for whom the EDB does not indicate Medicare as primary payer (MPP) but who have at least three consecutive months of dialysis treatment covered by Medicare; these patients are also designated as having MPP coverage. From these two data sources we construct a payer sequence file to provide payer history, and, beginning with the 2003 ADR, we use this file to identify Medicare eligibility status and other payers. The construction of this file is similar to that of the treatment history file. Payer status is maintained for each ESRD patient from the ESRD first service date until death or the end of the study period. Payer status information prior to the start of ESRD (ESRD first service date) is available from the backcasted payer sequence file. This payer sequence file is similar to the standard ESRD payer service file, except that the pre-ESRD payer sequence file begins at the first evidence of Medicare enrollment from the Enrollment Database, rather than first ESRD service date, as is the case with the ESRD payer sequence. The pre-ESRD payer sequence ends the day before the first ESRD service date. Payer data are used to categorize a patient as

MPP, Medicare as secondary payer (MSP) with EGHP, MSP non-EGHP, Medicare Advantage (Medicare + Choice), Medicaid, or a combination of payers (see the *Researcher's Guide to the USRDS Database* for details). With this approach, the USRDS is now able to apply payer status information in all outcome analyses using the "as-treated" model (see the discussion in *Chapter 11: Medicare Expenditures for Persons With ESRD*).

Primary Cause of Renal Failure

Information on the primary cause of renal failure is obtained directly from the Medical Evidence form. For the ADR, we use eight categories with corresponding ICD-9-CM codes as follows:

- Diabetes: 250.00, 250.01, 250.40, 250.41
- Hypertension: 401.0, 401.1, 401.9, 403.0, 403.1, 403.9, 403.91, 404.0, 404.1, 404.9, 440.1, 593.81, and 593.83
- Glomerulonephritis: 283.1, 283.11, 287.0, 443.1, 446.0, 446.2, 446.21, 446.29, 446.4, 580.0, 580.4, 580.9, 581.1, 581.8, 581.9, 582.0, 582.1, 582.9, 583.1, 583.2, 583.21, 583.22, 583.4, 583.81, 583.82, 583.9, 583.91, 583.92, 695.4, 710.0, and 710.1
- Cystic kidney: 583.9, 753.1, 753.13, 753.14, and 753.16
- Other urologic: 223.0, 223.9, 274.1, 590.0, 591.0, 592.0, 592.9, 599.0, and 599.6
- Other cause: 016.0, 042.0, 042.9, 043.9, 044.9, 135.0, 189.0, 189.1, 189.9, 202.8, 202.83, 202.85, 202.86, 203.0, 203.08,239.50, 239.51, 239.52, 270.0, 271.8, 272.7, 273.3, 274.1, 274.11, 275.4, 275.49, 277.3, 282.6, 282.61, 282.62, 282.63, 282.69, 282.83, 282.86, 287.3, 446.6, 572.4, 580.89, 582.89, 583.0, 583.6, 583.7, 583.89, 584.5, 587.0, 591.8, 590.9, 593.89, 593.9, 599.0, 639.3, 646.2, 714.0, 728.89, 753.0, 753.2, 753.21, 753.22, 753.29, 753.3, 753.39, 756.7, 756.71, 759.5, 759.8, 759.89, 866.0, 965.4, 965.9, 977.8, 982.8, 984.9, 996.8, 996.81, 996.82, 996.83, 996.84, 996.85, 996.86, 996.87, and 996.89
- Unknown cause: 239.5, 428.0, 500.0, 582.0, 586.0, 489.9, 589.0, 589.1, 589.9, 592.1, 593.1, 799.9, 799.99, 888.88, 899.9, 999.99, 999.9, and ICD-9-CM codes not covered by the lists of codes above
- Missing cause: no ICD-9-CM code listed

Race and Ethnicity

Data on patient race and ethnicity are obtained from the Medical Evidence form, the CMS Medicare Enrollment Database, the REMIS patient identification file, and the CROWNWeb patient roster. Because they are addressed in separate questions on the Medical Evidence form, patients can be assigned a racial category and an ethnic category independently. Patient ethnicity became a required field on the 1995 revised Medical Evidence form, but because the form did not go into effect until midway through 1995, data for 1995 are incomplete. Therefore, information on Hispanic patients is presented starting in 1996. The non-Hispanic category includes all non-Hispanics and patients with unknown ethnicity. Because of the small number of ESRD patients of some races, as well as how race is categorized in the U.S. Census data, we concentrate on White, Black/African American, Native American (including Alaskan Native), and Asian (including Pacific Islander) populations. Data on patients of other races will be presented as their numbers increase. Beginning with the 2016 ADR, the Hispanic and race fields will be combined to clarify differences between Hispanic and non-Hispanic Whites.

Analytical Methods Used in the ESRD Volume

Data sources are indicated in the footnotes of each table and figure in Volume 2: End-Stage Renal Disease (ESRD) in the United States. Additional information on these sources is also available in the *Data Sources* section above. Methodology used for the figures and tables in Volume 2 is described below in the corresponding chapter or *ESRD Reference Table Methods* section. When figure or table data come directly from a particular Reference Table, please refer to the appropriate Reference Table methods section for additional detail.

Chapter 1: Incidence, Prevalence, Patient Characteristics, and Treatment Modalities

Incidence and Prevalence

Here and throughout the ADR, the USRDS generally reports point prevalence as of December 31, while period prevalence is reported for a calendar year. Annual period prevalent data thus consist both of patients who have the disease at the end of the year and those who have the disease during the year and die before the year's end. Because the USRDS treats successful transplantation as a therapy rather than as a "recovery" from ESRD, patients with a functioning transplant are counted as prevalent patients.

Because data are available only for patients whose ESRD therapy is reported to CMS, we qualify the terms incidence and prevalence as incidence and prevalence of reported ESRD. Some ESRD registries use the term "acceptance into ESRD therapy." We believe, however, that "incidence of reported ESRD therapy" is more precise, because "acceptance" implies that remaining patients are rejected, when they may simply not be identified as ESRD cases or may not be reported to CMS. Beginning with the 1992 ADR, lost-to-follow-up patients are not included in the point prevalent counts; they are, however, reported in Table B.1 of the Reference Tables.

Rate adjustments in this chapter are as follows: overall rates (including those in the maps) are adjusted for age, sex, and race; rates by age are adjusted for sex and race; rates by race or ethnicity are adjusted for age and sex; and rates by primary cause of ESRD are adjusted for age, sex, and race. Direct adjustment as described in the *Statistical Methods* section of the chapter was used. Census data rate and prevalence calculations are now based on intercensal estimates; for details, see the section on the *United States Census* in the *Data Sources* section of this chapter.

For Figures 1.4–1.7, incident cases and incidence rates are taken directly from Reference Table A. More specifically, cases come from A.1 and rates come from A.2(2) and A.2(3). Similarly, data for Figures 1.13–1.16 come directly from Reference Table B. Specifically, prevalent cases correspond to those found in B.1 and prevalence corresponds to that found B.2(2) and B.2(3). For details on the methods used, refer to the sections for Reference Tables A and B and the section for statistical methods used for rate calculations.

Figures 1.21 and 1.23 report the home dialysis patient distribution, by therapy type and among incident and point prevalent populations, respectively.

For all maps by HSA, data were suppressed for HSAs with less than 11 cases.

Patient Care and Laboratory Values

For Tables 1.4, 1.5, and 1.6, and Figures 1.17, 1.18, 1.19, and 1.20, laboratory values and treatment characteristics were derived from questions on the Medical Evidence form. All eGFR values are calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation from data acquired from the Medical Evidence form.

Treatment Modalities

Modality figures and the associated Reference Tables describe the treatment modalities of all known ESRD patients, both Medicare and non-Medicare, who are not classified as lost-to-follow-up or as having recovered renal function (RRF). The RRF event, introduced in the 2007 ADR, is defined as an event that occurs within the first 180 days of ESRD initiation and lasts for at least 90 days. By definition, patients classified as having RRF post-initiation are included in the incident counts. Unless noted otherwise, incident and point prevalent cohorts without the 60-day stable modality rule are used in the analyses. Treatment modalities are defined as follows:

- Center hemodialysis: HD treatment received at a dialysis center
- Center self-hemodialysis: HD administered by the patient at a dialysis center; a category usually combined with center HD
- Home hemodialysis: HD administered by the patient at home; cannot always be reliably identified in the database
- CAPD: continuous ambulatory peritoneal dialysis; usually combined with CCPD and other PD
- CCPD: continuous cycling peritoneal dialysis; usually combined with CAPD and other PD
- Peritoneal dialysis: analyses typically consist of CAPD, CCPD and intermittent peritoneal dialysis (IPD)
- Other peritoneal dialysis: primarily IPD, a small category except among very young children; usually combined with CAPD and CCPD to form PD category
- Uncertain dialysis: a period in which the dialysis type is unknown or multiple modalities occur but do not last 60 days; usually combined with unknown dialysis to form an other/unknown dialysis category
- Unknown dialysis: a period in which the dialysis modality is not known (e.g., when dialysis sessions are performed in a hospital); usually combined with uncertain dialysis to form an other/unknown dialysis category
- Renal transplantation: a functioning graft from either a living donor (a blood relative or other living person) or a deceased donor
- Death: a category not appearing in the year-end

modality tables, which report only living patients, but used as an outcome (e.g., in tables showing living patients followed for a period of time for their modality treatment history)

Facilities began submitting patient data via CROWNWeb beginning in 2012. This information was previously submitted by facilities via the ESRD Networks. The new method of data input and submission may lead to unanticipated changes in trends beginning in 2012.

Chapter 2: Healthy People 2020

Objective CKD-3

Increase the proportion of hospital patients who incurred acute kidney injury who have follow-up renal evaluation in 6 months post-discharge

Data for this objective include all patients in the Medicare 5 percent sample who are aged 65 and older and who have hospitalized acute kidney injury (AKI) events in the given year (1992–2012). Hospitalized AKI is defined by the presence of ICD-9-CM diagnosis code 584 in any field of the inpatient claims, and renal evaluation is identified by a microalbumin test. Patients are followed from the discharge date to the earliest date of death, ESRD, end of Medicare coverage, or six months after the discharge date. CPT codes for urinary microalbumin measurement are identified from HEDIS 2008 specifications (HEDIS 2008, an NCQA program, is used to monitor the performance of managed health care plans), and include 82042, 82043, 82044, and 84156.

Objective D-12

Increase the proportion of persons with diagnosed diabetes who obtain an annual urine albumin measurement

The cohort includes general Medicare patients diagnosed with diabetes mellitus (DM) in each year, continuously enrolled in Medicare Parts A and B during the whole year, and aged 65 or older at the beginning of the year. CPT codes for urinary microalbumin measurement are those used in Objective CKD-3, above. Testing is tracked during each year. Diabetes is defined by a qualifying ICD-9-CM diagnosis code of DM on one or more Part A institutional claims (inpatient, skilled nursing facility, or home health agency), or two or more institutional outpatient claims and/or physician/supplier claims within a one-year observation period. Qualifying ICD-9-CM codes for diabetes mellitus are as follows: 250.XX, 357.2, 362.0X, and 366.41.

Objective CKD-4.1

Increase the proportion of persons with chronic kidney disease who receive medical evaluation with serum creatinine, lipids, and urine albumin

The cohort here is similar to that used for Objective D-12, but includes all CKD patients. Testing is tracked during each year. Patients are excluded if they are enrolled in a managed care program (HMO), acquire Medicare as secondary payer, are diagnosed with ESRD during the year, have a missing date of birth, or do not live in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories. Racial and ethnic categories are mutually exclusive. Methods of defining CKD are described in the CKD Analytical Methods chapter of Volume 1: Chronic Kidney Disease (CKD) in the United States. Serum creatinine is identified through CPT codes 80047–80050, 80053–80054, 80069, and 82565, while lipid testing is identified through CPT codes 80061, 82465, 82470, 83695, 83705, 83715–83721, 84478, 83700, 83701, and 83704. CPT codes for urinary microalbumin measurement are the same as those used for Objective CKD-3 above.

Objective CKD-4.2

Increase the proportion of persons with Type 1 or Type 2 diabetes and chronic kidney disease who receive medical evaluation with serum creatinine, urine albumin, HgbA1c, lipids, and eye examinations

Methods and codes used to determine rates of HbA1c testing and eye examinations are taken from HEDIS 2008 specifications. CPT codes 83036 and 83037 are used to identify HbA1c testing. Codes used to identify diabetic eye examinations are as follows: CPT codes, 92002, 92004, 92012, 92014, 92018, 92019, 92225, 92226, 92230, 92235, 92240, 92250, 92260, 67101, 67105, 67107, 67108, 67110, 67112, 67141, 67145, 67208, 67210, 67218, 67227, 67228, 67028, 67030, 67031, 67036, 67038, 67039, 67041, 67042, 67043, 67113, 67121, 67221, 67228, S0625, S0620, S0621, and S3000; ICD-9-CM procedure codes, 14.1–14.5, 14.9, 95.02, 95.03, 95.04, 95.11, 95.12, and 95.16; and ICD-9-CM diagnosis code V72.0. The cohort is similar to that used for Objective CKD-4.1, but includes all diabetic CKD patients. Methods of defining DM are described in the CKD Analytical Methods chapter Volume 1: Chronic Kidney Disease (CKD) in the United States.

Objective CKD-8

Reduce the rate of new cases of end-stage renal disease

Incident rates are calculated using the methods described for Chapter 1. Overall rates are adjusted by age, sex, and race; rates by age are adjusted for sex and race; rates by sex are adjusted for age and race; and rates by race and ethnicity are adjusted by age and sex.

Objective CKD-9.1

Reduce kidney failure due to diabetes

Rates of kidney failure due to DM are also calculated using the methods described for Chapter 1, and adjustments are the same as those described for Objective CKD-8, above.

Objective CKD-9.2

Reduce kidney failure due to diabetes among persons with diabetes

This table uses data from the National Health Interview Survey; all ages are included. Three-year data are used to estimate the prevalence of DM in the middle year, and the size of the population with DM is based on U.S. census data. The incident rate per million of ESRD caused by DM is calculated as the number of incident ESRD patients with a primary cause of ESRD of DM, divided by the size of the population with DM in that group.

Objectives CKD-10 & CKD-11.3

Increase the proportion of chronic kidney disease patients receiving care from a nephrologist at least 12 months before the start of renal replacement therapy

Increase the proportion of adult hemodialysis patients who use arteriovenous fistulas or have a maturing fistula as the primary mode of vascular access at the start of renal replacement therapy

These tables use data from the newest version of the Medical Evidence form. The cohorts include incident HD patients, with CKD-11.3 limited to those aged 18 and older at initiation who have a known vascular access at that time. CKD-10 includes only patients for whom it is known whether they saw a nephrologist prior to initiation.

