2015 USRDS Annual Data Report
Volume 1: CKD in the United States

Introduction to Volume 1: CKD in the United States

Introduction

Chronic kidney disease (CKD) has continued to receive more attention, primarily since the consensus definition and staging classification of CKD was first published by the National Kidney Foundation (NKF) Kidney Disease Outcomes Quality Initiative (KDOQI) (NKF, 2002). Federal agencies have also done much to raise awareness of CKD as a significant public health problem. The USRDS Annual Data Report (ADR) first included a chapter addressing CKD in 2002, and expanded this to a multi-chapter CKD volume in 2008. In 2002, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) launched a National Kidney Disease Education Program (NKDEP; NIDDK, 2002). NKDEP provides information for patients and providers regarding the detection of CKD and care of people with the disease.

The Centers for Disease Control and Prevention (CDC) supports a CKD initiative (CDC, 2015) with the CKD Surveillance Program as its major component; since 2007, this project has reported on many aspects of this important chronic condition.

A nexus between the common non-communicable diseases (NCDs), such as diabetes mellitus, hypertension, obesity, and CKD is well recognized. Over the last decade, the relationship between acute kidney injury (AKI) and CKD has received greater attention (Chawla et al., 2014). During the 2011 High-Level Meeting of the United Nations General Assembly on Prevention and Control of NCDs, it was recognized that, similar to other chronic NCDs, renal diseases "...pose a major health burden for many countries and that these diseases share common risk factors and can benefit from common responses to non-communicable diseases" (United Nations, 2011). The Meeting concluded, however, that CKD could be addressed as a complication of the four main NCDs highlighted by the World Health Organization: cardiovascular disease, cancer, chronic lung diseases, and diabetes mellitus. At present, the national NCD public health programs of many countries do not specifically include CKD as a public health priority. It is imperative that CKD be recognized as an NCD in its own right, and directly addressed in national programs to combat NCDs around the world. CKD is common, and is associated with high morbidity, mortality, and cost, yet is readily identifiable by simple testing of blood and urine. Timely recognition and treatment has the potential to delay progression of the disease and reduce complications.

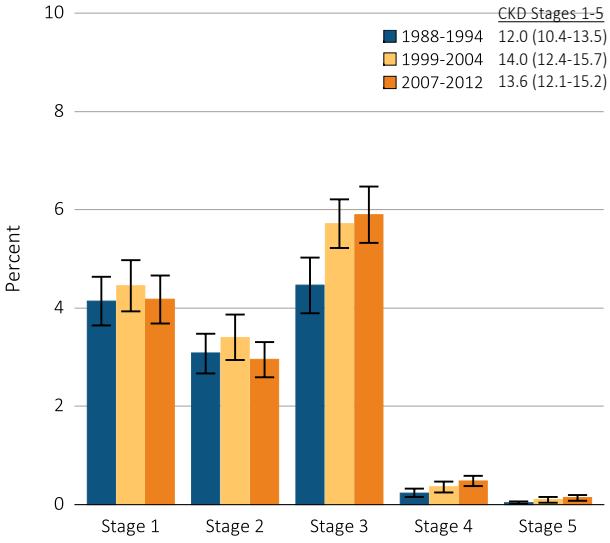
While the number of new patients with end-stage renal disease (ESRD) appears to be stabilizing in the United States, the need to further reduce both the incidence and prevalence of this devastating complication of kidney disease cannot be overemphasized. The key to success is undoubtedly in the realm of prevention and optimal management of CKD in order to slow progression with the goal of completely avoiding ESRD. Large observational studies have shown that even mild to moderate reductions in kidney function and small quantities of albumin in the urine are associated with high rates of all-cause mortality and cardiovascular mortality in particular (Chronic Kidney Disease Prognosis Consortium, 2010; Astor et al., 2011). CKD has therefore been appropriately recognized as a cardiovascular risk equivalent (Sarnak et al., 2003).

Volume 1 of the 2015 USRDS ADR provides key statistics on CKD in the United States. Volume 1 includes the following chapters: CKD in the General Population (Chapter 1); Identification and Care of Patients With CKD (Chapter 2); Morbidity and Mortality in Patients With CKD (Chapter 3); Cardiovascular Disease in Patients With CKD (Chapter 4); Acute Kidney Injury (Chapter 5); Medicare Expenditures for Persons With CKD (Chapter 6); Medicare Part D Prescription Drug Coverage in Patients With CKD (Chapter 7); and Transition of Care in Chronic Kidney Disease (Chapter 8).

Chapter 1: CKD in the General Population

As for many other conditions, the National Health and Nutrition Examination Survey (NHANES) has been a valuable resource for estimation of the prevalence of CKD in the United States. Chapter 1 uses these data to describe CKD in the U.S. general (non-institutionalized) population of people aged 20 and older. We find that CKD is more common than diabetes mellitus in the United States; an estimated 13.6% of adults have CKD, compared to 12.3% with diabetes mellitus (CDC, 2015b). This may well be an overestimate of CKD prevalence, as it is based on the single point estimates of serum creatinine and urine albumin available in the NHANES survey, while the consensus clinical definition of CKD requires the demonstration of persistent abnormality over at least a three-month period. However, for public health surveillance of CKD, a single measurement in stable, ambulatory individuals appears to be a satisfactory compromise, as implementation of two or more measurements is likely not practical in a national study such as NHANES. As shown in Figure i.1, the overall prevalence of CKD increased from 12% to 14% between 1988-1994 and 1999-2004 , but has since remained relatively stable. The largest increase has occurred in patients with Stage 3 CKD, from 4.5% to 6.0% since 1988.

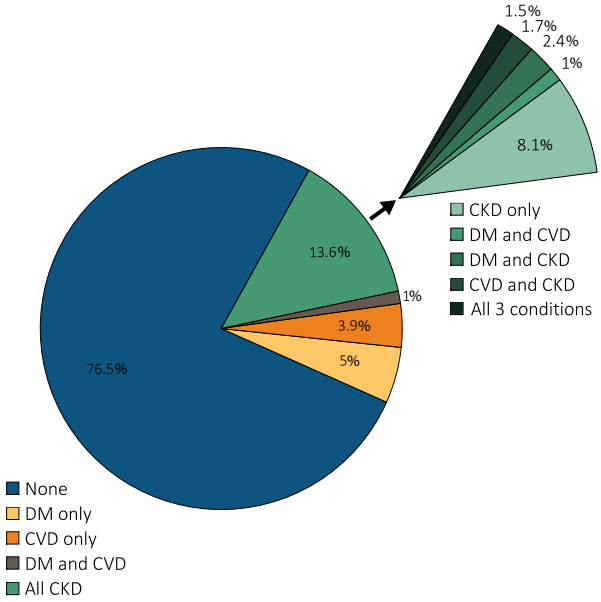
vol 1 Figure i.1 Prevalence of CKD by stage among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Whisker lines indicate 95% confidence intervals. Abbreviations: CKD, chronic kidney disease. This graphic also appears as Figure 1.2.

Aging as a risk factor for CKD has emerged as important theme in recent years. Other important and clinically relevant risk factors that should prompt screening for the presence of CKD include the presence of diabetes mellitus, hypertension, cardiovascular disease, obesity, or metabolic syndrome, a family history of ESRD or CKD, and a history of AKI. Consistent with the fact that CKD often occurs in the context of multiple comorbidities and has been termed a 'disease multiplier', we find that almost half of individuals with CKD also have diabetes and self-reported cardiovascular disease (Figure i.2).

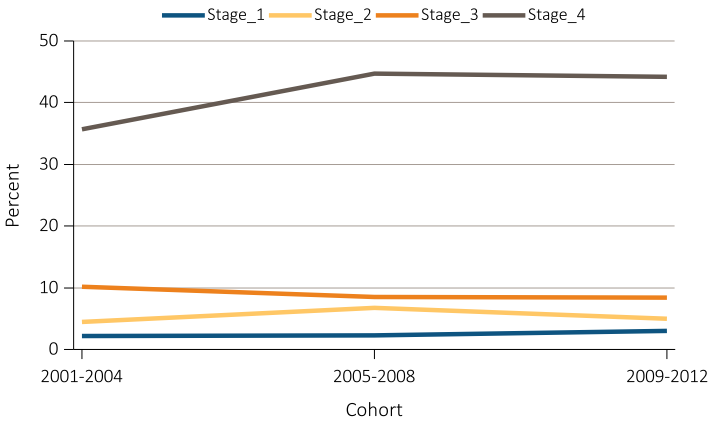
vol 1 Figure i.2 Distribution of NHANES participants with diabetes, self-reported cardiovascular disease, & single-sample markers of CKD, 2007-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Note: Cardiovascular disease designation is based on self-report of any CVD condition (see CKD Analytical Methods chapter for detail); CKD is defined as eGFR <60 or ACR ≥30. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; SR CVD, self-reported cardiovascular disease. This graphic also appears as Figure 1.1.

CKD is a notoriously silent disease, and patient awareness remains very low at less than 10% for those with Stages 1-3 CKD (Figure i.3). Not surprisingly, awareness is higher among those with Stage 4 CKD, by which time patients often experience overt symptoms.

vol 1 Figure i.3 NHANES participants with CKD aware of their kidney disease, 2001-2012

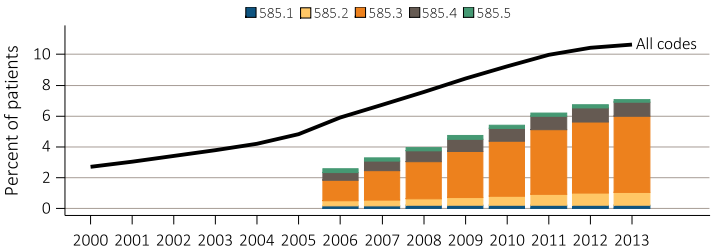


Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2012 participants aged 20 & older. Abbreviations: CKD, chronic kidney disease. This graphic also appears as Figure 1.16.

Chapter 2: Identification and Care of Patients With CKD

While the NHANES continues to serve as a rich source of information for estimating the prevalence of CKD and analyzing risk factors, it does not contain health system derived data, such as claims data from Medicare or other health plans or health systems. For this reason, this chapter utilizes 'recognized CKD,' which is indicated by the presence of a CKD diagnosis on an inpatient claim or two outpatient claims for services reimbursed by Medicare. Chapter 2 presents findings from the Medicare 5 percent sample for age-eligible Medicare enrollees (aged 65 and older), which is a very high-risk population for development of CKD and other comorbid conditions. Data for adults aged 20 and older can be found in the accompanying Reference Tables for this volume. The prevalence of recognized CKD in the Medicare population aged 65 years and older continues to rise over time, peaking at 10.7% in 2013, as shown in Figure i.4. This diagnosis claims-based estimate likely underestimates the true prevalence of CKD in enrollees using Medicare-reimbursed health care services (especially when compared to the high rate of CKD estimated from NHANES), but has high specificity, identifying the individuals likely to have an accurate diagnosis.

vol 1 Figure i.4 Trends in prevalence of recognized CKD, overall and by CKD stage, among Medicare patients aged 65+, 2000-2013

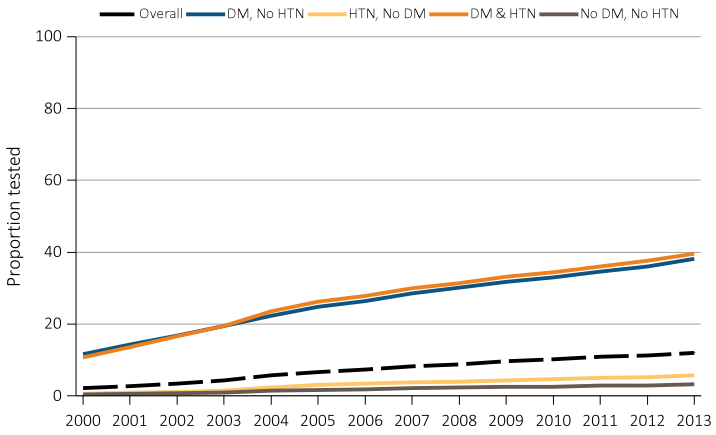


Data Source: Special analyses, Medicare 5 percent sample. Known CKD stages presented as bars; curve showing "All codes" includes known CKD stages (codes 585.1-585.5) and the CKD-stage unspecified codes (585.9, and remaining non-585 CKD codes). Note: In previous years, this graph reported 585.9 codes as a component of the stacked bars. Abbreviation: CKD, chronic kidney disease. This graphic also appears as Figure 2.1.

New this year, progression of CKD using stage-specific claims from a cohort of Medicare patients in 2008 was assessed over the period 2012-2013 (see Vol 1 Chapter 2, Table 2.5). Among patients with CKD Stages 4-5 in 2008, roughly 60% had died as of 2013 and 8% were alive with ESRD as of 2013.

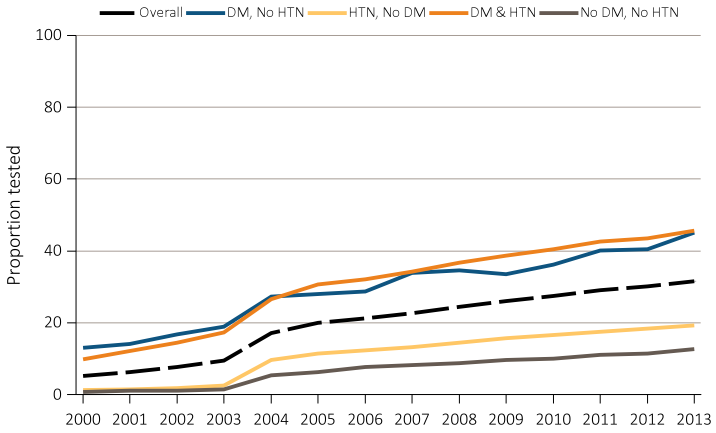
Urine albumin testing is important for monitoring patients with diabetes mellitus, and the recent Kidney Disease: Improving Global Outcomes (KDIGO) guidelines on CKD evaluation and management emphasize the importance of testing CKD patients for the presence of albuminuria in addition to estimated glomerular filtration rate (eGFR) for risk stratification purposes (KDIGO, 2013). In Medicare patients with or without CKD, the proportions with rates of urine albumin testing in the Medicare population have increased slowly over time in both those without and with CKD (Figures i.5 and i.6). Among patients with CKD, those seeing a nephrologist were more likely to receive urine albumin testing (Vol 1 Chapter 2, Table 2.7).

vol 1 Figure i.5 Trends in proportion of patients with urine albumin testing, by year, among Medicare patients aged 65+ WITHOUT a diagnosis of CKD, 2000-2013



Data Source: Special analyses, Medicare 5 percent sample. Patients 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. This graphic is adapted from Figure 2.3.a.

vol 1 Figure i.6 Trends in proportion of patients with urine albumin testing, by year, among Medicare patients aged 65+ WITH a diagnosis of CKD, 2000-2013



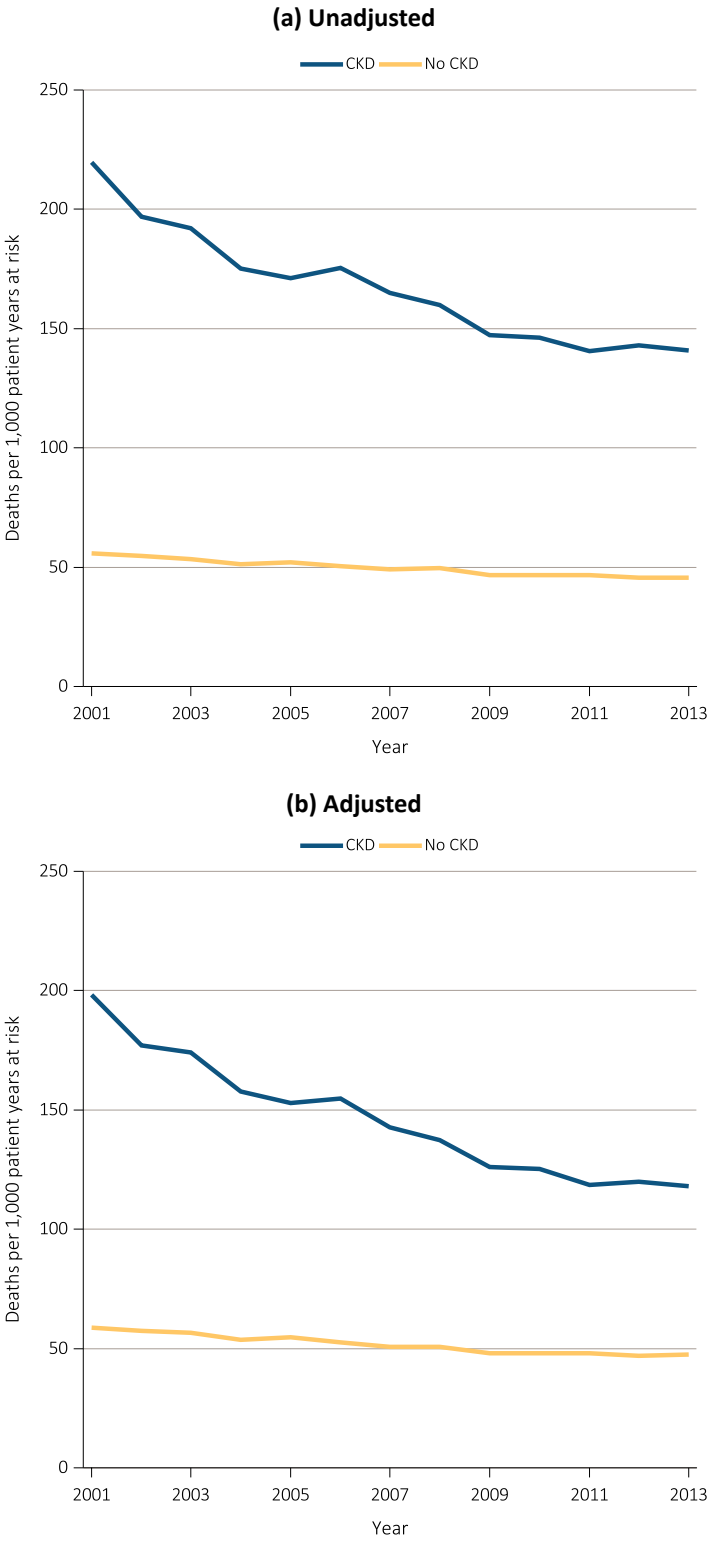
Data Source: Special analyses, Medicare 5 percent sample. Patients aged 65 and older with Part A & B coverage in the prior year. Tests tracked during each year. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension. This graphic is adapted from Figure 2.4.a.

Chapter 3: Morbidity and Mortality in Patients With CKD

Chapter 3 examines hospitalization and mortality for Medicare CKD patients as compared to other Medicare patients. Adjusted mortality rates are higher for Medicare patients with CKD than those without, and rates increase with CKD stage, a finding consistent with studies using biochemical measures to define CKD (serum creatinine with validated equations to eGFR, as in Matsushita et al., 2010).

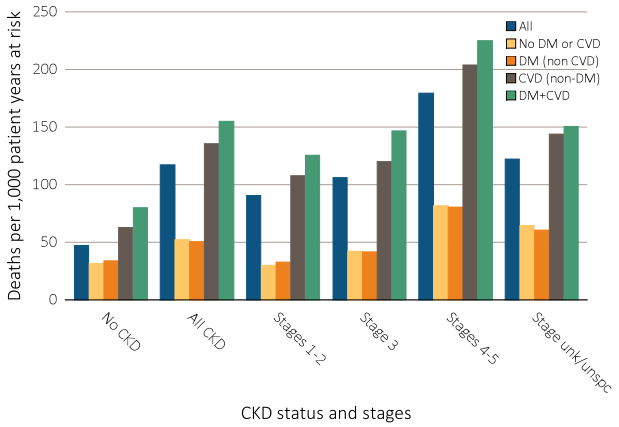
Figure i.7 shows the declining trends in adjusted and unadjusted mortality rates for Medicare patients. The co-occurrences of DM and CVD with CKD multiply a patient's risk of death, as shown in Figure i.8.

vol 1 Figure i.7 Unadjusted and adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and year, 2001-2013



Data source: Special analyses, Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients age 66 and older. Adj: age/sex/race. Ref: 2012 patients. Abbreviation: CKD, chronic kidney disease. This graphic also appears as Figure 3.1.

vol 1 Figure i.8 Adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by cardiovascular disease and diabetes mellitus, CKD status and stage, 2013



Data source: Special analyses, Medicare 5 percent sample. January 1, 2013 point prevalent patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus. This graphic also appears as Figure 3.6.

A consistent finding regarding hospitalization in the CKD population was an increasing rate of both overall and cause-specific admissions with advancing stages of CKD. When data were adjusted for age, race, and sex, CKD patients were hospitalized at a rate of 0.63 admissions per patient year overall: 0.54 for those in Stages 1-2, 0.61 for Stage 3, and 0.87 for Stages 4-5 (0.61 where stage was not specified; see Table A. ICD-9-CM codes for Chronic Kidney Disease (CKD) stages). In general, hospitalizations among CKD patients also increased in the presence of underlying comorbidities, such as diabetes and cardiovascular disease. This is consistent with previously published studies (Go et al., 2004).

Table A. ICD-9-CM codes for Chronic Kidney Disease (CKD) stages

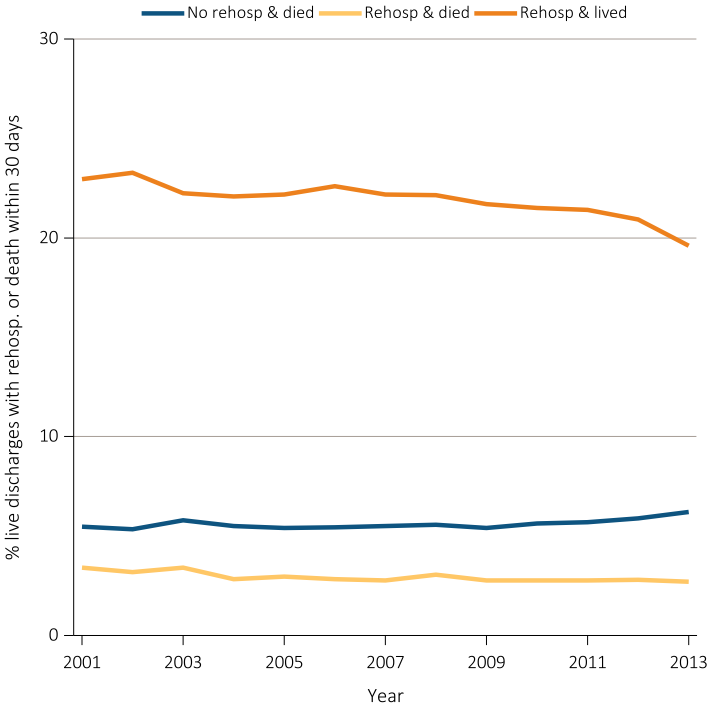
ICD-9-CM code[a]	Stage
585.1	CKD, Stage 1
585.2	CKD, Stage 2 (mild)
585.3	CKD, Stage 3 (moderate)
585.4	CKD, Stage 4 (severe)
585.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD stage-unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others

[a] For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used.

[b] In USRDS analyses, patients with ICD-9-CM code 585.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5.

Hospital readmissions are a key quality indicator for the Medicare program. In an attempt to lower the rate of readmission, the Medicare Hospital Readmission Reduction Program was instituted as part of the Patient Protection and Affordable Care Act (Centers for Medicare & Medicaid Services, 2010), reducing Medicare payments to hospitals with excess readmissions. Rates of rehospitalization for CKD patients were higher than those for patients without diagnosed CKD. In 2013, 22.3% of patients with CKD were readmitted within 30 days, compared to only 15.8% of those without CKD (Figure i.9).

vol 1 Figure i.9 Adjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare CKD patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1 and December 1, by year, 2001-2013

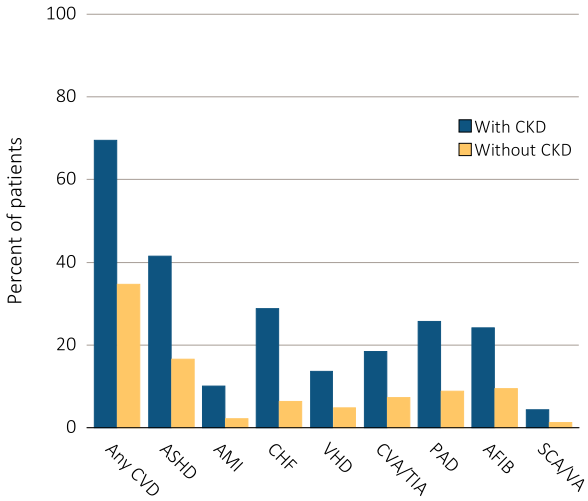


Data Source: Special analyses, Medicare 5 percent sample. Point prevalent Medicare patients aged 66 and older with CKD (defined during the prior year), discharged alive from an all-cause index hospitalization between January 1 and December 1 of the reported year. Adj: age/sex/race. Ref: 2013. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized. This graphic also appears as Figure 3.16.

Chapter 4: Cardiovascular Disease in Patients With CKD

Chapter 4 explores cardiovascular disease as an important comorbidity for patients with CKD. CKD patients are at high-risk for cardiovascular disease, and the presence of CKD often complicates cardiovascular disease treatment and prognosis. This year we continue to examine Medicare data with respect to the interaction of CKD and cardiovascular disease. Figure i.10 shows that the prevalence of any cardiovascular disease defined using Medicare claims is about twice as high for those with CKD compared to those without (69.8% versus 35.2%).

vol 1 Figure i.10 Cardiovascular disease in patients with or without CKD, 2013

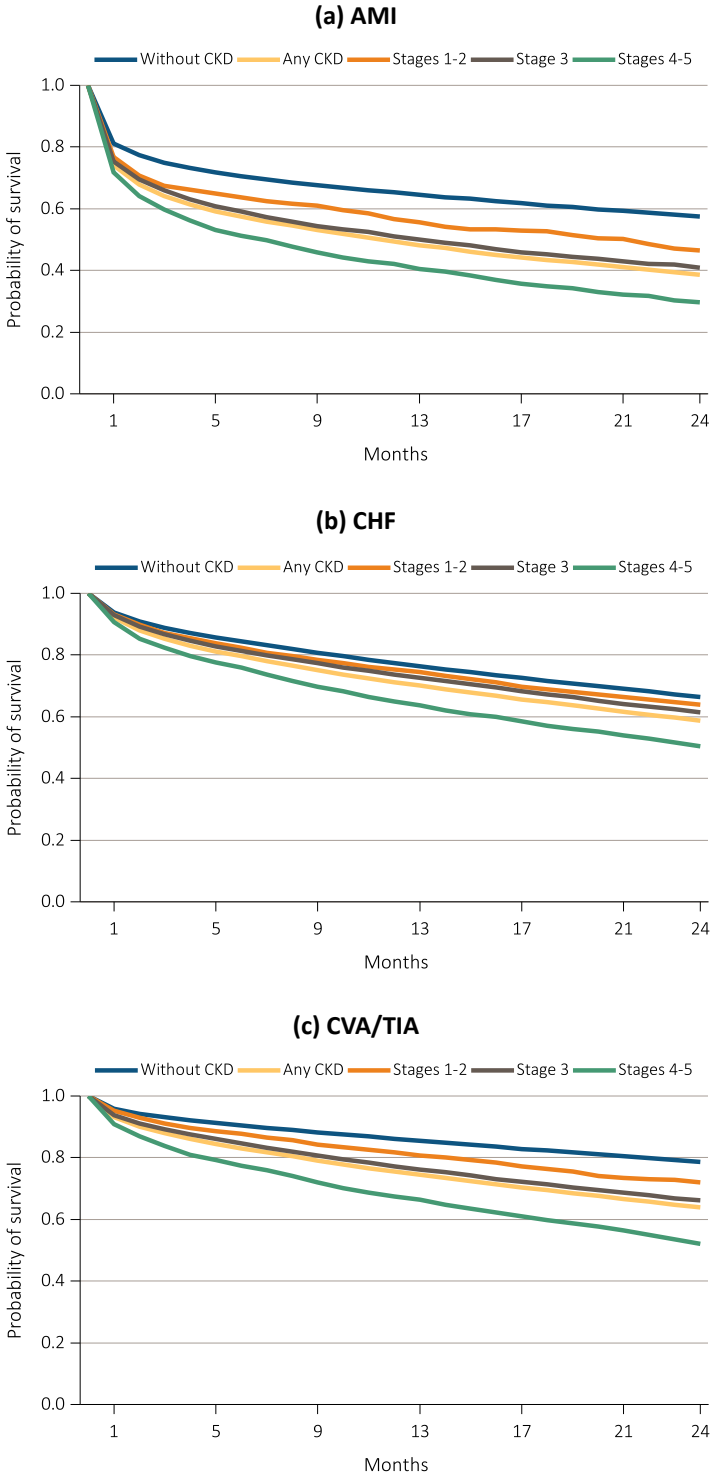


Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Totals of patients for the study cohort: N=1,238,888; With CKD=132,840; Without CKD=1,106,048. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias; VHD, valvular heart disease. This graphic also appears as Figure 4.1.

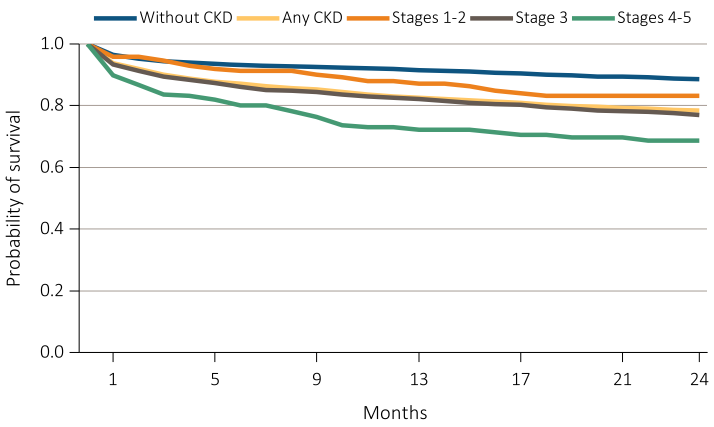
It is of note that atherosclerotic heart disease (ASHD) is the most frequent cardiovascular disease linked to CKD; its prevalence in CKD patients aged 66 years and older exceeds 40% in 2013. This data also shows that the proportion of cardiovascular disease patients undergoing cardiovascular procedures is higher among those with CKD that those without. This is gratifying to note, and suggests that 'therapeutic nihilism' toward those with CKD might well be on the decline. However, this issue will require further examination.

The presence of CKD worsens the short- and long-term prognosis for cardiovascular disease and many interventions, as shown in Figure i.11.

vol 1 Figure i.11 Survival of patients with a cardiovascular diagnosis or procedure, by CKD status, 2011-2013



(d) CABG

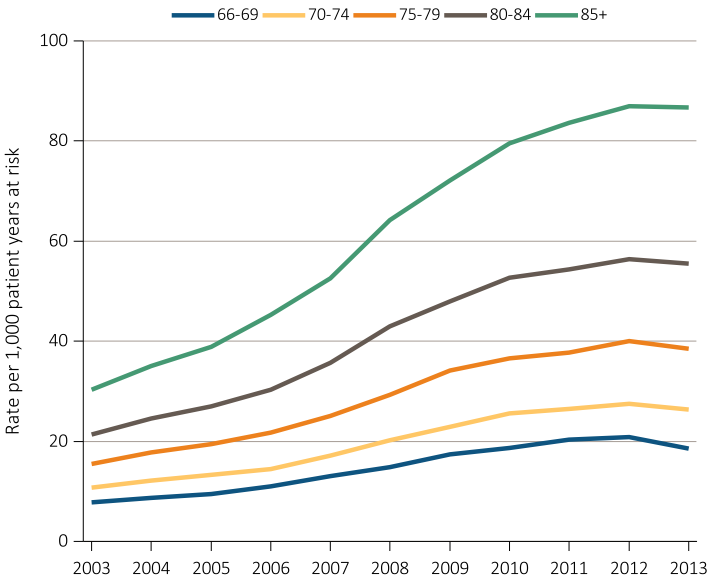


Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on the index date, which is the date of the first condition/ procedure claim, with fee-for-service coverage for the entire year prior to this date. Abbreviations: AMI, acute myocardial infarction; CABG, coronary artery bypass grafting; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack. This graphic is adapted from Figure 4.2.

Chapter 5: Acute Kidney Injury

In 2013, the unadjusted rate of AKI hospitalizations in the Medicare population fell by 4.9%. This fall was observed across all age and race groups (Figures i.12 and i.13). For Medicare patients aged 66 years and older with an AKI hospitalization in 2011, the cumulative probability of a recurrent AKI hospitalization within two years was 48% (Figure i.14). Among Medicare patients aged 66 years and older with a first AKI hospitalization, the in-hospital mortality rate in 2013 was 9.5% (or 14.4% when including discharge to hospice) and less than half of all patients were discharged to their home (Figure i.15).

vol 1 Figure i.12 Unadjusted rates of first hospitalization with AKI for Medicare patients aged 66+, by age and year, 2003-2013

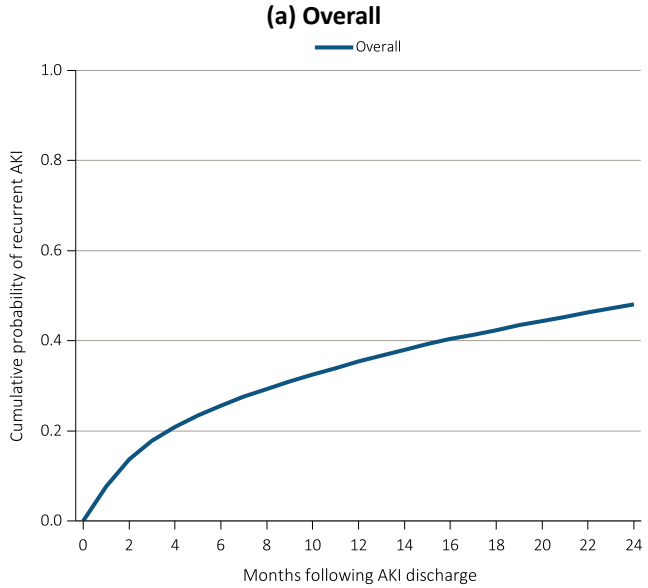


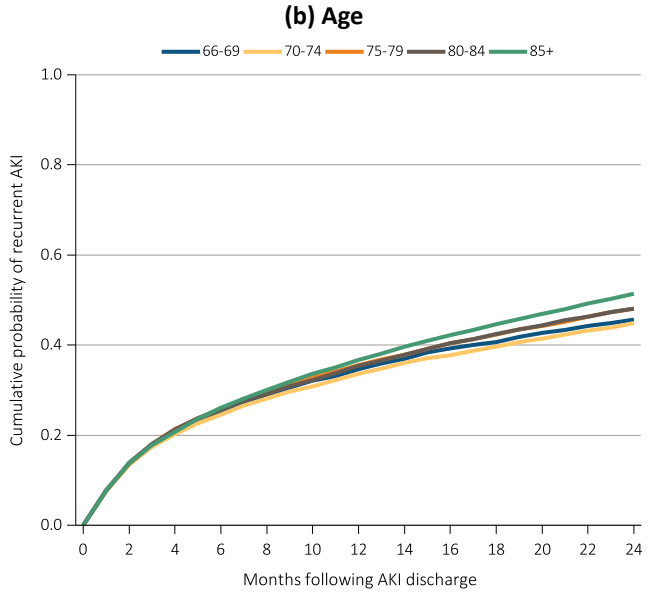
Data Source: Special analyses, Medicare 5 percent sample. Age as of January 1 of specified year. All patient-years at risk for Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease. This graphic also appears as Figure 5.2.

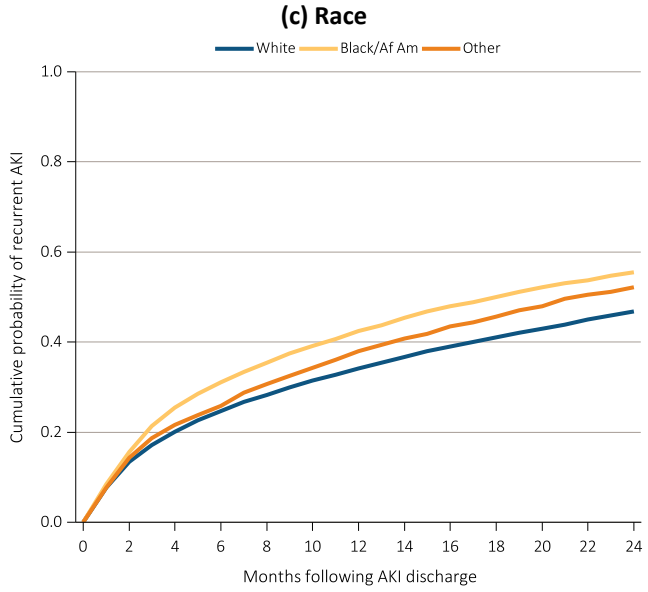
vol 1 Figure i.13 Unadjusted rates of first hospitalization with AKI for Medicare patients aged 66+, by race and year, 2003-2013

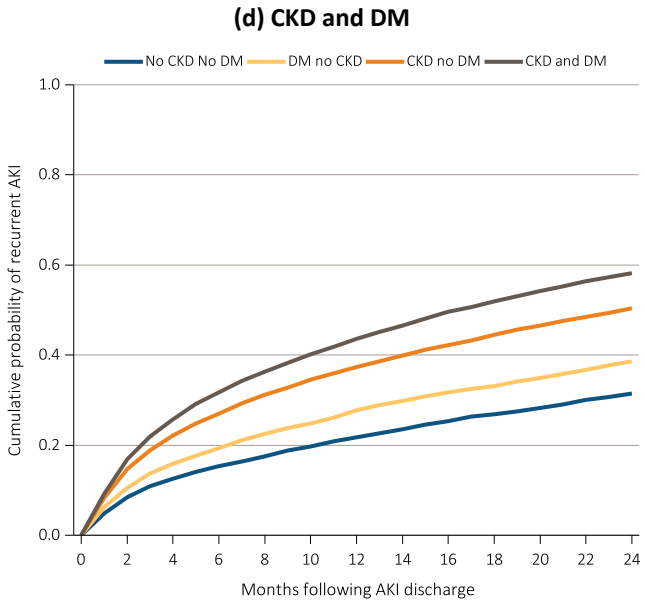
Data Source: Special analyses, Medicare 5 percent sample. All patient-years at risk for Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: Af Am, African American; AKI, acute kidney injury; ESRD, end-stage renal disease. This graphic also appears as Figure 5.3.

vol 1 Figure i.14 Cumulative probability of a recurrent AKI hospitalization within two years of live discharge from first AKI hospitalization in 2011 for Medicare patients aged 66+, (a) overall, (b) by age, (c) by race, and (d) by CKD and DM



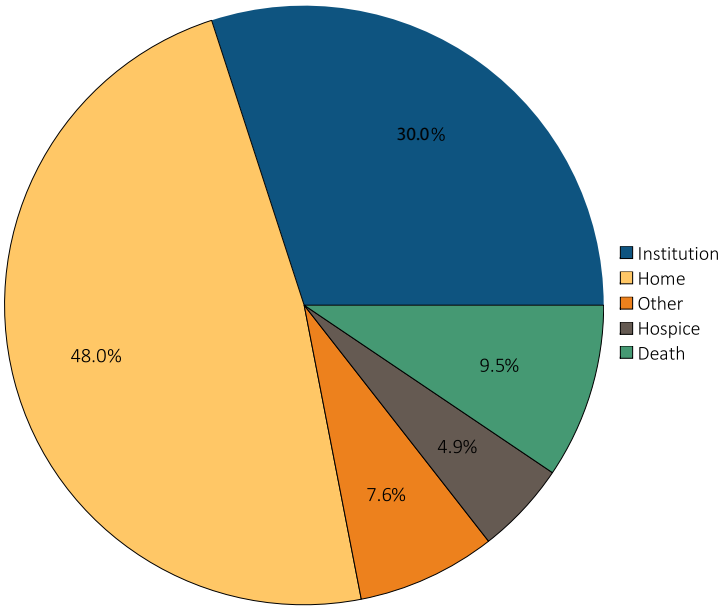






Data Source: Special analyses, Medicare 5 percent sample. Age on January 1, 2011. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form on 1/1/2011 and were discharged alive from an AKI hospitalization in 2011. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease. This graphic also appears as Figure 5.7.

vol 1 Figure i.15 Hospital discharge status of first AKI hospitalization for Medicare patients aged 66+, 2013

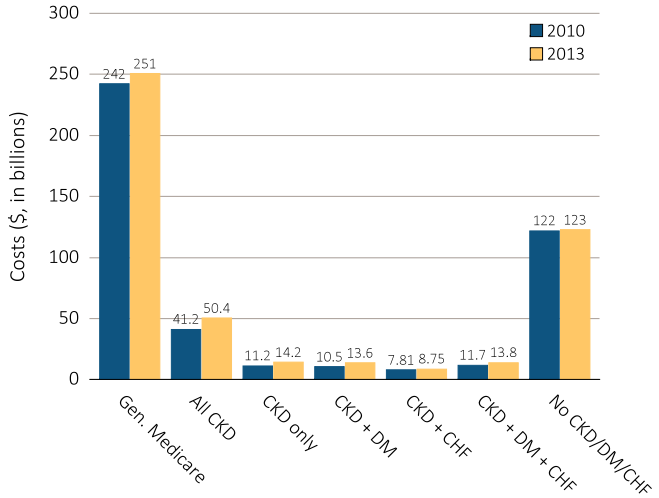


Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, did not have ESRD on 1/1/2013, and had a first AKI hospitalization in 2013. Institution includes short-term skilled nursing facilities, rehabilitation hospitals, and long-term care facilities. Home also includes patients receiving home health care services. Excludes patients admitted to the acute care hospital from a skilled nursing facility. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease. This graphic also appears as Figure 5.14.

Chapter 6: Medicare Expenditures for Persons With CKD

Among the general Medicare population aged 65 and older, total costs for Parts A, B, and D rose 3.7% to $251 billion between 2010 and 2013, while such costs rose 22.3% to $50.4 billion among CKD patients (Figure i.16). Therefore, costs in the non-ESRD CKD population exceeded those in the ESRD population ($30.9 billion, see Volume 2, Chapter 11, Medicare Expenditures for Persons with ESRD). Costs for these patients with CKD now represent 20.1% of all Medicare Parts A, B, and D spending. Although there was a universal rise in expenditure for all covered groups, certain patient populations with comorbid conditions in addition to CKD experienced higher rates of growth. Costs for patients without CKD, diabetes mellitus, or CHF increased by only 0.8%, while the costs for those with one or more of these three conditions increased by $9 billion. This is equivalent to the $9 billion increase in general Medicare spending on all elderly patients between 2010 and 2013.

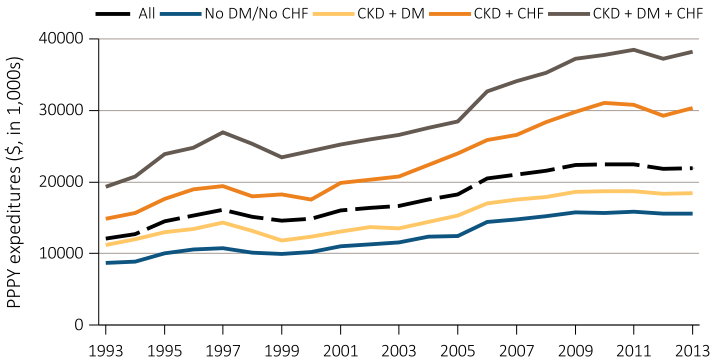
vol 1 Figure i.16 Overall Medicare Parts A, B, and D costs for fee-for-service patients aged 65 and older, by CKD, DM, CHF, and year, 2010 & 2013



Data source: Special analyses, Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure, DM, diabetes mellitus. This graphic also appears as Figure 6.1.

Figure i.17 illustrates PPPY costs for Medicare CKD patients aged 65 and older by the presence of diabetes mellitus and CHF. In 2013, PPPY costs for CKD patients varied greatly by the presence of their comorbidities. CKD patients without diabetes mellitus and without CHF cost $15,614 per person per year. Those with diabetes mellitus in addition to CKD averaged $18,404 PPPY, and patients with CKD and CHF cost $30,312, while expenditures for those with all three conditions reached $38,230 PPPY.

vol 1 Figure i.17 Per person per year expenditures on Parts A, B, and D services for the CKD Medicare population aged 65+, by DM, CHF, and year, 1993-2013

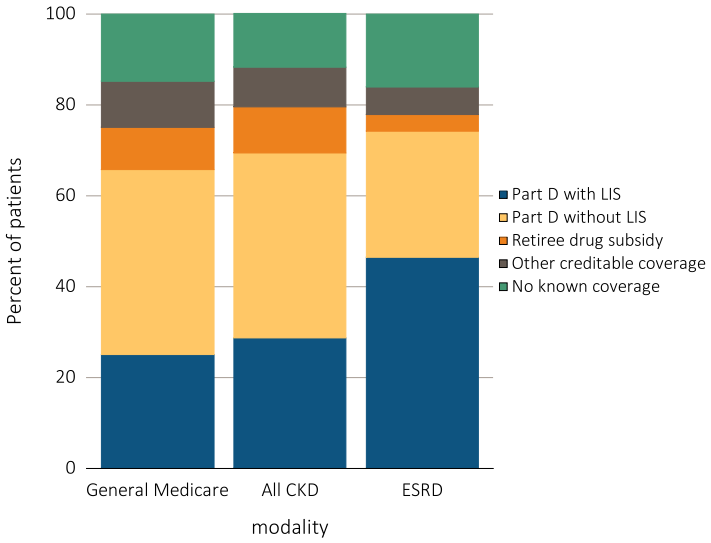


Data Source: Special analyses, Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure, DM, diabetes mellitus; PPPY, per person per year. This graphic also appears as Figure 6.5.

Chapter 7: Medicare Part D Prescription Drug Coverage in Patients With CKD

Approximately 69% of CKD patients were enrolled in Medicare Part D (including both stand-alone and Medicare Advantage plans) in 2013, slightly higher than enrollment in the general Medicare population and slightly lower than enrollment in the ESRD population. Compared to the general population, however, a higher percentage of CKD patients qualified for the Low-income Subsidy (LIS) (Figure i.18).

vol 1 Figure i.18 Sources of prescription drug coverage in Medicare enrollees, by population, 2013

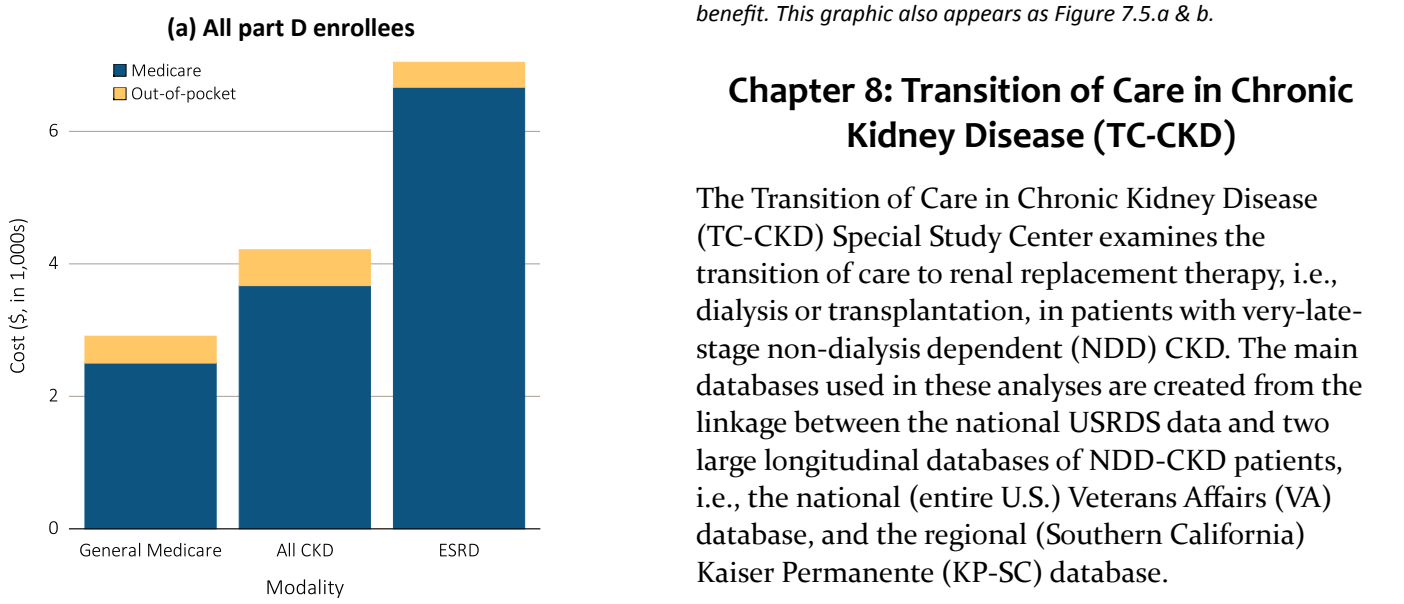


Data source: Special analyses, Medicare 5 percent sample. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; LIS, Medicare Low-income Subsidy; Part D, Medicare prescription drug coverage benefit. This graphic also appears as Figure 7.1.

In 2013, PPPY net Part D spending for CKD patients was 46% higher than for general Medicare patients, at $3,675 compared to $2,509. Similar to total Part D costs, out-of-pocket costs for CKD patients were 35% higher than for the general Medicare population. Due to the much higher proportion of LIS in the ESRD population, out-of-pocket costs represented a smaller share of total spending (5%) than in the other two groups (13% for CKD, and 14% for general Medicare) (Figure 1.19a).

Total spending for Part D-covered medications in 2013 was more than twice as high for patients with the LIS than for those without (Figure 1.19b). In the LIS population, however, out-of-pocket costs represented only 1-2% of these total expenditures, compared to 28-32% in each of the non-LIS populations.

vol 1 Figure i.19 Per person per year Medicare & out-of-pocket Part D costs for enrollees, 2013



Data source: Special analyses, Medicare 5 percent sample. Medicare totals include Part D claims for Part D enrollees with traditional Medicare (Parts A & B). CKD totals include Medicare CKD patients as determined from claims. ESRD totals include all Part D claims for Medicare ESRD patients with Medicare Part D stand-alone prescription drug plans. Costs are per person per year for calendar year 2013. Medicare total is the sum of Medicare net payment plus Low-income Supplement amount. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Part D, Medicare prescription drug coverage benefit. This graphic also appears as Figure 7.5.a & b.

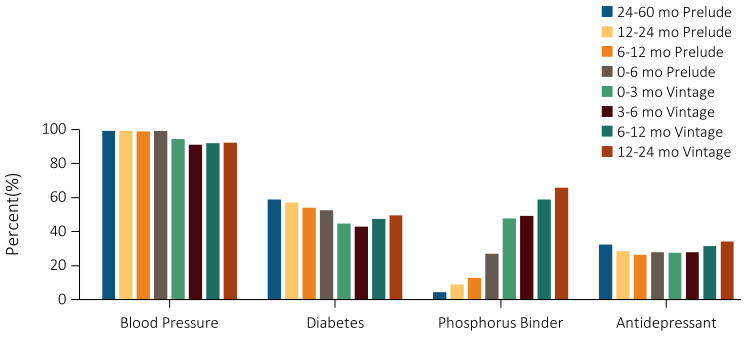
Chapter 8: Transition of Care in Chronic Kidney Disease (TC-CKD)

The Transition of Care in Chronic Kidney Disease (TC-CKD) Special Study Center examines the transition of care to renal replacement therapy, i.e., dialysis or transplantation, in patients with very-late-stage non-dialysis dependent (NDD) CKD. The main databases used in these analyses are created from the linkage between the national USRDS data and two large longitudinal databases of NDD-CKD patients, i.e., the national (entire U.S.) Veterans Affairs (VA) database, and the regional (Southern California) Kaiser Permanente (KP-SC) database.

Patterns of medication use before, during and after transition to ESRD are examined. As shown in Figure i.20, over 90% of patients were on blood pressure lowering medications prior to ESRD transition, and this high medication rate persisted during and throughout post-transition period. Diabetes medications were given to 50% of all veterans prior to ESRD transition, but this rate declined to 40% in Year 1 of the vintage. Phosphorus binders were rarely prescribed during the prelude to ESRD, but a major surge was observed in the final six months of the prelude and immediately prior to transition to ESRD, followed by a substantial rise during the vintage period. Anti-depressants show a rather constant prescription pattern independent of transition

to ESRD, in that almost 30% of veterans received these medications during both prelude and vintage, although some upwards trends is observed after transition to ESRD.

vol 1 Figure i.20 Medications prescribed to 52,172 incident ESRD veterans who transitioned to ESRD from 10/1/2007-9/30/2011

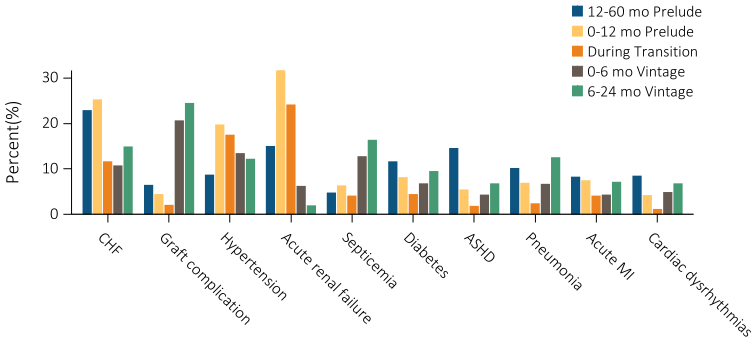


Data source: Special analyses, VHA Administrative data and CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease; mo, month; VHA, Veterans Health Administration. This graphic also appears as Figure 8.3.

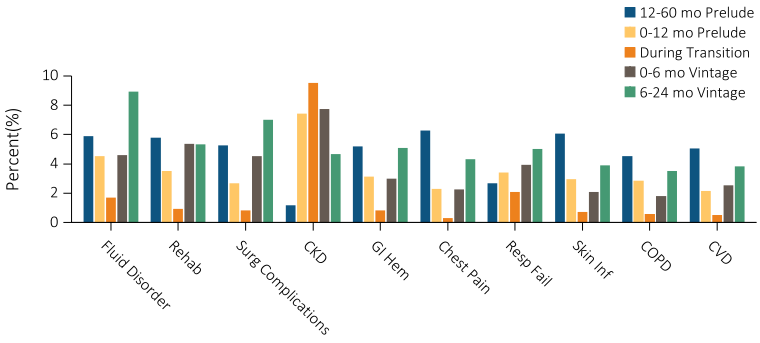
Cause-specific hospitalization events were also analyzed. Figure i.21 shows the top 20 causes of hospitalization among 46,625 veterans who transitioned to ESRD over the 4-year period (10/2007-9/2011) with at least one hospitalization event from -5 years prelude to +2 years vintage surrounding the transition intercept. Of the top 20 causes of hospitalization, notably septicemia-related hospital events increased dramatically after ESRD transition. The most common causes of hospital admission that also consisted of the ESRD transition day included acute renal failure, hypertension, CHF, and CKD.

vol 1 Figure i.21 Top 20 causes of hospitalizations in 46,625 incident ESRD veterans who were hospitalized at least once during the -60 months prior to ESRD transition (prelude) up to +24 months after ESRD transition (vintage)

(a) 10 of the top 20 causes of hospitalizations



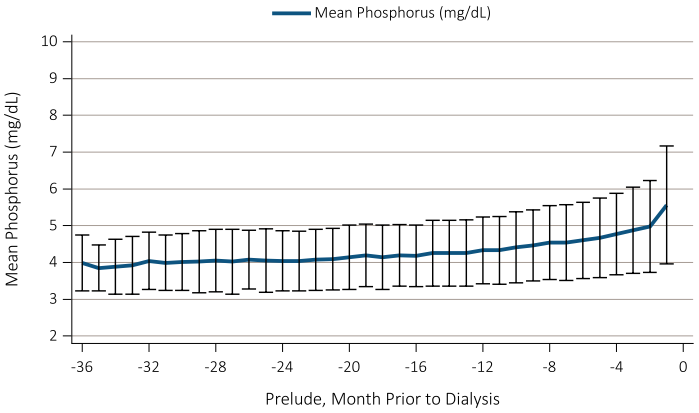
(b) 10 of the top 20 causes of hospitalizations



Data source: Special analyses, VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviations: ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CMS, Centers for Medicare & Medicaid; COPD, chronic obstructive pulmonary disease; CVD, acute cerebrovascular disease; GI Hem, gastrointestinal hemorrhage; MI, myocardial infarction; mo, month; Resp Fail, respiratory failure; Skin Inf, skin infection; surg, surgical; VHA, Veterans Health Administration. This graphic also appears as Figure 8.6.

