CKD in the United States: An Overview of the USRDS Annual Data Report, Volume 1

Introduction

Chronic kidney disease (CKD) has received significant attention over the last decade, primarily since the consensus definition and staging classification of CKD was first published by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI, 2002).

Federal agencies have also done much to raise awareness of CKD as a significant public health problem. Since 1988, NIH has sponsored the United States Renal Data System (USRDS), publishing a comprehensive Annual Data Report (ADR). The ADR first included a chapter addressing CKD in 2002, and expanded this to an annual, multi-chapter CKD volume in 2008. In 2002, the National Institutes of Health launched a National Kidney Disease Education Program (NKDEP; NIDDK, 2002). NKDEP provides information for patients and providers regarding the detection and care of people with CKD.

The Centers for Disease Control and Prevention (CDC) now support a CKD initiative (CDC, 2014a) with the CKD Surveillance Program as its major component; since 2007 this project has reported on many aspects of this important chronic condition (CDC, 2007).

A nexus between the common non-communicable diseases (NCDs), such as diabetes mellitus (DM), hypertension (HTN), 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 (UN) 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" (UN, 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 (CVD), cancer, chronic lung diseases and DM. 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, associated with high morbidity, mortality, and cost, yet readily identifiable by simple testing of blood and urine. Timely recognition and treatment has the potential to delay progression of disease and reduce complications.

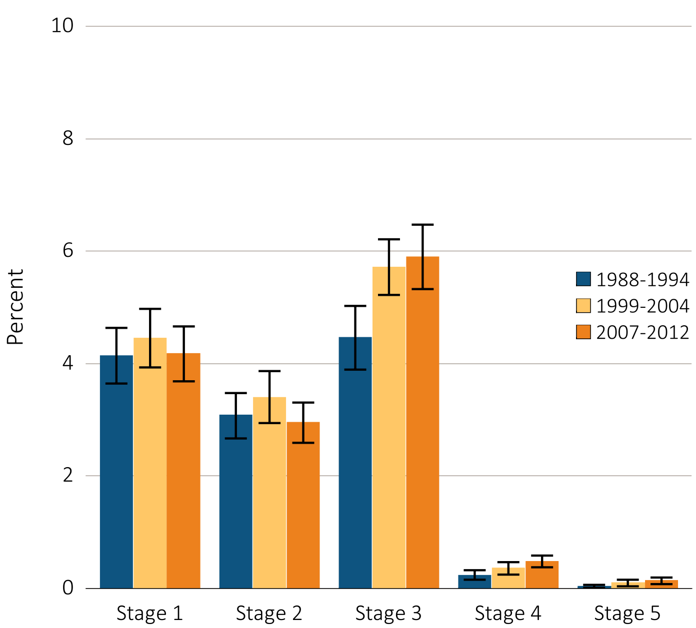
While the number of new patients with end-stage renal disease (ESRD) appears to be stabilizing in the United States (U.S.), the need to further reduce both the incidence and prevalence of this devastating complication of kidney disease cannot be overemphasized. The key to success is undoubtedly in the realm of prevention of both CKD and AKI. 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 (CKD Prognosis Consortium, 2010; Astor et al., 2011). CKD has therefore been appropriately recognized as a cardiovascular risk equivalent (Sarnak et al., 2003).

The 2014 USRDS Annual Data Report provides a detailed overview of key aspects of CKD in the U.S. As in previous years, we include in Volume 1 a chapter on Acute Kidney Injury. A chapter discussing prescription medication use through the Medicare Part D benefit, as well as comparisons to employer-sponsored health insurance populations throughout the Volume are not included in this year's ADR because of unavailability of the relevant data. These topics will return in the 2015 edition.

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 U.S. Chapter 1 uses these data to describe CKD in the U.S. general (non-institutionalized) population of people aged 20 or older. We find that CKD is more common than DM in the U.S.; an estimated 13.6 percent of adults have CKD, compared to 12.3 percent with DM (CDC, 2014b). 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 is a satisfactory compromise, as implementation of two or more measurements would not be practical in a national study such as NHANES. As shown in Figure i.1, the overall prevalence of CKD increased from 1988-1994 to 1999-2004 (12 percent to 14 percent), but has since remained relatively stable. The largest increase has occurred in patients with Stage 3 CKD, from 4.5 percent to 6.0 percent over the three time periods.