Objectives CKD-11.1 & CKD-11.2

Increase the proportion of adult hemodialysis patients who use an arteriovenous fistula as the primary mode of vascular access Decrease the proportion of adult hemodialysis patients who use catheters as the only mode of vascular access

These tables use data from CROWNWeb. The cohort includes prevalent HD patients from 2012 and 2013,who are aged 18 and older. Access type represents the last access type used in the year, according to CROWNWeb data.

Objective CKD-12

Increase the proportion of dialysis patients wait-listed and/or receiving a deceased donor kidney transplant within 1 year of end-stage renal disease start (among patients under 70 years of age)

The cohort includes patients from 2000–2013 who are younger than 70 at the initiation of ESRD. Percentages are calculated as the number of patients placed on the deceased donor organ waiting list or receiving a deceased donor transplant within one year of initiation, divided by the number of patients without a living donor available (i.e., patients receiving a living donor transplant are excluded), and are estimated using the Kaplan-Meier methodology.

Objective CKD-13.1

Increase the proportion of patients receiving a kidney transplant within 3 years of end-stage renal disease

The cohort includes patients from 1998–2010 who are younger than 70 at the initiation of ESRD. Patients are followed from ESRD certification to transplant, censoring at death or three years after the initiation of ESRD. Percentages are calculated using the Kaplan-Meier methodology.

Objective CKD-13.2

Increase the proportion of patients who receive a pre-emptive transplant at the start of end-stage renal disease

The cohort includes patients from 2001–2013 who are younger than 70 at the initiation of ESRD. Pre-emptive transplants are those in which ESRD initiation date is the date of transplant. Percentages are calculated as 100 (N/D), where N=the number of preemptive transplants in the year and D=the number of ESRD patients in the year.

Objectives CKD-14.1 & *CKD-14.3*

Reduce the total death rate for persons on dialysis

Reduce the cardiovascular death rate for persons on dialysis

Cohorts for these tables include period prevalent dialysis patients in each calendar year, 2001–2013, whose first ESRD service date is at least 90 days prior to the beginning of the year (point prevalent patients on January 1) or who reach day 91 of ESRD treatment during the year (incident patients). We exclude patients with unknown age or sex and those with an age calculated to be less than zero, as well as patients who are not residents of the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories. Age is calculated on January 1, and race is defined from the Medical Evidence form. Cardiovascular mortality is defined using codes from past and current Death Notification forms: 01, 02, 03, 04, 1, 2, 3, 4, 23, 25, 26, 27, 28, 29, 30, 31, 32, 36, and 37. Patients are followed from January 1 (for point prevalent dialysis patients) or day 91 of ESRD (for incident dialysis patients) until death, transplant, or December 31 of the year. Rates are estimated as the number of patients who die from any cause (Objective 14.1) and who die from cardiovascular disease (Objective 14.3) in each year, per 1,000 patient years at risk.

Objective CKD-14.2

Reduce the death rate in dialysis patients within the first 3 months of initiation of renal replacement therapy

Cohorts here include incident dialysis patients in each calendar year, 2001–2013. In addition to applying the same exclusion criteria described for Objectives 14.1 and 14.3, we further exclude patients with recovered kidney function. Age is calculated on the first ESRD service date. Patients are followed from the first service date until death, transplant, or 90 days after ESRD. Rates are estimated as the number of patients who die from any cause per 1,000 patient years at risk.

Objectives CKD-14.4 & CKD-14.5

Reduce the total death rate for persons with a functioning kidney transplant

Reduce the cardiovascular death rate in persons with a functioning transplant

Patient cohorts here include period prevalent transplant patients, 2001–2013, whose first ESRD service date is at least 90 days prior to the beginning of the year (point prevalent patients on January 1) or who reach day 91 of ESRD treatment (incident patients). Exclusion criteria are the same as those described for Objectives 14.1 and 14.3. Patients are followed from January 1 (for point prevalent dialysis patients) or day 91 of ESRD (for incident dialysis patients) until death or December 31 of the year. Rates are estimated as the number of patients who die from any cause (Objective 14.4) and who die from cardiovascular disease (Objective 14.5) in each year, per 1,000 patient years at risk.

Chapter 3: Clinical Indicators and Preventive Care

In Figure 3.1, all data are obtained from CROWNWeb clinical extracts for December 2014. The adequacy (Kt/V) analyses are restricted to patients at least 18 years old as of December 1, 2014. Patients must have been alive as of December 31, 2014, and must have had ESRD for at least one year as of the time of the measurement. If multiple measurements were available for a patient, the last one in the month was used. In Figure 3.1.b, all adult (aged 18 and older) patients who are on dialysis for at least 90 days as of December 1, 2014, and alive as of December 31, 2014, are included. If multiple hemoglobin measurements were available for a patient, the last one in the month was used. The categorical distribution of hemoglobin is shown for both HD and PD patients. In Figure 3.1c, the hypercalcemia measure was calculated as a 3 month rolling average for both HD and PD patients, who were alive as of December 31, 2014, and had ESRD for at least 90 days as of the time of measurement of an uncorrected serum calcium value.

Anemia Treatment

All of the findings in this section are based on Medicare claims data. Efforts have been made for the figures and tables to be as fully representative as possible of the U.S. dialysis patient population represented by CMS claims data, resulting in substantially larger sample sizes in some of the tables associated with this anemia section as compared with the 2014 ADR. The modality of the patient in each month is determined from the primary modality that is indicated on the claims file associated with each claim for hemoglobin, iron dose, and epoetin alfa (EPO) dose variables in the given month. For transfusion analyses, patients were assigned to HD or PD if having at least one claim for HD or PD therapy, respectively, in that month. There were very few patients having dual modality use within the same month.

Calculation of hemoglobin levels are shown in Figures 3.2, 3.3, 3.8, and 3.9. Hemoglobin values were based upon the first reported claim in each month for HD patients (Figures 3.2, 3.3) or for PD patients (Figure 3.8, 3.9). When hemoglobin levels were not available in claims data, hematocrit values, if available, were divided by 3 to serve as a proxy estimate. Patients were excluded in a given month if the hemoglobin level (or hemoglobin values estimated from hematocrit values) was <5 g/dL or >20 g/dL. Results are shown for erythropoiesis-stimulating agent (ESA)-treated patients in Figures 3.2, 3.3, 3.8, and 3.9, in which case analyses were restricted to patients who: (1) within the indicated month had a claim for ESA use and a claim for either hemoglobin or hematocrit level, and (2) at the start of the month, were on dialysis for 90 days or more and were aged 18 or older. In Figures 3.2 and 3.8, hemoglobin levels are also provided for all patients, and the same restrictions were used as described in statement 2 above, but not limited to patients with an ESA claim within the given month in 2012. In addition, hemoglobin levels for patients not on any ESA drugs in a month were also shown for HD patients (Figure 3.2) and PD patients (Figure 3.8).

Calculation of mean EPO dose levels is shown in Figures 3.2 and 3.8. Mean monthly EPO dose is provided for HD patients in Figure 3.2 and for PD patients in Figure 3.8. Mean monthly EPO dose is shown for patients who within a given month had an EPO claim, were on dialysis for 90 days or longer, and were 18 years and older at the start of the month. EPO dose is expressed as mean EPO units per week, averaged over all EPO claims within a given month. Patients were excluded from these calculations for a given month if their monthly average EPO dose was either less than 250 units per week (resulting in 0.4% being excluded) or if their monthly average EPO dose was greater than 400,000 units per week; these criteria resulted in <0.001% of patients being excluded.

Calculation of intravenous iron use is shown in Figures 3.4 and 3.10. Intravenous iron use and IV iron dose for HD patients is presented in Figure 3.4 and for PD patients in Figure 3.10. Monthly intravenous iron use was among patients on dialysis for 90 days or longer and 18 years or older at the start of the given month. Mean IV iron dose was calculated as the average dose of IV iron (iron sucrose and ferrous gluconate) a patient received, among patients receiving iron during the month. This analysis was restricted to only those patients who had more than 6 sessions but less than equal to 18 sessions in a month. The permissible range of values considered for sucrose and ferrous gluconate are (50–1800mg) and (12.5–1800mg) respectively.

Categorical distribution of iron store measures, transferrin saturation (TSAT) and serum ferritin for December 2012, December 2013, and December 2014, using CROWNWeb data are shown in Figures 3.5 and 3.6, respectively, for HD patients. For PD patients, iron store measures, TSAT and serum ferritin are shown in Figures 3.11 and 3.12, respectively. For Figure 3.5, dialysis patients on treatment for ESRD at least 1 year at the time of measurement of TSAT value for that year, ≥18 years old as of December 1 of that year and who were alive through December 31 of that year are included in the study. For each year, the latest non-missing TSAT value during October–December was used. Similar analyses were done for PD patients.

Figure 3.6 analyses include dialysis patients who were treated for ESRD for at least 1 year at the time of measurement of serum ferritin for that year, who were ≥18 years old as of December 1 of that year, and who were alive through December 31 of that year. For each year, the latest non-missing serum ferritin value during October–December, a 3-month time period, was used. Similar analyses were done for PD patients.

Percentage of all HD patients according to the number of red blood cell transfusions in a year is shown in Figure 3.7.a; calculated from Medicare claims data for years 2010–2013. Here, the denominator included all patients having a claim for at least one dialysis session during the month and who were 18 years or older at the start of the month, and the numerator consisted of the total number of claims for transfusions a patient had in a year. The modality of the first treatment in the year determines the modality of the patient for that year. Similarly, Figure 3.13.a, shows the distribution of the number of red blood cell transfusions received by PD patients, by year.

Calculations of the percentage of dialysis patients with one or more claims for a red blood cell transfusion in a given month from 2010–2013 by race are shown in Figures 3.7.b (HD patients) and 3.13.b (PD patients). For this calculation, the numerator consisted of dialysis patients with one or more red blood cell transfusion claims in a given month (the transfusion eventsclaims were identified using the codes as listed in Table m.1); the denominator included all patients having a claim for at least one dialysis session during the month and who were 18 years or older at the start of the month.

vol 2 **Table m.1 Transfusion codes used in defining a red blood cell transfusion**

Code	Code Type	Code Description
36430	CPT	Transfusion, blood or blood components
P9010	HCPCS	Blood (whole), for transfusion, per unit
P9011	HCPCS	Blood, split unit
P9016	HCPCS	Red blood cells, leukocytes reduced, each unit
P9021	HCPCS	Red blood cells, each unit
P9022	HCPCS	Red blood cells, washed, each unit
P9038	HCPCS	Red blood cells, irradiated, each unit
P9039	HCPCS	Red blood cells, deglycerolized, each unit
P9040	HCPCS	Red blood cells, leukocytes reduced, irradiated, each unit
P9051	HCPCS	Whole blood or red blood cells, leukocytes reduced, cmv-negative, each unit
P9054	HCPCS	Whole blood or red blood cells, leukocytes reduced, frozen, deglycerol, washed, each unit
P9056	HCPCS	Whole blood, leukocytes reduced, irradiated, each unit
P9057	HCPCS	Red blood cells, frozen/deglycerolized/ washed, leukocytes reduced, irradiated, each unit
P9058	HCPCS	Red blood cells, leukocytes reduced, cmv-negative, irradiated, each unit
99.03	ICD9	Other transfusion of whole blood; transfusion: blood NOS, hemodilution, NOS
99.04	ICD9	Transfusion of packed cells

Mineral and Bone Disorder

Distributions of calcium levels for HD and PD patients for December 2012, December 2013, and December 2014 using CROWNWeb data are shown in in Figures 3.14 and 3.15. Figure 3.14 analyses include HD patients on treatment for ESRD at least 1 year at the time of measurement of serum calcium value for that year, who were ≥18 years old as of December 1 of that year, and who were alive through December 31 of that year. Similar analyses were done for PD patients in Figure 3.15.

Distributions of phosphorus levels for HD and PD patients for December 2012, December 2013, and December 2014 using CROWNWeb data are shown in in Figures 3.16 and 3.17. For Figure 3.16 analyses include HD patients on treatment for ESRD at least 1 year at the time of measurement of serum phosphorus value for that year, who were ≥18 years old as of December 1 of that year, and who were alive through December 31 of that year. Similar analyses were done for PD patients in Figure 3.17.

Preventive Care

Figure 3.18 presents data on diabetic preventive care. The ESRD population includes patients initiating therapy at least 90 days prior to January 1 of the first year of each study period and with DM in the first year. Testing is tracked in the second year of each study period, and tests are at least 30 days apart. ESRD patients without Medicare inpatient/outpatient and physician/supplier coverage during the entire study period are omitted, as are general Medicare patients enrolled in an HMO or diagnosed with ESRD during the study period. Also omitted are those who do not reside in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories; who have a missing date of birth; who do not survive the entire reporting period; who have ESRD for fewer than 90 days prior to the start of the reporting interval; or who are lost to follow-up during the study period. Age is calculated at the end of the study period.

Patients are defined as having DM either through medical claims (one inpatient/home health/SNF claim, or two outpatient or physician/supplier claims), or through a listing of DM on the Medical Evidence form as the primary cause of ESRD or as a comorbid condition. ICD-9-CM diagnosis codes used to define DM are 250.xx, 357.2, 362.0x, and 366.41. Methods and codes used to determine rates of HgbA1c testing and eye examinations are taken from HEDIS 2008 specifications. CPT codes 83036 and 83037 are used to identify HgbA1c testing. Codes used to identify diabetic eye examinations are as follows: CPT codes, 67028, 67030, 67031, 67036, 67038, 67039, 67040, 67041, 67042, 67043, 67101, 67105, 67107, 67108, 67110, 67112, “67113, 67121, 67141, 67145, 67208, 67210, 67218, 67220, 67221, 67227, 67228, 92002, 92004, 92012, 92014, 92018, 92019, 92225, 92226, 92230, 92235, 92240, 92250, 92260, S0620, S0621, S0625, S3000; ICD-9-CM procedure codes, 14.1–14.5, 14.9, 95.02, 95.03, 95.04, 95.11, 95.12, and 95.16; and ICD-9-CM diagnosis code V72.0. Lipid testing is identified through CPT codes 80061, 82465, 82470, 83695, 83700, 83701, 83704, 83705, 83715, 83716, 83717, 83718, 83719, 83720, 83721, 84478. Comprehensive diabetic care includes at least one HgbA1c test, at least one lipids test, and at least one eye exam. HgbA1c and lipid tests occur at least 30 days apart.

