USRDS
UNITED STATES RENAL DATA SYSTEM

US Renal Data System 2019 Annual Data Report: Epidemiology of Kidney Disease in the United States

EXECUTIVE SUMMARY

Introduction

This year marks the publication of the 30th Annual Data Report (ADR) of the United States Renal Data System (USRDS). Broadly, the mission of the USRDS is to characterize the kidney disease population in the country and serve as a comprehensive, regularly updated, online resource for the descriptive epidemiology of kidney disease in the United States. In addition, supporting investigator initiated research by data provisioning to the community of researchers is one of the key functions of the USRDS. To this end, the USRDS prepares and regularly updates the standard analysis files (SAFs) for researchers, and fulfills data merge requests from researchers or organizations seeking to examine the outcomes of populations of interest with respect to the occurrence of end-stage renal disease (ESRD) and related complications. Last but not least, the USRDS Coordinating Center staff respond to a variety of queries related to kidney disease, ranging from simple to complex, from individuals as well as governmental and non-governmental agencies.

Both federal and non-federal agencies have done much to raise awareness of kidney disease as a significant public health problem. Only few decades ago kidney failure was a fatal disease. When dialysis was developed and made available as a chronic therapy, lack of insurance coverage represented a barrier to treatment. This resulted in the passage of the landmark Medicare ESRD program in 1972 to fund ESRD care for all Americans.

In 1988, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) established the USRDS, the largest and most comprehensive national ESRD surveillance system. The initial USRDS ADRs offered a detailed descriptive epidemiology of ESRD alone. A chapter addressing chronic kidney disease (CKD) was introduced in 2003, and was subsequently expanded into a multi-chapter CKD volume since 2009.

Since 2000, CKD has received increasing attention. The consensus definition and staging classification of CKD from KDOQI was first published in 2002 as the KDOQI Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification, and Stratification. That year also marked the launch of NIDDK's National Kidney Disease Education Program (NKDEP). NKDEP provides information for patients and providers regarding the detection of CKD and care of people with the disease. In 2006, the Centers for Disease Control

and Prevention launched a broad CKD initiative, with the CDC CKD Surveillance System as its major component. This project prioritizes the earlier stages of CKD, as opposed to ESRD, or the late transitions of care from advanced stages of CKD to ESRD.

In the 2019 ADR, we continue to characterize the spectrum of CKD and ESRD patient populations, and describe the distributions of patients by attributes such as age, sex, race, and comorbid conditions.

Our primary audiences are healthcare providers involved in care of patients with kidney disease — nephrologists, transplantation specialists, and general physicians. This report is also of value for healthcare facilities and organizations that provide comprehensive kidney care and renal replacement therapies, and to researchers, policy makers, and service or charitable organizations. We dedicate this work to the individual patients and their families and caregivers whose daily lives are affected by kidney disease.

What's New (or Relatively New) in the 2019 USRDS Annual Data Report

Beginning on October 1, 2015, the newly revised International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) coding system was implemented. Many of our data sources utilize these diagnosis codes to identify specific stages of kidney disease and common comorbid conditions. We continue to build on the challenge of transitioning our data and analyses from ICD-9-CM diagnosis and procedure codes to the ICD-10-CM codes. This has allowed us to provide continuity with the data trends and analyses presented in previous ADRs. In our previous ADRs, CKD and ESRD Analytical Methods chapters include detailed comparisons of the ICD-9-CM and ICD-10-CM diagnosis codes used to define medical conditions in the health insurance claim data files throughout the ADR.

No individual data source exists that captures the disease experiences of all Americans who live with kidney disease. A large proportion of our information is drawn from Medicare beneficiaries; however, they are not a nationally representative population.

As in the 2018 ADR, in the interest of drawing attention to disparities whenever possible, we continue to characterize the ESRD population by race *and* ethnicity categories, as opposed to race *or* ethnicity. In previous ADRs, we considered ethnicity separately from race, based on whether a person was Hispanic, or not. As the Hispanic population in America grows, it becomes more meaningful and accurate to examine separate cohorts of non-Hispanic White, non-Hispanic Black, and Hispanic patients, the majority of whom identify themselves as White. Whenever possible, our race categories match those of the US Census. Census definitions change periodically, most recently in 2000. We report data prior to 2000, but in the 2019 ADR we employ the most recent census categories wherever possible. However, race and ethnicity categorizations are limited by the categorizations available in the source datasets. We were unable to replicate the current census race and ethnicity characterization in the CKD volume for this reason.

Data Sources and Analytical Methods

Originally, the ADR was the product of a stand-alone ESRD database that served as a source of descriptive epidemiology of ESRD patients covering areas such as incidence, prevalence, modality of renal replacement and treatment history, along with biochemical data, dialysis claims, and information on medication use, payer histories, hospitalization events, deaths, physician/supplier services, dialysis providers, and kidney transplantation. The findings presented in the ADR are now drawn from numerous

data types and sources. Details of these are described in the Data Sources sections of the *CKD Analytical Methods* and *ESRD Analytical Methods* chapters in the 2018 ADR. We also describe data preparation and management, variable definition, and the analytical methods used to generate the study cohorts, and produce the statistics, figures, and tables presented in the ADR.

Renal Data Extraction and Referencing (RenDER) System

The USRDS Renal Data Extraction and Referencing (RenDER) System is an online data querying application available through the USRDS website, allowing access to a wealth of information regarding ESRD in the United States. It quickly returns an accurate table of data or interactive map based upon the user's query specifications. Tables can then be copied into a spreadsheet application on the user's computer for further manipulation and investigation. Map images can be copied or saved to local applications. In addition, a dBase file of the data, which can be opened in MS Excel, is also offered for download.

Summary of Data Sources

The majority of USRDS analyses employ claims-based and enrollment data obtained from the Centers for Medicare & Medicaid Services (CMS). Files for Medicare Parts A and B contain billing data from final action claims submitted for Medicare beneficiaries in which all adjustments have been resolved. The Medicare Prescription Drug Event File includes data submitted by health plans whenever a Medicare beneficiary fills a prescription; Part D coverage data has been available since its introduction in 2006.

For patients with CKD, acute kidney injury, and related comorbidities, analyses are performed on the Medicare 5% sample. These Standard Analytical Files (SAFs) are a random sample of 5% of the entire Medicare population. Medicare ESRD Claims SAFs contain data from claims for medical services provided to Medicare beneficiaries with ESRD. Institutional claims include those for inpatient, outpatient, skilled nursing facility, home health agency, and hospice services. Non-institutional claims include those for physicians and suppliers, and for durable medical equipment.

The Medicare Enrollment Database (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 and employer group health plan status, and Health Insurance Claim/Beneficiary Identification Code cross-referencing.

Other CMS data files consist of information submitted through ESRD specific forms completed by providers or facilities. These include the Medical Evidence form (CMS 2728), used to register patients at the onset of ESRD, the Death Notification form (CMS 2746), and the Facility Survey form (CMS 2744). The latter reports the counts of patients being treated at the end of the year, new ESRD patients starting treatment during the year, and patients who died during the year. Both Medicare and non-Medicare end-of-year patients are counted. CMS Dialysis Facility Compare data define corporation name and ownership type for each renal facility.

CROWNWeb is a web-based data collection system that was implemented nationally in May 2012. It captures clinical and administrative data from Medicare-certified dialysis facilities for all ESRD patients.

CDC National Surveillance Data was collected during 1993-1997 and 1999-2002. It was a non-patient specific survey of dialysis facilities on patient and staff counts, membrane types, reuse practices, water treatment methods, therapy types, vascular access use, antibiotic use, hepatitis vaccination, and conversion rates (for both staff and patients), as well as the incidence of HIV, AIDS, and tuberculosis.

Population data are from the 2000 and 2010 United States Census, and incorporate CDC postcensal and intercensal population estimates. USRDS summarizes the data with different race and ethnicity categories at state and national levels.

SECTION 1: CHRONIC KIDNEY DISEASE IN THE UNITED STATES

This section of the 2019 USRDS ADR provides an analysis of chronic kidney disease (CKD) in the United States. It includes the following topics as a road map to the early stages of kidney disease: *Identification and Care of Patients with CKD* and *Healthcare Expenditures for Persons with CKD*.

Through the analyses and investigations in these sections, we tell the story of CKD — one that is important not only to the domestic and international renal communities, but for the general population as well. It is important for everyone to understand and care about the growing implications of kidney disease. This executive summary synthesizes a wealth of data and describe how this often silent condition can be recognized. Throughout these sections, we present status and trends. We discuss risk prediction and prevention, disease management, and opportunities to slow disease progression. We discuss the interactions with common comorbid conditions and emphasize the need for interventions before reaching the often-irreversible need for renal replacement therapy.

Identification and Care of Patients with CKD

Patient Characteristics across Datasets

Table 1 provides the prevalence of recognized CKD, DM, and cardiovascular comorbid conditions among patients aged 65 and older in the Medicare population. Among this population, recognized (i.e., coded diagnosis of) CKD was observed in 14.5%. Over half of the Medicare cohort (53.4%) had at least one of these comorbid conditions, 20.2% had two or more, and 5.0% had all three.

Table 1: Prevalence of comorbid conditions by diagnosis codes (CKD, CVD, & DM), (a) total & (b) one or more, among Medicare patients aged 65+ years, 2017

(a) Any diagnosis of CKD, CVD, or DM

	Medicare 5%	
	Sample count	%
All	1,291,640	100
Total CKD	186,997	14.5
Total CVD	519,595	40.2
Total DM	309,510	24.0

(b) Combinations of CKD, CVD, or DM diagnoses

	Medicare 5%	
	Sample count	%
All	1,291,640	100
Only CKD	34,587	2.7
Only CVD	283,202	21.9
Only DM	110,487	8.6
CKD & DM, no CVD	25,109	1.9
CKD & CVD, no DM	62,479	4.8
DM & CVD, no CKD	109,092	8.4
CKD & CVD & DM	64,822	5.0
At least one comorbidity	689,778	53.4
At least two comorbidities	261,502	20.2
No CKD, no CVD, no DM	601,862	46.6

Data Source: Special analyses, Medicare 5% sample (aged 65 and older alive & eligible for all of 2017). Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus. CVD is defined as presence of any of the following comorbidities: cerebrovascular accident, peripheral vascular disease, atherosclerotic heart disease, congestive heart failure, dysrhythmia or other cardiac comorbidities.

Comparison of CKD Prevalence across Datasets

Table 2 presents the prevalence of recognized CKD by demographic characteristics in the Medicare (aged 65 years and older) population, overall and with DM or HTN. The prevalence of recognized CKD increased with age from 10.5% at ages 65–74 to 23.9% at age 85 and older in the Medicare data. Males had slightly higher prevalence than females.

The prevalence of recognized CKD among Blacks/African Americans (hereafter, Blacks) was higher than among Whites in the Medicare population. Results from adjusted analyses of the Medicare dataset (data not shown) confirm greater odds of recognized CKD in older patients, Blacks, and those with DM, HTN, or cardiovascular disease. As expected, the prevalence of recognized CKD was higher among those with a diagnosis of DM or HTN.

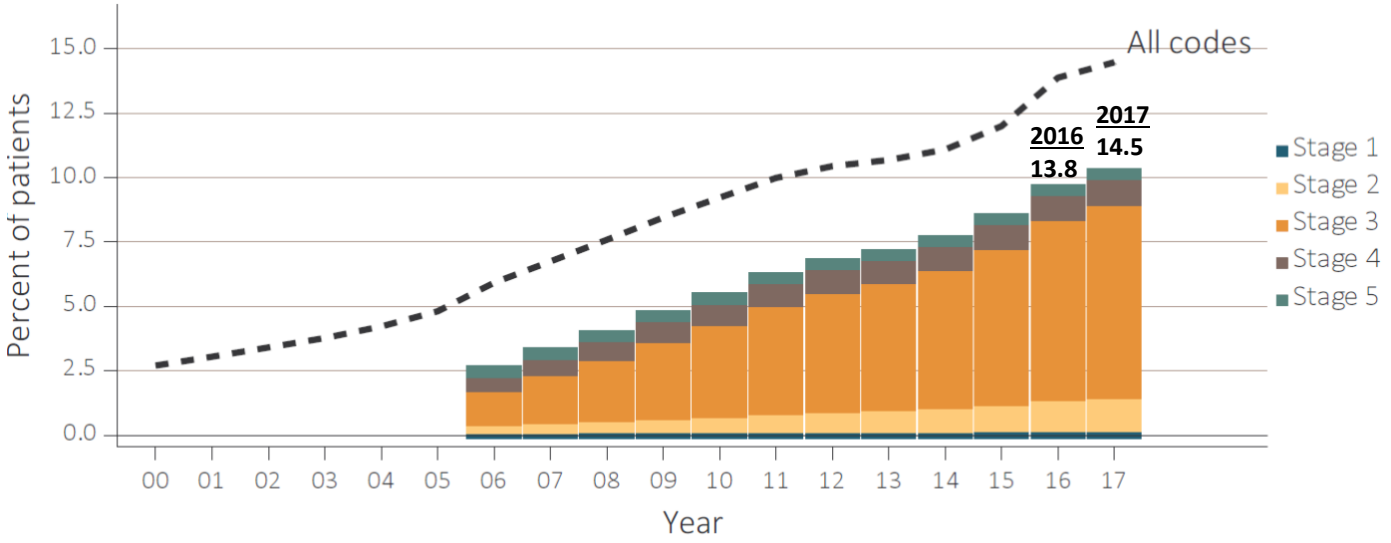
Table 2: Prevalence of CKD, by demographic characteristics and comorbidities, among Medicare 5% patients aged 65+ years, overall, and with diabetes mellitus or hypertension, 2017

	All	Diabetes (with or without hypertension)	Hypertension (without diabetes)
Overall	14.5	29.1	16.3
Age			
65-74	10.5	24.1	11.7
75-84	18.1	33.4	18.2
85+	23.9	39.6	25.5
Sex	.	.	.
Male	16.2	31.2	18.8
Female	13.1	27.1	14.6
Race/Ethnicity	.	.	.
White	14.2	29.0	16.2
Black/African American	19.3	32.3	19.5
Native American	14.6	25.9	14.9
Asian	14.5	27.8	15.1
Hispanic	13.6	26.3	15.1
Other/Unknown	8.5	21.0	10.6

Data Source: Special analyses, Medicare 5% sample, aged 65 and older, alive & eligible for all of 2017. Abbreviation: CKD, chronic kidney disease

Figure 1 shows the 2000-2017 trend in prevalence of recognized CKD overall and by CKD stage-specific code among Medicare patients. The prevalence of recognized CKD has steadily risen each year, accompanied by a comparable increase in the percentage of patients with a stage-specific CKD diagnosis code. There was a particularly sharp increase in 2016 versus 2015, possibly related to the switch to the ICD-10 diagnosis coding system which occurred on October 1, 2015. From 2016- 2017, the proportion of Medicare patients with recognized CKD increased from 13.8% to 14.5%.

Figure 1: Trends in prevalence of recognized CKD, overall and by CKD stage, among Medicare patients (aged 65+ years), 2000-2017



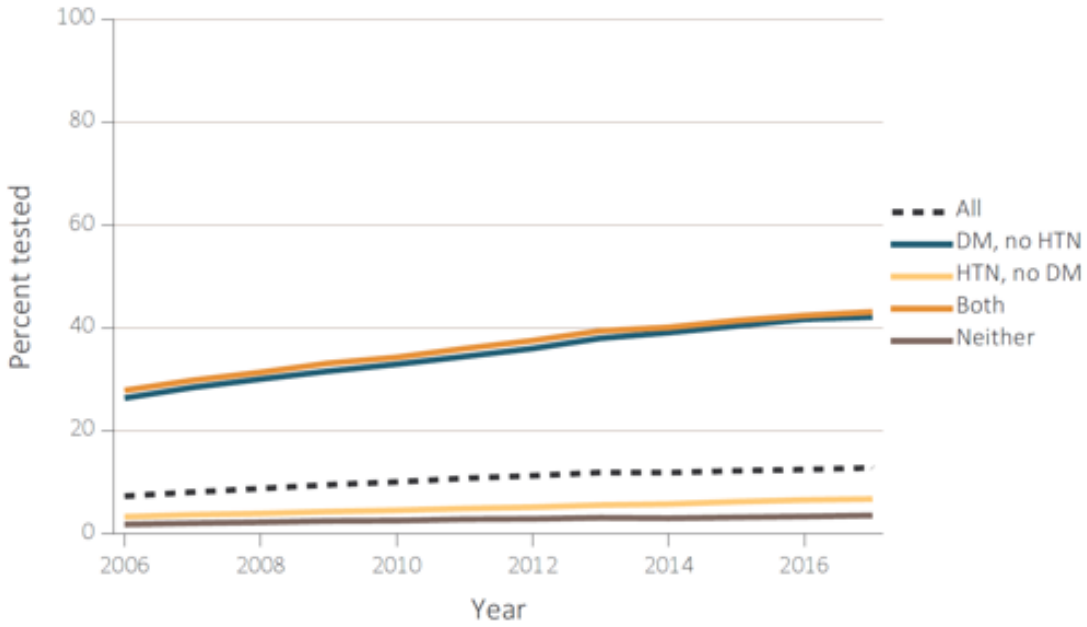
Data Source: Special analyses, Medicare 5% sample. Known CKD stages presented as bars; curve showing "All codes" includes known CKD stages (ICD-9 codes 585.1-585.5 or ICD-10 codes N18.1-N18.5) and the CKD-stage unspecified codes (ICD-9 code 585.9, ICD-10 code N18.9 and remaining non-stage specific CKD codes). For years 2000-2015, ICD-9 codes are used to identify CKD; additionally, starting October 1, 2015, ICD-10 codes are used to identify CKD. Note: In previous years, this graph reported 585.9 codes as a component of the stacked bars. Abbreviation: CKD, chronic kidney disease.

Laboratory Testing of Patients with and without CKD

As shown in **Figure 2,** 12.9% of Medicare patients aged 65 and over without diagnosed CKD received urine albumin testing in 2017. Assessment of urine protein was also included in these percentages, representing approximately 20% of the testing performed. Among Medicare patients, 42.2% with DM alone had urine albumin testing, compared to 6.8% of patients with HTN alone.

Having both DM and HTN is known to increase the likelihood of developing CKD. Among Medicare beneficiaries without a CKD diagnosis but with both DM and HTN, 43.2% had urine albumin testing in 2017.

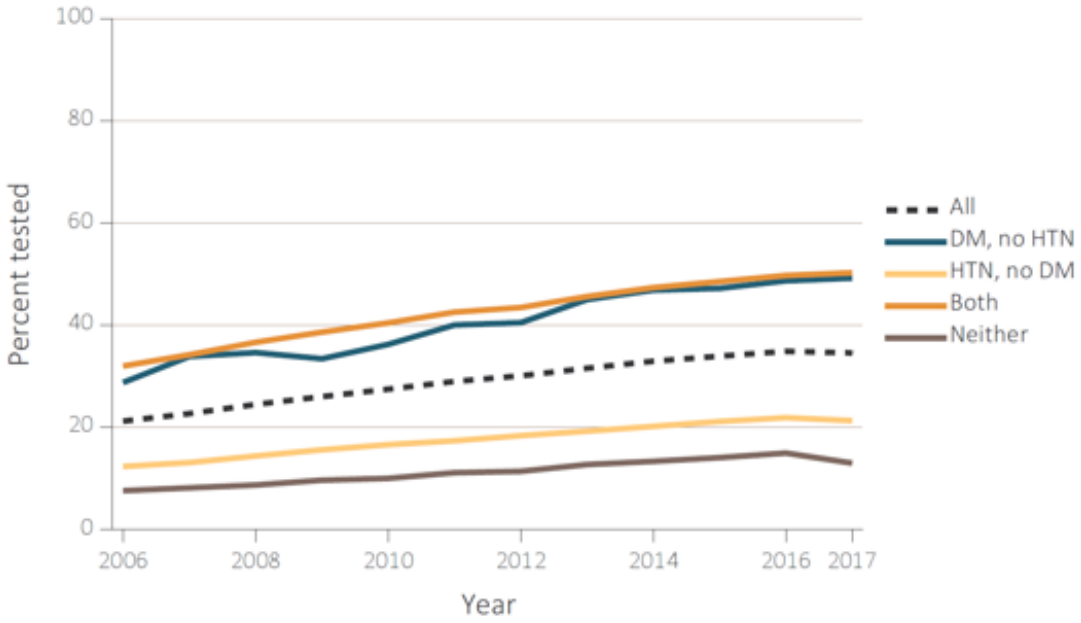
Figure 2: Trends in percent of patients with testing of urine albumin among patients without a diagnosis of CKD in the Medicare 5% sample, aged 65+ years, by year from 2006 to 2017



Data Source: Special analyses, Medicare 5% sample aged 65 and older with Part A & B coverage in the prior. Tests tracked during each year. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension.

As shown in **Figure 3**, patients with a diagnosis of CKD were tested for urine albumin at similar, though somewhat higher rates, than patients without CKD. In 2017, patients with the combined diagnoses of CKD, DM, and HTN, were tested for urine albumin in 50.3% of the Medicare population.

Figure 3: Trends in percent of patients with testing of urine albumin among patients with a diagnosis of CKD in the Medicare 5% sample, aged 65+ years, by year from 2006-2017



Data Source: Special analyses, Medicare 5% sample (aged 65 and older) with Part A & B coverage in the prior year. Tests tracked during each year. Abbreviations: CKD, chronic kidney disease, DM, diabetes mellitus, HTN, hypertension.

Healthcare Expenditures for Persons with CKD

Medicare spending for all beneficiaries who had CKD (12.5% of total) exceeded $84 billion in 2017, an increase of 6.3% from 2016 (**Tables 3** and **4**). When adding an additional $36 billion for end-stage renal disease (ESRD) costs (see **Figure 20**), total Medicare spending on both CKD and ESRD was over $120 billion, representing 33.8% of total Medicare fee-for-service (FFS) spending. Medicare spending for beneficiaries with CKD who were younger than age 65 (8% of total) exceeded $12 billion in 2017, representing 18% of total spending in this age group (**Table 4**). Growth in total CKD spending has primarily been driven by an increase in the number of identified cases, particularly those in the earlier stages (CKD Stages 1-3). Spending per patient-year for those with all three chronic conditions of CKD, DM, and HF was more than twice as high ($40,516) as for beneficiaries with only CKD ($16,112; **Table 3**). The analysis of expenses for beneficiaries with CKD indicates the effect of cost-containment efforts in this population, and avenues for potential savings. Reduction in expenditures could be achieved through the prevention of disease progression to later stages of CKD, and prevention of the development of concurrent chronic conditions such as DM and HF.