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



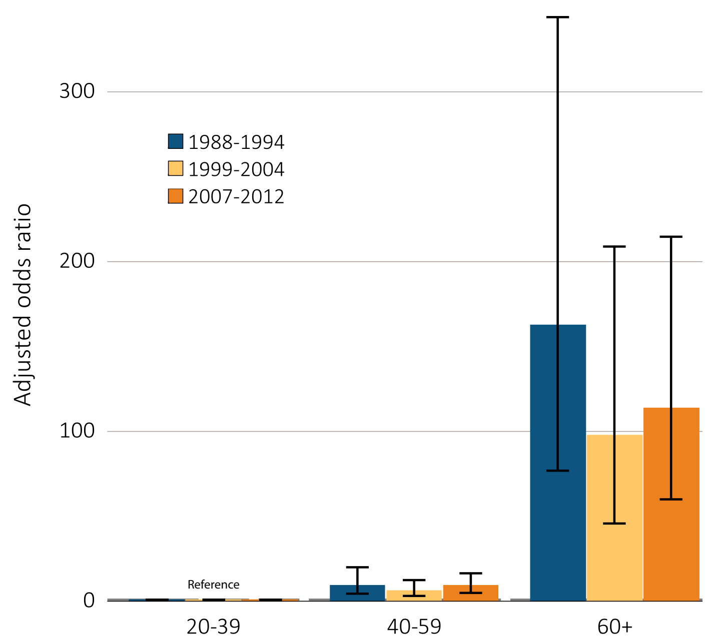
Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2005–2012 participants age 20 & older. Whisker lines indicate 95% confidence intervals. Abbreviations: CKD, chronic kidney disease. This graphic also appears as Figure 1.1.

Stages of CKD – KDOQI 2002 Definitions	
Stage 1:	eGFR ≥ 90 ml/min/1.73m² and ACR ≥ 30 mg/g
Stage 2:	eGFR 60-89 ml/min/1.73m² and ACR ≥ 30 mg/g
Stage 3:	eGFR 30-59 ml/min/1.73m²
Stage 4:	eGFR 15-29 ml/min/1.73m²
Stage 5:	eGFR < 15 ml/min/1.73m²

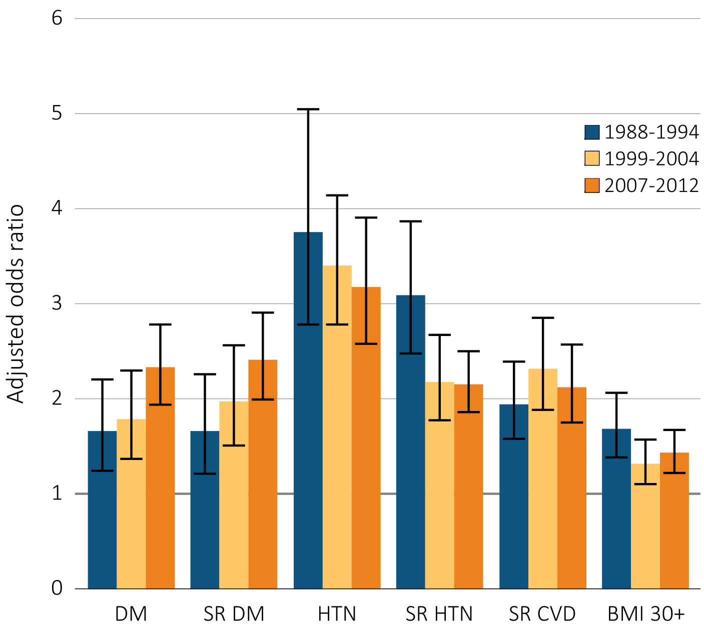
The aging kidney and age as a risk factor for CKD have emerged as important themes in recent years. Figure i.2 shows that age may indeed be the strongest risk factor for the presence of CKD of those available in the NHANES. This has practical implications for screening, prevention, risk stratification and treatment. Other important and clinically relevant risk factors that should prompt screening for the presence of CKD include the presence of DM, HTN, CVD, obesity, or metabolic syndrome, a family history of ESRD or CKD, and a history of AKI.