Figures 3.19 (a–d) present data on influenza vaccinations for prevalent ESRD patients by overall claims, age, race/ethnicity, and modality. The cohort for influenza vaccinations includes all ESRD patients initiating therapy at least 90 days prior to August 1 of the first year of the study period and alive on April 30 of the second year. Patients without Medicare inpatient/outpatient and physician/supplier coverage during the study period are omitted, as are those who do not reside in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories. Also omitted are those who have a missing date of birth; who have ESRD for fewer than 90 days prior to the start of the study period; or who are lost-to-follow-up during the study period. Age is calculated at the end of the study period. Influenza vaccinations are tracked between August 1 of the first year and April 30 of the second year in the study period. Influenza vaccinations are identified by CPT codes 90724, 90657, 90658, 90659, and 90660, and HCPCS code G0008.

Chapter 4: Vascular Access

Data for Figures 4.1–4.3 and 4.7, and Tables 4.1 and 4.6 are obtained from the Medical Evidence form (CMS 2728); data are restricted to the most recent version. Patients with missing vascular access data are excluded.

Figure 4.1 presents data for patients who began dialysis from 2005–2013; Table 4.1 and Figures 4.2–4.3 present data for patients beginning dialysis in 2013. Age is calculated as of the date regular chronic dialysis began. Figures 4.2–4.3 exclude patients not living in the 50 states or the District of Columbia; Figure 4.7 and Tables 4.3–4.5 include a cross-section of patients alive at each time point.

Vascular access use among prevalent patients is described in Table 4.2 and Figures 4.4–4.6. For Table 4.2, CROWNWeb data is used to obtain vascular access use for December 2013. Catheter use implied any catheter use, whereas, arteriovenous (AV) fistula and AV graft use shown are without the use of a central venous catheter. Figure 4.6 has data as reported from Fistula First from July 2003 to April 2012 and CROWNWeb data from June 2012 to December 2013. May 2012 was not included in the analysis to denote the breakpoint between two sources. This figure shows prevalence of the vascular type used and for June 2012 to December 2013, the denominator is obtained from the treatment history file, limited to hemodialysis patients who are non –transplanted and are alive at the end of each month. The numerator is obtained from vascular access extract files in CROWNWeb. Vascular access use for December 2014 was obtained from CROWNWeb data for December 2014. Catheter use at vascular access initiation includes data obtained from the Medical Evidence form for patients beginning dialysis between January 1, 2013 and December 31, 2013; vascular access data for all other time points are obtained from CROWNWeb. There is a 15-day look-back and 15-day look-forward time period to determine vascular access.

Table 4.7 and Figure 4.8 include patients with a fistula placed at any point between January 1, 2013 and December 31, 2013 who are already on ESRD at time of placement. Fistula placement was identified through inpatient, outpatient, and physician/supplier Medicare claims using the following ICD-9 procedure codes: 36818, 36819, 36820, 36821 and 36825. Subsequent first use of the placed fistula was determined by finding evidence of fistula use in CROWNWeb through the end of 2014. If the fistula was indicated to be used in CROWNWeb following the placement (and prior to any later fistula placements), the fistula was considered to have successfully matured for use. If CROWNWeb did not indicate the fistula was used following placement, the fistula was assumed to have failed to mature. In order to be included in the analyses, patients were required to have vascular access use data in CROWNWeb following the fistula placement. Time to maturation was determined using the date of fistula placement and the date of first use in CROWNWeb, given that the exact time of 'fistula maturity' is currently not determinable from CROWNWeb. Patients that died following the fistula placement were also included in the analysis.

Chapter 5: Hospitalization

Methods used to examine hospitalization in prevalent patients generally echo those used for the tables in *Reference Section G: Morbidity and Hospitalization* (described below). Inclusion and exclusion criteria are generally the same, as are the methods for counting hospital admissions and days, and defining the follow-up time at risk. One difference is the exclusion in Section G of patients of races that are unknown or other than White, Black/African American, Native American, or Asian; these patients are included in the Chapter 5 figures. Included patients have Medicare as primary payer, with Parts A and B coverage at the start of follow-up, and without HMO coverage. Rates include total admissions or hospital days during the time at risk, divided by patient years at risk. The period at risk begins at the later date of either January 1 or day 91 of ESRD, and censoring occurs at death, end of Medicare Parts A and B coverage, or December 31, in addition to other censoring criteria which vary by modality as described below. Since a currently hospitalized patient is not at risk for admission, hospital days are subtracted from the time at risk for hospital admissions. Additionally, rehospitalization rates include the percentage of live hospital discharges that are followed by a subsequent hospital admission within 30 days. Hospitalization data do not exclude inpatient stays for the purpose of rehabilitation therapy.

Inpatient institutional claims are used for the analyses, and methods for cleaning claims follow those described for Section G. Adjusted rates are calculated using the model-based adjustment method on the observed category-specific rates. Predicted rates are calculated with a Poisson model, and adjusted rates are then computed with the direct adjustment method and a reference cohort. This method is described further in the discussion of Section G, and in the statistical methods section later in this chapter.

Methods in Figures 5.1–5.2 follow those for *Reference Section G: Morbidity and Hospitalization*. Figure 5.1 presents adjusted rates of total hospital admissions and days per patient year. Prevalent ESRD patients are included, and rates are adjusted for age, sex, race, and primary cause of ESRD, with the 2011 ESRD cohort used as the reference.

Figure 5.2 shows the admission rates since 2005 for period prevalent ESRD patients. Included patients have Medicare as primary payer and are residents of the 50 states, the District of Columbia, Puerto Rico, and the U.S. territories. Patients with AIDS as a primary or secondary cause of death are excluded, as are patients with missing age or sex information. Rates are adjusted for age, sex, race, and primary cause of ESRD using the model-based adjustment method. The reference cohort includes period prevalent ESRD patients in 2011. New dialysis access codes for PD patients appeared in late 1998. For PD patients, dialysis access hospitalizations are those defined as “pure” inpatient vascular/dialysis access events, as described for Tables G.11–G.15. For HD patients, vascular access hospitalizations include “pure” inpatient vascular access events, and vascular access for HD patients excludes codes specific to PD catheters (996.56, 996.68, and V56.2). Principal ICD-9-CM diagnosis codes are used to identify cardiovascular and infection admissions. The cardiovascular category consists of codes 276.6, 394–398.99, 401–405, 410–420, 421.9, 422.90, 422.99, 423–438, and 440–459, while infection is indicated by codes 001–139, 254.1, 320–326, 331.81, 372–372.39, 373.0–373.2, 382–382.4, 383, 386.33, 386.35, 388.60, 390–393, 421–421.1, 422.0, 422.91–422.93, 460–466, 472–474.0, 475–476.1, 478.21–478.24, 478.29, 480–490, 491.1, 494, 510–511, 513.0, 518.6, 519.01, 522.5, 522.7, 527.3, 528.3, 540–542, 566–567.9, 569.5, 572–572.1, 573.1–573.3, 575–575.12, 590–590.9, 595–595.4, 597–597.89, 598.0, 599.0, 601–601.9, 604–604.9, 607.1, 607.2, 608.0, 608.4, 611.0, 614–616.1, 616.3–616.4, 616.8, 670, 680–686.9, 706.0, 711–711.9, 730–730.3, 730.8–730.9, 790.7–790.8, 996.60–996.69, 997.62, 998.5, and 999.3.

Figure 5.3 shows adjusted infectious and cardiovascular hospital day rates among prevalent ESRD patients. Again, rates are adjusted for age, gender, race, and primary cause of ESRD, with ESRD patients in 2011 used as the reference cohort. Principal ICD-9-CM codes for cardiovascular and infection hospitalizations are listed in the discussion of Figure 5.2.

Table 5.1 presents unadjusted and adjusted admission rates among adult (aged 22 and older) period prevalent HD patients. Principal ICD-9-CM diagnosis codes are used to identify cause-specific admissions: codes for cardiovascular and infectious admissions are listed in the discussion of Figure 5.2, while codes for vascular access infection are listed in Table m.2 in the section describing the methods for *Reference Section G: Morbidity and Hospitalization*. Rates are adjusted for age, sex, race, and primary ESRD diagnosis; values presented by one factor are adjusted for the other three. For adjusted rates, HD patients in 2011 are used as the reference cohort. Values by age, sex, race, and primary cause of ESRD are shown for 2012–2013 prevalent HD patients.

Figures 5.4–5.10 show rates of rehospitalization and/or death among prevalent HD patients of all ages (aged 66 and older in Figure 5.4), 30 days after hospital discharge. Live hospital discharges from January 1 to December 1 of the year are identified as index hospitalizations; the latter date provides a 30-day period following the latest discharge to evaluate rehospitalization. The units of analyses include hospital discharges rather than patients. Hospitalization data exclude transfers. Discharges with a same-day admission to long-term care or a critical access hospital are excluded. For HD patients in Figures 5.5–5.10, discharges with a transplant, loss to follow-up, or end of payer status before day 30 after discharge are excluded. For ESRD patients in Figure

5.4, the same exclusions apply except as related to transplant; discharges from transplant patients are excluded if they occur after 2 years and 11 months following the most recent transplant to ensure that complete claims are available during the 30-day post-discharge period.

Figures 5.4–5.7 and 5.9–5.10 indicate the percentage of discharges with readmission and/or death within 30 days after discharge. The groups indicate status at day 30 after discharge from the index hospitalization, and do not consider events after day 30. Figures 5.5–5.6 include all-cause index hospitalizations, while in Figure 5.7, categories of cause-specific admissions are based on principal ICD-9-CM diagnosis codes of the index hospitalization. Codes for cardiovascular and infectious hospitalizations are listed in the discussion of Figure 5.2; vascular access infection codes are 996.62 and 999.31. Figures 5.9–5.10 include the codes for discharges from cardiovascular hospitalizations listed for Figure 5.2, and Figure 5.10 includes the codes for acute myocardial infarction (AMI), congestive heart failure (CHF), stroke and dysrhythmia. ICD-9 CM codes for AMI: 410.x0 and 410.x1; CHF: 398.91, 402.x1, 404.x1, 404.x3. 425, and 428; stroke: 430–434; and dysrhythmia: 426–427. Figure 5.8 indicates the percentage of hospital discharges followed by a 30-day rehospitalization by cause-specific groups for both the index hospitalization and the rehospitalization. Categories of cause-specific rehospitalization also include non-vascular access infections, defined by infection codes excluding 996.62 and 999.31, and other, defined by codes other than cardiovascular and infectious.

Figure 5.4 shows overall percentages of discharges with 30-day rehospitalization and/or death in the general Medicare, chronic kidney disease (CKD), and ESRD populations. Data include point prevalent Medicare patients on December 31, 2012, who are aged 66 and older. For general Medicare patients with and without CKD, CKD is defined during 2012, and patients remain who are without ESRD, with continuous enrollment in Medicare Parts A and B, and without HMO coverage. Live hospital discharges from January 1 to December 1, 2013 are included.

Chapter 6: Mortality

Unless otherwise specified, patient cohorts underlying the analyses presented in Chapter 6 include Medicare and non–Medicare patients living in the 50 states, the District of Columbia, Puerto Rico, and the U.S. territories.

Figure 6.1 shows trends in mortality rates by modality among incident ESRD patients during 1996–2013. Modalities include ESRD, dialysis, HD, CAPD/CCPD, and first transplant; results aggregating across modalities are also presented. Patients are classified by year based on date of ESRD onset. Dialysis patients are followed from ESRD onset (i.e., day one) censored at the earliest of date of transplant, loss to follow-up, recovery of native renal function, or December 31, 2013. Transplant patients begin follow-up at the date of transplant and are censored on December 31, 2013. Adjusted mortality rates for each period after first treatment are computed separately by taking an appropriate weighted average of Cox-regression based predicted rates. The adjustment is made through model-based direct standardization, and is described later in the *Statistical Methods* section of this chapter. The Cox proportional hazard model serves as the basis for the predicted rates, adjusted for age, sex, race, and primary cause of ESRD. The reference population consists of 2011 period prevalent ESRD patients.

Figure 6.2 shows adjusted all-cause mortality among incident patients by year after incidence. The rates are based on the predicted cumulative hazard for patients in the reference dataset from an adjusted Cox model on survival based on incident patients in 2012.

Figure 6.3 displays adjusted mortality for incident patients in the first year by modality. Patients are followed from ESRD onset (day one; as reflected by first service date) up to one year, and censored at loss to follow-up, transplant, or recovery of kidney function. Note that patients with unknown age, sex, or primary cause of ESRD are excluded from the analysis. Rates are adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD, with the 2011 incident ESRD patients serving as the reference population. The adjustment method is similar to that used for Figure 6.2.

Table 6.1 shows the death rates for different race and age categories among period prevalent transplant and dialysis patients in 2012. Adjusted death rates within each age and race category are determined by calculating the weighted average within each sex and diagnosis category within each age and race category. Weighting is calculated according to the age, race, sex, and diagnosis category prevalence within the 2011 period prevalent reference data.

Table 6.2 shows cause-specific mortality rates by modality, and, among all ESRD patients, by age, race, and sex. Rates are adjusted for age, race, sex, ethnicity, and primary cause of ESRD in a manner similar to that used in Table 6.1. Rates for each demographic group are adjusted for all factors except the given group; e.g., death rates by age are adjusted for race, sex, ethnicity, and primary cause of ESRD, not age.

Table 6.3 presents adjusted three-month, one-year, two-year, three-year, and five-year survival by modality, and, in the ESRD cohort, by age, sex, race, and primary cause of ESRD. Data are obtained from Reference Tables in *Reference Section I: Patient Survival*.

Table 6.4 presents expected remaining lifetimes in years for the 2012 general U.S. population, and for 2013 prevalent dialysis and transplant patients. For period prevalent ESRD patients in 2013, expected lifetimes are calculated using the death rates from a generalized linear mixed model with 16 age groups, assuming a constant mortality rate within each age group. The method for calculating expected remaining lifetimes is described in the *Statistical Methods* section at the end of this chapter. Data for the general population are obtained from the CDC's National Vital Statistics Report, Table 7, "Life expectancy at selected ages, by race, Hispanic origin, race for non-Hispanic population, and sex: United States, 2012."

Table 6.5 shows adjusted all-cause mortality in the ESRD and general Medicare populations (over the age of 65) using the Medicare 5 percent sample. Follow-up for ESRD patents is from January 1 to December 31 of each year. For general Medicare patients, follow-up is from January 1 to December 31 of each year, censored at ESRD and at the end of Medicare entitlement. Adjusted mortality is adjusted for age, sex, and race, with 2011 ESRD patients serving as the reference.