Spending for CKD and Related Chronic Comorbidities

Beneficiaries Aged 65 and Older

Examining FFS Medicare spending reinforces CKD's reputation as a cost multiplier. Beneficiaries with recognized CKD represent 14% of the point prevalent aged Medicare population, yet accounted for 25% of total expenditures (**Table 3**).

We examined 2017 costs in relation to beneficiaries' CKD stage, age, sex, race, and concurrent disease, focusing on DM and HF. These conditions, in addition to CKD, represent some of the costliest chronic disease populations for Medicare. For example, HF affects 9% of beneficiaries in the FFS Medicare population, but accounts for 20% of expenditures. Thirty-five percent of overall expenditures were directed toward the 24% of beneficiaries with DM.

In those aged 65 and older, per-person per-year (PPPY) costs were 87% higher for patients with CKD only, versus those with no CKD, DM, or HF ($16,112 vs $8,620). Costs for those with CKD and DM were 51% higher than for those with DM only. Similarly, expenditures for those with CKD and HF were 47% higher than for those with HF alone. For beneficiaries with CKD, HF, and DM, costs were 43% higher than for those with only HF and DM. Overall, people with diagnoses of any condition of CKD, DM, and/or HF accounted for one-third of the Medicare aged 65 and older population, but over half of total programmatic costs.

Table 3: Prevalent Medicare fee-for-service patient counts and spending for beneficiaries aged 65 and older, by diabetes, heart failure, and/or CKD, ESRD excluded, 2017

	US Medicare Population	Total Spending (millions, US $)	PPPY (US $)	Population (%)	Spending (%)
All	24,749,640	286,506	11,961	100	100
With HF or CKD or DM	8,621,660	150,543	18,402	34.84	52.54
CKD only (- DM & HF)	1,401,980	21,595	16,112	5.67	7.54
DM only (- HF & CKD)	3,860,720	48,990	13,047	15.60	17.10
HF only (- DM & CKD)	855,720	17,569	22,202	3.46	6.13
CKD and DM only (- HF)	1,146,700	21,574	19,739	4.63	7.53
CKD and HF only (- DM)	395,680	11,141	32,536	1.60	3.89
DM and HF only (- CKD)	453,740	11,856	28,276	1.83	4.14
CKD and HF and DM	507,120	17,818	40,516	2.05	6.22
No CKD or DM or HF	16,127,980	135,963	8,620	65.17	47.46
All CKD (+/- DM & HF)	3,451,480	72,127	22,431	13.95	25.17
All DM (+/- CKD & HF)	5,968,280	100,238	17,564	24.12	34.99
All HF (+/- DM & CKD)	2,212,260	58,384	29,297	8.94	20.38
CKD and DM (+/- HF)	1,653,820	39,391	25,700	6.68	13.75
CKD and HF (+/- DM)	902,800	28,959	37,022	3.65	10.11
DM and HF (+/- CKD)	960,860	29,674	34,542	3.88	10.36

Data Source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; HF, heart failure; DM, diabetes mellitus; PPPY, per-person per-year.

Over time FFS Medicare beneficiaries aged 65 and older with recognized CKD have accounted for an increasing share of Medicare expenditures, expanding from 14.2% in 2008 to 25% in 2017. Much of this growth was due to the increased ascertainment of CKD as shown in Identification and Care of Patients with CKD, **Figure 1**. Persons aged 65 and older with CKD accounted for 7.6% and 14. 5% of the FFS Medicare population in 2008 and 2017, respectively.

Figure 4 presents total expenditures on Parts A, B, and D services for Medicare FFS beneficiaries with CKD, DM, and HF aged 65 and older. In 2017, expenditures for CKD patients reached $72 billion, accounting for 25% of the total spending for all FFS Medicare beneficiaries aged 65 and older. Care of beneficiaries with CKD and concurrent DM required $39 billion in 2017, or 39% of the total FFS Medicare spending on beneficiaries with DM. Spending on HF in the FFS Medicare population was $58 billion in 2017. Of this, $29 billion (50%) was spent on the CKD patient population with HF. Medicare expenditures for CKD were 20% higher in 2017 ($72 billion) than in 2016 ($62 billion). This was mostly due to an 18% increase in the ascertainment of CKD. The reason for this increase is not known, although 2016-2017 represented a change in coding (ICD-9 to ICD-10).

Figure 4: Overall Medicare Parts A, B, and D fee-for-service spending for general Medicare population aged 65 and older and for those with CKD, ESRD excluded, 2008-2017

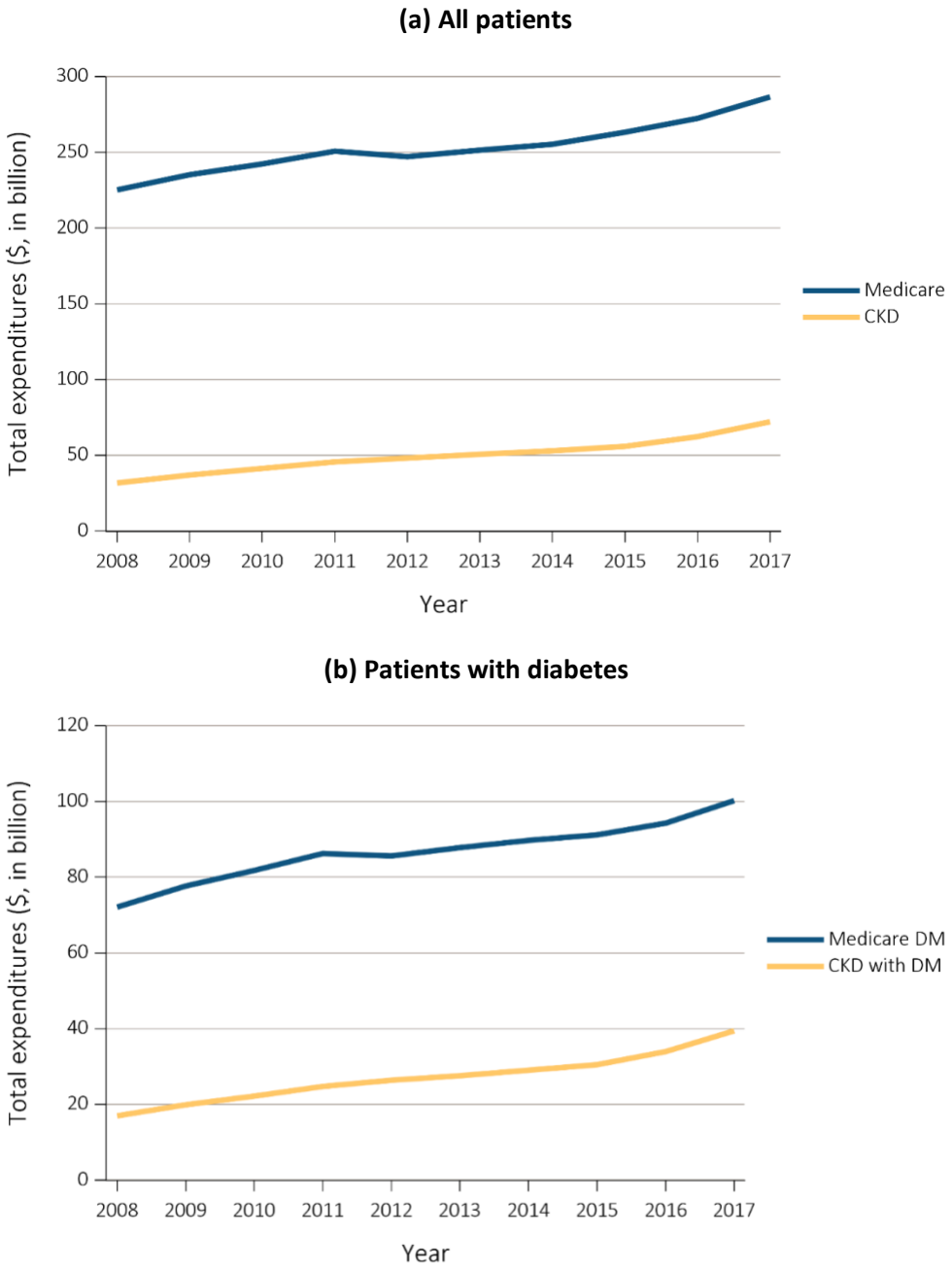
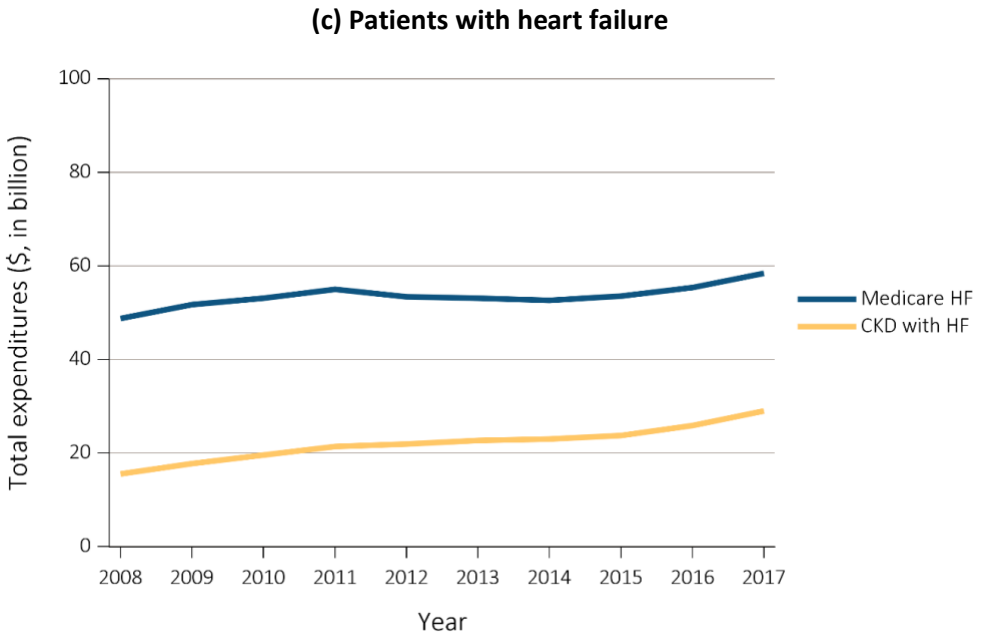


Figure 4 *continued on next page.*

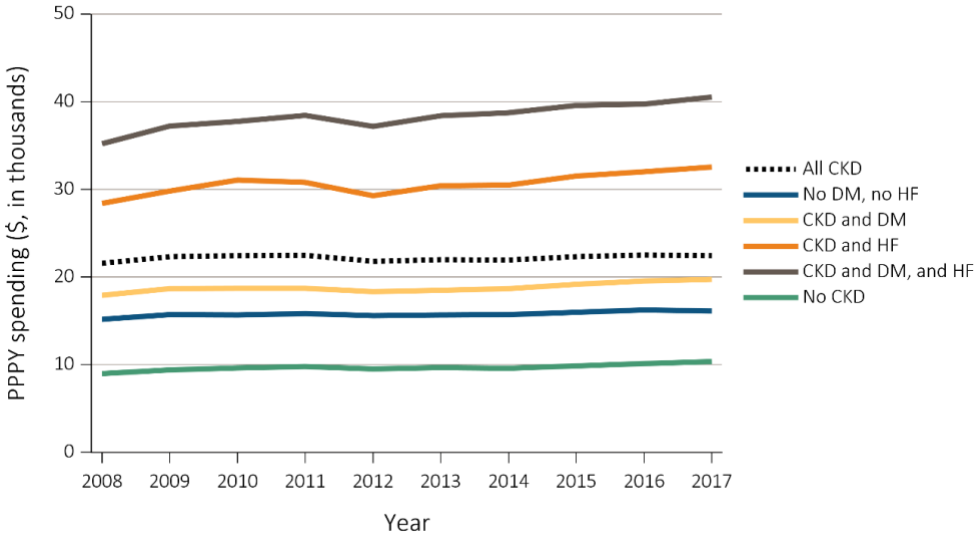
Figure 4, continued: Overall Medicare Parts A, B, and D fee-for-service spending for general Medicare population aged 65 and older and for those with CKD, ESRD excluded, 2008-2017



Data Source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease; HF, heart failure.

Figure 5 illustrates PPPY costs for CKD patients aged 65 and older by the presence of DM and HF. In 2017, PPPY costs for CKD patients varied greatly by the presence of these comorbidities. CKD patients without DM and HF required $16,112 PPPY from FFS Medicare. Those with DM in addition to CKD averaged $19,739 PPPY, and beneficiaries with both CKD and HF cost $32,536. Expenditures for those with all three conditions reached $40,516 PPPY in 2017 for FFS Medicare. Spending was also higher as comorbidities increased in the managed care populations.

Figure 5: Per-person per-year Medicare fee-for-service, spending for CKD patients aged 65 and older, by diabetes and heart failure, ESRD excluded, 2008-2017



Data Source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease; HF, heart failure; PPPY, per person per year.

Beneficiaries Younger than Age 65

For the FFS Medicare population under age 65 only 8% had CKD, but those individuals accounted for 18% of spending. Twenty-eight percent had one or more of CKD, DM, and/or HF, accounting for almost 46% of spending for this group (**Table 4**). Much of these expenditures, however, were for those who had DM, at 22% of the population and 35% of spending.

Table 4: Prevalent Medicare fee-for-service patient counts and spending for beneficiaries younger than age 65, by diabetes, heart failure, and/or CKD, ESRD excluded, 2017

	US Medicare Population	Total Costs (millions, US $)	PPPY spending (US $)	Population (%)	Spending (%)
All	4,673,160	67,829	15,131	100	100
With HF or CKD or DM	1,313,580	30,902	24,805	28.11	45.56
CKD only (- DM & HF)	147,260	3,594	25,649	3.15	5.30
DM only (- HF & CKD)	754,560	13,801	19,077	16.15	20.35
HF only (- DM & CKD)	97,780	2,540	27,601	2.09	3.74
CKD and DM only (- HF)	149,040	4,284	30,586	3.19	6.32
CKD and HF only (- DM)	26,840	1,137	46,516	0.57	1.68
DM and HF only (- CKD)	77,420	2,505	34,761	1.66	3.69
CKD and HF and DM	60,680	3,042	56,684	1.30	4.48
No CKD or DM or HF	3,359,580	36,927	11,408	71.89	54.44
All CKD (+/- DM & HF)	383,820	12,057	33,650	8.21	17.78
All DM (+/- CKD & HF)	1,041,700	23,631	23,889	22.29	34.84
All HF (+/- DM & CKD)	262,720	9,223	38,085	5.62	13.60
CKD and DM (+/- HF)	209,720	7,326	37,815	4.49	10.80
CKD and HF (+/- DM)	87,520	4,179	53,503	1.87	6.16
DM and HF (+/- CKD)	138,100	5,547	44,119	2.96	8.18

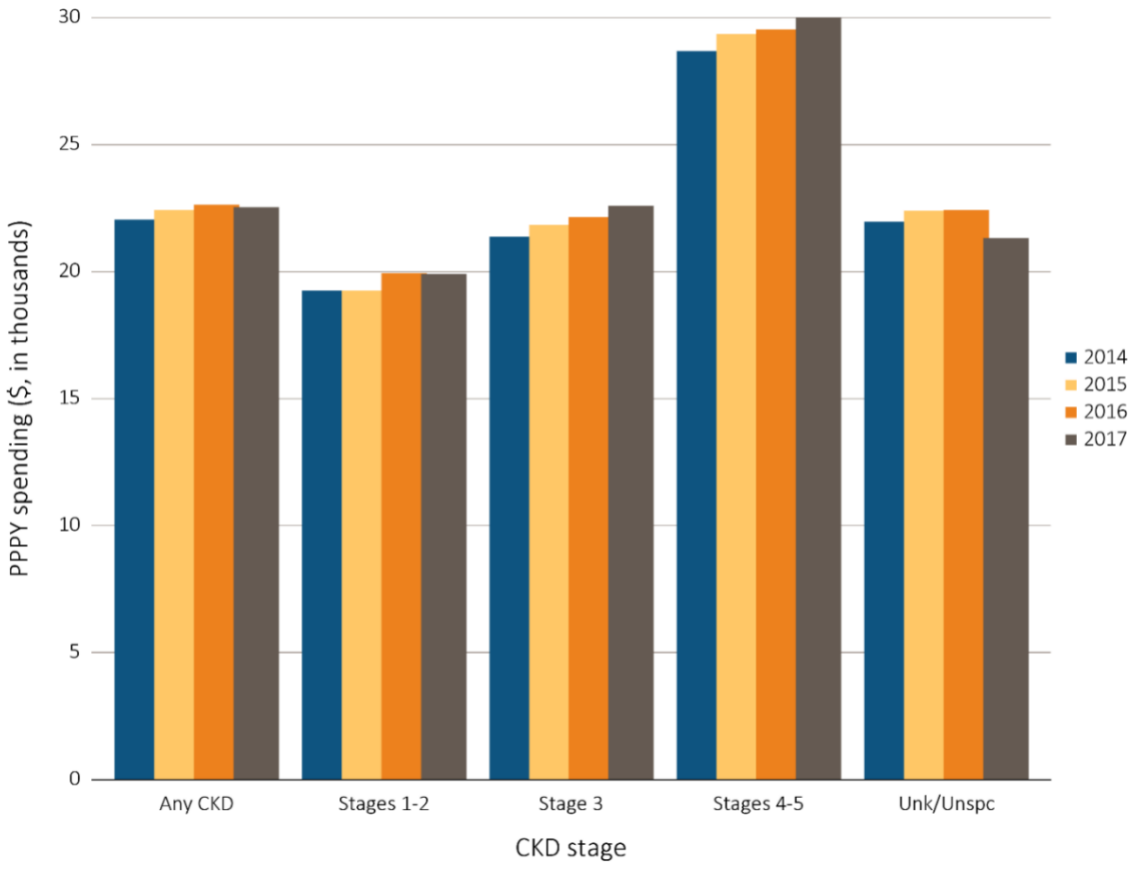
Data Source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease; HF, heart failure; PPPY, per-person per-year.

Spending for CKD by Stage and Patient Characteristics

All CKD patients 65 and older required increased care as they progressed to later stages of disease (**Figure 6**). In the FFS Medicare population, PPPY expenditures in 2016 ranged from $19,799 for those in Stages 1-2, to $30,640 for those in Stages 4-5.

Group trends in PPPY spending from 2014-2017 were mixed (**Figure 6**). FFS Medicare saw PPPY expenditures increase 2.2% overall for individuals with any CKD, but the increase was most dramatic for those in Stages 4-5, rising by 7%.

Figure 6: Overall per-person per-year spending for beneficiaries aged 65 and older, by CKD stage, and year, ESRD excluded, 2013-2016, Medicare fee-for service



Data Source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; PPPY, per-person per-year; Unk/Unspc, CKD stage unknown or unspecified.

Table 5 presents PPPY Medicare FFS spending for Parts A, B, and D services, for beneficiaries with CKD (but not ESRD), by stage of CKD. In 2017, PPPY costs reached $22,431 for FFS Medicare CKD patients aged 65 and older, a slight decrease from 2016 ($22,530). During this period, the distribution of identified patient-years also shifted towards the less severe and less costly stages. In 2017, costs for beneficiaries with Stages 4-5 CKD ($30,641) were 55% greater than for beneficiaries with Stages 1-2 CKD ($19,799). The number of

beneficiaries with unknown/unspecified CKD stage increased to over 1 million and accounted for 31% of all cases of CKD. The PPPY costs for those unknown/unspecified were slightly below those for the overall CKD population.

Spending for Black beneficiaries with CKD exceeded that for Whites by 10%, a slight increase over the 9.4% disparity observed in 2016.

Table 5: Per-person-per year Medicare Parts A, B, and D fee-for-service spending for all CKD beneficiaries aged 65 and older, by CKD stage, age, sex, and race, ESRD excluded, 2016 & 2017

	2016					2017				
	Any CKD	Stages 1-2	Stage 3	Stages 4-5	Unk/ Unspc	Any CKD	Stages 1-2	Stage 3	Stages 4-5	Unk/ Unspc
Patient years at risk	2,764,732	303,481	1,402,548	243,585	815,118	3,215,456	348,943	1,617,631	248,516	1,000,366
All patients	$22,530	$19,831	$22,040	$29,432	$22,316	$22,431	$19,799	$22,489	$30,641	$21,218
Age										
65-69	$21,691	$18,582	$21,969	$31,374	$20,594	$21,247	$18,239	$22,676	$33,265	$18,925
70-74	$21,378	$17,927	$21,136	$29,124	$21,314	$20,884	$18,276	$21,179	$30,883	$19,634
75-79	$22,216	$19,629	$21,634	$30,112	$22,054	$22,181	$19,255	$21,983	$30,859	$21,560
80-84	$22,674	$20,701	$21,804	$29,176	$22,874	$22,820	$20,652	$22,216	$30,242	$22,513
85+	$24,171	$22,745	$23,266	$28,582	$24,583	$24,671	$23,213	$24,014	$29,520	$24,666
Sex										
Male	$22,320	$19,759	$22,091	$29,633	$21,650	$22,306	$19,950	$22,710	$30,198	$20,791
Female	$22,724	$19,900	$21,993	$29,267	$22,956	$22,553	$19,651	$22,285	$31,005	$21,682
Race										
White	$22,316	$19,808	$21,905	$28,578	$22,138	$22,193	$19,873	$22,257	$30,091	$21,027
Black/African American	$24,417	$20,232	$23,288	$34,290	$24,251	$24,437	$19,724	$24,135	$33,301	$23,749
Other	$22,341	$19,397	$21,878	$30,033	$21,940	$22,502	$19,127	$23,031	$31,832	$20,651

Data source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Unk/Unspc, CKD stage unknown or unspecified.

Table 6 presents PPPY spending for beneficiaries with both CKD and DM. Among the 2017 FFS Medicare beneficiaries with these two conditions, PPPY spending for Blacks was $27,551 — 8.5% greater than the $25,398 incurred for Whites.