vol 1 **Figure i.2 Adjusted odds ratios of eGFR <60 ml/min/1.73m2 in NHANES participants by age & other risk factors, 1998-2012**

(a) Age category



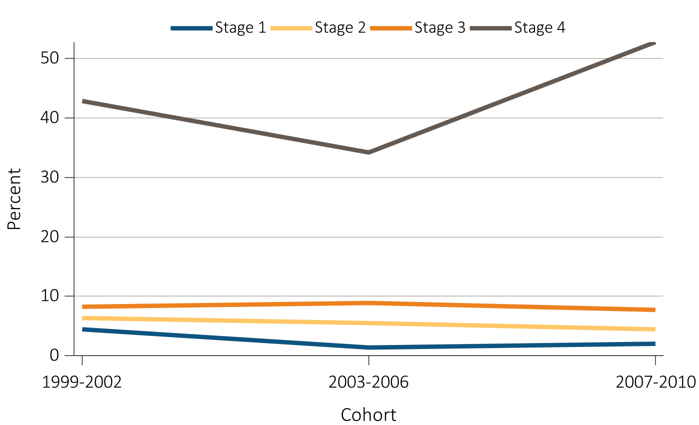
(b) CKD risk factor



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants age 20 & older; single-sample estimates of eGFR & ACR. Adj: 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; HTN, hypertension; SR, self-report. This graphic also appears as Figure 1.9.

CKD is a notoriously silent disease, and patient awareness remains very low at less than 10 percent for those with Stages 1-3 CKD (see 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, 1999-2010**

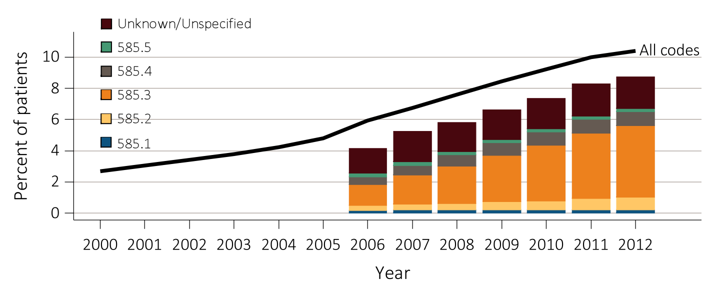


Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants age 20 & older. Abbreviations: CKD, chronic kidney disease. This graphic also appears as Figure 1.11.

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. Chapter 2 presents findings from the five percent Medicare sample for age-eligible Medicare enrollees (aged 65 or older), which is a very high-risk population for development of CKD and other comorbid conditions. Data for adults aged 20 or older can be found in the accompanying reference tables for this volume. The prevalence of recognized CKD in the Medicare population aged 65 years or older continues to rise over time, peaking at 10.4 percent in the most recent data available in 2012, as shown in Figure i.4. Unfortunately, this represents an underestimate of the true prevalence of CKD in enrollees using Medicare-reimbursed health care services, but has high specificity, identifying the individuals most likely to have an accurate diagnosis.

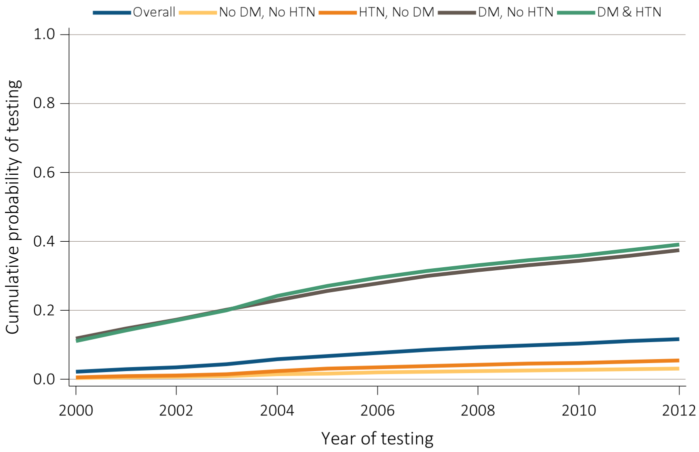
vol 1 **Figure i.4 Trends in CKD prevalence, overall and by CKD stage, among Medicare patients age 65+, 2000-2012**



Data Source: Medicare 5 percent sample. This graphic also appears as Figure 2.1.