Table 6.6 presents both unadjusted and adjusted all-cause mortality in the ESRD, dialysis, transplant, and general Medicare patients with cancer, DM, CHF, cerebrovascular accident/transient ischemic attack (CVA/TIA), and AMI. All cohorts are defined on January 1, and include patients aged 65 and older. Adjustment methods and follow-up are as defined for Table 6.5.

Chapter 7: Transplantation

Introduction

Figures 7.1–7.4 present an overview of trends in kidney transplantation. Figure 7.1 juxtaposes the percentage of prevalent dialysis patients wait-listed for a kidney transplant with the falling rate of transplantation in dialysis patients at all ages, 1996–2013. The data source is Reference Tables E.4 and E.9. Figure 7.2 shows the number of ESRD-certified candidates on the OPTN kidney transplant waiting list on December 31 of each year, for first and subsequent kidney-alone or kidney plus other organ transplants. Figure 7.2 also shows the median waiting time from wait-listing to kidney transplantation for candidates for kidney-alone transplants (i.e., the time by which 50% of these candidates had received a kidney transplant). Candidates listed at more than one transplant center on December 31 are counted only once. Median waiting time is reported for candidates newly listed in each given year. The data source is Reference Tables E.2 and E.3. Figure 7.3 presents the number of transplants by donor type. The data source is Reference Tables E.8, E.8.2, and E.8.3. Figure 7.4 shows the cumulative number of functioning kidney-alone and kidney-pancreas transplants. The data source is Reference Table D.9.

Waiting List

Figure 7.5 shows the percentage of patients wait-listed or receiving a deceased or living donor kidney-alone or kidney plus other organ transplant within one year of ESRD initiation, stratified by age. The data source is Reference Table E.5.2.

Figure 7.6 shows the annual mortality rates of dialysis patients who were wait-listed for a kidney-alone or kidney plus other organ transplant, per 1,000 dialysis patient years at risk, by time since listing. The data source is Reference Table H.6.

Transplant Counts and Rates

Table 7.1 shows the unadjusted kidney transplant rates of all donor types, by age, sex, race, and primary cause of ESRD, per 100 dialysis patient years. The data source is Reference Table E.9.

Figures 7.7–7.10 illustrate the counts and unadjusted rates of deceased kidney-alone and simultaneous kidney-pancreas transplants by age, sex, race, and primary cause of ESRD. The data source is Reference Tables E.8.2 and E.9.2.

Figures 7.11–7.14 portray the counts and unadjusted rates of living donor kidney-alone and simultaneous kidney-pancreas transplants by age, sex, race, and primary cause of ESRD. Diagnosis of cystic disease is included in the other diagnoses. The data source is Reference Tables E.8.3 and E.9.3.

Deceased Donation Counts and Rates

Figures 7.15–7.17 show the counts and unadjusted rates of deceased donor donation by age, sex, and race among all deaths among the U.S. population younger than 75 years old. Donors had at least one kidney recovered. Data on the deceased donors are obtained from United Network for Organ Sharing (UNOS), and data on the annual number of deaths in the U.S. population are obtained from the Centers for Disease Control and Prevention.

Transplant Outcomes

Table 7.2 shows one-, five-, and ten-year graft and patient outcomes for recipients who received a first kidney transplant from a deceased donor. Data sources for one-, five-, and ten-year trends are Reference Tables F.2, F.14, I.26; F.5, F.17, I.29; and F.6, F.18, I.30, respectively.

Table 7.3 shows one-, five-, and ten-year graft and patient outcomes for recipients who received a first kidney transplant from a living donor. Data sources for one-, five-, and ten-year trends are Reference Tables F.8, F.20, I.32; F.11, F.23,I.35; and F.12, F.24, I.36, respectively.

In both Tables 7.2 and 7.3, data are reported as unadjusted probabilities of each outcome, computed using Kaplan-Meier methods. All-cause graft failure includes repeat transplantation, return to dialysis, and death. The death outcome is not censored at graft failure, and deaths that occur after repeat transplantation or return to dialysis are assigned to the transplant cohort.

Figure 7.18 presents the percentage of acute rejections reported during the first post-transplant year in adult, first-time, kidney-alone transplant patients after discharge from the initial transplant hospitalization with a functioning graft. A recipient is assumed to have acute rejection if OPTN data collection forms note (1) acute rejection episodes, (2) that medications were given for acute rejection, or (3) that acute rejection was the primary cause of graft failure. If multiple rejection episodes are reported during the first year, only one rejection is counted in the numerator.

Table 7.4 presents the post-transplant total hospital admission rates, by age, sex, race, ethnicity, and primary cause of ESRD, per 1,000 patient years, among all kidney transplant patients. The data source is Reference Table G.5.

Chapter 8: Pediatric ESRD

Information on pediatric patients is a subset of ESRD patient data reported in other chapters of the ADR; methods used for most figures are therefore the same as those described in the related chapter discussions.

After reviewing the height and weight of patients aged 0–4 years old from 1996–2013, from the Medical Evidence form, a data cleaning process was deemed necessary for the pediatric chapter. There were 189 patients with unreasonable height and weight values, which we considered to be adults mistaken as pediatric patients. These patients have been excluded from all special analyses in the pediatric chapter.

Hospitalization

Figures 8.3–8.5 present adjusted admission rates in the first year of ESRD, by age, and modality, for 2003–2007 and 2008–2012 incident patients younger than 22. The patients are divided into five age groups (ages 0–4, 5–9, 10–13, 14–17 and 18–21) or three modality groups (HD, PD, and transplant). Since in-center hemodialysis patients who are younger than 65 and not disabled cannot bill for hospitalizations until 90 days after ESRD initiation, the 90-day rule is applied. Patients are required to survive the first 90 days after initiation, and are followed for admissions for up to one year after day 90. Data cleaning and counting of admissions and time at risk for admissions generally follow methods described for *Reference Section G: Morbidity and Hospitalization*. Censoring occurs at death, loss to follow-up, end of payer status, December 31, 2013, or at one year. Censoring also occurs three days prior to transplant for dialysis patients, and three years after the transplant date for transplant patients. Rates are adjusted for sex, race, Hispanic ethnicity, and primary cause of ESRD. Adjusted rates are calculated with a model-based adjustment method and an interval Poisson model. The reference cohort includes incident ESRD patients aged 0–21 years in 2010–2011. Principal ICD-9-CM diagnosis codes used for cardiovascular and infectious hospitalizations are listed in the discussion of Figure 5.1.

Mortality and Survival

Figures 8.6–8.8 present adjusted all-cause and cause-specific mortality in the first months of ESRD, by age, modality, and ethnicity, for 2003–2007 and 2008–2012 incident patients younger than 22 years old. The patients are divided into five age groups (ages 0–4, 5–9, 10–13, 14–17 and 18–21) or three modality groups (HD, PD, and transplant). Dialysis patients are followed from the day of ESRD onset until December 31, 2013, and censored at loss to follow-up, transplantation, or recovered function. Transplant patients who receive a first transplant in a calendar year are followed from the transplant date to December 31, 2013. Rates by age are adjusted for sex, race, Hispanic ethnicity, and primary cause of ESRD; rates by modality are adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. Incident ESRD patients who were younger than 22 years in 2010–2011 are used as the reference cohort. Cardiovascular mortality is defined using codes from past and current Death Notification forms: 01, 02, 03, 04, 1, 2, 3, 4, 23, 25, 26, 27, 28, 29, 30, 31, 32, 36, and 37; Infection mortality is defined using codes from past and current Death Notification forms: 10, 11, 12, 13, 33, 34, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 70, 71,74.

Figure 8.9 presents five-year survival for 2004–2008 incident ESRD patients aged 0–21 years, by age, modality, and ethnicity. The patients are divided into five age groups (age 0–4, 5–9, 10–13, 14–17 and 18–21) or three modality groups (HD, PD, and transplant). Dialysis patients are followed from the day of ESRD onset until December 31, 2013, and censored at loss to follow-up, transplantation, or recovered kidney function. Transplant patients who receive a first transplant in a calendar year are followed from the transplant date until December 31, 2013. Probabilities by age are adjusted for sex, race, Hispanic ethnicity, and primary cause of ESRD; probabilities by modality are adjusted for age, sex, race, Hispanic ethnicity, and primary cause of ESRD. The reference population consists of 2010–2011 incident pediatric ESRD patients.

Vascular Access

Data for Figures 8.10–8.12 and Table 8.2 are obtained from the Medical Evidence form; data are restricted to the most recent version. Figures 8.11 and 8.12 also include data from CROWNWeb. Patients with missing vascular access data are excluded. Figure 8.10 and Table 8.2 present data for pediatric patients who began dialysis from 2006–2013; age is calculated as of the date regular chronic dialysis began. In Figure 8.11, all HD pediatric patients who had ESRD at least 90 days at the time vascular access was reported were included. Patients must have been alive as of December 31, 2014. Figure 8.12 presents vascular access use during the first year of HD by time since initiation of ESRD treatment. Vascular access at initiation includes data obtained from the Medical Evidence form among pediatric patients new to HD from 06/01/2012–12/31/2012. The same patient cohort was followed for a year. Vascular access data for all other time points are obtained from CROWNWeb, and transitions to transplant/PD/death/other are obtained from the RXHIST (treatment history) file. For the 1-month, 3-month, 6-month, 9-month and 1-year time points, there is a 30 day look-back and look-forward time period to determine vascular access at that time point.

Transplantation

Figure 8.13 presents an overview of the pediatric transplant population. Figure 8.13.a shows the rate of ESRD among the U.S. population 0–21 years old, and the rate of transplantation in dialysis patients aged 0–21 years at transplant, 1996–2013. Pre-emptive transplant patients were included in both the numerator and the denominator. Figure 8.13.b shows the number of ESRD-certified pediatric candidates (0–21 years old) on the OPTN kidney transplant waiting list on December 31 of each year, and the median waiting time from wait-listing to kidney transplantation for new candidates (i.e., the time by which 50% of newly wait-listed candidates had received a kidney transplant). Candidates listed at more than one center on December 31 are counted only once. Median waiting time is reported for patients listed in each given year. Figure 8.13.c presents transplant counts for all pediatric (0–21 years old) recipients, by donor type.

Transplant and Outcomes

Figure 8.14 presents transplant rates per 100 dialysis patient years among pediatric patients on dialysis (0–21 years old). Figure 8.14.a presents rates by age group. Figure 8.14.b presents rates by race. Asian and Native American group were not displayed because of the fluctuation due to small population. Rates were calculated among dialysis patient years in that specific subgroup.

Figure 8.15 shows the median waiting time from initiation of HD or PD in incident pediatric ESRD patients (0–21 years old) to first transplant. Patient age in Figure 8.15.b was defined as the age at initiation of HD or PD. Incident dialysis and transplant patients are defined at the onset of dialysis or the day of transplant with the 60-day rule. Figure 8.15.b includes pediatric patients (0–21 years old) starting initiation of HD or PD in 1996–2012, and having the first transplant before 12/31/2014.

Figure 8.16 presents the repeat transplant rate for all pediatric patients (0–21 years old). The study cohort is 1996–2013. Figure 8.16.a shows the rates by age at the first transplant date, Figure 8.16.b presents the rates by the primary cause of ESRD. When calculating the rates, the numerator includes the total number of renal re-transplants, and the denominator includes the total number of renal transplants. Figure 8.16b includes only patients who are 0–21 years old at the time of first transplant and repeat transplant.

Table 8.3 presents patient outcomes for pediatric recipients (ages 0–21) who received a kidney transplant from a deceased or living donor. Table 8.3.a presents adjusted one-year outcomes, Table 8.3.b presents adjusted five-year outcomes, and Table 8.3.c presents adjusted ten-year outcomes. Death outcome probabilities are calculated among first-time transplants. Data are reported as adjusted probabilities of each outcome, and are computed using Cox proportional hazards models. The death outcome is not censored at graft failure, and includes deaths that occur after repeat transplantation or return to dialysis. These probabilities are adjusted as described below.

For the all-cause graft failure analyses, data are reported as adjusted probabilities of each outcome, and are computed using Cox proportional hazards models. Probabilities are adjusted for age, sex, race, primary cause of ESRD, and first versus subsequent transplant, and standardized to 2011 patient characteristics. All-cause graft failure includes re-transplant, return to dialysis, and death.

For the probability of death analyses, the Cox model and the model-based adjustment method are used for adjusted probabilities. The adjusted survival probability for a cohort is based on expected survival probability for the cohort and the reference population. The survival/conditional probabilities are modeled separately for each period: 0–90 days, 91 days to one year, one year to two years, two years to three years, three years to five years, and five years to ten years. The expected survival probabilities for 90 days, one year, two years, and so on are calculated based on the survival/conditional survival probabilities. We fit one model for each cohort to obtain adjusted probabilities overall and for age, sex, race, and primary cause of ESRD. The reference population consists of 2011 incident ESRD patients. The death outcome is not censored at graft failure, and includes deaths that occur after re-transplant or return to dialysis.

Young Adults

Analytical methods in the young adult section are similar to the pediatric section. The reference population consists of 2010–2011 incident young adult ESRD patients who were 22–29 years old.

Chapter 9: Cardiovascular Disease

This chapter describes the prevalence of cardiovascular comorbidities and selected cardiovascular procedures in fee-for-service, eligible Medicare enrollees. According to a previously validated method for using Medicare claims to identify diabetic patients, a patient is considered diabetic if, within a one-year observation period, he or she has a qualifying ICD-9-CM diagnosis code of diabetes mellitus (DM) on one or more Part A institutional claims (inpatient, skilled nursing facility, or home health agency), or two or more institutional outpatient claims and/or Part B physician/supplier claims (Herbert et al., 1999). With this methodology, we identify patients with comorbid conditions and procedures using the ICD-9-CM diagnosis codes.