Figure i.22 shows the pre-ESRD trend in serum phosphorus in 11,896 veterans who eventually transitioned to ESRD over 20 calendar quarters or 5 years. Serum phosphorus increased from 4 to above 5.5 mg/dL immediately prior to transition to ESRD.

vol 1 Figure i.22 Trend in serum phosphorus level during the prelude (pre-ESRD) time over 36 months in 11,896 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011



Data source: Special analyses, VHA Administrative data, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; g/dL, grams per deciliter; VHA, Veterans Health Administration. This graphic also appears as Figure 8.9.

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Chapter 1: CKD in the General Population

- Almost half of individuals with CKD also have diabetes and/or self-reported CVD.
- Overall prevalence of CKD in the general population is approximately 14%, which closely mirrors the prevalence of individuals in the high-risk KDIGO prognosis categories.
- Approximately 20% of individuals have measured ACR between 10-29 mg/g, which although below the threshold for diagnosing albuminuria, indicates some protein in the urine.
- Age is the greatest predictor of low eGFR (eGFR < 60 ml/min/1.73m2), while hypertension is the greatest predictor of albuminuria (ACR > 30 mg/g).
- Comparing three cohorts of NHANES participants (1988-1994, 1999-2004, and 2007-2012) improvements have occurred in the percent of individuals at target blood pressures, percent of individuals not smoking, and percentage of diabetics with glycosylated hemoglobin < 7%.
- Within the same cohorts, little improvement has been seen in the percent of individuals with CKD being aware of their disease, especially in stages 1 to 3. A small improvement in disease awareness has been seen in those with Stage 4 CKD.
- Self-reported CKD is very low in the U.S. general population, ranging from 1.8 % in Virginia to 4.0% in Arizona.

Introduction

This chapter presents representative cross-sectional estimates of chronic kidney disease (CKD) prevalence in the United States (U.S.), analyzing data from the National Health and Nutrition Examination Survey (NHANES; CDC 2015a). Administered by the Centers for Disease Control and Prevention (CDC), the NHANES program of studies combines interviews and physical examinations, creating a valuable source of information for assessing disease prevalence and at-risk groups in the general U.S. population. NHANES data are released biennially; we primarily report trends based on three 6-year time periods within the last 24 years—1988–1994, 1999-2004 and 2007-2012. NHANES data collection was not conducted during 1995-1998.

Utilizing a data source new to the ADR, the Behavioral Risk Factors Surveillance System (BRFSS; CDC 2015b), this year we also present the 2012 prevalence of self-reported kidney disease by geographic region. Also administered by the CDC, the BRFSS is a system of health-related telephone surveys that collect state-level data of U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. Similar to the NHANES survey, weights are applied to allow generation of estimates that are representative of the U.S. population. In the survey, each participant is asked a simple question pertaining to kidney disease "(Ever told) you have kidney disease?" With the availability of participants' residence, we can begin to assess geographic distributions of self-reported kidney disease in a representative sample of U.S. residents.

The biochemical data available in NHANES are used to evaluate kidney function through estimating glomerular filtration rate (eGFR), and kidney damage through urinary albumin excretion. Consistent with the prevalence assessment of other diseases included in this national survey, both parameters are measured at a single point in time. In clinical practice, diagnosis of CKD typically requires multiple assessments of kidney function and urine protein over weeks or months. Due to the fact that repeated measures of kidney function are limited to a voluntary subset of the 1988–1994 NHANES participants, we must rely on a single, cross-sectional sample available on the full

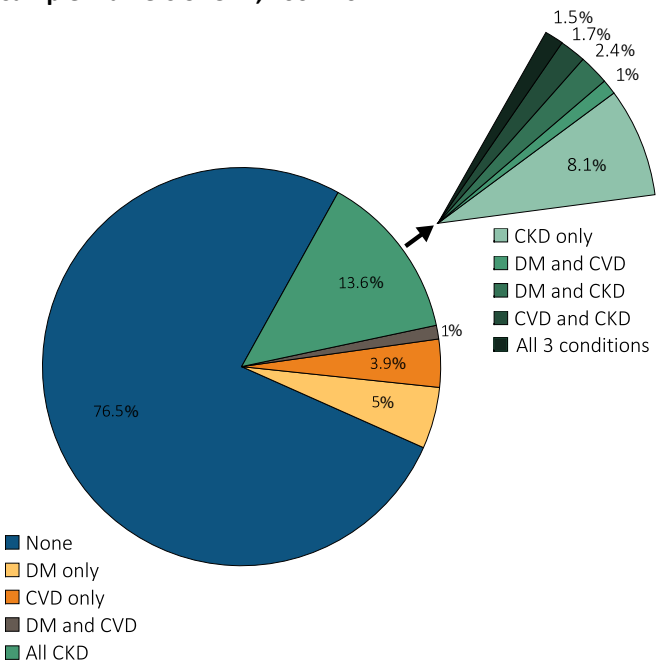
samples in all three cohorts to estimate the prevalence of CKD in the U.S. adult population, and to determine CKD trends over time. Thus, the estimates of CKD reported in this chapter will be higher than would be the case if measures of eGFR and urine albumin/creatinine ratio (ACR) were repeated over time to fulfill the 'persistence for 3 months or longer' criteria for the clinical diagnosis of CKD.

As the NHANES database does not contain diagnostic information, we developed criteria underlying the definition of CKD based upon the KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease (KDIGO, 2012). First, we evaluate kidney function by eGFR as calculated using the CKD-EPI creatinine equation (Levey et al., 2009). Individuals with eGFR <60 ml/min/1.73m2 are considered to have reduced kidney function. Secondly, we use the ACR to assess urinary albumin excretion, and consider four categories of measurements: <10 mg/g, 10-<30 mg/g (normal to slightly elevated values), 30-300 mg/g (microalbuminuria), and >300 mg/g (macroalbuminuria). Lastly, we consider a composite measure of both eGFR and ACR, classifying individuals as CKD if they have either an eGFR <60 ml/min/1.73m2 or ACR ≥30 mg/g. Staging of kidney disease follows the Kidney Disease Outcomes and Quality Improvement (KDOQI) CKD guidelines (NKF, 2002). In contrast, other chapters in this ADR volume identify the presence of CKD and its related stages based on ICD-9-CM (International Classification of Diseases, 9th revision, clinical modification) diagnosis codes.

This chapter begins with an examination of the prevalence of CKD in the U.S. among individuals aged 20 or older. We also evaluate the population distributions of eGFR and ACR over time, and the KDIGO prognostic categories based on cross-tabulations of these two measures in the 2007-2012 NHANES samples. Next, we assess the burden of CKD among individuals with interrelated conditions of public health relevance—diabetes mellitus (DM), hypertension (HTN), self-reported cardiovascular disease (SR CVD), and obesity.

Figure 1.1 displays the importance of CKD as a non-communicable chronic disease; large proportions of individuals with kidney disease also suffer from DM, SR CVD, or have all three conditions.

vol 1 Figure 1.1 Distribution of NHANES participants with diabetes, self-reported cardiovascular disease, & single-sample markers of CKD, 2007-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Note: Cardiovascular disease designation is based on self-report of any CVD condition (see CKD Analytical Methods chapter for detail); CKD is defined as eGFR <60 or ACR ≥30. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; SR CVD, self-reported cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate.

Through exploration of the implications of kidney function and the related comorbidities of DM, HTN, and SR CVD in the general population, this chapter sets the stage for Chapter 2 (Vol. 1, Identification and Care of Patients with CKD). There we discuss CKD as recognized in the health care system via analysis of Medicare claims data, providing extensive information on morbidity, interventions, and costs.

We conclude the chapter by examining participant awareness of CKD and hypertension, treatment of CKD and comorbidities, and control of major CKD risk factors. We also illustrate the burden of hypertension, total cholesterol, elevated uric acid, smoking, and glycemic control within populations of individuals with eGFR <60 or ACR ≥30. It will be important to determine whether changes in the awareness, treatment, and control of major risk factors translate into reduced rates of cardiovascular events, death, and progression of CKD to end-stage renal disease.

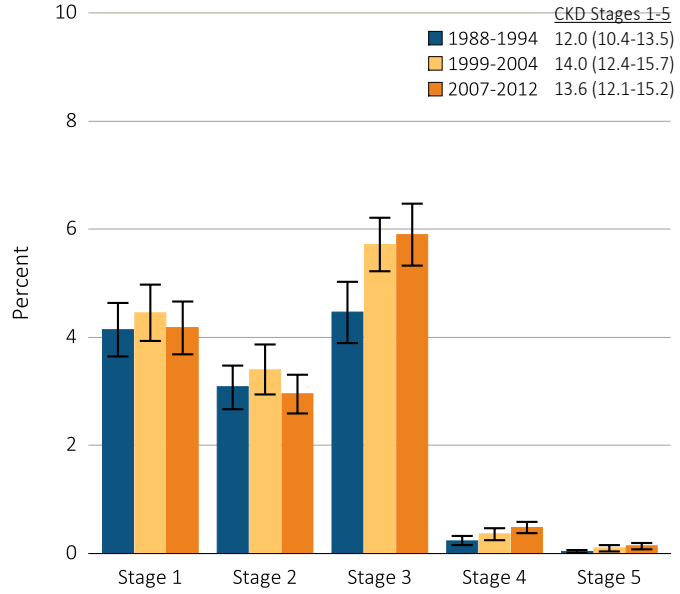
Analytical Methods

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

Prevalence of CKD

The overall prevalence of CKD in the U.S. increased from 1988-1994 to 1999-2004 (12% to 14%), but has since remained stable (2007-2012). Figure 1.2 shows that the largest increase occurred in Stage 3 CKD, which rose from 4.5% to 6.0% over the three time periods. Percent of individuals in stages 1 and 2 increased from 1988-1994 to 1999-2004, but then reverted to initial levels in the most recent time frame.

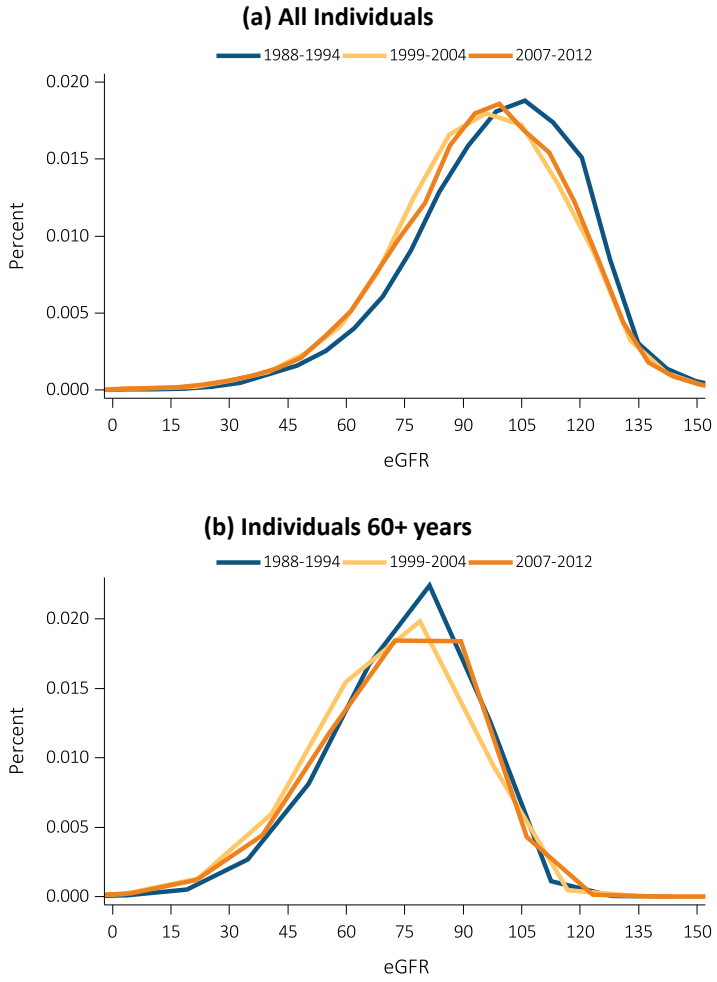
vol 1 Figure 1.2 Prevalence of CKD by stage among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Whisker lines indicate 95% confidence intervals. Abbreviations: CKD, chronic kidney disease.

Figure 1.3 illustrates density distributions of eGFR in 1988–1994, 1999-2004 and 2007-2012. Overall, a population shift towards lower eGFR levels was observed as compared with the 1988-1994 period, with most of the leftward shift confined to eGFR levels between 50 and 130 ml/min/1.73 m². To explore whether the change could be attributed to an aging U.S. population, the distribution was also examined among individuals over the age of 60 years. Within the older population there has been less change in the distribution over the three time periods examined.

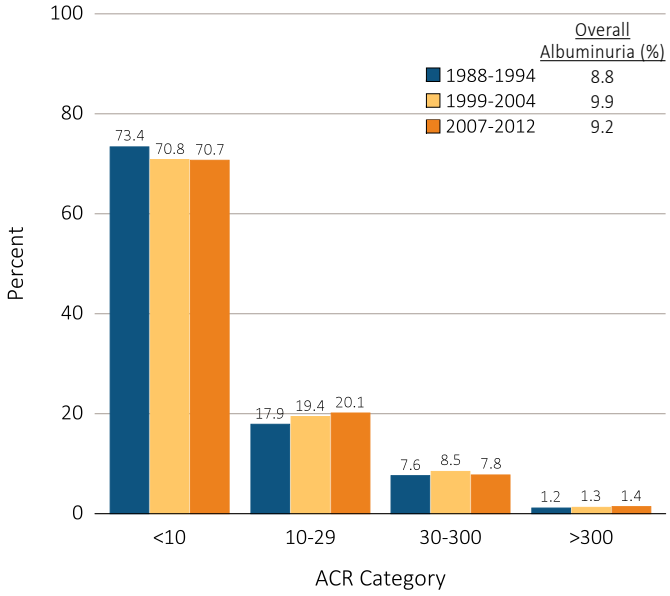
vol 1 Figure 1.3 eGFR distribution among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR; eGFR calculated using the CKD-EPI equation. Abbreviations: eGFR, estimated glomerular filtration rate. Accounts for change in serum creatinine assays.

Figure 1.4, with corresponding findings for ACR, shows little change in the distribution patterns of individuals with microalbuminuria or macroalbuminuria. However, examination of the group with ACR < 30 mg/g, shows a decrease in the proportion of individuals with ACR < 10 and, an increase in the proportion of individuals with ACR 10 to <30 mg/g, over the three eras.

vol 1 Figure 1.4 Urine albumin/creatinine ratio distribution among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of ACR. Abbreviations: ACR, urine albumin/creatinine ratio.

When assessing the inter-relationship of eGFR and ACR, we saw increased prevalence of albuminuria with decreases in kidney function. For example, in the 2007 to 2012 NHANES sample, 6.5% of persons with normal kidney function (>90 eGFR ml/min/1.73m2) had some evidence of albuminuria. This increased to 9.4% among individuals with an eGFR of 60-90, 22.2% for those with an eGFR of 45-59, and 46.7% for those with an eGFR of 30-44. For persons with Stage 4 CKD (eGFR <30 ml/min/1.73m2), over half have evidence of micro- or macroalbuminuria. Details of this cross-tabulation can be viewed in Table 1.2 of the 2014 ADR. Over the three time periods there was a rise in the percent of individuals in the three higher-risk KDIGO categories, increasing from 12% of 1988-1994 participants to approximately 14 % in both 1999-2004 and 2007-2012 (see Table 1.1).

Comorbidity, Risk Factors, Treatment, and Control

Many studies have shown that older age, diabetes, hypertension, cardiovascular disease and higher body mass index (≥30 kg/m2; BMI) are associated with CKD. Data showing the percentage of adult NHANES participants with either a spot eGFR <60 ml/min/1.73 m2 or a spot ACR ≥30 mg/g confirms higher estimated prevalence in the presence of each of these risk factors (Table 1.2).

vol 1 Table 1.1 Prognosis of CKD by KDIGO 2012 eGFR and albuminuria categories, percentage of NHANES participants, 1998-2012

	NHANES 1988-1994		NHANES 1999-2004		NHANES 2007-2012	
Low risk		88.0		85.9		86.2
Moderately high risk		9.0		10.5		9.8
High risk	12.0	2.1	14.1	2.3	13.8	2.3
Very high risk		0.9		1.3		1.7

Data source: National Health and Nutrition Examination Survey (NHANES), 1988-1994, 1999-2004 & 2007-2012 participants aged 20 and older. Single-sample estimates of eGFR and ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; GFR, glomerular filtration rate; KDIGO, Kidney Disease: Improving Global Outcomes CKD Work Group. Low risk: eGFR ≥ 60 ml/min/1.73 m2 and ACR < 30 mg/g; moderately high risk: eGFR 45-59 ml/min/1.73 m2 or eGFR ≥ 60 ml/min/1.73 m2 and ACR 30-300 mg/g; high risk: eGFR 30-44 ml/min/1.73 m2 or eGFR 45-59 ml/min/1.73 m2 and ACR 30-300 mg/g or eGFR ≥ 60 ml/min/1.73 m2 and ACR > 300 mg/g; very high risk: eGFR < 30 ml/min/1.73 m2 or eGFR 30-44 ml/min/1.73 m2 and ACR 30-300 mg/g or eGFR ≥ 60 ml/min/1.73 m2 and ACR > 300 mg/g.

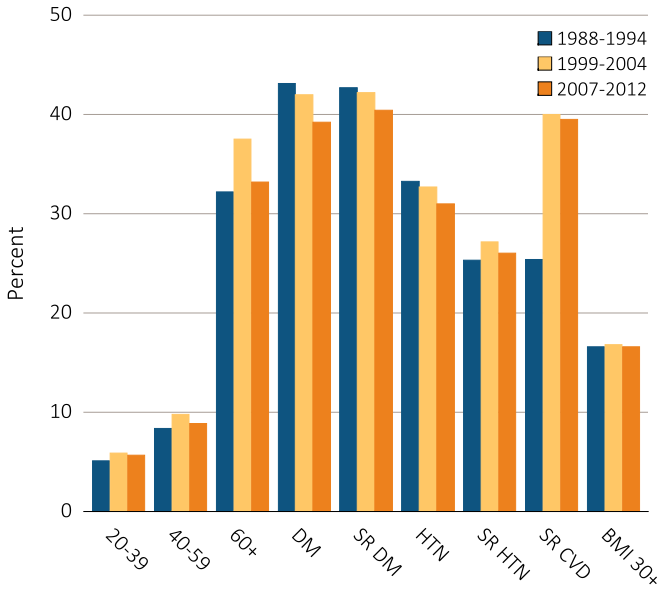
vol 1 **Table 1.2 Prevalence (%) of CKD in NHANES population within age, sex, race/ethnicity, & risk-factor categories, 1998-2012**

	All CKD			eGFR <60ml/min/1.73m2			ACR ≥30 mg/g		
	1988-1994	1999-2004	2007-2012	1988-1994	1999-2004	2007-2012	1988-1994	1999-2004	2007-2012
Age									
20-39	5.1	5.9	5.7	0.1	0.3	0.2	5.0	5.8	5.5
40-59	8.4	9.8	8.9	1.3	2.0	2.3	7.5	8.4	7.2
60+	32.2	37.5	33.2	19.1	25.1	22.7	18.0	20.1	17.7
Sex									
Male	10.2	12.3	12.1	4.1	5.0	5.4	7.4	9.2	8.7
Female	14.2	15.7	15.1	5.6	7.2	7.6	10.2	10.3	9.6
Race/Ethnicity									
Non-Hispanic White	12.3	14.0	13.9	5.5	7.0	7.6	8.2	8.9	8.4
Non-Hispanic Black/African American	14.5	14.9	15.9	4.1	5.0	6.2	12.7	12.4	12.3
Mexican American	11.8	11.2	12.0	5.0	1.5	2.2	8.2	10.5	10.8
Other Hispanic	14.1	13.6	11.8	3.8	3.9	4.0	12.1	11.5	9.8
Other Non-Hispanic	11.2	15.0	11.5	2.9	4.6	3.7	9.7	12.6	9.7
Risk Factor									
Diabetes	43.1	42.0	39.2	15.6	17.0	19.6	36.3	33.3	28.6
Self-reported diabetes	42.7	42.2	40.4	16.4	18.5	21.1	35.9	32.6	29.3
Hypertension	33.3	32.7	31.0	15.3	17.1	17.1	23.4	21.3	19.8
Self-reported hypertension	25.3	27.2	26.0	12.9	15.8	15.2	17.1	16.4	16.2
Self-reported cardiovascular disease	25.4	40.0	39.5	14.5	27.3	26.8	16.6	23.0	23.8
Obesity (BMI >30)	16.6	16.8	16.6	6.2	6.4	7.3	12.3	12.6	11.5
All	12.0	14.0	13.6	4.9	6.2	6.5	8.8	9.8	9.2

Data source: National Health and Nutrition Examination Survey (NHANES), 1988-1994, 1999-2004 & 2007-2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Diabetes defined as either HbA1c >7%, self-reported (SR), or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Values in Figure 1.12 cannot be directly compared to those in Table 1.2 due to different Survey cohorts. The table represents NHANES participants who are classified as hypertensive (measured/treated) but some of those are at target blood pressure. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; BP, blood pressure, CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; HbA1c, glycosylated hemoglobin.

Occurrences of eGFR less than 60 ml/min/1.73 m² and ACR ≥30 mg/g for adult NHANES participants are shown in Table 1.2. When CKD is defined by either eGFR <60 or ACR ≥30, prevalence estimates over time rose from 12.0 to 14.0%, and then decreased to 13.6% (Figure 1.5). The largest relative increase in prevalence (1.6-fold) was seen among those with SR CVD, where estimates rose from 25.4% in 1988-1994 to 40.0% in 1999-2004 and 39.5% in 2007-2012. The prevalence of eGFR <60 rose from 4.9 to 6.2% and then to 6.5% over the three periods, with the largest relative increase (1.5-fold) in those aged 40–59 (from 1988-1994 to 1999-2004). Prevalence for ACR ≥30 first rose from 8.8 to 9.8%, then declined to 9.2% across the three periods; this increased from 16.6 to 23.0%, and then to 23.8% for those with SR CVD.

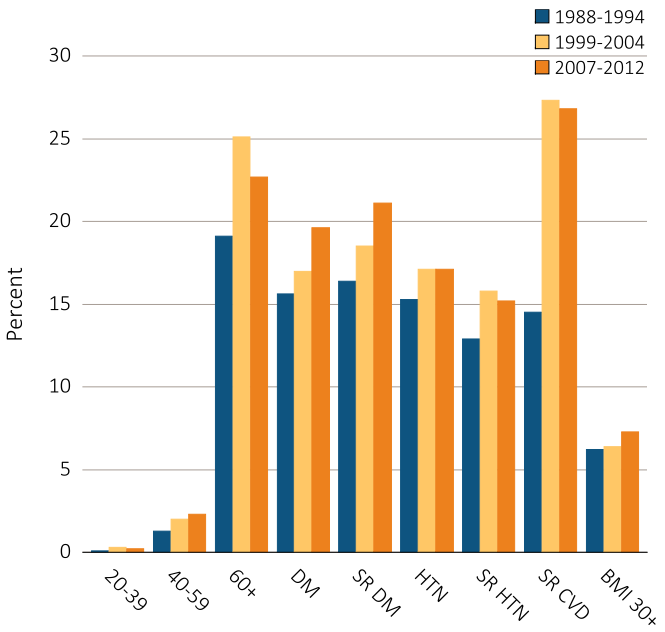
vol 1 **Figure 1.5 Prevalence of CKD by age & risk factor among NHANES participants, 1998-2012**



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Diabetes defined as either HbA1c >7%, self-reported, or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Abbreviations: BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HbA1c, glycosylated hemoglobin; HTN, hypertension; SR, self-reported.

Figure 1.6 shows that CKD defined by eGFR <60 was much more prevalent in individuals aged 60 and older. Low eGFR was present for up to 25.0% of the cohort of 1999-2004 participants, compared to 0.3% of individuals aged 20 to 39 years and 2.0% of those aged 40 to 59 years. The prevalence of low eGFR also rose in all other comorbidity categories after the years 1988-1994, especially for SR CVD. Although some of the divergence in prevalence estimates for markers of SR CKD may result from a change in data collection methods and categorization after the 1988-1994 cohort, these substantial differences have yet to be adequately explained.

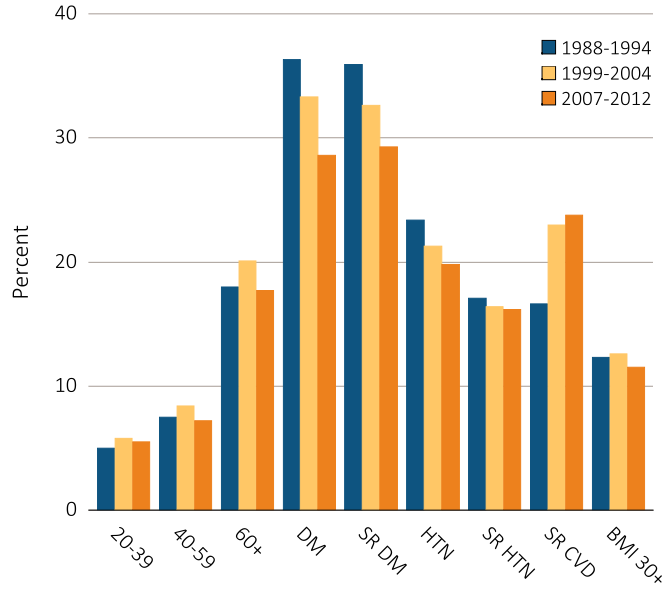
vol 1 **Figure 1.6 NHANES participants with eGFR <60 ml/min/1.73 m2, by age & risk factor, 1998-2012**



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR; eGFR calculated using the CKD-EPI equation. Diabetes defined as either HbA1c >7%, self-reported (SR), or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Abbreviations: BMI, body mass index; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HbA1c, glycosylated hemoglobin; HTN, hypertension; SR, self-reported.

The prevalence of ACR ≥30 mg/g has decreased over the three time periods among individuals with DM, self-reported DM, HTN, self-reported HTN, and higher BMI (Figure 1.7). Prevalence also increased in the older age groups, but less markedly than for eGFR <60.

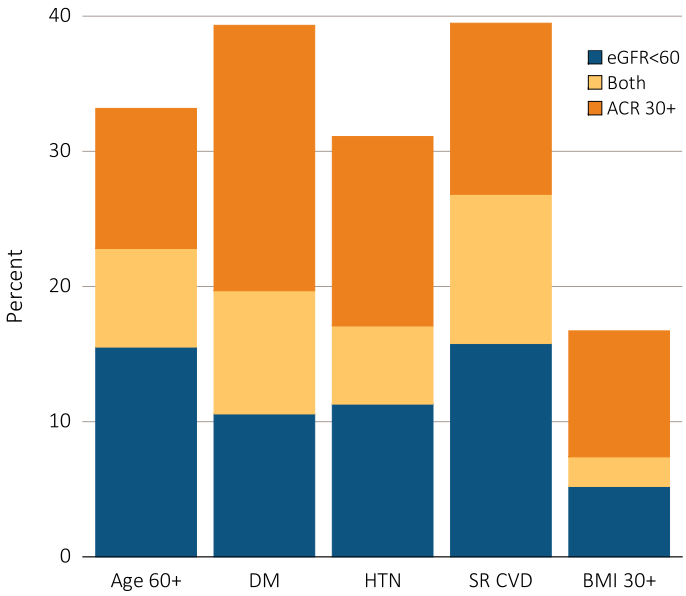
vol 1 Figure 1.7 NHANES participants with urine albumin/creatinine ratio ≥30 mg/g, by age & risk factor, 1998-2012



Data source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of ACR. Diabetes defined as either HbA1c >7%, self-reported (SR), or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Abbreviations: BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HbA1c, glycosylated hemoglobin; HTN, hypertension; SR, self-report.

Figure 1.8 displays the prevalence of CKD markers (eGFR <60 ml/min/1.73 m2 and ACR ≥30 mg/g) among adult NHANES 2007–2012 participants aged 60 years and older, and those with comorbid conditions of diabetes, hypertension, SR CVD, and higher BMI. The prevalence of eGFR <60 was highest among those aged 60 years or older (22.8%) and those with SR CVD (26.8%), followed by those with DM , HTN, and higher BMI, at 20.3, 17.2 and 7.4%, respectively. An ACR ≥ 30 was most common in those with diabetes, at 29.3%, followed by those with SR CVD, aged 60 or older, with HTN, and higher BMI, at 19.8, 17.7, 13.7, and 11.5%, respectively. The presence of both eGFR <60 and ACR ≥30 was most common with SR CVD, at 15.8%, followed by DM, those aged 60 years and older, HTN, and higher BMI, at 9.7, 7.3, 5.8, and 2.2%, respectively.

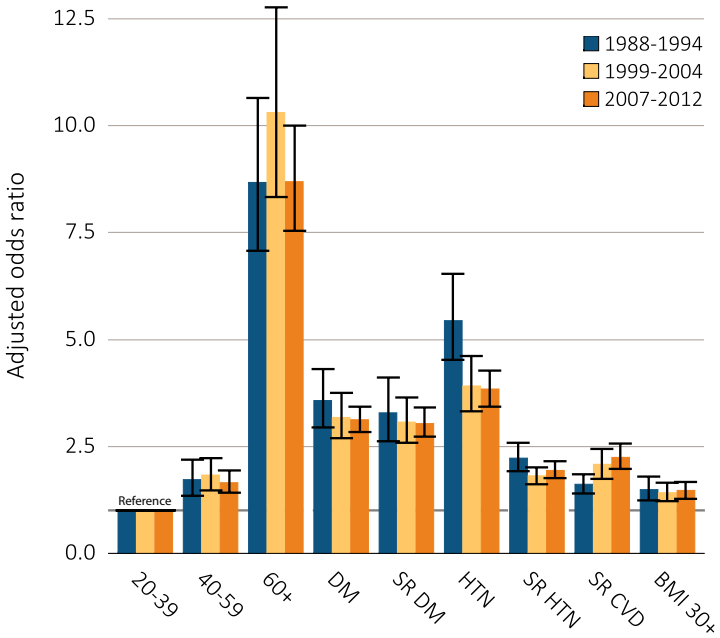
vol 1 Figure 1.8 Distribution of markers of CKD in NHANES participants with diabetes, hypertension, self-reported cardiovascular disease, & obesity, 2007–2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; CKD, chronic kidney disease; DM, diabetes mellitus; SR CVD, self-reported cardiovascular disease; eGFR, estimated glomerular filtration rate; HTN, hypertension.

Figures 1.9-1.11 show the greater odds ratios for presence of eGFR <60 ml/min/1.73 m2, ACR ≥ 30 mg/g, and either eGFR <60 or ACR ≥30 for each of the comorbid conditions, once adjusted for age, sex, and race.

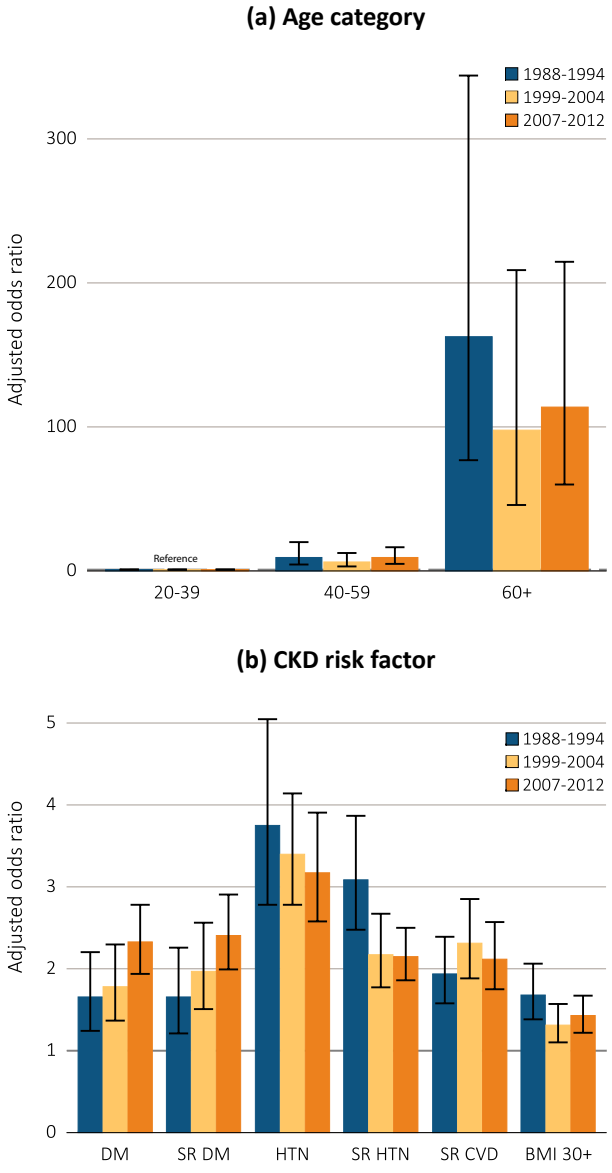
vol 1 Figure 1.9 Adjusted odds ratios of CKD in NHANES participants by risk factor, 1998-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. CKD defined as presence of eGFR <60 ml/min/1.73 m2, ACR ≥ 30 mg/g, and either eGFR <60 or ACR ≥30 for each of the comorbid conditions. Adjusted for age, sex, & race; single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Whisker lines indicate 95% confidence intervals. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension; SR, self-report.

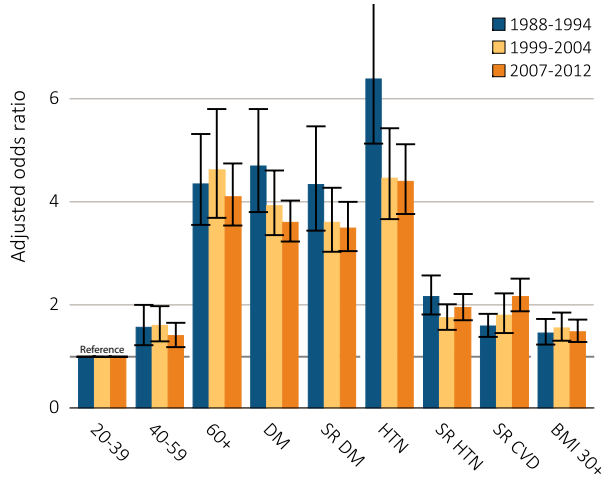
Adjusted odds ratios for eGFR <60 ml/min/1.73 m² or ACR ≥30 mg/g (Figure 1.9) were lower in NHANES 1999-2004 and 2007–2012 participants than in 1988–1994 for each risk factor except SR CVD, where adjusted odds ratios rose from 1.61 to 2.25. For eGFR <60 alone (Figure 1.10), adjusted odds ratios followed a similar pattern, except for diabetes and self-reported diabetes, where the odds increased from 1.66 to approximately 2.35 in both groups. Also, eGFR <60 showed a very strong association with age, with adjusted odds ratios in the 100 range. For ACR ≥30 alone (Figure 1.11), a substantial decline in the adjusted odds ratio is seen among those for both diabetes (from 4.70 to 3.60) and hypertension (from 6.37 to 4.40), while a substantial increase in the adjusted odds ratio is seen for SR CVD (from 1.59 to 2.17).

vol 1 Figure 1.10 Adjusted odds ratios of eGFR <60 ml/min/1.73m2 in NHANES participants by age & risk factor, 1998-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older; single-sample estimates of eGFR. Adjusted for age, sex, & race; eGFR calculated using the CKD-EPI equation. Whisker lines indicate 95% confidence intervals. Abbreviations: BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension; SR, self-report.

vol 1 **Figure 1.11 Adjusted odds ratios of urine albumin/creatinine ratio ≥30 mg/g in NHANES participants by age & risk factor, 1998-2012**



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older; single-sample estimates of ACR. Adjusted for age, sex, & race. Whisker lines indicate 95% confidence intervals. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HTN, hypertension; SR, self-report.

Treatment of CKD

Table 1.3 presents awareness of hypertension, treatment of CKD contributing conditions, and control of hypertension, hyperlipidemia, and diabetes in NHANES 1988–1994, 1999–2004 and 2007–2012 adult participants with eGFR <60 ml/min/1.73 m² or ACR ≥30 mg/g. While the prevalence of hypertension among CKD patients was similar in the three periods, ranging from 69.3 to 74.0%, the proportion of participants unaware of their hypertension rose from 33.4% to 50.6% in the first two survey time frames and then declined to 22.5% by the third survey period.

vol 1 **Table 1.3 Awareness, treatment, & measures of control of CKD risk factors, percent of NHANES participants, 1998-2012**

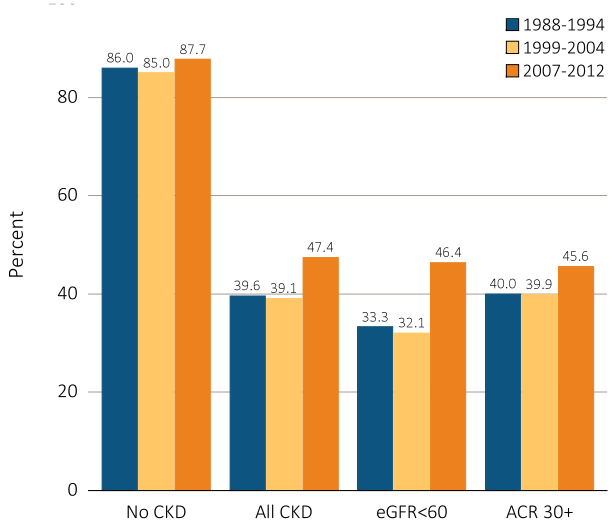
	All CKD				eGFR <60 ml/min/1.73m2				ACR ≥30			
	1988-1994	1999-2004	2007-2012	Trend p-value	1988-1994	1999-2004	2007-2012	Trend p-value	1988-1994	1999-2004	2007-2012	Trend p-value
Hypertension, by current hypertensive status[a]												
Non-hypertensive status	30.7	26.5	26.0		18.4	14.3	15.9		32.0	30.4	29.1	
Hypertensive (measured/ treated)	69.3	73.5	74.0	**0.01**	81.6	85.7	84.1	0.29	68.0	69.6	70.9	0.07
Control of hypertension among hypertensive patients[b]												
Unaware	33.4	50.6	22.5		22.8	44.2	16.4		36.0	54.7	25.1	
Aware, not treated	14.7	6.3	6.5		12.1	4.2	2.8		15.7	7.1	8.7	
Aware, treated, uncontrolled	39.2	31.5	43.9	**<0.001**	47.8	36.4	46.6	**<0.001**	38.4	30.2	44.8	**<0.001**
Aware, treated, controlled	12.7	11.5	27.2		17.3	15.2	34.2		9.9	8.0	21.4	
Total cholesterol[c]												
<200 (desirable)	35.1	46.6	58.7		27.2	45.6	62.1		38.2	47.5	58.2	
200–239 (borderline high)	33.5	32.6	26.4	**<0.001**	32.7	33.7	23.5	**<0.001**	32.8	31.9	27.3	**<0.001**
240+ (high)	31.4	20.8	14.9		40.0	20.7	13.4		29.0	20.6	14.5	
Uric Acid												
Normal	69.6	69.2	69.2	0.84	54.4	55.2	55.1	0.84	73.9	74.0	75.4	0.45
High	30.4	30.8	30.8		45.6	44.8	44.9		26.1	26.0	24.6	
Smoking												
Current	22.2	16.9	14.6		11.9	7.8	8.2		0.03	21.3	17.6	
Former	35.2	32.3	32.6	**<0.001**	43.2	39.4	40.1	**0.03**	31.5	29.1	29.7	**<0.001**
Never	42.6	50.7	52.8		44.9	52.8	51.6		41.5	49.6	52.6	
Control of diabetes among patients with diabetes[d]												
Glycohemoglobin <7% (controlled)	31.5	39.2	45.3		37.1	50.9	55.0		29.6	33.6	37.9	
Glycohemoglobin 7% or higher (uncontrolled)	68.5	60.8	55.7	**<0.001**		49.1	45.0	**0.003**		66.4	62.1	**0.04**

Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of all biologic markers; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate. a. Hypertension defined as blood pressure ≥130/≥80 for those with CKD and diabetes, otherwise ≥140/≥90, or self- reported treatment for hypertension. b. Awareness and treatment are self-reported. Control defined as <130/<80 for those with CKD and diabetes; otherwise <140/<90. c. Total cholesterol classified according to Adult Treatment Panel III blood cholesterol guidelines (ATP III). d. Glycosylated hemoglobin classified according to American Diabetes Association guidelines. Trend tests for control of hypertension compares unaware to the three aware categories, total cholesterol tests < 200 vs. 200+, smoking tests any current or past smoking vs. never.

The proportion of hypertensive individuals who were aware, treated, and disease-controlled rose steadily from approximately 12% in the early cohorts to 27.2% in 2007-2012. In the subgroup with diabetes, glycemic control improved firmly from 31.5 to 39.2, and then to 45.3% over the three survey periods.

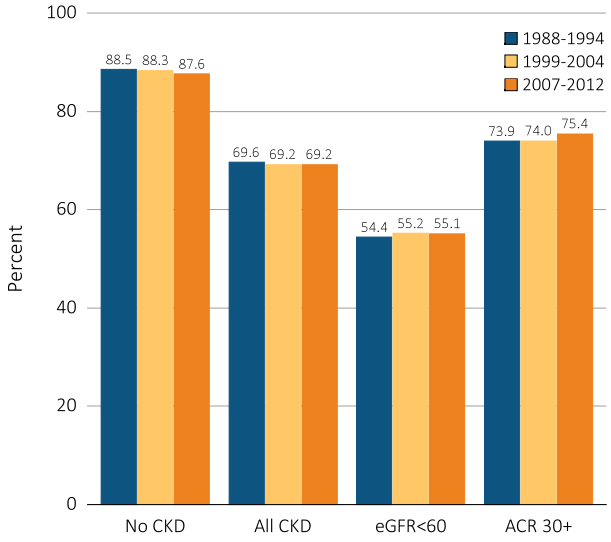
As illustrated by Figures 1.12-1.15, over the periods of 1988–1994, 1999–2004 and 2007–2012, improvements in the management of hypertension, smoking, and hyperglycemia among diabetic participants occurred, regardless of whether eGFR or ACR was used for subgroup definition.

vol 1 Figure 1.12 NHANES participants at target blood pressure, 1998-2012



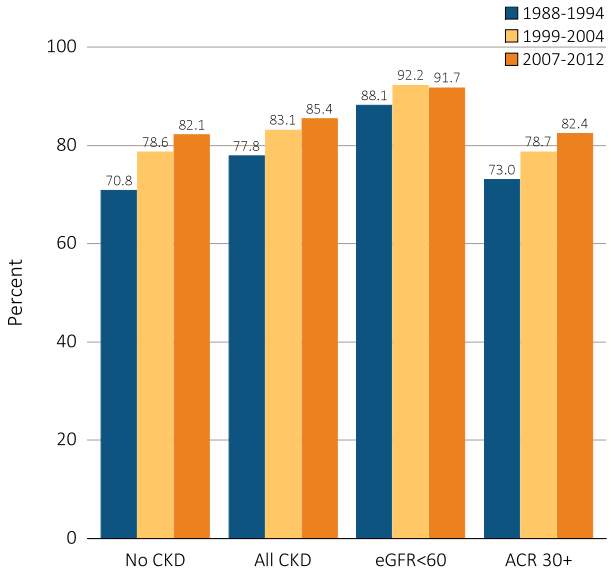
Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Figure represents all hypertensive participants including those who were at target blood pressure, probably due to medication. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.13 NHANES participants within uric acid normal range, 1998-2012



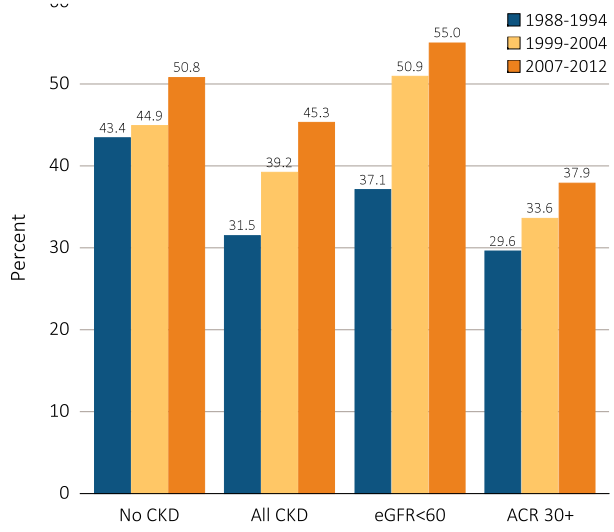
Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.14 NHANES participants not currently smoking, 1998-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.15 Diabetic NHANES participants with glycosylated hemoglobin <7%, 1998-2012

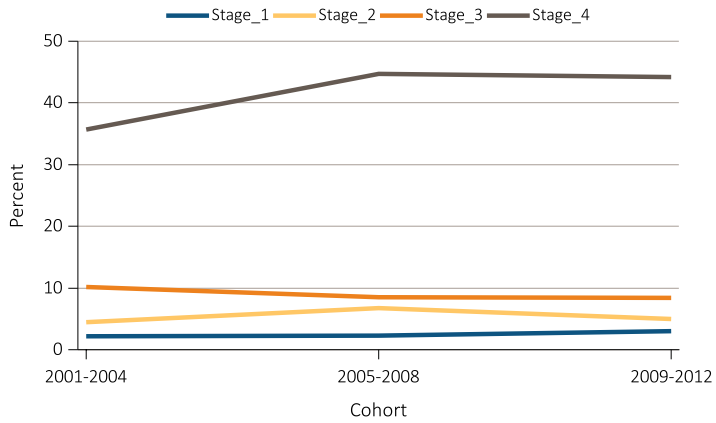


Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

CKD Awareness

Among the individuals that are classified as having CKD by laboratory measurements, the percent of those individuals being aware of their kidney disease has remained low over the years 2001-2012 (Figure 1.16). There is some suggestion of an improvement among individuals with Stage 4 CKD between the years 2001-2004 and 2005-2008, although this did not persist in the 2009-2012 cohort. Note that 4-year cohorts are examined in this graphic and the awareness variable was not included in the in the years 1988-1994 sampling of NHANES. Awareness is not presented for Stage 5 CKD due to very small sample size.

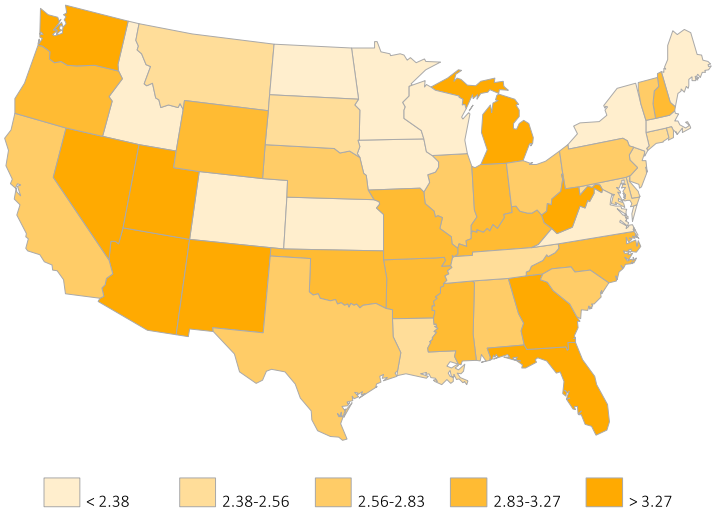
vol 1 Figure 1.16 NHANES participants with CKD aware of their kidney disease, 2001-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2012 participants aged 20 & older. Abbreviations: CKD, chronic kidney disease.

Figure 1.17 displays the state-specific proportion of individuals who reported being told they had 'kidney disease' based on the 2012 BRFSS sample. The overall national mean was very low at 2.8%. Also at 2.8%, the prevalence of self-reported kidney disease ('weak or failing kidneys') in NHANES matches this national estimate from the BRFSS survey, suggesting poor identification or awareness of kidney disease in the general population. States with the highest proportion of participants who indicate that they have been informed that they had kidney disease include: Arizona, Florida, West Virginia, Georgia, Hawaii, New Mexico, Michigan, and Washington. Conversely, the states with the lowest proportion reporting kidney disease include: Virginia, Massachusetts, Wisconsin, New York, Colorado, Iowa, Indiana and North Dakota. These differences could reflect varying prevalence of kidney disease by state, or variations in survey participants' awareness of the condition, if present. Underlying prevalence of kidney disease by individual U.S. state is unknown; therefore it is presently unclear whether higher prevalence of 'self-reported kidney disease' reflects higher actual prevalence of the disease, greater awareness among those that have the condition, or a combination of both.

vol 1 Figure 1.17 Estimated prevalence of self-reported kidney disease by state (%), BRFSS participants, 2012 (N = 464,494).



Data source: Behavioral Risk Factors Surveillance System (BRFSS), 2012 participants aged 20 & older.

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Chapter 2: Identification and Care of Patients With CKD

- Over half of patients from the Medicare 5 percent sample have either a diagnosis of chronic kidney disease (CKD), cardiovascular disease, or diabetes, while over 18% have two or more of these conditions.
- Of the 10.7% of Medicare patients diagnosed with CKD in 2013, nearly half also have diabetes, and over 92% also have hypertension.
- In both the Medicare 5 percent sample and the NHANES datasets, patients in older age groups, Black patients, and patients with a cardiovascular disease diagnosis tended to have a higher prevalence of CKD.
- The total population with recognized CKD from the Medicare 5 percent sample has grown steadily between 2000-2013 for all races.
- Of patients in the Medicare 5 percent sample diagnosed with CKD stage 3 in 2008, 2% had progressed to ESRD and 42% had died by 2013. In the general Medicare population without identified CKD, progression to ESRD and death was 0.13% and 22%, respectively.
- Urine albumin testing is important for monitoring patients with diabetes mellitus. Among patients with diabetes in the Medicare population, with or without a diagnosis of CKD, testing for urine albumin has been steadily rising over time though it is still done in less than half of such patients. Among all diabetes patients, the rate of albumin testing in 2008 was 32%, increasing to 40% in 2013.
- Among Medicare patients with diagnosed CKD, patients who saw a nephrologist were more likely to be tested with urine albumin or serum creatinine (59% and 94%, respectively) than those who saw only a primary care physician (39% and 92%, respectively).

Introduction

The epidemiological evaluation of care in patients with chronic kidney disease (CKD) is a significant challenge, as most large datasets lack the biochemical data (serum creatinine and urine protein) required to definitively identify the disease. A random survey sample such as the National Health and Nutrition Examination Survey (NHANES) dataset contains the necessary biochemical information, as shown in Chapter 1, to estimate the prevalence of CKD in the population. However, the cross-sectional nature of the NHANES study and relatively small sample of patients (compared to large administrative datasets) limits the precision of estimated prevalence; evaluation of long-term outcomes, adverse events, and quality of care delivered to patients with CKD; and the ability to conduct analyses on subsets of patients. In addition, the NHANES survey only includes a single measure of serum creatinine and microalbuminuria. KDIGO guidelines state that two measures over 90 days is necessary to definitively determine CKD. Thus NHANES will over estimate actual number of persons with CKD.

Analyses of USRDS data for this chapter utilize the general Medicare 5 percent sample, which includes an average of 1.2 million individuals each year, to assess the recognized CKD population. Analyses are restricted to patients aged 65 and older given that age is the main criterion for Medicare eligibility and is limited to those persons with both part A and part B fee for service coverage. Persons covered in managed care are not included due to the absence of billing

claims. The term "recognized CKD" is used because patients are identified based on the presence of a relevant diagnosis code in Medicare billing claims, meaning that either a provider or billing coder in the health care system recognized the presence of CKD and submitted a claim. As such, any observed trends may not necessarily relate to a true change in disease prevalence, but rather could represent changes in awareness or recognition of CKD, or of billing practices in general.

Identifying the recognized CKD population includes a variety of ICD-9-CM diagnosis codes, some of which are sub-codes under related comorbidities such as diabetes (250.4x) and hypertension (403.9x), and some of which are more kidney-disease specific, such as glomerular disease (583.x). In 2005, new CKD stage-specific codes (585.x) were introduced, providing an opportunity to track trends in the severity of CKD over time. Since their introduction, the CKD stage-specific codes have represented the majority of CKD diagnosis codes utilized, and there is evidence of a growing recognition of CKD over time. Studies have shown that diagnosis codes for CKD generally have excellent specificity (>90%) though their sensitivity is low (Grams et al., 2011). Table A lists the CKD-related ICD-9-CM codes used in this chapter.

Analytical Methods

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

Table A. ICD-9-CM codes for Chronic Kidney Disease (CKD) stages

ICD-9-CM code[a]	Stage
585.1	CKD, Stage 1
585.2	CKD, Stage 2 (mild)
585.3	CKD, Stage 3 (moderate)
585.4	CKD, Stage 4 (severe)
585.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD stage-unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others

[a] For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used.

[b] In USRDS analyses, patients with ICD-9-CM code 585.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5.

Prevalence of Recognized CKD and Odds of a CKD Diagnosis Code

Table 2.1 provides the prevalence of coded CKD, diabetes, and cardiovascular comorbid conditions among patients in the Medicare population aged 65 and older. Over half of the population has at least one of these comorbid conditions, and over 18% have two or more.

vol 1 **Table 2.1 Prevalence of coded comorbid conditions (CKD, CVD & DM), (a) total, and (b) one or more, among Medicare patients aged 65+, 2013**

(a) Total coded comorbid conditions

	N	%
5% Medicare patients	1,260,903	100
Total CKD	134,254	10.6
Total CVD	499,135	39.6
Total DM	301,308	23.9

(b) One or more coded comorbid conditions

	N	%
5% Medicare patients	1,260,903	100
Only CKD	22,310	1.8
Only CVD	285,628	22.6
Only DM	117,892	9.3
CKD & DM, no CVD	17,030	1.3
CKD & CVD, no DM	47,121	3.7
DM & CVD, no CKD	118,593	9.4
CKD & CVD & DM	47,793	3.8
No CKD, no CVD, no DM	604,536	47.9

Data Source: Special analyses, Medicare 5 percent sample. Period prevalent patients, 2013, without ESRD, aged 65 and older (Medicare). 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.

Table 2.2 presents demographic and comorbidity characteristics of patients aged 65 and older in the Medicare 5 percent sample and among those with a diagnosis of CKD. The mean age was 75.9 years overall, and 77.9 years for those with CKD. The high prevalence of comorbid conditions in the overall sample reflects the older age of these patients. For example, 60% and 24% of the total Medicare population have diagnoses of hypertension and diabetes, respectively. Among patients diagnosed with CKD, rates of comorbidity are even higher; nearly half also have diabetes and over 92% also have hypertension.

vol 1 Table 2.2 Demographic characteristics of all patients and of CKD patients, among Medicare patients aged 65+, 2013

	All patients		Patients with CKD	
	N	(%)	N	(%)
All	1,260,903	100	134,254	100
Age				
65-74	693,399	55.0	50,417	37.6
75-84	396,086	31.4	53,005	39.5
85+	171,418	13.6	30,832	23.0
Sex				
Male	543,687	43.1	63,674	47.4
Female	717,216	56.9	70,580	52.6
Race				
White	1,086,649	86.2	111,527	83.1
Black/Af Am	95,465	7.6	14,606	10.9
Native Am	5,296	0.4	598	0.5
Asian	23,890	1.9	2,739	2.0
Other	41,786	3.3	4,359	3.3
Unknown	7,817	0.6	425	0.3
Comorbidity				
DM	301,308	23.9	64,823	48.3
HTN	755,850	60.0	123,821	92.2
CVD	499,135	39.6	94,914	70.7

Data Source: Special analyses, Medicare 5 percent sample. Period prevalent patients, 2013, without ESRD, aged 65 and older (Medicare). Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HTN, hypertension; Af Am, African American; Native Am, Native American. 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.