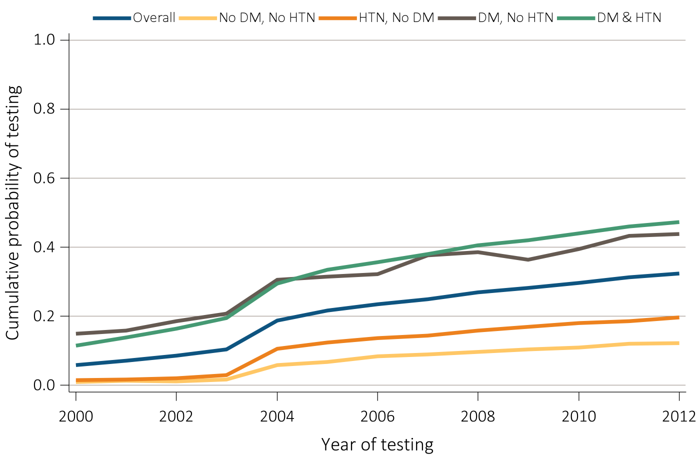
The recent Kidney Disease: Improving Global Outcomes (KDIGO) guidelines on CKD evaluation and management emphasize the importance of assessing the presence of albuminuria in addition to estimated glomerular filtration rate (eGFR) for risk stratification (KDIGO, 2013). Rates of urine albumin testing in the Medicare population have increased slowly over time in both those with and without CKD, as shown in Figures i.5 and i.6. However, rates of such testing remain very low among non-diabetic patients, who because of other health factors are at high risk for kidney disease.

vol 1 Figure i.5 Unadjusted cumulative probability for urine albumin testing, among Medicare patients age 65+ without a diagnosis of CKD, 2000-2012



Data Source: Medicare patients from the 5 percent sample, age 65 or 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.

vol 1 Figure i.6 Unadjusted cumulative probability of urine albumin testing, among Medicare patients age 65+ with a diagnosis of CKD, 2000-2012



Data Source: Medicare patients from the 5 percent sample, age 65 or 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.

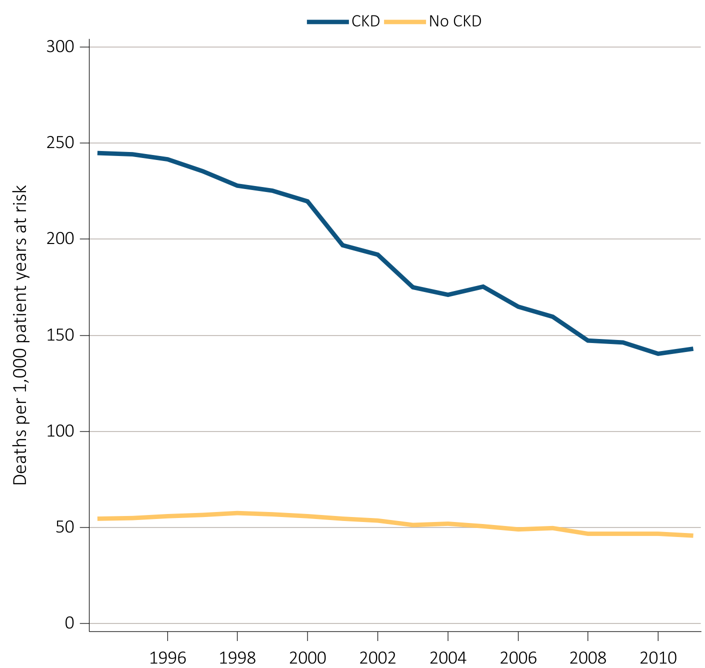
Care of CKD patients after diagnosis is challenging to assess. In the Medicare CKD population aged 65 and older, it appears that 91 percent see a primary care physician within a year of diagnosis, while 62 percent visit a cardiologist; only 31 percent, however, see a nephrologist. When restricted to patients with CKD of Stages 3–5 (based on diagnosis codes), this rate reaches 55 percent.