Cardiovascular comorbidities include atherosclerotic heart disease (ASHD), acute myocardial infarction (AMI), congestive heart failure (CHF), cerebrovascular accident/transient ischemic attack (CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AFIB), and sudden cardiac arrest and ventricular arrhythmias (SCA/VA). The algorithm above is used to define these cardiovascular conditions using the following ICD-9-CM code values in Table m.2.

vol 2 Table m.2 ICD-9-CM diagnosis codes used to define cardiovascular disorders in the USRDS ADR, Volume 2, Chapter 9

Condition name	ICD-9-CM diagnosis codes
Any cardiovascular disease (CVD)	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 410-414; 422; 425-428; 430-438; 440-444; 447; 451-453; 557; V42.1, V45.0, V45.81, V45.82, V53.3
Atherosclerotic heart disease (ASHD)	410-414; V45.81, V45.82
Acute myocardial infarction (AMI)	410; 412
Congestive heart failure (CHF)	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 422a; 425a; 428; V42.1a
Systolic or both systolic & diastolic	428.2, 428.4
Diastolic only	428.3
Heart failure, unspecified	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 422a; 425a; 428 (not 428.2-428.4); V42.1a
Cerebrovascular accident/transitory ischemic attack (CVA/ TIA)	430–438
Peripheral arterial disease (PAD)	440–444; 447; 557
Atrial fibrillation (AFIB)	427.3
Sudden cardiac arrest/ventricular arrhythmias (SCA/VA)	427.1, 427.4, 427.41, 427.42, 427.5, 427.69

Data Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification. Diagnosis codes can have up to five digits with a decimal point between the 3rd and 4th digit. Codes listed with three digits include all existing 4th and 5th digits, and those listed with four digits include all existing 5th digits. Peripheral arterial disease is defined as having a diagnosis and/or a procedure. These codes are used to determine prevalent or comorbid CHF, but are excluded when determining incident CHF events and when CHF is the dependent variable.

Cardiovascular procedures include percutaneous coronary interventions (PCI), coronary artery bypass grafting (CABG), and the placement of implantable cardioverter defibrillators (ICD) and cardiac resynchronization devices with defibrillators (CRT-D). Procedures require only one claim with the procedure code. The presence of PAD is determined by the diagnosis or a claim for a procedure. Table m.3 shows the codes and type of claims used to identify each procedure.

Figure 9.1 shows the causes of death in prevalent dialysis patients during 2011-2013. The data source is Reference Table H.12. Table 9.1 displays the prevalence of cardiovascular comorbidities and procedures, by modality, age, race and gender, among ESRD patients in 2013. The cohort includes point prevalent hemodialysis, peritoneal dialysis, and transplant patients with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, and whose ESRD service date is at least 90 days prior to January 1, 2011, and who survived past 2012. We exclude patients with unknown age, gender, or race and those with an age calculated to be less than zero or greater than 110. Figures 9.2 and 9.3 show the percentage of patients who had cardiovascular comorbidities, by modality and age, respectively, among ESRD patients in 2013. The cohort is the same one used for Table 9.1. Figure 9.4 illustrates the unadjusted survival of patients, by cardiovascular diagnosis or procedure and modality. The cohort includes point prevalent hemodialysis, peritoneal dialysis, and transplant patients with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July, 1, 2010 to December 31, 2010, and whose first ESRD service date is at least 90 days prior to January 1, 2011, and who survived past 2011. Patients with CHF, PAD, and CVA/TIA are those whose Medicare claims indicated the diagnosis or procedure in 2011 or Medical Evidence forms reported the comorbidities during ten years before the first ESRD service date. Patients with ASHD, AMI, AFIB, SCA/VA, PCI, CABG, or ICD/CRT-D are those whose Medicare claims indicate the diagnosis or procedure in 2011. Patients are followed from January 1, 2012, until the earliest date of death, modality change, transplant, loss to follow-up, recovery of renal function, or December 31, 2013. The Kaplan-Meier method is used to estimate all-cause survival.

Table 9.2 describes the characteristics of hemodialysis and peritoneal dialysis patients with CHF, by age, sex, race, diabetic status, and type of heart failure in 2013. The study cohort is similar to that described for Table 9.1, except that patients who received a transplant were excluded.

vol 2 Table m.3 Procedure codes (ICD-9-CM and HCPCS) & claims files used to define cardiovascular procedures in the ADR, Volume 2, Chapter 9

Peripheral arterial disease (PAD)	
ICD-9-CM Procedure codes: Claims files searched: IP, OP, SN Values:	39.25, 39.26, 39.29; 84.0, 84.1, 84.91
HCPCS codes: Claims files searched: PB, OP-revenue Values:	24900, 24920, 25900, 25905, 25920, 25927, 27295, 27590, 27591, 27592, 27598, 27880, 27881, 27882, 27888, 27889, 28800, 28805, 34900, 35131, 35132, 35141, 35142, 35151, 35152, 34051, 34151, 34201, 34203, 34800–34834, 35081– 35103, 35331, 35341, 35351, 35355, 35361, 35363, 35371, 35372, 35381, 35450, 35452, 35454, 35456, 35459, 35470, 35471, 35472, 35473, 35474, 35480, 35481, 35482, 35483, 35485, 35490, 35491, 35492, 35493, 35495, 35521, 35531, 35533, 35541, 35546, 35548, 35549, 35551, 35556, 35558, 35563, 35565, 35566, 35571, 35583, 35585, 35587, 35621, 35623, 35646, 35647, 35651, 35654, 35656, 35661, 35663, 35665, 35666, 35671
Percutaneous coronary interventions (PCI)	
ICD-9-CM Procedure codes: Claims files searched: IP, OP, SN Values:	00.66; 36.01, 36.02, 36.05, 36.06, 36.07
HCPCS codes: Claims files searched: PB, OP-revenue Values:	92980-92982, 92984, 92995- 92996, G0290, G0291
Coronary artery bypass graft (CABG)	
ICD-9-CM Procedure codes: Claims files searched: IP Values:	36.1
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)	
ICD-9-CM Procedure codes: Claims files searched: IP, OP, SN Values:	00.51; 37.94

Data Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; HCPCS, Healthcare Common Procedure Coding System, IP, inpatient, OP, outpatient services during inpatient stay, SN, skilled nursing facility, PB, physician and supplier services covered by Part B, OP-revenue, outpatient revenue claims during inpatient stay. ICD-9-CM procedure codes have up to four digits with a decimal point between the 2nd and 3rd digits. Codes listed with three digits include all possible 4th digits. HCPCS codes have 5 digits without a decimal point. Peripheral arterial disease is defined as having a diagnosis and/or a procedure.

Chapter 10: Providers

The methods and data sources used to identify dialysis facilities are the same as those used in Reference Table J. Please refer to the section on *Reference Section J: Providers*, found later in this document, for detailed methods and data source description.

A facility's hospital-based or freestanding status is determined from the third and fourth digits of the provider number assigned to each unit by CMS. A facility's profit status is determined through the ownership type field on the CMS survey (for years prior to 2001) or the profit status field of the DFC database (2001 to the present).

Figures 10.1 and 10.2 show the counts of units and patients for all provider types from the 2011-2013 Annual Facility Survey. Figure 10.3 presents the percentage of patients who are being treated by PD and home HD by provider type and patient characteristics.

Figure 10.4 presents the percentage of patient-months in 2013 during which a hemodialysis patient had a particular type of access: catheter, fistula, graft, or other/missing type. The figures show these percentages among all patient-months ("Among Prevalent Dialysis Patients") and only among those patient-months during which a HD patient was new to dialysis ("Among Incident Dialysis Patients") stratified by patient characteristics. Figure 10.5 shows the distribution of all facilities' percentage of patients with the above-specified vascular access types, among both incident and all prevalent hemodialysis patients.

Figure 10.6 shows the percentage of dialysis patients on the kidney transplant waiting list in 2010, 2011, 2012, and 2013, stratified by patient characteristics. This set of figures measures wait-listing only among patients younger than 70 because transplants in people aged 70 and older occur much less frequently.

Hospitalization and Mortality

Tables 10.1 and 10.4 compare mortality and hospitalization among dialysis provider types and chains, using standardized mortality ratios (SMRs) and standardized hospitalization ratios (SHRs). Both measures are estimated using a two-stage Cox proportional hazards model (described below). SMR and SHR calculations include all 2010, 2011, 2012, and 2013 period prevalent dialysis patients; SHR calculations include only dialysis patients with Medicare as primary payer.

Adjustment

Both SMRs and SHRs are adjusted for patient age, race, ethnicity, sex, DM, duration of ESRD, nursing home status, patient comorbidities at incidence, and body mass index (BMI) at incidence. The SMR is additionally adjusted for race-specific population death rates.

To facilitate comparison of the SMR and SHR across years, Table 10.1 (SMR) and Table 10.3 (SHR) report these measures with the year adjustment removed from the model. That is, the measures do not compare outcomes for each year to the national norm for that year, but rather compare each year to the national averages over the entire reporting period combined (e.g., four years). Because all years are reported relative to the same standard, values can be compared across years, facilitating identification of short-term trends over time. Tables 10.2 (SMR) and 10.4 (SHR) present a one-year version of the respective measure.

Confidence Intervals

Given the large number of observations that go into the SMR and SHR models, we choose to approximate rather than directly calculate the 95% confidence intervals for the respective measure. This approach gains efficiency with minimal loss of precision. In particular, the exact 95% confidence intervals are derived by applying the Wilson-Hilferty Approximation (Wilson and Hilferty, 1931), which approximates chi-square percentiles using percentiles of the standard normal distribution (Breslow and Day, 1987).

Patient Placement

We identified each patient's dialysis provider at each point in time using data from a combination of Medicare-paid dialysis claims, the Medical Evidence form (CMS 2728), and paid dialysis claims. Starting with day 91 after onset of ESRD, we attribute a patient to a facility according to the following rules. A patient is attributed to a facility once the patient has been treated there for 60 days. When a patient transfers from one facility to another, the patient continues to be attributed to the original facility for 60 days and then is attributed to the destination facility. In particular, a patient is attributed to their current facility on day 91 of ESRD if that facility had treated him or her for at least 60 days. If on day 91, the facility had treated a patient for fewer than 60 days, we wait until the patient reaches day 60 of treatment at that facility before attributing the patient to the new facility. When a patient is not treated in a single facility for a span of 60 days (for instance, if there were two switches within 60 days of each other), we do not attribute that patient to any facility. Patients were censored upon receiving a transplant. Patients who withdrew from dialysis or recovered renal function remained assigned to their treatment facility for 60 days after withdrawal or recovery. If a period of one year passed with neither paid dialysis claims nor CROWNWeb/SIMS information to indicate that a patient was receiving dialysis treatment, we considered the patient lost to follow-up and did not include that patient in the analysis from that point forward. When dialysis claims or other evidence of dialysis reappeared, the patient was included in the analysis again starting after 60 days of continuous therapy at a single facility.

Chapter 11: Medicare Expenditures for Persons With ESRD

For the 2015 ADR, reported costs of ESRD include only those ESRD beneficiaries covered by Original Medicare (fee-for-service) for their Medicare Part A and B benefits. Medicare expenditures can be calculated from the claims submitted for payment for health care provided to these individuals, but not for those enrolled in Medicare Advantage (managed care) plans. The Medicare program pays for services provided through Medicare Advantage plans on a risk-adjusted, per-capita basis, and not by specific claims for services. Methods of estimating Medicare expenditures for Medicare Advantage beneficiaries with ESRD will be explored for future ADRs.

Figures 11.1–11.2, total costs to Medicare, were taken from Reference Table K.1. In Figure 11.2 total Medicare from each year costs was taken from the Medicare Trustees Report, Table B.1 which is available at *https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/TrusteesReports.html*. Part C costs were deducted to show the fee-for-service Medicare costs. Figure 11.3 presents point prevalence of Medicare as Primary Payer, Medicare as Secondary Payer, and non-Medicare ESRD patients by year using the USRDS database. Figure 11.4 describes the percent change in ESRD Medicare spending in total and per patient year, excluding claims with Medicare as secondary payer. The calculations are based on Reference Table K.4. Figure 11.5 shows the total Medicare ESRD expenditures by type of service, which was taken from Reference Table K.1. The analysis includes period prevalent patients, specifically, all ESRD patients with at least one Medicare claim. Figure 11.6 describes total Medicare ESRD expenditures by modality. Medicare costs are from claims data. Figure 11.7 shows the total Medicare ESRD expenditures per person per year by modality. The analysis includes period prevalent ESRD patients, and excludes patients with Medicare as secondary payer. Data sources are Reference Tables K.7, K.8, K.9.

Chapter 12: Prescription Drug Coverage in Patients With ESRD

In figures and tables regarding enrollment and utilization of Medicare Part D, we analyze cohorts of Medicare enrollees in 2011–2013 based on 100% of the ESRD population receiving hemodialysis, receiving peritoneal dialysis, or with a functioning kidney transplant, along with cohorts of Medicare enrollees in 2011–2013 based on the Medicare 5 percent sample (general Medicare enrollees). For general Medicare enrollees, we require continuous enrollment in Medicare Parts A and B during the previous calendar year; and Medicare enrollment in January of the index year. For hemodialysis, peritoneal dialysis, and kidney transplant cohorts, we identify all point prevalent patients alive and enrolled in Medicare on January 1 of the index year, with ESRD onset at least 90 days earlier; treatment modality is identified on January 1.

In Figures 12.1–12.3, the type of prescription drug coverage is defined sequentially. That is, we first classify patients as "Part D with LIS," if there exists at least one calendar month in 2013 with Part D enrollment and receipt of the low-income subsidy (LIS). In patients without one such month, we classify remaining patients as "Part D without LIS," if there exists at least one calendar month with Part D enrollment. In patients without one such month, we classify remaining patients as "retiree drug subsidy," if there exists at least one calendar month with employer receipt of the subsidy. In patients without one such month, we classify remaining patients as "other creditable coverage," if there exists at least one calendar month with enrollment in military, government employee, or employer group health plans. And we classify all remaining patients as "no known coverage."

For Figure 12.4 and Table 12.1, we classify Part D enrollees as LIS recipients, if there exists at least one calendar month in 2013 with receipt of the LIS. In Table 12.3, the proportion enrolled in Part D is the sum of those enrolled in Part D with the LIS and without the LIS.

Part D costs for ESRD patients are based on Part D enrollees with traditional Medicare (Parts A&B), using the period prevalent, as-treated model. ESRD patients in Medicare Advantage Part D plans and Medicare secondary payer are excluded. In an as-treated model, patients are first classified by their modality at entry into the analysis, and retain that classification until a modality change. When a change is encountered in the data, the beginning modality is censored at the change date plus 60 days, and a new observation with the new modality is created. The first 60 days after a change are attributed to the previous modality to account for any carryover effects. Some figures also include the general Medicare population (not enrolled in a Medicare Advantage Part D plan) based on the Medicare 5 percent sample. Costs in Tables 12.4–12.6 and Figure 12.5 are presented as the total Part D net payment, estimated as the Medicare covered amount plus the low income subsidy amount (LIS). Out-of-pocket cost is estimated as patient pay amount plus the True Out-of-Pocket Costs (TrOOP) amount. Table 12.6 shows six common prescribed Part D drug classes (based on the Anatomical Therapeutic Chemical (ATC) Classification System and the National Drug Code Directory from the Food and Drug Administration (FDA)) by cost and percentage of patients with any prescription filled.