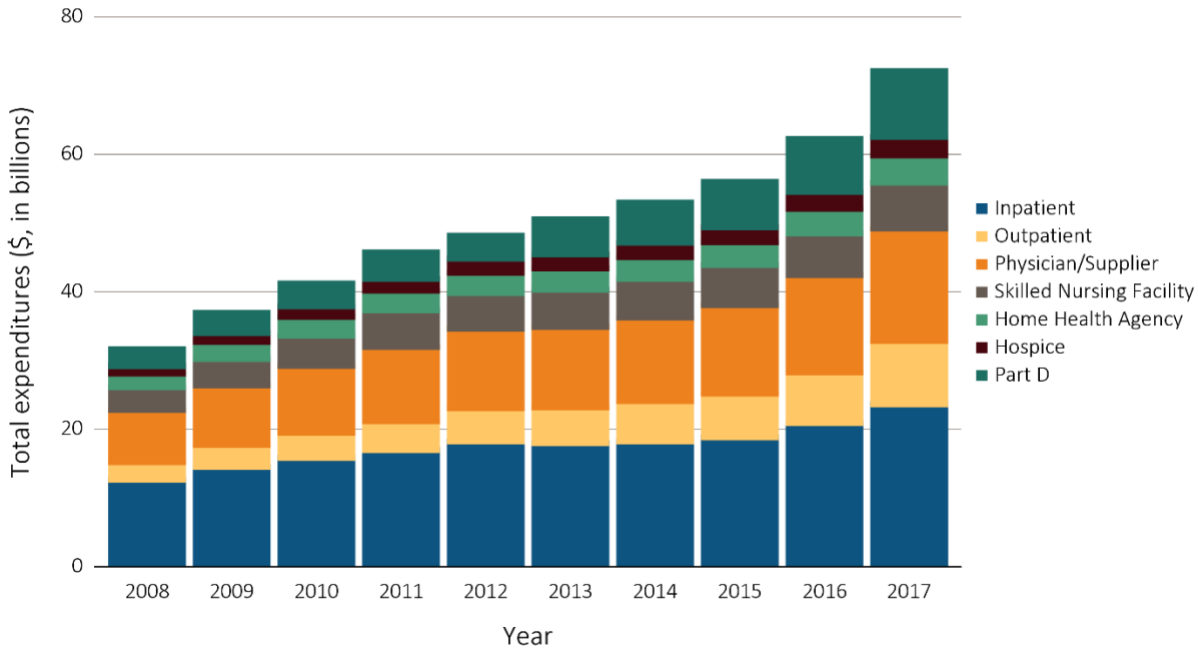
Table 6: Per-person per-year Medicare Parts A, B, and D fee-for-service spending for CKD patients with diabetes, aged 65 and older, by CKD stage, age, sex, and race, ESRD excluded, 2016 & 2017

	2016					2017				
	Any CKD	Stages 1-2	Stage 3	Stages 4-5	Unk/ Unspc	Any CKD	Stages 1-2	Stage 3	Stages 4-5	Unk/ Unspc
Patient years at risk	1,326,783	149,136	674,218	128,867	374,562	1,532,711	173,012	775,963	134,507	449,229
All patients	$25,582	$22,770	$25,339	$32,873	$24,631	$25,700	$22,157	$26,171	$34,348	$23,664
Age										
65-69	$25,052	$22,228	$25,708	$34,159	$22,998	$25,084	$20,898	$26,615	$36,823	$22,277
70-74	$24,466	$20,698	$24,618	$32,017	$23,682	$24,356	$20,667	$25,222	$34,622	$22,063
75-79	$25,514	$22,108	$25,037	$33,670	$25,011	$25,474	$21,596	$25,660	$34,760	$23,896
80-84	$25,916	$24,048	$25,287	$32,019	$25,377	$25,881	$22,787	$25,995	$31,895	$24,528
85+	$27,168	$26,658	$26,249	$32,737	$26,624	$28,183	$26,785	$27,649	$34,244	$27,177
Sex										
Male	$24,803	$22,420	$24,719	$32,411	$23,542	$25,141	$21,878	$25,942	$33,435	$22,910
Female	$26,366	$23,149	$25,971	$33,266	$25,729	$26,280	$22,463	$26,403	$35,119	$24,505
Race										
White	$25,444	$22,836	$25,301	$32,168	$24,519	$25,398	$22,371	$25,830	$33,865	$23,407
Black/African American	$26,985	$22,477	$25,896	$36,332	$26,753	$27,551	$21,260	$27,662	$37,502	$25,848
Other	$24,741	$22,645	$24,834	$32,710	$22,748	$25,901	$21,668	$27,406	$32,761	$23,430

Data source: Medicare 5% sample. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Unk/Unspc, CKD stage unknown or unspecified.

Most spending for CKD patients was incurred for inpatient and outpatient care, physician/supplier services, and care in skilled nursing facilities. Spending for Part D increased a great deal in recent years. FFS Medicare expenditures for beneficiaries with CKD in 2017 included 33% for inpatient care, 23% for physician/supplier services, 13% for outpatient care, 9.3% on for skilled nursing facilities, and 13% for Part D (**Figure 7**). In the Medicare non-CKD population, these expenditure percentages were 29% to provide inpatient care, 27% for physician/supplier services, 16% for outpatient, and 7% for skilled nursing facility care (not shown).

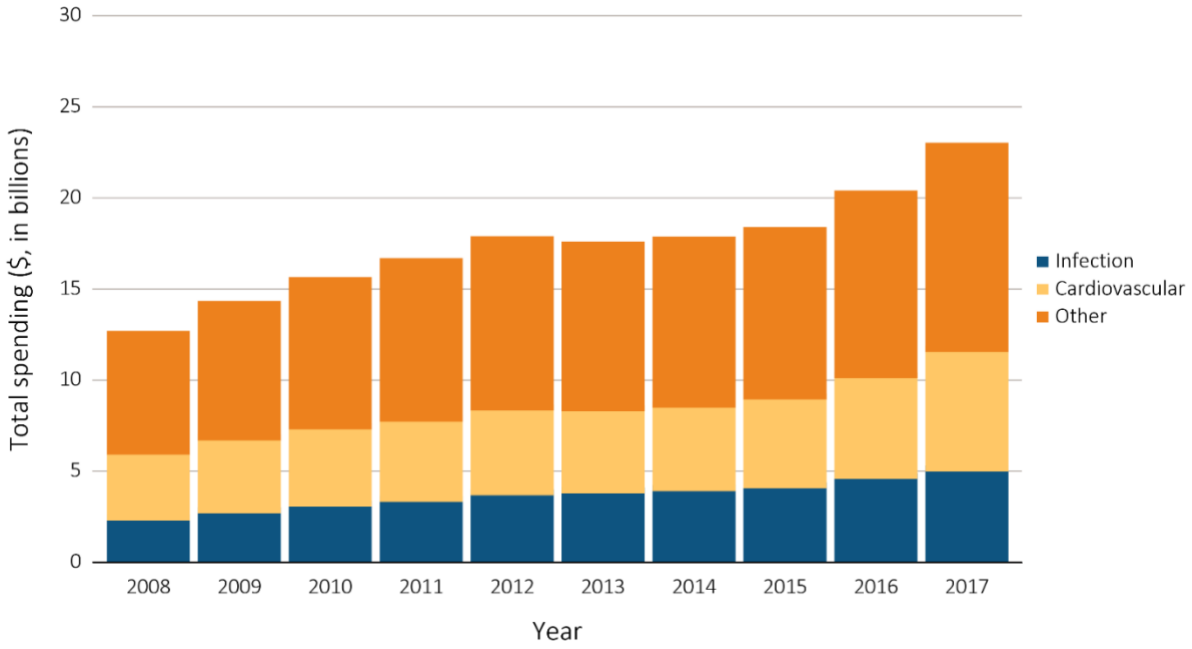
Figure 7: Trends in total Medicare Parts A, B, and D fee-for-service spending for CKD patients aged 65 and older, by claim type, ESRD excluded, 2008-2017



Data source: Medicare 5% sample. Part D data occurring since 2006. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease.

Hospitalization expenditures accounted for a large proportion of spending for CKD. Of the 2017 inpatient hospitalization spending for those with CKD, 22% resulted from admissions to treat infections, and 29% from cardiovascular conditions, with the remaining 49% resulting from all other causes (**Figure 8**).

Figure 8: Total Medicare fee-for-service inpatient spending for CKD patients aged 65 and older, by cause of hospitalization, ESRD excluded, 2008-2017



Data source: Medicare 5% sample. Part D data occurring since 2006. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease.

SECTION 2: END-STAGE RENAL DISEASE IN THE UNITED STATES

Section 2 of the 2019 ADR provides key statistics on end-stage renal disease (ESRD) in the United States and includes the following topics: *Incidence, Prevalence, Patient Characteristics, and Treatment Modalities*; *Vascular Access*; *Mortality; Transplantation, Healthcare Expenditures for Persons with ESRD,* and *ESRD Among Children, Adolescents, and Young Adults.*

Incidence, Prevalence, Patient Characteristics, and Treatment Modalities

INCIDENCE

- After plateauing in the 2000s, the crude incidence rate of ESRD rose from 2011 to 2015 and has been stable since, while the standardized rate has declined slightly since its peak in 2006 (Figure 9).
- In 2017, there were 124,500 newly reported cases of ESRD; the unadjusted (crude) incidence rate was 370.2 per million/year in the US population (Table 7).

PREVALENCE

- The number of prevalent ESRD cases has continued to rise by about 20,000 cases per year (Table 8). In contrast to the standardized incidence rate trend (Table 7), the age-sex-race-standardized prevalence of ESRD has continued to increase since 2006 (Table 8).
- On December 31, 2017, there were 746,557 prevalent cases of ESRD; the crude prevalence (proportion) was 2,204 per million in the US population (Table 8).

CHARACTERISTICS OF INCIDENT ESRD CASES

- In 2017, 33.4% of incident ESRD patients had received little or no pre-ESRD nephrology care (Table 11.a).

TREATMENT MODALITIES

- In 2017, 86.9% of incident ESRD patients began renal replacement therapy with hemodialysis (HD), 10.1% started with peritoneal dialysis (PD), and 2.9% received a preemptive kidney transplant (Figure 10).
- On December 31, 2017, 62.7% of all prevalent ESRD patients were receiving HD therapy, 7.1% were being treated with PD, and 29.9% had a functioning kidney transplant (Figure 12). Among patients being treated with HD, 98.0% used in-center HD, and 2.0% used home HD (*Reference Table D.1*).

INCIDENCE OF ESRD: COUNTS, RATES, AND TRENDS

Overall Incidence Counts and Rate

In 2017, there were 124,500 incident cases of ESRD in the United States; the crude incidence rate was 370.2 per million/year. After a year-by-year rise in the number of incident ESRD cases from 1980 through 2000, the count plateaued between 2007 and 2011 but rose again from 2012 to 2017. **Table 7** and **Figure 9** provide the annual counts and crude and age-sex-race standardized incidence rates of ESRD from 1980 through 2017.

It should be noted that the crude and standardized incidence rates of ESRD were the same in 2011; that is not a coincidence but rather reflects the fact that the standard population (the source of stratum-specific weights) was the 2011 US population. The trends in crude and standardized rates are different, however. The crude ESRD incidence rate (and count) increased steadily from 1980 through 2006, remained relatively stable until 2011, and increased again in recent years. This recent trend implies that the burden of kidney failure in the United States —the expected impact on healthcare utilization and costs—continues to increase, due to the aging US population and the increasing prevalence of obesity and diabetes mellitus (DM).

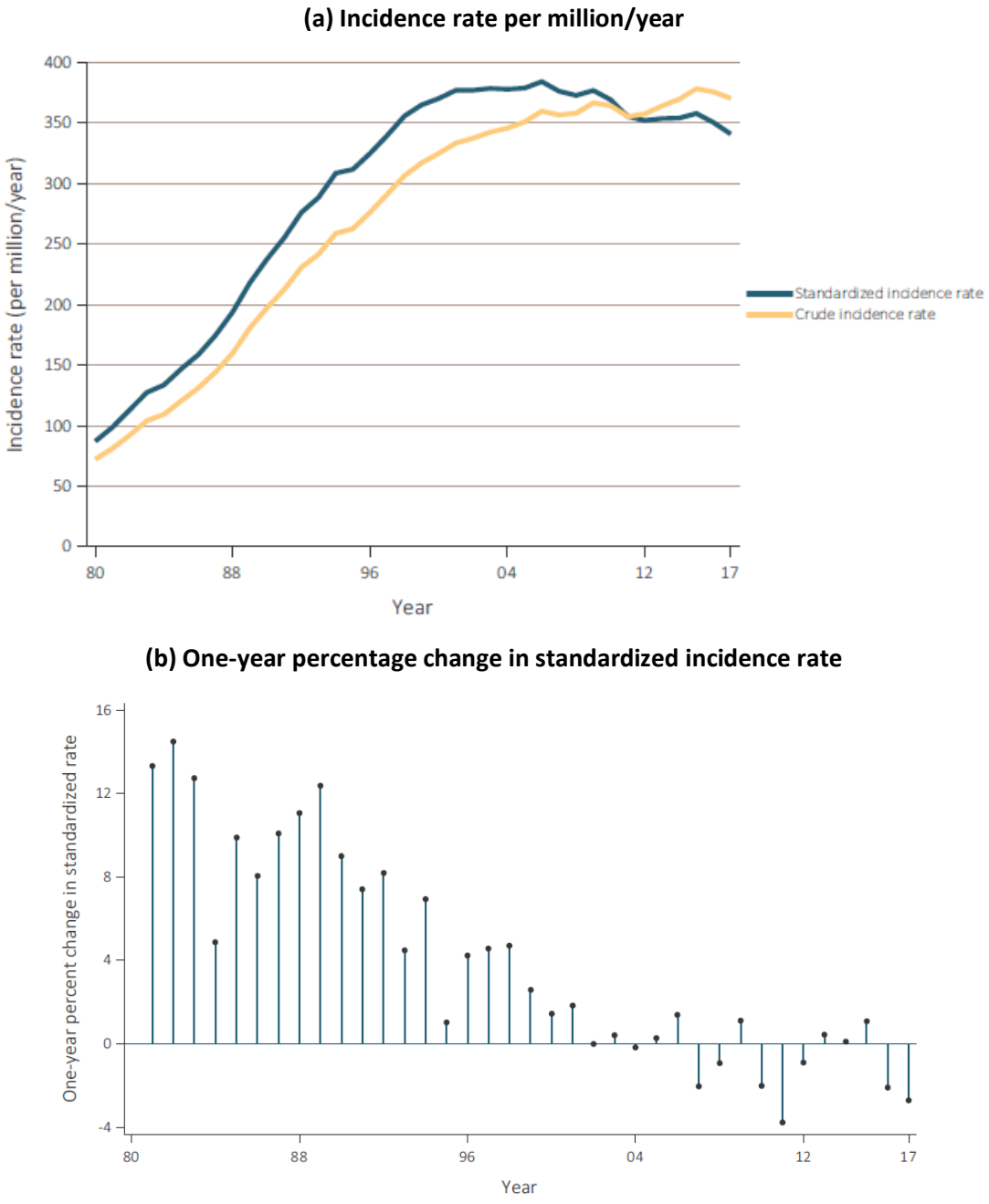
In contrast, the standardized ESRD incidence rate increased from 1980 through 2001, leveled off through 2006, and has since declined slightly in most years (**Table 7**). The standardized rate of 340.7 per million in 2017 was the lowest rate since 1998. The specific implication of this recent downward trend is more difficult to interpret, but it likely reflects improvements in the prevention or postponement of kidney failure in the United States, possibly due to interventions such as increases in blood-pressure control and the use of statins in the general population.

Table 7: Trends in annual number of ESRD incident cases, crude and standardized incidence rates of ESRD, and annual percentage change in the US population, 1980-2017

Year	No. incident cases	% Change from previous year	Crude rate (per million /year)	% Change from previous year	Standardized rate (per million/year)	% Change from previous year
1980	17,901	n/a	72.3	.	87.1	n/a
1981	20,029	12	81.2	12.3	98.7	13.3
1982	22,547	13	92.1	13.4	113.0	14.5
1983	25,796	14	104.0	12.9	127.4	12.7
1984	27,326	6	109.4	5.2	133.6	4.9
1985	30,209	11	120.4	10.1	146.8	9.9
1986	33,131	10	131.1	8.9	158.6	8.0
1987	36,612	11	144.2	10.0	174.6	10.1
1988	41,003	12	159.9	10.9	193.9	11.1
1989	46,329	13	180.7	13.0	217.9	12.4
1990	50,827	10	197.2	9.1	237.5	9.0
1991	55,383	9	212.4	7.7	255.1	7.4
1992	60,913	10	230.7	8.6	276.0	8.2
1993	64,503	6	241.5	4.7	288.4	4.5
1994	69,972	8	258.7	7.1	308.4	6.9
1995	72,209	3	262.6	1.5	311.6	1.0
1996	77,017	7	276.2	5.2	324.8	4.2
1997	82,138	7	291.1	5.4	339.6	4.6
1998	87,345	6	306.3	5.2	355.6	4.7
1999	91,414	5	316.9	3.5	364.8	2.6
2000	94,721	4	324.8	2.5	370.1	1.5
2001	97,987	3	333.3	2.6	376.9	1.8
2002	100,202	2	337.3	1.2	376.9	0.0
2003	102,620	2	342.3	1.5	378.4	0.4
2004	104,488	2	345.6	1.0	377.7	-0.2
2005	106,646	2	350.8	1.5	378.7	0.3
2006	110,371	3	359.6	2.5	384.0	1.4
2007	110,368	0	356.5	-0.9	376.1	-2.1
2008	111,926	1	357.9	0.4	372.6	-0.9
2009	115,583	3	366.5	2.4	376.7	1.1
2010	115,953	0	364.1	-0.7	369.1	-2.0
2011	113,830	-2	355.2	-2.4	355.2	-3.8
2012	115,604	2	357.4	0.6	352.0	-0.9
2013	118,449	2	364.0	1.8	353.5	0.4
2014	121,474	3	369.5	1.5	353.9	0.1
2015	125,237	3	378.2	2.4	357.7	1.1
2016	125,408	0	375.5	-0.7	350.2	-2.1
2017	124,500	-1	370.2	-1.4	340.7	-2.7

Data Source: Special analyses, USRDS ESRD Database. The special analyses exclude US territories, unknown age, and unknown/other races. Standardized to the age-sex-race distribution of the 2011 US population. Abbreviations: ESRD, end-stage renal disease.

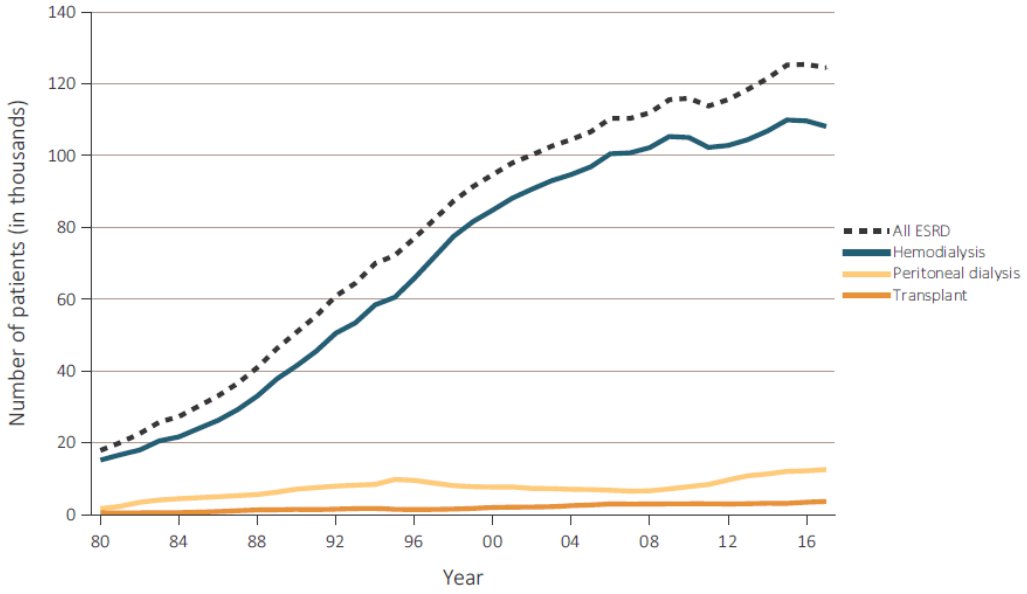
Figure 9: Trends in the (a) crude and standardized incidence rates of ESRD, and (b) the annual percentage change in the standardized incidence rate of ESRD in the US population, 1980-2017



Data Source: Special analyses, USRDS ESRD Database. The special analyses exclude US territories, unknown age, and unknown/other races. Standardized to the age-sex-race distribution of the 2011 US population. Abbreviation: ESRD, end-stage renal disease.

In all years since 1980, hemodialysis was the predominant form of initial therapy among incident cases (**Figure 10**). The number of incident peritoneal dialysis patients peaked in the mid-1990s, then declined for more than a decade, and has been increasing again since 2008; the number in 2017 was 12,572.

Figure 10: Trends in the annual number of ESRD incident cases, by modality, in the US population, 1980-2017



Data Source: Reference Table D.1 and special analysis of USRDS ESRD Database. Persons with "Uncertain Dialysis" were included in the "All ESRD" total, but are not represented separately. Abbreviation: ESRD, end-stage renal disease.