Table 2.3 presents the prevalence and adjusted odds ratio of recognized CKD in the Medicare population. Of Medicare patients aged 65 and older, 10.7% have a coded diagnosis of CKD. The prevalence of recognized CKD increases with age, from 7.32% at ages 65–74 to 18% at age 85 and older. Males have slightly higher prevalence than females. The prevalence among Black/African Americans (15.3%) is roughly 50% higher than Whites, while Asians and Native Americans have a prevalence about 10 percent higher than Whites. Results from the adjusted analyses confirm greater odds of recognized CKD in older patients, Blacks, and those with diabetes, hypertension, or cardiovascular disease.

vol 1 Table 2.3 Prevalence of CKD, and adjusted odds ratios of CKD among Medicare patients aged 65+, 2013

	Prevalence of CKD (% of overall)	Adjusted odds ratios of CKD
Overall	10.7	
Age		
65-74	7.3	Ref.
75-84	13.4	1.5
85+	18.0	2.1
Sex		
Male	11.7	1.3
Female	9.8	Ref.
Race		
White	10.3	Ref.
Black/Af Am	15.3	1.4
Native Am	11.3	1.1
Asian	11.5	1.1
Other/Unknown	10.4	1.0
Comorbidity		
DM	21.5	2.2
HTN	16.4	3.8
CVD	19.0	2.2

Data Source: Special analyses, Medicare 5 percent sample. Period prevalent patients, 2013, without ESRD, aged 65 and older (Medicare). Adjustments included are age, gender, race, and comorbidities. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HTN, hypertension; Af Am, African American; Native Am, Native American. 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.

Table 2.4 compares the prevalence of CKD in the NHANES and Medicare populations among patients aged 65 and older, according to demographic characteristics and comorbid conditions. In both datasets, patients in older age groups, Black patients, and patients with a cardiovascular disease diagnosis tended to have a higher prevalence of CKD. However, the absolute prevalence of CKD is substantially lower in Medicare versus NHANES data. This reflects the under capture of "recognized CKD" in Medicare claims as well as the over estimation of CKD in the NHANES survey.

vol 1 **Table 2.4 Percent of patients with CKD by demographic characteristics, among patients overall and with DM, HTN, or CVD, in NHANES (2011-2012) and Medicare (2013) datasets**

	Overall		DM (No HTN)		HTN (No DM)		Any CVD	
	NHANES	Medicare	NHANES	Medicare	NHANES	Medicare	NHANES[a]	Medicare[b]
Age								
65-74	26.4	7.3	7.5	9.8	31.4	12.9	40.9	21.6
75-79	50.4	13.4	*	14.0	45.4	20.1	66.7	27.7
80+	65.2	18.0	*	18.7	67.2	27.5	80.5	32.4
Race								
White	38.3	10.3	24.9	12.0	44.5	17.9	55.6	25.2
Black/Af Am	49.9	15.3	*	11.9	46.6	22.2	68.3	35.9
Native Am	-	11.3	-	11.8	-	19.0	-	29.4
Asian	-	11.5	-	12.8	-	17.8	-	30.2
Other/Unknown	42.4	10.4	18.3	11.7	47.0	16.2	70.1	28.1
Sex								
Male	37.9	11.7	29.5	13.6	41.7	20.5	44.3	27.6
Female	41.3	9.8	20.7	10.4	47.2	16.6	75.9	24.9
All	39.7	10.7	26.6	12.0	44.9	18.1	58.5	26.2

Data Source: Special analyses, Medicare 5 percent sample, aged 65 and older alive & eligible for all of 2013 and NHANES 2011-2012 participants, aged 65 and older. CKD claims as well as other diseases identified in 2013. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HTN, hypertension; Af Am, African American; Native Am, Native American.

** Values for cells with 10 or fewer patients are suppressed.*

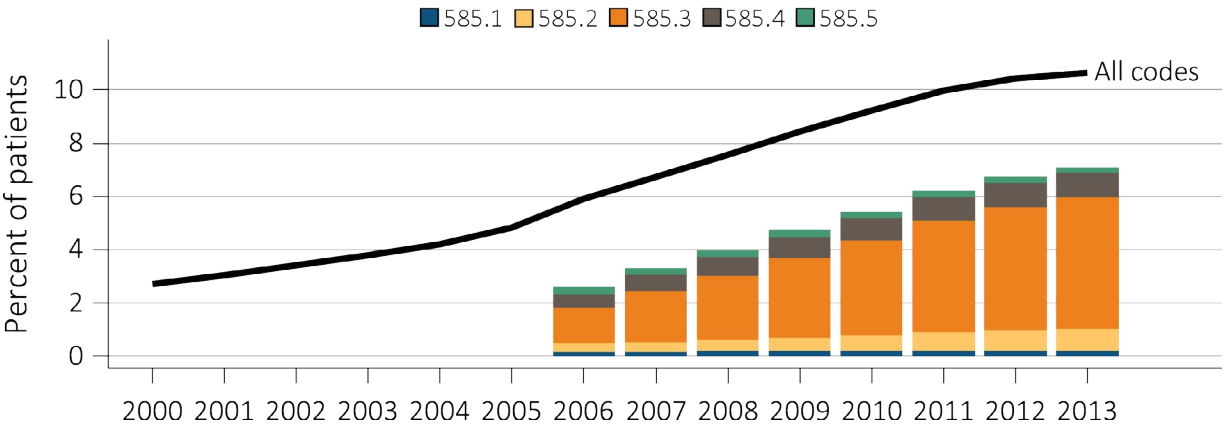
[a] CVD defined as any of the self-report diseases: angina, myocardial infarction, stroke, coronary heart disease, or congestive heart failure.

[b] CVD defined as either one of the following comorbidities: cerebrovascular accident, peripheral vascular disease, atherosclerotic heart disease, congestive heart failure, dysrhythmia or other cardiac comorbidities.

- No available data.

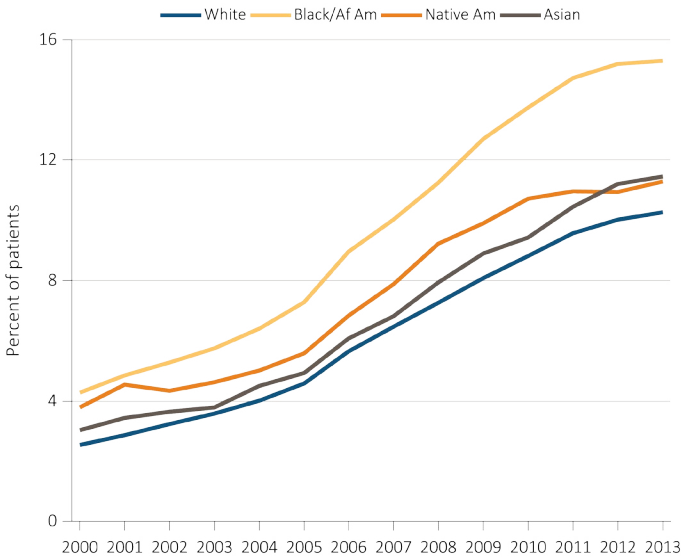
Figure 2.1 shows the temporal trend in prevalence of recognized CKD overall and by CKD stage-specific code from 2000-2013. Figure 2.2 shows CKD prevalence stratified by race, among Medicare patients aged 65 and older during the same period. These figures show that the prevalence of recognized CKD has steadily risen each year. Likewise, the prevalence of recognized CKD prevalence has risen each year in each race group.

vol 1 **Figure 2.1 Trends in prevalence of recognized CKD, overall and by CKD stage, among Medicare patients aged 65+, 2000-2013**



Data Source: Special analyses, Medicare 5 percent sample. Known CKD stages presented as bars; curve showing "All codes" includes known CKD stages (codes 585.1-585.5) and the CKD-stage unspecified codes (585.9, and remaining non-585 CKD codes). Note: In previous years, this graph reported 585.9 codes as a component of the stacked bars. Abbreviation: CKD, chronic kidney disease.

vol 1 **Figure 2.2 Trends in prevalence of recognized CKD, by race, among Medicare patients aged 65+, 2000-2013**



Data Source: Special analyses, Medicare 5 percent sample. Abbreviations: Af Am, African American; CKD, chronic kidney disease; Native Am, Native American.

CKD Progression and Outcomes, Based on Diagnosis Codes

Table 2.5 shows progression of kidney disease by CKD stage, ESRD, or death in 2012-2013 for a cohort of patients based on CKD diagnosis in 2008. Roughly a quarter of patients with early stage CKD (codes for CKD Stage 1 or 2) or CKD stage unspecified in 2008, and who were alive in 2013, did not have a CKD diagnosis code in 2012-2013.

As shown in Table 2.5, the percent of all Medicare patients from 2008 who died or were alive with ESRD by the end of 2013 (i.e., after 5 years) was 24% and 0.3%, respectively. In comparison, patients with a CKD diagnosis in 2008 were even more likely to have these outcomes. Among patients with CKD Stages 1-3 in 2008, approximately 40% had died by 2013, while 1-2% were alive with ESRD. Among patients with CKD Stages 4-5 in 2008, roughly 60% had died and 8% were alive with ESRD in 2013.

vol 1 **Table 2.5 Progression of CKD from 2008 to 2013, Medicare 5% cohort alive and not yet ESRD in 2008**

			2012-2013 status										
			Total	No CKD diagnosis	CKD Stage 1	CKD Stage 2	CKD Stage 3	CKD Stage 4	CKD Stage 5	CKD Stage-Unspecified	ESRD	Death	Lost to follow-up
2008 status	No CKD diagnosis	N	1,132,034	643,787	2,241	8,074	43,180	5,904	1,459	42,226	1,449	246,410	137,304
		%		56.9	0.2	0.7	3.8	0.5	0.1	3.7	0.1	21.8	12.1
	CKD Stage 1	N	2,462	384	109	85	342	84	12	155	41	1,033	217
		%		15.6	4.4	3.5	13.9	3.4	0.5	6.3	1.7	42.0	8.8
	CKD Stage 2	N	5,249	831	50	430	1,102	144	31	314	45	1,860	442
		%		15.8	1.0	8.2	21.0	2.7	0.6	6.0	0.9	35.4	8.4
	CKD Stage 3	N	29,329	2,410	113	518	7,745	1,764	206	1,242	629	12,439	2,263
		%		8.2	0.4	1.8	26.4	6.0	0.7	4.2	2.1	42.4	7.7
	CKD Stage 4	N	8,774	251	22	48	753	1,010	149	176	700	5,197	468
		%		2.9	0.3	0.6	8.6	11.5	1.7	2.0	8.0	59.2	5.3
	CKD Stage 5	N	2,632	185	10	14	206	67	55	93	217	1,637	148
		%		7.0	0.4	0.5	7.8	2.6	2.1	3.5	8.2	62.2	5.6
	CKD Stage-Unspecified	N	44,479	8,620	221	600	4,397	1,077	184	4,857	313	20,773	3,437
		%		19.4	0.5	1.4	9.9	2.4	0.4	10.9	0.7	46.7	7.7
	Any CKD	N	92,925	12,681	525	1,695	14,545	4,146	637	6,837	1,945	42,939	6,975
		%		13.7	0.6	1.8	15.7	4.5	0.7	7.4	2.1	46.2	7.5
	Total	N	1,224,959	656,468	2,766	9,769	57,725	10,050	2,096	49,063	3,394	289,349	144,279
		%	100	53.6	0.2	0.8	4.7	0.8	0.2	4.0	0.3	23.6	11.8

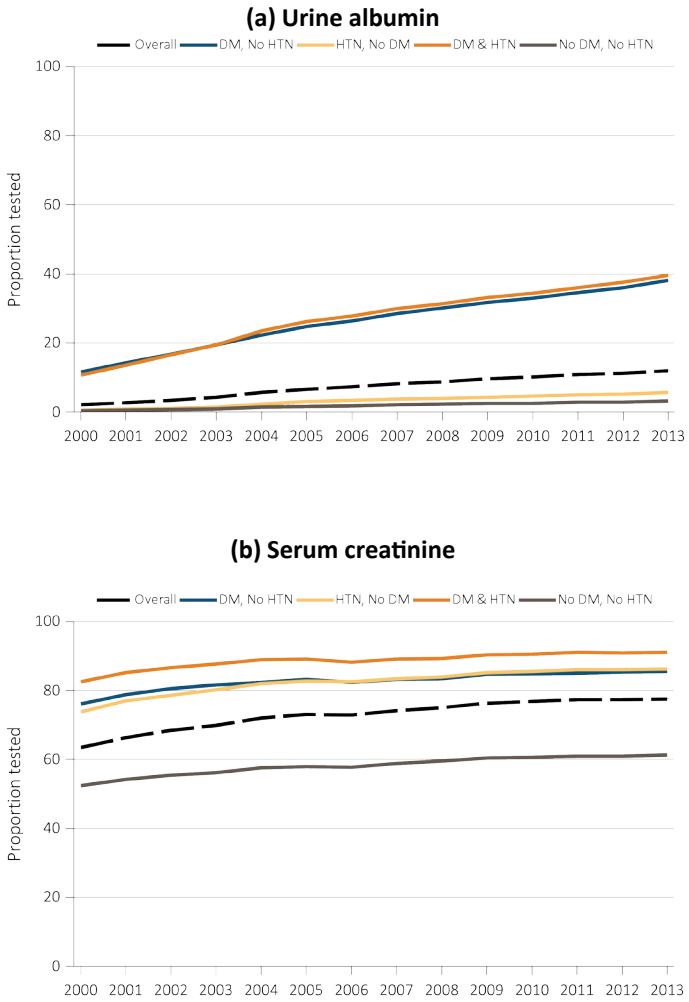
Data Source: Special analyses, Medicare 5 percent sample. Patients alive & eligible for all of 2008. Death and ESRD status were examined yearly between 2009-2013, and carried forward if present. If ESRD occurred before death, the death information was used. Among patients without death or ESRD by 2013 the last CKD diagnosis claim was used; if not available, then the last CKD diagnosis claim from 2012 was used. Lost to follow-up represents the patients that did not have 2013 data available. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease.

Laboratory Testing of Patients With and Without CKD

Assessing the care of patients at high risk for kidney disease has long been a focus of the USRDS, and is now part of the Healthy People 2020 goals developed by the Department of Health and Human Services (see the Healthy People 2020 chapter in Volume 2). Although there are no recommendations to screen asymptomatic patients not at high risk for CKD, individuals at risk for CKD (most notably those with diabetes mellitus) should be screened periodically for kidney disease, and those with CKD should be monitored for progression of disease. Urine albumin and creatinine tests are valuable laboratory markers to detect signs of kidney damage, as well as to evaluate decline in kidney function. Urine testing for albumin in patients with diabetes has been recommended for some time by the American Diabetes Association (ADA). The 2012 Kidney Disease Improving Global Outcomes (KDIGO) guidelines on CKD evaluation and management recommend risk stratification of CKD patients using both the urine albumin/creatinine ratio and the estimated glomerular filtration rate (based on estimating equations incorporating serum creatinine values), emphasizing that both tests are needed to understand patients' kidney disease status and risk of death and progression to end-stage renal disease (ESRD) (Matsushita et al., 2010; Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group, 2012).

As shown in Figure 2.3, 77.8% of Medicare patients without diagnosed CKD received serum creatinine testing in 2013, while 12% received a urine albumin test. Thirty-eight percent of patients with diabetes alone had urine albumin testing, compared to 6% of patients with hypertension alone. Having both diabetes and hypertension is known to increase the likelihood of developing CKD: among these patients, 91% had serum creatinine testing and 40% had urine albumin testing in 2013. Because urine albumin testing must be ordered separately from standard blood tests (as opposed to serum creatinine, which is usually included as part of a standard panel of tests), it may better represent intent to assess kidney disease. There has been a steady rise in use of urine albumin testing over time, particularly in those with diabetes, from 32% in 2008 to 40% in 2013.

vol 1 Figure 2.3 Trends in proportion of patients with (a) urine albumin & (b) serum creatinine testing, by year, among Medicare patients aged 65+ WITHOUT a diagnosis of CKD, 2000-2013

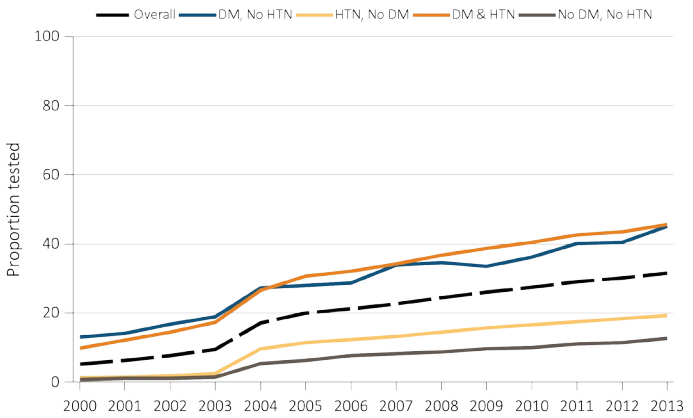


Data Source: Special analyses, Medicare 5 percent sample, aged 65 and older with Part A & B coverage in the prior year. Tests tracked during each year. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension.

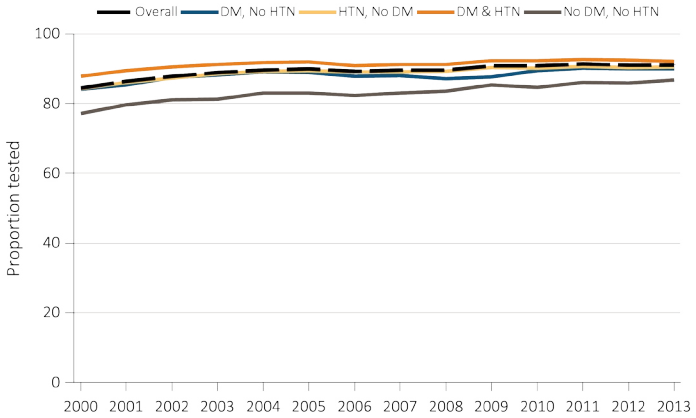
As shown in Figure 2.4, among patients with a diagnosis of CKD, patterns of testing were similar, though at somewhat higher rates than among patients without CKD. For example, in 2013, in patients with a diagnosis of CKD, 46% had urine albumin testing and 92% had serum creatinine testing among patients who also had both diabetes and hypertension.

vol 1 Figure 2.4 Trends in Proportion of patients with (a) urine albumin & (b) serum creatinine testing, by year, among Medicare patients aged 65+ WITH a diagnosis of CKD, 2000-2013

(a) Urine albumin



(b) Serum creatinine

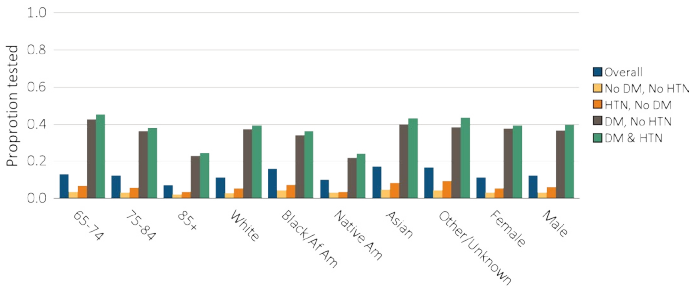


Data Source: Special analyses, Medicare 5 percent sample, aged 65 and older with Part A & B coverage in the prior year. Tests tracked during each year. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension.

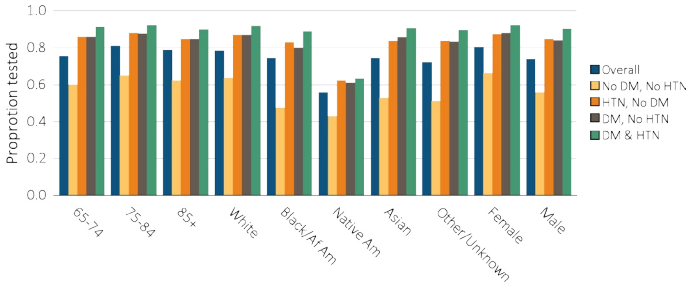
Figures 2.5 and 2.6 provide the proportions tested by demographic characteristics, among those without and with a diagnosis of CKD, respectively, using most recent available (2013) data. Both Figures 2.5 and 2.6 demonstrate lower rates of urine albumin testing with older age, and among patients of Native American or Black race. Serum creatinine testing appears uniformly high, regardless of CKD status, presence of other comorbidities, or demographics, with somewhat lower rates for Native Americans. This again may relate to the fact that serum creatinine is usually included with standard panels of routinely ordered blood tests. The lower rate for Native Americans could be reflective of these patients receiving care at Indian Health Service facilities.

vol 1 Figure 2.5 Proportion of patients with (a) urine albumin & (b) serum creatinine testing by demographic characteristics, adjusted for age, race and gender, among Medicare patients aged 65+ WITHOUT a diagnosis of CKD, 2013

(a) Urine albumin



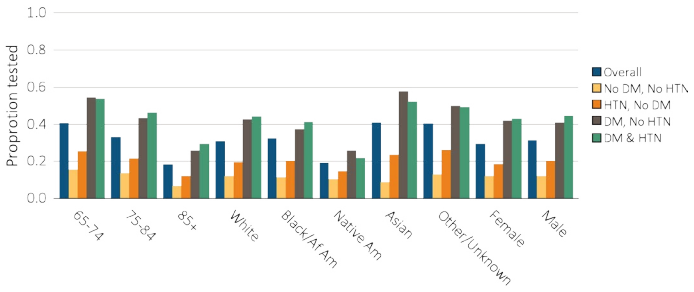
(b) Serum creatinine



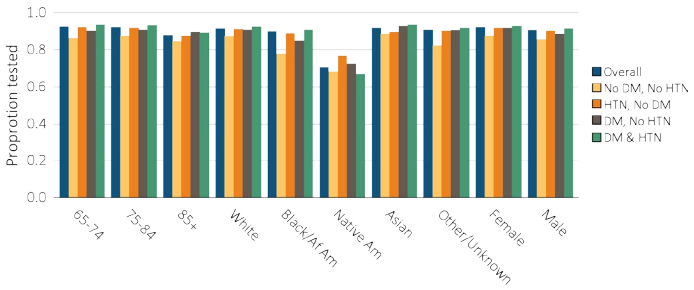
Data Source: Special analyses, Medicare 5 percent sample. Models are adjusted for age, race, and gender. Abbreviations: Af Am, African American; CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension; Native Am, Native American.

vol 1 Figure 2.6 Proportion of patients with (a) urine albumin & (b) serum creatinine testing by demographic characteristics, adjusted for age, race and gender, among Medicare patients aged 65+ WITH a diagnosis of CKD, 2013

(a) Urine albumin



(b) Serum creatinine



Data Source: Special analyses, Medicare 5 percent sample. Models are adjusted for age, race, and gender. Abbreviations: Af Am, African American; CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension; Native Am, Native American.

Physician Visits After a CKD Diagnosis

Table 2.6 indicates the proportion of patients with at least one visit to a primary care physician, cardiologist, or nephrologist in 2013, among those with a CKD diagnosis in 2012. Patients with any CKD diagnosis are far more likely to visit a primary care physician or cardiologist than a nephrologist. This may relate in part to the fact that most guidelines (including the KDIGO CKD guidelines) suggest referral to nephrology only for advanced CKD (Stage 4 CKD, i.e., once the estimated glomerular filtration rate (eGFR) falls to under 30 ml/min/1.73 m^2), unless there are other concerns such as rapid progression of disease. Indeed, fewer than one-third of patients with any CKD claim in 2012 were seen by a nephrologist over the subsequent year. However, among those with more advanced CKD, nearly half with CKD Stage 3, and roughly two-thirds with CKD Stage 4 or higher, visited a nephrologist in 2013. Whether the involvement of a nephrologist improves outcomes, and at what stage of CKD, is a matter of ongoing interest. Overall, the patterns of physician visits varied little across demographic categories. A notable exception is that patients 85 and older with CKD stages 3 or higher were less likely than younger patients to visit a nephrologist.

Table 2.7 presents the proportion of patients with CKD (based on diagnostic code) who were tested for urine albumin or serum creatinine in 2013, according to whether they saw a primary care physician or nephrologist in 2012. Patients who saw a nephrologist were more likely to be tested with urine albumin or serum creatinine than those who saw only a primary care physician. The difference in percent tested between those with and without a nephrology visit was most pronounced for patients without diabetes mellitus. This may relate to the wide promulgation of guidelines directed at primary care physicians, such as those from the ADA, for routine renal function assessment in diabetics.

vol 1 **Table 2.6 Percent of patients with a physician visit in 2013 after a CKD diagnosis in 2012, among Medicare patients aged 65+**

	Any CKD diagnosis			CKD diagnosis code of 585.3 (Stage 3)			CKD diagnosis code of 585.4 (Stage 4) or higher		
	Primary care	Cardiologist	Nephrologist	Primary care	Cardiologist	Nephrologist	Primary care	Cardiologist	Nephrologist
Age									
65-74	89.1	54.9	32.3	89.3	54.4	55.4	81.0	49.3	70.7
75-84	92.3	63.3	31.0	92.0	62.1	48.5	84.0	55.0	69.1
85+	93.7	64.7	24.4	93.6	63.0	36.1	87.4	54.4	57.7
Sex									
Male	91.4	60.1	29.4	91.6	59.5	48.0	83.8	53.2	66.5
Female	91.2	60.3	36.2	90.8	59.6	55.4	83.4	51.1	70.2
Race									
White	90.2	54.0	29.6	89.9	53.0	46.3	84.6	48.8	68.1
Black/Af Am	91.8	56.9	29.5	91.7	55.8	46.9	84.6	49.6	65.6
Other	90.6	62.9	31.0	91.0	62.7	50.9	82.7	56.1	69.0
Overall	91.2	59.7	30.4	91.3	59.1	48.9	83.6	52.6	67.1

Data Source: Special analyses, Medicare 5 percent sample. Patients alive & eligible for all of 2012. CKD diagnosis is at date of first CKD claim in 2012; claims for physician visits were searched during the 12 months following that date. CKD diagnosis code of 585.4 or higher represents CKD Stages 4-5. Abbreviation: CKD, chronic kidney disease; Af Am, African American; Native Am, Native American.

vol 1 **Table 2.7 Proportion of CKD patients in 2012 with physician visit (nephrologist, PCP, both and neither) in 2012, with lab testing in the following year (2013), by comorbidity**

	PCP Only					Nephrologist with and without PCP					Neither				
		Urine albumin testing		Serum creatinine testing			Urine albumin testing		Serum creatinine testing			Urine albumin testing		Serum creatinine testing	
	N	n	%	n	%	N	n	%	n	%	N	n	%	n	%
Overall	63,914	--	23.4	--	90.3	32,131	--	50.4	--	94.5	5,970	--	16.5	--	79.5
No DM, No HTN	4,008	318	7.9	3,450	86.1	937	346	36.9	858	91.6	667	35	5.3	482	72.3
HTN, No DM	30,449	3,143	10.3	27,180	89.3	14,144	5,794	41.0	13,353	94.4	2,913	212	7.3	2,309	79.3
DM, No HTN	1,647	683	41.5	1,498	91.0	410	228	55.6	383	93.4	190	58	30.5	155	81.6
DM & HTN	27,810	10,835	39.0	25,596	92.0	16,640	9,813	59.0	15,773	94.8	2,200	681	31.0	1,798	81.7

Data Source: Special analyses, Medicare 5 percent sample. Patients alive & eligible for all of 2013 with a CKD diagnosis claim in 2012. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension; PCP, primary care physician.

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Notes

Chapter 3: Morbidity and Mortality in Patients With CKD

Mortality

• In 2013, adjusted mortality rates remained higher for Medicare patients with CKD (117.9/1,000) than those without (47.5/1,000), and these rates increase with CKD severity, although this gap has narrowed in the period 2001-2013.

• Male patients had slightly higher mortality rates (52.6/1,000) than females (43.4/1,000), more so among those with CKD (male: 128.7/1,000; female: 110.0/1,000).

• In contrast to previous estimations indicating racial disparity, in 2013, with adjustment for sex and age, no difference was exhibited in the rate of mortality between White and Black Medicare patients with CKD.

Hospitalization

• A notable decrease in hospitalization rates occurred from 2012 to 2013; even after adjustment, admission rates decreased by 11% for CKD patients, and by 10.1% for those without. However, rates of both overall and cause-specific admissions did increase with advancing stages of CKD.

• Older patients exhibited greater rates of hospitalization than did the younger age cohorts. In the CKD group, 769.9/1,000 for those over 85, 37.9% higher than the 558.4/1,000 rate for those 66 to 69 after adjustment.

• Racial differences in hospitalization were notable. In the CKD group, Black patients showed higher rates (719.7/1,000) than Whites (624.8/1,000) or those of other races (544.6/1,000) with adjustment, and this disparity increased with disease severity.

Rehospitalization

• Rates of rehospitalization for CKD patients were higher (22.3%) than those for patients without diagnosed CKD (15.8%).

• Male patients exhibited higher rehospitalization rates than did females in the no CKD group. (adjusted percentage were 16.7 for males and 15.3 for females).

Introduction

In this chapter we evaluate the morbidity and mortality of patients with chronic kidney disease (CKD). Each year's analysis sample was limited to patients aged 66 and older who were continuously enrolled in Medicare; employing a one-year entry period allowed us to identify CKD and other medical conditions using ICD-9-CM (International Classification of Diseases, 9th revision, clinical modification) diagnosis codes from Medicare claims. Their hospitalizations, services, and deaths are then reported for the following calendar year. For example, the rates reported for 2013 are based on events in 2013 for patients with and without CKD in 2012. We initially present results on mortality, then focus on hospitalizations, and end with an examination of patient readmission to the hospital within 30 days

of discharge from their first hospitalization of the calendar year (referred to as the index hospitalization).

Adjusted mortality rates are higher for Medicare patients with CKD than for those without, and rates increase with advancing CKD stage, a finding consistent with studies using biochemical measures to define CKD (Matsushita et al., 2010). The co-occurrence of diabetes mellitus (DM) and cardiovascular disease (CVD) with CKD increase a patient's risk of death. This is clinically significant, as cardiovascular risk factors are relatively undertreated in CKD patients in the United States (U.S.); we illustrate this through data on disease awareness, treatment, and control of risk factors from the population-level National Health and Nutrition Examination Survey (NHANES) cohorts shown in Chapter 1, CKD in the General Population. Clearly, early detection and active treatment are important considerations in reducing morbidity and mortality in the CKD population.

As with mortality, hospitalization rates in the CKD population increase for both overall and cause-specific admissions with advancing stages of CKD. When data were adjusted for age, race, and sex, CKD patients were hospitalized at a rate of 0.63 admissions per patient year overall—0.54 for those in Stages 1-2, 0.61 for Stage 3, and 0.87 for Stages 4-5 (0.61 where stage was not specified; see Table A). It has been known for over a decade that rates of hospitalization for cardiovascular disease and infection also rise with CKD stage (Go et al., 2004). In general, and not surprisingly, hospitalizations among CKD patients also increase in the presence of underlying comorbidities, such as diabetes and CVD.

Hospital readmissions are a key quality indicator for the Medicare program. In an attempt to lower the rate of readmission, the Medicare Hospital Readmission Reduction Program was instituted as part of the Patient Protection and Affordable Care Act, (CMS, 2010) reducing Medicare payments to hospitals with excess readmissions. Rates of rehospitalization for CKD patients were higher than those for patients without diagnosed CKD. In 2013, 22.3% of patients with CKD were readmitted within 30 days, compared to only 15.8% of those without CKD. These rates have not changed significantly in the past decade, which is of major concern.

In Chapter 2, Identification and Care of Patients with Chronic Kidney Disease, we document the increasing recognition of CKD through analysis of diagnosis codes from Medicare claims. The ascertainment of CKD cases through claims data has increased in recent years, likely resulting in decreased estimates of average disease severity, as influenced by the early disease stage of those identified most recently. Thus, changes in mortality and hospitalization rates over time should be viewed with some caution.

Analytical Methods

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

Mortality Rates

As with many chronic conditions, patient mortality is of paramount importance to consider as a major outcome in those with CKD. Table 3.1 presents the mortality rates for several demographic subgroups of patients, both unadjusted and adjusted for age, sex, and race. This year, we have modified the application of adjustment variables; in the 2014 ADR and in prior years, data were also adjusted for prior year hospitalization and disease comorbidities. These were removed as covariates starting this year, as it was felt that presenting highly adjusted rates would make mortality rates seem artificially much lower than they actually are. This modification should be kept in mind when comparing adjusted rates with those in prior ADRs, as differences are apparent.

For patients with CKD, the unadjusted mortality rate was 140.9 per 1,000 patient years; this decreased to 117.5 per 1,000 patient years after adjusting for age, sex and race. As expected, as age increased mortality rates also rose, particularly for the oldest cohort. In all cases, male patients had slightly higher mortality rates than did females, more so for those with CKD, and when adjusted.

The relationship of race and mortality is not as consistent, however. As was also reported in the 2014 ADR, White patients had higher unadjusted mortality rates than did Black/African American patients. In previous years, after taking adjustment factors into account, however, Black patients had a higher rate of mortality than Whites. In the 2013 data introduced for this report, for the first time we observe no difference in the rates of mortality for CKD patients between these race groups.

vol 1 Table 3.1 Unadjusted and adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status, 2013

	Unadjusted		Adjusted	
	No CKD	All CKD	No CKD	All CKD
All	45.7	140.9	47.2	117.5
Age				
66–69	15.5	67.7	15.2	66.5
70–74	21.1	76.9	20.9	74.7
75–84	44.5	123.2	44.5	121.0
85+	141.7	257.6	142.1	255.1
Sex				
Male	45.9	144.8	52.6	128.7
Female	45.6	137.5	43.4	110.0
Race				
White	46.5	144.3	47.6	118.8
Black/African American	44.7	128.5	50.0	118.7
Other	34.5	113.8	37.7	95.2

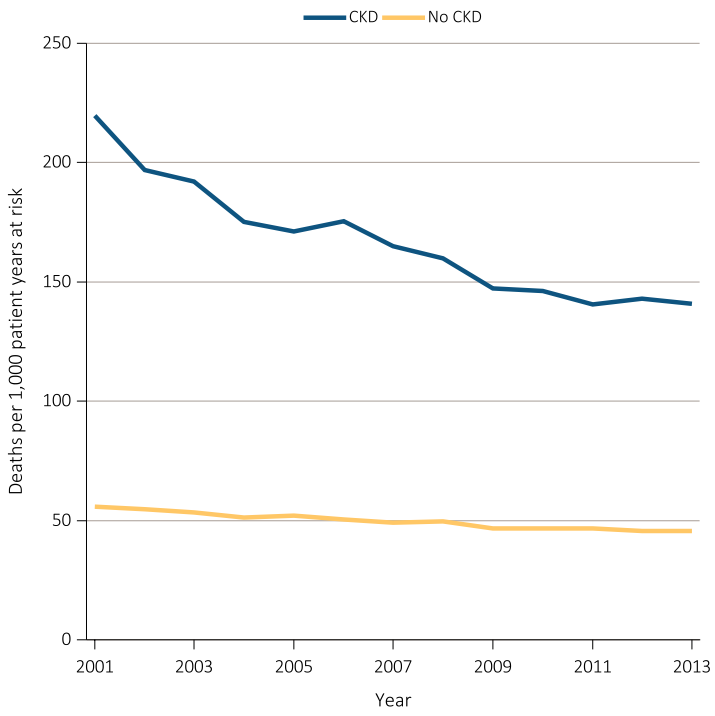
Data source: Medicare 5 percent sample. January 1, 2013 point prevalent patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. Abbreviation: CKD, chronic kidney disease.

Trends in the mortality rates for Medicare patients aged 66 and older are shown in Figure 3.1. Unadjusted mortality in CKD patients has decreased by 35.9% since 2001, from 220 deaths per 1,000 patient years to 141 deaths in 2013. For those without CKD, the unadjusted rate decreased from 56 deaths per 1,000 patient years in 2001 to 46 deaths in 2013, a reduction of 18.1%.

When adjusted for age, race, and sex, the 2013 mortality rate for CKD patients reduced considerably, to 118 deaths per 1,000 patient years at risk. Among those without CKD, adjustment for these factors resulted in a slightly higher mortality rate of 48 deaths per 1,000 patient years, as compared to the unadjusted rate of 46. One major contributor to the discrepancy between adjusted and unadjusted death rates was the relative age difference between the CKD and non-CKD cohorts. In 2013, the mean age of patients with CKD was 79.1 years, compared to 75.9 years for those without, and 76.2 years for the sample as a whole.

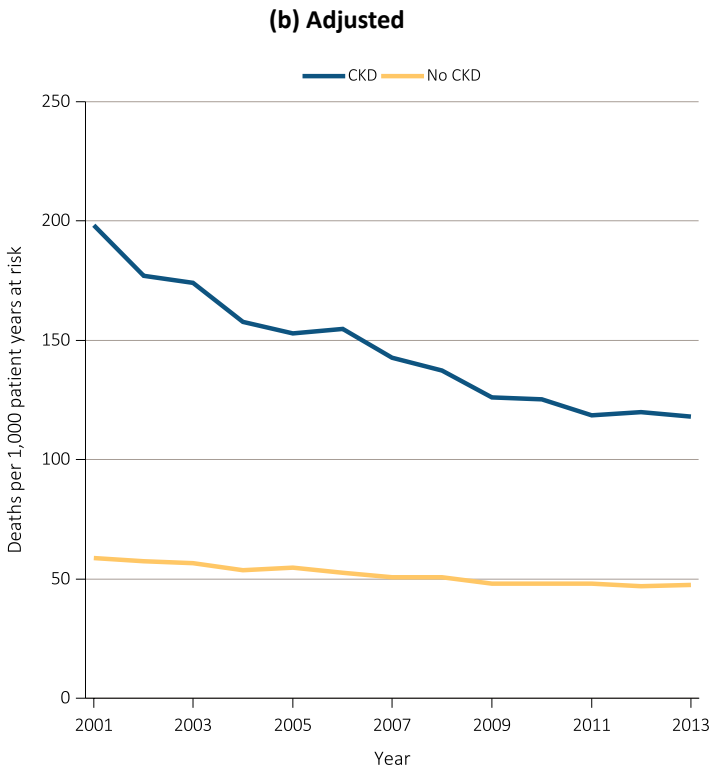
vol 1 Figure 3.1 Unadjusted and adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and year, 2001-2013

(a) Unadjusted



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adj: age/sex/race. Ref: 2012 patients. Abbreviation: CKD, chronic kidney disease.

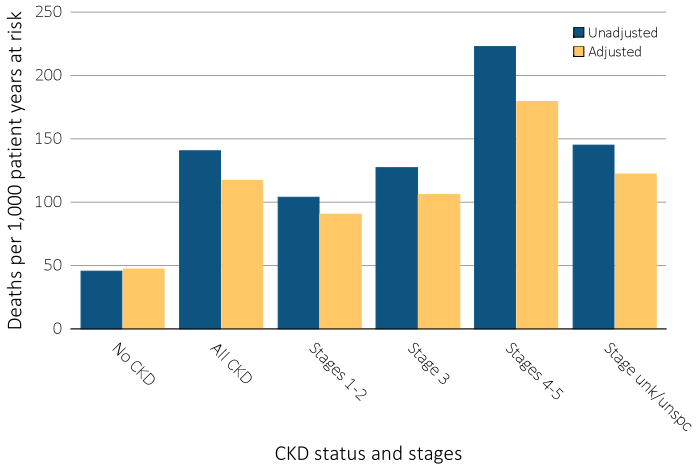
vol 1 Figure 3.1 Unadjusted and adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and year, 2001-2013 *(continued)*



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adj: age/sex/race. Ref: 2012 patients. Abbreviation: CKD, chronic kidney disease.

As expected, unadjusted mortality rates increased with progressing stage of CKD, as shown in Figure 3.2. These rose progressively, from 104 deaths per 1,000 patient years for those in Stages 1 and 2, to 127 for Stage 3, and 223 for Stages 4 and 5 (without ESRD; stages identified by the ICD-9-CM codes, see Table A). Those without an identified CKD stage or with a diagnosis other than the 585 code series had an unadjusted mortality rate falling between that of Stage 3 and Stages 4-5, at 145 deaths per 1,000 patient years at risk. After adjustment, death rates for Stages 1-2 and Stage 3 were 54 and 65 deaths per 1,000 patient years, respectively. The adjusted rate for Stages 4-5 was slightly higher, at 107 deaths per 1,000 patient years at risk. Those with an unspecified CKD stage had death rates at 78 per 1,000 patient years.

vol 1 Figure 3.2 Unadjusted and adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Table A. ICD-9-CM codes for Chronic Kidney Disease (CKD) stages

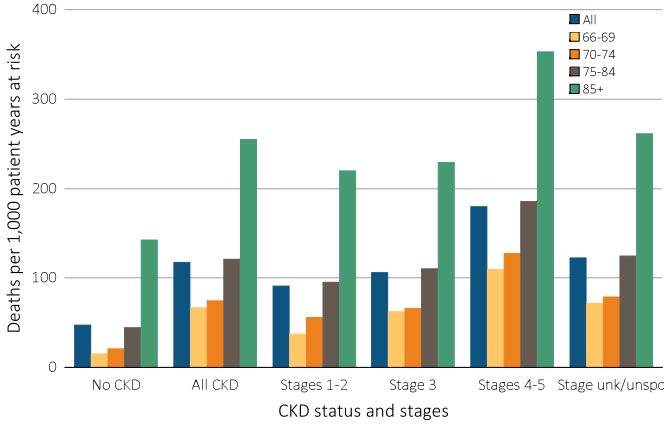
ICD-9-CM code[a]	Stage
585.1	CKD, Stage 1
585.2	CKD, Stage 2 (mild)
585.3	CKD, Stage 3 (moderate)
585.4	CKD, Stage 4 (severe)
585.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD stage-unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others

[a] For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used.

[b] In USRDS analyses, patients with ICD-9-CM code 585.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5.

Adjusted mortality rates for 2013 are shown by CKD and age groups in Figure 3.3. As expected, the mortality rates for older patients groups were higher. In the CKD group, those aged 66-69 years had a mortality rate of 66 deaths per 1,000 patient years at risk, while those aged 75-84 had nearly double that, at 121 deaths. As might be expected, patients aged 85 and older experienced the highest rates of mortality, with 255 deaths per 1,000 patient years.

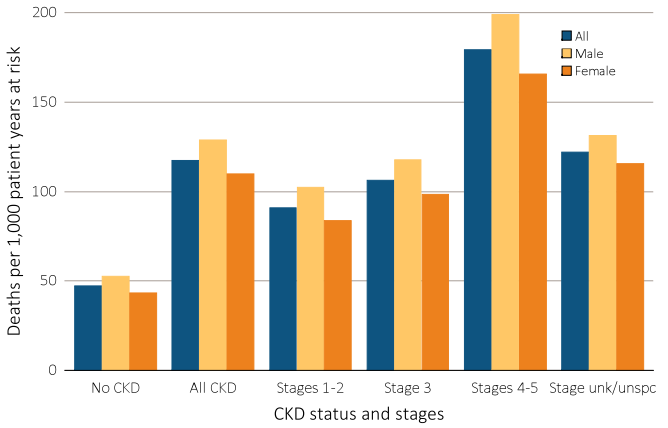
vol 1 Figure 3.3 Adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by age, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

A comparison of adjusted mortality rates in 2013 by CKD groups and sex is shown in Figure 3.4. The rates for males and females were similar for the earlier Stages 1-2 and 3, and the unknown group. A disparity between males and females becomes notable at Stages 4-5, with adjusted mortality rates of 124.6 and 94.7 per 1,000 patient years at risk for males and females, respectively.

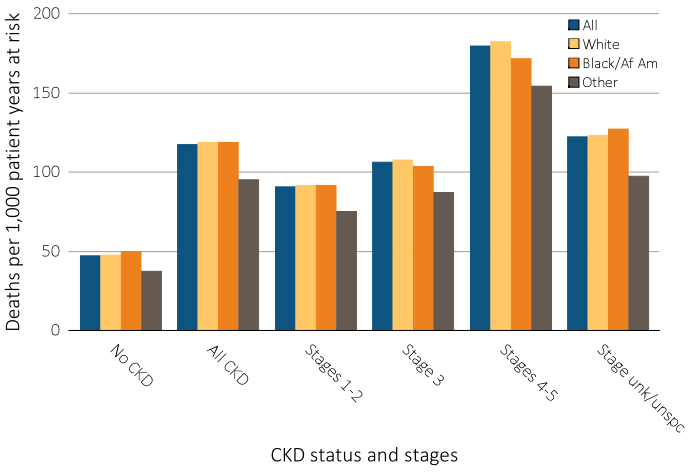
vol 1 Figure 3.4 Adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by sex, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Figure 3.5 illustrates the adjusted mortality rates by race, CKD status, and stage. The rates for the CKD group were more than twice that of the non-CKD group for patients of all races. For those with CKD, the mortality rates for Whites were higher than Blacks in Stages 1-2, 3, and 4-5. For Whites in Stages 1-2 the adjusted rates were 55 per 1,000 patient years at risk, 66/1,000 and 110/1,000 for Stages 3 and 4-5, respectively. The Black patient groups showed adjusted rates of 50 deaths per 1,000 patient years at risk, 57/1,000 and 85/1,000 in Stages 1-2, 3 and 4-5, respectively. Only in the group of patients with no CKD stage specified did Black patients exhibit greater rates of mortality.

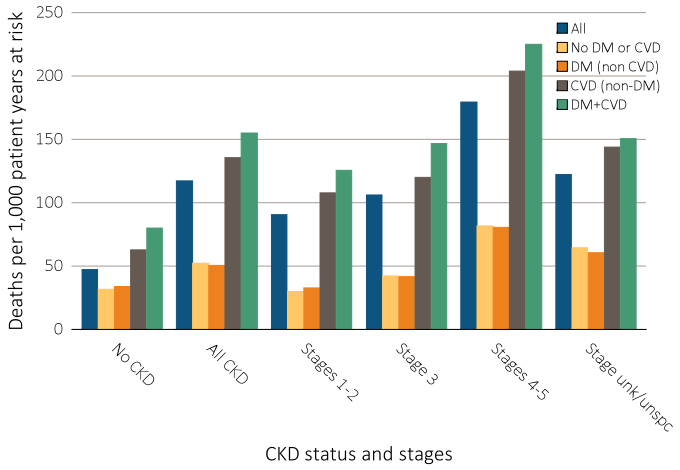
vol 1 Figure 3.5 Adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by race, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. Abbreviations: Af Am, African American; CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted rates of mortality were observed to be higher with greater patient health complexity. Figure 3.6 presents mortality rates by the presence of two common comorbidities of CKD—diabetes and CVD. These comorbid conditions dramatically influence the health outcomes of these patients; in 2013, those with CKD but without DM or CVD had an adjusted mortality rate of 52 deaths per 1,000 patient years at risk, while those with both DM and CVD experienced triple that rate, at 155 deaths per 1,000 patient years.

vol 1 **Figure 3.6 Adjusted all-cause mortality rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by cardiovascular disease and diabetes mellitus, CKD status, and stage, 2013**



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus.

Hospitalization Rates

Table 3.2 shows all-cause hospitalization rates in 2013 for older Medicare patients, by whether they had recognized CKD during 2012. The unadjusted rate for those with CKD was 656 hospitalizations per 1,000 patient years at risk, compared to a much lower rate of 244 for patients without CKD. Encouragingly, 2013 admission rates for CKD patients showed a reduction from 2011 levels (unadjusted CKD: 757/1,000; unadjusted no CKD: 285/1,000). Across all demographic characteristics, the unadjusted hospitalization rate for patients with CKD was two to three times the corresponding rate for patients without CKD. Once adjustment was made for age, race, and sex, the hospitalization rate for patients with CKD (627 per 1,000 patient years at risk) was 152.8% greater than for those without CKD (248 per 1,000). As with mortality, the adjusted hospitalization rate increased with age for all patients. In contrast to the mortality findings, however, women with CKD had higher adjusted hospitalization rates (636.3/1,000) than did men (620.2/1,000); whereas women without CKD (246.7/1,000) had lower adjusted hospitalization rates than did men (250.2/1,000).

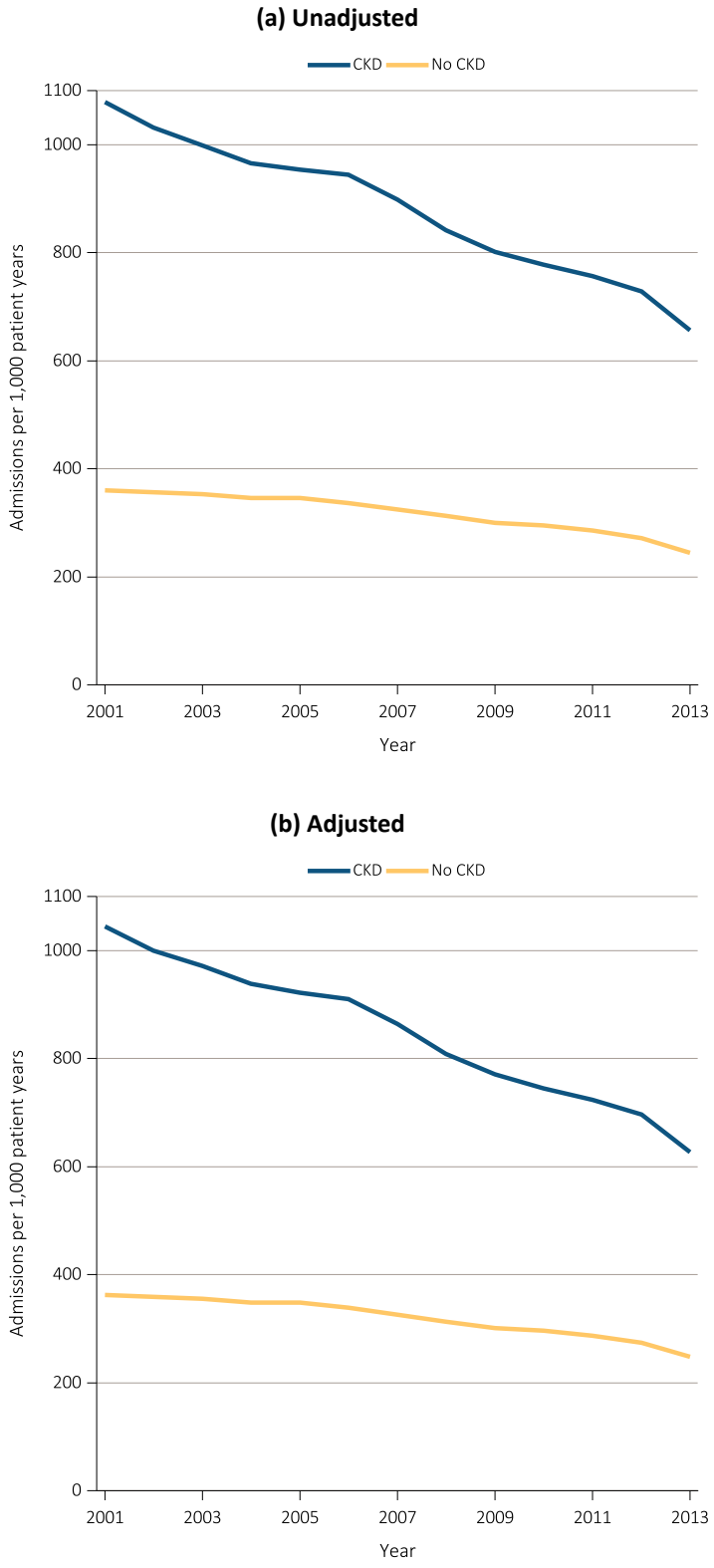
vol 1 **Table 3.2 Unadjusted and adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status, 2013**

	Unadjusted		Adjusted	
	No CKD	All CKD	No CKD	All CKD
All	244.3	655.9	247.8	626.8
Age				
66–69	154.8	558.8	154.8	558.4
70–74	191.6	568.2	191.5	567.5
75–84	273.1	660.5	273.1	658.2
85+	419.6	767.9	423.1	769.9
Sex				
Male	235.8	643.7	250.2	620.2
Female	250.5	666.7	246.7	636.3
Race				
White	246.0	651.5	248.4	624.8
Black/ African American	261.2	734.9	273.0	719.7
Other	196.8	572.4	205.7	544.6

Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients, aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. Abbreviations: CKD, chronic kidney disease.

Figure 3.7 presents the trends for unadjusted and adjusted hospitalization rates for Medicare patients over the past 13 years. The overall trends between adjusted and unadjusted rates, CKD and non CKD, were consistent with data presented thus far. After adjustment, the pattern of hospitalization rates across this time frame showed a gradual decline and was less variable. A notable decrease in hospitalization rates occurred from 2012 to 2013; even after adjustment the CKD group decreased by 11.1%, from 696 to 627 per 1,000 patient years at risk for the CKD group, and 10.5%, from 274 to 248 per 1,000 patient years at risk for non-CKD group.

vol 1 Figure 3.7 Unadjusted and adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and year, 2001-2013

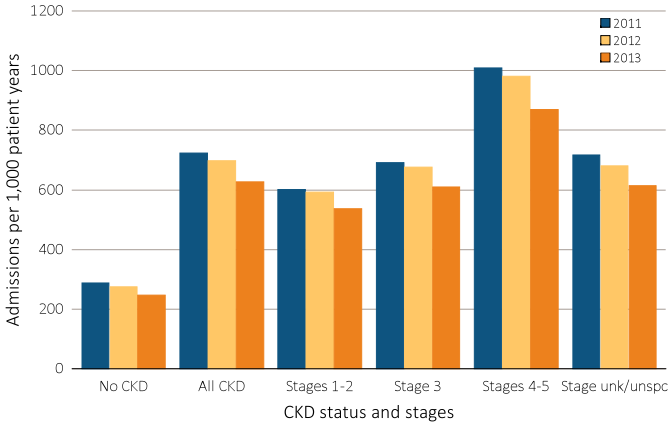


Data source: Medicare 5 percent sample. January 1 of each reported year point prevalent Medicare patients aged 66 and older. Adj: age/sex/race. Ref: 2013 patients. Abbreviations: CKD, chronic kidney disease.

For patients with CKD, differences can be observed in the rates of hospitalizations necessary to treat different comorbid conditions. Figure 3.8 shows the adjusted hospitalization rates for all causes; in Figures 3.9 through 3.11, we present hospitalization rates resulting from CVD (23.3% of all-cause admissions), infection (20.2%), and all other cause categories (56.5%), respectively. As the covariates in the adjusted model no longer include comorbidities and prior year hospitalizations, the adjusted rates do vary noticeably from results presented in the 2014 ADR.