Chapter 13: International Comparisons

Data Collection

Each country was provided a data-collection form spreadsheet (Microsoft Excel) to complete for years 2008 through 2013. Countries were asked to report patient count data for each year, if available, for the entire population, by sex (male, female), or by five different age categories (0–19, 20–44, 45–64, 65–74, 75+) for: (1) the country's or region's general population; (2) patients new to ESRD during the year; (3) patients new to ESRD during the year among new ESRD patients for whom DM was the primary cause of ESRD; (4) the point-prevalent count of ESRD patients living on December 31 of the given year; (5) total number of patients with a functioning kidney transplant on

December 31st of the given year; (6) total number of kidney transplants performed during the year, by type of kidney transplant (cadaveric, living donor, other donor); and (7) the number of dialysis patients, HD patients, CAPD/APD/ IPD patients, and home HD patients on December 31st of the indicated year. Prevalence was reported for all patients at the end of the calendar year (December 31, 2013), except where otherwise noted. Data for Italy, South Africa, and Lebanon were taken directly from the respective registry's annual report (McDonald et al., 2013; Italian Registry of Dialysis and Transplant, 2014; Davids et al., 2014; Elzein, 2012). Information for Ukraine was based on a recent publication of registry data from Ukraine (Kolesnyk et al., 2014). Data provided by Argentina may be supplemented by Marinovich et al., 2014.

Data Loading and Cleaning

The data were imported into SAS from Microsoft Excel and data quality checks were performed, with follow-up with registries, as needed. The global map was created using the Google Developers Visualization GeoChart API in JavaScript. The base image was then uploaded into Microsoft PowerPoint 2010.

Statistical Analyses

Incidence and prevalence were calculated as the count divided by the total population for that year, multiplied by one million. For age-specific and sex-specific categories, incidence and prevalence were calculated as the count in each category divided by the total population in the category, multiplied by one million.

To contribute data from your country's registry, please contact *international@usrds.org*.

Chapter 14: USRDS Special Study Center on Palliative and End-of-Life Care

Methods for the creation of the figures and tables in Chapter 14 are described within the chapter itself.

ESRD Reference Table Methods

Reference Section A: Incidence

The Reference Tables present parallel sets of counts and rates for incidence (Section A) and December 31 point prevalence (Section B). Section B also presents annual period prevalent counts and counts of lost-to-follow-up patients. Because the U.S. population figures (shown in Reference Section M) used in the ADR include only residents of the 50 states and the District of Columbia, tables also focus on patients from these areas. Exceptions are Tables A.1, A.6, A.8, and A.10, all of which present data specific to patients in Puerto Rico and the U.S. territories, or include these patients in the patient population. Age is computed as of the beginning of ESRD therapy.

Rates in Table A.2, A.9 and A.11 are adjusted for age, sex, race, and ethnicity with the 2011 national population as reference.

Reference Section B: Prevalence

With the exception of Tables B.1, B.6, B.8, and B.10, these tables focus on patients in the 50 states and the District of Columbia. Age is calculated as of December 31. Rates in Table B.2, B.9 and B.11 are adjusted for age, sex, race, and ethnicity with the 2011 national population as reference.

Reference Section C: Patient Characteristics

Data in these tables are based on information collected with the 1995 and 2005 Medical Evidence 2728 forms. Table C.1 contains data on biochemical markers from 2005–2013. A new Medical Evidence form (CMS 2728) was introduced in 2005 that included glycosylated hemoglobin (HbA1c), total cholesterol, low-density lipoprotein, high-density lipoprotein and triglycerides. Because these data elements had not been collected on the previous form, values are not available for the first few months of 2005. Data prior to 2005 on mean values reported for these markers may be unreliable due to low numbers of patients. Blood urea nitrogen was dropped from the 2005 form, and in later years Tables C.1(2) and C.1(3) BUN cells are blank because of this change.

Reference Section D: Treatment Modalities

Reference Section D is divided into four parts. The first, Tables D.1–D.11 and D.15–D.16, provides counts and percentages—by demographics, geographic location, and treatment modality—of incident and prevalent patients alive at the end of each year. Age is computed as of the start of ESRD for incident patients and as of December 31 for point prevalent patients.

Table D.12 shows modality at day 90 and at two years after first service for all incident Medicare patients beginning renal replacement therapy from 2009–2011. The 90-day rule is used to exclude patients who die during the first 90 days of ESRD, and age is computed as of the first ESRD service date.

The third section, Tables D.13–D.14, presents counts of prevalent patients alive at the end of each year, by ESRD exposure time and modality. Table D.13 shows counts by the number of years of ESRD, while Table D.14 presents counts by the number of years on the end-of-year treatment modality. For the duration of ESRD exposure, zero should be read as less than one year, one as at least one full year, but less than two, and so on.

The fourth section, Tables D.17–D.24, presents counts of incident and prevalent patients alive at the end of selected years (i.e., 2005, 2009, 2013), by demographic characteristics, payer category, and treatment modality. Again, age is computed as of the start of ESRD for incident patients and as of December 31 for point prevalent patients. The payer categories are:

- Medicare FFS (i.e., Medicare as primary payer)
- Medicare/Medicaid (i.e., dually eligible)
- MSP (i.e., Medicare as secondary payer): EGHP and non-EGHP
- HMO (i.e., Medicare Advantage or Medicare+Choice plans)
- Other and unknown payers

The detailed discussion of payer categories can be found in the *Database Definitions* section at the beginning of this chapter.

Reference Section E: Transplantation

Tables E.1–E.5 present data regarding the kidney transplant waiting list. Table E.1 presents counts of ESRD-certified candidates newly added to the waiting list for a kidney or kidney-pancreas transplant during the given year. Patients listed at multiple transplant centers are counted only once. Table E.2 presents wait times, defined as the median time in days from first listing to transplant among patients listed for a kidney-alone transplant, and is estimated with the Kaplan-Meier method. Patients listed at multiple centers are counted from the time of the first listing. The data are censored at the loss-of-follow-up, death, or the 'end-of-study' (which is 2013 for the 2015 Reference Table). Given that the median waiting time is about four years, the value cannot be estimated reliably without at least 4 year of follow-up. As a result, the 2015 Table E.2 only shows data up to year 2009. Table E.3 presents counts of ESRD-certified patients on the waiting list at any transplant center on December 31 of the given year, regardless of when the first listing occurred. Table E.4 includes point prevalent dialysis patients wait-listed for a kidney on December 31 of the given year. Table E.5 presents the percentage of patients wait-listed or receiving a transplant within one year of ESRD initiation. Patients receiving a deceased donor kidney transplant are included in Tables E.5, E.5.3, and E.5.4, and patients receiving a deceased or live donor kidney transplant are included in Tables E.5.2, E.5.5, and E.5.6. Percentages in Tables E.2 and E.5 are calculated using the Kaplan-Meier method.

Transplant counts are presented in Tables E.6–E.8. All kidney transplants, including kidney-alone and kidney plus at least one other organ, are included unless specified in the footnote, and all counts include non-Medicare patients. Table E.8 illustrates the distribution of recipients by donor type and panel reactive antibody level, determined from the OPTN Recipient Histocompatibility form, and shows a cross-tabulation of recipients and donors in terms of cytomegalovirus antibody status, hepatitis C antibody status, and Epstein-Barr antibody status at the time of transplantation. A recipient/donor is considered positive for any of these antibodies if any applicable OPTN data source indicates positive. Unknown status is applied when no applicable data fields indicate "positive" or "negative." In Table E.8.2, cold ischemia time (in hours) is reported for deceased donor transplants only, and is taken from the OPTN Transplant Recipient Registration form.

Transplant rates per 100 dialysis patient years are shown in Table E.9. All HD patients, PD (CAPD/CCPD) patients, and patients on an unknown form of dialysis are included, as are all non-Medicare dialysis patients. A patient's dialysis days are counted from the beginning of the specified year, or from day one of ESRD dialysis therapy if treatment begins within the specified year, until transplant, death, or the end of the year, whichever comes first. Dialysis time for patients returning to dialysis from transplant is counted. Transplant rates are calculated as the number of transplants, including kidney-alone and kidney plus at least one other organ, divided by the total number of dialysis patient years for each year.

Reference Section F: Transplantation: Outcomes

This section presents probabilities of graft survival and graft failure necessitating dialysis or repeat transplantation, by donor type, age, sex, race, ethnicity, primary cause of ESRD, and first versus subsequent transplant. Data are presented for outcomes at 90 days, one year, two years, three years, five years, and ten years post-transplant. This section seeks to address two major issues: the probability of graft survival at various times post-transplant, and the probability that a recipient will return to dialysis or require repeat transplantation at various times post-transplant. Recipients are followed from the transplant date to graft failure, death, or the end of the follow-up period (December 31, 2013). In the analysis of graft survival, death is considered a graft failure. In the analysis of graft failure necessitating dialysis or repeat transplantation, patients are followed until graft failure (excluding death), and patient follow-up is censored at death. To produce a standard patient cohort, patients with unknown age or sex are omitted. Unknown age is defined as a missing age at transplant, or an age calculated to be less than zero or greater than 100 years. Patients are also excluded if their first ESRD service date is prior to 1977.

Unadjusted survival probabilities are estimated using the Kaplan-Meier method, while the Cox proportional hazards model is used for adjusted probabilities. Probabilities are adjusted for age, sex, race, primary cause of ESRD, and first versus subsequent transplant, and standardized to 2011 recipient characteristics.

Reference Section G: Morbidity and Hospitalization

Hospitalization Reference Tables present adjusted total admission and hospital day rates, by year, 2004–2013. The model-based adjustment method used in these tables is discussed later in this section and in the *Statistical Methods* section at the end of this chapter.

Because hospitalization data for non-Medicare patients may be incomplete, analyses in this section include only patients with Medicare as their primary payer. Hospitalization data are obtained from institutional inpatient claims. As in Chapter 5, hospitalization data in *Reference Section G: Morbidity and Hospitalization* do not exclude inpatient stays for the purpose of rehabilitation therapy.

Tables G.1–G.15 include dialysis and transplant patients who are on their modality for at least 60 days, reaching day 91 of ESRD by the end of the year, and residing in the 50 states, the District of Columbia, Puerto Rico, and the U.S. territories. Excluded are patients with AIDS as a primary or secondary cause of death; patients with missing values for age, sex, or race; and patients of races that are unknown or other than White, Black/African American, Native American, or Asian. Age is determined on January 1 of each year. Patients are also classified according to their primary cause of ESRD, in which the "other" category includes patients with missing data or causes other than diabetes mellitus (DM), hypertension, or glomerulonephritis.

Patients are classified by modality at the beginning of the year:

- All dialysis: patients on HD, CAPD/CCPD, or dialysis of an unknown type, as well as those on more than one modality in the past 60 days
- Hemodialysis: patients on HD for at least 60 days as of the start of the period at risk
- CAPD/CCPD: patients on CAPD/CCPD for at least 60 days as of the start of the period at risk
- Transplant: patients with a functioning transplant, and who received the transplant less than three years prior to the start of the period at risk
- All-ESRD: all patients

To limit the contribution of patient years at risk from patients who do not have Medicare coverage but do have Medicare as a secondary payer or HMO coverage, and who therefore have incomplete hospitalization data, cohorts include only patients with Medicare Parts A and B coverage at the start of follow-up. The follow-up period is censored when a patient's payer status changes to no longer having Medicare Parts A and B coverage or Medicare as a primary payer.

For patients in the all-dialysis, HD, and PD categories, the period at risk for all hospitalization analyses is from January 1 or day 91 of ESRD until the earliest of death, three days prior to transplant, end of Medicare Parts A and B coverage, or December 31. Modality change is considered a censoring event only in the case of a change from dialysis to transplant. For dialysis patients in the all-ESRD category, in contrast, the analysis period is censored only at death, end of Medicare Parts A and B coverage, or December 31 of the given year; a modality change is not used as a censoring event. For transplant patients in the all-ESRD and transplant categories, the period is censored at the earliest of death, three years after the transplant date, end of Medicare Parts A and B coverage, or December 31 of the given year. The censoring of transplant patients at three years following the transplant is necessary because Medicare eligibility may be lost and hospitalization data may be incomplete for these patients.

Time at risk is calculated differently for hospital days and total admissions. Since a hospitalized patient remains at risk for additional hospital days, rates for hospital days include hospital days in the time at risk value. Since a currently hospitalized patient is not, however, at risk for new admissions, hospital days for each year are subtracted from the time at risk for total admissions. In the case of a hospitalization in which admission occurs the same day as discharge, zero days are subtracted from the time at risk for total admissions. When hospitalizations span the start of the analysis period, only the days within the period are subtracted from the time at risk for total admissions.

All admissions and hospital days during the analysis period are included, respectively, in the total admissions and hospital days for each year. An admission for a hospitalization that occurs before and spans the start of the analysis period is excluded from the total admissions for that period, and only the hospitalization days within the period are counted in the total days for hospital day rates. The minimum length of stay is one day, and hospitalizations with an admission and discharge on the same day, as well as those with a discharge the day after admission, are both counted as one day.

As in previous ADRs, all overlapping and only certain adjacent hospitalizations are combined, due to the fact that many adjacent claims may actually be legitimate separate hospitalizations. Specifically, hospitalizations with an admission on the same day or the day after a previous discharge are combined only when there is a discharge transfer code or indication of an interim claim. In the case of two hospitalizations combined into one, the principal diagnosis and procedure codes are retained from the first of the two hospitalizations, with the combined hospitalization extending from the first admission date to the last discharge date.

The methodology for computing adjusted total admission and hospital day rates uses the model-based adjustment method (discussed in the section on statistical methods). Predicted rates for each subgroup combination of age, sex, race, primary cause of ESRD, and year are obtained using a model with the Poisson assumption. For prevalent patient cohorts, this model uses data from the current and previous two years, with respective weights of 1, 1/4, and 1/8. Adjusted rates are then calculated using the direct adjustment method, with all 2011 ESRD patients as the reference cohort.