PREVALENCE OF ESRD: COUNTS, PREVALENCE, AND TRENDS

Overall Prevalence

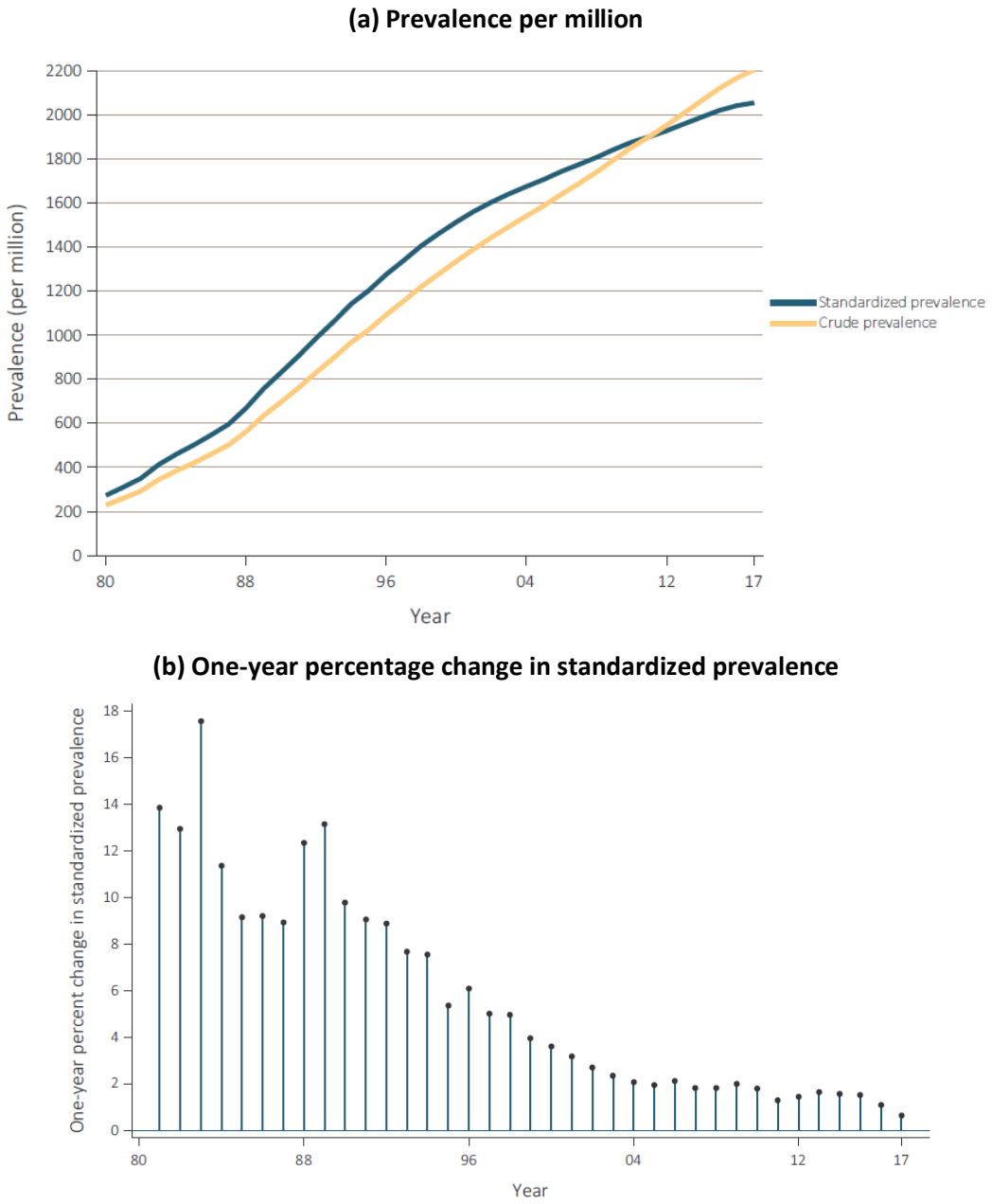
On December 31, 2017, there were 746,557 prevalent cases of ESRD in the United States; this represents an increase of 2.6% since 2016, and of 91.1% since 2000 (**Table 8** and **Figure 11**). The crude ESRD prevalence reached 2,203 per million, an increase of 1.7% since 2016 and 65.0% since 2000 (**Table 8**).

As shown in **Figure 11** and **Table 8** both crude and age-sex-race-standardized prevalences of ESRD increased steadily between 1980 and 2017. In general, however, the absolute and proportional yearly changes were a little greater for the crude prevalence than for the standardized prevalence, particularly after 2000 (**Table 8**). The increasing prevalent count and crude prevalence indicate the need for additional resources to manage ESRD in the US population, as demonstrated in the section titled *Healthcare Expenditures for Persons with ESRD*.

Because prevalence reflects both the incidence and course of the disease, these ESRD prevalence trends result from not only an increasing number of incident cases (**Table 7**) but also longer survival among ESRD patients. This is supported by the mortality data shown in the section titled *Mortality* and in *Reference Table H*. *Table H.2* shows that the crude mortality rate among all ESRD patients declined from 185.6 per 1,000/year in 1996 to 137.2 per 1,000/year in 2017, an absolute decrease of 48.4 per 1,000/year. Had the 1996 mortality rate among patients with ESRD remained that high through 2017, the prevalence of ESRD would have been

much lower than what we observed in 2017. Improving survival in the ESRD population was clearly the primary cause of increasing prevalence in the past two decades.

Figure 11: Trends in the (a) crude and standardized prevalence of ESRD, and (b) annual percentage change in the standardized prevalence of ESRD, in the US population, 1980-2017



Data Source: Special analyses, USRDS ESRD Database. Standardized to the age-sex-race distribution of the 2011 US population. Special analyses exclude unknown age, sex, HSA, and unknown/other race. Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.

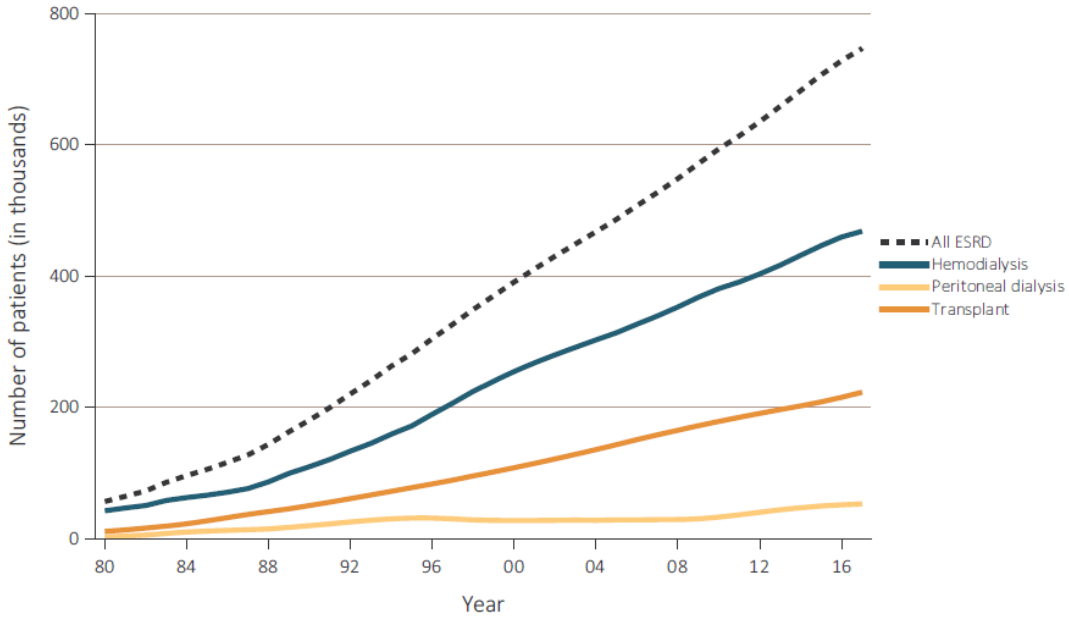
Table 8: Trends in annual number of ESRD prevalent cases, crude and standardized ESRD prevalence, and annual percentage changes, in the US population, 1980-2017

Year	No. prevalent cases	% change from previous year	Crude prevalence (per million/ year)	% Change from previous year	Standardized Prevalence (per million/year)	% Change from previous year
1980	56,402	n/a	228.9	n/a	272.7	n/a
1981	64,216	13.9	259.8	13.5	310.4	13.8
1982	72,449	12.8	292.9	12.7	350.5	12.9
1983	85,561	18.1	343.9	17.4	412.0	17.5
1984	95,870	12.0	383.5	11.5	458.8	11.4
1985	105,412	10.0	419.5	9.4	500.7	9.1
1986	116,115	10.2	459.7	9.6	546.7	9.2
1987	127,469	9.8	501.8	9.2	595.5	8.9
1988	143,509	12.6	562.0	12.0	668.9	12.3
1989	162,735	13.4	634.7	12.9	756.8	13.1
1990	180,556	11.0	696.7	9.8	830.7	9.8
1991	199,601	10.5	761.2	9.3	905.7	9.0
1992	220,409	10.4	830.8	9.1	986.0	8.9
1993	240,624	9.2	896.6	7.9	1061.4	7.6
1994	262,718	9.2	967.3	7.9	1141.3	7.5
1995	281,671	7.2	1023.9	5.9	1202.4	5.4
1996	304,556	8.1	1092.2	6.7	1275.4	6.1
1997	326,376	7.2	1155.0	5.7	1339.0	5.0
1998	348,925	6.9	1219.7	5.6	1405.3	5.0
1999	369,794	6.0	1277.7	4.8	1460.7	3.9
2000	390,759	5.7	1335.3	4.5	1513.2	3.6
2001	410,733	5.1	1390.1	4.1	1561.2	3.2
2002	430,122	4.7	1442.8	3.8	1603.1	2.7
2003	448,783	4.3	1492.3	3.4	1640.5	2.3
2004	467,339	4.1	1540.2	3.2	1674.3	2.1
2005	486,242	4.0	1587.4	3.1	1706.6	1.9
2006	507,037	4.3	1639.0	3.3	1742.6	2.1
2007	527,198	4.0	1688.0	3.0	1774.2	1.8
2008	548,305	4.0	1739.3	3.0	1806.5	1.8
2009	571,083	4.2	1796.2	3.3	1842.3	2.0
2010	593,495	3.9	1851.6	3.1	1875.4	1.8
2011	613,356	3.3	1899.7	2.6	1899.7	1.3
2012	635,068	3.5	1951.9	2.7	1927.1	1.4
2013	658,351	3.7	2007.9	2.9	1958.4	1.6
2014	682,312	3.6	2063.8	2.8	1989.0	1.6
2015	706,372	3.5	2119.0	2.7	2019.2	1.5
2016	727,912	3.0	2166.1	2.2	2041.1	1.1
2017	746,557	2.6	2203.5	1.7	2053.9	0.6

Data Source: Special analyses of the USRDS ESRD Database. The special analyses exclude US territories, unknown age, and unknown/other races. Standardized to the age-sex-race distribution of the 2011 US population. Abbreviations: ESRD, end-stage renal disease; n/a, not applicable.

Among prevalent ESRD cases on December 31, 2017, 62.7% used hemodialysis as their renal replacement therapy, 7.1% used peritoneal dialysis, and 29.9% had a functioning kidney transplant (**Figure 12**). The size of the prevalent HD population increased from 2000 to 2017 by 84.1% (**Figure 12**); the prevalent PD population increased by 92.5%, and the transplant population increased by 106.6% during the same period.

Figure 12: Trends in the number of ESRD prevalent cases, by modality, in the US population, 1980-2017



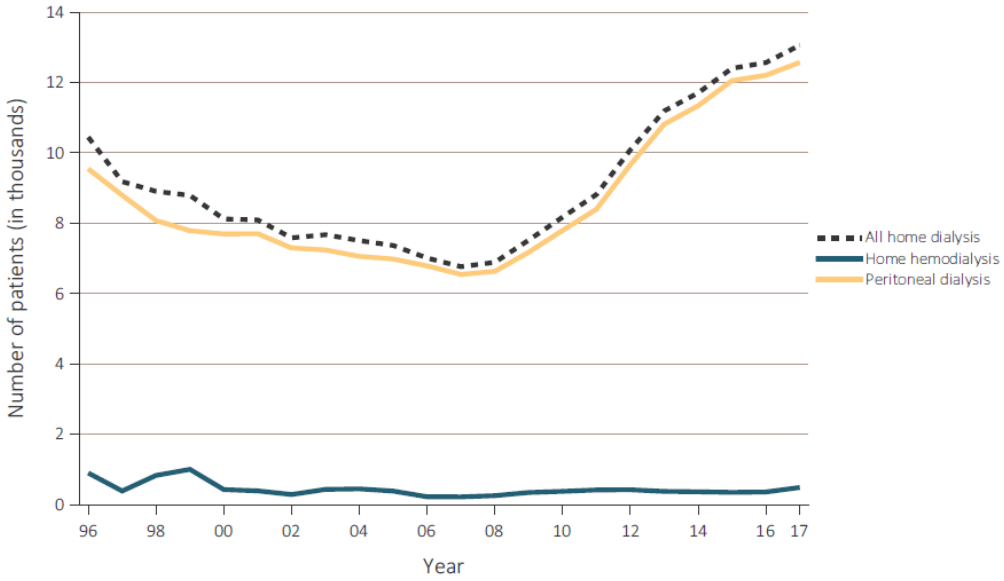
Data Source: Reference Table D.1 and special analysis of USRDS ESRD Database. Abbreviation: ESRD, end-stage renal disease. Persons with "Uncertain Dialysis" were included in the "All ESRD" total, but are not represented separately.

Modality of Renal Replacement Therapy: Incident ESRD Cases

Trends in Incident Counts: By Renal Replacement Therapy Modality

Use of home dialysis among incident ESRD patients decreased from 1996 to 2007, but has increased appreciably from 2008 through 2017 (**Figure 13**). Overall, home dialysis use in 2017 was 93.0% higher than at its least utilized point in 2007. In 2017, use of PD and home HD were 92.1% and 120.8% higher, respectively, than in 2007. PD has continued to be the dominant form of home dialysis. Despite the large proportional rise in home HD, its overall use was only 4.0% of all incident ESRD patients receiving dialysis in 2017 (*Reference Table D.1*).

Figure 13: Trends in the number of incident ESRD cases using home dialysis, by type of therapy, in the US population, 1996-2017



Data Source: Reference Table D.1 and special analysis, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease.

Renal Replacement Therapy Modality Use: By Incident Patient Characteristics

Use of peritoneal dialysis and preemptive kidney transplants were markedly more common in 2017 among younger ESRD patients than among older patients, and they were a little less common among Black/African American and Hispanic ESRD patients than in White patients (**Table 9**). Use of PD and preemptive kidney transplants were more common among ESRD patients with glomerular or cystic kidney disease as the primary cause of ESRD than in patients with other primary causes of ESRD. This difference is partially due to age, as both glomerular and cystic kidney disease are more common in younger patients.

Table 9: Number and percentage of incident ESRD patients receiving hemodialysis (HD), peritoneal dialysis (PD), and a transplant, by age, sex, race, ethnicity, and primary cause of ESRD, in the US population, 2017

	Total	HD		PD		Transplant	
	n	n	%	n	%	n	%
Age							
0-21	1,319	677	51.3	367	27.8	275	20.8
22-44	13,464	10,533	78.2	2,011	14.9	920	6.8
45-64	47,191	40,232	85.3	5,213	11.0	1,746	3.7
65-74	33,785	30,075	89.0	3,055	9.0	655	1.9
75+	28,610	26,614	93.0	1,926	6.7	70	0.2
Sex							
Male	72,403	62,927	86.9	7,394	10.2	2,082	2.9
Female	51,966	45,204	87.0	5,178	10.0	1,584	3.0
Race							
White	83,368	71,879	86.2	8,789	10.5	2,700	3.2
Black/African American	31,965	28,975	90.6	2,657	8.3	333	1.0
American Indian or Alaska Native	1,151	1,038	90.2	72	6.3	41	3.6
Asian	5,570	4,394	78.9	808	14.5	368	6.6
Native Hawaiian or Pacific Islander	1,548	1,351	87.3	178	11.5	19	1.2
Other or Multiracial	426	344	80.8	54	12.7	28	6.6
Unknown	341	150	44.0	14	4.1	177	51.9
Ethnicity							
Hispanic	18,361	16,260	88.6	1,769	9.6	332	1.8
Non-Hispanic	104,620	91,263	87.2	10,734	10.3	2,623	2.5
Unknown	1,388	608	43.8	69	5.0	711	51.2
Primary Cause of ESRD							
Diabetes	58,372	52,355	89.7	5,571	9.5	446	0.8
Hypertension	35,843	31,963	89.2	3,509	9.8	371	1.0
Glomerulonephritis	8,797	6,634	75.4	1,641	18.7	522	5.9
Cystic Kidney	3,480	2,077	59.7	806	23.2	597	17.2
Other/Unknown	17,877	15,102	84.5	1,045	5.8	1,730	9.7
Total	124,369	108,131	86.9	12,572	10.1	3,666	2.9

Data Source: Reference Table D.10 and special analyses, USRDS ESRD Database. The numbers in this table exclude "Uncertain Dialysis." Hemodialysis includes home hemodialysis and in-center hemodialysis. Values for cells with 10 or fewer patients are suppressed.

Renal Replacement Therapy Modality Use: By Prevalent Patient Characteristics

Distributions of the modality used by prevalent ESRD patients (**Table 10**), by patient characteristics, generally reflect those distributions for incident ESRD patients (**Table 9**). Uses of PD and kidney transplant were more common among patients who were younger, White, non-Hispanic, and with glomerular disease or cystic kidney disease as the primary cause of their ESRD (**Table 10**).

Table 10: Number and percentage of prevalent ESRD patients receiving hemodialysis (HD), peritoneal dialysis (PD), and a transplant, by age, sex, race, ethnicity, and the primary cause of ESRD, in the United States, 2017

	Total	HD		PD		Transplant	
		N	%	N	%	N	%
Age							
0-21	9,667	1,608	16.6	977	10.1	7,082	73.3
22-44	103,821	50,835	49.0	9,124	8.8	43,862	42.2
45-64	321,810	190,655	59.2	22,899	7.1	108,256	33.6
65-74	184,582	123,915	67.1	12,293	6.7	48,374	26.2
75+	123,794	101,094	81.7	7,426	6.0	15,274	12.3
Sex							
Male	432,010	269,474	62.4	29,774	6.9	132,762	30.7
Female	311,614	198,612	63.7	22,944	7.4	90,058	28.9
Race							
White	457,238	266,515	58.3	34,983	7.7	155,740	34.1
Black/African American	224,784	166,015	73.9	12,686	5.6	46,083	20.5
American Indian or Alaska Native	7,788	5,458	70.1	446	5.7	1,884	24.2
Asian	37,101	21,053	56.7	3,592	9.7	12,456	33.6
Native Hawaiian or Pacific Islander	9,581	7,017	73.2	758	7.9	1,806	18.8
Other or Multiracial	3,657	1,475	40.3	203	5.6	1,979	54.1
Unknown	3,525	574	16.3	51	1.4	2,900	82.3
Ethnicity							
Hispanic	131,937	87,714	66.5	8,396	6.4	35,827	27.2
Non-Hispanic	594,733	378,065	63.6	44,088	7.4	172,580	29.0
Unknown	17,004	2,328	13.7	235	1.4	14,441	84.9
Primary Cause of ESRD							
Diabetes	287,181	218,282	76.0	20,255	7.1	48,644	16.9
Hypertension	192,907	139,092	72.1	14,831	7.7	38,984	20.2
Glomerulonephritis	115,535	45,094	39.0	8,907	7.7	61,534	53.3
Cystic Kidney	36,604	11,331	31.0	2,742	7.5	22,531	61.6
Other/Unknown	111,447	54,308	48.7	5,984	5.4	51,155	45.9
Total	743,624	468,086	62.9	52,718	7.1	222,820	30.0

Data Source: Reference Table D.11 and special analyses, USRDS ESRD Database. The numbers in this table exclude "Uncertain Dialysis" and include "Unknown sex." Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

PATIENT AND TREATMENT CHARACTERISTICS AT ESRD ONSET

Pre-ESRD Care

In 2017, 19.2% of patients starting ESRD therapy were reported on the CMS 2728 form as not having received nephrology care before ESRD onset (**Table 11.a**), a decrease of 0.6% from 2016. An additional 14.1% had an unknown duration of pre-ESRD nephrology care. Because treatment characteristics, such as erythropoiesis-stimulating agent (ESA) use and dietary care, for the unknown group were similar to those with no pre-ESRD nephrology care, one may assume that up to 33.3% of new ESRD cases received little or no pre-ESRD nephrology care (**Table 11.a**).

Several differences were notable in the distributions of pre-ESRD nephrology care by patient characteristics. The youngest patients 0-21 years old were most likely (44.7%) and adults 22-44 years old were least likely (29.2%) to have had 12 months or more of pre-ESRD nephrology care. Blacks were slightly 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 cause of their disease reported as cystic kidney disease or, to a lesser extent, glomerulonephritis, were more likely to have had pre-ESRD nephrology care than were patients with a diagnosis of DM or hypertension (HTN). 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 with advanced chronic kidney disease (CKD), approaching the need for dialysis, might be assigned the diagnosis of HTN in the absence of evidence of other possible etiologies.

Both dietary care and erythropoiesis-stimulating agent (ESA) use were more prevalent among incident ESRD cases in 2017 who had the longest duration of pre-ESRD nephrology care (**Table 11.b**). The prevalence of dietary care was 13.3% in patients with >12 months of pre-ESRD nephrology care and only 0.3% in patients with no such care. Similarly, the prevalence of ESA use was 21.7% in patients with >12 months of pre-ESRD nephrology care and only 0.9% in patients with no such care. The association between eGFR at the start of renal replacement therapy and duration of pre-ESRD nephrology care was slightly non-monotonic. The prevalence of starting renal replacement therapy (RRT) early (≥15 ml/min/1.73 m_2) and late (<5 ml/min/1.73 m_2) was greatest for patients with no pre-ESRD nephrology care (11.5% and 19.7%, respectively). Use of a catheter only for vascular access was strongly and inversely associated with duration of pre-ESRD nephrology care, being 36.3% for patients with >12 months of pre-nephrology care and 80.5% for patients with no such care. In contrast, AV fistula use was much more common for patients with >12 months of pre-ESRD nephrology care (24.4%) than for patients with no such care (2.4%).