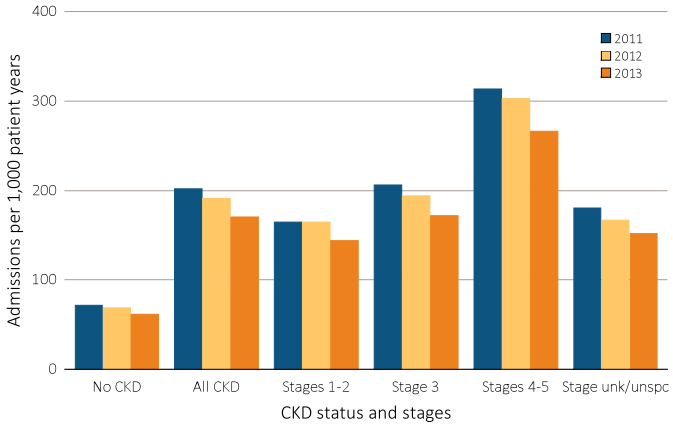
Rates of all-cause hospitalizations in 2013 increased with disease severity, from 536 admissions per 1,000 patient years for those in Stages 1 and 2, to 609 for Stage 3, and 869 for Stages 4 and 5; these are uniformly lower than those occurring in 2011 and 2012 (see Figure 3.8). The pattern of increase for hospitalizations resulting from a primary diagnosis of CVD was similar, with rates increasing from 144 admissions per 1,000 patient years for CKD Stages 1 and 2, to 172 for Stage 3, and 266 for Stages 4 and 5 (see Figure 3.9).

vol 1 Figure 3.8 Adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and stage, 2011-2013



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adj: age/sex/race. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

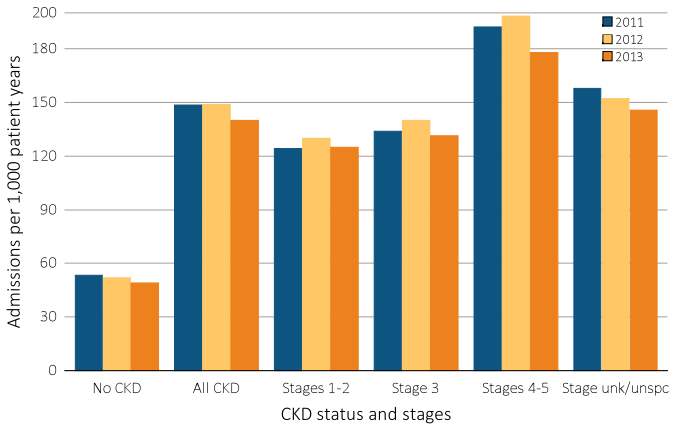
vol 1 Figure 3.9 Adjusted rates of hospitalization for cardiovascular disease (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and stage, 2011-2013



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted hospitalization rates for infection by CKD status and stages are shown in Figure 3.10. Although the rates increased slightly from 2011 to 2012, they returned to lower or almost equal levels in 2013.

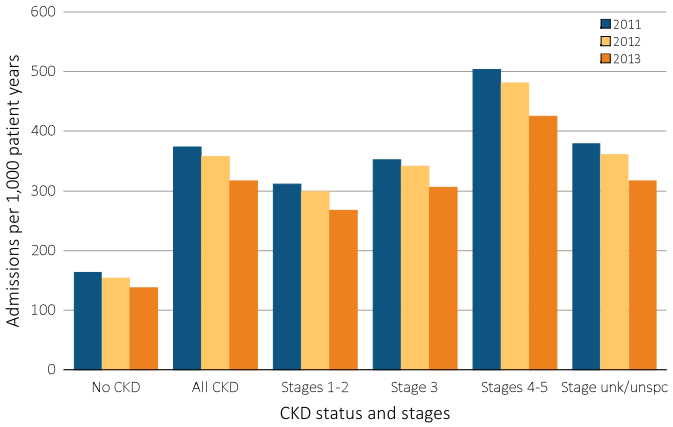
vol 1 Figure 3.10 Adjusted rates of hospitalization for infection (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and stage, 2011-2013



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Figure 3.11 presents the adjusted rates of hospitalization resulting from all other health causes. The pattern was similar to that seen in Figure 3.8, with rates steadily decreasing from 2011 to 2013.

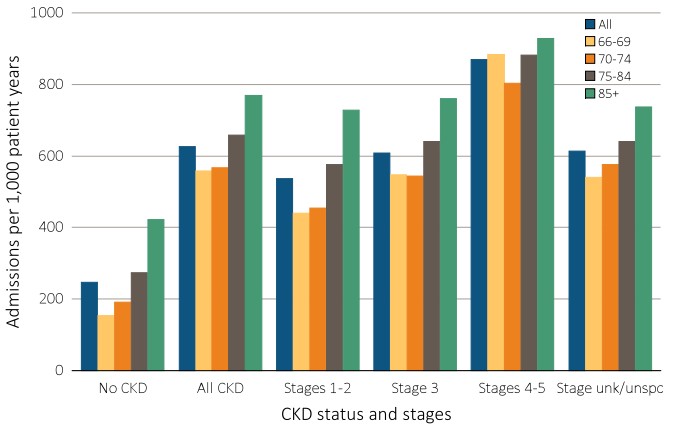
vol 1 Figure 3.11 Adjusted rates of hospitalization for causes other than cardiovascular disease and infection (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by CKD status and stage, 2011-2013



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

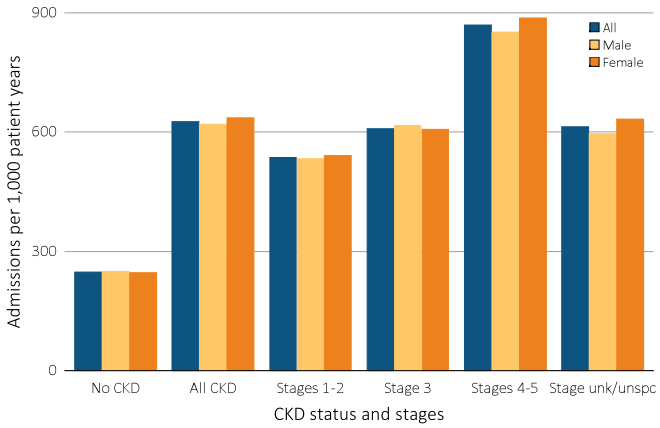
Demographic comparisons also highlight differences in all-cause hospitalization rates for CKD, as shown in Figures 3.12-3.14. In general, and consistent with mortality patterns, older patients exhibit higher rates of hospitalization than do the younger age cohorts. An interaction between age and disease severity is observed in later stages of CKD. As seen in Figure 3.12, rates for younger patients were lower in Stages 1-2 and 3, but in Stages 4-5 the rate for patients aged 70-74 was lower than for all other groups.

vol 1 Figure 3.12 Adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by age, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

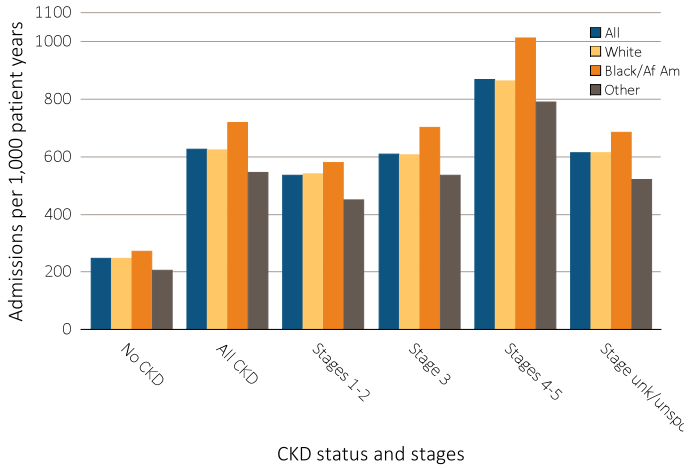
vol 1 Figure 3.13 Adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by sex, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Racial differences in hospitalization were notable. In both non CKD and CKD populations, black persons are hospitalized more frequently than other races. In 2013, Black patients in the CKD group showed higher rates than Whites or those of other races (720 per 1,000 patient years vs 625 and 545, respectively; Figure 3.15). This disparity increases with disease severity, with rates for Black patients 7.2% higher than Whites in Stages 1-2 (580 vs 540), 15.8% in Stage 3 (701 vs 606) and 17.4% higher in Stage 4 or 5 (1,013 vs 864). Patients of other races experience the lowest rates of hospitalization in all disease stages.

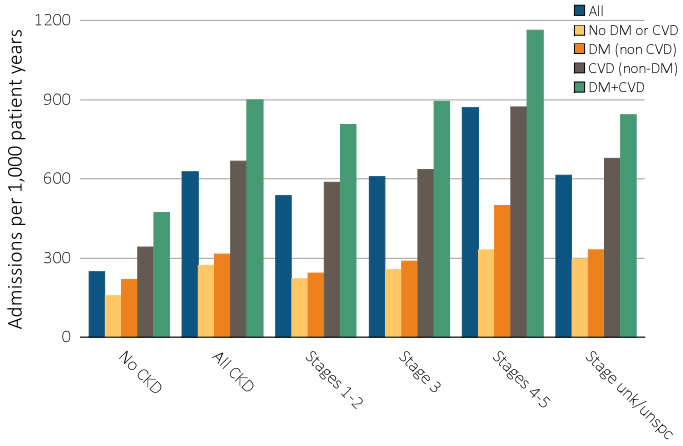
vol 1 Figure 3.14 Adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by race, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: Af Am, African American; CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted rates of all-cause hospitalization increased in the presence of diabetes and CVD for patients both with and without CKD (see Figure 3.15). In the non CKD population, the adjusted hospitalization rates were 157.1/1,000 for no DM or CVD, 219.5/1,000 for DM only, 340.9 for CVD only and 473.0/1,000 for CM with CVD. In 2013, admissions per 1,000 patient years increased from 273 for CKD patients without DM or CVD, to 316 for CKD patients with only DM and 667 for those with only cardiovascular disease, to a high of 898 for CKD patients with both comorbidities. This additional disease burden was most striking for patients with Stage 4 or 5 CKD; patients with both DM and CVD in addition to late-stage CKD had an all-cause hospitalization rate of 1,162 admissions per 1,000 patient years, compared to only 331 for late-stage CKD patients without DM or CVD.

vol 1 Figure 3.15 Adjusted all-cause hospitalization rates (per 1,000 patient years at risk) for Medicare patients aged 66 and older, by cardiovascular disease and diabetes mellitus, CKD status, and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older. Adj: age/sex/race; rates by one factor are adjusted for the others. Ref: all patients, 2013. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; unk/unspc, CKD stage unidentified.

Rehospitalization

Reducing the rate of readmission to a hospital within 30 days of discharge from the original hospitalization is a quality assurance goal for many healthcare systems, including the Medicare program. Table 3.3 shows the distribution of unadjusted percentages of rehospitalization among those with and without recognized CKD, by CKD stage, stratified by age groups, sex and race, in the Medicare population in 2013. The unadjusted proportion of Medicare patients aged 66 and older who were readmitted to the hospital within 30 days of discharge from a first, all-cause hospitalization was 15.8% for those without CKD and 22.3% for those with CKD (see Table 3.3). These rates represent a slight decrease from 2012 levels. Rehospitalization rates increased slightly with stage of CKD, from 21.0 percent in stages 1-2 to 24.1 percent in stages 4-5.

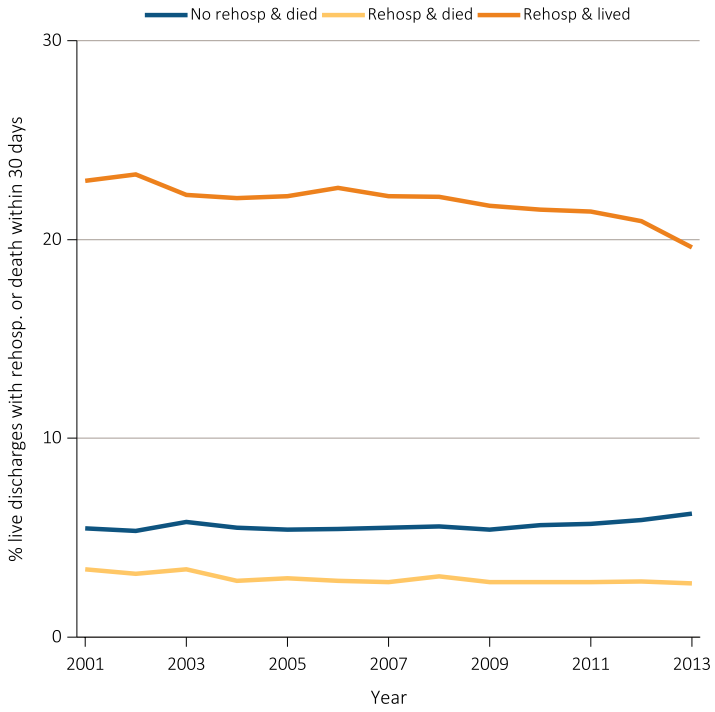
vol 1 Table 3.3 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by CKD status and stage, 2013

	No CKD	All CKD	Stages 1-2	Stage 3	Stages 4-5	Stage Unknown / unspecified
All	15.8	22.3	21.0	22.2	24.1	22.0
Age						
66-69	15.3	24.4	23.9	23.6	25.1	25.2
70-74	15.5	23.1	21.5	22.4	24.4	23.9
75-84	16.1	22.8	20.7	22.6	25.7	22.4
85+	15.9	20.3	19.9	20.9	21.7	19.1
Sex						
Male	16.6	22.8	22.0	22.4	25.3	22.5
Female	15.3	21.8	20.1	22.0	23.3	21.6
Race						
White	15.6	21.9	20.7	21.8	23.5	21.7
Black/African American	17.5	25.3	22.7	25.2	27.8	24.8
Other	17.3	21.5	22.3	21.6	22.2	20.7
No rehospitalization & died	4.5	6.2	5.6	5.9	8.0	6.2
Rehospitalization & died	1.7	2.7	2.1	2.8	3.3	2.6
Rehospitalization & lived	14.1	19.6	19.0	19.4	20.9	19.4

Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013; unadjusted. See Table A for CKD stage definitions. Abbreviations: CKD, chronic kidney disease.

The adjusted trend for readmissions from 2001-2013 is shown in Figure 3.16. Results may differ from those presented in previous ADRs, in part because the adjustment variables of disease comorbidity and prior year hospitalization are no longer applied in the model. Specifically, the percentage of patients who were rehospitalized and lived within 30 days of the initial discharge declined from 22.9% in 2006 to 19.6% in 2013, amounting to a decrease of 3.3% over the 13-year period. While any reductions are encouraging, the proportion of patients who were rehospitalized and subsequently died within 30 days of the initial discharge has not changed significantly—reducing by only 0.7% from 2012 levels. Of note, the rate of patients who were not rehospitalized but died within 30 days of the initial discharge has increased somewhat, by 0.8% since 2009.

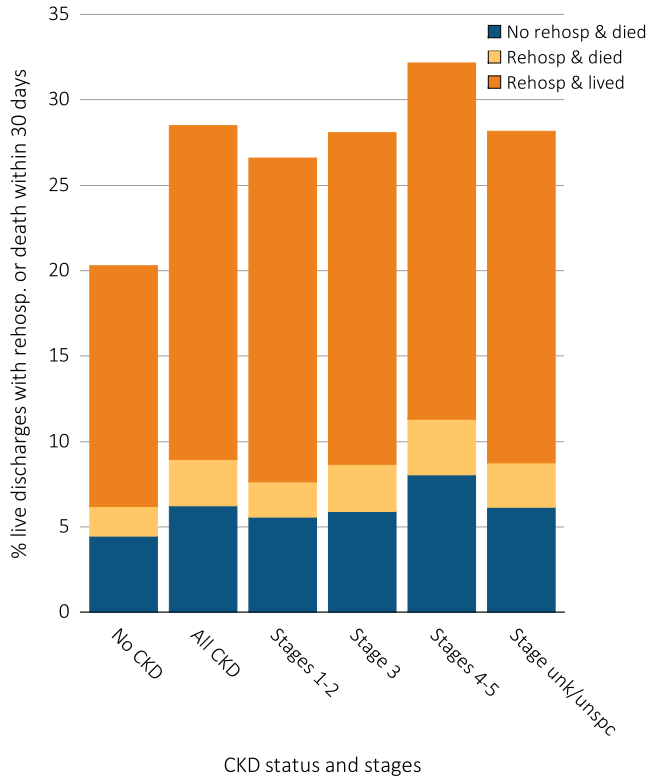
vol 1 Figure 3.16. Adjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare CKD patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by year, 2001-2013



Data source: Medicare 5 percent sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older with CKD (defined during the prior year), discharged alive from an all-cause index hospitalization between January 1 and December 1 of the reported year. Adj: age/sex/race. Ref: 2013. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized.

Figure 3.17 presents the percentages of Medicare patients who were rehospitalized and/or died with or without rehospitalization within 30 days of discharge following an index hospitalization. Compared to those without a diagnosis of CKD, those with CKD had a higher proportion of live discharges linked to a rehospitalization or death.

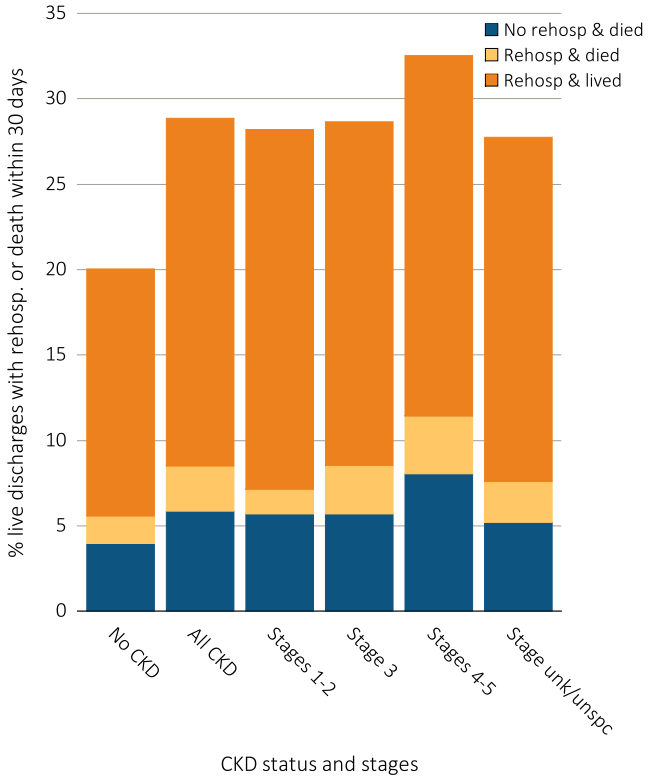
vol 1 Figure 3.17 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by CKD status and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013, unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.18 shows the death and rehospitalization percentages for older Medicare patients who were discharged alive from a cardiovascular index hospitalization; 23.0% of patients with CKD and 16.1% of those without required rehospitalization within 30 days. Otherwise, the magnitude and pattern of these readmission rates were similar to those for all-cause index hospitalizations.

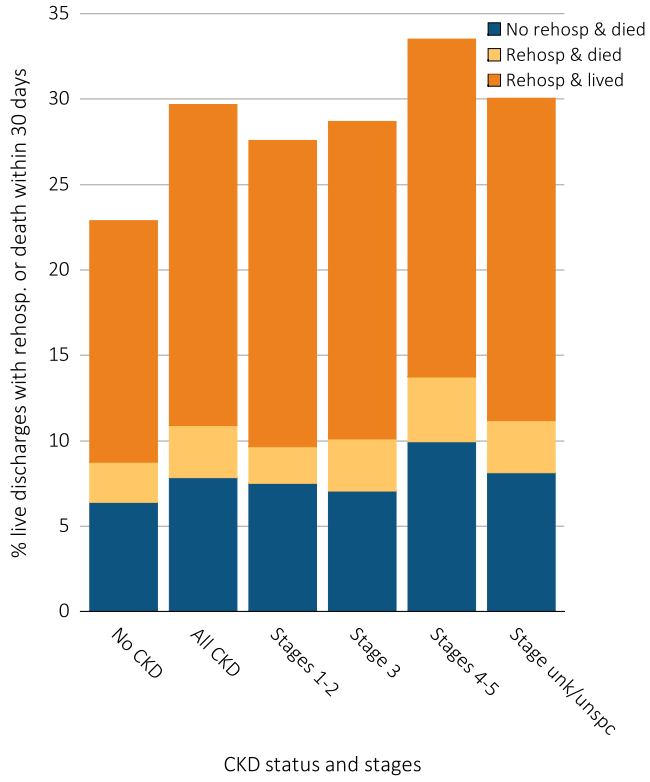
vol 1 Figure 3.18 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from a cardiovascular-related index hospitalization between January 1 and December 1, by CKD status and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Of all patients who experienced an infection-related admission, 17.9% required rehospitalization (see Figure 3.19). In the CKD group, 18.8 % of patients were subsequently rehospitalized and lived within 30 days of the initial discharge, and an additional 3.1% died following rehospitalization; 7.8% of patients were not rehospitalized and died. For those without CKD, these three percentages were 14.2%, 2.4%, and 6.4% respectively.

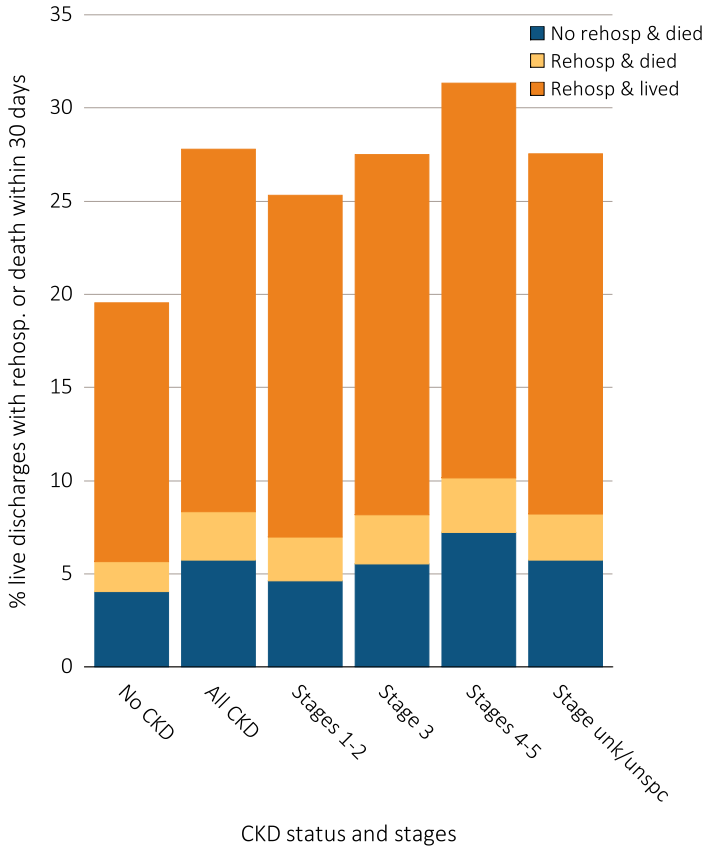
vol 1 Figure 3.19 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an infection-related index hospitalization between January 1 and December 1, by CKD status and stage, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013, unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.20 shows the death and rehospitalization percentages for Medicare patients aged 66 and older who were discharged alive from index hospitalization of all causes other than CVD and infection. The patterns of these percentages were similar to those for all-cause index hospitalizations. For the CKD group, patients who were not rehospitalized but died, rehospitalized and died, or rehospitalized and lived were 5.7%, 2.6% and 19.5%, respectively. In the no-CKD group, these percentages were somewhat lower: 4.1%, 1.6% and 13.9% respectively.

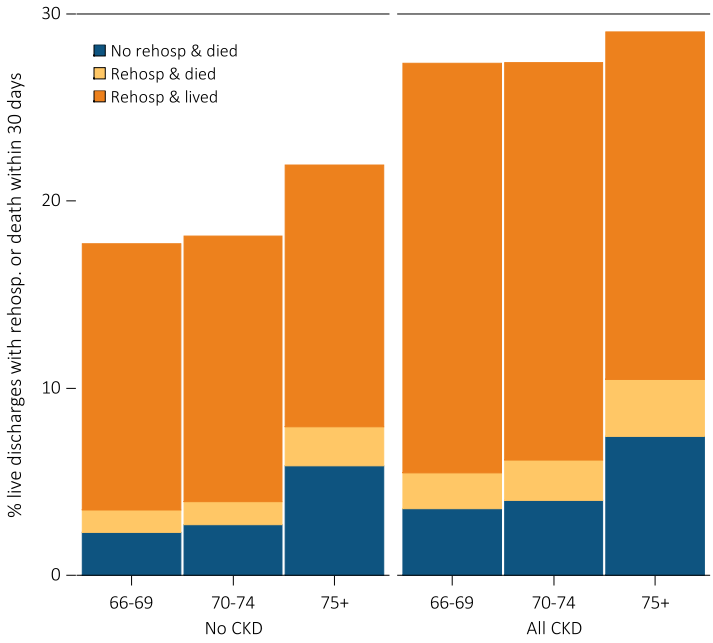
vol 1 Figure 3.20 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from a non-cardiovascular and non-infection related index hospitalization between January 1 and December 1, by CKD status and stage, 2013



Data Source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

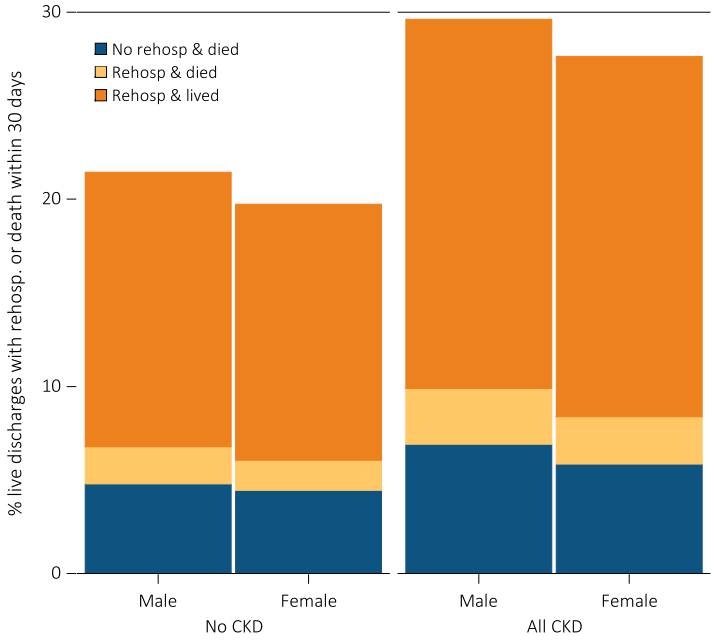
Figure 3.21 illustrates a comparison by age group of the percentages of Medicare patients that were re-hospitalized or died within 30 days of discharge from an all-cause, index hospitalization, among those with CKD and those without. Rates of rehospitalization with survival in patients with CKD decreased with age across all stages of CKD in the Medicare population. These findings are likely due to the competing risk of death in older age groups. For both patients with and without CKD, the proportion returning to the hospital and dying within 30 days of discharge or dying without rehospitalization, increased with older age.

vol 1 Figure 3.21 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by age and CKD status, 2013



Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized.

vol 1 Figure 3.22 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by sex and CKD status, 2013

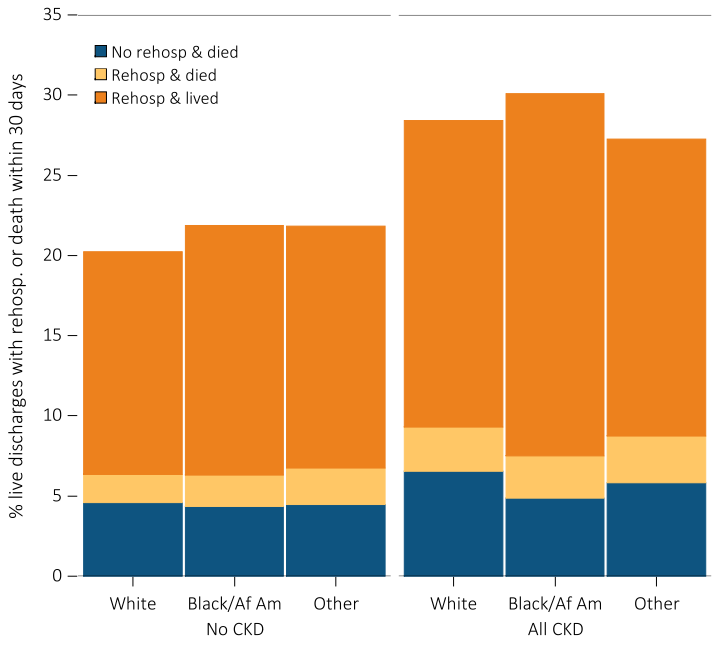


Data source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized.

Figure 3.22 compares the rates of all-cause hospitalization rates by sex. Male patients exhibited higher rates than did females in all outcome categories. Also, CKD patients in all categories showed higher rates than did those without. Specifically, 6.9% of males do not require rehospitalization, 3.0% were rehospitalized and later died within 30 days of the initial discharge, and 19.7% were rehospitalized and lived.

Racial trends in post-discharge outcomes were mixed. As shown in Figure 3.23, for both patients with and without CKD, Blacks who were rehospitalized subsequently survive at greater rates (17.5%) than both Whites (15.6%) and patients of other races (17.4%). Whites experienced the highest rates of death without rehospitalization (4.6%), and more patients of other races were observed to have died following their rehospitalization (4.5%).

vol 1 Figure 3.23 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by race and CKD status, 2013



Data Source: Medicare 5 percent sample. January 1, 2013 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2013, and December 1, 2013; unadjusted. Abbreviations: Af Am, African American; CKD, chronic kidney disease; Rehosp, rehospitalized.

This chapter focused on mortality and morbidity in the Medicare population with and without CKD. While hospitalization rates have been decreasing over time, the underlying causes for this decline and lessons learnt requires further research as well as enhanced quality improvement efforts. In future iterations of the ADR, we will examine data on morbidity and mortality in the CKD population from non-Medicare data sources.

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Go AS, Chertow GM, Fan D, McCulloch CE, Hsu C. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. *New England Journal of Medicine* 2004;351(13):1296-1305.

Matsushita K, van der Velde M, Astor BC, Woodward M, Levey AS, de Jong PE, Coresh J, Gansevoort RT. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. *Lancet* 2010;375(9731):2073–81.

Chapter 4: Cardiovascular Disease in Patients With CKD

- The prevalence of cardiovascular disease is 69.6% among patients aged 66 and older who have CKD, compared to 34.7% among those who do not have CKD.
- The presence of CKD worsens the short- and long-term prognosis for many common cardiovascular diseases. The two-year survival of AMI patients without a diagnosis of CKD is 57%, compared to 46% for CKD Stage 1-2 patients and 30% for CKD Stage 4-5 patients.
- Over a two-year period, Medicare patients with both congestive heart failure and CKD have an adjusted survival probability of 75.3%, compared with 88.9% for those with CKD alone.
- Atrial fibrillation is common among Medicare patients with CKD (24.1%). The prevalence of atrial fibrillation rises for males with more advanced stages of CKD, age, hypertension, and congestive heart failure. Nearly half of CKD patients with congestive heart failure have a diagnosis of atrial fibrillation.

Introduction

Cardiovascular disease remains the leading cause of death in most developed countries including the United States (Centers for Disease Control and Prevention. National Center for Health Statistics, 2015) and accounts for over half the deaths among those on dialysis (see Volume 2, Chapter 9: Cardiovascular Disease in Patients with ESRD). Death from cardiovascular disease is far more common in patients with chronic kidney disease (CKD) than progression to end-stage renal disease (ESRD) (Gargiulo et al., 2015). CKD has been recognized as an independent risk factor for cardiovascular disease and has now been recognized as a coronary disease risk equivalent (Briasoulis and Bakris, 2013), similar to diabetes mellitus. The complex relationship between cardiovascular disease and kidney disease is thought to be due to shared traditional risk factors (e.g., diabetes mellitus, hypertension, physical inactivity, left ventricular hypertrophy, smoking, family history, and dyslipidemia), as well as the influence of non-traditional risk factors in the presence of CKD (e.g., endothelial dysfunction, vascular medial hyperplasia, sclerosis and calcification, volume overload, abnormalities in mineral metabolism, anemia, malnutrition, inflammation, oxidative stress, and autonomic imbalance). The cardio-renal syndrome continues to pose both a diagnostic and therapeutic challenge for those with heart failure (Husain-Syed et al., 2015). Not surprisingly, cardiovascular disease is often an important comorbidity among patients with CKD.

In this chapter, we review recent trends in the prevalence and outcomes of cardiovascular disease in CKD patients and compare these to outcomes of cardiovascular disease in patients without CKD, focusing on the high-risk, elderly Medicare population. Their CKD and cardiovascular disease diagnoses were obtained from billing claims from the Medicare 5 percent sample. The overall study cohort for 2013 includes 1,238,888 patients, of which 132,840 patients have CKD.

Analytical Methods

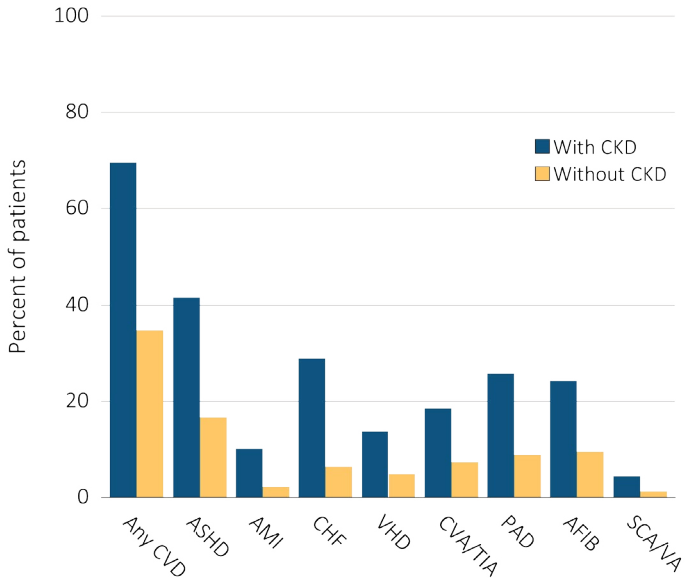
See the CKD Analytical Methods chapter for an explanation of analytical methods used to generate the study cohorts, figures, and tables in this chapter.

Cardiovascular Disease Prevalence and Outcomes in CKD

As shown in Figure 4.1, elderly CKD patients have a greater burden of cardiovascular disease than do their counterparts without a diagnosis of CKD for a wide range of conditions. Stable atherosclerotic heart disease

(ASHD), acute myocardial infarction (AMI), congestive heart failure (CHF), valvular heart disease (VHD), stroke (cerebrovascular accident/transient ischemic attack, CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AFIB), and sudden cardiac arrest and ventricular arrhythmias (SCA/VA) are all more common in CKD patients aged 66 and older when compared to those without CKD. Indeed, the prevalence of any cardiovascular disease is double among those with CKD compared to those without (69.6% versus 34.7%).

vol 1 Figure 4.1 Cardiovascular disease in patients with or without CKD, 2013

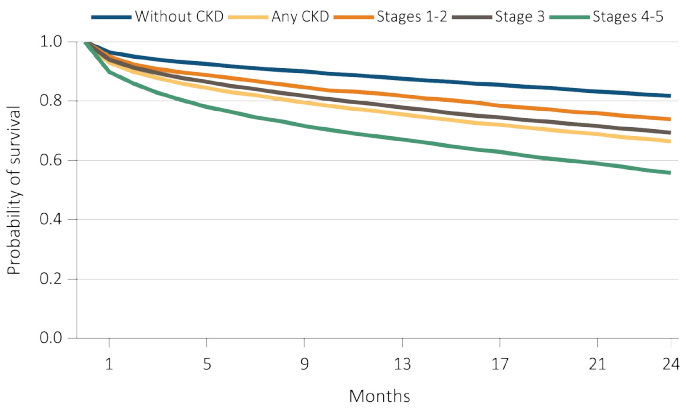


Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Totals of patients for the study cohort: N=1,238,888; With CKD=132,840; Without CKD=1,106,048. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias; VHD, valvular heart disease.

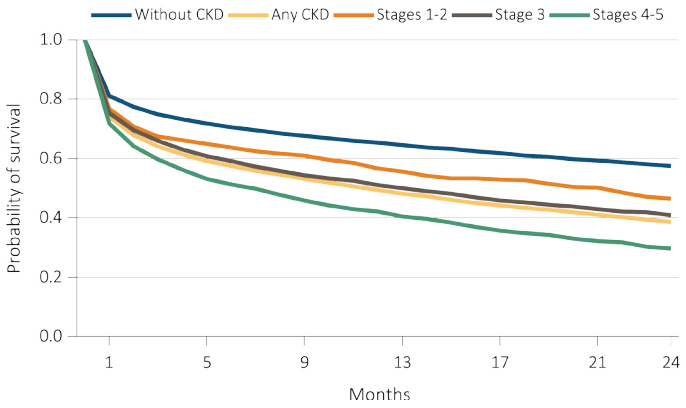
The presence of CKD also worsens the short- and long-term prognosis for many of these common cardiovascular diseases. Figures 4.2.a through 4.2.k illustrate survival in patients with cardiovascular disease stratified by the presence of CKD and its severity. In general, CKD patients have worse survival across all of the conditions reported, with late stages of CKD associated with the worst outcomes. This pattern also is true in patients who undergo common major procedures for the treatment of cardiovascular diseases. For example, the two-year survival of AMI patients without a diagnosis of CKD is 57%, compared to 46% for CKD Stage 1-2 patients and 30% for CKD Stage 4-5 patients.

vol 1 Figure 4.2 Survival of patients with a cardiovascular diagnosis or procedure, by CKD status, 2011-2013

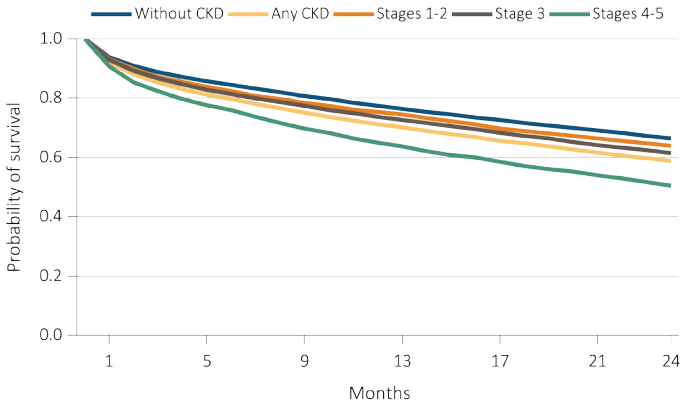
(a) ASHD



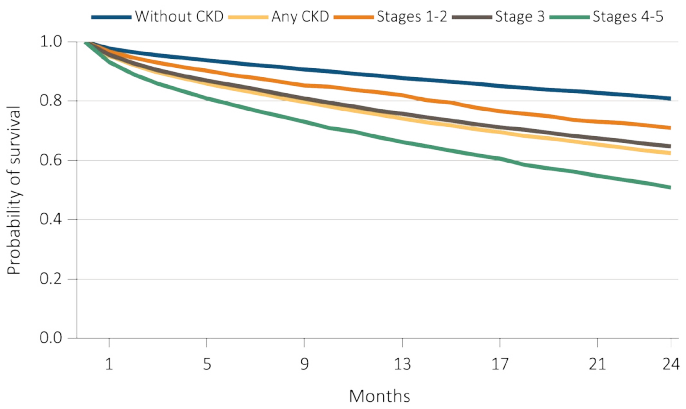
(b) AMI



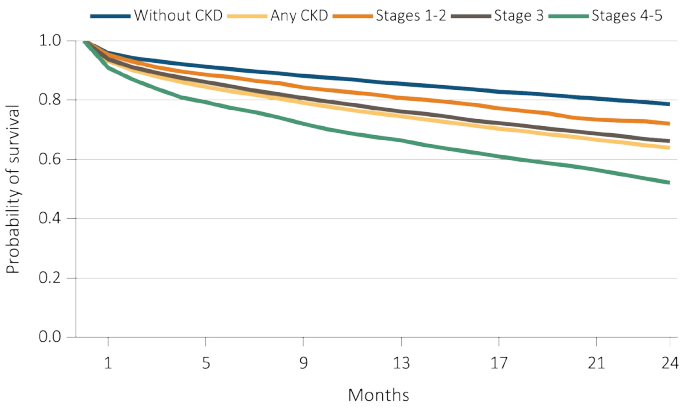
(c) CHF



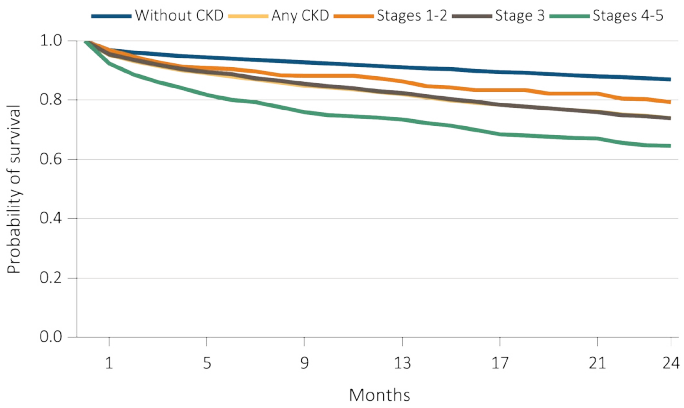
(d) VHD



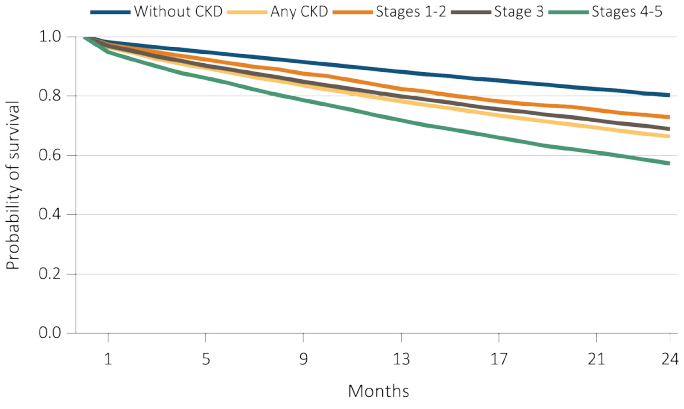
(e) CVA/TIA



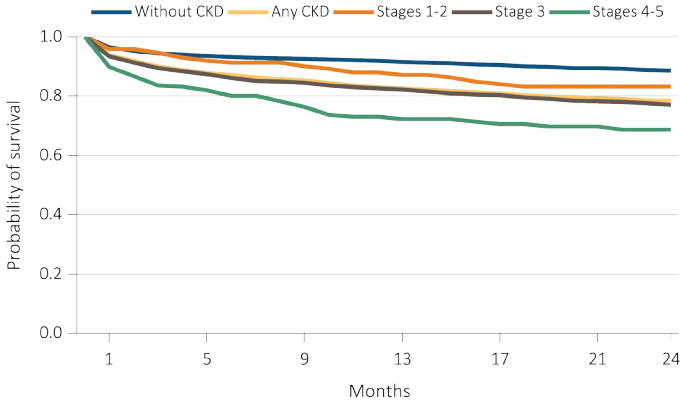
(i) PCI



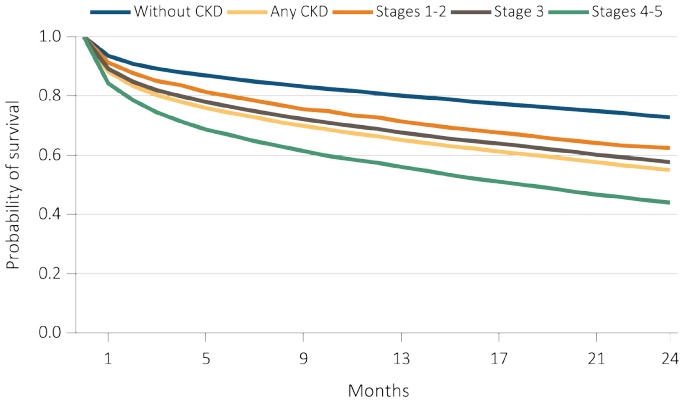
(f) PAD



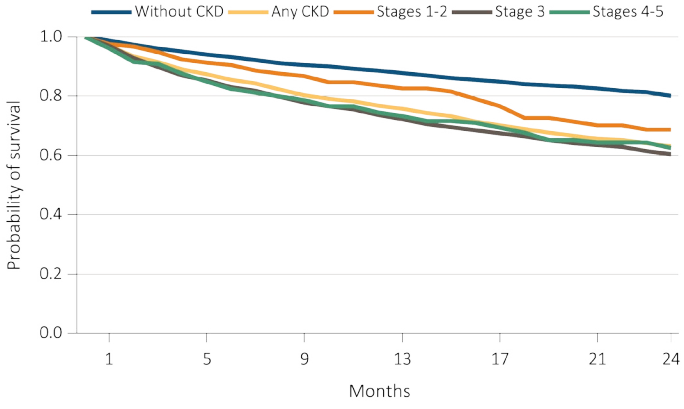
(j) CABG



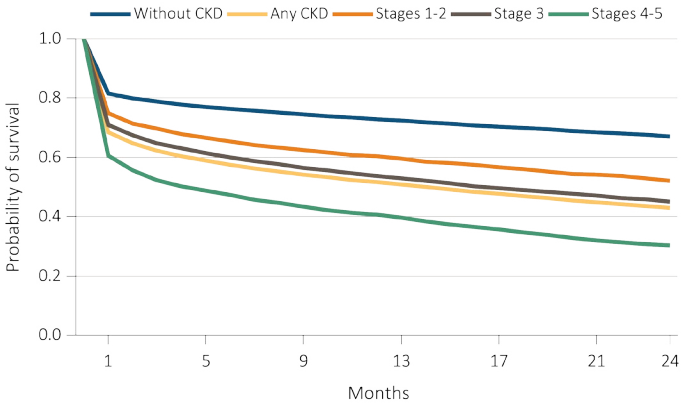
(g) AFIB



(k) ICD/CRT/D



(h) SCA/VA



Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on the index date, which is the date of the first condition/ procedure claim, with fee-for-service coverage for the entire year prior to this date. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CABG, coronary artery bypass grafting; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/ transient ischemic attack; CVD, cardiovascular disease; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PAD, peripheral arterial disease; PCI, percutaneous coronary interventions; SCA/VA, sudden cardiac arrest and ventricular arrhythmias; VHD, valvular heart disease.

vol 1 **Table 4.1 Prevalence of cardiovascular comorbidities & procedures (%), by CKD status, age, race & sex, 2013**

	Overall	66-69	70-74	75-84	85+	White	Black/ Af Am	Other	Male	Female
Cardiovascular Comorbidities[1]										
Atherosclerotic heart disease (ASHD)										
Without CKD	16.5	10.5	14.6	20.1	22.9	17.0	13.3	13.3	22.0	12.5
Any CKD	41.5	33.1	38.3	43.5	45.0	42.5	35.6	38.2	49.0	34.7
Acute myocardial infarction (AMI)										
Without CKD	2.3	1.5	2.0	2.6	3.3	2.3	1.8	1.5	2.9	1.8
Any CKD	10.1	8.7	9.5	10.1	11.1	10.4	8.8	7.7	11.9	8.4
Congestive heart failure (CHF)										
Without CKD	6.4	3.0	4.3	7.4	13.8	6.4	7.6	5.0	6.6	6.3
Any CKD	28.8	21.3	22.7	27.9	38.3	28.9	30.4	24.5	28.9	28.7
Valvular heart disease (VHD)										
Without CKD	4.9	2.4	3.7	6.2	8.5	5.1	3.2	3.6	4.7	5.0
Any CKD	13.6	8.4	10.1	14.0	18.2	14.2	10.2	11.1	13.5	13.7
Cerebrovascular accident/transient ischemic attack (CVA-TIA)										
Without CKD	7.3	3.9	5.7	9.1	12.0	7.3	8.2	5.8	7.2	7.3
Any CKD	18.4	13.7	16.1	19.5	20.9	18.3	20.2	16.3	18.6	18.2
Peripheral artery disease (PAD)										
Without CKD	8.9	4.2	6.3	10.5	18.3	9.0	9.9	6.9	9.0	8.9
Any CKD	25.8	19.2	21.8	26.2	31.5	26.1	25.5	22.1	26.9	24.8
Atrial fibrillation (AFIB)										
Without CKD	9.5	4.0	6.6	12.1	18.5	10.1	4.8	5.1	10.7	8.6
Any CKD	24.1	14.1	17.5	25.0	32.7	25.9	14.6	16.0	26.4	22.1
Cardiac arrest and ventricular arrhythmias (SCA/VA)										
Without CKD	1.3	0.8	1.2	1.6	1.6	1.4	1.1	0.8	1.8	0.9
Any CKD	4.3	3.9	4.1	4.7	4.3	4.4	4.5	2.8	5.9	2.9
Cardiovascular Procedures[2]										
Revascularization - percutaneous coronary interventions (PCI)										
Without CKD	2.3	3.5	2.7	2.1	1.3	2.4	1.9	2.0	2.4	2.2
Any CKD	3.6	5.2	4.3	3.6	2.5	3.6	3.2	3.2	3.7	3.3
Revascularization - coronary artery bypass graft (CABG)										
Without CKD	1.1	1.7	1.4	1.1	0.3	1.1	0.8	0.9	1.4	0.7
Any CKD	1.8	3.0	2.7	1.9	0.6	1.9	1.0	1.4	2.2	1.2
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)										
Without CKD	0.6	1.0	1.0	0.6	0.2	0.6	0.4	0.5	0.9	0.3
Any CKD	1.0	1.6	1.5	1.2	0.4	1.0	1.0	0.9	1.6	0.5

Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Total patients for the study cohort: N=1,238,888. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; Af Am, African American; CABG, coronary artery bypass grafting; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PAD, peripheral arterial disease; PCI, percutaneous coronary interventions; SCA/VA, sudden cardiac arrest and ventricular arrhythmias; VHD, valvular heart disease.

[1] The denominators for overall prevalence of all cardiovascular comorbidities are 1,106,048 Medicare enrollees age 66+ without CKD and 132,840 Medicare enrollees age 66+ with any CKD.

[2] The denominators for overall prevalence of PCI and CABG are 182,891 Medicare enrollees age 66+ with ASHD and without CKD and 55,108 Medicare enrollees age 66+ with ASHD and with any CKD. The denominators for overall prevalence of ICD/CRT-D is 70,766 Medicare enrollees age 66+ with CHF and without CKD and 38,256 Medicare enrollees age 66+ with CHF and with any CKD.

The prevalence of these conditions also generally increases with age and presence of CKD (Table 4.1). The relationship with race, ethnicity, and sex is less straightforward. Major procedures utilized for the treatment of cardiovascular disease are more common among CKD patients, including percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), and the placement of implantable cardioverter defibrillators (ICD) and cardiac resynchronization (CRT) devices.

Congestive Heart Failure and Chronic Kidney Disease

Congestive heart failure (CHF) is among the more frequently diagnosed types of cardiovascular diseases among CKD patients. In 2013, the prevalence of CHF in CKD patients aged 66 and older was nearly 30% (Table 4.1). Given its importance in this population, key characteristics of CHF in CKD patients are further examined in Table 4.2 after stratifying CHF based on systolic dysfunction (i.e., heart failure with decreased ejection fraction), diastolic dysfunction (i.e., heart failure with preserved ejection fraction), or unspecified. For ease of reporting and for consistency with clinical approaches for categorizing the disease, systolic CHF includes patients with systolic dysfunction regardless of the presence of concomitant diastolic dysfunction. Patients with isolated diastolic CHF are treated separately since long-term risk assessments and treatments vary for this group.

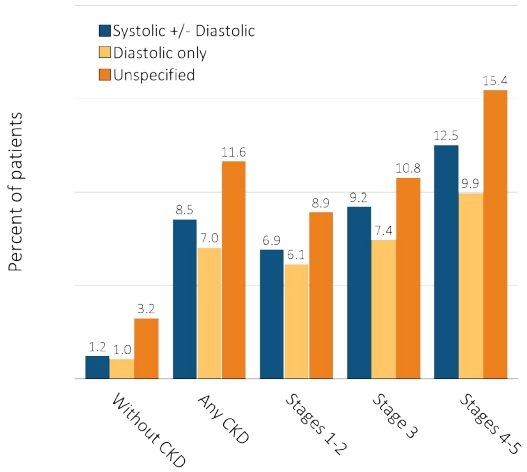
In general, the distribution of age and sex show similar patterns among patients with both CHF and CKD when compared with those with CHF without CKD. However, the proportion of Blacks/African Americans and diabetic patients is higher among patients with both CHF and CKD. These patterns were consistent regardless of whether systolic, diastolic, or unspecified CHF was identified. The relative proportion of patients with systolic CHF is slightly higher than diastolic CHF in CKD patients, and increases with greater severity of CKD (e.g., Stages 1-2 vs. Stage 3 vs. Stages 4-5), although the vast majority of patients have unspecified CHF in all instances (Figure 4.3).

vol 1 Table 4.2 Characteristics of patients with heart failure, by CKD status, 2013

	Systolic +/- Diastolic heart failure		Diastolic only heart failure		Heart failure, unspecified	
	Without CKD	Any CKD	Without CKD	Any CKD	Without CKD	Any CKD
N	13,419	11,339	11,584	9,315	35,899	15,470
Age (% of N):						
66-69	13.7	11.0	10.6	9.2	11.1	9.3
70-74	19.5	16.5	14.9	14.5	15.7	14.6
75-84	38.8	39.2	38.1	38.3	36.9	38.3
85+	28.0	33.2	36.3	38.0	36.3	37.9
Sex (% of N)						
Male	54.1	57.7	31.8	36.3	39.8	45.2
Female	45.9	42.3	68.2	63.7	60.2	54.8
Race (% of N)						
White	87.7	83.8	88.2	84.8	85.9	83.0
Black/African American	8.0	11.6	7.7	10.7	9.1	11.4
Other race	4.3	4.6	4.1	4.5	5.1	5.7
Comorbidity (% of N)						
Non-diabetes	61.6	43.0	62.7	44.0	62.3	44.8
Diabetes	38.4	57.0	37.3	56.0	37.7	55.2

Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Total patients for the study cohort: N=97,026. Abbreviation: CKD, chronic kidney disease.

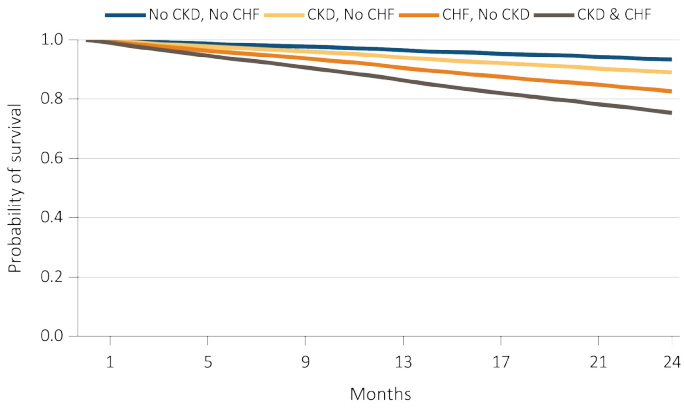
vol 1 Figure 4.3 Heart failure in patients with or without CKD, 2013



Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Totals of patients for the study cohort: N=1,238,88; Without CKD=1,106,048; Any CKD=132,840; Stages 1-2=13,271; Stage 3=61,466; Stages 4-5=13,504. Abbreviations: CKD, chronic kidney disease.

The presence of CHF worsens survival among patients with and without CKD (Figure 4.4), but to a greater extent among those with CKD (p-value for interaction <0.0001). Over a two-year period, patients with both CHF and CKD have an adjusted survival probability of 75.3%, as compared with 88.9% for those with CKD alone.

vol 1 Figure 4.4 Adjusted survival of patients by CKD and CHF status, 2012-2013



Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2011 with fee-for-service coverage for the entire calendar year. Survival is adjusted for age, sex, race, diabetic status, and hypertension status. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure.