Tables G.11–G.15 show inpatient utilization in the period prevalent ESRD patients. Methods—including modality definitions, inclusion criteria, data cleaning, follow-up time definitions, and rate calculations—generally follow those described for the total admission rates in Tables G.1–G.5, but some differences do exist. While patients of races other than White, Black/African American, Native American, or Asian are excluded from G.1–G.5, they are included in G.11–G.15, except where rates are given by race. Rates are unadjusted and reflect total admissions per 100 patient years for 2005–2007, 2008–2010, and 2011–2013 (pooled) prevalent patients. While the rates for all causes are computed similarly to the unadjusted rates in G.1–G.5, the other nine cause-specific categories only include admissions for specific diseases. Vascular access and PD access hospitalizations are those classified as “pure” inpatient vascular/dialysis access events. Such access events are defined as admissions with a specified ICD-9-CM principal diagnosis code, or an ICD-9-CM principal procedure code in conjunction with a certain Diagnosis Related Group (DRG) code. Codes are listed in Table m.4. If an admission does not qualify as vascular/dialysis access, it is classified by the principal diagnosis code into one of eight other mutually exclusive groups. Categories and ICD-9-CM codes are as follows: circulatory diseases, 390–459; digestive diseases, 520–579; genitourinary diseases, 580–629; endocrine and metabolic diseases, 240–279; respiratory diseases, 460–519; infectious diseases, 001–139; and cancer, 140–172, 174–208, 230–231, and 233–234. Hospitalizations that do not fall under any of these categories are counted under all others.

vol 2 Table m.4 DRG & ICD-9-CM codes for vascular access & peritoneal dialysis access variables

DRG codes[a] prior to October 1, 2007

112 Percutaneous cardiovascular procedure

120 Other circulatory system OR procedure

315 Other kidney and urinary tract OR procedure

442 Other OR procedure for injuries with complication

443 Other OR procedure for injuries without complication

478 Other vascular procedure with complication

479 Other vascular procedure without complication

DRG codes[a] after September 30, 2007

252 Other vascular procedures with Major complicating conditions (MCC)

264 Other circulatory system O.R. procedures

673 Other kidney & urinary tract procedures with MCC

674 Other kidney & urinary tract procedures with CC

675 Other kidney & urinary tract procedures without CC/MCC

907 Other O.R. procedures for injuries with MCC

908 Other O.R. procedures for injuries with CC

909 Other O.R. procedures for injuries without CC/Medicare

ICD-9-CM procedure codes[a]

38.95 Venous catheterization for renal dialysis

39.27 Arteriovenostomy for renal dialysis

39.42 Revision of arteriovenous shunt for renal dialysis

39.43 Removal of arteriovenous shunt for renal dialysis

39.93 Placement of vessel-to-vessel cannula

39.94 Replacement of vessel-to-vessel cannula

86.07 Placement of totally implantable vascular access device

ICD-9-CM diagnosis codes[b]

996.1 Mechanical complication of vascular device, implant, graft

996.56 Mechanical complication due to peritoneal dialysis catheter

996.62 Infectious complication of vascular device, implant, graft

996.68 Infectious complication due to peritoneal dialysis catheter

996.73 Other complication due to renal dialysis device, implant, graft

999.31 Infection due to central venous catheter

V56.1 Fitting and adjustment of extracorporeal dialysis catheter

V56.2 Fitting and adjustment of peritoneal dialysis catheter

[a] *DRG and procedure codes are used in conjunction to define inpatient pure vascular access events (both must be present).*
[b] *The presence of any of these diagnosis codes as the "Principal Diagnosis Code" is sufficient to define an inpatient pure vascular access or peritoneal dialysis access event.*

Tables G.1.1–G.5.1 present adjusted rates similar to those shown in G.1–G.5, but include more patient subgroups. Additionally, Tables G.1.2–G.5.2 display the counts of the total admissions, patient years at risk, and total patients that are used to calculate the total admission rates.

Reference Section H: Mortality and Causes of Death

Cohorts for tables in Section H include both Medicare and non–Medicare patients living in the 50 states, the District of Columbia, Puerto Rico, and the U.S. territories. The 60-day stable modality rule and 90-day rule are not applied to tables in Section H.

The cohorts in Tables H.1–H.12 are comprised of period prevalent patients, including those alive on January 1 and those incident during a calendar year. All patients are followed from either January 1 (for those alive on January 1) or from the date of onset of ESRD (for those patients incident in a calendar year). Follow-up is censored at loss to follow-up, date of transplant (for dialysis patients), recovery of function, or December 31 of the year. Age is defined at the beginning of follow-up. In calculating adjusted mortality, beginning in 1996, we have adjusted and reported for five race groups (White, Black/African American, Native American, Asian, and Other), as well as for ethnicity (Hispanics and non-Hispanics).

Tables H.1, H.2, and H.2.1 present mortality data for all ESRD patients. Total deaths are presented in Table H.1. Overall unadjusted and adjusted annual mortality rates by age, sex, race/ethnicity, primary cause of ESRD, and years of ESRD treatment are presented in Table H.2. Category-specific unadjusted mortality rates are calculated as total patient deaths divided by total follow-up time. Adjusted rates are computed by an appropriately weighted average of predicted category-specific rates, with the predicted rates based on generalized linear mixed models. Such methods, akin to direct standardization, are described in the *Statistical Methods* section later in this chapter. Overall mortality rates are adjusted for age, sex, race, primary cause of ESRD, and years of ESRD treatment, while rates for each individual category are adjusted for the other four factors. The reference population includes 2011 prevalent ESRD patients. Table H.2.1 presents unadjusted mortality rates by age, sex, race, and primary cause of ESRD for 2013 prevalent ESRD patients; rates are again smoothed using a generalized linear mixed model.

The same methods are used for Tables H.3, H.4, and H.4.1 (dialysis); H.5 (dialysis patients, never on transplant waiting list); H.6 (dialysis patients on transplant waiting list); H.7 (dialysis patients, returned to dialysis from transplant); H.8 and H.8.1 (HD); H.9 and H.9.1 (CAPD/CCPD); and H.10 and H.10.1 (transplant).

For Table H.13, general U.S. population life expectancy, the data source is Table 7 in the National Vital Statistics Report (NVSR), Deaths: Final Data for 2012. The methodology used is different from previous years: the expected remaining lifetime reported for a five year age range is the mean of the values for the starting age and the ending age. For example, the value reported for the 15–19 year old age group is the average of the values at the exact ages 15 and 20. For the age group 0–14 years old, the number reported is the mean of the values for the exact ages of 0, 1, 5, 10 and 15. Similarly, the life expectancy of the age 85+ group is the mean of the values for the exact ages of 85, 90, 95 and 100.

Reference Section I: Patient Survival

These tables present patient survival probabilities, based on incident cohorts. All causes of death are included, as are all non-Medicare patients and patients living in the 50 states, the District of Columbia, Puerto Rico, and the U.S. territories. Patients were excluded if sex is unknown, or if age is unknown. All new ESRD patients with a first ESRD service date between January 1, 1996 and December 31, 2012, are included in the analysis. These patients are followed from day one (ESRD onset) until death, loss to follow-up, or December 31, 2013. For dialysis patients, both HD and PD, follow-up is also censored at recovery of native renal function and at receipt of a kidney transplant. Unadjusted patient survival probabilities are estimated using the Kaplan-Meier method, while adjusted survival is computed through model-based direct standardization using Cox regression. Incident 2011 ESRD patients served as the reference population for both overall and subgroup-specific adjusted survival.

Reference Section J: Providers

In Reference Section J, we define a chain-affiliated unit as a freestanding dialysis unit owned or operated by a corporation at the end of a year. The category of small dialysis organization (SDO) includes all organizations meeting our definition of a chain but not owned by DaVita, Fresenius Medical Care (Fresenius), or Dialysis Clinic, Inc. (DCI).

Data are obtained from CMS's Annual Facility Survey (1988 to the present), Renal Dialysis Facilities Cost Report (Form 265–94, 1994–2000), and Dialysis Facility Compare (DFC) database (2001 to the present), as well as the CDC National Surveillance of Dialysis-Associated Diseases in the United States (1988–2002, excluding 1998, when the CDC did not conduct a survey). The CDC discontinued the National Surveillance of Dialysis-Associated Diseases after 2002.

A facility's hospital-based or freestanding status is determined from the third and fourth digits of the provider number assigned to each unit by CMS. A facility's profit status is determined through the ownership type field on the CMS survey (for years prior to 2001) or the profit status field of the DFC database (2001 to the present).

Reference Section K: Medicare Claims Data

Cost information in this section is derived from Medicare inpatient, outpatient, skilled nursing facility, hospice, home health, physician/supplier, durable medical equipment, and Part D claims data in the CMS SAFs, which are created annually six months after the end of each calendar year. Claims data are obtained for all patient identification numbers in the USRDS Database. The claims data are then merged with patient demographic data and modality information in the USRDS Database.

The economic analyses for this section focus on the claim payment amount, which is the amount of the payment made from the Medicare trust fund for the services covered by the claim record. These analyses also include the pass-through per diem amount, which applies to inpatient claims and reimburses the provider for capital-related costs, direct medical education costs, and organ acquisition costs.

The Reference Tables in section K exclude patients who were classified as MSP and individuals with missing values for demographics, modality, or payer status, unless otherwise specified.

Payer Sequence

The payer sequence is similar in concept to the USRDS treatment history. Payer status is tracked for each ESRD patient from the first ESRD service date until death or the end of the study period. Data from the Medicare Enrollment Database and dialysis claims information are used to categorize payer status as Medicare primary payer (MPP), Medicare secondary payer (MSP), or non-Medicare. The claims database contains data only for MPP and MSP patients, so economic analyses are restricted to these categories. In addition, as it is impossible to determine the complete cost of care for ESRD patients with MSP coverage, analyses of costs per person per year exclude patients during the periods when they have this coverage.

Payment Categories

Medicare payments are broken into several categories. Estimates of costs from the outpatient SAF are derived for the individual services provided. Since complete data on line-item payments are available starting with the 2001 outpatient SAF, the estimates for outpatient payment categories are taken directly from the claims data for calendar years 2004–2013, with adjustments as noted.

Model 1: As-treated actuarial model

In an as-treated model patients are first classified by their modality at entry into the analysis, and retain that classification until a modality change. When a change is encountered in the data, the initial modality is censored, and a new observation with the new modality is created. Under this method, aggregation of Medicare payments is done on an as-treated basis, attributing all payments for a particular claim to the patient's modality at the time of the claim.

In Section K of the Reference Tables, we classify patients into four as-treated modality categories: HD, CAPD/CCPD, other dialysis, and transplant. The "other dialysis" category includes cases in which the dialysis modality is unknown or is not HD or CAPD/CCPD, while the transplant category includes patients who have a functioning graft at the start of the period, or who receive a transplant during the period. Some tables also include categories for all dialysis (HD, CAPD/CCPD, and other dialysis) and all ESRD (all-dialysis and transplant).

The study spans the 10 years from January 1, 2004 to December 31, 2013, and ESRD patients prevalent on January 1, 2004, or incident at any time during the period are potentially eligible for inclusion. The initial study start date for a given patient is defined as the latest of January 1, 2004, or the first ESRD service date in the USRDS Database for that patient. Claims during periods that a patient is classified as MSP are included in Tables K.1–K.4, and are excluded for the rest of the tables in Section K.

To express costs as dollars per year at risk, total costs during the follow-up period are divided by the length of the period. Costs per patient year at risk are calculated by patient category, and stratified by age, sex, race, modality, and diabetic status (based on the patient's primary cause of ESRD).

Model 2: Categorical calendar year model

This model, described in the Health Care Financing Administration (now CMS) research report on ESRD (1993–1995), is used for Reference Tables K.10–K.13. With this method, patients are classified into four mutually exclusive treatment groups:

- Dialysis: ESRD patients who are on dialysis for the entire calendar year, or for that part of the year in which they are alive and have ESRD
- Transplant: ESRD patients receiving a kidney transplant during the calendar year
- Functioning graft: ESRD patients with a functioning graft for the entire calendar year, or for that part of the year in which they are alive and have ESRD
- Graft failure: ESRD patients who have had a transplant, but return to dialysis due to loss of graft function during the calendar year; patients with a graft failure and a transplant in the same calendar year are classified in the transplant category

Reference Section L: Vascular Access

Tables L.1–L.6 include period prevalent HD patients with Medicare as primary payer. Placements are identified from Medicare claims, and rates represent the total number of events divided by the time at risk. Follow-up is censored at death, change in modality, change in payer status, or the end of the prevalent year.

Tables L.7–L.8 include point prevalent PD patients with Medicare as primary payer. Complications are obtained from claims during the time at risk in the prevalent year, and rates represent the total number of events divided by the time at risk. Follow-up time is censored at death, a change in modality, a change in payer status, a claim for HD vascular access placement, or at the end of the prevalent year.

Reference Section M: Census Populations

Table M.1 includes the U.S. resident population on July 1 for year 1996–2013. The data sources are U.S. census, intercensal and postcensal population estimates from the CDC Bridged-Race Population Database. They are used to calculate incidence and prevalence rates.

Statistical Methods

Methods for Calculating Rates

The calculation of observed rates is straightforward, with some rates based on counts and others on follow-up time. The ESRD incident rate in 2009, for example, is the observed incident count divided by the 2009 population size and, if the unit is per million population, multiplied by one million. The 2009 death rate for prevalent ESRD patients is the number of deaths in 2009 divided by the total follow-up time (patient years) in 2009 of the 2009 prevalent patients, and, if the unit is per thousand patient years, multiplied by one thousand. Standard errors of estimated rates are based on the assumption of the data; the observed count has a Poisson or binomial distribution. The count-based rate describes the proportion having the "event," and the time-based rate tells how often the "event" occurs.

Model-based Rates

Some patient groups may be very small, and their observed rates are, therefore, unstable. If follow-up time is considered, the hazard of an event may change over time. A model-based method can improve the stability of these estimates and incorporate changes of hazard over time. In this ADR, for example, we have used the generalized linear mixed Poisson model to estimate prevalent patient mortality rates for *Reference Section H: Mortality and Causes of Death*.

Measurement Unit for Rates

Both observed and model-based rates are calculated per unit of population (i.e., per 1,000 patients) or per unit of follow-up time (i.e., per 1,000 patient years). Calculating rates per unit of follow-up time can account for varying lengths of follow-up among patients. Patient years are calculated as the total number of years, or fractions of a year, of follow-up time for a group of patients.

Take, for example, a calculation of 2010 first hospitalization rates for two groups of patients, all receiving dialysis therapy on January 1, 2010. Group A consists of three patients: patient one had a first hospitalization on March 31, 2010; patient two was hospitalized on June 30, 2010, and patient three was on dialysis through December 31, 2010; with no hospitalizations. Group B also has three patients: patient four was first hospitalized on December 31, 2010; patient five was hospitalized on September 30, 2010; and patient six was on HD the entire year, with no hospitalizations through December 31, 2010.