Table 11: Distribution (in %) of (a) demographic and (b) clinical characteristics, by the reported duration of pre-ESRD nephrology care, among incident ESRD cases in the US population, 2017

(a) Demographic characteristics (% within row)

Variable Category	No. of cases	Duration of pre-ESRD nephrology care				
		>12 months	6-12 months	0-6 months	None	Unknown/ Missing
Total	120,925	32.6	19.9	14.2	19.2	14.1
Age						
0-21	1,348	44.7	13.4	15.7	19.1	7.2
22-44	13,279	29.2	18.5	14.8	24.5	13.1
45-64	45,682	30	20.2	14.6	21.4	13.9
65-74	32,715	34.8	20.4	13.5	17	14.3
75+	27,900	35.5	19.8	13.9	15.8	15.1
Sex						
Female	50,778	32.6	20.4	14.4	18.2	14.5
Male	70,147	32.6	19.5	14	20	13.8
Race						
White	81,413	34.2	20.1	14.2	18.4	13.1
Black/African American	31,416	28.4	19.2	13.9	21.4	17.1
American Indian/Alaska Native	1,175	27.5	21.5	17.3	23.3	10.4
Asian	5,393	34.9	20.1	14.7	16.7	13.7
Native Hawaiian/ Pacific Islander	1,525	30.1	18.4	15.9	23.7	11.9
Other/Unknown	*	66.7	*	*	*	33.3
Ethnicity						
Hispanic	17,335	26.1	19.2	15.4	24.9	14.5
Non-Hispanic	103,590	33.7	20	14	18.3	14
Primary Diagnosis						
Diabetes	58,251	33	21.7	14.4	17.2	13.7
Hypertension	35,754	29.7	19.1	13.9	20.4	16.8
Glomerulonephritis	8,822	41.2	19.1	13.8	17.3	8.6
Cystic kidney	3,518	57.3	17.1	9.3	9.6	6.7
Other/Unknown	14,580	26.8	15.7	15.3	27.9	14.3

Table 11 continued on next page.

Table 11, continued: Distribution (in %) of (a) demographic and (b) clinical characteristics, by the reported duration of pre-ESRD nephrology care, among incident ESRD cases in the US population, 2017

(b) Clinical characteristics (% within column)

Variable Category	No. of cases	Duration of pre-ESRD nephrology care				
		>12 months	6-12 months	0-6 months	None	Unknown / Missing
Dietary care						
No	109,944	86.7	88.4	83.5	99.7	99.8
Yes	10,981	13.3	11.6	16.5	0.3	0.2
ESA use						
No	104,508	78.3	83.7	81	97.8	99.1
Yes	16,417	21.7	16.3	19	2.2	0.9
eGFR at RRT start						
<5	16,801	11.8	12.3	12.7	19.7	14.4
5-<10	57,680	50.1	49.5	47	44.8	44.3
10-<15	33,221	28.8	28.4	28.2	24	27.0
≥15	13,167	9.3	9.7	12	11.5	14.2
Vascular access						
AV fistula	17,774	24.4	18.5	10.2	2.4	8.2
AV graft	3,275	3.7	3.4	2.5	1	2.0
CV Catheter with maturing fistula/graft	17,653	15.4	16.8	14.7	12.1	13.0
CV Catheter only	66,970	36.3	46.6	62.1	80.5	70.9
Other/Unknown	15,253	20.3	14.7	10.5	4	5.9
Total	120,925	100	100	100	100	100

*Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. *Count ≤10. 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: AV, arteriovenous; CKD-EPI, chronic kidney disease epidemiology calculation; CV, central venous; eGFR, estimated glomerular filtration rate; ESA, erythropoiesis-stimulating agents; ESRD, end-stage renal disease; RRT, renal replacement therapy.*

EGFR AT ESRD ONSET

Mean eGFR at ESRD start among incident ESRD patients in 2017 was higher in young patients (≤21 years), males, Whites, non-Hispanics, and those with diabetes as their primary cause of ESRD (**Table 12**). Incident ESRD patients with cystic kidney disease listed as the primary cause had higher mean Hgb levels at ESRD onset than did other groups. ESA usage among incident ESRD patients was greater in young patients (≤21 years), females, and Whites.

Table 12: Distributions of laboratory values (mean) and treatment characteristics (%), by age, sex, race, ethnicity, and the primary cause of ESRD, among incident ESRD cases, 2017

	Nutrition			Anemia		Lipids		Diabetes
	eGFR (ml/min/1.73 m²)	Serum albumin (g/dL)	Dietary care (%)	Hemoglobin (g/dL)	ESA use (%)	Total cholesterol (mg/dL)	LDL (mg/dL)	HbA1c (%)
Age								
0-21	14.0	3.4	41.5	9.7	26.6	179.1	107.4	5.2
22-44	9.4	3.2	9.1	9.2	10.3	169.4	102	6.9
45-64	9.9	3.2	8.9	9.3	11.5	158.6	93.5	6.8
65-74	10.1	3.2	9.3	9.4	14.0	146.6	83.7	6.5
75+	10.3	3.2	8.1	9.4	15.6	141.9	80	6.4
Sex								
Male	10.3	3.2	9.2	9.4	12.1	147.3	86	6.6
Female	9.7	3.2	9.1	9.2	14.6	163.4	94.8	6.8
Race								
White	10.3	3.2	9.5	9.5	13.4	150.9	87	6.7
Black/African American	9.7	3.2	8.0	9.1	11.4	158	95.2	6.6
American Indian/Alaska Native	9.2	2.8	7.6	9.1	11.9	149.6	80.1	7.0
Asian	8.9	3.3	10.2	9.3	19.6	162.8	91.8	6.6
Native Hawaiian/Pacific Islander	8.5	3.1	9.6	9.3	13.4	156	99.3	6.9
Ethnicity								
Yes	9.5	3.1	8.8	9.2	11.9	152.7	87.7	6.7
No	10.1	3.2	9.2	9.4	13.5	153.7	89.8	6.7
Primary Cause of ESRD								
Diabetes	10.1	3.1	8.5	9.3	13.8	151.4	87.7	7.0
Hypertension	9.5	3.3	7.3	9.3	11.6	152.2	89.5	6.1
Glomerulonephritis	9.4	3.3	13.3	9.5	17.4	170.9	101.1	5.7
Cystic kidney	9.8	3.8	18.1	10.1	16.2	168.2	98	5.5
Total	10.0	3.2	9.1	9.3	13.1	153.5	89.5	6.7

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: eGFR, estimated glomerular filtration rate; ESA, erythropoiesis-stimulating agents; ESRD, end-stage renal disease; HbA1c, glycosylated hemoglobin; LDL, low-density lipoprotein.

Vascular Access

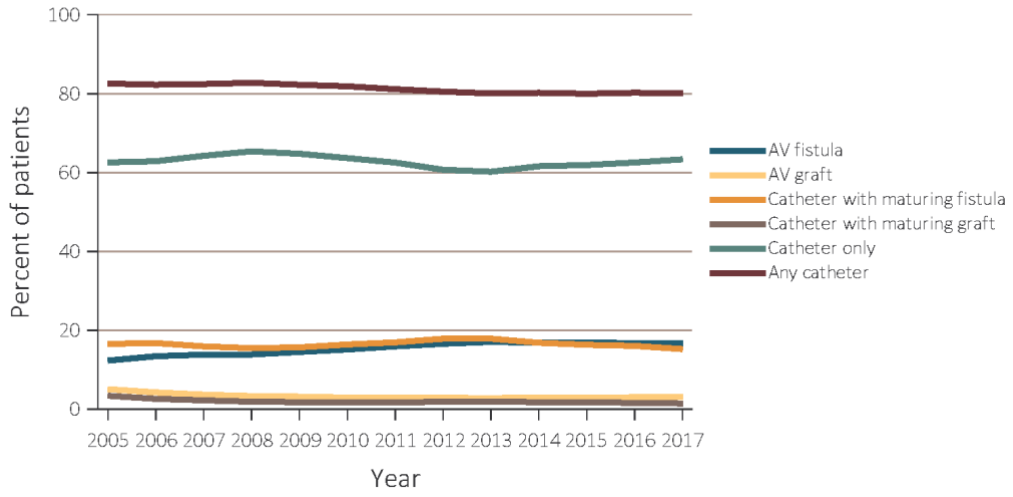
HIGHLIGHTS

- In 2017, 80% of patients were using a catheter at hemodialysis (HD) initiation (Figure 14).
- AV fistula use at HD initiation rose from 12% to 17% over the period 2005-2017 (Figure 14).
- The percentage of patients using an arteriovenous (AV) fistula or with a maturing AV fistula at HD initiation increased from 28.9% to 32% over the same period (Figure 12).
- The proportion of patients with an AV graft for vascular access at HD initiation decreased from 5% to 3% between 2005 and 2017 (Figure 14).
- Catheter use at HD incidence was modestly higher for patients who were younger (age <45 years old), of Hispanic ethnicity, or having congestive heart failure or other cardiac disease.
- By May 2018, 62.9% of prevalent dialysis patients were using an AV fistula and 17.5% using a graft for HD, while 19.6% were using a catheter (Figure 15).
- Among prevalent HD patients, catheter use was much higher (52%) for HD patients ≤21 years old (versus 19-21% in other age groups), and was modestly higher for female (22%) than for male (17.7%) HD patients. Fistula use was modestly higher for prevalent HD patients who were male, 22-74 years old, and of Hispanic ethnicity. Graft use continued to be more prevalent among black HD patients.

VASCULAR ACCESS USE AT INITIATION OF HEMODIALYSIS

In 2017, 80.1% of patients were using a catheter at HD initiation, a practice that has changed only marginally since 2005 (**Figure 14**). In 2017, 62.6% of incident ESRD patients had neither an AV fistula nor AV graft in place or maturing at their first outpatient HD session. This peaked at 65.4% in 2008, and has remained relatively stable since 2012, at just above 60%. The proportion of patients with an AV graft for vascular access at HD initiation decreased from 5% to 3% between 2005 and 2017. Over the last several years, there has been a relatively small absolute increase in AV fistula use at HD initiation, rising from 12.3% in 2005 to 16.8% in 2017, but with a plateau seen in the past several years. Over the same period, the percentage of patients with either an AV fistula or a maturing AV fistula increased from 28.9% to 32%.

Figure 14: Vascular access use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2005-2017



Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2005-2017. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Table 13 shows dialysis access use at HD initiation, stratified by patient characteristics. The 0-21 year old age group had the highest percentage of catheter use at HD initiation (87.6%) and lowest percentage of AV fistula use (4.5%). Many of these patients were children who subsequently received a kidney transplant relatively quickly, with HD serving as a bridge to transplantation, or those in the youngest age categories, who, being quite small, may have presented surgical challenges in creating an AV fistula. The 65-74 year age group had the highest percentage of patients with AV fistula use at HD initiation (18.2%), with slightly lower levels seen for individuals 75 years or older (17.2%) and those between 45-64 years (16.8%).

Patients of Hispanic ethnicity or Black/African American race displayed the lowest proportion of AV fistula use (13.9% and 14.6%, respectively) at HD initiation, with those of Hispanic ethnicity having the highest use of a catheter alone (67.1%). Non-Hispanic Blacks/African Americans displayed the highest proportion of AV graft use at HD initiation (4.6%), with lower AV graft use among other races (2.3%) and Whites (2.5%), while the lowest observed AV graft use was for Hispanic ethnicity alone (2.1%).

Consistent with previous years, those with cystic kidney disease had higher rates of AV fistula use at HD initiation (37.3%), perhaps related to younger age at disease detection, slower progression of underlying CKD, earlier nephrology referral, more consistent pre-dialysis nephrology care, or relatively well preserved vasculature.

Table 13: Vascular access used at hemodialysis initiation by patient characteristics from the ESRD Medical Evidence form (CMS 2728), 2017

	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only
All	16.8	3.1	15.2	1.5	63.4
Age					
0-21	4.5	1.1	6.5	0.5	87.6
22-44	13.1	2.1	15.2	1.1	68.5
45-64	16.8	2.6	16.4	1.4	62.9
65-74	18.2	3.4	15.5	1.5	61.3
75+	17.2	3.9	13.4	1.7	63.8
Sex					
Male	18.5	2.4	15.7	1.2	62.3
Female	14.6	4.1	14.7	1.9	64.8
Race					
White	17.5	2.5	15.2	1.3	63.6
Black/African American	14.6	4.6	15.1	2.1	63.6
American Indian or Alaska Native	15.5	2.7	19.2	0.5	62.1
Asian	20.5	3.4	15.1	1.2	59.8
Other or Multiracial	16.7	2.3	18.9	0.9	61.1
Ethnicity					
Hispanic	13.9	2.1	15.4	1.4	67.1
Non-Hispanic	17.3	3.3	15.2	1.5	62.7
Race/Ethnicity					
Non-Hispanic White	18.5	2.6	15.1	1.2	62.6
Non-Hispanic Black/African American	14.6	4.6	15.1	2.1	63.6
Primary Cause of ESRD					
Diabetes	17.5	3.2	17.4	1.5	60.3
Hypertension	17	3.5	14.2	1.4	63.9
Glomerulonephritis	18	2.5	13.2	1.6	64.7
Cystic kidney	37.3	3.2	13.7	0.7	45.1
Other urologic	13.6	3	12.2	1.9	69.4
Other cause	8.9	2	10.3	1.4	77.5
Unknown/Missing	12.9	1.8	9	1.3	75
Comorbidities					
Diabetes	16.5	3.1	16.6	1.5	62.3
Congestive heart failure	12.6	2.7	15.7	1.5	67.5
Atherosclerotic heart disease	16.3	3	17.6	1.7	61.4
Cerebrovascular disease	13.9	3.6	15.4	2	65.1
Peripheral vascular disease	14.3	2.9	17.1	1.6	64
Hypertension	17.2	3.2	15.5	1.5	62.6
Other cardiac disease	13.7	2.8	15.2	1.6	66.8

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 14 shows patterns of access use among prevalent HD patients with ESRD for at least 90 days. By May 2018, 63% of these patients were using an AV fistula. In general, demographic variation among prevalent patients was similar to the patterns observed for incident patients. Those in the 0-21 year old age group displayed the highest catheter use, while the 45-64 year group had the lowest catheter use. Blacks displayed the lowest AV fistula utilization, but highest AV graft use. Multiracial patients and those in the other race category reported the highest catheter use. When examined by primary cause of ESRD, individuals with cystic kidney disease maintained the highest fistula usage. However, the differences in vascular access use among prevalent HD patients with different etiologies were smaller than those observed in incident dialysis patients (**Table 13**).

Table 14: Distribution of type of vascular access in use among prevalent hemodialysis patients in 2018, from CROWNWeb data, May 2018

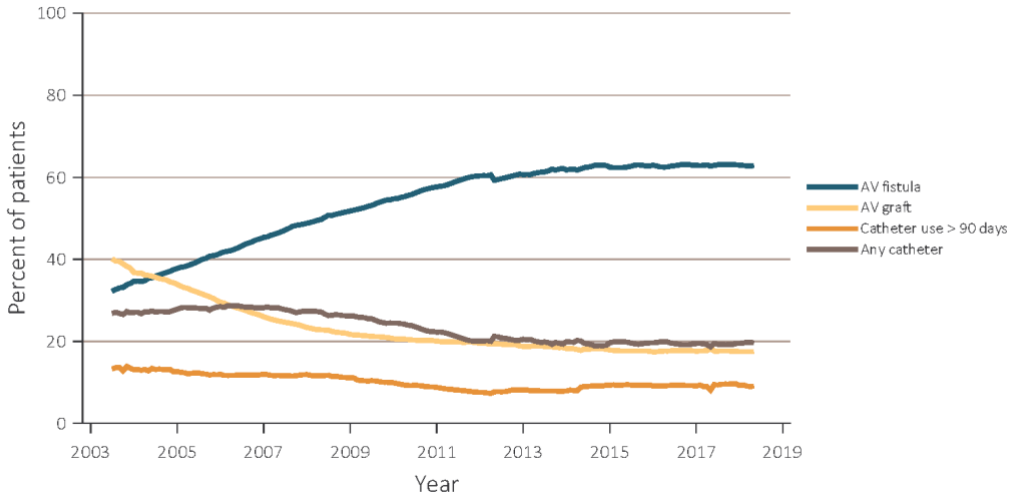
	AV fistula	AV graft	Catheter
All	63	17.6	19.5
Age			
0-21	41.3	6.3	52.4
22-44	64.1	14.8	21.2
45-64	65	16.4	18.6
65-74	62.6	18.4	19
75+	59.3	20.3	20.4
Sex			
Male	68.6	13.8	17.7
Female	55.4	22.7	22
Race			
White	65.6	13.9	20.6
Black/African American	57.5	24.1	18.4
American Indian or Alaska Native	74.5	10.1	15.4
Asian	67.9	16.5	15.6
Other or Multiracial	62.1	13.8	24.1
Ethnicity			
Hispanic	68.6	13.9	17.4
Non-Hispanic	61.7	18.4	19.9
Race/Ethnicity			
Non-Hispanic White	64.1	13.9	22
Non-Hispanic Black/African-American	57.5	24.1	18.4
Primary Cause of ESRD			
Diabetes	63.6	17.1	19.3
Hypertension	62.5	18.5	19
Glomerulonephritis	64.7	17.9	17.4
Cystic kidney	69.1	15.3	15.6
Other urologic	61.6	16.5	21.8
Other cause	56.6	17	26.4
Unknown/Missing	61.5	17.7	20.8

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; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease

Figure 15 displays trends in vascular access use among prevalent HD patients from 2003 to mid-2018. Between July 2003 and April 2012, these data reflect the monthly point prevalence of vascular access at dialysis facilities from the Fistula First Breakthrough Initiative and from May 2012 through May 2018 from monthly CROWNWeb clinical data. A large increase in AV fistula use has occurred since 2003, rising from 32% to 62.9% of patients, although this change has recently plateaued. In contrast, AV graft use has decreased from 40% to 17.5% over the same period. Catheter use has had a complementary decline,

decreasing from 27% to 19.6%. In May 2018, only 9.1% of prevalent HD patients had been using a catheter for greater than 90 days, which represents very little change in this practice over the prior 10 years.

Figure 15: Trends in vascular access type use among ESRD prevalent patients, 2003-2018



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 May 2018. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

Mortality

HIGHLIGHTS

- In 2017, adjusted mortality rates for ESRD, dialysis, and transplant patients were 134, 165, and 29 per 1,000 patient-years. By dialysis modality, mortality rates were 167 for hemodialysis (HD) patients and 156 for peritoneal dialysis (PD) patients, per 1,000 patient-years (Figure 16).
- Between 2001 and 2017, adjusted mortality rates decreased for dialysis patients by 28%. The net reductions in mortality from 2001 to 2017 were 27% for HD patients and 42% for PD patients (Figure 16.b).
- Between 2001 and 2017, unadjusted (crude) mortality rates decreased by 1% for transplant recipients. After accounting for changes in population characteristics (primarily increasing age), trends in post-transplant mortality were much more pronounced, with adjusted mortality rates decreasing by 41% (Figure 16.a).

The decline in mortality in the end-stage renal disease (ESRD) population has important implications for both patients and resource allocation. Increasing lifespan among ESRD patients is a primary reason for continued growth in the prevalent ESRD population. In 2017, adjusted mortality rates for ESRD, dialysis, and transplant patients were 134, 165, and 29 per 1,000 patient-years. By dialysis modality, mortality rates were 167 for hemodialysis (HD) patients and 156 for peritoneal dialysis (PD) patients, per 1,000 patient-years (**Figure 16.b**). Between 2001 and 2017, adjusted mortality rates decreased for dialysis patients by 28%. The net reductions in mortality from 2001 to 2017 were 27% for HD patients and 42% for PD patients (**Figure 16.b**). Between 2001 and 2017, unadjusted (crude) mortality rates decreased by 1% for transplant recipients. After accounting for changes in population characteristics (primarily increasing age), trends in post-transplant mortality were much more pronounced, with adjusted mortality rates decreasing by 41% (**Figure 16.a**).

MORTALITY AMONG ESRD PATIENTS: OVERALL AND BY MODALITY

Overall mortality rates among ESRD (dialysis and transplant) patients have consistently declined over the last 16 years, with rates levelling during recent years. Between 2001 and 2017, the unadjusted death rate (not shown) for the ESRD population decreased by 27%, from 187 to 137 per 1,000 patient-years, while the adjusted death rate (**Figure 16.a**) decreased by 29%. The unadjusted death rate for the dialysis population decreased by 26%, while the adjusted death rate decreased by 28%. The unadjusted death rate for the transplant population decreased by 1%, while the adjusted death rate decreased by 41%.

Differences between the unadjusted and adjusted rates largely reflect changes in the age distribution of the ESRD population. Death rates for dialysis and transplant patients decreased by over 30% between 2001 and 2017 within most age groups, and the adjusted rate reflects this decrease. The unadjusted rate was affected by both this decrease and by the fact that the ESRD population was older in 2017 than in 2001, which offsets the effect. For example, patients over the age of 65 comprised 45% of the dialysis population in 2001 and 47% in 2017; in the same years, transplant recipients over the age of 65 comprised 10% and 28% of the transplant recipient population. Thus, the increase in age among transplant patients masked overall improvements in mortality.

From 2001 to 2010, the adjusted mortality rate decreased by 22%, and by 8% from 2011 to 2017 for the ESRD population (**Figure 16.a**). The trend was similar for dialysis (HD and PD) patients, with the adjusted mortality rate decreasing by 21% from 2001 to 2010 and by 7% from 2011 to 2017 (**Figure 16.a**).

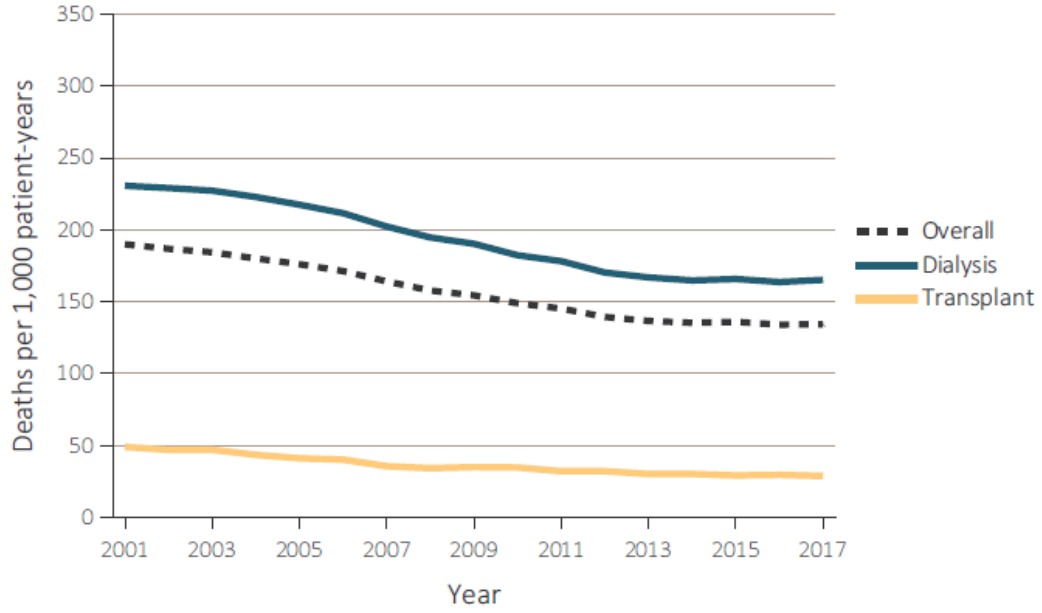
Among transplant patients, adjusted mortality decreased by 29% from 2001 to 2010 and by 10% from 2011 to 2017 (**Figure 16.a**).