Atrial Fibrillation and Chronic Kidney Disease

Atrial fibrillation is one of the most common arrhythmias seen in the general U.S. population and is associated with significant morbidity and mortality. The prevalence of atrial fibrillation among CKD patients is high as well; it is present in approximately one-quarter of the population. The prevalence of atrial fibrillation rises with more advanced stages of CKD, age, male sex, hypertension, and congestive heart failure (Table 4.3). In patients with CKD, the presence of congestive heart failure raises the prevalence of atrial fibrillation to nearly half of all patients. Patients with atrial fibrillation and CKD have an increased risk of stroke and bleeding, making the use of oral anticoagulants challenging, as demonstrated by recent reports. The risk of bleeding is particularly high when warfarin is used in combination with aspirin (Olesen et al., 2012).

vol 1 Table 4.3 Prevalence of AFIB by stage of CKD, age, race, sex, diabetic status, hypertension status, and CHF status, 2013

	Stage of CKD		
	Stages 1-2	Stage 3	Stages 4-5
AFIB (Overall)	20.8	24.5	26.6
Age:			
66-69	11.3	14.7	16.8
70-74	14.9	18.0	20.8
75-84	22.6	25.1	26.6
85+	31.3	32.9	32.9
Sex			
Male	23.0	27.3	29.3
Female	18.8	22.0	24.4
Race			
White	22.9	26.3	29.3
Black/African American	12.9	15.4	14.2
Other race	11.7	16.1	18.6
Comorbidity			
Non-diabetes	20.5	24.0	25.9
Diabetes	21.1	25.1	27.3
Non-hypertension	10.3	15.0	17.1
Hypertension	21.7	25.2	27.0
No Heart Failure (CHF)	12.5	14.2	13.5
Heart Failure (CHF)	47.8	49.8	46.7

Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Totals of patients for the study cohort: N=88,241; Stages 1-2=13,271; Stage 3=61,466; Stages 4-5=13,504. Abbreviations: AFIB, atrial fibrillation; CHF, congestive heart failure; CKD, chronic kidney disease.

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Notes

Chapter 5: Acute Kidney Injury

- In 2013, the percent of Medicare fee-for-service beneficiaries experiencing an AKI hospitalization was 3.9%, slightly lower than the 4.1% in 2012. This decrease in rates was also observed across all age and race groups.
- For Medicare patients aged 66 years and older with an AKI hospitalization in 2011, the cumulative probability of a recurrent AKI hospitalization within two years was 48%.
- Overall, less than 20% of patients had a nephrology visit within one year of live discharge from an AKI hospitalization. Among patients without pre-existing CKD or diabetes, less than 5% had nephrology follow-up within one year.
- Among Medicare patients aged 66 years and older with a first AKI hospitalization, the in-hospital mortality rate in 2013 was 9.5% (or 14.4% when including discharge to hospice) and less than half of all patients were discharged to their home.

Introduction

Acute kidney injury (AKI) has gained increasing recognition as a major risk factor for the development of chronic kidney disease (CKD). The clearest example of this relationship is seen in cases of severe dialysis-requiring AKI where patients fail to recover renal function. Indeed, acute tubular necrosis without recovery is the primary diagnosis for 2 to 3% of incident end-stage renal disease (ESRD) cases annually. Yet this represents a small fraction of the renal disease burden resulting from AKI, as studies have demonstrated significantly increased long-term risk of CKD and ESRD following AKI, even after initial recovery of renal function. Furthermore, this relationship is bi-directional and CKD patients are at substantially greater risk of suffering an episode of AKI. As a result, AKI is frequently superimposed on CKD and therefore plays a key role in CKD progression.

In this chapter, we examine antecedents and outcomes associated with AKI using the Medicare 5 percent sample. Medicare administrative data do not contain clinical or biochemical data with which to identify an AKI episode using consensus criteria based on changes in serum creatinine or urinary output. Instead, episodes of AKI, including those requiring dialysis, are identified using ICD-9-CM (International Classification of Diseases, 9th revision, clinical modification) diagnosis codes from billing claims. While this approach carries a high degree of specificity, an important limitation of this indirect method is poor sensitivity, generally <30%, and even lower for less severe cases of AKI. In addition, time trends in AKI incidence must be interpreted with caution due to the possibility of "code creep," whereby non-clinical factors (such as changing billing thresholds or increased awareness/recognition of AKI) increase the likelihood of administrative coding for AKI. Thus, a rising incidence of AKI may represent a true increase in AKI cases, an increased likelihood to code for AKI, or a combination of both factors. In addition, a lower threshold for coding for AKI would lead to identification of less severe episodes and an apparent decrease in the rate of associated adverse outcomes. For this chapter, we identified and included all hospitalizations during which a diagnosis of AKI was coded, referring to these as AKI hospitalizations, even if AKI was not the primary diagnosis.

We begin this chapter by exploring trends in AKI hospitalizations and characteristics of these patients, including age, sex, race, and comorbidity status. We focused on hospitalizations because AKI occurring exclusively in the community is uncommon and often unrecognized. In general, AKI has increased over time while the percent of AKI hospitalizations that required dialysis has decreased, although that may have started

to level off in 2013. Rates of AKI per 1,000 patient years at risk increase with increasing age. Patients with diabetes and/or CKD also have higher rates, while patients with CKD alone are associated with higher risk than those with diabetes alone.

Next we explore outcomes and follow-up after an AKI hospitalization. Among Medicare patients aged 66 years and older, 35% have a recurrent AKI hospitalization by one year, and 48% have a recurrent AKI hospitalization within two years. These findings highlight the at-risk nature of this population, and support published recommendations for post-AKI follow-up care. However, only 12.7% and 16.1% of patients are seen by a nephrologist at 3 and 6 months post-discharge respectively. The proportion of patients seen for follow-up care is higher among those with pre-existing CKD, but even among this group with recognized kidney disease fewer than 25% are seen within 6 months.

As noted above, AKI plays an important role in CKD development and progression. Among patients without pre-existing CKD who experienced an AKI hospitalization, nearly 30% were reclassified as having some degree of CKD in the subsequent year.

Lastly, we explore patient disposition following an AKI hospitalization. Among patients not admitted from a nursing facility, 48% of Medicare patients suffering an AKI hospitalization return directly to their homes, while 30% are institutionalized in a skilled nursing facility. These outcomes highlight the significant morbidity associated with AKI.

Analytical Methods

In 2013, the Medicare 5 percent sample was received by the Coordinating Center from the Medicare Chronic Conditions Warehouse, a different source than in previous years. When this data was tabulated, rates per patient year at risk for AKI were lower for 2013 than in 2012. We cannot rule out that this is an artifact of the differing source for the Medicare 5 percent data files, so caution should be used in drawing conclusions regarding trends.

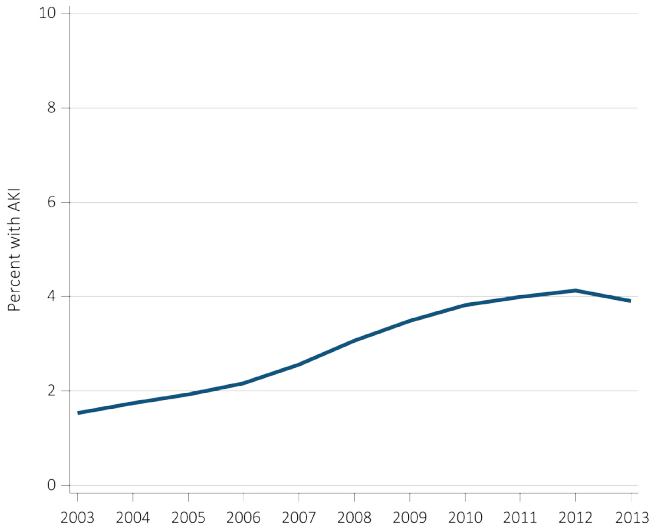
Note that all the figures except Figure 5.14 include all beneficiaries meeting the specified inclusion criteria. In Figure 5.14, those beneficiaries who were admitted to the inpatient setting where the AKI hospitalization occurred from a long-term care facility ('point of origin for admission,' previously named 'source of admission,' is 5) are excluded. Therefore, the category of institution in this figure includes only those newly admitted following their hospitalization. See the CKD Analytical Methods chapter for a more detailed explanation of the analytical methods used to generate the figures and table in this chapter.

Characteristics of Patients With Acute Kidney Injury

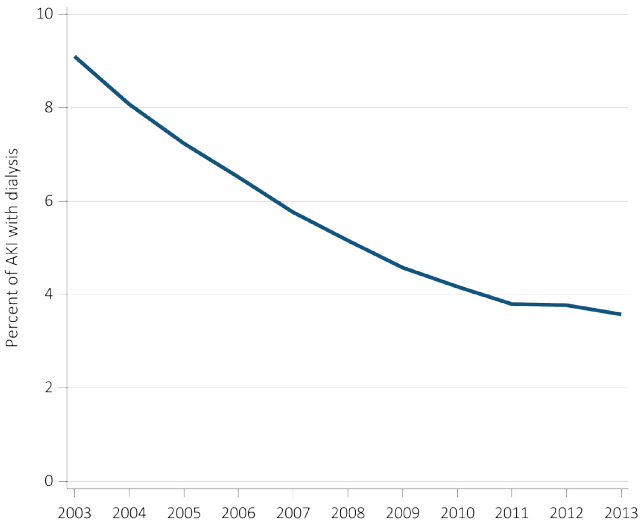
As shown in Figure 5.1, the percentage of patients with an AKI hospitalization in the Medicare fee-for-service population has risen over the past decade, reaching 3.9% in 2013, compared to 1.5% in 2003 (n=51,909 for 2013). Notably, the percentage in 2013 showed a decline from 4.1% in 2012. The proportion of AKI patients requiring dialysis has continued to decline, falling from 9.1% in 2003 to 3.6% in 2013 (n= 1,854 in 2013). These findings suggest that code creep for AKI is indeed occurring: while the threshold for defining (and thus coding for) AKI has decreased over the last 10 years, the threshold for dialysis initiation has likely remained fairly stable.

vol 1 **Figure 5.1 Percent of Medicare patients aged 66+ (a) with at least one AKI hospitalization, and (b) with an AKI hospitalization that included dialysis, by year, 2003-2013**

(a) Percent with an AKI hospitalization



(b) Percent of first AKI hospitalizations with dialysis



Data Source: Special analyses, Medicare 5 percent sample. Panel 5.1.a: Percent with an AKI hospitalization among all Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Panel 5.1.b: Percent of patients receiving dialysis during their first AKI hospitalization among patients with a first AKI hospitalization. Dialysis is identified by a diagnosis or charge for dialysis on the AKI hospitalization inpatient claim or a physician/supplier (Part B) claim for dialysis during the time period of the AKI inpatient claim. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease.

Acute kidney injury occurs commonly in older adults, and the incidence rises with age. In the fee-for-service Medicare population, patients aged 80 years and older comprise nearly 55% of all patients with an AKI hospitalization, as shown in Table 5.1. Males accounted for a slight majority of all AKI hospitalizations in all years. Diabetes mellitus and pre-existing CKD are recognized as two major risk factors for AKI; at least one of these risk factors was present in 57.3% of Medicare patients with an AKI hospitalization and 20.3% of patients had both.

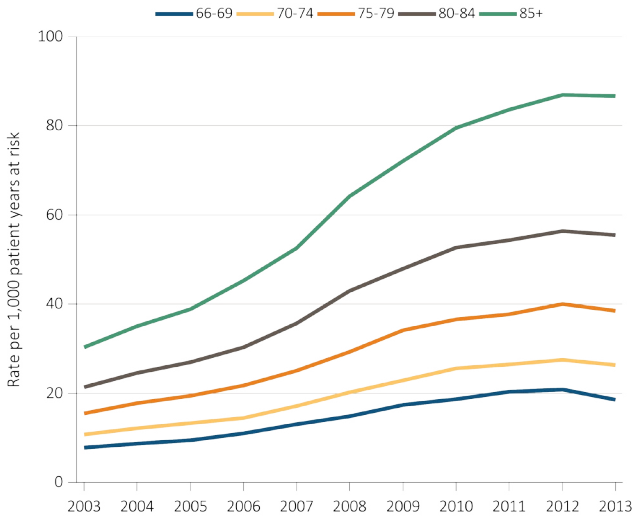
Rates of AKI are strongly influenced by age, as shown in Figure 5.2. Among fee-for-service Medicare patients in 2013, the rate of AKI for those ages 66-69 is 18.5 per 1,000 patient years, increasing to 26.4, 38.5, 55.5, and 86.7 respectively, for ages 70-74, 75-79, 80-84, and 85 years and older. Between 2003 and 2012, unadjusted rates of AKI increase across all age ranges. The most recent data from 2013 show a decrease in AKI rates in the Medicare population; the overall rate falls from 43.0 to 40.9 per 1,000 patient years, and similar decreases are observed within each age group.

vol 1 **Table 5.1 Characteristics of Medicare patients aged 66+ with at least one AKI hospitalization, by age, sex, race, CKD, DM, and year, 2003-2013**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Age											
66-69	10.6	10.5	10.3	10.6	10.6	10.3	10.8	10.8	11.3	11.3	11.4
70-74	16.5	16.3	16.0	15.3	15.4	15.5	15.4	15.6	15.6	15.9	16.1
75-79	21.8	21.3	21.0	20.2	19.4	18.5	18.6	18.0	17.7	18.0	17.9
80-84	22.5	22.9	22.9	22.3	22.4	22.4	21.5	21.3	20.7	19.9	19.5
85+	28.6	29.0	29.9	31.6	32.1	33.4	33.7	34.3	34.7	34.8	35.2
Sex											
Female	47.9	48.0	47.7	48.1	47.8	47.8	47.8	47.5	47.7	48.2	47.7
Male	52.1	52.0	52.3	51.9	52.2	52.2	52.2	52.5	52.3	51.8	52.3
Race											
White	82.9	82.6	81.7	82.0	82.8	83.2	83.2	83.1	83.1	82.7	83.1
Black/African American	12.7	13.0	13.7	13.5	12.5	12.0	12.0	12.1	12.0	12.2	11.6
Native American	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Asian	1.0	1.3	1.2	1.2	1.2	1.4	1.4	1.4	1.5	1.5	1.6
Other	3.0	2.9	3.1	2.9	3.0	3.0	3.0	3.0	2.9	3.1	3.2
Pre-existing comorbidities											
No DM or CKD, prior year	55.0	53.3	52.2	51.2	49.4	48.2	47.2	46.0	44.5	43.5	42.7
DM no CKD, prior year	24.6	25.2	25.1	25.1	23.1	23.0	22.5	22.5	22.0	21.2	21.3
CKD no DM, prior year	8.8	9.5	9.5	10.0	12.1	12.8	13.5	13.9	14.8	15.2	15.7
Both CKD & DM, prior year	11.7	12.0	13.2	13.7	15.4	16.0	16.8	17.7	18.7	20.1	20.3

Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

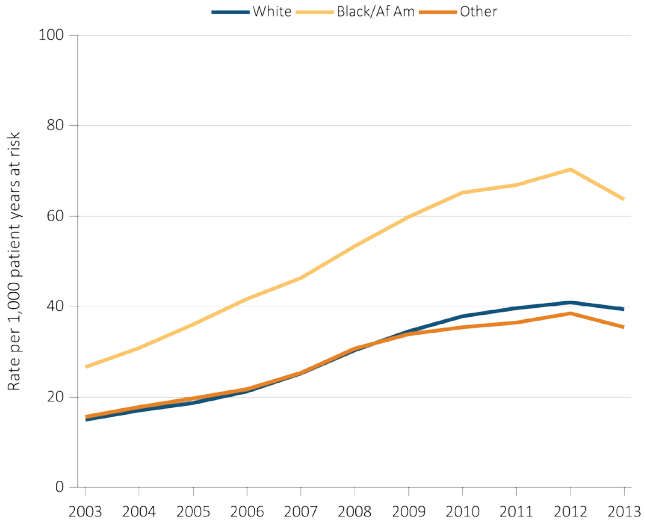
vol 1 Figure 5.2 Unadjusted rates of first hospitalization with AKI for Medicare patients aged 66+, by age and year, 2003-2013



Data Source: Special analyses, Medicare 5 percent sample. Age as of January 1 of specified year. All patient-years at risk for Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease.

Rates of AKI in fee-for-service Medicare patients aged 66 and older vary considerably by race, as shown in Figure 5.3. In 2013, the incidence rate was 63.7 per 1,000 patient years at risk in Blacks compared to 39.3 and 35.5, respectively, in Whites and individuals of other races. The rates of diagnosed AKI have more than doubled in the past decade in all race groups. The decrease in AKI rates in 2013 noted above was observed in all race groups and was most pronounced in Blacks, who had a relative 9.4% decrease compared to 3.9% and 7.8% decreases in Whites and individuals of other races, respectively.

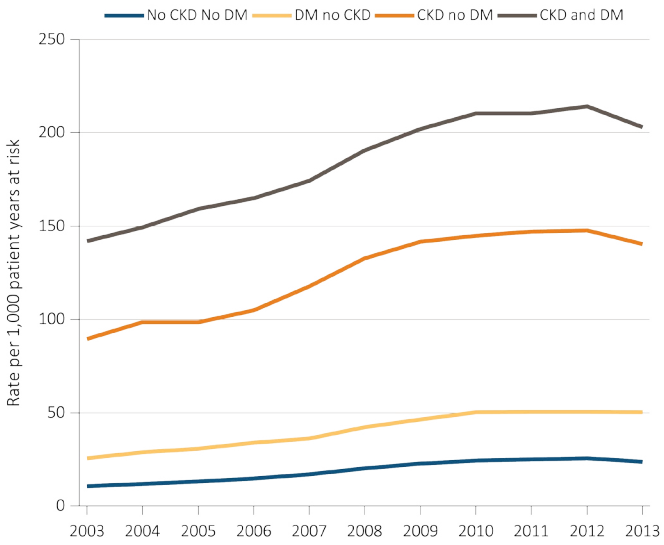
vol 1 Figure 5.3 Unadjusted rates of first hospitalization with AKI for Medicare patients aged 66+, by race and year, 2003-2013



Data Source: Special analyses, Medicare 5 percent sample. All patient-years at risk for Medicare patients aged 66 or older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: Af Am, African American; AKI, acute kidney injury; ESRD, end-stage renal disease.

The incidence rates for AKI, shown in Figure 5.4, also vary substantially by underlying comorbidity. In 2013, Medicare patients with diabetes and no known CKD had an AKI incidence rate of 50.1 per 1,000 patient years compared to 23.7 per 1,000 patient years in non-diabetic, non-CKD patients. Non-diabetic patients with CKD experienced an AKI incidence rate of 140.3 per 1,000 patient years, while the rate in patients with both diabetes and CKD was 203.1 per 1,000 patient years. That is, about 20 percent of patients with both CKD and diabetes will experience a hospitalization with AKI in a year.

vol 1 Figure 5.4 Unadjusted rates of first hospitalization with AKI for Medicare patients aged 66+, by CKD, DM, and year, 2003-2013



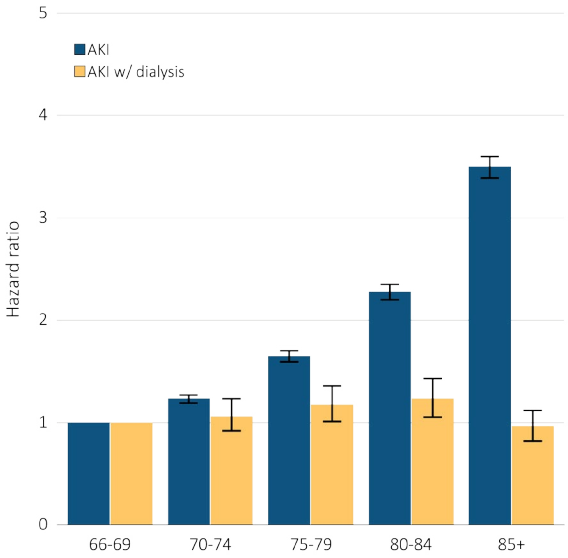
Data Source: Special analyses, Medicare 5 percent sample. All patient-years at risk for Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on January 1 of year shown. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

Hospitalization for Acute Kidney Injury

As indicated in Figure 5.5, the adjusted hazard for an AKI hospitalization is highly associated with age and increases with older age groups. After controlling for comorbid conditions, persons ages 85 and over are 3.5 times more likely to have an AKI hospitalization than

persons 65 to 69. However, age does not affect the probability of dialysis-requiring AKI. Since dialysis is a treatment choice between physicians and patients, this relationship could reflect either a decline in AKI severity with increasing age, or a higher threshold to pursue dialysis therapy in older age groups.

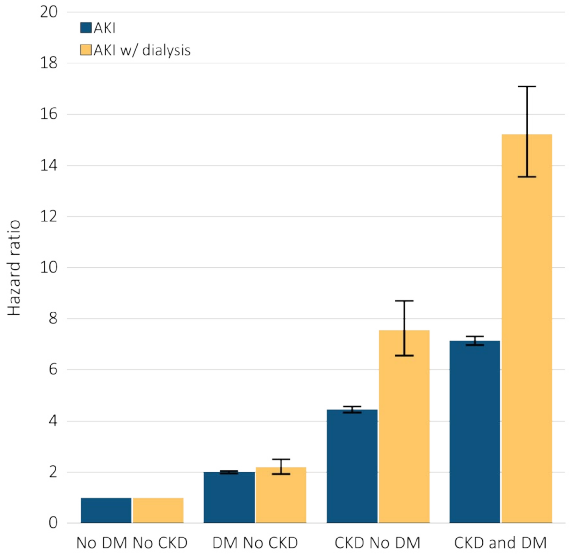
vol 1 Figure 5.5 Adjusted hazard of a first AKI hospitalization in Medicare patients aged 66+, overall and dialysis-requiring, by age, 2013



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 or older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on 1/1/2013. Dialysis is identified by a diagnosis or charge for dialysis on the AKI inpatient claim or a physician/supplier (Part B) claim for dialysis during the time period of the AKI inpatient claim. Models each include age, race, sex, DM, and CKD status in prior year. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Error bars represent 95% confidence interval of estimates. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease.

As shown in Figure 5.6, when examining baseline comorbid conditions, it is apparent that diabetes and CKD influence AKI risk both independently and synergistically. Compared to patients with neither comorbidity, patients with both diabetes and CKD have an adjusted hazard ratio of 7.15 for an episode of AKI. Having either diabetes or CKD alone confers a hazard ratio of 1.99 and 4.44, respectively. The relationship is even more pronounced for AKI requiring dialysis, as patients with both diabetes and CKD have an adjusted hazard ratio of 15.22 compared to patients with neither comorbidity.

vol 1 Figure 5.6 Adjusted hazard of a first AKI hospitalization in Medicare patients aged 66+, overall and dialysis-requiring, by DM & CKD status, 2013



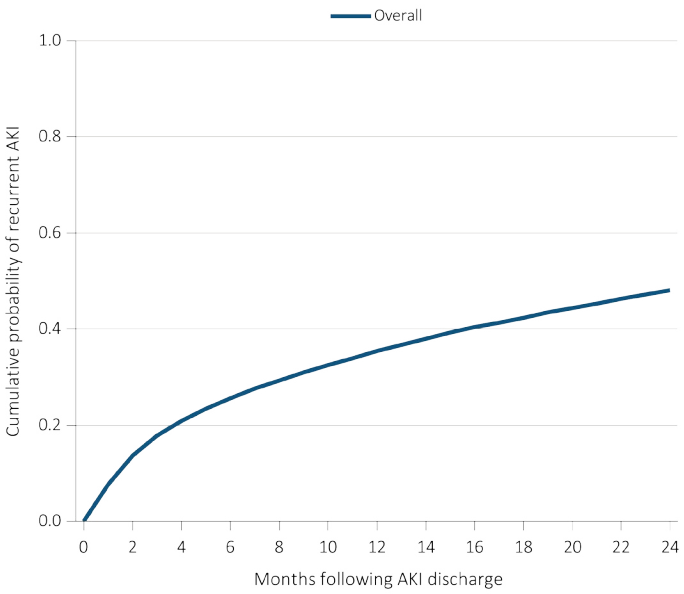
Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were alive on 1/1/2013. Dialysis is identified by a diagnosis or charge for dialysis on the AKI inpatient claim or a physician/supplier (Part B) claim for dialysis during the time period of the AKI inpatient claim. Models each include age, race, sex, DM, and CKD status in prior year. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Error bars represent 95% confidence interval of estimates. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

Following an AKI hospitalization in 2011, the overall probability of a recurrent AKI event is 0.35 in the next 12 months and 0.48 by 24 months, as shown in Figure 5.7a. In contrast to first episodes, the rate of recurrent AKI is relatively similar across age groups in the fee-for-service Medicare population (5.7b); however, interpretation of this finding is limited due to the effect of death censoring, which is higher in older age groups.

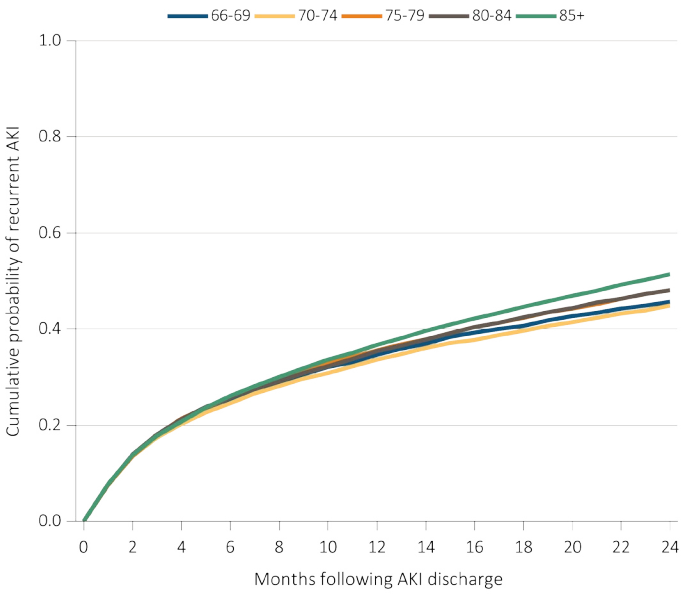
Whites are less likely to have a recurrent AKI hospitalization than other races, with a probability of 0.47 at 24 months compared to 0.55 and 0.52 in Blacks and individuals of other races, respectively (Figure 5.7c). Similarly, having either diabetes or CKD is associated with an increased probability for recurrent AKI compared to having neither (Figure 5.7d). The highest probability for recurrent AKI is seen in patients with both diabetes and CKD, in whom the probability reaches 0.58 by 24 months. In contrast, patients with neither comorbidity have a cumulative probability for recurrent AKI hospitalization of 0.32 by 24 months.

vol 1 Figure 5.7 Cumulative probability of a recurrent AKI hospitalization within two years of live discharge from first AKI hospitalization in 2011 for Medicare patients aged 66+, (a) overall, (b) by age, (c) by race, and (d) by CKD and DM

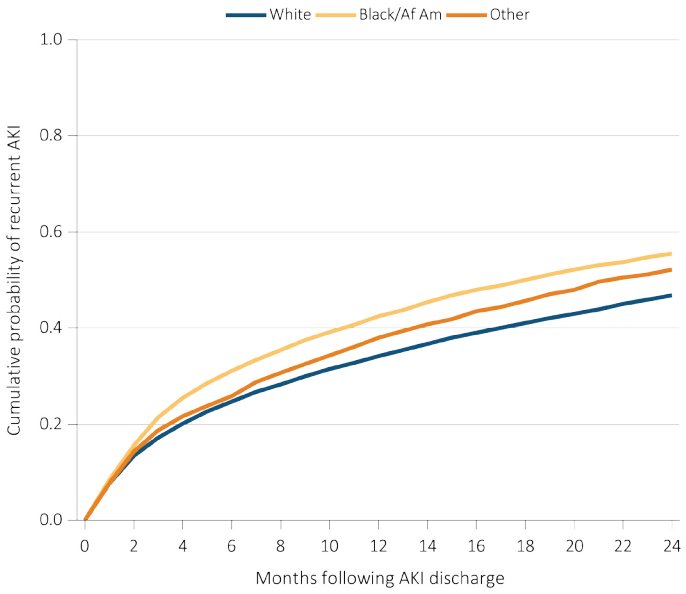
(a) Overall



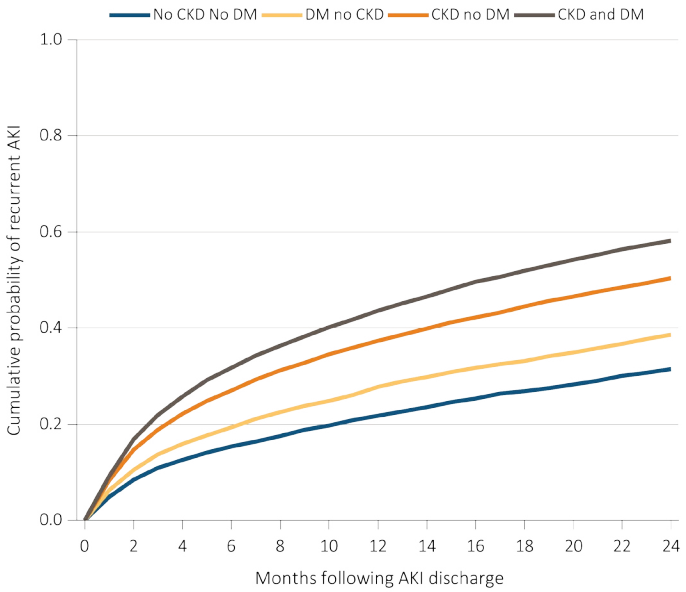
(b) Age



(c) Race



(d) CKD and DM



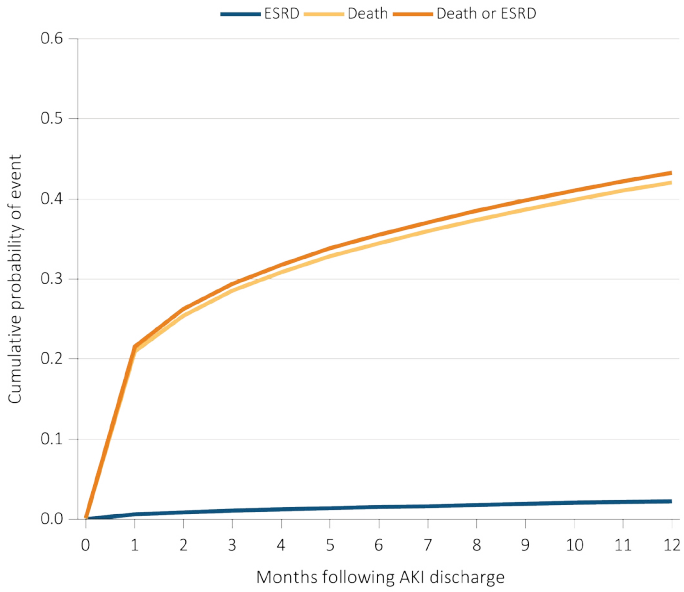
Data Source: Special analyses, Medicare 5 percent sample. Age on January 1, 2011. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form on 1/1/2011 and were discharged alive from an AKI hospitalization in 2011. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

Patient Care and Outcomes

Poor short-term outcomes for AKI, including hospital mortality, are well-described in the literature. Figure 5.8 shows that survivors of an AKI hospitalization (those discharged alive) continue to face significant risk for adverse outcomes following discharge. Among survivors of an AKI hospitalization in 2011-2012,

the overall probability of developing ESRD in the following year is about 2% in the Medicare fee-for-service population aged 66 and older. In this same time frame, the probability of death is nearly 43%.

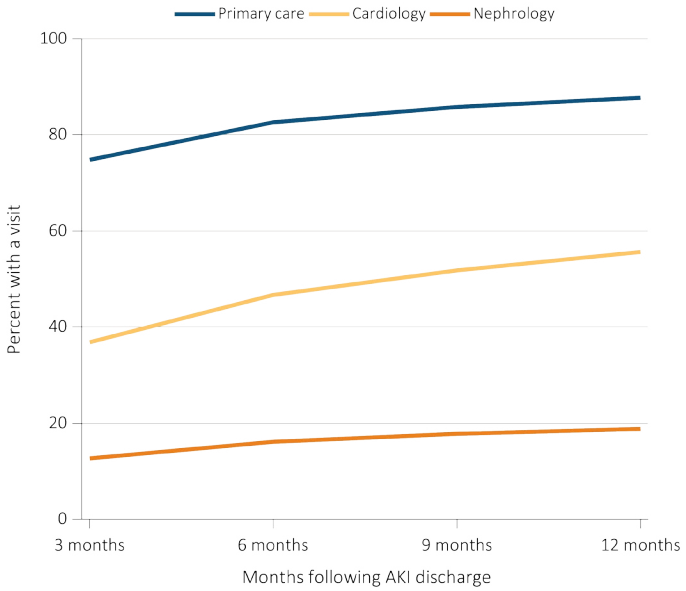
vol 1 Figure 5.8 Cumulative probability of death-censored ESRD, death, and the composite of death or ESRD within one year of live discharge from first AKI hospitalization occurring in 2011-2012 for Medicare patients aged 66+



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 or older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form, and were discharged alive from a first AKI hospitalization in 2011 or 2012. All models censored at the end of Medicare Parts A & B participation, switch to Medicare Advantage program, or 365 days after AKI discharge. Model for ESRD also is censored at death. Model for death is not censored at the start of ESRD. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease.

Following an initial AKI hospitalization, 74.8% of patients see a primary care physician within three months of discharge, while 36.8% and 12.7%, respectively, see a cardiologist or nephrologist, as illustrated in Figure 5.9. Follow-up increases with time, but the percentage of patients seen by a nephrologist at 12 months following an AKI hospitalization is still only 18.8%.

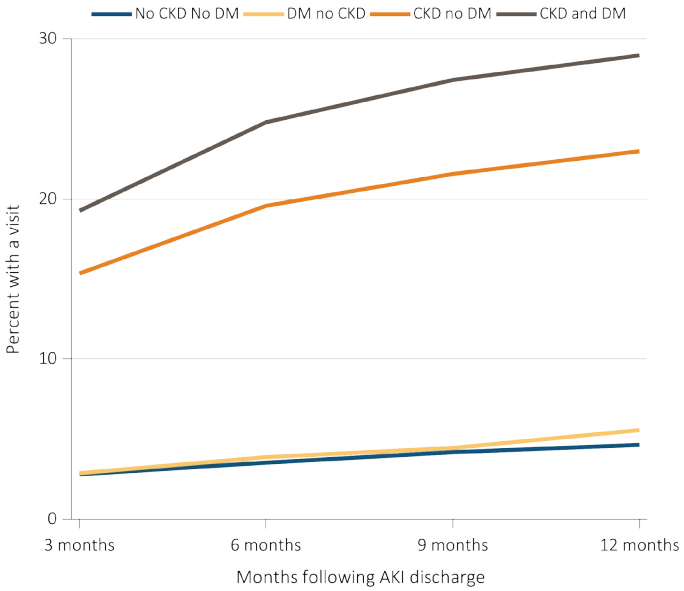
vol 1 Figure 5.9 Outpatient physician visits within one year of live discharge from first AKI hospitalization in 2012 for Medicare patients aged 66+, by physician specialty and time



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form on 1/1/2012, and were discharged alive from a first AKI hospitalization in 2012. For each time point, the denominator is all patients alive, without ESRD, not in a Medicare Advantage plan and with Medicare Parts A & B. Physician visits are from physician/supplier claims with provider specialty codes for primary care (01, 08-family practice, 11-internal medicine), cardiology (06), and nephrology (39) and claim source indicating an outpatient setting. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease.

Figure 5.10 shows that compared to the overall AKI cohort, patients with AKI superimposed on pre-existing CKD were more likely to have a nephrologist visit following an AKI hospitalization. At 3 months, 15.4% of "AKI on CKD" patients without diabetes had seen a nephrologist, and this rose to 23.0% by 12 months. For patients with both CKD and diabetes, 29.0% saw a nephrologist by 12 months. In contrast, just 4.6% of AKI patients without diabetes or CKD were seen by a nephrologist by 12 months following AKI hospitalization.

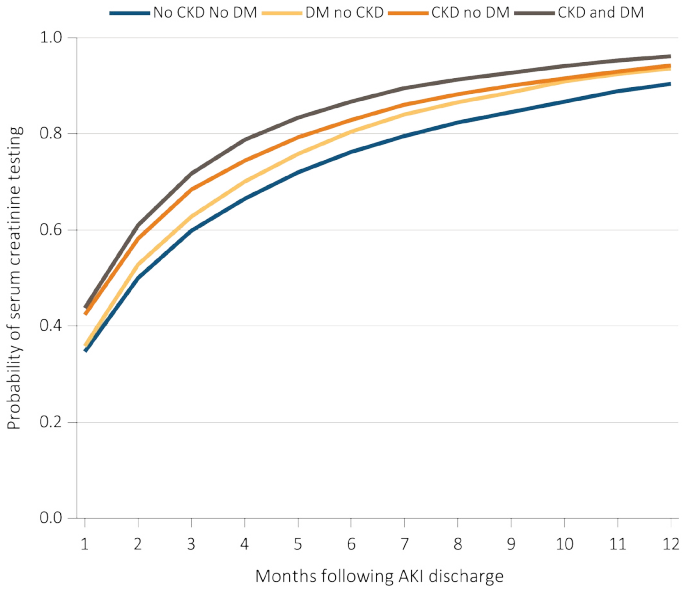
vol 1 Figure 5.10 Outpatient nephrology visits within one year of live discharge from first AKI hospitalization in 2012 for Medicare patients aged 66+, by CKD, DM, and time



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form on 1/1/2012, and were discharged alive from a first AKI hospitalization in 2012. For each time point, the denominator is all patients alive, without ESRD, not in a Medicare Advantage plan and with Medicare Parts A & B. Physician visits are from physician/supplier claims with provider specialty codes for nephrology (39) and claim source indicating an outpatient setting. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

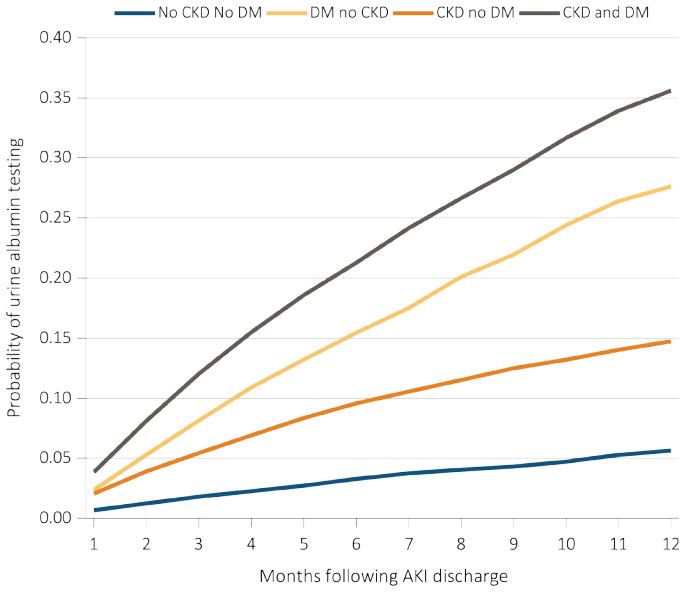
Among individuals suffering an in-hospital AKI event, the probability of serum creatinine and urine albumin testing increased with time following index hospitalization discharge, as shown in Figures 5.11 and 5.12. Of those patients with AKI in 2012, 83% had a follow-up creatinine test billed to Medicare by 6 months after hospitalization, while only 13% had urine albumin testing billed by this point. Rates of serum creatinine testing were relatively similar regardless of diabetes or CKD status, and at least 90% of patients in each comorbidity group were tested by 12 months. However, the probability of urine albumin testing varied considerably by comorbidity status. By 12 months, urine albumin testing occurred in 6% of patients without pre-existing CKD or diabetes, compared to 15% in non-diabetic patients with CKD, 28% in patients with diabetes but not CKD, and 36% in patients with both.

vol 1 Figure 5.11 Cumulative probability of a claim for a serum creatinine test within one year of live discharge from first AKI hospitalization in 2012 for Medicare patients aged 66+, by CKD, DM, and time



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, no ESRD by first service date from Medical Evidence form on 1/1/2012, and were discharged alive from a first AKI hospitalization in 2012. Date of first serum creatinine test following AKI discharge is from inpatient and outpatient claims with healthcare common procedure coding system (HCPCS) codes of 80048, 80050, 80053, 80069, or 82565. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

vol 1 Figure 5.12 Cumulative probability of a claim for an urine albumin test within one year of live discharge from first AKI hospitalization in 2012 for Medicare patients aged 66+, by CKD, DM, and time



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A and B, no Medicare Advantage plan, no ESRD by first service date from Medical

Evidence form on 1/1/2012, and were discharged alive from a first AKI hospitalization in 2012. Date of first urine albumin test following AKI discharge is from inpatient and outpatient claims with healthcare common procedure coding system (HCPCS) codes of 82042, 82043, 82044, or 84156. Censored at death, ESRD, end of Medicare Parts A & B participation, or switch to Medicare Advantage program. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; DM, diabetes mellitus; ESRD, end-stage renal disease.

Changes in CKD Status After Acute Kidney Injury

CKD status changes significantly in the year following an AKI hospitalization, as shown in Figure 5.13. Among patients without baseline CKD, nearly 30% are reclassified as having some degree of CKD, including 0.20% being declared ESRD. Table A shows the ICD-9-CM diagnosis codes used to define stages of chronic kidney disease for Figure 5.13.

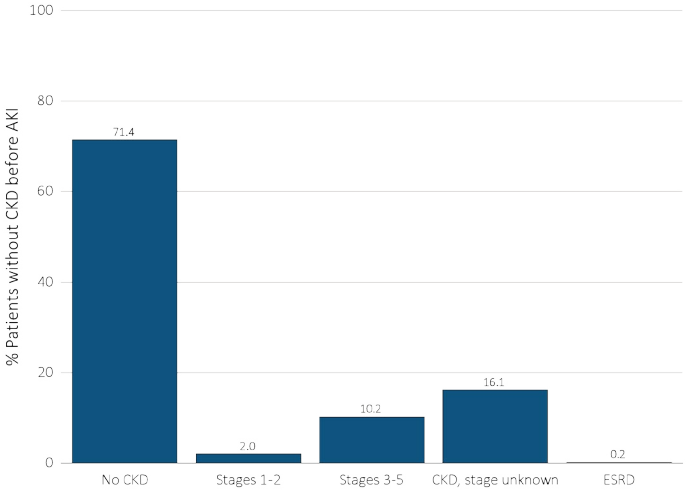
Table A. ICD-9-CM codes for Chronic Kidney Disease (CKD) stages

ICD-9-CM code[a]	Stage
585.1	CKD, Stage 1
585.2	CKD, Stage 2 (mild)
585.3	CKD, Stage 3 (moderate)
585.4	CKD, Stage 4 (severe)
585.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD stage-unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others

[a] For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used.

[b] In USRDS analyses, patients with ICD-9-CM code 585.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5.

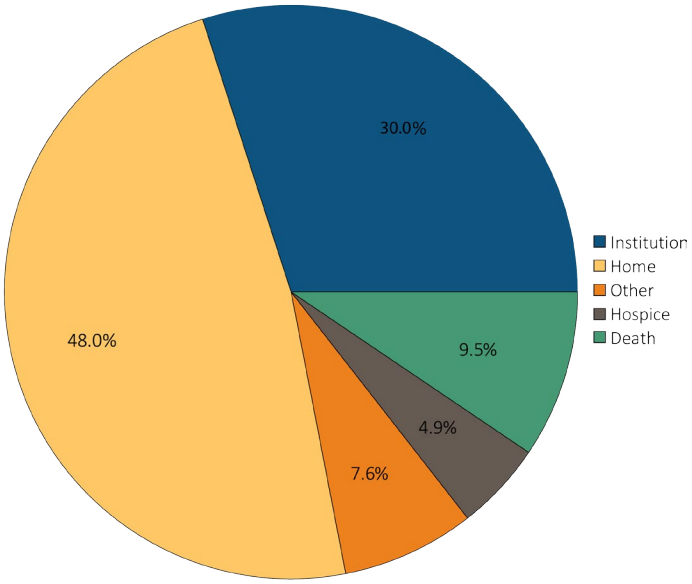
vol 1 Figure 5.13 Renal status one year following discharge from AKI hospitalization in 2011-2012, among surviving Medicare patients aged 66+ without kidney disease prior to AKI hospitalization, by CKD stage and ESRD status



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan, did not have ESRD, were discharged alive from a first AKI hospitalization in 2011 or 2012, and did not have any claims with a diagnosis of CKD in the 365 days prior to the AKI. Renal status after AKI determined from claims between discharge from AKI hospitalization and 365 days after discharge. Stage determined by 585.x claim closest to 365 days after discharge; ESRD by first service date on Medical Evidence form. Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; ESRD, end-stage renal disease.

In Figure 5.14, we examine the status and disposition for AKI patients once they are discharged from the hospital. After excluding patients admitted from a skilled nursing facility (n=2,221, leaving a total of 49,688 AKI discharges), among AKI patients aged 66 and older in 2013, fewer than 50% were discharged directly to their home. Mortality (including discharge to hospice) was 14.4%, while 30.0% of patients discharged to institutions including short-term skilled nursing facility stays, rehabilitation hospitals, or long-term care facilities.

vol 1 Figure 5.14 Hospital discharge status of first AKI hospitalization for Medicare patients aged 66+, 2013



Data Source: Special analyses, Medicare 5 percent sample. Medicare patients aged 66 or older who had both Medicare Parts A & B, no Medicare Advantage plan, did not have ESRD on 1/1/2013 and had a first AKI hospitalization in 2013. Institution includes short-term skilled nursing facilities, rehabilitation hospitals, and long-term care facilities. Home also includes patients receiving home health care services. Excludes patients admitted to the acute care hospital from a skilled nursing facility. Abbreviations: AKI, acute kidney injury; ESRD, end-stage renal disease.

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Waikar SS, Wald R, Chertow GM, Curhan GC, Winkelmayer WC, Liangos O, Sosa MA, Jaber BL. Validity of international classification of diseases, ninth revision, clinical modification codes for acute renal failure. *J Am Soc Nephrol* 2006;17:1688–1694.

Grams ME, Waikar SS, MacMahon B, Whelton S, Ballew SH, Coresh J. Performance and limitations of administrative data in the identification of AKI. *Clin J Am Soc Nephrol* 2014;9:682-9.

Chapter 6: Medicare Expenditures for Persons With CKD

- Medicare spending for patients with CKD aged 65 and older exceeded $50 billion in 2013, representing 20% of all Medicare spending in this age group.
- Patients with one or more of the chronic conditions accounted for $8 billion of the total $9 billion in Medicare spending growth for patients aged 65 and older between 2010 and 2013.
- Over 70% of Medicare spending for CKD patients aged 65 and older was incurred by those who also had diabetes, congestive heart failure, or both.
- While spending per year at risk was 12.7% higher for Blacks than Whites in 2013, this represents a reduction from the 19.6% gap than occurred in 2010.
- Spending per year at risk was more than twice as high for patients with all three chronic conditions of CKD, diabetes, and congestive heart failure ($38,230) than in patients with only CKD ($15,614).

Introduction

Determining the economic impact of chronic kidney disease (CKD) on a health care system is challenging. The considerable under-recognition of CKD (as noted in Vol. 1, Chapters 1, 2, and 3) affects estimates of CKD-related expenditures in several ways:

- Biochemical measures of renal function support the most definitive criterion, but health plan datasets, including Medicare's, rarely contain this information on a reliable or large scale.
- Even medical record data with complete laboratory results would be subject to substantial under-identification because many persons with underlying CKD have not been tested.
- Identification of cases of CKD based on ICD-9-CM (International Classification of Diseases, 9th revision, Clinical Modification) diagnosis codes will also reduce estimated total CKD expenditures below their true level, as formal diagnoses are not commonly documented early in the disease process.

However, assuming that under-identification is most common in the earliest and least costly cases, resulting estimates of cost per patient year will be biased upwards. To the extent that under-identification is not constant over time, the interpretation of trend data is also confounded.

Conversely, efforts to increase CKD identification may inaccurately affect estimates of CKD-related health system costs. For example, even if the true total number of cases in the population is constant, greater identification over time will likely result in artificially high trends in total expenditures, as the number of identified cases grows. Greater identification will have the opposite effect on trends in per-patient-year expenditures, as the distribution of identified cases is likely to become less severe. In addition, it is not possible to accurately attribute health care expenditures solely to kidney disease; the costs of CKD are influenced by its interactive nature, and resulting associations with cardiovascular disease, diabetes mellitus (DM), stroke, and infectious complications.

In addition, the use of Medicare billing data to describe total Medicare expenditures is becoming increasingly problematic. Medicare pays for persons

in managed care plans ("Medicare Advantage") on a monthly capitated basis so billing data are not available. In recent years, Medicare enrollment in managed care plans has accelerated, possibly due to enhanced part D coverage in these plans. As a result, the percent of Medicare beneficiaries enrolled in managed care increased from 13 percent in 2004 to 27 percent in 2012 (CMS, 2013). Thus, while this chapter covers the majority of Medicare beneficiaries with CKD, a significant percentage will be missing.

The methodology we employ to calculate costs related to CKD (excluding end-stage renal disease; ESRD), was first discussed in the 2011 USRDS Annual Data Report and continued in subsequent ADRs. This method utilizes ICD-9-CM diagnosis codes to create a point prevalent CKD cohort from patients classified as having CKD on January 1 of each given year. As described in the 2013 ADR, this cost-calculation method does not include "new" CKD patients, who in the 2009 and 2010 ADR accounted for a disproportionate percentage of overall costs, resulting from a possible association with high rates of acute kidney injury (AKI). How to best integrate the costs of AKI patients into CKD calculations is a continuing area for research due to the potential for transition from AKI to CKD.

In this chapter, costs are defined as Medicare expenditures rather than true economic costs, using claims from Medicare Parts A, B, and D as based on the 5 percent Medicare sample. Only persons aged 65 and over were included, and disabled persons with CKD were not examined in this chapter. Patients with recognized CKD, who represent 10% of the point prevalent aged Medicare population, accounted for 20% of total expenditures (see Table 6.1). We examined CKD costs in relation to patients' CKD stage, age, sex, race, and concurrent disease, focusing on DM and congestive heart failure (CHF). Diabetes and CHF, in addition to CKD, represent the highest chronic disease population-level expenditures for Medicare, and thus were analyzed as coexisting diseases. CHF, for example, affects 9% of patients in the fee-for-service Medicare population, but accounts for 21% of expenditures. Thirty-five percent of overall expenditures were directed toward the 24% of patients with DM. Overall, people with diagnoses of DM, CKD, and/or CHF accounted for one-third of the Medicare population, and one-half of programmatic costs.

vol 1 **Table 6.1 Point prevalent distribution of Medicare fee-for-service patients aged 65+, and total annual costs of Medicare Parts A, B, and D services, by DM, CHF, and/or CKD, 2013**

	U.S. Medicare Population	Costs (millions, U.S. $)	PPPY (U.S. $)	Population (%)	Costs (%)
All	23,897,280	$250,503	$10,854	100.00	100.00
With CHF or CKD or DM	8,041,400	$127,725	$16,810	33.65	50.99
CKD only (- DM & CHF)	964,240	$14,223	$15,614	4.04	5.68
DM only (- CHF & CKD)	4,088,260	$47,039	$11,842	17.11	18.78
CHF only (- DM & CKD)	911,260	$17,321	$20,716	3.81	6.91
CKD and DM only (- CHF)	780,520	$13,605	$18,404	3.27	5.43
CKD and CHF only (- DM)	339,040	$8,748	$30,312	1.42	3.49
DM and CHF only (- CKD)	535,020	$12,968	$26,477	2.24	5.18
CKD and CHF and DM	423,060	$13,822	$38,230	1.77	5.52
No CKD or DM or CHF	15,855,880	$122,778	$7,931	66.35	49.01
All CKD (+/- DM & CHF)	2,506,860	$50,398	$21,909	10.49	20.12
All DM (+/- CKD & CHF)	5,826,860	$87,433	$15,718	24.38	34.90
All CHF (+/- DM & CKD)	2,208,380	$52,858	$26,750	9.24	21.10
CKD and DM (+/- CHF)	1,203,580	$27,427	$24,916	5.04	10.95
CKD and CHF (+/- DM)	762,100	$22,570	$34,715	3.19	9.01
DM and CHF (+/- CKD)	958,080	$26,789	$31,469	4.01	10.69

Data Source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure; DM, diabetes mellitus; PPPY, per patient per year costs.

We next present data on overall Medicare costs and those related to CKD, with and without DM and CHF, allowing for comparison of trends. CKD with comorbidities contributes significant cost stress to the Medicare system, accounting for large proportions of Medicare spending on DM and CHF. CKD patients with DM accounted for 31.4% of Medicare spending on DM, while CKD with CHF accounted for greater than 42.7% of Medicare CHF spending.

We conclude by presenting costs for different Medicare populations, including CKD patients with concurrent DM and CHF, comparing 2010 and 2013 expenditures. Although costs in all categories have grown, the rate of growth differs across groups. These data will further illustrate the importance of prevention and management of comorbidities in CKD cost-reduction efforts.

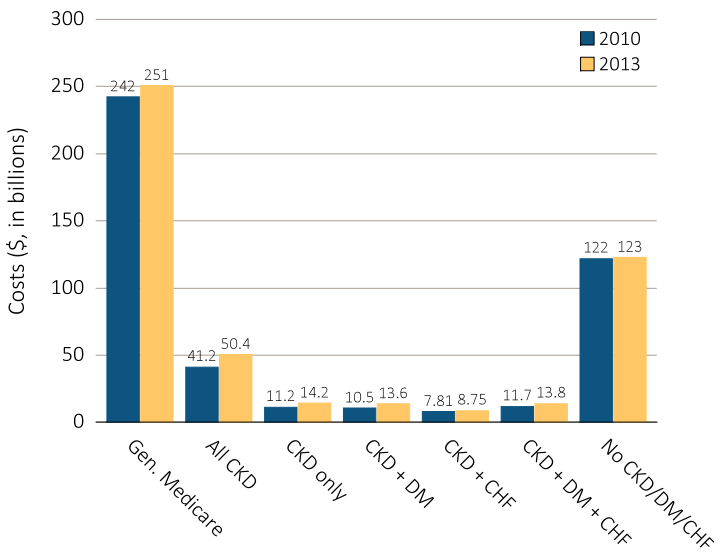
Analytical Methods

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

Costs of CKD by Stage and Patient Characteristics

Among the general Medicare population aged 65 and older, total costs for Parts A, B, and D rose 3.7% to $251 billion between 2010 and 2013, while such costs rose 22.3% to $50.4 billion among the CKD patients (Figure 6.1). Therefore, costs in the non-ESRD CKD population exceeded those in the ESRD population ($30.9 billion, see Volume 2, Chapter 11, Costs of ESRD). Costs for these patients with CKD now represent 20.1% of all Medicare Parts A, B, and D spending. Although there was a universal rise in expenditure for all covered groups, certain patient populations with comorbid conditions in addition to CKD experienced higher rates of growth. Costs for patients without CKD, DM, or CHF increased by only 0.8%, while the costs for those with one or more of these three conditions increased by $9 billion. This is equivalent to the $9 billion increase in general Medicare spending on all elderly patients between 2010 and 2013.

vol 1 **Figure 6.1 Overall Medicare Parts A, B, and D costs for fee-for-service patients aged 65 and older, by CKD, DM, CHF, and year, 2010 & 2013**



Data source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure, DM, diabetes mellitus.

Table 6.2 shows overall per person per year (PPPY) costs of Parts A, B, and D services for patients with CKD (but not ESRD) by stage of CKD (see Table A for definitions). In 2013, PPPY costs reached $21,909 for Medicare CKD patients aged 65 and older, an 8.7% increase compared to 2012 ($20,162) but a decrease since 2010 ($22,440). The overall difference reflects both changes in average spending by stage (spending increased in all CKD stages from 2012), and the shift in the distribution of identified patient years towards the less severe and less costly stages. Costs for patients with Stages 4-5 CKD ($27,405) were 38.0% greater than costs for patients with Stages 1-2 CKD ($19,859). Costs for Black/African-American patients exceeded those for White patients by 12.7%, somewhat lower than the 19.6% gap observed in 2010.

vol 1 **Table 6.2 Overall per person per year costs for Medicare Parts A, B, and D services for CKD patients, by CKD stage, age, sex, race, and year, 2010 & 2013**

	2010					2013				
	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	1,836,715	161,650	660,612	202,278	812,175	2,300,310	227,260	1,023,273	229,857	819,920
All patients	$22,440	$19,086	$21,392	$28,793	$22,377	$21,909	$19,859	$21,253	$27,405	$21,756
Age										
65-69	$20,433	$17,054	$20,117	$29,474	$19,716	$20,964	$16,943	$20,819	$30,890	$20,281
70-74	$20,670	$16,688	$19,642	$28,231	$20,763	$20,274	$17,503	$19,475	$26,615	$20,607
75-79	$21,921	$18,782	$20,615	$29,599	$21,823	$21,441	$19,930	$20,817	$26,369	$21,354
80-84	$23,422	$20,967	$22,218	$28,209	$23,596	$22,375	$21,218	$21,468	$27,384	$22,367
85+	$24,714	$22,255	$23,798	$28,732	$24,623	$23,737	$23,650	$23,076	$27,165	$23,409
Sex										
Male	$21,841	$18,540	$21,078	$28,438	$21,586	$21,545	$19,753	$21,223	$26,807	$21,063
Female	$22,977	$19,604	$21,687	$29,083	$23,071	$22,233	$19,957	$21,280	$27,884	$22,372
Race										
White	$21,798	$18,248	$20,946	$27,690	$21,758	$21,550	$19,629	$20,926	$26,551	$21,496
Black/African American	$26,075	$22,567	$24,024	$33,206	$26,372	$24,281	$20,729	$23,235	$32,322	$23,784
Other	$25,054	$22,153	$23,325	$33,833	$24,720	$22,694	$20,901	$22,487	$27,658	$22,100

Data source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; Unk/unspc, CKD stage unknown or unspecified.