Patients one to six contribute 0.25, 0.5, 1.0, 1.0, 0.75, and 1.0 patient years at risk, respectively. The first hospitalization rate per thousand patients is 667 for both groups in 2010. But the first hospitalization rate per thousand patient years at risk is 1,143 for Group A and 727 for Group B (calculated as [2 total events / 1.75 total patient years at risk] x 1,000 for Group A and [2 total events / 2.75 patient years at risk] x 1,000 for Group B). The resulting rate is lower for Group B because of the longer total follow-up time.

Rates per unit of population may be influenced by the proportion of patients who are followed for only a fraction of a year. The event rate per unit of population is likely to be lower, for example, in a group of patients followed for only one month until censoring than in a group whose patients are each followed for up to a full year. Rates per unit of follow-up time at risk, in contrast, count only the actual time that a patient is at risk for the event.

Methods for Adjusting Rates

Because each cohort contains a different patient mix, observed event rates may not be comparable across cohorts. Adjusted analyses make results comparable by reporting rates that would have arisen had each cohort contained patients with the same distribution of confounders—such as age, sex, race, and primary cause of ESRD—as the reference population.

Direct Adjustment

There are several rate-adjustment methods, but only the direct method allows rates to be compared (Pickle & White, 1995). Here the adjusted rate is derived by applying the observed category-specific rates to a single standard population (i.e., the rate is a weighted average of the observed category-specific rates, using as weights the proportion of each category in the reference population). Categories are defined by the adjusting variables. For example, if a rate is adjusted for race and sex and there are three race groups (White, Black/African American, and Other) and two sex groups, there are six categories: White males, White females, Black/African American males, Black/African American females, males of other races, and females of other races.

Suppose we try to compare state-level incidence rates in 2009 after removing the difference caused by race. To do this, we need to calculate the incidence rate, adjusted for race, for each state. Because racial distributions in each state are quite different, we use as reference the national population—here, the population at the end of 2009—with five race groups (White, Black/African American, Native American, Asian, and Other).

Assuming the incidence rate of state A in 2009 is 173 per million population, and the race-specific rates and race distribution of the national populations are as shown in Table m.5 below, the adjusted incidence rate of state A with the national population as reference is (153 x 75.1%) + (250 x 12.3%) + (303 x 0.9%) + (174 x 3.6%) + (220 x 8%) = 158.73 per million population. This means that if state A had the same racial distribution as the entire country, its incidence rate would be 158.73 instead of 173. If state B had an adjusted incidence rate of 205, we could say that state B had a higher incidence rate than state A if they both had the same racial distribution as the whole country.

vol 2 **Table m.5 Example of adjusted incident rate calculation**

	Incidence rate of State A	National population (%)
White	153	75.1
Black/African American	250	12.3
Native American	303	0.9
Asian	174	3.6
Other	220	8.0

This method is used to produce some adjusted incidence and prevalence rates in Chapters 1 and 3, and in Reference Sections A and B, as well as in the model-based adjustment method.

Model-based Adjustment

Under some circumstances there are disadvantages to the direct adjustment method. Suppose we are calculating mortality rates for a set of groups, and adjusting for potential confounding variables. If one category in a group has only a few patients or deaths, its estimated category-specific mortality rate will be unstable, likely making the adjusted rate unstable as well. In addition, if one includes a category with no patients, the method is not valid for calculating an adjusted mortality rate for the group. An attractive alternative is a model-based approach, in which we find a good model to calculate category-specific estimated rates for each group, and then calculate direct adjusted rates using these estimates with a given reference population. This method can also be extended to adjustments with continuous adjusting variables (Liu et al., 2006). As in previous ADRs, standard errors of the adjusted rates are calculated using a bootstrap approach. In general, the bootstrap approach works well, but is time consuming. Convergence problems occur in a few bootstrap replications and such cases are ignored in the calculation. In this ADR we use model-based adjustments to calculate adjusted mortality rates, adjusted hospitalization rates, and state-level adjusted incidence and prevalence rates using the Poisson model and some other rates, as described in the text on the individual figures.

Survival Probabilities and Mortality Rates

Unadjusted Survival Probabilities

In this ADR, unadjusted survival probabilities are calculated using the Kaplan-Meier method, and corresponding standard errors are calculated with Greenwood's formula (Kalbfleisch & Prentice, 2002). Survival probabilities in *Reference Section I: Patient Survival* are expressed as percentages from 0 to 100. The mortality/event rate in the period of (0,t) is calculated by [-ln(Survival at time t)]. This event rate will be the same as that estimated by event time divided by follow-up time after adjustment of the unit, if the event rate is a constant over time.

Survival Probability With Competing Risks

When competing risks exist, the estimate of the cumulative incidence function of a specific cause may be biased if the other competing risks are ignored. If we have K competing risks, the cumulative incidence function of cause k, k=1, 2, ..., K, at time t, $I_k(t)$, is defined as the probability of failing from cause k before time t (including time t), Prob(T≤t, D=k). Then

$$I_k(t) = \int_0^t \lambda_k(s) S(s) ds$$

where $\lambda_k(s)$ is the hazard of event from cause k at time s and S(s) is the survival probability at time s (the probability of no event happening). If we have failing time t_1, t_2, ..., t_m, the cumulative incidence function of cause k at tim

$$I_k(t) = \sum \hat{\lambda}_k(t_j) \hat{S}(t_j - 1)$$

Where $\hat{\lambda}_k(t_j) = D_{kj}/n_j$, $\hat{S}(t_j - 1)$ is the Kaplan-Meier estimate of survival at time t_j-1, D_{kj} is the number of patients failing from cause k at time t_j, and n_j is the number of patients at risk at prior time t_j (Putter et al., 2007).

Adjusted Survival Probabilities

Adjusted survival probabilities are reported in *Reference Section I: Patient Survival,* with age, sex, race, Hispanic ethnicity, and primary cause of ESRD used as adjusting risk factors. The model-based adjustment method is used, with survival probabilities/conditional survival probabilities predicted from the Cox regression model (Kalbfleisch & Prentice, 1980, 2002). This process yields estimates of probabilities that would have arisen in each year if the patients had had the same attributes as the reference population. Since the probabilities in each table are adjusted to the same reference set of patient attributes, any remaining differences among cohorts and years are due to factors other than age, sex, race, Hispanic ethnicity, and primary cause of ESRD. The adjusted mortality rates for incident cohorts in *Reference Section H: Mortality and Causes of Death* are calculated using similar methods.

Generalized Linear Models

Generalized Linear Mixed Model for Mortality Rates

We use the generalized linear mixed model with log link and Poisson distribution to calculate mortality and first transplant rates for prevalent patients. While rates are reported for a year, data from the previous two years with different weights are also used to improve the stability of the estimates.

The generalized linear mixed model, which considers both fixed and random effects, is implemented using the SAS macro GLIMMIX. Rates for the intersections of age, sex, race, and diagnosis are estimated using the log linear equation Log (rate) = (fixed effects) + (random effect). Fixed effects include year, age, sex, race, and primary cause of ESRD, and all two-way interactions among age, sex, race, and primary cause of ESRD. Assumed to be independently and identically distributed with a normal distribution, the random effect is the four-way interaction of age, sex, race, and primary cause of ESRD. Age is used as a categorical variable.

For tables with mortality rates for both intersecting and marginal groups, we have used a single model to calculate all rates in each table. The marginal rates are simply the weighted averages of the estimated, cross-classified rates, with cell-specific patient years as weights. For this approach, the use of a single model means that GLIMMIX cannot give the standard errors for some of these estimated rates; the bootstrap method is, therefore, used instead.

The adjusted mortality rates for prevalent cohorts in *Reference Section H: Mortality and Causes of Death* are calculated using the direct adjustment method based on the category-specific mortality rates from the generalized linear mixed models.

Generalized Linear Model for Hospitalization Rates

In this ADR, hospitalization Reference Tables present rates of total admissions and hospital days. We use a generalized linear model with log link and Poisson distribution; the model includes age, sex, race, primary cause of ESRD, and their two-way interactions.

To stabilize the estimates, three years of data are used with different weights. Year is also included in the model as a covariate. The adjusted hospitalization rates are calculated using the direct adjustment method, based on the category-specific admission rate from the generalized linear models.

Standardized Mortality Ratios

The standardized mortality ratio (SMR) compares the mortality of a group of patients relative to a specific norm, or reference, after adjusting for some important risk factors. For example, the dialysis chain-level SMR is used to compare mortality in prevalent dialysis patients—after adjusting for age, race, ethnicity, sex, DM, duration of ESRD, nursing home status, patient comorbidities at incidence, and BMI at incidence in each dialysis chain. Qualitatively, the degree to which the facility's SMR varies from 1.00 is the degree to which it exceeds (>1.00) or is under (<1.00) the national death rates for patients with the same characteristics as those in the facility. For example, an SMR=1.10 would indicate that the facility's death rates typically exceed national death rates by 10% (e.g., 22 deaths observed where 20 were expected, according to the facility's patient mix). Similarly, an SMR=0.95 would indicate that the facility's death rates are typically 5% below the national death rates (e.g., 19 observed versus 20 expected deaths). An SMR=1.00 would indicate that the facility's death rates equal the national death rates, on average. Note that if multiple years are included in fitting the model, the interpretation of the SMR for a particular year is different depending on whether calendar year is included in the model or not. If calendar year is included as an adjustment, the SMR for a particular year compares facility outcomes to the national average rates for that particular year. On the other hand, if calendar year is not included, the comparison is to the national rates over the entire period included in fitting the model.

Method of SMR Calculation

The SMR is designed to reflect the number of deaths for the patients at a facility, relative to the number of deaths that would be expected based on overall national rates and the characteristics of the patients at that facility. Specifically, the SMR is calculated as the ratio of two numbers; the numerator ("observed") is the actual number of deaths, excluding deaths due to abused drugs and accidents unrelated to treatment, over a specified time period. The denominator ("expected") is the number of deaths that would be expected if patients at that facility died at the national rate for patients with similar characteristics. The expected mortality is calculated from a Cox model (Cox, 1972; SAS Institute Inc., 2004; Kalbfleisch and Prentice, 2002; Collett, 1994). The model used is fit in two stages. The Stage I model is a Cox model stratified by facility and adjusted for patient characteristics. This model allows the baseline survival probabilities to vary between strata (facilities), and assumes that the regression coefficients are the same across all strata. Stratification by facility at this stage avoids biases in estimating regression coefficients that can occur if the covariate distributions vary substantially across centers. The results of this analysis are estimates of the regression coefficients in the Cox model and these provide an estimate of the relative risk for each patient. This is based on a linear predictor that arises from the Cox model, and is then used as an offset in the Stage II model, which is unstratified and includes an adjustment for the race-specific age-adjusted state population death rates.

Standardized Hospitalization Ratios

The Standardized Hospitalization Ratios (SHR) for Admissions is designed to reflect the number of hospital admissions for the patients at a dialysis facility, relative to the number of hospital admissions that would be expected based on overall national rates and the characteristics of the patients at that facility. Numerically, the SHR is calculated as the ratio of two numbers: the numerator ("observed") is the actual number of hospital admissions for the patients in a facility over a specified time period, and the denominator ("expected") is the number of hospital admissions that would have been expected for the same patients if they were in a facility conforming to the national norm.

The denominator of the SHR stems from a proportional rates model (Lawless and Nadeau, 1995; Lin et al., 2000; Kalbfleisch and Prentice, 2002). This is the recurrent event analog of the well-known proportional hazards or Cox model (Cox, 1972; Kalbfleisch and Prentice, 2002). To accommodate large-scale data, we adopt a model with piecewise constant baseline rates (e.g., Cook and Lawless, 2007) and the computational methodology developed in Liu, Schaubel and Kalbfleisch (2012). The modeling process has two stages. At Stage I, a stratified model is fitted to the national data with piecewise-constant baseline rates, stratification by facility and adjusting for age, sex, DM, duration of ESRD, nursing home status, comorbidities at incidence, BMI at incidence, and calendar year. The baseline rate function is assumed to be a step function with break points at 6 months, 1 year, 2 years, 3 years, and 5 years since the onset of dialysis. This model allows the baseline hospitalization rates to vary between strata (facilities), but assumes that the regression coefficients are the same across all strata; this approach is robust to possible differences between facilities in the patient mix being treated. The stratification on facilities is important in this phase to avoid bias due to possible confounding between covariates and facility effects. At Stage II, the relative risk estimates from the first stage are used to create offsets, and an unstratified model is fitted to obtain estimates of an overall baseline rate function.

Expected Remaining Lifetimes

The expected remaining lifetime for a patient group is the average of the remaining life expectancies for the patients in that group. Some patients will live longer than, and some will live less than, the average. Although the average cannot be known until all patients in the cohort have died, the expected remaining lifetime can be projected by assuming that patients in the cohort will die at the same rates as those observed among groups of recently prevalent ESRD patients.

For a subgroup of ESRD patients of a particular age, the expected remaining lifetime is calculated using a survival function, estimated for the group. Let S(A) denote the survival function of patients at age A. Among patients alive at age A, the probability of surviving X more years is $S(X|A) = S(A+X)/S(A)$. For a given starting age A, the expected remaining lifetime is then equal to the area under the curve of S(X|A) plotted versus X. Because few patients live beyond 100, this area is truncated at the upper age limit A + X = 100.

Half-lives (Median Time)

Conditional Half-life

The conditional half-life is conditional on having survived a given period of length T_0 without the event, the point at which 50% of patients who survived the given period remain alive. In other words, it is the median remaining lifetime conditional on surviving a given period T_0.

The conditional half-life is estimated using the Kaplan-Meier method if the median survival time falls in the duration of follow-up. Otherwise, the conditional half-life is estimated as the following:

Estimate the survival probabilities $S(t_0)$ and $S(t_1)$ using the Kaplan-Meier method from the data available, where $t_0<t_1$ and T1 is within the follow-up

$$I_k(t) = \int_0^t \lambda_k(s)S(s)ds$$

the estimate of the conditional half-life = μ·ln(2).

This method can be used only when the hazard is a constant after t_0 and t_1 is chosen to be big enough to obtain a stable estimate of $\ln(S(t_0))-\ln(S(t_1))$.

Mapping Methods

Throughout the ADR, data in maps and graphs are unadjusted unless otherwise noted. Because of area size and limitations in the mapping software, data for Puerto Rico and the U.S. territories are not included in the maps.

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