Among HD patients, the adjusted mortality rate decreased by 20% from 2001 to 2010 and by 7% from 2011 to 2017. Among PD patients, the mortality rate decreased by 37% from 2001 to 2010 and by 7% from 2011 to 2017 (**Figure 16.b**). The net reductions in mortality from 2001 to 2017 were 27% for HD patients and 42% for PD patients.

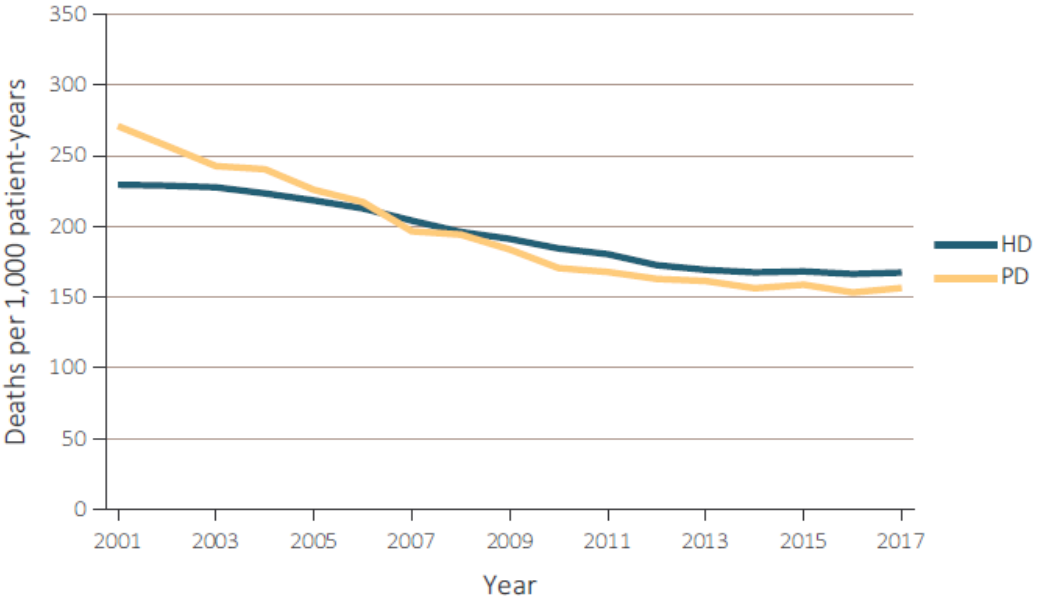
Adjusted mortality rates in 2017 were 134, 165, and 29 per 1,000 patient-years for ESRD, dialysis, and transplant patients. By dialysis modality, mortality rates were 167 per 1,000 patient-years for HD patients and 156 for PD patients.

Figure 16: Adjusted all-cause mortality by treatment modality (a) overall, dialysis, and transplant, and (b) hemodialysis and peritoneal dialysis, for period-prevalent patients, 2001-2017

(a) Overall, dialysis, and transplant



(b) Hemodialysis and peritoneal dialysis



Data Source: Reference Tables H.2_adj, H.4_adj, H.8_adj, H.9_adj, and H.10_adj. Adjusted for age, sex, race, ethnicity, primary diagnosis and vintage. Reference population: period prevalent ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Transplantation

HIGHLIGHTS

- In 2017, 20,945 kidney transplants were performed in the United States (20,467 were kidney-alone; Figure 20).
- On December 31, 2017, the kidney transplant waiting list had 75,745 candidates on dialysis, 47,996 (63.4%) of whom were active. Eighty-five percent of all candidates were awaiting their first transplant (Figure 17).
- Fewer than a third (28%) of kidneys transplanted in 2017 were from living donors (Figure 20).
- While the overall number of kidney transplants has increased, the unadjusted rate of kidney transplantation among dialysis patients had declined beginning in 2000. However, the rate appears to have stabilized as of 2013, and has started to rise slightly, driven by an increase in deceased-donor transplant rates, over the last three years (Figure 21).

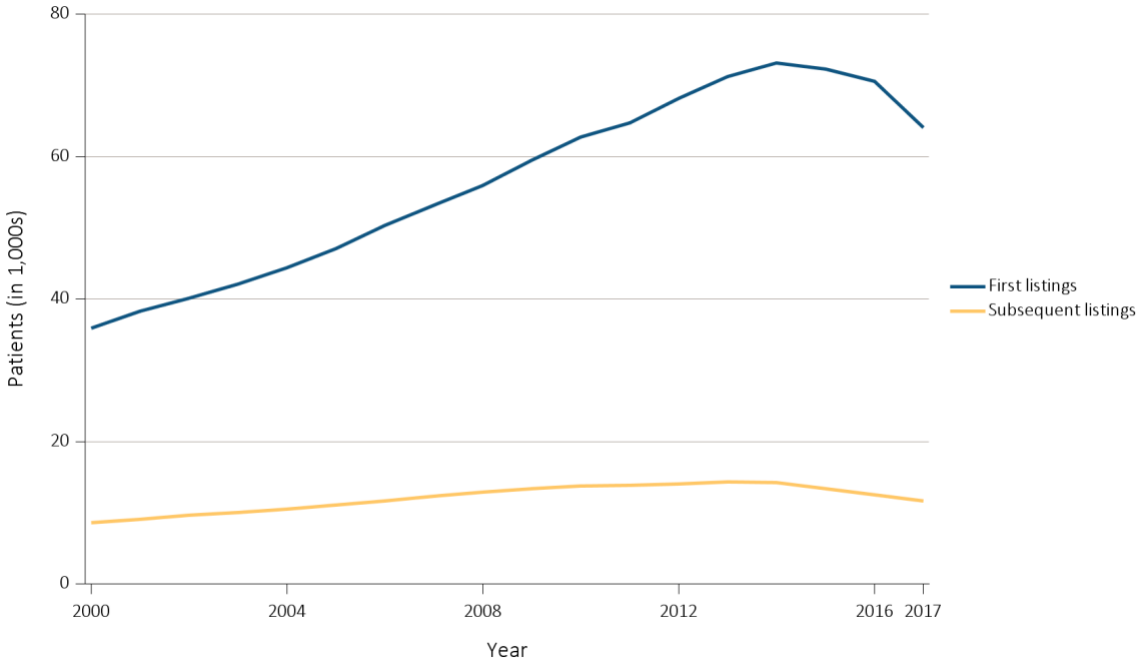
KIDNEY TRANSPLANT WAITING LIST

As of December 31, 2017, the number of people on the kidney transplant waiting list continued to decline, for the third year in a row, by 8.8% over the previous year, to 75,745 candidates (dialysis patients only), 85% of whom were awaiting their first kidney transplant (**Figure 17**). This decline was primarily driven by a reduction in the number of inactive wait-listed candidates to 27,749, an 11.4% reduction compared to the previous year (*Reference Table E.3*). This decrease almost certainly resulted from the Kidney Allocation System (KAS) policy changes, which took effect on December 4, 2014. For patients already on dialysis at the time of listing, the KAS ties the start of waiting time to date of dialysis initiation, regardless of when listing occurred. This change reduced the incentive to list dialysis patients until they are actively ready for transplantation.

For those who meet glomerular filtration rate (GFR) criteria and are pre-dialysis, however, there is still an advantage to listing before dialysis initiation. Nevertheless, with about 21,000 kidney transplants performed in the United States in 2017, the active waiting list remains substantially larger than the supply of donor kidneys, which presents a continuing challenge.

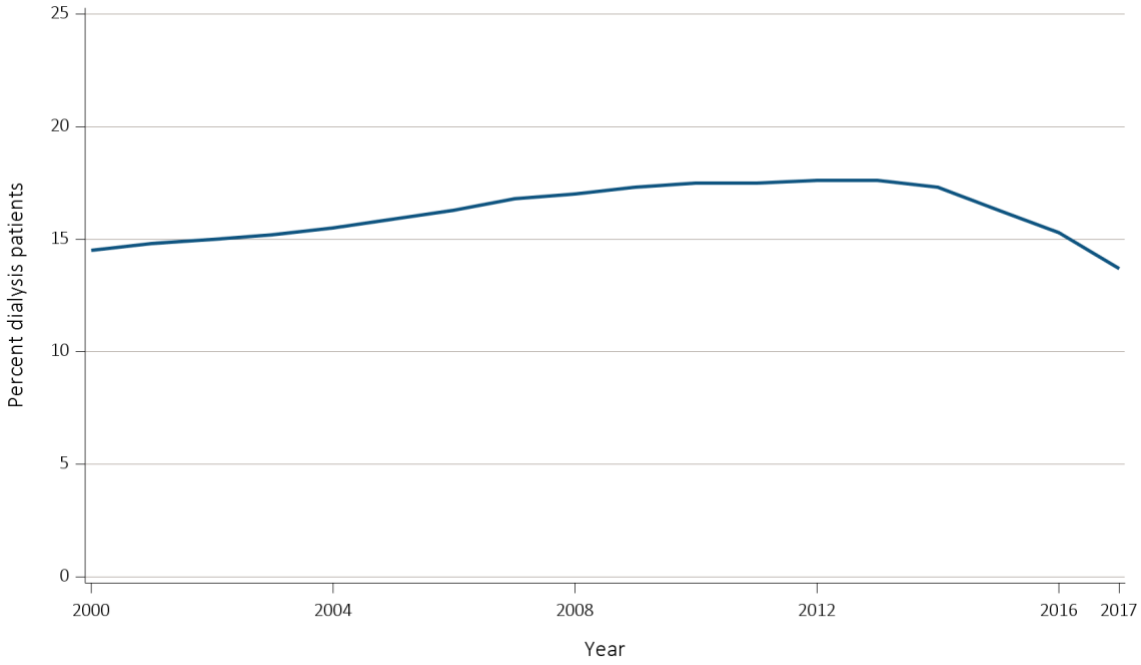
Like the trends for absolute number of wait-listed patients (shown in **Figure 17**), the percentage of prevalent dialysis patients wait-listed for a kidney also continues to decline (**Figure 18**).

Figure 17: Number of patients wait-listed for kidney transplant, 1999-2017



Data Source: Reference Table E.3. Number of patients wait-listed for kidney transplant. Waiting-list counts include all candidates listed for a kidney transplant on December 31 of each year. Note that trends may be influenced by changes to the kidney allocation system (KAS) policy that were implemented in December 2014, as more fully described in the text.

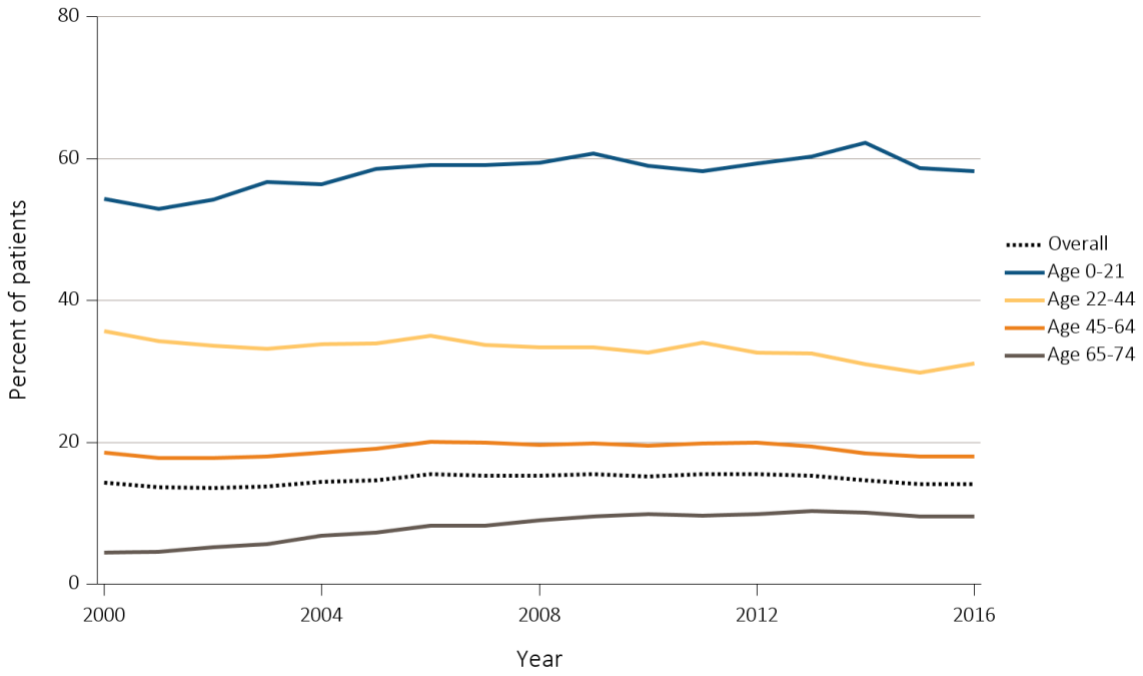
Figure 18: Percentage of dialysis patients who were wait-listed, 1999-2017



Data Source: Reference Table E.4. Percentage of dialysis patients on the kidney waiting list is for all dialysis patients. Note that trends may be influenced by changes to the kidney allocation system (KAS) policy that were implemented in December 2014, as described more fully in the text above.

In 2017, 13.7% of incident ESRD patients who started dialysis that year joined a waiting list or received a deceased or living-donor transplant within one year of ESRD initiation (**Figure 19**). Since 2001, the overall percentage of patients wait-listed or receiving a transplant in their first ESRD year has remained relatively flat (**Figure 19**).

Figure 19: Percentage of incident patients who were wait-listed or received a kidney transplant within one year of ESRD initiation, by age, 1999-2016



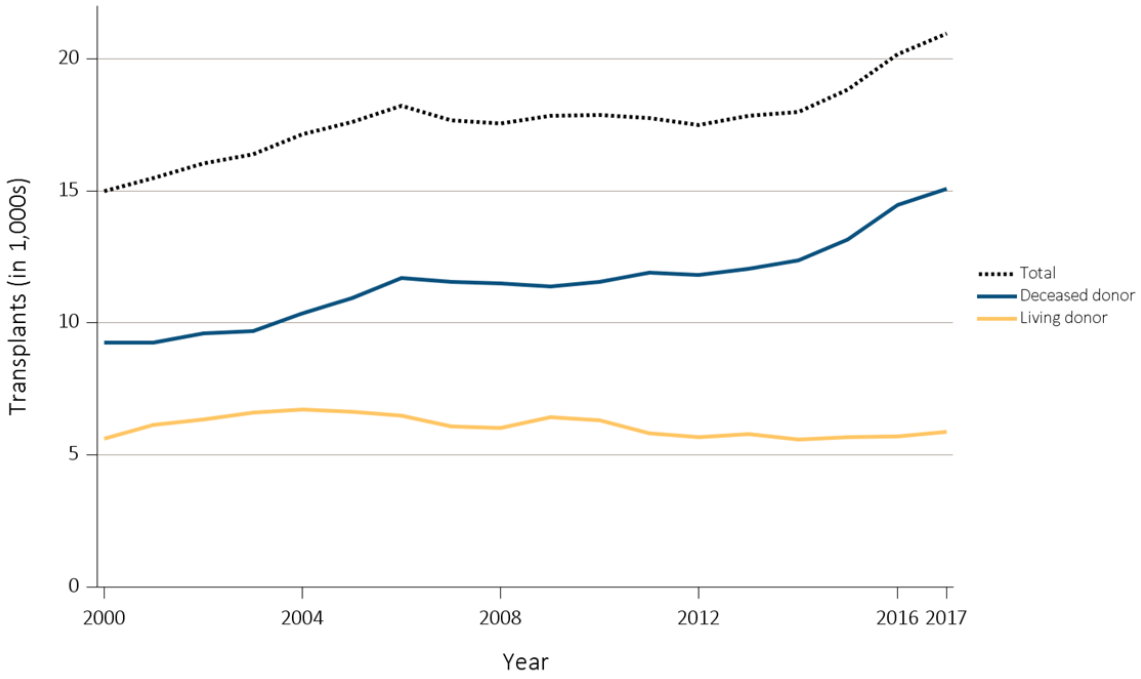
Data Source: Reference Table E.5(2). Waiting list or transplantation among incident ESRD patients by age (0-74 years). Note that trends may be influenced by changes to the kidney allocation system (KAS) policy that were implemented in December 2014, as more fully described in the text above. Abbreviation: ESRD, end-stage renal disease.

TRANSPLANT COUNTS AND RATES

During 2017, 20,945 kidney transplants were performed in the United States (20,467 were kidney-alone), continuing the relatively rapid rise seen over the last few years (**Figure 20**). This increase was exclusively from deceased donors. Of the transplants, 5,870 were identified as originating from living donors (28.0%) and 15,064 (72.0%) from deceased donors.

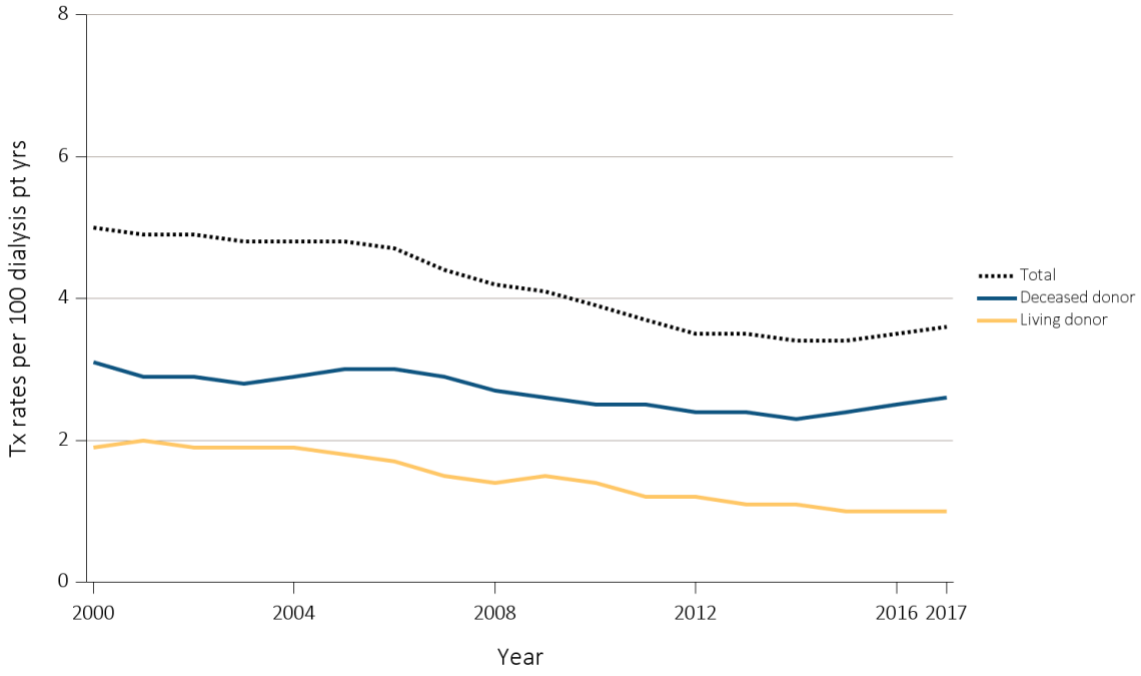
As the overall dialysis population expanded, the annual unadjusted transplant rate per 100 dialysis patient-years saw a continuous decline, although it had plateaued beginning in 2013 (**Figure 21**), it has recently started to increase. The rise is likely driven by the relatively large increase in deceased-donor counts since 2015.

Figure 20: Number of kidney transplants by donor type, 1999-2017



Data Source: Reference Table E.5(2). Waiting list or transplantation among incident ESRD patients by age (0-74 years). Note that trends may be influenced by changes to the kidney allocation system (KAS) policy that were implemented in December 2014, as more fully described in the text above.

Figure 21: Unadjusted kidney transplant rates, by donor type, 1999-2017



Data Source: Reference Table E.9. Unadjusted transplant rates are for all dialysis patients. Note that trends may be influenced by changes to the kidney allocation system (KAS) policy that were implemented in December 2014. Abbreviations: pt yrs, patient-years; tx, transplant.

In 2017, transplant rates increased slightly relative to 2016 for most patient categories (**Table 15**). Most of the increases over the last few years occurred among younger (<65 years) and Black patients, which likely resulted from KAS policy changes.