Table A. ICD-9-CM codes for Chronic Kidney Disease (CKD) stages

ICD-9-CM code[a]	Stage
585.1	CKD, Stage 1
585.2	CKD, Stage 2 (mild)
585.3	CKD, Stage 3 (moderate)
585.4	CKD, Stage 4 (severe)
585.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD stage-unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others

[a] *For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used.*

[b] *In USRDS analyses, patients with ICD-9-CM code 585.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5.*

In Table 6.3, PPPY costs are shown for patients with both CKD and DM. Among 2013 Medicare patients with these two conditions, PPPY costs for Blacks were $26,927—9.6% greater than the $24,561 incurred by Whites.

Table 6.4 shows PPPY costs for patients with CKD and concurrent CHF. In 2013, PPPY costs for Black patients with both conditions reached $38,433—12.9% higher than the $34,036 PPPY cost for their White counterparts.

vol 1 Table 6.3 Per person per year costs for Parts A, B, and D services for Medicare CKD patients with DM, by CKD stage, age, sex, race, and year, 2010 & 2013

	2010					2013				
	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	870,939	78,316	322,900	105,972	363,752	1,100,774	110,909	499,897	120,675	369,293
All patients	$25,510	$22,117	$24,455	$32,940	$25,013	$24,916	$22,364	$24,453	$31,383	$24,195
Age										
65-69	$23,726	$20,296	$23,689	$32,805	$22,369	$24,561	$19,721	$24,561	$35,068	$23,317
70-74	$23,731	$19,499	$23,058	$31,020	$23,381	$23,086	$20,435	$22,703	$29,438	$22,593
75-79	$25,251	$22,248	$23,774	$33,883	$24,735	$24,407	$22,238	$23,877	$30,046	$23,991
80-84	$26,767	$23,625	$25,412	$32,635	$26,773	$25,445	$25,351	$24,631	$31,640	$24,415
85+	$28,441	$27,272	$27,127	$34,251	$27,763	$27,446	$25,803	$27,016	$31,741	$26,787
Sex										
Male	$24,252	$21,432	$23,568	$31,835	$23,411	$23,991	$21,786	$23,870	$30,042	$23,036
Female	$26,702	$22,820	$25,348	$33,877	$26,471	$25,807	$22,950	$25,031	$32,468	$25,316
Race										
White	$24,732	$20,831	$23,872	$31,583	$24,378	$24,561	$22,005	$24,117	$30,658	$23,995
Black/African American	$28,904	$26,164	$27,066	$37,642	$28,153	$26,927	$23,254	$26,221	$35,389	$25,637
Other	$27,767	$25,507	$26,488	$36,765	$26,553	$25,089	$23,869	$25,051	$30,165	$23,873

Data source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; Unk/unspc, CKD stage unknown or unspecified.

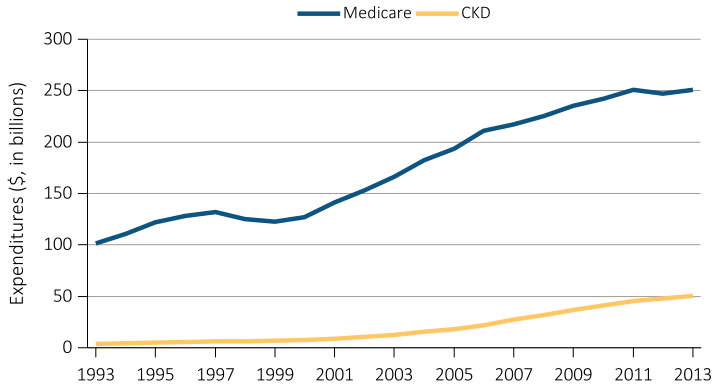
vol 1 Table 6.4 Per person per year costs for Parts A, B, and D services for Medicare CKD patients with CHF, by CKD stage, age, sex, race, and year, 2010 & 2013

	2010					2013				
	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	562,712	41,614	194,915	78,541	247,642	650,146	55,549	289,311	85,666	219,619
All patients	$34,766	$33,276	$34,044	$40,563	$33,747	$34,715	$34,113	$34,538	$38,846	$33,489
Age										
65-69	$38,358	$35,804	$36,982	$48,801	$36,829	$39,428	$35,086	$39,209	$49,990	$37,486
70-74	$35,829	$33,511	$34,277	$42,201	$35,726	$35,991	$33,863	$35,775	$38,857	$35,831
75-79	$35,488	$34,861	$34,770	$41,926	$34,023	$35,836	$35,367	$35,538	$39,405	$34,965
80-84	$34,529	$32,621	$33,500	$38,629	$34,304	$34,272	$34,736	$33,785	$38,077	$33,247
85+	$32,757	$31,195	$32,686	$37,841	$31,510	$32,144	$32,517	$32,234	$35,904	$30,458
Sex										
Male	$33,906	$33,686	$33,122	$39,935	$32,686	$33,603	$33,431	$34,001	$38,291	$31,364
Female	$35,535	$32,912	$34,959	$41,098	$34,634	$35,714	$34,745	$35,049	$39,284	$35,337
Race										
White	$33,569	$31,617	$33,051	$38,595	$32,772	$34,036	$33,122	$33,993	$37,641	$32,969
Black/African American	$40,868	$38,856	$39,480	$48,402	$39,330	$38,433	$37,541	$37,469	$45,290	$36,567
Other	$40,817	$40,894	$39,173	$48,838	$38,873	$37,206	$40,194	$36,955	$39,873	$35,497

Data source: Medicare 5 percent sample. Abbreviations: CHF, congestive heart failure; CKD, chronic kidney disease; Unk/unspc, CKD stage unknown or unspecified.

Over time, the costs for Medicare patients aged 65 and older with recognized CKD have accounted for an increasing share of Medicare expenditures, expanding from 4.2% in 1995, to 7.7% in 2003, and 20.1% in 2013. Much of this growth was due to the increased ascertainment of CKD as shown in Chapter 2 of this Volume, Identification and Care of Patients with CKD. Figure 6.2 compares total expenditures on Part A, B, and D services for the Medicare fee-for-service patients as a whole, with those with CKD.

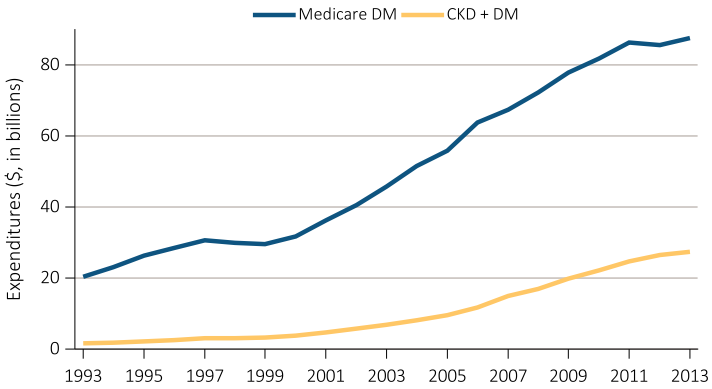
vol 1 Figure 6.2 Overall expenditures on Parts A, B, and D services for the Medicare population aged 65+ and for those with CKD, by year, 1993-2013



Data source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease.

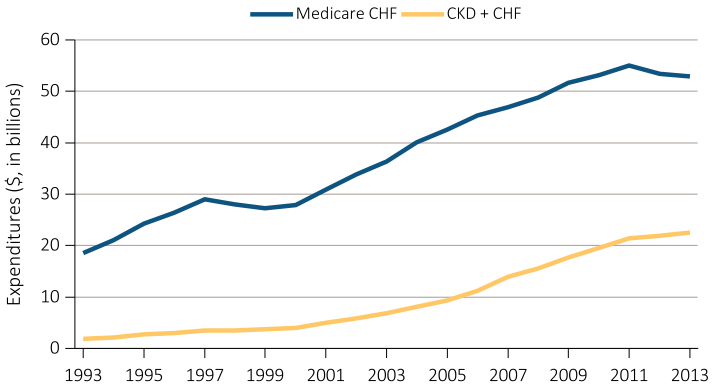
In Figures 6.3 and 6.4 we show total Part A, B, and D service expenditures for Medicare fee-for-service patients with DM and CHF, respectively. Spending for patients with comorbid DM and CKD, and CHF and CKD are also presented. Costs for patients with CKD and concurrent DM amounted to $27.4 billion in 2013, or 31.4% of total Medicare spending on DM. Spending on CHF in the Medicare population was $52.9 billion in 2013. Of this, $22.6 billion (42.7%) was spent on the CKD patient population with CHF.

vol 1 Figure 6.3 Overall expenditures on Parts A, B, and D services for the Medicare DM population aged 65+ and for those with CKD and DM, by year, 1993-2013



Data Source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus.

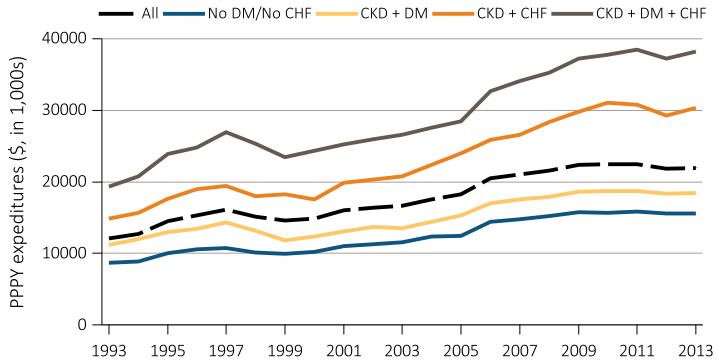
vol 1 Figure 6.4 Overall expenditures on Parts A, B, and D services for the Medicare CHF population aged 65+ and for those with CKD and CHF, by year, 1993-2013



Data Source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure.

Figure 6.5 illustrates PPPY costs for Medicare CKD patients aged 65 and older by the presence of DM and CHF. In 2013, PPPY costs for CKD patients varied greatly by the presence of their comorbidities. CKD patients without DM and without CHF cost $15,614 per person per year. Those with DM in addition to CKD averaged $18,404 PPPY, and patients with CKD and CHF cost $30,312, while expenditures for those with all three conditions reached $38,230 PPPY.

vol 1 Figure 6.5 Per person per year expenditures on Parts A, B, and D services for the CKD Medicare population aged 65+, by DM, CHF, and year, 1993-2013



Data Source: Medicare 5 percent sample. Abbreviations: CKD, chronic kidney disease; CHF, congestive heart failure, DM, diabetes mellitus; PPPY, per person per year.

Cost growth per patient per year as shown in Figure 6.5 was considerably smaller in the 2009-2013 period than the growth in total costs for these comorbidity combinations shown in Figure 6.1. This indicates that the growth in overall costs was influenced more so by an increase in the number of patients with these conditions, than by growth in actual PPPY costs.

Conclusion

The analysis of cost data in the Medicare CKD population indicates avenues for potential cost savings, enduring racial cost disparities, and the effect of cost containment efforts in the CKD population. Potential cost savings could be achieved through the prevention of disease progression to later stages of CKD, and development of concurrent chronic conditions such as DM and CHF. Patients with CKD, DM, and CHF, alone or in combination, account for the vast majority of spending growth in the entire aged 65 or older Medicare population. In the Medicare CKD population, Black patients continue to exhibit higher costs in all disease categories as compared to Whites. However, the overall gap in spending between Black and White patients has declined in recent years. Despite accounting for an increasing share of Medicare spending, recent cost data shows that there have been decreases in the PPPY costs of CKD, especially for those in the later stages of the disease. Establishing the sources of this decline should be an important research priority. Growth in total CKD spending has been driven by growth in the number of identified cases, particularly in the earlier stages (CKD 1-3), that has more than offset the decline in spending per patient year.

References

Centers for Medicare and Medicaid Services (CMS). Medicare & Medicaid Statistical Supplement: 2013 Edition. Website. Retrieved October 8, 2015 from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/MedicareMedicaidStatSupp/2013.html.

Notes

Chapter 7: Medicare Part D Prescription Drug Coverage in Patients With CKD

- Approximately 69% of CKD patients are enrolled in Medicare Part D, including both the stand-alone and Medicare Advantage plans. This is slightly higher than the Part D enrollment in the general Medicare population (66%), and slightly lower than enrollment in the ESRD population (74%).
- Compared to Whites (23%), higher proportions of Asian (71%) and Black (53%) patients qualify for Part D coverage with the Low-income Subsidy (LIS) in CKD populations.
- The percentage of patients who receive the LIS is higher for CKD patients across all age and race categories than among their general Medicare counterparts.
- In 2013, per patient per year Medicare Part D spending for CKD patients was 46% higher than for general Medicare patients, at $3,675 as compared to $2,509.
- Total spending for Part D-covered medications in 2013 was more than twice as high for CKD patients with the LIS ($6,088) than for those without ($2,873). In addition, out-of-pocket costs represented only 1-2% of total expenditures, compared to 28-32% in each of the non-LIS populations.
- Statin, beta blocker, and renin-angiotensin-system (RAS)-acting agents were each prescribed to more than 50% of the CKD patient group during 2013, and over one third had at least one claim for a calcium channel blocker. Among these four drug classes, renin-angiotensin-system (RAS)-acting agents ranked first in terms of Medicare spending, followed closely by statins.

Introduction

The optional Medicare Part D prescription drug benefit has been available to all beneficiaries since 2006. Part D benefits can be managed through a stand-alone prescription drug plan (PDP) or through a Medicare Advantage (MA) managed care plan, which provides medical as well as prescription benefits. Chronic Kidney Disease (CKD) patients can choose to enroll in an MA plan; ESRD patients, in contrast, are precluded from entering an MA plan if they are not already enrolled in one when they reach ESRD. Enrollment data presented in this chapter encompass both types of plans, while the spending data focus on stand-alone plans. In December 2013, approximately 22.4 million Medicare-enrolled elderly and disabled people, as well as individuals with ESRD were enrolled in a stand-alone Medicare Part D PDP (Kaiser, 2015). An additional 14.0 million Medicare beneficiaries received drug coverage through an MA plan.

Before 2006, these patients obtained drug coverage through various avenues—insurance plans, state Medicaid programs, pharmaceutical assistance programs, or samples received from physicians. Those with none of these options paid for their medications out-of-pocket. After 2006, however, the majority of Medicare enrollees obtained Part D coverage. The premiums for Part D coverage are partially subsidized; beneficiaries who delay voluntary enrollment yet lack other creditable coverage at least equivalent to Part D are charged higher premiums once they do enroll. Consequently, 66% of general Medicare, 69% of CKD, and 74% of ESRD patients were enrolled in Part D in 2013. Other Medicare-enrolled CKD patients choose to obtain outpatient medication benefits through retiree drug subsidy plans or other creditable coverage that is equivalent to or better than Part D, including employer group health plans, Veterans Administration benefits, Medicaid wrap-around programs, and state kidney programs. Some enrollees remain uninsured

and pay out-of-pocket for their outpatient prescription medications.

The percentage of CKD patients with Part D coverage increased from 59 to 69% between 2011 and 2013. The proportion of CKD patients with no known coverage was 11.8%, lower than the 14.8% seen in the general Medicare population.

Part D does not cover all medications prescribed to Medicare enrollees. Several drug categories—including over-the-counter medications, barbiturates, benzodiazepines, anorexia and weight loss or gain medications, prescription vitamins (except for prenatal vitamins), and cough and cold medications—are excluded from the Part D program formulary. This results in a lack of coverage for some drugs commonly prescribed to treat CKD, including oral iron, ergocalciferol, and cholecalciferol; oral calcitriol, doxercalciferol, and paricalcitol are covered. In January, 2013, Medicare Part D coverage was expanded to include benzodiazepines with no restrictions, and barbiturates when prescribed for specific indications.

Prior to the start of the Medicare Part D program in 2006, patients dually-enrolled in Medicare and Medicaid received prescription benefits under state Medicaid programs. The Part D program, however, offers a substantial Low-income Subsidy (LIS) benefit to enrollees with limited assets and income, including those who are dually-enrolled. The LIS provides full or partial waivers for many out-of-pocket cost-sharing requirements, including premiums, deductibles, and copayments, and provides full or partial coverage during the Part D coverage gap ("donut hole"). In 2013, 42% of CKD patients enrolled in Part D qualified for the LIS, compared with 38% of general Medicare patients and 63% of ESRD patients (see Figure 7.1). Among Medicare Part D enrollees, 81% of Asian patients with CKD received the LIS, compared to 69% of Blacks/African Americans and 34% of Whites. Net Part D expenditures[1] for identified CKD patients rose from $5.4 billion in 2011 to $7.1 billion in 2013—an increase of 32%, compared to the lesser cost growth of 15 and 28% for general Medicare and ESRD patients, respectively.

Out-of-pocket (OOP) Part D costs for CKD patients were higher than for general Medicare patients, at $541 versus $400 per person per year (PPPY) in 2013. CKD patient OOP costs relative to total Part D costs were proportionally lower than those in the general Medicare population due to a higher rate of LIS coverage for these persons. Under the Affordable Care Act, the coverage gap ("donut" hole) in the Part D benefit will be phased out by 2020. As part of the phase-out, pharmaceutical manufacturers have provided a 50% discount to non-LIS patients on the price of brand-name drugs purchased in the coverage gap, and the Part D plans paid an additional 2.5% of brand name costs in the gap. Plans paid 21% of the cost of generics purchased by non-LIS patients in the coverage gap.

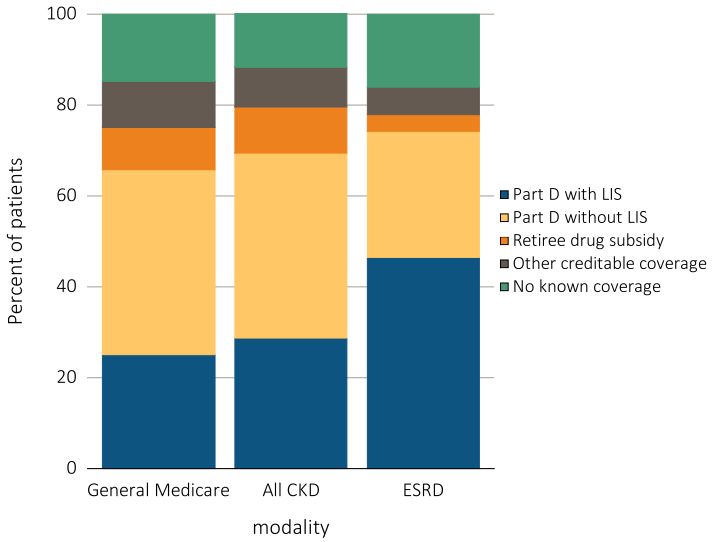
Analytical Methods

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

Part D Enrollment Patterns

Approximately 69% of CKD patients were enrolled in Medicare Part D (including both stand-alone and MA plans) in 2013, slightly higher than enrollment in the general Medicare population and slightly lower than enrollment in the ESRD population. Compared to the general population, however, a higher percentage of CKD patients qualified for the LIS (Figure 7.1).

vol 1 **Figure 7.1 Sources of prescription drug coverage in Medicare enrollees, by population, 2013**

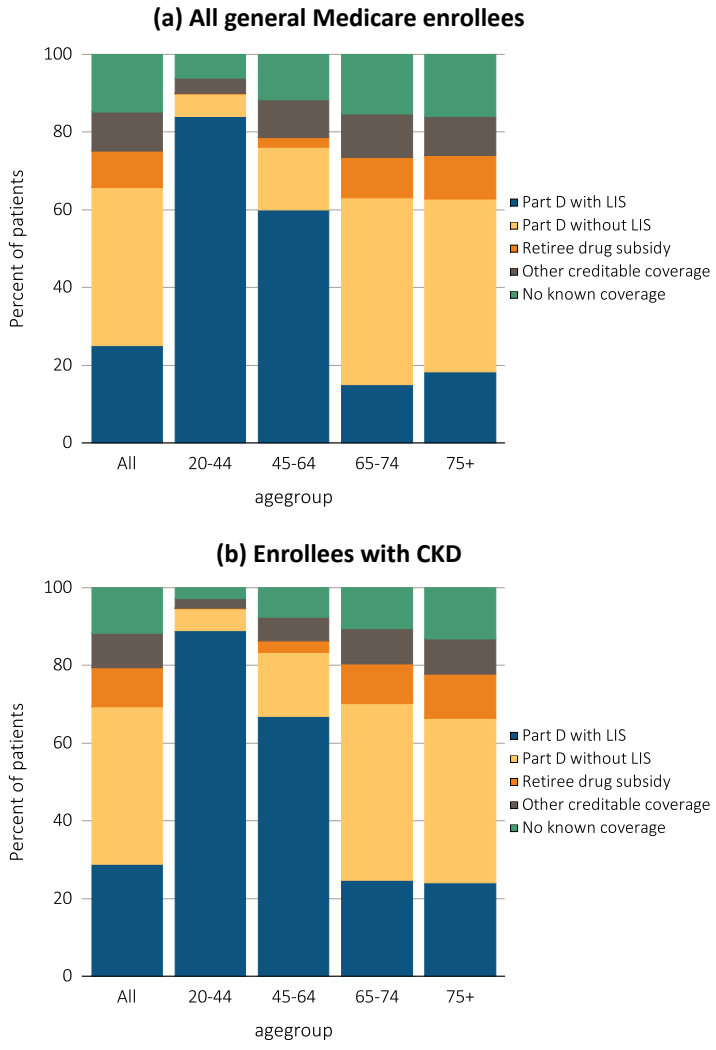


Data source: Medicare 5 percent sample. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; LIS, Medicare Low-income Subsidy; Part D, Medicare prescription drug coverage benefit.

[1] *Net Part D spending represents the sum of the Medicare covered amount and the Low-income Subsidy amount.*

Among both general Medicare beneficiaries and those with CKD, the percentage of patients enrolled in Part D generally declines with age. This decline is largely attributable to the high share of LIS eligibility among beneficiaries whose Medicare eligibility arises from disability rather than age, many of whom are automatically enrolled in a Part D plan. Eighty-nine percent of CKD patients aged 20–44 received the LIS in 2013. It is important to note that patients in the two younger age groups are disabled. In the two older age groups, similar proportions of general Medicare and CKD patients were enrolled in Part D, at 63–70%. The proportion of patients with LIS declined with age in both populations (with the exception of those aged 75 and older in the general Medicare population), but CKD patients in each age category were more likely to receive this subsidy (Figure 7.2).

vol 1 Figure 7.2 Sources of prescription drug coverage in Medicare enrollees, by age, 2013

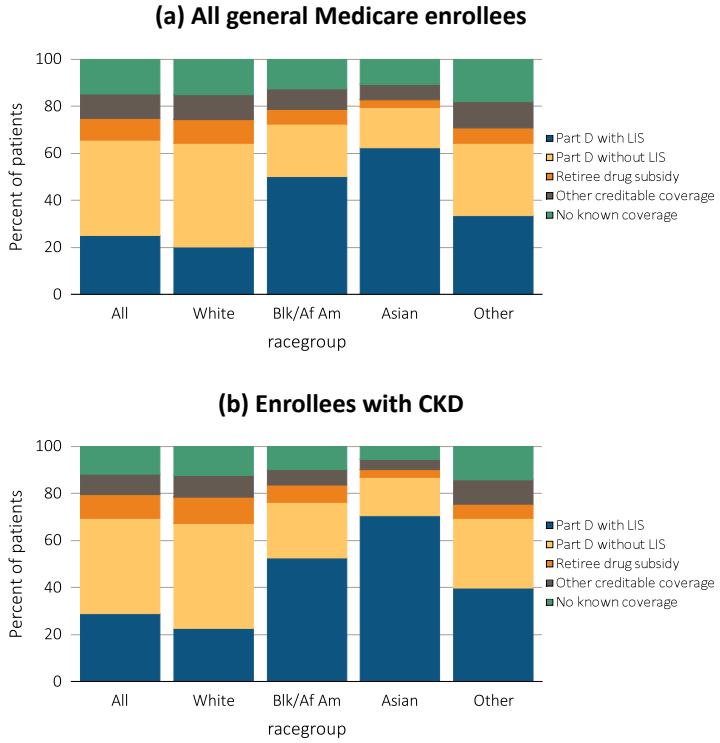


Data source: Medicare 5 percent sample. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: CKD, chronic kidney disease; LIS, Medicare low income subsidy; Part D, Medicare prescription drug coverage benefit.

Patterns of coverage by race were similar in the general Medicare and CKD populations (Figure 7.3). Compared to Whites, a higher portion of Asian patients and Black patients had Part D coverage with the LIS. Across all races, the percentage of patients with the LIS was higher for CKD patients than among their general Medicare counterparts.

Table 7.1 reports the percent of general Medicare and CKD enrollees who were eligible for the LIS, stratified by both age and race.

vol 1 Figure 7.3 Sources of prescription drug coverage in Medicare enrollees, by race, 2013



vol 1 **Table 7.1 Medicare Part D enrollees (%) with or without the Low-income Subsidy, by age & race, 2013**

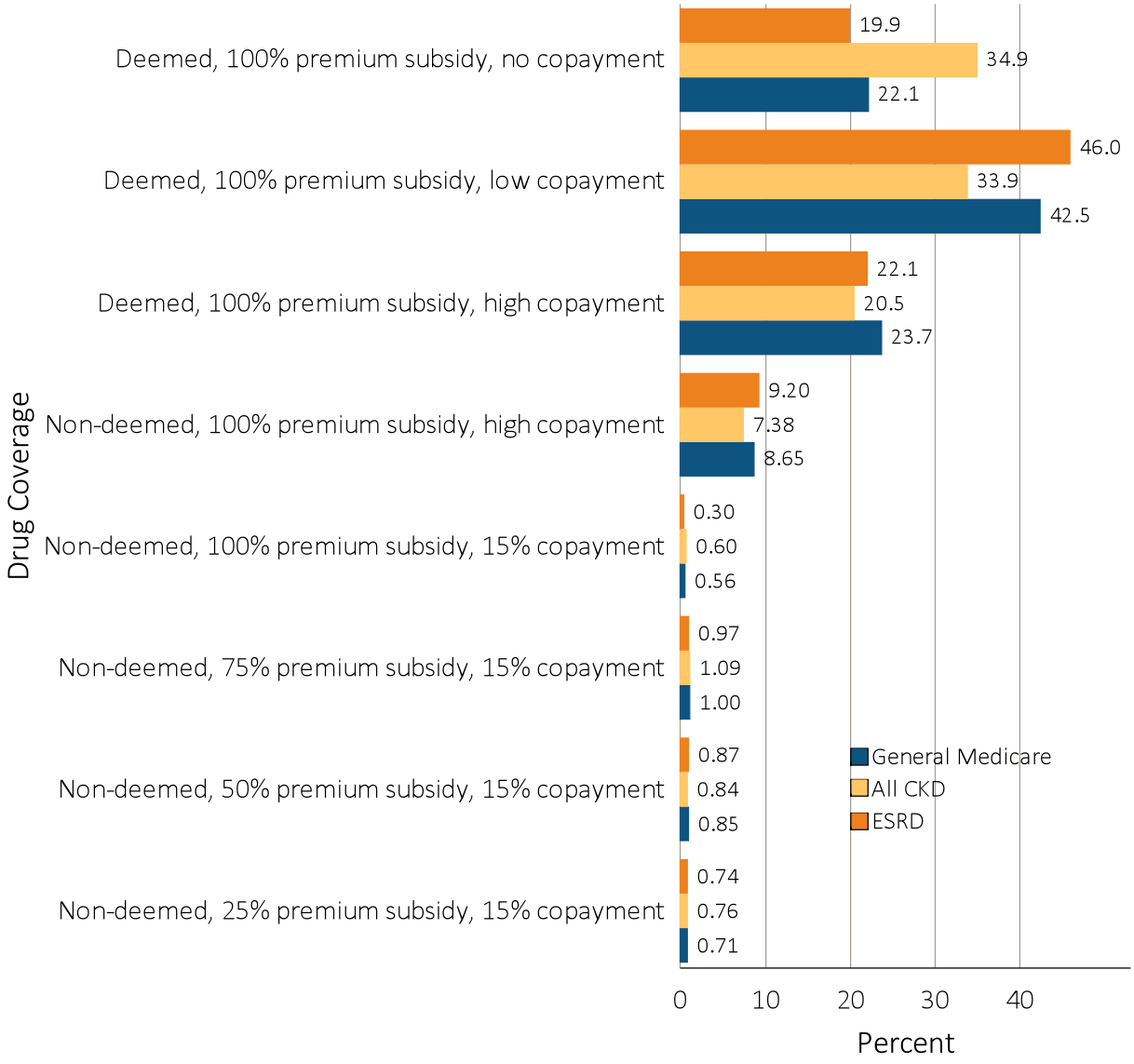
	General Medicare		All CKD	
	Part D with Low-income Subsidy	Part D remaining enrollees	Part D with Low-income Subsidy	Part D remaining enrollees
White				
All ages	31.4	68.6	33.8	66.2
20-44	93.0	7.0	93.9	6.1
45-64	76.1	23.9	77.8	22.2
65-74	18.3	81.7	28.1	71.9
75+	23.0	77.0	28.9	71.1
Black/African American				
All ages	69.2	30.8	68.9	31.1
20-44	95.5	4.5	94.5	5.5
45-64	85.9	14.1	84.7	15.3
65-74	51.4	48.6	59.9	40.1
75+	60.2	39.9	65.5	34.5
Asian				
All ages	78.3	21.7	81.3	18.7
20-44	92.3	7.7	100.0	0.0
45-64	85.5	14.6	85.4	14.6
65-74	71.7	28.3	77.1	22.9
75+	80.9	19.1	82.4	17.6
Other race				
All ages	52.1	47.9	57.3	42.7
20-44	93.0	7.0	93.8	6.3
45-64	78.1	21.9	81.9	18.1
65-74	36.8	63.2	43.9	56.1
75+	49.9	50.1	59.0	41.0

Data source: Medicare 5% sample. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: CKD, chronic kidney disease; Part D, Medicare prescription drug coverage benefit.

Data source: Medicare 5 percent sample. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: Blk/Af Am, Black/African American; CKD, chronic kidney disease; LIS, Medicare Low-income Subsidy; Part D, Medicare prescription drug coverage benefit.

Several categories of Medicare beneficiaries automatically qualify for LIS and Part D benefits, and are considered to be "deemed". These individuals include full-benefit Medicare/Medicaid dual eligible individuals, partial dual eligible individuals, Qualified Medicare Beneficiaries (QMB-only), Specified Low-income Medicare Beneficiaries (SLMB-only), Qualifying Individuals (QI), and people who receive Supplemental Security Income (SSI) benefits but not Medicaid. Other Medicare beneficiaries with limited incomes and resources that do not automatically qualify for LIS (non-deemed) can apply for LIS and have their eligibility determined by their State Medicaid agency or the Social Security Administration.

vol 1 **Figure 7.4 Distribution of Low-income Subsidy categories in Part D general Medicare, CKD, & ESRD patients, 2013** *Data source:*



Medicare 5% sample. Point prevalent Medicare enrollees alive on January 1, 2013. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Part D, Medicare prescription drug coverage benefit.

The distribution of Part D enrollees receiving the LIS across benefit categories (premium subsidy, copayment) is described in Figure 7.4. The vast majority of LIS recipients were eligible for a full premium subsidy.

Part D Coverage Plans

The Centers for Medicare and Medicaid Services provide prescription drug plans (PDPs) with guidance on structuring a "standard" Part D PDP. The upper portion of Table 7.2 shows the standard benefit design for PDPs in 2008 and 2013. In 2013, for example, beneficiaries shared costs with the PDP (as co-insurance or copayments) until the combined total reached $2,970 during the initial coverage period. After reaching this level, beneficiaries went into the coverage gap, or "donut hole," where they paid 100% of costs.

Since 2011, the government has been providing non-LIS recipients reaching the coverage gap with more assistance each year. In 2013, patients received a 50% discount on brand name drugs from manufacturers plus 2.5% coverage from their Part D plans, and plans paid 21% of generic drug costs in the gap. Beneficiaries who paid a yearly out-of-pocket drug cost of $4,750 reached the catastrophic coverage phase, in which they paid only a small copayment for their drugs until the end of the year.

vol 1 **Table 7.2 Medicare Part D parameters for defined standard benefit, 2008 & 2013**

	2008	2013
Deductible After the deductible is met, the beneficiary pays 25% of total prescription costs up to the initial coverage limit.	$275	$325
Initial coverage limit The coverage gap ("donut hole") begins at this point. The beneficiary pays 100% of their prescription costs up to the out-of-pocket threshold	$2,510	$2,970
Out-of-pocket threshold The total out-of-pocket costs including the "donut hole"	$4,050	$4,750
Total covered Part D prescription out-of-pocket spending: (including the coverage gap). Catastrophic coverage begins after this point.	$5,726.25	$6,733.75
Catastrophic coverage benefit		
Generic/preferred multi-source drug	$2.25	$2.651
Other drugs	$5.60	$6.601
[1]plus a 52.50% brand name medication discount		
2013 Example:		
$325 (deductible)	$275	$325
+(($$2970-$325)*25%)(initial coverage)	$558.75	$652.50
+(($6733.75-$2970)*100%)(coverage gap)	$3,216.25	$3,763.75
Total (maximum out-of-pocket costs prior to catastrophic coverage, excluding plan premium)	$4,050.00	$4,750.00

The catastrophic coverage amount is the greater of 5% of medication cost or the values shown in the chart above. In 2013, beneficiaries were charged $2.65 for those generic or preferred multisource drugs with a retail price less than $53, and 5% for those with a retail price over $53. For brand name drugs, beneficiaries paid $6.60 for those drugs with a retail price less than $132, and 5% for those with a retail price over $132. Table adapted from http://www.q1medicare.com/PartD-The-2013-Medicare-Part-D-Outlook.php.

PDPs have the latitude to structure their plans differently from what is presented here; companies offering non-standard plans must show that their coverage is at least actuarially equivalent to the standard plan. Many have developed plans with no deductibles or with drug copayments instead of the 25% co-insurance, and some plans provide generic and/or brand name drug coverage during the coverage gap.

Among general Medicare beneficiaries, patients with CKD, and those with ESRD, enrollment in Medicare Part D rose between 2011 and 2013 (Table 7.3). In each year, enrollment was slightly higher for those with CKD than in the general Medicare population; enrollment has been greatest for patients with ESRD.

vol 1 **Table 7.3 General Medicare, CKD, & ESRD patients enrolled in Part D (%)**

	General Medicare	All CKD	All ESRD
2011	55.8	59.4	68.9
2012	57.6	60.5	71.9
2013	65.7	69.4	74.2

Data source: Medicare 5 percent sample. Point prevalent Medicare enrollees alive on January 1. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Part D, Medicare prescription drug coverage benefit.

Spending Under Stand-alone Part D Plans

In 2013, the total Part D payment for patients with identified kidney disease (CKD patients not on dialysis, and ESRD patients) was $9.4 billion—about 20% of total Part D prescription drug costs, and a $2.2 billion increase from 2011 (Table 7.4). These costs do not include drugs contained under the ESRD prospective payment system in 2013 (e.g. ESAs, IV vitamin D, and iron) or billed to Medicare Part B (e.g. immunosuppressants).

vol 1 Table 7.4 Total estimated Medicare Part D costs for enrollees, 2011 & 2013

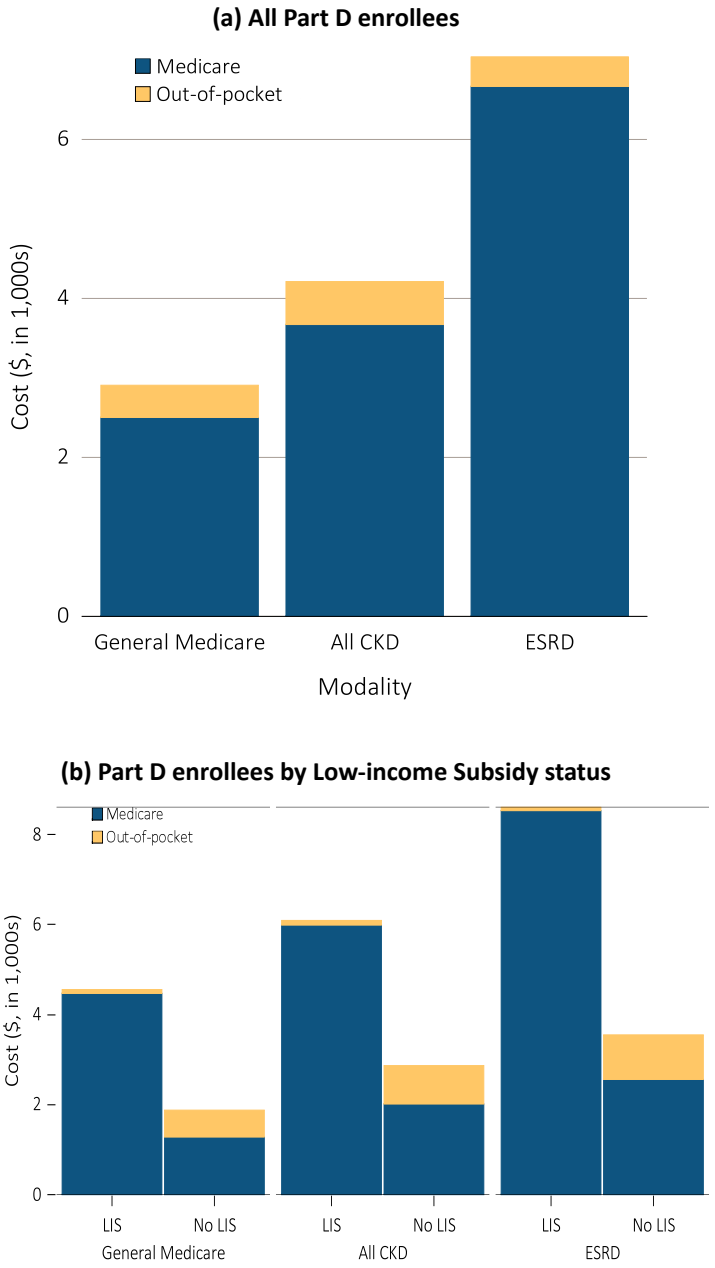
	General Medicare	All CKD	All ESRD
2011	41.39	5.38	1.80
2013	47.45	7.11	2.30

Data source: Medicare Part D claims. Medicare totals include Part D claims for Part D enrollees with traditional Medicare (Parts A & B). CKD totals include Medicare CKD patients, as determined from claims. ESRD totals include all Part D claims for Medicare ESRD patients with Medicare Part D stand-alone prescription drug plans. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Part D, Medicare prescription drug coverage benefit.

In 2013, PPPY net Part D spending for CKD patients was 46% higher than for general Medicare patients, at $3,675 compared to $2,509. Similar to total Part D costs, out-of-pocket costs for CKD patients were 35% higher than general Medicare population. Due to the much higher proportion of LIS in the ESRD population, out-of-pocket costs represented a smaller share of total spending (5%) than in the other two groups (13% for CKD, and 14% for general Medicare) (Figure 7.5a).

Total spending for Part D-covered medications in 2013 was more than twice as high for patients with the LIS than for those without (Figure 7.5b). In the LIS population, however, out-of-pocket costs represented only 1-2% of these total expenditures, compared to 28-32% in each of the non-LIS populations.

vol 1 Figure 7.5 Per person per year Medicare & out-of-pocket Part D costs for enrollees, 2013



Data source: Medicare Part D claims. Medicare totals include Part D claims for Part D enrollees with traditional Medicare (Parts A & B). CKD totals include Medicare CKD patients as determined from claims. ESRD totals include all Part D claims for Medicare ESRD patients with Medicare Part D stand-alone prescription drug plans. Costs are per person per year for calendar year 2013. Medicare total is the sum of Medicare net payment plus Low-income Supplement amount. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Part D, Medicare prescription drug coverage benefit.

Total per person per year Medicare Part D spending varied widely between those with and without the LIS (Table 7.5), excluding patient obligations. Overall, ESRD patients had the highest spending in both categories. Total PPPY Medicare-paid Part D costs in LIS and non-LIS patients varied from $4,476 and $1,282 PPPY in the general Medicare population to $5,985 and $2,018 among patients with CKD, and to $8,522 and $2,552 among those with ESRD. By race, PPPY spending in the general Medicare and CKD non-LIS populations was highest for Blacks, but in the general Medicare and CKD LIS populations was highest for Whites and Asians respectively. In each of the three populations, spending was highest in the ages 45-64 category, regardless of LIS status.

vol 1 **Table 7.5 Per person per year Part D costs ($) for enrollees, by Low-income Subsidy status, 2013**

	General Medicare		All CKD		All ESRD	
	Part D with Low-income Subsidy	Part D remaining enrollees	Part D with Low-income Subsidy	Part D remaining enrollees	Part D with Low-income Subsidy	Part D remaining enrollees
Age						
All	4,476	1,282	5,985	2,018	8,522	2,552
20-44	4,592	1,653	8,603	2,754	9,251	2,177
45-64	5,921	2,395	8,786	3,800	9,315	2,851
65-74	3,925	1,237	6,317	2,361	7,499	2,785
75+	3,424	1,204	4,479	1,733	5,889	2,049
Sex						
Male	4,380	1,339	6,215	2,149	8,554	2,548
Female	4,539	1,241	5,845	1,891	8,488	2,558
Race						
White	4,682	1,282	6,120	1,996	8,175	2,556
Black	4,021	1,338	5,541	2,230	9,039	2,539
Asian	4,229	1,133	6,418	2,038	8,816	2,663
Other race	4,001	1,270	5,918	2,163	6,162	2,065

Data source: Medicare Part D claims. All Medicare patients with Medicare Part D stand-alone prescription drug plans. CKD determined from claims. ESRD patients with Medicare Part D stand-alone prescription drug plans. Costs are per person per year for calendar year 2013. Medicare PPPY is the sum of Medicare net payment and the Low-income Supplement amount. LIS status is determined from the Part D enrollment. A person is classified as LIS if they are eligible for the LIS for at least one month during 2013. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage renal disease; Part D, Medicare prescription drug coverage benefit.

Prescription Drug Therapy

Statin, beta blocker, renin-angiotensin-system (RAS)-acting agents were each prescribed to more than 50% of the CKD patient group during 2013, and over one third had at least one claim for a calcium channel blocker. Among these four drug classes, Renin-angiotensin-system (RAS)-acting agents ranked first in term of Medicare expenditures, followed closely by statins (Table 7.6).

vol 1 **Table 7.6 Common drug classes used by Part D-enrolled CKD patients, by percent of patients, drug class, and net cost, 2013**

	Percent of patients (%)	Net costs ($)
Statins	60.1%	230,603,390
Calcium channel blockers	34.6%	72,740,048
Beta blockers	57.8%	109,500,131
Renin-angiotensin-system (RAS)-acting agents	59.3%	235,885,110

Data source: Medicare Part D claims. CKD patients with Medicare Part D stand-alone prescription drug plans in the Medicare 5 percent sample. Net Part D spending represents the sum of the Medicare covered amount and the Low- income Subsidy amount. Renin-angiotensin-system (RAS)-acting agents contain three drug classes: angiotensin-receptor blockers (ARBs), angiotensin-converting enzyme inhibitors (ACE-inhibitors) and direct renin inhibitors.

References

The Henry J. Kaiser Family Foundation. Medicare Indicators: Prescription Drug Plans. Website. Retrieved October 13, 2015 from http://kff.org/state-category/medicare/prescription-drug-plans/enrollment-prescription-drug-plans-medicare/

Notes

Chapter 8: Transition of Care in CKD

• Almost 30% of all 52,172 veterans who transitioned to ESRD across the nation over a 4-year period (10/2007-9/2011) received anti-depressant medications prior to transition (prelude period), while after transition to ESRD (vintage period) the anti-depressant prescription rate increased slightly.

• Phosphorus binders were rarely prescribed during the prelude period prior to ESRD transition, but a major surge was observed in the final six months of the prelude period, followed by a substantial rise during the dialysis vintage period.

• Among comorbid conditions that were obtained from multiple sources for 47,555 veterans who transition to ESRD with at least one identified comorbidity, congestive heart failure (CHF) and diabetes mellitus were each present in over half of the veterans, chronic pulmonary disease was recorded in over 40%, and almost a quarter of all patients had the diagnosis of cancer, while 28% had prior myocardial infarction.

• Among the 46,625 veterans who transitioned to ESRD over the 4-year period with at least one hospitalization event, the most common causes of hospital admission that also included the ESRD transition day in the hospital included: acute kidney injury (AKI, acute renal failure), hypertension, congestive heart failure, and CKD per se, while septicemia-related hospital admissions increased dramatically after ESRD transition.

• Congestive heart failure (CHF) was the most common reason for hospital admission prior to ESRD transition (prelude time), whereas dialysis access complications were the most common cause after ESRD transition (vintage time).

• For hospitalizations that included the transition to ESRD event, i.e., the first hemodialysis treatment, AKI was the leading cause of hospitalization.

• Prelude trend analyses provide important information about changes in clinical and laboratory measures over time during several years prior to transition to ESRD, including measured serum phosphorus in 11,896 veterans who eventually transitioned to ESRD over 5 years, which gradually increased from the 3.8 to 4.0 range to above 5.5 mg/dL immediately prior to transition to ESRD.

Introduction

The Transition of Care in Chronic Kidney Disease (TC-CKD) Special Study Center examines the transition of care to renal replacement therapy, i.e., dialysis or transplantation, in patients with very-late-stage non-dialysis dependent (NDD) CKD. These are often people with an estimated glomerular filtration rate (eGFR) <25 ml/min/1.73 m2. The main databases used in these analyses are created from the linkage between the national USRDS data and two large longitudinal databases of NDD-CKD patients, i.e., the national (entire U.S.) Veterans Affairs (VA) database, and the regional (Southern California) Kaiser Permanente (KP-SC) database. These linkages allow us to identify all VA and all KP-SC patients who have transitioned to ESRD from the index point in time onwards. Each of these linked databases consists of thousands of NDD-CKD patients who have transitioned to ESRD each year, in whom historical data for up to -5 (minus five) years prior to ESRD (the so-called "prelude" period) and up to +2 (plus two) years after ESRD transition (the so-called early "vintage" period) will be examined.

In the first phase of this Special Study operation we have examined the recent national veterans

and KP-SC cohorts of incident ESRD patients. We provide pre-ESRD (prelude) data on all available ESRD transitions since 10/1/2007 among veterans and since 1/1/2007 among KP-SC patients. Some of these analyses including preliminary post-ESRD data of approximately 52,000 incident ESRD veterans who transitioned to ESRD over four years, i.e., between 10/1/2007 and 9/30/2011, were presented in our first report in the 2014 ADR. This year our chapter includes additional data of the first two years of the vintage period in these incident dialysis patients; we also present the -5 year prelude (pre-ESRD) data for the first time along with additional data from the USRDS. In future ADRs we plan to provide annual updates based on linkages to data from thousands of incident ESRD patients who transition to ESRD in subsequent years.

As stated under the original goals of this Special Study Center, we also plan to test the hypotheses that a pre-ESRD (prelude) data-driven individualized approach to the transition of care into ESRD in very-late-stage NDD-CKD is associated with more favorable outcomes, particularly if the decision is based on such pre-ESRD factors as clinical and laboratory variables including the CKD progression rate, comorbid conditions during prelude period, and demographics. In subsequent years we also plan to develop and validate scoring systems derived from these pre-ESRD data to better ascertain the extent to which timing, preparation and modality of ESRD may be associated with better outcomes.

The Veterans Health Administration

There are approximately 22 million veterans in the United States of who 9 million are enrolled in the Veterans Health Administration (VHA), including almost 6 million who receive their healthcare in one of the VHA facilities. During the fiscal year of 2013 there were 86.4 million outpatient visits and 694,700 inpatient admissions at Veterans Affairs (VA) healthcare facilities[1]. Whereas currently some 90% of the U.S. veteran population consists of males, it is estimated that by 2040 approximately 18% of the VA population will be females. Minority veterans comprised about 22% of the total veterans' population in 2014. The majority of minority veterans are those of Black or African American race (12% of all veterans), and Hispanics or Latinos of any race comprise approximately 7% of all veterans[2].

The VHA facility network consists of 150 hospitals, along with 820 community-based outpatient clinics and 300 vet centers[3]. Services provided by the VA department and VHA facilities include comprehensive medical care, life insurance, disability compensation, home loans, educational benefits, pensions and vocational rehabilitation training.

Management of ESRD in the VHA

The VHA provides comprehensive medical care for patients with kidney disease, including acute kidney injury (AKI) and all stages of CKD. Management of kidney disease that does not require dialysis or transplantation is typically provided by VA personnel at one of the nationwide VHA facilities, or by local private providers (outsourced by the VHA) in cases where the VHA cannot provide adequate care, e.g. for reasons such as prohibitive distance or lack of adequate resources.

Any veteran who develops ESRD is eligible to receive kidney replacement therapy from the VHA. Dialysis care is a covered benefit under VA's Medical Benefits Package for veterans enrolled in the VA, irrespective of their service connectedness[4] For patients requiring in-center dialysis treatment, the VHA provides dialysis both through dialysis units maintained and operated by individual VA facilities, (hence usually hospital based dialysis centers), or by outsourcing dialysis services to private dialysis providers. This may happen in cases where the distance from a VA facility is prohibitive for thrice-weekly dialysis, when there is a lack of home dialysis resources or expertise, or when the capacity of the VA facility-operated dialysis unit is exceeded. There are currently 71 VA facilities nationwide which maintain and operate an in-house (in-center) dialysis center[5]. Most such hospital based dialysis units provide both chronic outpatient and acute inpatient dialysis treatments in the same location simultaneously. In the USRDS ADR census they are usually counted under the category of "hospital based" facilities. Approximately 90% of the ESRD veterans, however, receive dialysis treatment in non-VHA facilities including dialysis chains, but their transition data, including and in particular their prelude and early vintage analyses are also included in this chapter (see below).

Highlights of the Incident ESRD Veterans Data between 10/1/2007 and 9/30/2011

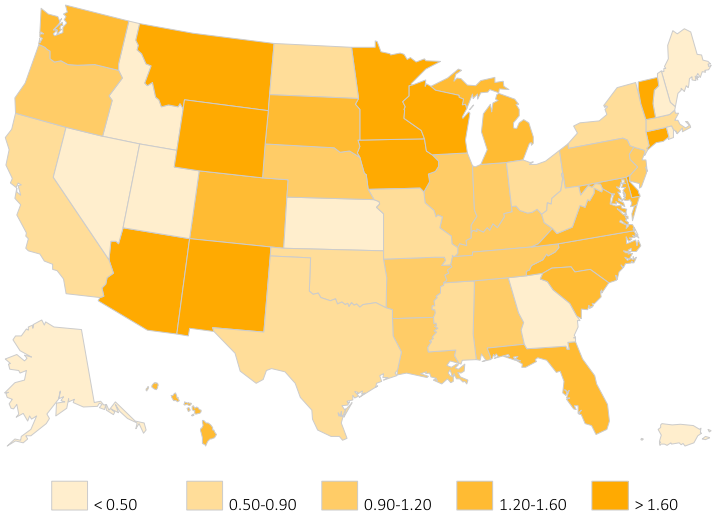
As reported in the 2014 ADR chapter, between 10/1/2007 and 9/30/2011 (over four fiscal years), 52,172 veterans transitioned to ESRD (mean ± SD age: 70.3 ±12.1 years old) including 24% Blacks and 6% Hispanics. The cause of ESRD in majority of them was diabetes mellitus (41.7%) or hypertension (31.4%). During the very early vintage period mortality was exceptionally high, so that during the first three months after transition 10.4% of all incident ESRD veterans died, while 1.4% received kidney transplantation during this time. Hemodialysis therapy was the dominating modality comprising 92.3% of the incident ESRD veterans at three months, whereas home dialysis modalities were scarce including peritoneal dialysis (6.1%) and home hemodialysis (<1%) at this time.

Preemptive Kidney Transplantation among Veterans across the Nation

Figure 8.1 shows the proportions of preemptive kidney transplantation in each state and territory of the United States. The rates are calculated based on the number of preemptive transplants divided by the total number of the incident ESRD veterans in that state or territory (n=589 preemptive transplantations over four years in the entire nation). The states with the highest preemptive kidney transplant rates among veterans (>1.6%) were Arizona, Connecticut, Delaware, Iowa, Minnesota, Montana, New Mexico, Vermont, Wisconsin, and Wyoming.

As reported in the 2014 ADR chapter on Transition of Care in CKD, during each year of the 4-year observation period approximately 13,000 veterans transitioned to ESRD, with an average rate of ESRD transition of 1,087 veterans per month across the entire nation. In this report we have calculated the ESRD incident rates for veterans in each calendar year (Jan 1-Dec 31), instead of fiscal year (Oct 1-Sep 30). The U.S. Census data were accessed to obtain the Veterans population data using the Census Fact Finder site[6]. We then calculated counts of all veterans in each year and per age strata. The USRDS incidence rates

vol 1 **Figure 8.1. Distribution of preemptive kidney transplant rates among 52,172 incident ESRD veterans across the states and territories of the United States, 10/1/2007-9/30/2011**



Data source: VHA Administrative data, USRDS ESRD Database. States and territories of the United States of America. Abbreviations: ESRD, end-stage renal disease.

for ESRD among U.S. adults were obtained from the 2014 SAFS databases for comparison. For the three calendar years 2008, 2009 and 2010, the ESRD incident rates among veterans were 604.6, 624.0 and 604.1 per million veterans, respectively. Given the ESRD incident rates of 488.0, 499.3 and 495.6 per million per the USRDS population, the calculated crude rate ratio of ESRD incidence among veterans compared to the U.S. general population is 1.24, 1.25, and 1.22 for calendar years 2008 through 2010, respectively, suggesting that the ESRD is 22% to 25% more likely to occur among veterans than the general U.S. population. However, the VA population is considerably older than the general U.S. population. On an age specific and age adjusted basis, the rate of ESRD is 25 to 40% lower than the U.S. rate of ESRD. This lower-than-expected risk occurs despite the fact that the VA population is predominantly male. The remarkably low rate of ESRD among VA patients is unexplained. Is it because the VA system provides an integrated health care system with better care to CKD patients? Is it because there is a selection bias of persons into military service? After all, there is a screening of military candidates that could remove persons with greater risk of ESRD from the resultant VA pool of persons. Further research may shed some light on this issue.

vol 1 **Table 8.1. Rates and ratios of incident ESRD among veterans and in U.S. adults, 10/1/2007-9/30/2011**

	55-64 years			65-74 years			75 years or older		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
Incident ESRD veterans	3,180	3,292	3,115	3,054	3,187	3,080	5,924	5,787	5,740
All veterans	5,718,302	5,441,739	5,340,529	4,148,572	4,152,331	4,294,221	4,911,012	4,851,671	4,839,173
ESRD rate in veterans, per million	**556**	**605**	**583**	**736**	**768**	**717**	**1206**	**1193**	**1186**
ESRD rate in the U.S., per million	773	778	752	1297	1311	276	545	1559	1582
ESRD rate ratio (Vet: U.S.)[a]	**0.72**	**0.78**	**0.78**	**0.57**	**0.59**	**0.56**	**0.78**	**0.76**	**0.75**

Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data, U.S. Census Bureau; data derived from U.S. veteran incident dialysis patients. [a]Veterans to U.S. rate ratios. Abbreviations: ESRD, end-stage renal disease; PM; per million; Vet, veterans.