Table 15: Unadjusted kidney transplant rates, all donor types, by age, sex, race, and primary cause of ESRD, per 100 dialysis patient-years, 2008-2017

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Age										
0-21	32.5	34.6	32.8	32.0	32.5	31.6	31.8	33.2	34.2	35.8
22-44	8.8	8.7	8.1	7.7	7.6	7.3	7.2	8.6	8.5	8.6
45-64	5.1	4.9	4.8	4.5	4.2	4.3	4.1	4.0	4.2	4.5
65-74	2.6	2.6	2.6	2.6	2.5	2.4	2.4	2.2	2.4	2.4
75 and older	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.3
Sex										
Male	4.6	4.4	4.3	4.1	3.9	3.8	3.7	3.7	3.7	3.8
Female	3.7	3.7	3.5	3.3	3.1	3.1	3.0	3.1	3.3	3.3
Race										
White	4.9	4.8	4.4	4.3	4.1	4.0	3.9	3.7	3.9	3.9
Black/African American	2.9	2.9	2.9	2.8	2.5	2.5	2.4	2.7	2.7	2.7
American Indian/Alaska Native	3.4	3.5	2.8	2.9	2.4	2.1	2.6	2.9	2.6	2.8
Asian	5.4	5.0	4.9	4.7	4.6	4.6	4.5	4.9	5.0	5.2
Native Hawaiian or Pacific Islander	3.2	3.1	2.9	2.4	2.4	2.2	2.6	2.6	2.4	2.6
Other or Multiracial	5.2	6.1	6.9	6.7	6.4	3.1	4.1	3.5	4.5	4.4
Unknown	14.0	11.2	8.9	9.5	8.6	8.5	12.8	12.7	11.1	13.0
Primary Cause of ESRD										
Diabetes	2.8	2.7	2.6	2.5	2.3	2.3	2.2	2.0	2.1	2.1
Hypertension	2.9	2.8	2.7	2.5	2.5	2.5	2.4	2.5	2.6	2.8
Glomerulonephritis	8.2	8.1	8.2	7.7	7.4	7.2	7.0	7.6	7.4	7.8
All	4.2	4.1	3.9	3.7	3.5	3.5	3.4	3.4	3.5	3.6

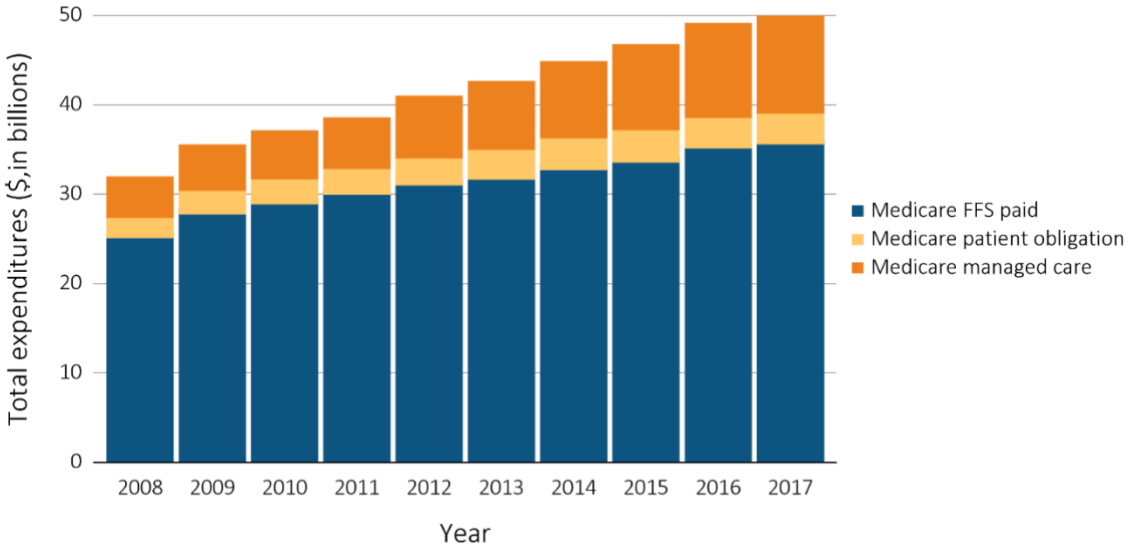
Data Source: Reference Table E.9. Note that trends may be influenced by changes to the kidney allocation system (KAS) policy that were implemented in December 2014. Abbreviation: ESRD, end-stage renal disease.

Healthcare Expenditures for Persons with ESRD

Overall & Per Person Per Year Costs of ESRD

Figure 22 displays Medicare's total annual paid claims for period prevalent ESRD patients from 2008-2017. This represents about three quarters of all spending for the care of US ESRD patients (USRDS, 2014). Medicare fee-for-service (FFS) ESRD spending rose by 1.3% from 2016 to 2017. The Medicare patient obligation amount has also grown over the years in proportion to these paid claims. Patient obligations may be paid by the patient, by a secondary insurer, or may be uncollected. Overall, the patient obligation represented 8.8% of the total fee-for-service Medicare Allowable Payments in 2016. Medicare payments to managed care plans under the Medicare Advantage coverage option also increased from 2008 to 2017.

Figure 22: Trends in fee-for-service ESRD expenditures, 2008-2017

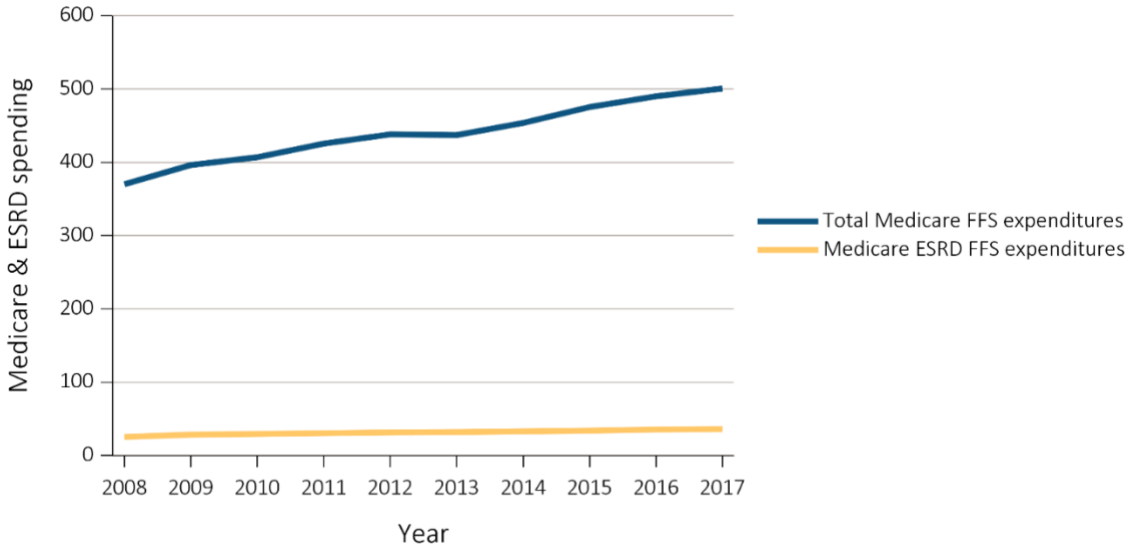


Data Source: USRDS ESRD Database; Reference Table K.1. Abbreviations: ESRD, end-stage renal disease; FFS, fee-for-service.

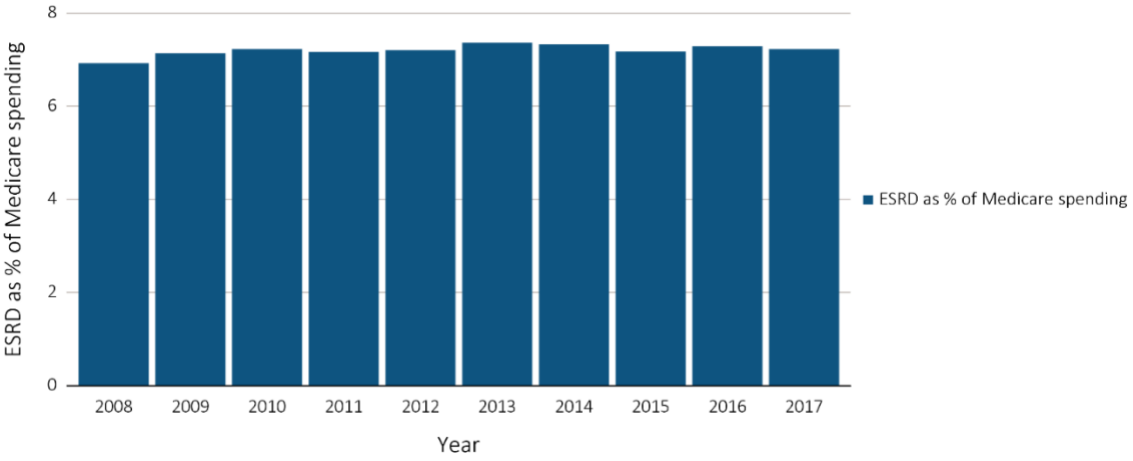
As illustrated in **Figure 23**, total Medicare fee-for-service spending in the general Medicare population increased by 2.1% in 2016 to $500.5 billion. The spending for ESRD patients of $35.9 billion accounted for 7.2% of the overall Medicare paid claims in the fee-for-service system, a share that has remained approximately constant during the current decade.

Figure 23: Trends in (a) total Medicare & ESRD fee-for-service spending ($, in billions), and (b) ESRD spending as percentage of Medicare fee-for-service spending, 2008-2017

(a) Total Medicare & ESRD FFS spending ($, in billions)



(b) ESRD spending as percentage of total Medicare FFS spending

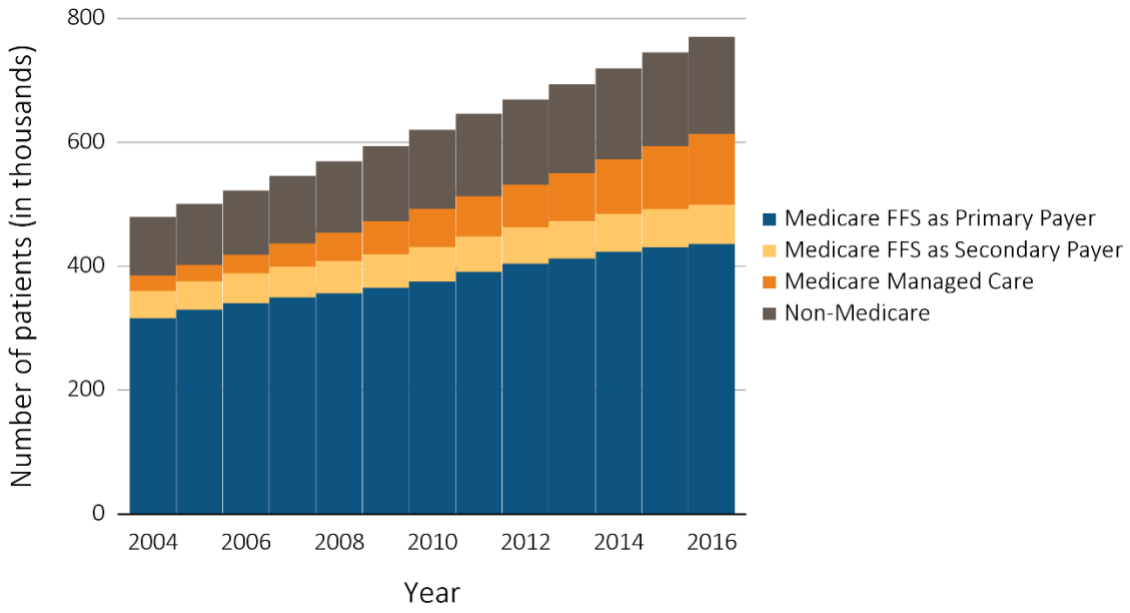


Data Source: Total ESRD spending obtained from USRDS ESRD Database; Reference Table K.1. Total Medicare expenditures obtained from Trustees Report, Table II.B1 https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/TrusteesReports.html*. Abbreviations: ESRD, end-stage renal disease; FFS, fee-for-service.*

Funding Sources for the ESRD Population

Figure 24 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 fee-for-service as primary payer (MPP), Medicare fee-for-service as secondary payer (MSP), Medicare Advantage managed care plans, or non-Medicare. Non-Medicare patients in the EDB included those who were pre- or post-Medicare entitlement. The number of ESRD patients with MPP grew by 1.2% from 2015 (435,873) to 2016 (441,162). The MSP ESRD population increased by 2.8% from 2015 (61,610) to 2016 (63,340), while the Medicare managed care and non-Medicare ESRD population increased by 12.4% and 3.8%, to 114,316 and 146,354, respectively.

Figure 24: Trends in numbers of point prevalent ESRD patients, 2004-2016



Data Source: USRDS ESRD Database. December 31 point prevalent ESRD patients. Abbreviations: ESRD, end-stage renal disease; FFS, fee-for-service.

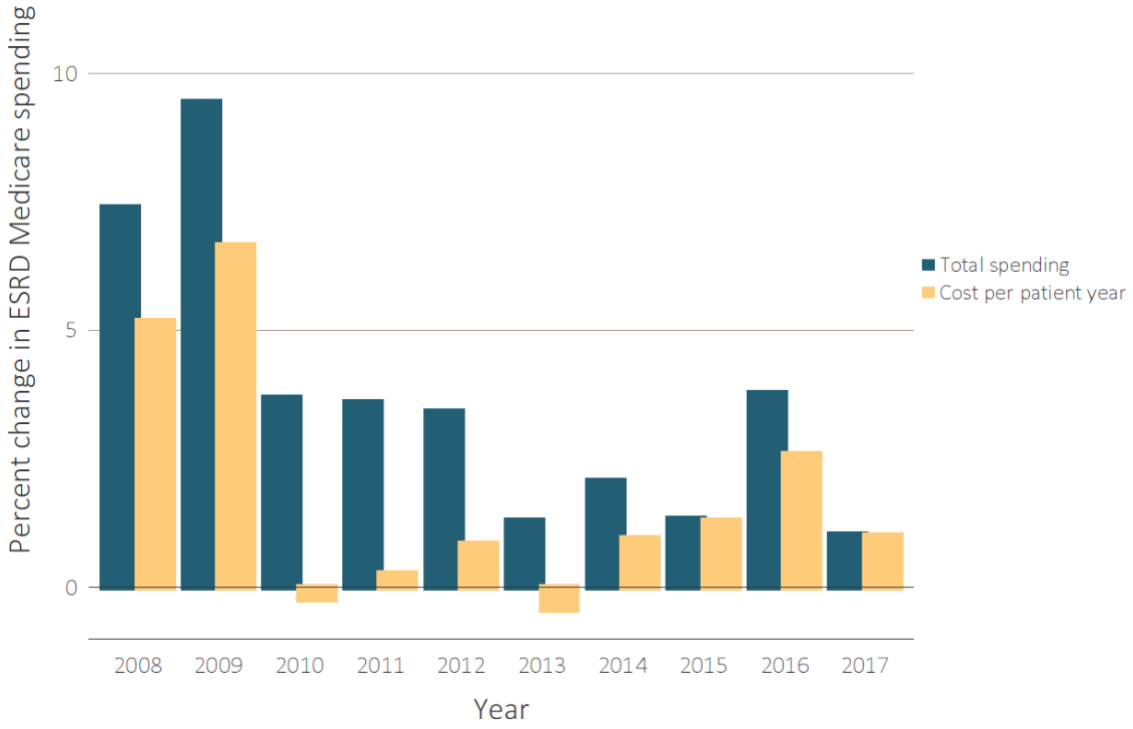
Figure 25 displays the annual percent change in Medicare ESRD fee-for-service spending for all ESRD patients for whom Medicare is the primary payer. Part D costs are included in these measures. However, as Part D is a voluntary component of the Medicare program, some recipients do not participate or 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 eighth consecutive year, the annual increase in total Medicare ESRD spending for beneficiaries with primary payer status was less than 5%. In 2017, total Medicare paid claims for ESRD services and supplies increased by 1% to $32.6 billion (see **Figure 25**; for total and specific values see *Reference Table K.4*).

In 2017, ESRD PPPY spending increased by 1%. For the second year in a row, most of the increase in Medicare expenditures for beneficiaries with ESRD was attributable to higher PPPY spending rather than

growth in the number of covered lives. This reverses the trend from 2010-2013 when increases in covered lives were the primary cause of spending growth. In 2014, changes in PPPY spending and covered lives contributed about equally to total spending growth.

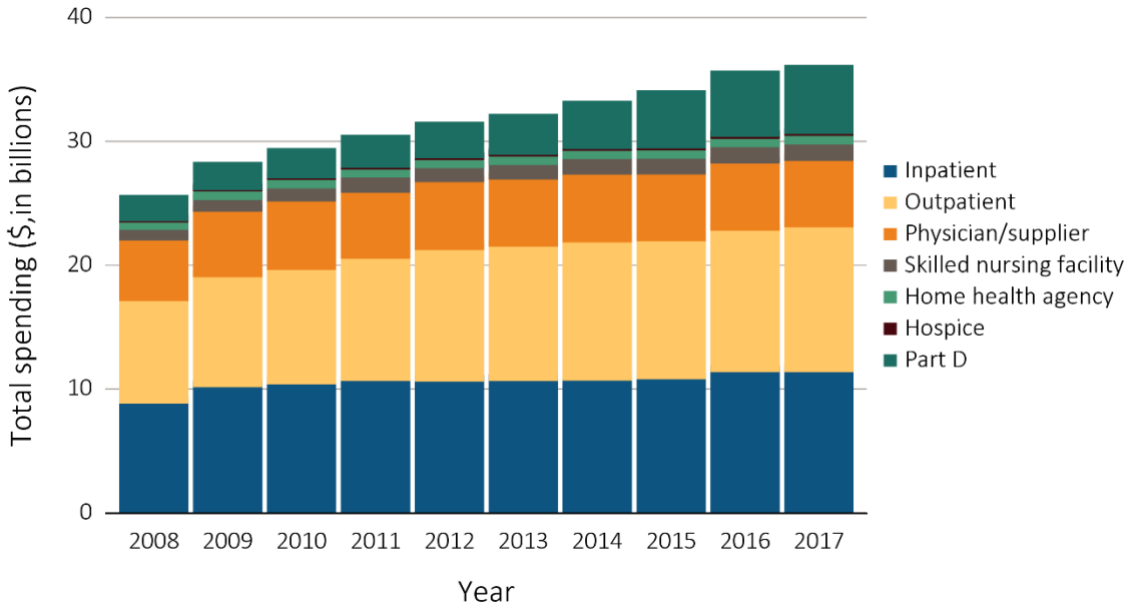
Figure 25: Annual percent change in Medicare ESRD spending, 2008-2017



Data Source: USRDS ESRD Database; Reference Table K.4. Total Medicare ESRD costs from claims data; includes all claims with Medicare as primary payer only. Abbreviation: ESRD, end-stage renal disease.

Total Medicare fee-for-service spending for ESRD patients is reported by type of service in **Figure 26**. Between 2016 and 2017, spending for Part D claims grew faster (4.7%) than spending for any other claim type. All other categories of spending rose by less than 3%. The smallest share of Medicare spending for ESRD patients was for hospice care, which increased by 0.4% in 2017.

Figure 26: Trends in total Medicare fee-for-service spending for ESRD, by type of service, 2008-2017



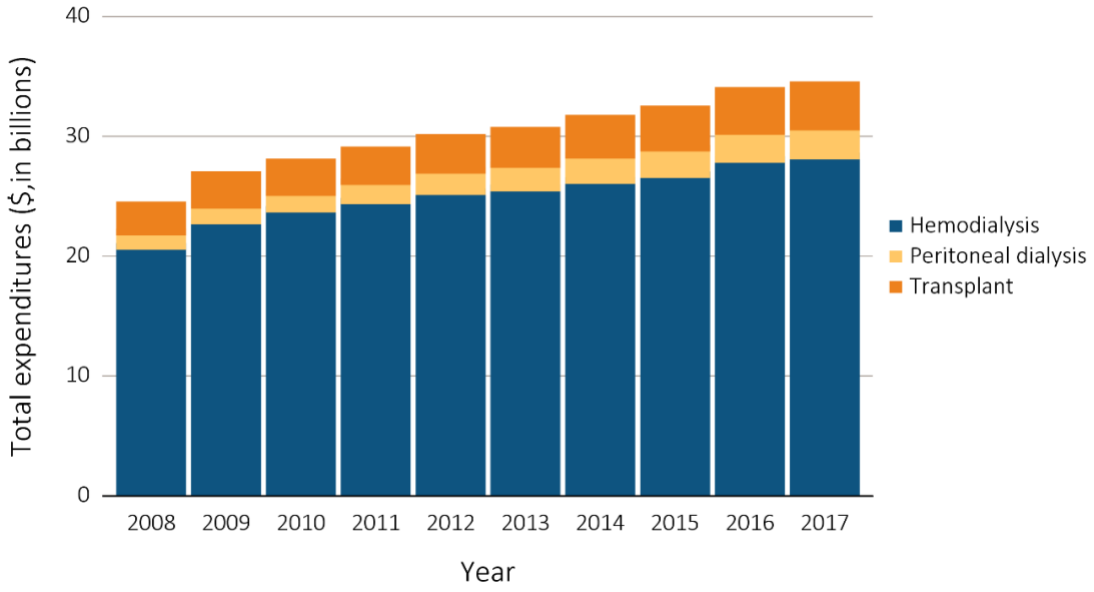
Data Source: USRDS ESRD Database; Reference Table K.1. Total Medicare costs from claims data. Abbreviation: ESRD, end-stage renal disease.

ESRD Spending by Modality

For patients receiving HD, both total and PPPY fee-for-service spending increased by 1.3% and 0.6%, respectively, between 2016 and 2017 (**Figures 27** and **28**). Note that total spending includes costs for beneficiaries with Medicare as either primary or secondary payer, and PPPY amounts include only beneficiaries with Medicare as primary payer.

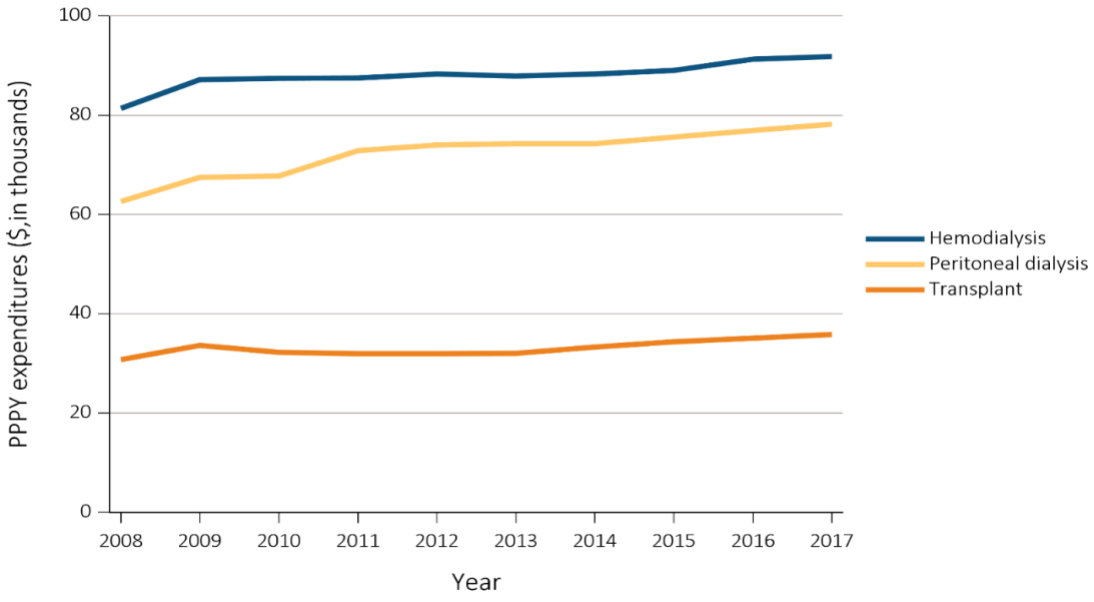
Between 2016 and 2017, total spending on PD increased by 3%, as the share of patients receiving PD continued to rise. However, while growth on PD spending on a PPPY basis also increased slightly between 2016 and 2017 (1.6%), it remained less costly on a per-patient basis in 2017 ($78,159) than HD ($91,795). Finally, transplant spending in 2017 increased from 2016 levels by 3.8% in total and 2.1% in PPPY expenditures. In 2017, the PPPY cost for transplant patients, $35,817, remained far lower than spending for either dialysis modality.