The status of incident ESRD veterans during the first three months upon transition to ESRD (10/1/2007-9/30/2011) is shown in Table 8.2. On Day 1 versus Day 90 of the ESRD service, 82.9% and 78.4% of the 52,172 veterans (n=43,256 and 40,918), respectively, received in–center hemodialysis treatment, whereas the number of peritoneal dialysis (PD) patients at these two points in time was 4.9% (n=2,552) and 5.2 % (n=2,697). There were 1.1 % (n=589) registered preemptive kidney transplant recipients on Day 1 of ESRD service initiation. During the first three months of the transition to ESRD, 10.3% (n=5,348) died, 1.3% (n=701) received a kidney transplantation, and 3.5% (n=1,789) stopped dialysis therapy including recovered from ESRD. The 10.4% crude mortality rate of incident ESRD veterans during the first three months is equivalent to an annualized mortality rate of 41.6% and reflects the similar early excess mortality found in the general ESRD population.

vol 1 **Table 8.2. Status of 52,172 incident ESRD veterans on Day 1 and Day 90 after transition to ESRD, 10/1/2007-9/30/2011**

	Day 1		Day 90	
	n	%	n	%
Dialysis Modality				
In-center	43,256	82.9	40,918	78.4
Home HD	260	0.5	258	0.5
CAPD	1,405	2.7	1,302	2.5
CCPD	1,174	2.2	1.395	2.7
Uncertain[a]	5,287	10.1	447	0.9
Outcomes[b]				
Death	201	0.4	5,348	10.3
Transplant	589	1.1	701	1.3
Lost to follow-up			5	<0.1
Recovered			1,798	3.5
Total	**52,172**	**100**	**52,172**	**100**

Data source: USRDS ESRD Database. Table adapted from the 2014 USRDS Annual Data Report. [a]Uncertain groups have no known dialysis modality, [b]n for outcomes is cumulative for subsequent periods after Day 1. Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycling peritoneal dialysis; ESRD, end-stage renal disease; HD hemodialysis.

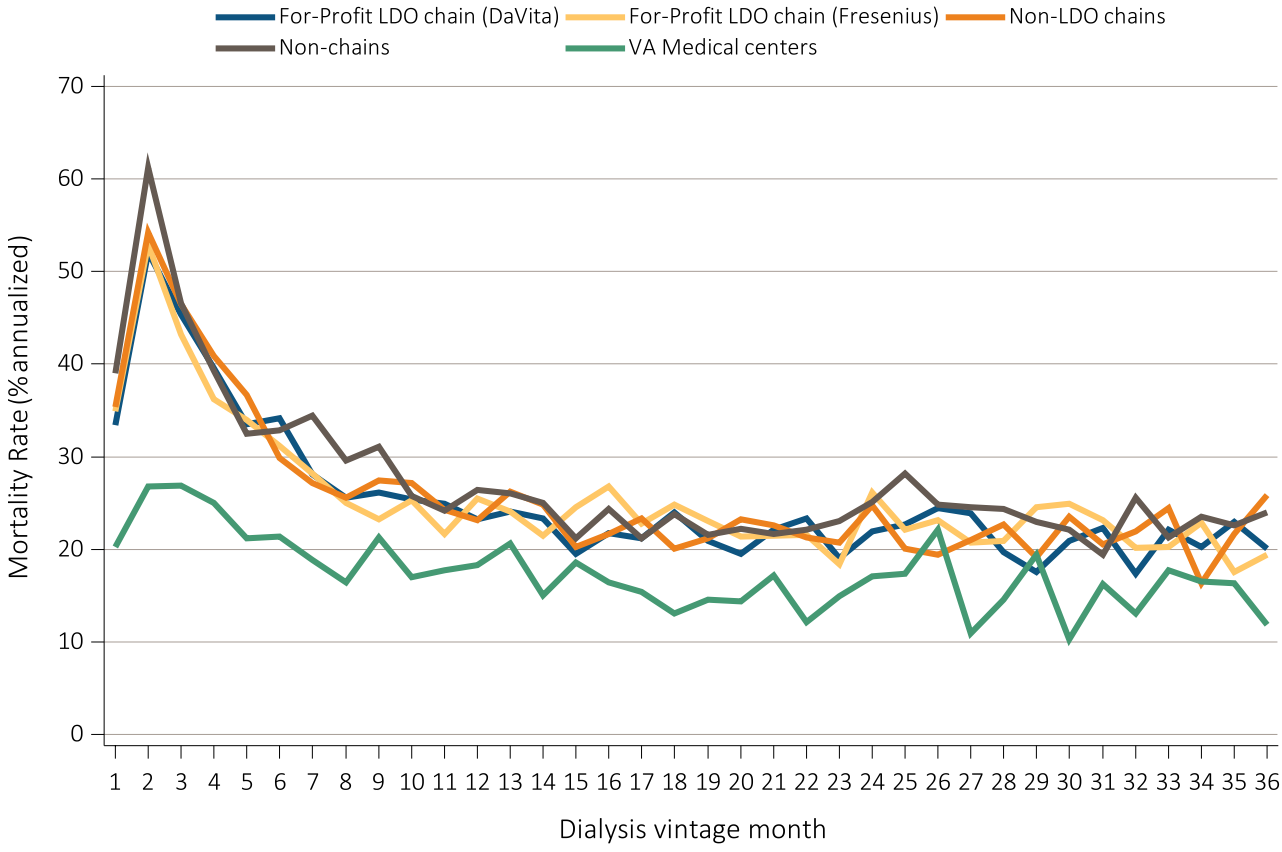
Dialysis Providers and Outcomes after Transition to ESRD

Upon transition to ESRD only 9.9% (n=5,157) received dialysis therapy in one of the in-center dialysis units based at VHA medical centers, while 52.1% of all incident dialysis veterans received maintenance dialysis therapy in outsourced facilities that included for-profit "large dialysis organizations" (LDO), i.e., Fresenius Medical Care (FMC, 27.6%) and DaVita Kidney Care (DVT, 24.5%), or in other dialysis chains (13.1%) or in a dialysis unit that did not belong to any chain (i.e. free-standing and hospital based units, 21.1%). The mean age of veterans at the initiation of the dialysis treatment in a VHA medical center was 64.6 years compared to 70.3 to 72.1 years in the outsourced (non-VHA) dialysis facilities; and VHA medical centers had 41.3% Black patients as compared to 24.1% of all incident ESRD veterans. Higher proportion of Blacks and younger age may explain lower mortality rates in VHA based dialysis units. In addition to age and race, further adjustments for potential differences in comorbidity burden and/or other patient characteristics will be necessary to better describe provider-associated outcomes in dialyzed veterans.

Figure 8.2 shows the crude, annualized, month-by-month mortality rates during the first 36 months after transition to ESRD across dialysis providers. As shown here mortality rates were exceptionally high during the first several months of transition to ESRD among all providers. The annualized mortality in Month 2 was the highest (>50% per year) in non-VHA units and lowest (26.8% per year) in VHA affiliated dialysis units. Given higher fluctuation of the rates in Year 3 that is likely secondary to small size of the denominators during this time, all subsequent mortality analyses are based on the first 24 months (two years) of vintage to mitigate imprecision.

Table 8.3 shows the crude month-by-month mortality rates in the first 24 months after transition to ESRD across dialysis providers as the source of the rates in Figure 8.2. As shown here mortality rates were exceptionally high during the first several months of transition to ESRD among all providers. The annualized mortality in Month 2 was the highest (>50% per year) in non-VHA units and lowest (26.8% per year) in VHA affiliated dialysis units.

vol 1 **Figure 8.2. Annualized monthly unadjusted mortality of incident ESRD veterans who transitioned to ESRD during 10/1/2007-9/30/2011 and who were followed for up to 36 months, by dialysis provider**



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviation: DaVita, DaVita Kidney Care; ESRD, end-stage renal disease; LDO, large dialysis organization; VA, Veterans' Affairs.

vol 1 **Table 8.3. Annualized month-by-month unadjusted mortality in 52,172 incident ESRD veterans during the first 24 months after transition to ESRD by dialysis provider, 10/1/2007-9/30/2011**

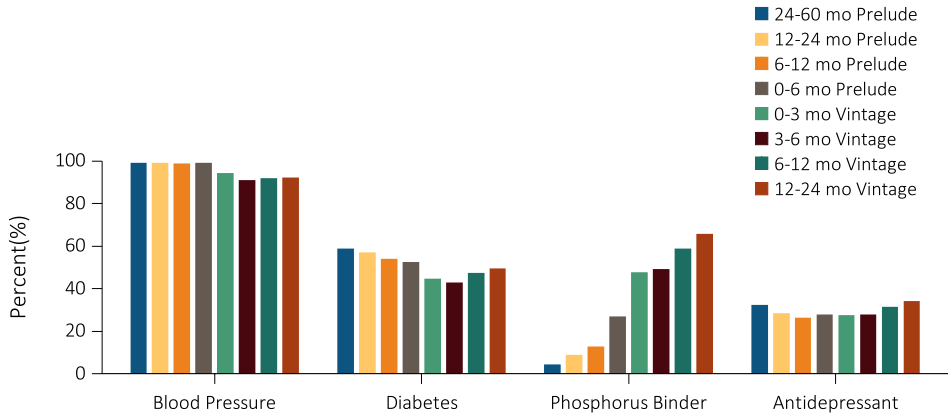
	DVT			FMC			Other Chains			Non-Chain			VHA		
Month	Died	Alive	Rate %	Died	Alive	Rate %	Died	Alive	Rate %	Died	Alive	Rate %	Died	Alive	Rate %
1	355	12,763	33.38	418	14,376	34.89	202	6,847	35.4	358	11,005	39.04	86	5,100	20.24
2	538	12,408	52.03	615	13,958	52.87	300	6,645	54.18	543	10,647	61.2	112	5,014	26.8
3	449	11,870	45.39	480	13,343	43.17	246	6,345	46.52	392	10,104	46.56	110	4,902	26.93
4	377	11,421	39.61	388	12,863	36.2	208	6,099	40.92	318	9,712	39.29	100	4,792	25.04
5	308	11,044	33.47	353	12,475	33.96	180	5,891	36.67	254	9,394	32.45	83	4,692	21.23
6	306	10,736	34.2	315	12,122	31.18	142	5,711	29.84	250	9,140	32.82	82	4,609	21.35
7	244	10,430	28.07	277	11,807	28.15	126	5,569	27.15	255	8,890	34.42	71	4,527	18.82
8	217	10,186	25.56	240	11,530	24.98	116	5,443	25.57	213	8,635	29.6	61	4,456	16.43
9	217	9,969	26.12	219	11,290	23.28	122	5,327	27.48	218	8,422	31.06	78	4,395	21.3
10	206	9,752	25.35	233	11,071	25.26	118	5,205	27.2	176	8,204	25.74	61	4,317	16.96
11	198	9,546	24.89	196	10,838	21.7	103	5,087	24.3	162	8,028	24.22	63	4,256	17.76
12	181	9,348	23.23	226	10,642	25.48	96	4,984	23.11	173	7,866	26.39	64	4,193	18.32
13	184	9,167	24.09	209	10,416	24.08	107	4,888	26.27	167	7,693	26.05	71	4,129	20.63
14	175	8,983	23.38	183	10,207	21.51	99	4,781	24.85	157	7,526	25.03	51	4,058	15.08
15	143	8,808	19.48	205	10,024	24.54	79	4,682	20.25	130	7,369	21.17	62	4,007	18.57
16	157	8,665	21.74	219	9,819	26.76	83	4,603	21.64	147	7,239	24.37	54	3,945	16.43
17	150	8,508	21.16	182	9,600	22.75	88	4,520	23.36	125	7,092	21.15	50	3,891	15.42
18	167	8,358	23.98	195	9,418	24.85	74	4,432	20.04	138	6,967	23.77	42	3,841	13.12
19	143	8,191	20.95	177	9,223	23.03	77	4,358	21.2	123	6,829	21.61	46	3,799	14.53
20	131	8,048	19.53	161	9,046	21.36	83	4,281	23.27	124	6,706	22.19	45	3,753	14.39
21	146	7,917	22.13	159	8,885	21.47	79	4,198	22.58	119	6,582	21.7	53	3,708	17.15
22	151	7,771	23.32	157	8,726	21.59	73	4,119	21.27	119	6,463	22.1	37	3,655	12.15
23	121	7,620	19.06	131	8,569	18.35	70	4,046	20.76	122	6,344	23.08	45	3,618	14.93
24	137	7,499	21.92	184	8,438	26.17	82	3,976	24.75	130	6,222	25.07	51	3,573	17.13

Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Provider is based on the patient's provider on Day 1. Rates represent the 12-month annualized rate. Abbreviations: DVT, DaVita Kidney Care; ESRD, end-stage renal disease; FMC, Fresenius Medical Care; VHA, Veterans' Health Administration.

Prescribed Medications upon Transition to ESRD

Patterns of medication use before, during and after transition to ESRD are examined in this section. Four groups of medications were analyzed including (1) medication used for blood pressure management (beta blockers, alpha blockers, calcium channel blockers, vasodilators, thiazide diuretics, loop diuretics, potassium sparing diuretics, and RAAS inhibitors); diabetes medications (insulin and oral hypoglycemic); (3) phosphorus binders (sevelamer, lanthanum, and calcium acetate) and (4) antidepressants. As shown in Figure 8.3 over 90% of patients were on blood pressure lowering medications prior to ESRD transition, and this high medication rate persisted during and throughout post-transition period. Diabetes medications were given to 50% of all veterans prior to ESRD transition, but this rate declined to 40% in Year 1 of the vintage. Phosphorus binders were rarely prescribed during the prelude to ESRD, but a major surge was observed in the final six months of the prelude and immediately prior to transition to ESRD, followed by a substantial rise during the vintage period. Anti-depressants showed a rather constant prescription pattern independent of transition to ESRD, in that almost 30% of veterans received these medications during both prelude and vintage, although some upwards trends are observed after transition to ESRD.

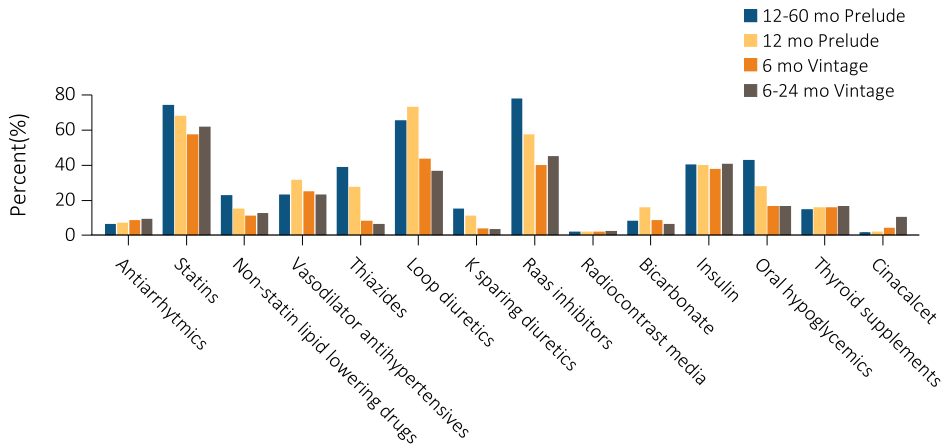
vol 1 Figure 8.3. Medications prescribed to 52,172 incident ESRD veterans who transitioned to ESRD from 10/1/2007-9/30/2011



Data source: VHA Administrative data, CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Abbreviations: ESRD, end-stage renal disease; mo, month.

More granular data on type of prescribed medications are presented in Figure 8.4. The time periods are combined into 2 prelude periods (last 12 months and prior to final 12 months) and two vintage periods (first six months and after six months of dialysis therapy). As shown here, statins, RAAS inhibitors and loop diuretics were prescribed to over two-thirds of veterans during the prelude time. The use of thiazide, potassium sparing and loop diuretics dropped dramatically after transition to ESRD. Bicarbonate use showed a surge in the final 12 months of prelude. The calcimimetic agent cinacalcet was mostly prescribed in the vintage but not prelude time.

vol 1 Figure 8.4. Detail of the medications prescribed to 52,172 incident ESRD veterans who transitioned to ESRD during 10/1/2007-9/30/2011

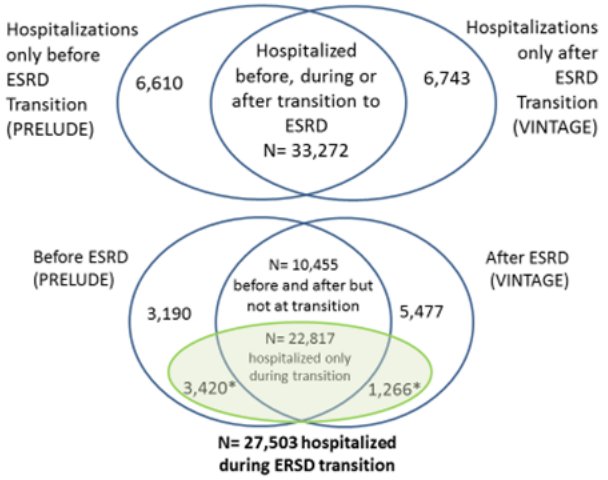


Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Abbreviations: ESRD, end-stage renal disease; K, potassium; mo, month.

Hospitalization Pattern during Transition to ESRD

To obtain accurate hospitalization data for the 52,172 veterans who transitioned to ESRD over the four years (10/2007-9/2011), additional database merging was done between the veteran ESRD data and the inpatient and outpatient data from VA sources (including Inpatient Acute Care Main, Inpatient Acute Care Surgery, MedSAS Outpatient Event file, and MedSAS Inpatient Encounters file) as well as the CMS Medicare-Inpatient and Outpatient data sources (including CMS RIF-Outpatient, and Additional Chronic Conditions obtained from CMS Beneficiary Files under BASF & MBSF). 46,625 patients or 89.4% of all veterans who transitioned to ESRD were hospitalized at least once during a period of -5 years prior to (prelude) and +2 years after transition to ESRD (vintage). Figure 8.5 shows the Venn diagram of these hospitalization counts: 6,610 veterans were hospitalized only before but not after and 6,743 only after but not before the transition to ESRD, whereas 33,272 veterans were in the hospital both before and after the ESRD transition. There were 27,503 veterans (52.7%) in whom the transition to ESRD happened while they were in the hospital, including 22,817 veterans (43.7%) whose only hospitalization event during the entire seven years of observation (from -5 year prelude to +2 year vintage) was to transition to ESRD.

vol 1 Figure 8.5. Hospitalization events in 46,625 incident ESRD veterans who transitioned to ESRD during 10/1/2007-9/30/2011

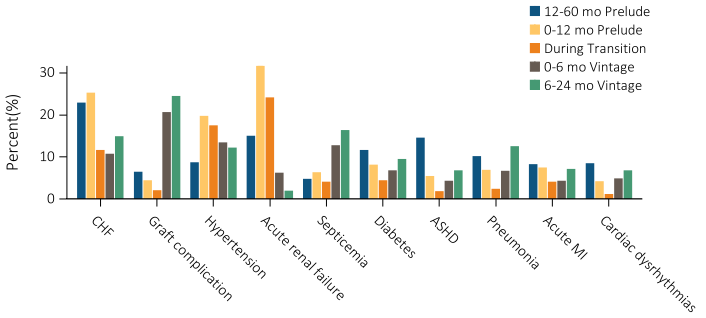


*Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Upper Venn diagram: three major hospitalization categories; Lower Venn diagram: focus of hospital events during transition to ESRD. Abbreviations: ESRD, end-stage renal disease. * Unique patients with an event during transition and before or after transition to ESRD*

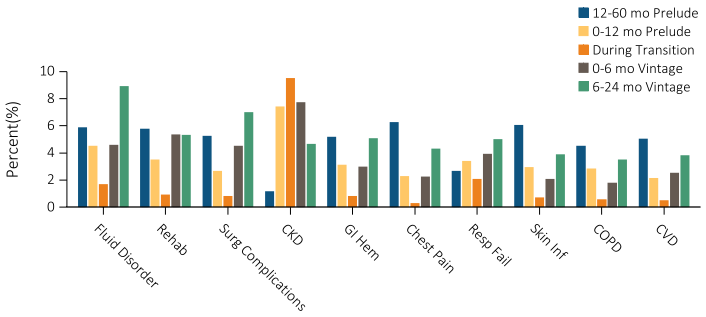
Cause-specific hospitalization events were also analyzed. Figure 8.6 shows the top 20 causes of hospitalization among 46,625 veterans who transitioned to ESRD over the 4-year period (10/2007-9/2011) with at least one hospitalization event from -5 years prelude to +2 years vintage surrounding the transition intercept. These hospitalizations were then divided into five time categories, including two prelude periods (the final 12 months of prelude and the time prior to these 12 months, in that the patient discharge day was still prior to transition to dialysis), two vintage categories (the first six months of dialysis therapy, and thereafter, in that the admission day was after transition to ESRD) and finally the fifth group consisting of the dialysis initiation event or preemptive kidney transplantation, i.e., any hospitalization that started in the prelude and ended in the vintage. The top 20 causes of hospitalization included congestive heart failure (CHF), dialysis access complications (graft complication), hypertension, acute kidney injury (acute renal failure), septicemia, diabetes, atherosclerotic heart disease (ASHD), pneumonia, acute myocardial infarction (acute MI), cardiac arrhythmias, fluid overload (fluid disorder), rehabilitation, surgery (surgical complication), chronic kidney disease (CKD), GI hemorrhage, chest pain, respiratory failure, skin infection (skin Inf), COPD, and cerebrovascular disease (CVD). Of note, septicemia related hospital events increased dramatically after ESRD transition. The most common causes of hospital admission that also consisted of the ESRD transition day included acute renal failure, hypertension, CHF, and CKD.

vol 1 Figure 8.6. The top 20 causes of hospitalizations in 46,625 incident ESRD veterans who were hospitalized at least once during the period between 60 months prior to ESRD transition (prelude) and 24 months following ESRD transition (vintage)

(a) 10 of the top 20 causes of hospitalizations



(b) 10 of the top 20 causes of hospitalizations



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviations: ASHD, astherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, acute cerebrovascular disease; GI Hem, gastrointestinal hemorrhage; MI, myocardial infarction; mo, month; Resp Fail, respiratory failure; Skin Inf, skin infection; surg, surgical.

Hospitalization events during each of the five aforementioned periods are ranked in Table 8.4. Congestive heart failure (CHF) is the most common reason for hospital admission prior to ESRD transition during prelude time, whereas dialysis access complications is the most common cause after ESRD transition. For hospitalizations that included the ESRD transition events (mostly first dialysis therapy), acute renal failure (AKI) was the leading cause.

vol 1 **Table 8.4. Ranking of the top 20 causes of hospitalization in 46,625 incident ESRD veterans who were hospitalized at least once during the period between 60 months prior to ESRD transition (prelude) and 24 months following ESRD transition (vintage)**

Hospitalization Event	Overall (7 year cohort)	-60 to -12 months of prelude	Last 12 months of prelude	During ESRD transition	First 6 months of vintage	+6 to +24 months of vintage
Congestive heart failure	**1**	**1**	**1**	3	4	2
Dialysis access (graft) complication	2	9	10	10	**1**	**1**
Hypertension	3	7	3	2	3	4
Acute renal failure	4	3	2	**1**	8	
Septicemia	5	18	8	7	2	3
Diabetes	6	4	4	5	6	6
Atherosclerotic heart disease	7	2	9	12	15	10
Pneumonia	8	5	7	8	7	5
Acute myocardial infarction	9	6	5	6	13	8
Cardiac dysrhythmias	10	8	12	13	10	11
Fluid disorder/fluid overload	11	13	11	11	12	7
Rehabilitation	12	12	15	14	9	12
Surgical complications	13	14	19	15	11	9
Chronic kidney disease	14		6	4	5	15
Gastrointestinal hemorrhage	15	16	16	16	17	14
Chest pain	16	10				16
Respiratory failure	17		14	9	14	13
Skin infection	18	11	18	18		18
Chronic obstructive pulmonary disease	19	15	17			17
Acute cerebrovascular disease	20	17			19	19
Peripheral and visceral atherosclerosis		19				
Anemia			13			
Urinary tract infection		20	20		18	20
Other circulatory disease					16	
Intestinal infection					20	
Aortic; peripheral, visceral artery aneurysm				19		
Multiple myeloma				20		

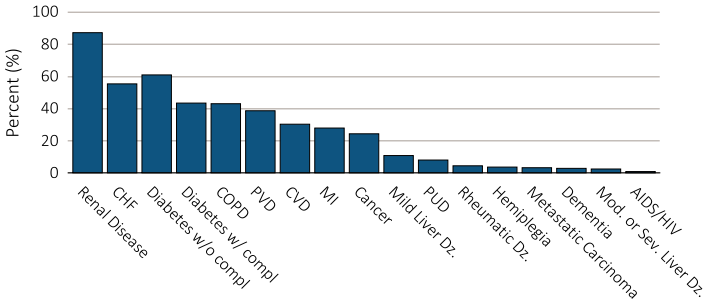
Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviation: ESRD, end-stage renal disease.

Comorbid Conditions upon Transition to ESRD

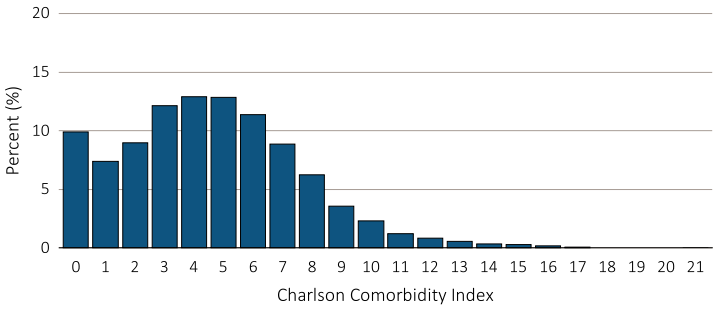
Comorbid conditions are examined in this section. The comorbidity data were obtained from multiple sources as described under the hospitalization section. After merging comorbid conditions from all sources, 47,555 veterans (91.2%) were identified with at least one comorbid condition. Figure 8.7a shows the most common comorbidities among these veterans prior to transition to ESRD; the comorbidity list is restricted to those used for the calculation of Charlson Comorbidity Index, as shown in Figure 8.7b. In addition to renal disease, CHF and diabetes were present in over half of the veterans, while chronic pulmonary disease was recorded in over 40%. Of note, almost a quarter of all patients had the diagnosis of cancer and 28% had prior myocardial infarction.

vol 1 Figure 8.7. Selected comorbid conditions for calculation of the Charlson Comorbidity Index prior to transition to ESRD in 47,555 incident ESRD veterans

(a) Common comorbidities among veterans prior to transition to ESRD



(b) Charlson Comorbidity Index Score



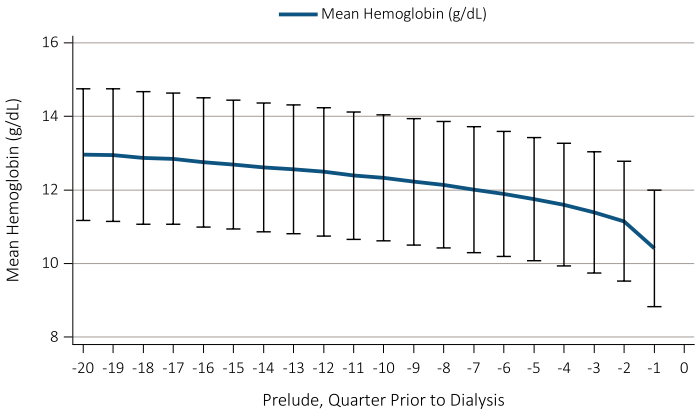
Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: CHF, congestive heart failure; compl, complications; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; Dz, disease; ESRD, end-stage renal disease; MI, myocardial infarction; Mod, moderate; PVD, periphral vascular disease; PUD, peptic ulcer disease; Sev, Severe.

Trends during Prelude Period (Prior to ESRD Transition)

This section includes for the first time selected prelude (pre-ESRD) data and their trends by going back in time for up to -5 years prior to the transition intercept. This period of time reflected by a negative number is referred to as the "prelude" to distinguish it from the "vintage", which is the time (shown with a positive number) after the transition to ESRD. Vintage and prelude start with the start of dialysis therapy (or preemptive transplant) going forward and backward.

Selected prelude trends of the laboratory data are shown below. Figure 8.8 shows the pre-ESRD trend in blood hemoglobin in 28,717 veterans who eventually transitioned to ESRD over 20 calendar quarters or five years. As shown here blood hemoglobin dropped from 13 to below 11 g/dL over the prelude period with progression of CKD to ESRD.

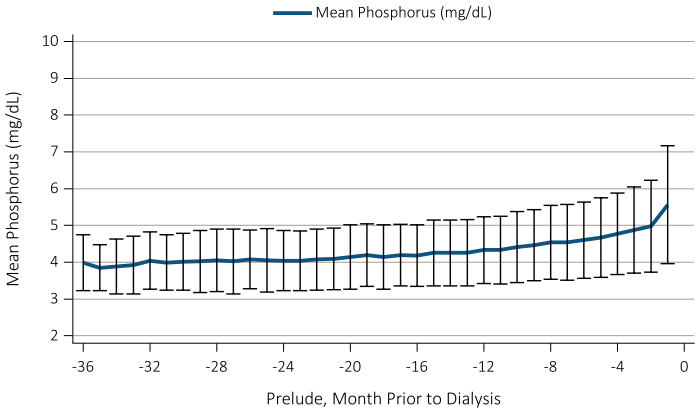
vol 1 Figure 8.8. Trend in blood hemoglobin levels during the prelude (pre-ESRD) period, over 20 calendar quarters in 28,717 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011



Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; g/dL, grams per deciliter.

Figure 8.9 shows the pre-ESRD trend in serum phosphorus in 11,896 veterans who eventually transitioned to ESRD over 36 months or 3 years. Serum phosphorus increased from 4 to above 5.5 mg/dL immediately prior to transition to ESRD.

vol 1 Figure 8.9. Trend in serum phosphorus level during the prelude (pre-ESRD) period, over 36 months in 11,896 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011

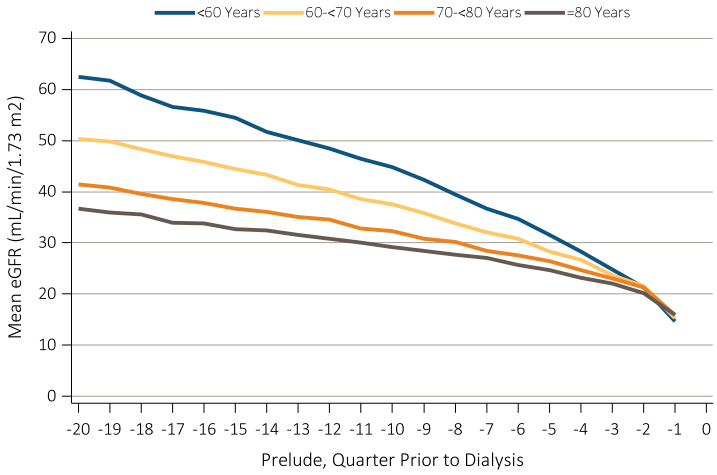


Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

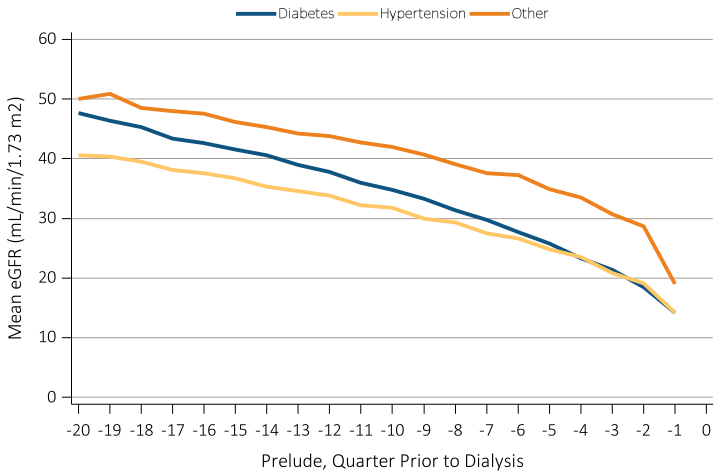
Figure 8.10 shows the pre-ESRD trend in eGFR in 30,245 veterans who transitioned to ESRD over 20 calendar quarters (five years). The upper panel shows that older CKD patients have slower rate of progression than younger patients. The lower panel suggests that those with diabetes as a cause of ESRD have a faster CKD progression.

vol 1 Figure 8.10. Trend in eGFR during the prelude (pre-ESRD) period, over 20 calendar quarters in 30,245 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011

(a) Stratified by age



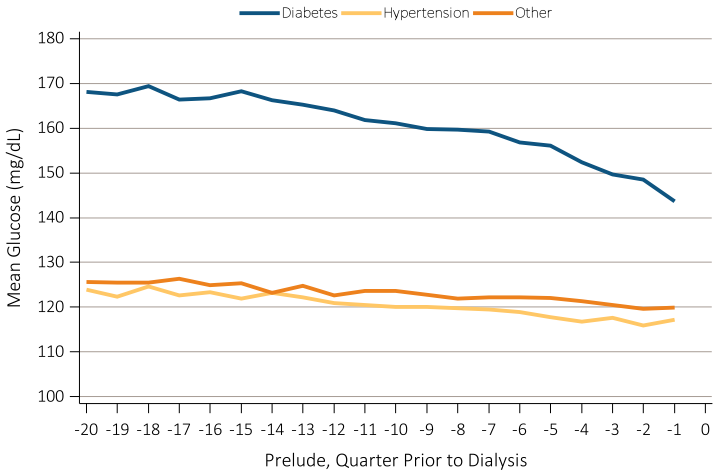
(b) Stratified according to ESRD etiology



Data source: VHA Administrative data, USRDS ESRD Database.
Abbreviations: eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease.

Figure 8.11 shows the pre-ESRD trend in glucose in 29,920 veterans who transitioned to ESRD over 20 calendar quarters or five years. Diabetic patients appear to exhibit a gradual fall in serum glucose over time as their CKD progresses to ESRD. Blood glucose levels do not change among persons whose ESRD is not due to diabetes.

vol 1 Figure 8.11. Trend in blood glucose level during the prelude (pre-ESRD) period, over 20 calendar quarters in 29,920 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011



Data source: VHA Administrative data, USRDS ESRD Database.
Abbreviations: ESRD, end-stage renal disease.

Kaiser Permanente of Southern California

California is the most populous (38 million) and racially/ethnically diverse U.S. state, and Southern California (SC) is the most populous mega-region of California with 23 million people (60% of California's population), and bears four of the nation's 50 most populated cities (Los Angeles, San Diego, Fresno, and Long Beach). It encompasses the Los Angeles Metropolitan region (including Los Angeles and Orange Counties combined, with >17 million people) and is the fifteenth largest economy in the world. In addition to substantial socioeconomic diversity, SC has remarkable racial/ethnic diversity (38% Hispanics, 14% Asians, and 7% Blacks). The Kaiser Permanente of Southern California (KP-SC) Health System is an integrated health care system that provides comprehensive health services for ~4 million residents of Southern California. KP-SC is the KP's largest region.

Transition to ESRD in Kaiser Permanente of Southern California

The Kaiser Permanente transition to ESRD database contains race, ethnicity, sex, and zip code as well as socioeconomic information (education and household income) created from the KP-SC Geocoding database defined using the 2009 U.S. Census data. Mortality data of ESRD were obtained from the KP-SC Mortality database, which combines multiple data sources: including California State Death Master Files,

California State Multiple Cause of Death Master Files (MCOD), Social Security Administration (SSA) Death Master Files, KP-SC Hospital and Emergency Room (ER) records, KP-SC Membership System, Perinatal Data Mart (PDM) and Outside Claims Processing System (OCPS).

Between 01/01/2007 and 12/31/2011 a total of 5,989 KP-SC members transitioned to ESRD. They were 62.6 ± 14.6 years old (mean ± SD). They included 57.7% men and 42.3% women. Racial/ethnic groups included non-Hispanic whites (31.1%), Blacks (21.9%), Asians (9.5%), Hispanics (34.3%), and others (2.3%). The cause of ESRD was diabetes in 51.1% and hypertension in 18.5%. During the first three months, 6.3% of all incident ESRD patients died and 2.5% received kidney transplantation. After three months, 82.6% were on HD and 12.3% on PD (CAPD and CCPD). Around 0.5% received home hemodialysis.

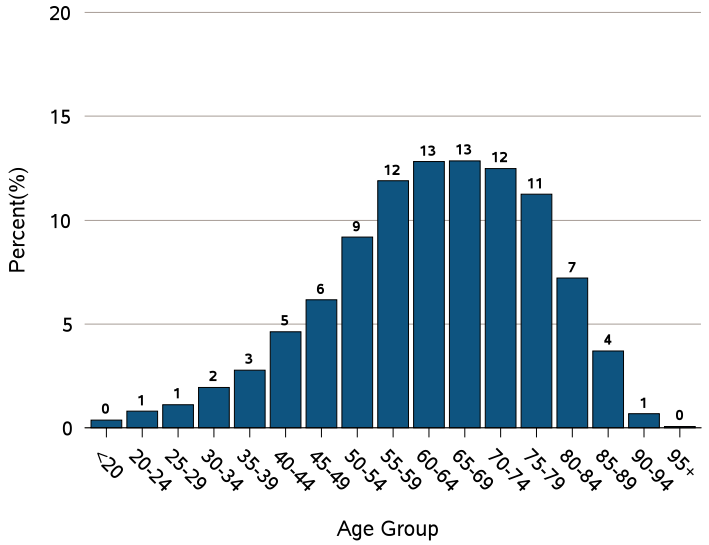
Table 8.5 and Figure 8.12 show the age distribution upon first ESRD service.

vol 1 **Table 8.5. Age distribution of 5,989 KP-SC patients who transitioned to ESRD, 1/1/2007-12/31/2011**

Age group	Frequency	Percent (%)
<20	23	0.38
20-24	48	0.8
25-29	67	1.12
30-34	117	1.95
35-39	167	2.79
40-44	278	4.64
45-49	369	6.16
50-54	550	9.18
55-59	712	11.89
60-64	767	12.81
65-69	770	12.86
70-74	748	12.49
75-79	673	11.24
80-84	432	7.21
85-89	222	3.71
90-94	41	0.68
95+	5	0.08

Data source: Kaiser Permanente Southern California Electronic Health Records. Also see Figure 8.12. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California.

vol 1 **Figure 8.12. Age distribution of 5,989 KP-SC patients who transitioned to ESRD, 1/1/2007-12/31/2011**

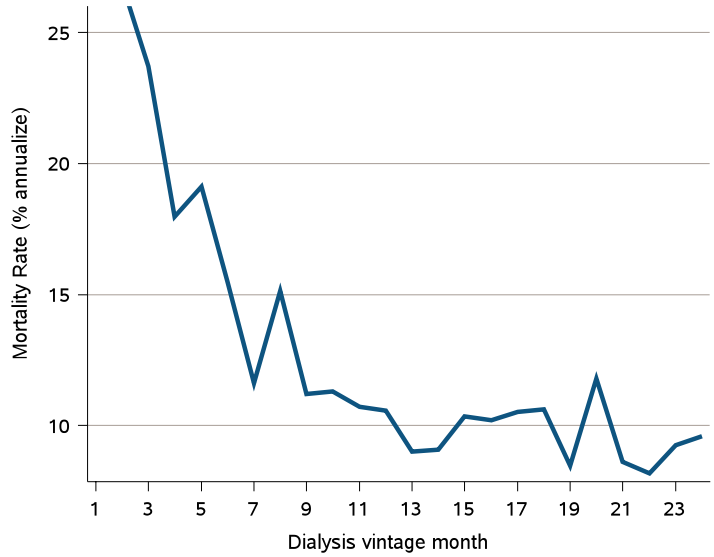


Data source: Kaiser Permanente Southern California Electronic Health Records. Also see Figure 8.6. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California.

Outcomes of KP-SC Patients who Transitioned to ESRD

The annualized mortality rates of the 5,989 incident dialysis patients over the first 24 months of the vintage are depicted under Figure 8.13. The high mortality in the first several months bears resemblance to that seen among incident ESRD veterans and the U.S. ESRD population.

vol 1 **Figure 8.13. Annualized mortality rate of the 5,989 incident dialysis patients over the first 24 months after ESRD transition (vintage)**

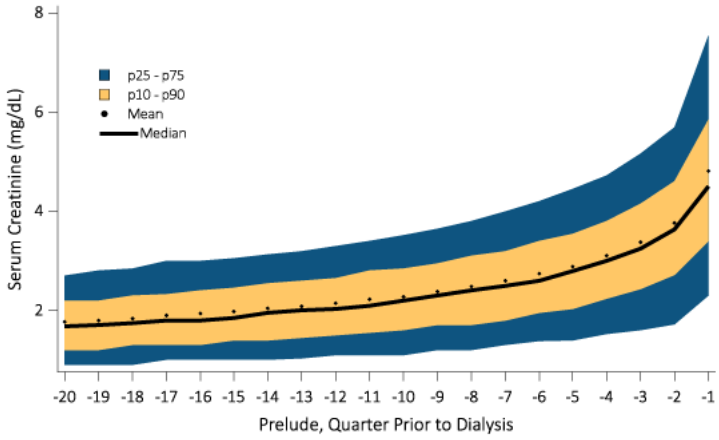


Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviation: ESRD, end-stage renal disease.

Prelude Laboratory Trends of TC-CKD data in KP-SC

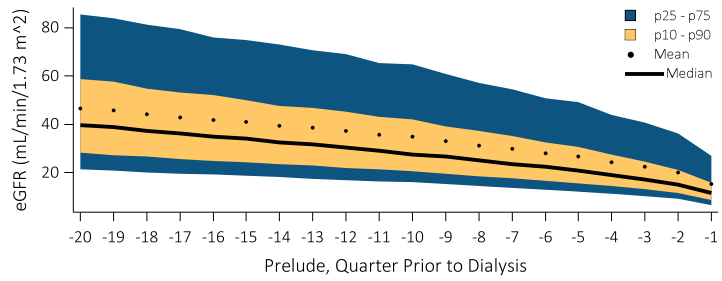
These data were created from the Kaiser Permanente Southern California Laboratory database which tracks KP-SC inpatient and outpatient laboratory orders and its results covers over 20 years of data. Prelude variables (serum creatinine, and eGFR) are averaged by 91 day quarters (n=20), six months (n=6) and years (n=5) prior to the start of dialysis (see Figure 8.14).

vol 1 Figure 8.14. Gradual rise in serum creatinine level during the period prior to ESRD transition (prelude) of 20 calendar quarters, among 5,665 patients who later transitioned to dialysis



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviation: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

vol 1 Figure 8.15. eGFR during the period prior to ESRD transition (prelude) of 20 calendar quarters, among 5,665 patients who later transitioned to dialysis



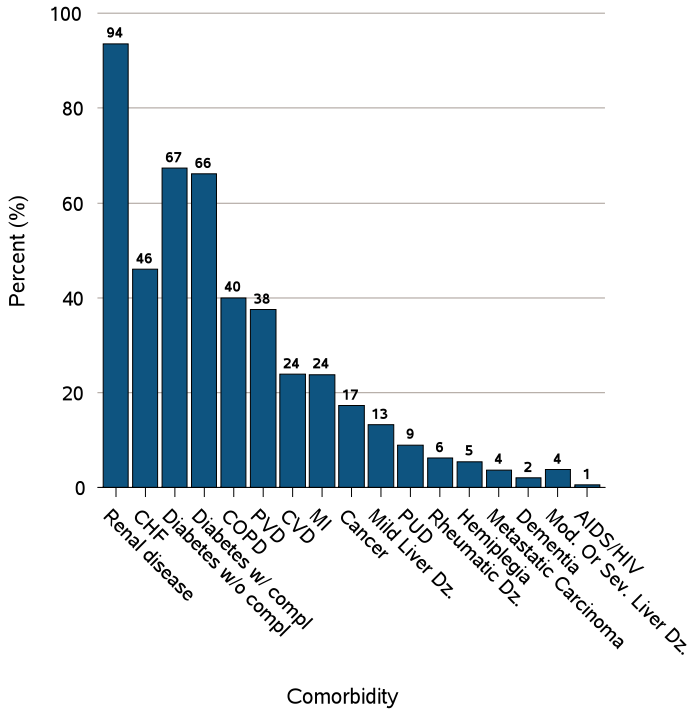
Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviation: eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease; mL/min, milliliters per minute.

TC-CKD Comorbidity Data Prior to ESRD Transition at KP-SC

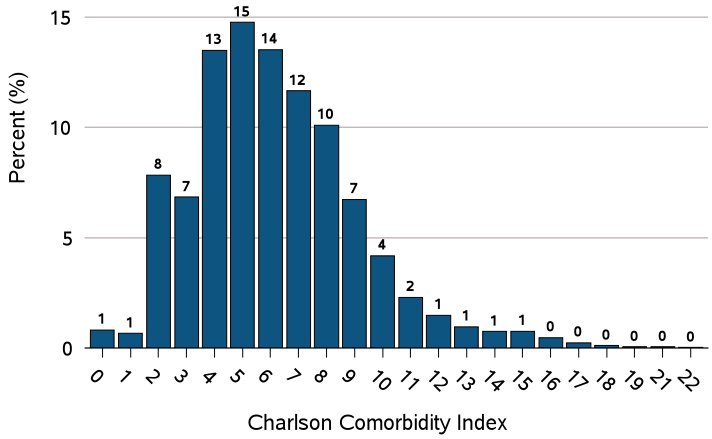
The comorbidity data during the prelude period were created from the Kaiser Permanente Southern California utilization database that provides comprehensive KP-SC patients medical utilization information from 1981 to the present (see Figure 8.16).

vol 1 Figure 8.16. Selected comorbid conditions for calculation of the Charlson Comorbidity Index prior to transition to ESRD in 5,858 KP-SC patients

(a) Common comorbidities among veterans prior to transition to ESRD



(b) Charlson Comorbidity Index Score



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: CHF, congestive heart failure; compl, complications; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; Dz, disease; ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; MI, myocardial infarction; Mod, moderate; PVD, peripheral vascular disease; PUD, peptic ulcer disease; Sev, Severe.

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Volume 1: CKD Analytical Methods

Contents

Introduction

In this chapter we describe the data management and preparation, database definitions, and the data sources used to conduct the analyses contained in Volume 1 of the 2015 USRDS Annual Data Report (ADR), which focuses on chronic kidney disease (CKD) prior to end-stage renal disease (ESRD). Datasets and methods used for ESRD analyses are described in the ESRD Analytic Methods chapter of Volume 2.

Data Sources

The USRDS maintains several databases to describe kidney disease in the United States (U.S.). Data on the non-institutionalized, general population were obtained from the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS). For patients with CKD, acute kidney injury (AKI), and related comorbidities, data on diagnoses, demographic characteristics, health care procedures, prescription drug plan participation, and filled prescriptions were obtained from the standard Centers for Medicare and Medicaid Services (CMS) Medicare 5 percent sample claims files, beneficiary summary files, and Part D plan characteristics, premiums, and events files. Patients in the 5 percent files were matched to the USRDS ESRD databases to obtain the date of first service, which was used as the starting date of ESRD.

National Health and Nutrition Examination Survey

NHANES is a series of health examination surveys conducted by the National Center for Health Statistics (NCHS) of the U.S. Centers for Disease Control and Prevention (CDC). Begun in 1959, NHANES was designed to monitor the health and nutritional status of the non-institutionalized civilian population in the United States. NHANES III was conducted in two phases between 1988 and 1994. In 1999, NHANES became a continuous, annual survey to allow regular estimates, with the release of public-use data files every two years. Both NHANES III and NHANES 1999–2012 were nationally-representative, cross-sectional surveys that used a complex, stratified, multi-stage probability cluster sampling design that included the selection of primary sampling units (counties), household segments within the counties, and sample persons from selected households (Johnson et al., 2013). Survey participants were interviewed in their homes and/or received standardized medical examinations in mobile examination centers. Both sets of surveys over-sampled African Americans, Mexican Americans, and individuals aged 60 or older to improve the estimates for these subgroups.

Behavioral Risk Factor Surveillance System

The BRFSS is a series of telephone-based surveys of health-related risk behaviors, chronic health conditions, and use of preventive services designed to provide state-specific estimates (CDC 2015). Like NHANES, it is also conducted by the CDC through the NCHS. It began in 1984 with 15 states, and expanded nationwide in 1993. As of 2011, cell phone users were included in the sample frame in addition to traditional land-line subscribers. A question regarding kidney health was added in 2012-- specifically, respondents were asked, "Has a doctor, nurse, or other health professional ever told you have kidney disease? Do NOT include kidney stones, bladder infection or incontinence (Incontinence is not being able to control urine flow.)." Allowable responses were "yes", "no", and "not sure", with additional coding for "refused to answer" and "missing/not asked." Of the 475,687 respondents in 2012, only 202 respondents refused to answer (0.04%) three were missing, and 1,322 answered "not sure" (0.28%).

Centers for Medicare and Medicaid Services Medicare 5 Percent Sample

These files contain billing data from final action claims on behalf of Medicare beneficiaries; all adjustments have been resolved and submitted to Medicare for reimbursement by health care providers. CMS and its contractors produced the 5 percent data sets by selecting all final action claims for Medicare beneficiaries whose CMS Health Insurance Claims (HIC) number has the last two digits of 05, 20, 45, 70 or 95. These five two-digit pairs were randomly selected to create a sample containing five percent of the total number of Medicare beneficiaries (Merriman and Asper, 2007). The sample design has the effect of creating a built-in longitudinal panel dataset. Once in the sample, a beneficiary will remain a part of all future-year data files until death or a change to their HIC number. In 2015, the USRDS Coordinating Center received the data files from the Medicare Chronic Conditions Warehouse contractor, which included a cross-walk file to match the non-informational beneficiary identification variable to the identification variable historically used for the ADR. The files, described below, are collectively referred to in the ADR as the Medicare 5 percent files. The 2015 ADR includes

all claims up to December 31, 2013, that were submitted and processed by June of 2014.

Enrollment Data (Denominator File)

In 2015, for the 2013 data year we received two files from the Master Beneficiary Summary File--one for Parts A and B (MBSF_AB_SUMMARY; formerly called the Denominator file) and another for Part D (MBSF_D_CMPNTS). The files provided demographic information on each beneficiary in the sample, as well as dates of enrollment in the various Medicare programs (Hospital Insurance [Part A], Supplemental Medical Insurance [Part B], Medicare Advantage managed care plans [Part C] and Prescription Drug Benefit [Part D]).

Medicare Parts A and B Claims Files

Claims files for Medicare Parts A and B were divided into two groups based on the type of healthcare provider--institutional and physician/supplier. Institutional claims were divided into five sets of files based on the type of medical service: INPATIENT, OUTPATIENT, and HHA: home health agency, HOSPICE, and SNF: skilled nursing facility care. For each type of medical service, we received six files corresponding to different parts of the claim (<type of service>_BASE_CLAIMS_J: the base claim file, <type of service>_REVENUE_CENTER_J: revenue center file, <type of service>_CONDITION_CODES: condition code file, <type of service>_OCCURRNCE_CODE: occurrence code file, <type of service>_SPAN_CODES: span code file, and <type of service>_VALUE_CODES: value code file).

Physician and supplier claims (also referred to as carrier claims) were received in one set for durable medical equipment (DME) and another for all other Part B covered services (BCARRIER). For each of these, we received two files corresponding to different parts of the claim (<type of service>_CLAIMS_J: the base claim file and <type of service>_LINE_J: the line file).

Medicare Part D Files

For Part D, we received files on beneficiary information and claims, as well as information about plan characteristics and premiums. The MBSF_D_CMPNTS file, mentioned above, contains monthly enrollment information for Part D program participation, type of plan, creditable coverage, eligibility for cost sharing and low income subsidies, and additional information. The Part D Events (PDE) file contains all final action claims for prescription drugs submitted by pharmacies on behalf of the Part D beneficiary. This data set contains details about the drug (name, days supplied, dose, strength, quantity, etc.) and payment amounts.

In addition to these beneficiary and beneficiary-prescription fill level datasets, we also received files with data about the Part D plan, prescribers, and pharmacies. For the ADR, we used the Plan Characteristics file (PLAN_CHAR) and premium (PREMIUM) files to report on the coverage gap and distribution of premiums.

ESRD Medical Evidence Form

The analyses in this volume of the ADR often exclude patients with ESRD or censor time-dependent outcomes at the point when a patient reaches ESRD. To obtain this information on ESRD, we searched the USRDS ESRD databases for the beneficiaries in the Medicare 5 percent files. The date of ESRD was determined from the ESRD Medical Evidence form (CMS 2728), the official form for registering ESRD patients, which must be submitted by dialysis or transplant providers within 45 days of ESRD initiation. First service date for ESRD is reported on this form and was used as the date when ESRD began for analyses in this Volume. See Volume 2 for additional information on how the Medical Evidence form was used in analyses of ESRD patients.

ESRD Death Notification Form

The Master Beneficiary Summary File delivered with the Medicare 5 percent sample files contains the date of death as reported to Medicare. For this volume, we supplemented this date of death for patients in the Medicare 5 percent file who experienced ESRD prior to death with information from the ESRD Death Notification form (CMS 2746; the official form for reporting the death of a patient with ESRD). According to CMS policy, this form must be submitted by dialysis or transplant providers within 30 days of a patient's death.

General Methods for the Medicare 5 Percent Files

For the purpose of analysis, to create a sample cohort several restrictions were applied to the raw Medicare 5 percent files. The specific restrictions used for each figure and table are detailed in the chapter-specific sections. The general rationale and explanation of these restrictions apply to all analyses with the Medicare 5 percent files, and are detailed here. It is important to remember that the primary purpose of the data collection underlying this dataset was to reimburse health care providers for services performed for beneficiaries; information that is not necessary to facilitate payment for services, such as results of lab tests, family medical history, or health behaviors such as smoking, generally is not available in the dataset.

Plan Participation

Medicare currently provides medical benefits through four programs known by the part of Title XVIII of the Social Security Act that created them—Part A provides hospital insurance, Part B provides supplemental medical insurance (including physician services, durable medical equipment, ambulance, radiology, and laboratory services), Part C is for enrollment in managed care plans (which provide all part A and part B services), and Part D provides prescription drug coverage (CMS, 2014). Part A coverage is free to beneficiaries, while the other parts can have premiums paid by the beneficiary and are optional. Beneficiaries are also allowed to switch between original Medicare (fee-for-service) to Medicare Advantage plans (Part C) during open enrollment. Medicare Advantage plan providers are not paid through the claims submission process, therefore, there are no data in the Medicare 5 percent claims files for these patients. Over the course of a year, people become newly eligible for Medicare (e.g., reach age 65) and enroll in the program, people die and therefore are not eligible during part of the year, and people drop their coverage. To create appropriate denominators for the statistics that are presented, samples were often limited to beneficiaries that were enrolled in both Parts A and B and were not enrolled in a Medicare Advantage plan (Part C). In some analyses, the cohort was limited to patients who met these restrictions on a certain date, such as January 1 of the reported year. In other cases the sample may have been limited to beneficiaries meeting those enrollment restrictions during the entire calendar year.

In most analyses that were limited to patients with a certain disease or disorder, such as CKD, the beneficiaries must have been enrolled in Parts A and B and not Part C for the year prior to the reported year (the entry period or 'year one'). This ensures that each patient has 12 months of Medicare claims from which to determine the presence of the disorder. The outcome under analysis was then determined from claims in the year following the entry period ('year two'). Prevalence analyses, however, were not subject to this requirement and often used claims during the reported year (the typical year two) to determine the presence of the disorder.