Figure 27: Total Medicare ESRD expenditures, by modality, 2008-2017



Data Source: USRDS ESRD Database. Total Medicare costs from claims data for period prevalent ESRD patients. Abbreviation: ESRD, end-stage renal disease.

Figure 28: Total Medicare ESRD expenditures per person per year, by modality, 2008-2017



Data Source: USRDS ESRD Database; Reference Tables K.7, K.8, & K.9. Period prevalent ESRD patients; includes all claims with Medicare as primary payer only. Abbreviations: ESRD, end-stage renal disease; PPPY, per person per year.

ESRD among Children, Adolescents, and Young Adults

Highlights

- The number of children and adolescents beginning end-stage renal disease (ESRD) care is steadily decreasing from a high of 17.5 per million in 2004 to 12.9 per million population in 2017, representing a decrease of 26.3% (Figure 29.a/c).
- As of December 31, 2017, the point prevalence of children and adolescents, 0 to 21 years of age, with ESRD was 8,959, or 98.7 per million population (Figure 29.b/d).
- 16.1% of incident and 72.8% of prevalent children and adolescents with ESRD have kidney transplants, in 2017 (Figure 29).

Epidemiology of End-stage Renal Disease in Children

The number of children and adolescents beginning ESRD care is steadily decreasing from a high of 17.5 per million population (PMP) in 2004 to 12.9 PMP in 2017—a decline of 26.3% (**Figure 29.a/c**). The ESRD incidence varies by age group; in 2017 there were 181 cases in those aged 0-4 years, 105 aged 5-9, 155 aged 10-13, 294 aged 14-17, and 438 aged 18-21 years, for a total of 1,173 children with incident ESRD in 2017. Within these age-based cohorts, incidence rates in 2017 were 9.1 PMP per year for 0-4 year olds, 5.2 for 5-9 year olds, 9.3 for 10-13 year olds, 17.5 for those aged 14-17 years, and 25.6 PMP for those aged 18–21 years.

As of December 31, 2017, the point prevalence of children, 0 to 21 years of age, with ESRD was 8,959, or 98.7 PMP (**Figure 29.b/d**). Overall, the prevalence of ESRD in children in the United States has been generally stable for the most recent decade.

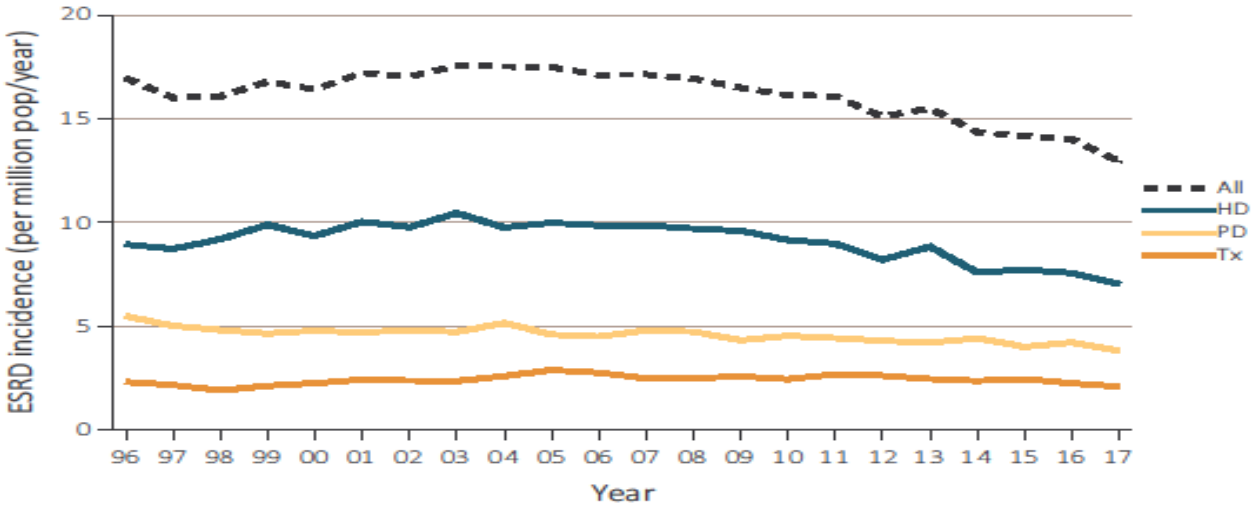
Incidence and Prevalence by ESRD Modality

Although PD is not frequently used in adults, its use is much greater in young children. However, children initiate ESRD therapy with HD more frequently than PD or transplantation. In 2017, 638 (54.4%) initiated therapy with HD, 346 (29.5%) with PD, and 189 (16.1%) with transplant.

Of the 8,959 children and adolescents under 22 years of age with prevalent ESRD as of December 31, 2017, kidney transplant was the most common ESRD modality (6,518; 72.8%), followed by HD (1,500; 16.7%) and PD (924; 10.3%) (**Figure 29.b**). This equates to a point prevalence PMP children of 16.5 for HD, 10.2 for PD, and 71.8 for transplant.

Figure 29: (a, c) Incidence and (b, d) December 31 point prevalence of ESRD among pediatric patients (aged 0–21 years) per million population per year, by modality and race, 1996-2016

(a) Incidence by modality



(b) Point prevalence by modality

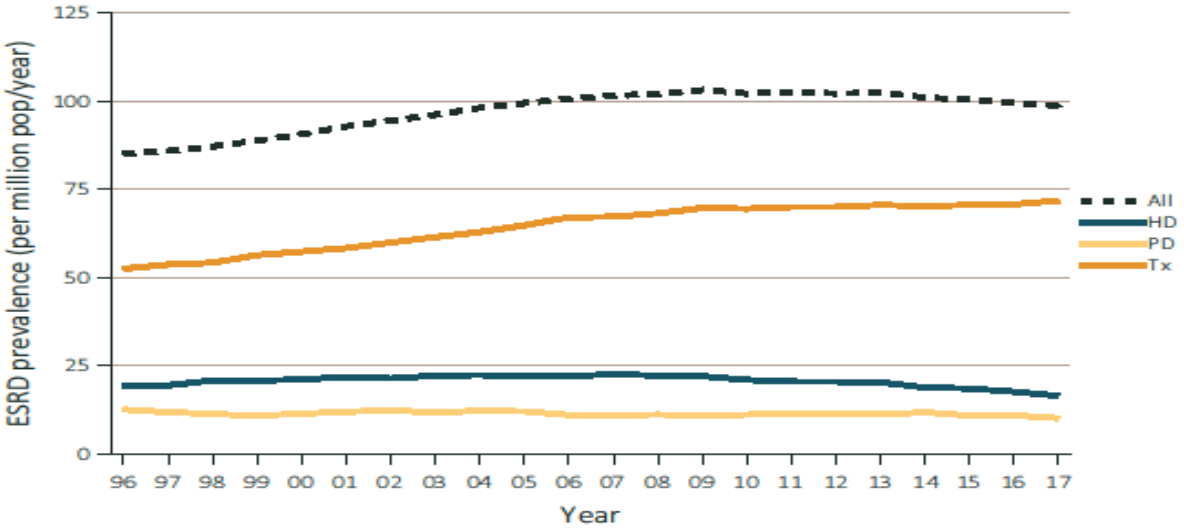
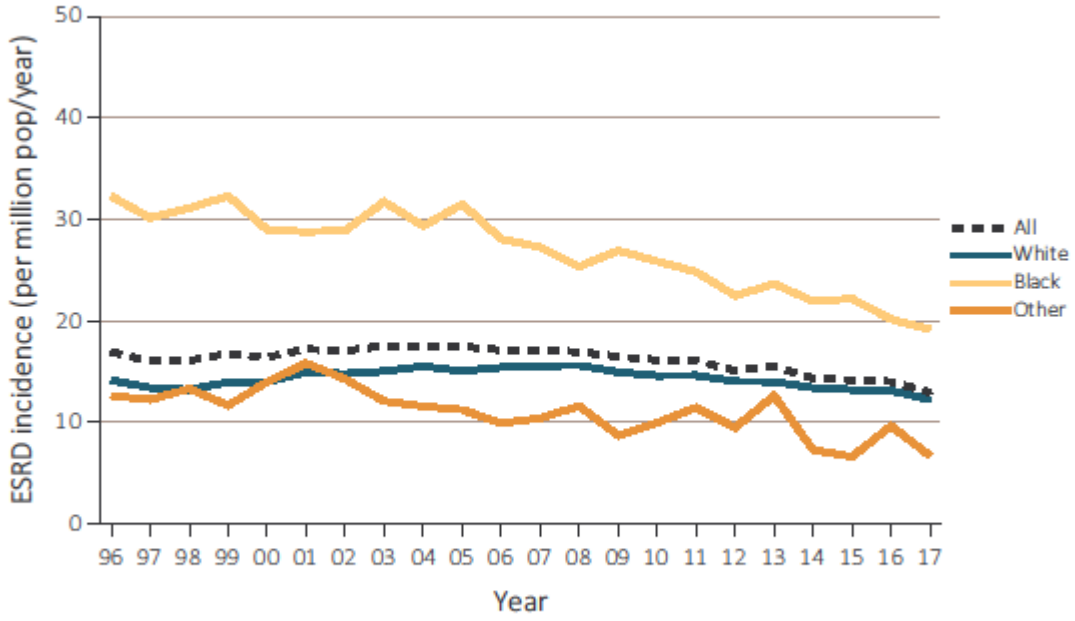
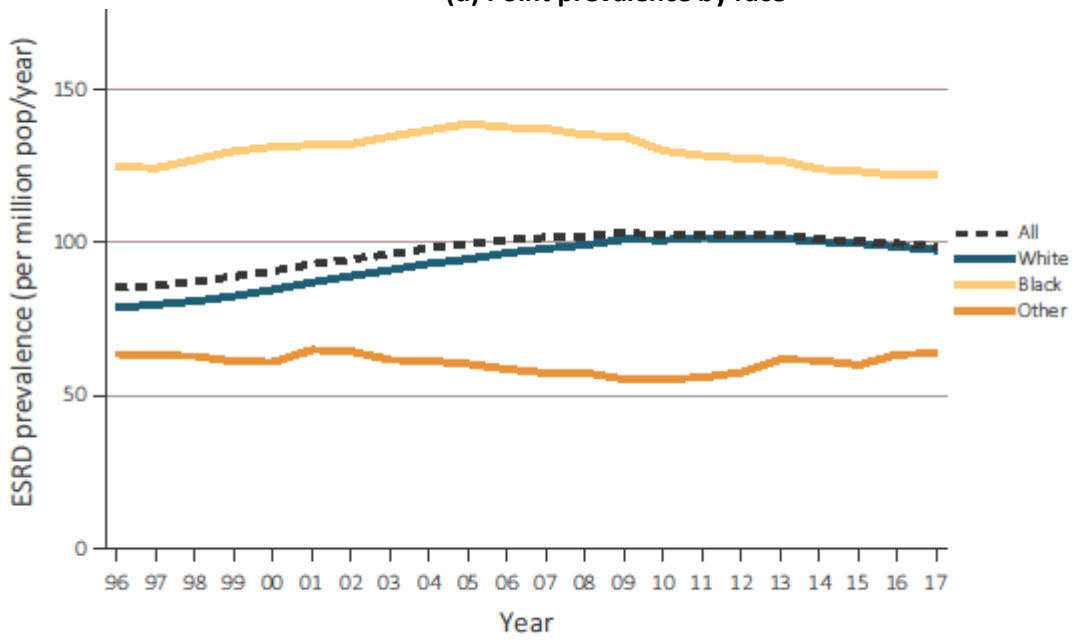


Figure 29, continued: (a, c) Incidence and (b, d) December 31 point prevalence of ESRD among pediatric patients (aged 0–21 years) per million population per year, by modality and race, 1996-2016

(c) Incidence by race



(d) Point prevalence by race



Data Source: Special analyses, USRDS ESRD Database. This special analyses exclude US territories, unknown age, sex and unknown/other races. Peritoneal dialysis consists of continuous ambulatory peritoneal dialysis and continuous cycling peritoneal dialysis. All consists of hemodialysis, peritoneal dialysis, uncertain dialysis, and transplant. Adjusted for age, sex and race. Reference population: 2011 US population. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

MORTALITY

For patients beginning ESRD therapy during 2008-2012, the probability of five-year survival was 0.91 (**Figure 30.b**). The probability of surviving five years by age was the worst for the youngest and oldest subsets, including 0.83 for ages 0-4 and 0.89 for ages 18-21 years (**Figure 30.a**). Patients initiating ESRD care with transplantation had the highest probability of surviving five years, at 0.98, as compared to 0.84 with HD, and 0.87 with PD (**Figure 30.b**).

Figure 30: Adjusted five-year survival in incident pediatric patients (aged 0-21 years) from day 1, by (a) age and (b) modality, 2008-2012

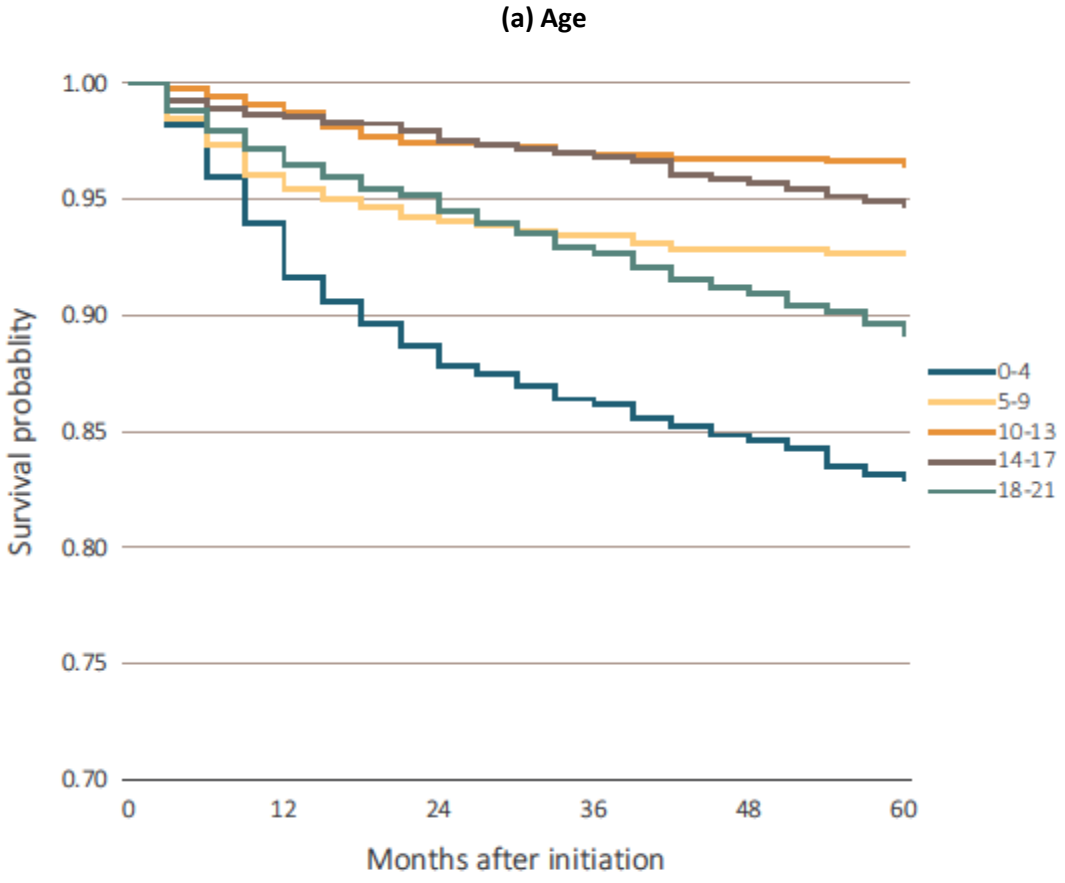
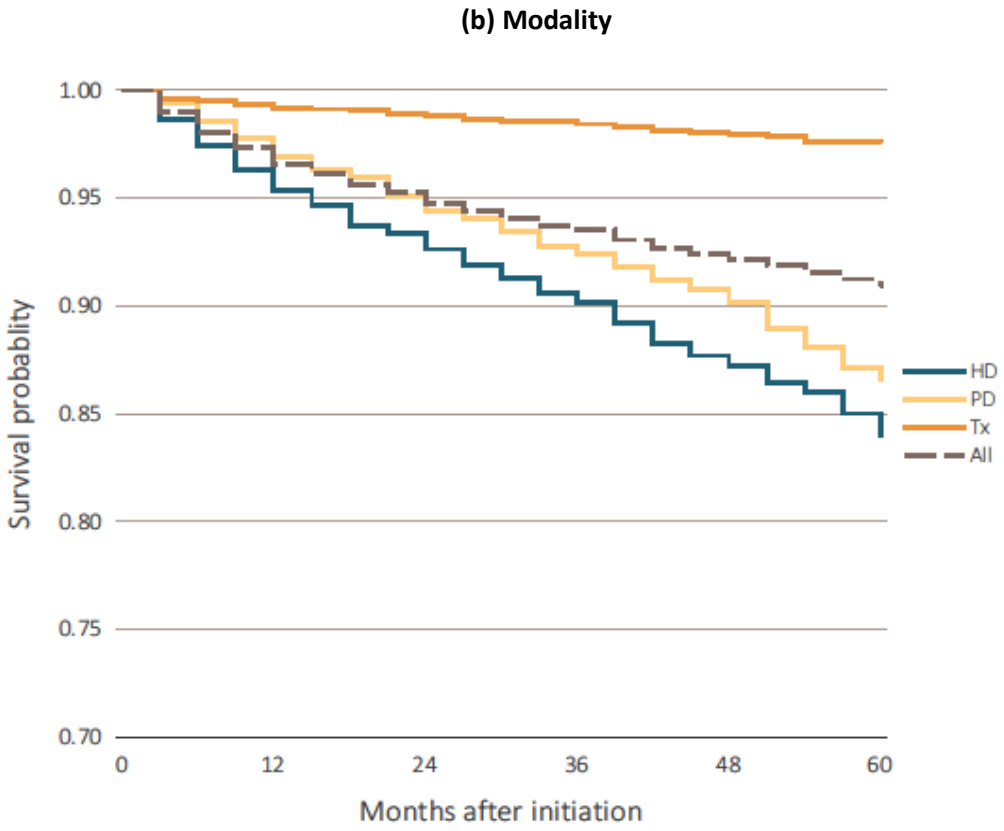


Figure 30, continued: Adjusted five-year survival in incident pediatric patients (aged 0-21 years) from day 1, by (a) age and (b) modality, 2008-2012



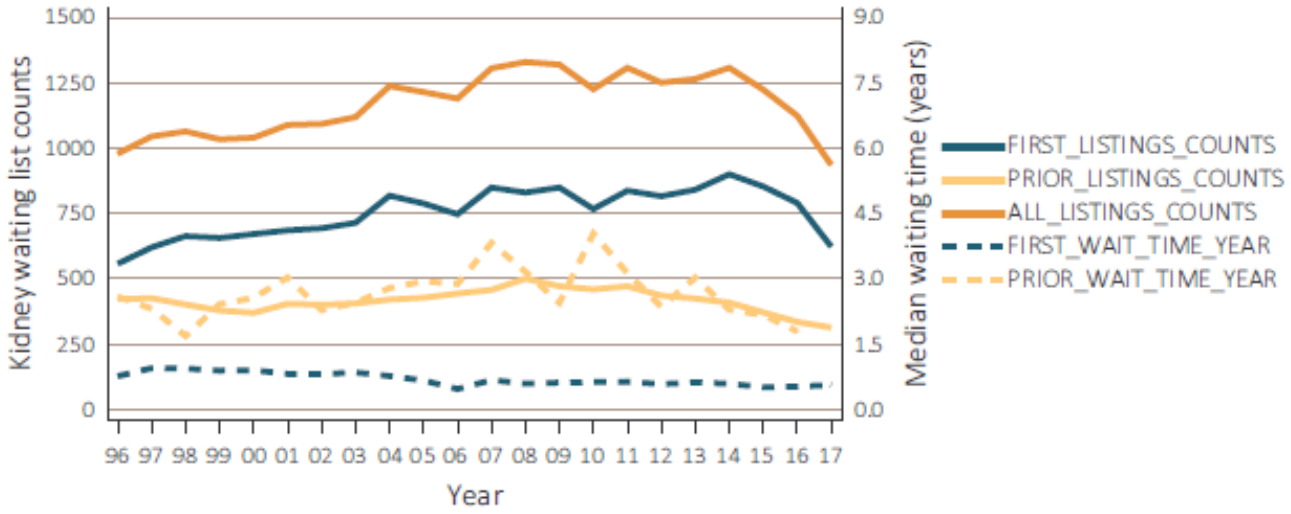
Data Source: Special analyses, USRDS ESRD Database. This special analyses exclude US territories, unknown age and sex. Incident dialysis and transplant patients defined at the onset of dialysis or the day of transplant without the 60-day rule; followed to December 31, 2017. (a) Adjusted for sex, race, primary cause of ESRD, and Hispanic ethnicity. (b) Adjusted for age, sex, race, primary cause of ESRD and Hispanic ethnicity. Reference population: incident ESRD patients aged 0-21, 2010-2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Tx, transplant.

Vascular Access

When examining race and etiology of ESRD in age-adjusted analysis, 36.6% of children received a kidney transplant within their first year of ESRD care, including 30.1% of children with weight greater than or equal to 10 kg (data not shown).

In 2017, 936 children were wait-listed for a kidney transplant, including 623 patients listed for the first time and 313 patients listed for repeat transplant. The number of patients awaiting a kidney transplant has ranged from 936 to 1,330 since 2004 (**Figure 31**).

Figure 31: Trends in pediatric transplantation (aged 0-21 years), by kidney transplant counts and waiting list times, patients 18-21 years



Data Source: 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 2012. Abbreviations: ESRD, end-stage renal disease; Tx, transplant.