Reason for Entitlement

In this volume, the majority of analyses were restricted to beneficiaries that were age-eligible for Medicare and, therefore, aged 65 and older. Beneficiaries under the age of 65 may have qualified for Medicare on the basis of disability (meeting requirements for one of the Social Security Administration's income support programs for disabled individuals) or diagnosis of ESRD (patients that are excluded from the CKD volume) and are not representative of the U.S. population of the same age. In contrast, 98% of the U.S. population aged 65 and older is eligible for Medicare (McBean, 2012). However, unlike the chapter-specific figures and tables, the reference tables for this Volume included all adult (aged 20 or older), non-ESRD Medicare beneficiaries regardless of reason for entitlement.

ESRD

As the focus of this volume is on patients that do not have ESRD, patients under age 65 who were only eligible for Medicare due to ESRD were excluded. Most analyses restrict the sample to beneficiaries that did not have ESRD, either as of a certain date or for the entire calendar year. Additionally, analyses of time-to-event outcomes (e.g., mortality, hospitalization, rehospitalization, time to the performance of a laboratory test) often censored a patient at the start of ESRD, as well as at death, disenrollment from Parts A and B of Medicare, or upon switch to a Medicare Advantage plan. The start of ESRD was the date of first service from the CMS 2728 form.

Identification of Major Comorbidities

According to a previously validated method for using Medicare claims to identify diabetic patients (Herbert et al., 1999), a patient is considered diabetic if, within a one-year observation period, he or she had a qualifying ICD-9-CM diagnosis code of diabetes mellitus (DM) on one or more Part A institutional claims (inpatient, skilled nursing facility, or home health agency), or two or more institutional outpatient claims and/or Part B physician/supplier claims. This algorithm—one inpatient claim, or two outpatient claims with specified diagnosis codes—was used to determine the presence of CKD and 13 other conditions commonly associated with CKD as risk factors, co-occurring conditions, or consequences of the disease. Tables m.1 and m.2 list these conditions and the ICD-9-CM diagnostic codes used to define them. Additionally, the overall grouping of cardiovascular disease (CVD) included patients with at least one of these individual conditions: atherosclerotic heart disease, congestive heart failure, cerebrovascular accident/transient ischemic attack, peripheral vascular disease, dysrhythmias, or other cardiac conditions. Analyses within individual chapters also defined additional conditions using the same algorithmic structure, as described in the chapter-specific sections below.

vol 1 **Table m.1 ICD-9-CM diagnosis codes used to define chronic kidney disease in the Medicare 5 percent sample throughout Volume 1 of the ADR**

Condition name	ICD-9-CM codes
Chronic kidney disease	016.0; 095.4; 189.0,189.9; 223.0; 236.91; 250.4; 271.4; 274.1; 283.11; 403; 404; 440.1; 442.1; 477.3; 572.4; 581-588; 591; 642.1; 646.2; 753.12-753.19; 753.2; 794.4
Staging of chronic kidney disease	
Stage 1	585.1
Stage 2	585.2
Stage 3	585.3
Stage 4	585.4
Stage 5	585.5 or 585.6 with no CMS 2728 form
Stage unknown or unspecified	Patient has no claims with codes 585.1-585.6 but has: 016.0; 095.4; 189.0,189.9; 223.0; 236.91; 250.4; 271.4; 274.1; 283.11; 403; 404; 440.1; 442.1; 477.3; 572.4; 581-584; 585.9; 586-588; 591; 642.1; 646.2; 753.12-753.19; 753.2; 794.4

Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification. Diagnosis codes can have up to five digits with a decimal point between the 3rd and 4th digit. Codes listed with three digits include all existing 4th and 5th digits, and those listed with four digits include all existing 5th digits.

vol 1 **Table m.2 ICD-9-CM diagnosis codes used to define medical conditions in the Medicare 5 percent sample throughout Volume 1 of the ADR**

Condition name	ICD-9-CM codes
Anemia	280-285
Atherosclerotic heart disease (ASHD)	410-414; V45.81; V45.82
Cancer	140-172; 174-208; 230-231; 233-234
Cardiac, other	420-424; 429; 785.0-785.3; V42.2; V43.3
Cerebrovascular accident (CVA) / transient ischemic attack (TIA)	430-438
Chronic obstructive pulmonary disorder (COPD)	491-494; 496; 510
Congestive heart failure (CHF)	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 422; 425; 428; V42.1
Diabetes mellitus (DM)	250; 357.2; 362.0; 366.41
Dysrhythmia	426-427; V45.0; V53.3
Gastrointestinal bleeding disorders (GI)	456.0-456.2; 530.7; 531-534; 569.84-569.85; 578
Hypertension (HTN)	362.11; 401-405; 437.2
Liver disease	570-571; 572.1, 572.4; 573.1-573.3; V42.7
Peripheral vascular disease (PVD)	440-444; 447; 451-453; 557

Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification. Diagnosis codes can have up to five digits with a decimal point between the 3rd and 4th digit. Codes listed with three digits include all existing 4th and 5th digits, and those listed with four digits include all existing 5th digits.

Chapter 1: CKD in the General Population

Analyses in this chapter used data collected through the NHANES, a nationally representative survey that combines interviews and medical examinations to assess the health of the U.S. non-institutionalized civilian population (Johnson et al., 2013). NHANES III was fielded in 1988-1994; starting in 1999 and continuing to the present, the NHANES collects data continuously and releases public-use data files in two-year cycles. Data for this chapter represents participants 20 years and older in NHANES III (1988–1994) and in the NHANES continuous cycle years 2005–2006, 2007–2008, 2009–2010, and 2011-2012. The statistical software package SAS®, version 9.3, was

used to analyze all NHANES data, incorporating the sampling weights and survey design through its survey procedures.

In this chapter, age was defined as the participant's age at the time of the household interview, categorized into the following age groups: 20-39, 40-59, or 60 and older. Race and ethnicity ass self-reported and categorized as non-Hispanic White, non-Hispanic African American, or other.

The identification of CKD was based on the 2012 guidelines from the Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group (KDIGO, 2013) implemented with the data available in NHANES. KDIGO defines CKD as "abnormalities of kidney structure or function, present for >3 months, with implications for health." Decreased glomerular filtration rate (GFR) is defined as GFR less than 60 ml/min/1.73 m2, which we calculated using the Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI) estimated glomerular filtration rate (eGFR) equation (Levey et al., 2009). Markers of kidney damage include albuminuria, a history of kidney transplantation, and abnormalities as detected by histology or in urine sediment, electrolytes (due to tubular disorders), or structure (detected by imaging). With NHANES data we used the urine albumin creatinine ratio (ACR) to measure albuminuria, but did not have information regarding the other markers of kidney damage. Also, the NHANES only included a single measurement of both serum creatinine (sCR, used to generate eGFR) and ACR, so we could not address the three-month persistence criteria for defining CKD.

The eGFR (measured in ml/min/1.73 m2) was calculated using the CKD-EPI equation, based on the NCHS-recommended standardized creatinine values (Selvin et al., 2007). The CKD-EPI equation is:

$$eGFR = 141 * \min\left(\frac{sCR}{\kappa},1\right)^{\alpha} * \max\left(\frac{sCR}{\kappa},1\right)^{-1.209} * 0.993^{AGE} * 1.018 * F * 1.159 * B$$

where:

sCR = serum creatinine in mg/dL

κ = 0.7 if female, 0.9 if male

α = -0.329 if female, -0.411 if male

F = 1 if female, 0 if male

B = 1 if Black/African American, 0 otherwise

AGE is measured in years

The ACR is the ratio of urinary albumin (mg/L) to urinary creatinine (mg/dL). Based on an NCHS suggestion, the urine creatinine value was adjusted to NHANES 2007-2008 (CDC, 2009).

Staging of CKD was first introduced by the National Kidney Foundation's Kidney Disease Outcomes and Quality Improvement Guidelines in 2002 (NKF, 2002). Following these guidelines, we defined stages of CKD in this chapter as:

- Stage 1: ACR ≥30 and eGFR ≥90
- Stage 2: ACR ≥30 and 60 ≤ eGFR <90
- Stage 3: 30≤ eGFR <60
- Stage 4: 15≤ eGFR <60
- Stage 5: eGFR <15

Participants with diabetes mellitus (DM) included those with any of the following: (1) an affirmative answer to the question "Have you ever been told by a doctor or other health professional that you have diabetes or sugar diabetes (other than during pregnancy)?", (2) an affirmative response to either "are you now taking insulin?" or "are you now taking diabetic pills to lower your blood sugar?", or (3) hemoglobin A1c (HbA1c; glycohemoglobin) ≥7%. Participants with self-reported diabetes mellitus (SR DM) were those who reported having been told by a doctor that they have diabetes or sugar diabetes (other than during pregnancy). In NHANES 2005–2012, participants answering "borderline" were classified as non-diabetic, to agree with NHANES III coding. Control of DM is assessed as an HbA1c less than 7%.

Patients with hypertension (HTN) were those with either (1) high blood pressure, defined as systolic blood pressure above 140 mmHg (>130 mmHg for those with CKD or SR DM) or diastolic blood pressure above 90 mmHg (>80 mmHg for those with CKD or

SR DM) or (2) an affirmative answer to the question "Are you now taking prescribed medicine for high blood pressure?" Self-reported hypertension (SR HTN) was identified through an affirmative answer to the question "Have you ever been told by a doctor or other health professional that you had hypertension, also called high blood pressure?" Patients were classified as aware of their HTN if they reported having been told they have high blood pressure, as treated for their HTN if they reported currently taking a prescription medication to control HTN, and as in control of their HTN if their blood pressure at time of medical examination was ≤140/≤90 (≤130/≤80 for CKD or SR DM).

Participants who self-reported any of the following diseases were considered to have self-reported cardiovascular disease (SR CVD): angina, myocardial infarction, stroke, coronary heart disease, or congestive heart failure. Hyperlipidemia was measured in the medical examination. We assessed whether total cholesterol fell into one of three categories: <200 (desirable), 200–239 (borderline high), and ≥240 (high). Individuals were classified as current smokers if they gave an affirmative answer to the question "Do you now smoke cigarettes?" and former smokers if they responded negatively to the previous question, but affirmatively to the question "Have you smoked at least 100 cigarettes in your life?"

Adjusted odds ratios in Figures 1.9-1.11 were calculated using logistic regression, incorporating the sampling weight and survey design. Each figure displays the results of seven logistic models. The model for age included age (20-39/40-59/60+), sex (male/female) and race (White/Black/other). Models for the six other factors shown in the figure (DM, SR DM, HTN, SR HTN, SR CVD, and body mass index [BMI] greater than 30) included age (20-39/40-59/60+), sex (male/female), race (White/Black/other) and presence of the risk factor shown (yes vs. no). Ninety-five percent confidence intervals are displayed.

Figure 1.17 tabulates responses to the 2012 Behavioral Risk Factor Surveillance System question, "Has a doctor, nurse, or other health professional ever told you have kidney disease?" by U.S. state.

Chapter 2: Identification and Care of Patients With CKD

All of the analyses in the Prevalence of Recognized CKD and Prevalence & Odds of a CKD Diagnosis Code sections of this chapter included point prevalent patients who survived all of the reported year (2013 for most of the figures and tables), were continuously enrolled in Medicare Parts A and B in the reported year, were not enrolled in a Medicare Advantage plan (Part C), did not have or develop ESRD during reported year, and were aged 65 or older as of January 1 of the reported year. The sections Laboratory Testing of Patients With and Without CKD and Visits with a Physician after CKD Diagnosis include patients meeting the restrictions described above, for a one-year entry period (year one) before the reported year (year two) and on January 1 of year two. Patients were then censored in the analysis if they died, developed ESRD, switched to a Medicare Advantage plan (Part C), or disenrolled from Parts A and B during year two.

Table 2.1 presents the prevalence of coded CKD, diabetes (DM), and cardiovascular comorbid conditions in the fee-for-service, age-eligible Medicare population. Cardiovascular disease (CVD) was defined as the presence of any of the following comorbidities: cerebrovascular accident, peripheral vascular disease, atherosclerotic heart disease, congestive heart failure, dysrhythmia or other cardiac comorbidities. Table 2.2 shows the distribution of characteristics among the prevalent fee-for-service, age-eligible Medicare population, both overall and among those with CKD, by age, sex, race, and comorbidity in 2013. Comorbidities included were DM, hypertension (HTN), and CVD. Each comorbidity was defined by medical claims (at least one inpatient or two outpatient claims) during the reported year. Refer to the Identification of Major Comorbidities section of this chapter for the complete methodology used to identify these comorbidities, and Tables m.1 and m.2 for a list of ICD-9-CM codes used.

Table 2.3 shows the unadjusted prevalence and adjusted odds ratios for the presence of diagnosed CKD by age (65-74/75-85/85+), sex (male/female), race (White/Black/Native American/Asian/other), and comorbidity in 2013. Comorbidities included were DM, HTN and CVD. Logistic regression was used to estimate the odds ratios of the probability of having a CKD diagnosis. Figure 2.1 and Figure 2.2 illustrate the prevalence of CKD over time in the fee-for-service,

age-eligible Medicare population—overall, by CKD stages, and by race. Table 2.4 shows the percent of patients with CKD by demographic characteristics, among patients overall, and those with DM, HTN, or CVD, in both the NHANES (2011-2012, see the section Chapter 1: CKD in the General Population in this chapter for methods) and the Medicare 5 percent (2013) datasets. NHANES data included the 2011-2012 survey years and were restricted to participants aged 65 or older. NHANES CVD was self-reported and defined as having at least one of the following comorbidities: CVA, peripheral vascular disease (PVD), atherosclerotic heart disease (ASHD), CHF, dysrhythmia, or other cardiac comorbidities. Medicare CVD was defined as mentioned above. Values for cells with 10 or fewer patients were suppressed and marked with an asterisk.

Table 2.5 shows progression of kidney disease by CKD stage, end-stage renal disease (ESRD), or death in 2012-2013 for the in the fee-for-service, age-eligible Medicare population in 2008. The analysis cohort required patients to be alive & eligible for all of 2008. Death and ESRD status were examined yearly between 2009 and 2013, and carried forward if present. If ESRD occurred before death, the death information was used. Among patients without death or ESRD by 2013 the last CKD diagnosis claim was used; if this was not available, the last CKD diagnosis claim from 2012 was used. Lost to follow-up status represents the patients that did not have 2013 data available.

Figures 2.3–2.6 show statistics on laboratory testing for serum creatinine and urine albumin among various patient populations and by patient characteristics. For these analyses, a one-year period was used to define comorbid conditions (year one) and laboratory testing was assessed in the following year (year two, the year reported in the figures). Patients must have had Medicare Parts A and B coverage, no Part C participation (Medicare Advantage plans), no ESRD, and have been alive for all of year one, through to January 1 of year two. Additionally, the sample was limited to patients residing in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories. First urinary microalbumin measurement was defined as the first claim with a Healthcare Common Procedure Coding System (HCPCS, similar to the Current Procedural Terminology, CPT®, system) code of 82042, 82043, 82044, or 84156. Likewise, first serum creatinine measurement was defined as the first claim with a HCPCS code of 80047, 80048, 80049, 80050, 80053, 80054, 80069, or 82565.

Figures 2.3 and 2.4 show the proportion of patients tested across time, from 2000-2013 for patients with (Figure 2.4) and without (Figure 2.3) CKD. Figures 2.5 and 2.6 show the adjusted prevalence of testing in 2013 for those with (Figure 2.6) and without (Figure 2.5) CKD, by comorbidity status : (1) the patient has neither DM nor HTN; (2) the patient has HTN but not DM; (3) the patient has DM but not HTN; and (4) the patient has both DM and HTN. Adjustments were made for age (65-<75/75-<85/85+), sex (male/female), and race (White/Black/Native American/Asian / Hispanic/other/unknown).

Table 2.6 examined physician visits in the year after a diagnosis of CKD. Similar to the laboratory testing, the sample included patients who were alive, without ESRD, did not have a Medicare Advantage plan, and had both Parts A and B coverage for all of 2012. The date of the earliest CKD claim (any CKD or Stage 3/4/5 [585.3–585.6]) in 2012 was used as the date of CKD diagnosis, and claims were then searched for services provided by primary care physicians, nephrologists, and cardiologists for the 365 days following that date. Primary care visits were defined based on a physician specialty code of 01, 08 and 11. Cardiologist visits were defined based on specialty code 06, and nephrology visits were defined based on specialty code 36.

Table 2.7 presented the proportion of patients in the fee-for-service, age-eligible Medicare population in 2013 with CKD (based on diagnostic code) who were tested for urine albumin or serum creatinine in 2013, according to whether they saw a primary care physician or nephrologist in 2012. The analysis cohort required patients to be alive and eligible for all of 2013 with a CKD diagnosis claim in 2012.

Chapter 3: Morbidity and Mortality

The analyses in this chapter used a one-year entry period to determine disease conditions prior to hospitalization, referred to as 'year one'. Patients were required to be alive, aged 65 or older (on January 1), without ESRD, not in a Medicare Advantage plan (Part C) and covered by Parts A and B for all of year one. Claims from year one were then searched for diagnoses as described in the Identification of Major Comorbidities section of this chapter. Additionally, patients must have met these criteria and be aged 66 or older on January 1 of the following year (year two). Mortality and hospitalization were then determined from January 2 to December 31 of year two. Analyses

were also limited to patients residing in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories. The calculation of years at risk began on January 1 of year two, and was censored at the earliest of the date of death, start of ESRD, disenrollment from Medicare Parts A or B, switch to a Medicare Advantage plan (Part C), or December 31 of year two.

Mortality

The date of death was provided by CMS in the Master Beneficiary Summary File. If the patient experienced ESRD prior to death, the date of death from the USRDS ESRD database was also used in the analysis (this date integrated data from the ESRD Death Notification form CMS 2746 and Social Security Death Master file). Figure 3.1 shows time trends in unadjusted and adjusted all-cause mortality by CKD status from 2001 to 2013, and Figure 3.2 shows rates for 2013 by CKD status and stage. Unadjusted mortality was calculated as the number of deaths divided by the number of patient-years at risk, and expressed as "per 1,000 patient years." Adjusted mortality was based on a Cox regression model and adjusted for age (66-<70/70-<75/75-<85/85+ years), race (White, Black or African American/other), and sex. This was a modified set of adjustment covariates than used in previous ADRs; therefore, differences between this year's adjusted rates and previous years' adjusted rates may be notable (prior year hospitalization and comorbidities were not included in the adjustments). All patients in 2012 were used as the reference cohort for Figure 3.1, while all patients in 2013 formed the reference cohort for Table 3.1 and Figures 3.2, 3.3, 3.4, 3.5 and 3.6.

Hospitalization

For the hospitalization analysis, additional processing was performed on the inpatient claims data. A patient's inpatient claims were ordered by date, and compared to identify overlapping claims (two claims covering the same time frame), consecutive claims (one claim's admission date on the day following the previous claim's discharge date), transfers (patient discharge status of 02 on the claim), and interim claims (claim sequence number, the third digit of the 'type of bill' code, of 2, 3, or 4). In these cases, the claims were consolidated into one claim with dates, diagnoses, and procedures combined. Analyses excluded claims from non-acute care facilities such as rehabilitation hospitals (the last four digits of the provider number between 2500 and 3999, or the third digit of R or T).

Unadjusted admission rates were calculated as the number of hospitalizations divided by the number of patient years at risk, and expressed as "per 1,000 patient years." Adjusted admission rates in this chapter included the following variables as adjustments: age (66-<70/70-<74/75-<85/85+), race (White/Black/other), and sex (male/female). As with mortality, a different set of adjustment covariates were applied, thus adjusted rates for this year may differ substantially from prior ADRs. A model-based adjustment method was used, with a generalized linear model using a Poisson distribution and log link function. The sample included data from the current and previous two years, with respective weights of 1.0, 0.25 and 0.125. Adjusted rates reflected the distribution of a reference cohort, specified below in the discussion of the respective figures. With this method, the parameter estimates from the model were used to calculate an estimated admission rate for each patient in the reference cohort. Overall adjusted rates were then computed as the weighted average of these individual rates, using the time at risk of each patient in the reference cohort as the weight.

Table 3.2 and Figures 3.7, 3.8, and 3.12-3.15 show adjusted all-cause admission rates for fee-for-service Medicare patients aged 66 and older. Table 3.2 also shows the unadjusted rates. As mentioned above, diabetes and cardiovascular disease were ascertained in 2012 for the analysis of hospital admissions in 2013, as described in the Identification of Major Comorbidities section of this chapter. All patients must have been66 years or older, not have had ESRD on 1/1/2013, had Medicare Parts A and B coverage for all of 2012 and on 1/1/2013, and were not participating in a Medicare Advantage plan from 1/1/2012 through 1/1/2013. Rates presented by one factor were adjusted for the others. The reference cohort included Medicare patients in 2013, aged 66 and older.

vol 1 **Table m.3 ICD-9-CM diagnosis codes used to define cause of hospitalization**

Hospitalization cause	Primary claim diagnosis for hospital stay, ICD-9-CM codes
Cardiovascular hospitalizations	276.6; 394-398; 401-405; 410-438; 440-459
Infectious hospitalizations	001-139; 254.1; 320-326; 331.81; 372.0-372.3; 373.0-373.3; 382.0-382.4; 383; 386.33, 386.35; 388.6; 390-391; 392.0, 392.9; 393; 421.0, 421.1; 422.0, 422.91-422.93; 460-466; 472-473; 474.0; 475; 476.0, 476.1;478.21, 478.22, 478.24, 478.29; 480-490; 491.1; 494; 510; 511; 513.0; 518.6; 519.01; 522.5, 522.7; 527.3; 528.3; 540-542; 566-567; 569.5; 572.0-572.1; 573.1-573.3; 575.0-575.12; 590; 595.1-595.4; 597; 598.0; 599.0; 601; 604; 607.1-607.2; 608.0, 608.4; 611.0; 614-616.1, 616.3, 616.4, 616.8; 670; 680-686; 706.0; 711; 730.0-730.3, 730.8-730.9; 790.7, 790.8; 996.6; 998.5; 999.3
Other causes of hospitalization	All codes except those included in Cardiovascular or Infectious above.

Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification. Diagnosis codes can have up to five digits with a decimal point between the 3rd and 4th digit. Codes listed with three digits include all existing 4th and 5th digits, and those listed with four digits include all existing 5th digits.

Figures 3.9 - 3.11 show adjusted, cause-specific admission rates by CKD status and stage. Cause-specific rates reflect hospital admissions for the purpose of the specified condition, cardiovascular or infectious, and were identified using the principal ICD-9-CM diagnosis code on the claim. Code values are shown in Table m.3. The 'other cause' of hospitalization is a residual category consisting of all hospitalizations other than cardiovascular or infectious.

Rehospitalization

Analyses of rehospitalization focused on the 30 days following discharge from a hospitalization in year two, the year reported in the figure. As in all the analyses in this chapter, comorbidities, including CKD, were defined during year one, the year prior to that reported in the figure. Each of a person's hospitalizations between January 1 and December 1 of year two was identified; the latter date (12/1) was a cutoff to allow a 30-day follow-up period after discharge to evaluate rehospitalization. The unit of analysis was a hospital discharge rather than a patient. Hospital stays were excluded if the patient died before discharge, developed ESRD within 30 days of discharge, switched to a Medicare Advantage (Part C) plan or disenrolled from Parts A and B coverage within 30 days of discharge (unless the Parts A and B coverage loss was due to death). Due to the December 1 cutoff, all patients were at risk of death or rehospitalization for the entire 30 day period, so results are presented as percentages. Since death and rehospitalization are competing risks, the outcome is presented as: (1) the percent of hospital discharges that had the patient both return to the hospital and die within 30 days, (2) the percent with the patient rehospitalized within 30 days but alive on day 30, and (3) the percent where the patient died within 30 days without a rehospitalization. Table 3.3 shows the unadjusted percentage rehospitalized (both alive and dead on day 30) for age, sex, and race groups, plus the composite death and rehospitalization outcome described above by CKD status and stage. Figure 3.16 shows the adjusted percentages for the three-part rehospitalization and death outcome across time from 2001 to 2013. Live hospital discharges from January 1 to December 1 of each year are included. Rates were adjusted for age, sex, and race using direct adjustment, with a reference group of discharges in 2013. Figure 3.17 shows results for 2013 for patients with and without CKD before the all-cause index hospitalization, while Figures 3.18-3.20 show this for cardiovascular, infection, and other cause-specific index hospitalizations. Figure 3.21 illustrates this by age group, Figure 3.22 by sex, Figure3.23 by race group. and Figure 3.15 for cardiovascular-related hospitalization instead of all-cause. Figure 3.14 displays annual trends in rates of rehospitalization and/or death within 30 days after hospital discharge among CKD patients.

Chapter 4: Cardiovascular Disease in Patients With CKD

This chapter describes the prevalence of cardiovascular comorbidities and selected cardiovascular procedures in fee-for-service, age-eligible Medicare enrollees. Cardiovascular comorbidities included atherosclerotic heart disease (ASHD), acute myocardial infarction (AMI), congestive heart failure (CHF), valvular heart disease (VHD), cerebrovascular accident/transient ischemic attack (CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AFIB), and sudden cardiac arrest and ventricular arrhythmias (SCA/VA). The same algorithm described in the Identification of Major Comorbidities section of this chapter (one inpatient or two outpatient claims with the specific

diagnosis) was used to define these cardiovascular conditions. Code values are shown in Table m.4. The presence of CKD, CKD staging, and comorbidities such as diabetes mellitus (DM) and hypertension (HTN) are also defined as described in the Identification of Major Comorbidities section of this chapter and Tables m.1 and m.2.

vol 1 **Table m.4 ICD-9-CM diagnosis codes used to define cardiovascular disorders in Volume 1, Chapter 4 of the ADR**

Condition name	ICD-9-CM diagnosis codes
Any cardiovascular disease (CVD)	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 410-414; 422; 425-428; 430-438; 440-444; 447; 451-453; 557; V42.1, V45.0, V45.81, V45.82, V53.3
Atherosclerotic heart disease (ASHD)	410-414; V45.81, V45.82
Acute myocardial infarction (AMI)	410; 412
Congestive heart failure (CHF)	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 422a; 425a; 428; V42.1a
Systolic or both systolic & diastolic	428.2, 428.4
Diastolic only	428.3
Heart failure, unspecified	398.91; 402.01, 402.11, 402.91; 404.01, 404.03, 404.11, 404.13, 404.91, 404.93; 422a; 425a; 428 (not 428.2-428.4); V42.1a
Valvular heart disease (VHD)	424
Cerebrovascular accident/ transitory ischemic attack (CVA/TIA)	430–438
Peripheral arterial disease (PAD)	440–444; 447; 557
Atrial fibrillation (AFIB)	427.3
Sudden cardiac arrest/ ventricular arrhythmias (SCA/VA)	427.1, 427.4, 427.41, 427.42, 427.5, 427.69

Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification. Diagnosis codes can have up to five digits with a decimal point between the 3rd and 4th digit. Codes listed with three digits include all existing 4th and 5th digits, and those listed with four digits include all existing 5th digits. Peripheral arterial disease is defined as having a diagnosis and/or a procedure. a These codes are used to determine prevalent or comorbid CHF, but are excluded when determining incident CHF events and when CHF is the dependent variable.

Cardiovascular procedures included percutaneous coronary interventions (PCI), coronary artery bypass grafting (CABG), and the placement of implantable cardioverter defibrillators (ICD) and cardiac resynchronization devices with defibrillators (CRT-D). Procedures required only one claim with the procedure code. The presence of PAD was determined by the diagnosis or a claim for a procedure. Table m.5 shows the codes and type of claims used to identify each procedure.

vol 1 Table m.5 Procedure codes (ICD-9-CM and HCPCS) & claims files used to define cardiovascular procedures in Volume 1, Chapter 4 of the ADR

Peripheral arterial disease (PAD)

ICD-9-CM Procedure codes:

Claims files searched:	IP, OP, SN
Values:	39.25, 39.26, 39.29; 84.0, 84.1, 84.91

HCPCS codes:

Claims files searched:	PB, OP-revenue
Values:	24900, 24920, 25900, 25905, 25920, 25927, 27295, 27590, 27591, 27592, 27598, 27880, 27881, 27882, 27888, 27889, 28800, 28805, 34900, 35131, 35132, 35141, 35142, 35151, 35152, 34051, 34151, 34201, 34203, 34800–34834, 35081–35103, 35331, 35341, 35351, 35355, 35361, 35363, 35371, 35372, 35381, 35450, 35452, 35454, 35456, 35459, 35470, 35471, 35472, 35473, 35474, 35480, 35481, 35482, 35483, 35485, 35490, 35491, 35492, 35493, 35495, 35521, 35531, 35533, 35541, 35546, 35548, 35549, 35551, 35556, 35558, 35563, 35565, 35566, 35571, 35583, 35585, 35587, 35621, 35623, 35646, 35647, 35651, 35654, 35656, 35661, 35663, 35665, 35666, 35671

Percutaneous coronary interventions (PCI)

ICD-9-CM Procedure codes:

Claims files searched:	IP, OP, SN
Values:	00.66; 36.01, 36.02, 36.05, 36.06, 36.07

HCPCS codes:

Claims files searched:	PB, OP-revenue
Values:	92980-92982, 92984, 92995-92996, G0290, G0291

Coronary artery bypass graft (CABG)

ICD-9-CM Procedure codes:

Claims files searched:	IP
Values:	36.1

Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)

ICD-9-CM Procedure codes:

Claims files searched:	IP, OP, SN
Values:	00.51; 37.94

Source: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; HCPCS, Healthcare Common Procedure Coding System, IP, inpatient, OP, outpatient services during inpatient stay, SN, skilled nursing facility, PB, physician and supplier services covered by Part B, OP-revenue, outpatient revenue claims during inpatient stay. ICD-9-CM procedure codes have up to four digits with a decimal point between the 2nd and 3rd digits. Codes listed with three digits include all possible 4th digits. HCPCS codes have 5 digits without a decimal point. Peripheral arterial disease is defined as having a diagnosis and/or a procedure.

For Figure 4.1, the study cohort included Medicare enrollees who were alive, aged 66 and older, resided in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, did not have ESRD on December 31, 2013, and who were continuously enrolled in Medicare Parts A and B and not enrolled in a Medicare Advantage plan (Part C) for all of 2013. Cardiovascular conditions, CKD, and CKD staging were determined from claims in 2013.

Table 4.1 presents the prevalence data shown in Figure 4.1 by age, race, sex, and CKD status, and presents data on cardiovascular procedures performed in 2013. The cohort was the same as used for Figure 4.1. However, the denominators for the cardiovascular procedures were not "all patients in the cohort", which was the denominator for the prevalence statistics. The percent with PCI or CABG were out of cohort members with ASHD, and the percent with ICD/CRT-D was out of cohort members with CHF.

Figure 4.2 presents the unadjusted, two-year survival of patients with cardiovascular conditions or cardiovascular procedures. To form the study cohort for each condition and procedure, Medicare claims from 1/1/2010 through 12/31/2013 were searched for the diagnoses/procedure codes specified in Tables m.4 and m.5, and the date of the first claim with a specified code was considered the index date. To be retained in the analysis cohort, the patient must have been aged 66 or older on the index date, resided in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, was enrolled in Medicare Parts A and B, and not enrolled in a Medicare Advantage plan (Part C). Patients with ESRD on or before the index date were excluded. Claims for the patient in the 365 days prior to the index date were then searched for a prior occurrence of the given condition/procedure, and these patients were excluded from the analysis. CHF in this figure excluded those with only diagnosis codes of 422, 425, and V42.1. CKD status and stage were also determined from the patient's claims in the 365 days prior to the index date. Patients were then followed from the index date until the earliest of date of death, three years after the index date, ESRD diagnosis, or December 31, 2013. The Kaplan-Meier method was used to estimate survival.

Type of heart failure for the calendar year was determined by frequency of diagnoses and a hierarchy. The presence of systolic (428.2x or 428.4), diastolic (428.3x) and unspecified (all other CHF diagnosis codes in Table m.4 excluding 422, 425, and V42.1) diagnoses was determined by searching all reported diagnoses on all claims for a given calendar day. Each day was counted as systolic if there were any systolic diagnoses, as diastolic if there were no systolic diagnoses but at least one diastolic diagnosis, and as unspecified if there were no systolic or diastolic diagnoses but at least one unspecified diagnosis. The number of days with systolic, diastolic, and unspecified diagnoses was then summed for the calendar year. The patient's type of heart failure for the year was then determined by a hierarchy similar to that applied for each calendar day: if the patient had any systolic heart failure and no diastolic-only heart failure, he/she was classified as systolic heart failure; if the patient had diastolic heart failure and no systolic, he/she was classified as diastolic heart failure; and if the patient had only unspecified heart failure, he/she was classified as unspecified heart failure. When a patient had both systolic and diastolic-only diagnosis days during the year, he/she was assigned to the heart failure type that was most frequent during the year.

Table 4.2 describes the characteristics of CHF patients by age, sex, race, diabetic status, and type of heart failure. The study cohort included Medicare enrollees who were alive, aged 66 and older, resided in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, who did not have ESRD on December 31, 2013, and who were continuously enrolled in Medicare Parts A and B and not enrolled in a Medicare Advantage plan (Part C) for all of 2013.

Figure 4.3 shows the distribution of heart failure type by CKD status in 2013 and employed the same study cohort as in Table 4.2. The denominators were the total numbers of patients in each CKD status or stage group, and the numerators were the numbers of patients with the given heart failure type within that CKD status or stage group.

Figure 4.4 presents the adjusted, two-year survival of patients with and without CKD and CHF. The adjusted probability of survival was calculated using the results of a Cox model, in which significant factors included age group, sex, race, diabetic (DM) status, hypertension (HTN) status, CHF status, and CKD status. An interaction term between CHF status and CKD status was also significant in the final model. CHF, CKD, DM and HTN statuses were determined from claims for 2011; the study cohort included Medicare enrollees who were alive and aged 66 or

older on December 31, 2011, resided in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, were continuously enrolled in Medicare Parts A and B, and were not enrolled in a Medicare Advantage plan for all of 2011. Patients with ESRD on or before December 31, 2011 were excluded. Follow-up began on 1/1/2012 and continued until death or 12/31/2013. Type of heart failure was determined by the same procedure as the previous figures using claims from 2011. Codes used to define DM and HTN can be found in Table m.2 of this chapter. Age was defined as of 12/31/2011. Since the interaction between CHF status and CKD status was significant in the Cox model, adjusted survival curves were created for the four combination groups of CHF status and CKD status (No CKD and no CHF, CKD and no CHF, CHF and no CKD, and CKD and CHF). The survival curves were adjusted for the other significant factors in the model listed above.

Table 4.3 presents the prevalence of AFIB by CKD stage, age, race, sex, diabetic status, hypertension status, and heart failure (CHF) status for 2013. The cohort was the same used for Figure 4.1.

Chapter 5: Acute Kidney Injury

For the 2015 ADR, acute kidney injury (AKI) was determined by the definition implemented with the 2014 ADR. Prior to the 2014 ADR, a patient was considered to have had an AKI hospitalization if either (1) he/she had an AKI diagnosis during an inpatient stay (ICD-9-CM code of 584.5-584.9) or (2) had dialysis as an inpatient prior to the first service date from the ESRD Medical Evidence Form (CMS 2728), or had no form. From the 2014 ADR onward, in order to qualify as having an AKI, hospitalization patients must have a diagnosis code for AKI associated with their inpatient stay, but not necessarily as the primary diagnosis. As in prior years, this chapter only examined in-hospital AKI. Dialysis during the AKI hospitalization was defined using diagnosis, procedure, and revenue center codes. The inpatient claims file was searched for ICD-9-CM diagnosis codes V45.1, V56.0, and V56.1; ICD-9-CM procedure codes 39.95 and 54.98; and Medicare revenue center codes 0800–0809. Additionally, physician and supplier claims (PB file) were searched for HCPCS codes 90935, 90937, 90945, and 90947, with service dates that corresponded to the patient's inpatient stay. Patients with ESRD prior to the inpatient stay were not counted as having AKI.

Characteristics of Patients with AKI

The cohort used for Figures 5.1-5.4 and Table 5.1 included all patients alive, aged 66 or older, enrolled in Medicare Parts A and B, not enrolled in a Medicare Advantage (Part C) program, and without ESRD on January 1 of the reported year. The comorbidities of CKD and diabetes mellitus (DM) were determined as described in the Identification of Major Comorbidities section of this chapter and Tables m.1 and m.2, used claims from a one-year entry period (year one, the calendar year before the year in which hospitalization was assessed for AKI) and then assessed hospitalization in the following year (year two, the year reported in the figures and tables). While a patient can have had more than one hospitalization with AKI during a given calendar year, the figures and table in this section counted only the first AKI hospitalization per patient, per year. Each calendar year formed a separate cohort; so a patient can have had a "first" AKI hospitalization in multiple years.

Figure 5.1 has two panels that employ different denominators. Panel A shows the fraction of the entire cohort (described in the previous paragraph) that had a hospitalization with a diagnosis of AKI in each year. Panel B, however, used the numerator of Panel A as its denominator, showing the fraction of cohort patients with at least one AKI hospitalization that received a dialysis procedure during that AKI hospitalization. Note that these percentages did not take into account each patient's individualized time at risk—for example, a patient who died in February was still included in the denominator for the entire year, even though he/she was not at risk of having an AKI hospitalization after February. These percentages answered the question, "What percent of people (meeting the cohort inclusion criteria in the previous paragraph) alive on January 1 experienced an AKI hospitalization during the year?" Table 5.1 also used the total number of cohort patients with at least one AKI hospitalization as the denominator, and presents the distribution of age, sex, race, DM, and CKD for those with AKI.

Figures 5.2-5.4 used the entire analysis cohort as the denominator to calculate rates of first AKI per 1,000 patient years at risk. Only the first hospitalization with AKI for a patient was counted as an event, and years at risk were calculated for each patient as the time (total days divided by 365.25) between January 1 of the reported year (year two) to the earliest date of AKI

hospitalization, ESRD, disenrollment from Medicare Parts A and B, switch to a Medicare Advantage plan, death, or December 31 of year two. Age was as of January 1 of year two, while CKD and DM status were determined by claims in year one. A Cox proportional hazard model with no covariates, stratified by the variable of interest, was used to estimate survival, and the rate was calculated as –[log(survival)] and multiplied by 1,000 to generate the rate per 1000 patient years at risk.

Hospitalization for AKI

Figures 5.5 and 5.6 present the results from two Cox proportional hazard models, and illustrate time to first AKI hospitalization and time to first AKI hospitalization when that hospitalization included dialysis treatment, respectively. Each model included the following covariates: age (66-<70/70-<75/75-<79/80-<85/85+ years), race (White/Black/other), sex (male/female), and a variable representing CKD in combination with DM. The four categories of the combined DM and CKD variable were: patients without CKD and DM (reference group), patients with CKD but not DM, patients with DM but not CKD, and patients with both CKD and DM. Figure 5.5 presents the hazard ratios (HRs) for age from the model, while Figure 5.6 presents the HRs for the CKD and DM variable from that same model. The darker bars indicate the 'time to first-AKI' model, while the lighter bars show the 'time to first-AKI when that hospitalization included dialysis' model. The cohort used was the same as the 2013 cohort used for Figures 5.1-5.4 and Table 5.1: all Medicare patients alive, aged 66 or older, without ESRD, with Parts A and B coverage, and with no Medicare Advantage plan on 1/1/2013. Each patient was followed from January 1, 2013 to the earliest of date of death, ESRD first service date, disenrollment from Part A or B, switch to a Medicare Advantage plan, or December 31, 2013.

Figure 5.7 shows the probability of having a second hospitalization for AKI within 24 months of the first AKI hospitalization. The sample for this figure began with the 2011 cohort as used in the Characteristics of Patients with Acute Kidney Injury section above—alive, aged 66 or older, without ESRD, with Medicare Parts A and B, and not in a Medicare Advantage plan on 1/1/2011. The first AKI hospitalization in 2011 was identified. Age was as of 1/1/2011, and comorbidities were defined by searching claims one year prior to the AKI admission date (admission date-365 through one day before admission). Within this customized date range, CKD and DM status were defined according to the algorithm and codes described in the Identification of Major Comorbidities section and Tables m.1 and m.2 of this chapter. The final cohort for Figure 5.7 included only those patients with at least one AKI hospitalization in 2011 who were discharged alive. Follow-up began on the date of discharge listed on the claim for the AKI hospitalization, and continued until the earlier of a second AKI hospitalization, death, ESRD, disenrollment from Parts A or B, switch to a Medicare Advantage program, or 730 days following the first AKI discharge. Kaplan Meier methods were used to estimate survival with the cumulative probability of a recurrent AKI hospitalization defined as (1-survival).

Patient Care and Outcomes

Figure 5.8 shows the outcomes of death or ESRD within one year of a live discharge from an AKI hospitalization. To increase the precision of these estimates, we created the cohort for this figure to include patients with a first AKI hospitalization in 2011 or 2012. Patients were alive, aged 66 or older, without ESRD, with Parts A and B coverage, and with no Medicare Advantage plan on January 1 of the year of their AKI hospitalization. Those who were discharged alive from their AKI hospitalization were followed from the date of discharge until 365 days after discharge. For the models of time to ESRD and time to the composite end point of ESRD or death, the survival time was calculated from the date of AKI discharge to the earliest date of ESRD, death, disenrollment from Parts A or B, switch to a Medicare Advantage program, or 365 days following the first AKI discharge. Note that the mortality model in this year's ADR was not censored at the start of ESRD. For the mortality model, survival time was calculated from the date of AKI discharge to the earliest of death, disenrollment from Parts A or B, switch to a Medicare Advantage program, or 365 days following the first AKI discharge.

Figures 5.9 and 5.10 present physician visits after a live discharge from an AKI hospitalization. Claims were searched for services provided by primary care physicians, nephrologists, and cardiologists for 365 days following the discharge date of the AKI hospitalization. Primary care visits were defined based on the Medicare physician specialty code values of 01, 08 and 11, cardiologist visits with specialty code 06, and nephrology visits with specialty code 36. Figures

5.11 and 5.12 show time-to-first-claim for specified laboratory tests. A first serum creatinine measurement was defined as the first claim with a Healthcare Common Procedure Coding System (HCPCS) code of 80047, 80048, 80049, 80050, 80053, 80054, 80069, or 82565. Likewise, first urinary microalbumin measurement was defined as the first claim with an HCPCS code of 82042, 82043, 82044, or 84156. Patients were followed from date of discharge until 365 days after discharge, and censored on the earliest date of death, development of ESRD, disenrollment from Parts A or B, or switch to a Medicare Advantage program.

Figure 5.13 shows the renal status after one year for patients discharged alive from their first AKI hospitalization. To increase the precision of the estimates, we created the cohort for this figure from patients with a first AKI hospitalization in 2011 or 2012. Patients were alive, aged 66 or older, without ESRD, with Parts A and B coverage, with no Medicare Advantage plan on January 1 of the year of their AKI hospitalization, and did not have any claims with a diagnosis of CKD in the 365 days prior to that AKI admission. Renal status after AKI was determined from claims occurring between discharge from the AKI hospitalization and 365 days after discharge. CKD stage was determined by the 585.x claim closest to 365 days after discharge, and ESRD by first service date on the ESRD Medical Evidence form.

Figure 5.14 shows discharge status following a patient's first AKI hospitalization in 2013. The cohort included all patients who experienced an AKI hospitalization during 2013 and who were alive, aged 66 or older, enrolled in Medicare Parts A and B, not enrolled in a Medicare Advantage program, and without ESRD on January 1, 2013. Patients admitted to the acute care hospital from a long-term care facility ('point of origin for admission,' previously named 'source of admission,' is 5) were excluded. Patients with a 'patient discharge status' code of 01 (routine discharge to home) or 06 (discharged to home under care of a home health service organization in anticipation of covered skilled care) were identified as being discharged home. Those with a 'patient discharge status' of 50 (discharged to routine or continuous hospice at home) or 51 (transferred to an inpatient hospice program or facility) were identified as being discharged to hospice. Those identified as being discharged to an institution were those whose 'patient discharge status' was 03 (transferred to a Skilled Nursing Facility with Medicare certification in anticipation of skilled care), 62 (transferred to an inpatient rehabilitation facility including distinct part units of a hospital), or 63 (transferred to long term care hospital). Death was determined both by the date of death from the Master Beneficiary Summary File and the 'patient discharge status' of 20 (expired—this code is used only when the patient dies). 'Other' is a residual category that includes all discharges not identified by the previous categories.

Chapter 6: Medicare Expenditures for CKD

For this year's ADR, data on the Medicare Part D Prescription Drug Program were again included in this chapter. These data were not available in time for inclusion in the 2014 ADR; costs in the 2014 version of this chapter only referred to expenditures under the Medicare Part A (Hospital Insurance) and Part B (Supplemental Medical Insurance) programs. Costs from Medicare Part D have been added back into total costs for 2006 through 2013.

The cohort used for this chapter continued the methodology introduced in the 2010 ADR, which only tabulated CKD costs for patients with CKD diagnoses (one inpatient and/or two outpatient) among their claims in the year prior to the reported year (year one). For example, the total costs of CKD for 2013 (year two) included all costs incurred by patients with a CKD diagnosis in 2012 (year one). Prior to the 2010 ADR, patients newly diagnosed with CKD during year two were also included in the total.

The same general Medicare point prevalent cohort was used to create all the tables and figures in this chapter. Each year's cohort included patients aged 65 and older who were alive and without ESRD on January 1 of the reported year (year two). Cohort members were continuously enrolled in Medicare Parts A and B and not enrolled in a Medicare Advantage plan (Part C) for all of year one (the one-year entry period prior to the year in which costs were assessed). Costs were aggregated for the reported year (year two). Patient years at risk were calculated as the number of days (divided by 365.25) between January 1 of year two and the earliest of death, development of ESRD, disenrollment from Parts A or B, switch to a Medicare Advantage program, or December 31 of year two. Dividing the total cost amount by the patient years at risk yielded the per person per year (PPPY) costs. Since these total costs and number of patients were based on

the 5 percent Medicare files, counts and expenditures were multiplied by 20 to represent 100% of Medicare fee-for-service Parts A, B, and D expenditures for age-eligible patients who were continuously enrolled in Parts A and B and not enrolled in a Medicare Advantage plan for all of the previous year (year one).

Claims can be submitted for episodes of care that span calendar years. The expenditures for these claims are spilt across calendar years based on the fraction of the claim's total days that occurred in the reported year. For example, if a claim began on December 29, 2012, and ended on January 7, 20123, it spanned 10 days, with three days in 2012 and seven days in 2013. Seventy percent of that claim's total expenditure amount would be added to total expenditures for 2013 and 30% to total expenditures for 2012.

The disease conditions of CKD--congestive heart failure (CHF), diabetes mellitus (DM), and the stage of CKD--are determined from the claims in the year prior to the reported year (year one) with the algorithm described in the Identification of Major Comorbidities section of this chapter, using the diagnosis codes listed in Tables m.1 and m.2. Age was determined as of December 31 of year one. Race and sex were provided by the Master Beneficiary Summary File.

Chapter 7: Medicare Part D Prescription Drug Coverage in Patients With CKD

This chapter describes the participation in the Medicare Part D program by Medicare beneficiaries overall, and by those with CKD and ESRD. CKD was determined as described in the Identification of Major Comorbidities section of this chapter and Table m.1, using claims from a one-year entry period (year one, the calendar year before the year in which Part D utilization was assessed).Part D utilization was assessed in the following year (year two, the year reported in the figures and tables), while ESRD was determined by the date of first ESRD service. In this Part D chapter in Volume 1, both the General Medicare cohort and the CKD cohort had the same inclusion criteria, which represent a change from prior ADRs. This is also different from the sample used to describe General Medicare patients in Volume 2, Chapter 12, which does not apply restrictions based on year one Medicare participation.

In this chapter, beneficiaries must have been enrolled in Parts A and B and not enrolled in a Medicare Advantage plan for all of year one, and be alive, without ESRD, and enrolled in Parts A and B on January 1 of year two. Note that those with a Medicare Advantage plan in January of year two were not specifically excluded; if a beneficiary was not in a Medicare Advantage plan for all of year one, but switched to Medicare Advantage for year two, they were still included in the analysis cohort. These criteria were necessary to enable CKD identification, as diagnosis codes were only available for those with fee-for-service Medicare. In order to have an appropriate comparison for the CKD cohort, the same exclusion criteria were applied to the General Medicare group. Unlike the other chapters in Volume 1, this chapter includes all beneficiaries aged 20 years and older. For inclusion, those under age 65 must have been eligible for Medicare through participation in federal disability programs (Social Security Disability Insurance or Supplemental Security Income) or their entitlement related to amyotrophic lateral sclerosis, and thus should not be viewed as representative of the U.S. general population under age 65.

For comparison, several figures and tables also include the ESRD population. Patients were selected from the USRDS ESRD database who had Medicare as either their primary or secondary payer, and had ESRD for at least 90 days by January 1 of the analysis year (year two). See the ESRD Methods chapter for more information on the USRDS ESRD database.

Figures 7.1-7.3 summarize the prescription drug insurance coverage for Medicare beneficiaries by source, comparing General Medicare, CKD, and ESRD populations and by showing results by age and race categories. The sources of coverage across the calendar year were combined into mutually exclusive and exhaustive categories in a hierarchical manner. Enrollment in a Part D plan was determined by the first digit of the Part D Plan Contract Number variable (one for each month) being "E" (an employer direct plan, a valid value starting in 2007), "H" (a managed care organization other than a regional preferred provider organization (PPO)), "R" (a regional PPO), or "S" (a stand-alone prescription drug plan). A beneficiary was considered to be enrolled in a Part D plan for the year if he or she was enrolled for one month or more of the analysis year. If a beneficiary was enrolled in a Part D plan and received a low-income subsidy (LIS) in at least one month, he or she was classified as "Part D with LIS", and as "Part D without LIS" otherwise. The receipt of a low

income subsidy was determined by the monthly Cost Sharing Group Code values "01" through "08." For beneficiaries not enrolled in a Part D plan, there were several options for non-Medicare prescription drug coverage as reported to the Medicare program. A beneficiary was classified as "Retiree Drug Subsidy" if they were not enrolled in a Part D plan but had at least one month with a Part D Retiree Drug Subsidy Indicator value of "Y" (yes), indicating he or she was enrolled in an employer-sponsored prescription drug plan that qualified for Part D's retiree drug subsidy. If the patient was not in a Part D plan or employer-sponsored plan, they were classified as "Other Creditable Coverage" if the Creditable Coverage Switch has a value of "1", indicating another form of drug coverage that was at least as generous as the Part D benefit. This alternate coverage is known as creditable coverage because beneficiaries who maintain it do not have to pay a late enrollment penalty if they later enroll in Part D. If a beneficiary met none of the situations described above, he or she was classified as "No Known Coverage." Figure 7.1 presents the distribution of this categorical variable for the General Medicare, CKD, and ESRD cohorts described above. Figure 7.2 shows these categories by age groups (20-44/45-64/65-74/75+) for General Medicare and CKD, while Figure 7.3 shows it by race groups (White/Black or African American/Asian/Other).

Table 7.1 was limited to beneficiaries who were enrolled in Part D prescription plans for at least one month of the analysis year. Part D plan enrollment and receipt of LIS were determined as described for Figures 7.1 – 7.3. Table 7.1 shows the percent of Part D enrollees with LIS within each race group ("all ages" row) and by age groups within the race group (also defined as above) for the General Medicare cohort and the CKD cohort. Figure 7.4 was limited to those enrolled in a Part D plan with LIS and shows the different types of LIS, as determined by the values of the Cost Sharing Group Code, for the General Medicare, CKD, and ESRD cohorts.

Table 7.2 is an adaptation of data presented in the 2016 Medicare Outlook section of the www.q1medicare.com website, and has no analyses. Table 7.3 shows the percent of beneficiaries with Part D coverage for the past three years in the General Medicare, CKD, and ESRD cohorts. A beneficiary was considered enrolled in Part D if at least one month's Part D Plan Contract Number had the first digit of "E","H","R", or "S."

The next several tables and figures present data on Medicare spending for Part D benefits. The Part D benefit expenditure for a prescription drug event (PDE) is the sum of the amount of cost sharing for the drug that was paid by the Part D low-income subsidy (LIS Amount) and the net amount that the Part D plan paid for the PDE (Covered D Plan Paid Amount). Table 7.4 shows the total Medicare Part D benefit expenditures for the General Medicare, CKD, and ESRD cohorts (defined above) for beneficiaries enrolled in stand-alone Part D plans (i.e., spending for Medicare Advantage prescription drug plans was not included). These cost numbers are, therefore, comparable to the statistics presented in Chapter 6, which show Medicare spending on Parts A and B benefits for those not in Medicare Advantage plans.

Figure 7.5a shows Medicare spending and patient out-of-pocket amounts per patient per year for the General Medicare, CKD, and ESRD cohorts, again for only those who were in stand-alone Part D plans. Out of pocket cost was the sum of the amount paid by the patient without being reimbursed by a third party (Patient Payment Amount) which included all copayments, coinsurance, deductible, or other patient payment amounts and the amount of any payment made by other third-party payers that reduced the beneficiary's liability for the PDE (Other True Out-of-Pocket Amount). Two examples of this were payments by qualified state pharmacy assistance programs or charities. Figure 7.5b breaks out these costs by whether the patient received any low income subsidies. Table 7.5 stratifies these costs by age, sex, and race.

Table 7.6 shows four therapeutic drug classes commonly prescribed to patients with CKD – statins, calcium channel blockers, beta blockers, and angiotensin II receptor blockers. These individual prescriptions were grouped based on the Anatomical Therapeutic Chemical Classification System and the National Drug Code Directory from the Food and Drug Administration. This table was limited to those in the CKD cohort who have stand-alone Part D prescription drug coverage. The first column shows the percent of patients with CKD who filled at least one prescription for a drug in the given class and the second column shows the total amount spent by Medicare on each drug class for CKD patients with stand-alone Part D plans.

Reference Tables: CKD

Reference Tables B.1–B.6 present estimated point prevalent (December 31) counts of the Medicare non-ESRD population, based on the 5 percent Medicare sample, for adults aged 20 and older rather than the age-eligible (aged 65 and older) cohort presented in Chapter 2. Each year's cohort included all patients alive and without ESRD, who were continuously enrolled in Medicare Parts A and B, and not enrolled in a Medicare Advantage program (Part C) for the entire year. Age was calculated as of December 31 of the reported year. Race and sex were provided by the Master Beneficiary Summary File. The disease conditions of CKD, congestive heart failure (CHF), and diabetes mellitus (DM) and the stage of CKD were determined from the claims in the reported year, using the methods described in the Identification of Major Comorbidities section of this chapter and the diagnosis codes listed in Tables m.1 and m.2. Counts were multiplied by 20 to represent 100% of the Medicare population meeting the cohort definition.

Reference Tables B.7-B.10 are based on NHANES data (see the NHANES methods description in the Chapter 1: CKD in the General Population section, above). For Table B.8, CKD is defined as an estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73m2 (which identifies Stages 3 and 4) or urine albumin creatinine ratio (ACR) greater than 30 mg/g (which identifies Stages 1 and 2). eGFR was estimated from one serum creatinine measurement using the CKD-EPI equation (Levey et al., 2009). The consensus definition of CKD requires two measurements of both eGFR and ACR meeting the criteria above, within a three-month period, but only one measurement of each is available in NHANES. Therefore, the resulting numbers overestimate the true number of CKD patients in the general U.S. population. CKD staging is as defined by the Kidney Disease Outcomes and Quality Improvement (KDOQI) CKD guidelines (NKF, 2002). In Table B.9, DM was defined as in Chapter 1, and eGFR and ACR as described for Table B.8. Table B.10 presents results for CHF, which is self-reported in NHANES as an affirmative answer to, "Has a doctor or other health professional ever told you that you have congestive heart failure?"

Tables K.1–5 present estimates of per-person per-year Parts A, B, and D Medicare expenditures for point prevalent (December 31) general Medicare patients, also derived from the 5 percent Medicare sample. Methods for these tables were the same as those described in the Chapter 6: Medicare Expenditures for CKD section of this document. The reference tables include all adult patients aged 20 and older, while the chapter presents these costs only for those age-eligible for Medicare (aged 65 or older).

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