Chapter 3: Morbidity and Mortality in Patients with CKD

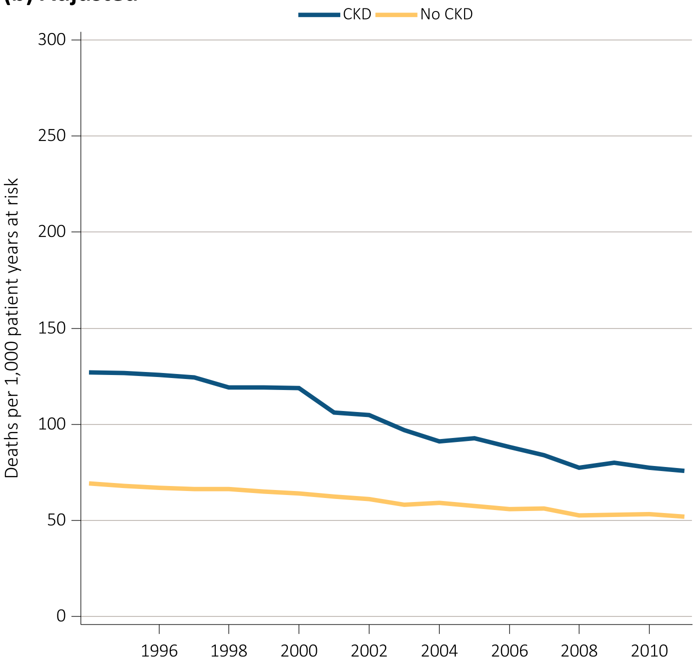
Chapter 3 examines hospitalization and mortality for CKD patients as compared to other Medicare patients. Adjusted mortality rates are higher for Medicare patients with CKD than those without, and rates increase with CKD stage, a finding consistent with studies using biochemical measures to define CKD (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, 1995-2012

(a) Unadjusted

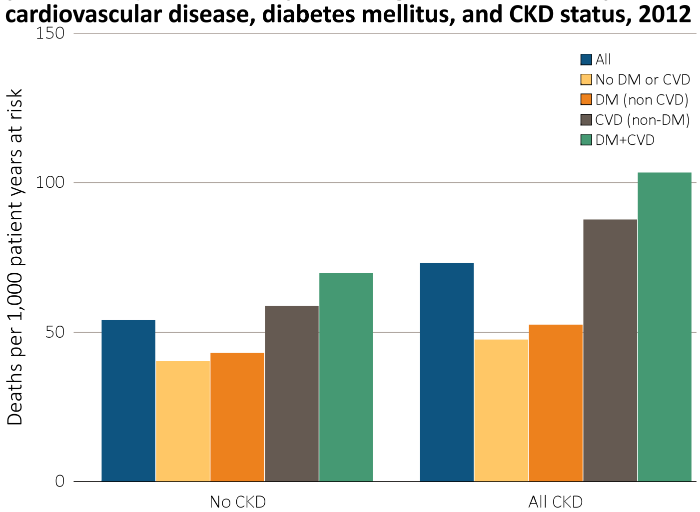


(b) Adjusted



Data source: Medicare 5 percent sample. January 1 point prevalent Medicare patients age 66 and older. Adj: age/sex/race/prior year hospitalization/comorbidities. Ref: 2012 patients. Abbreviations: CKD, chronic kidney disease. This graphic also appears as Figure 3.1.

vol 1 **Figure i.8 Adjusted mortality rates (per 1,000 patient years at risk) in Medicare patients aged 66 and older, by cardiovascular disease, diabetes mellitus, and CKD status, 2012**

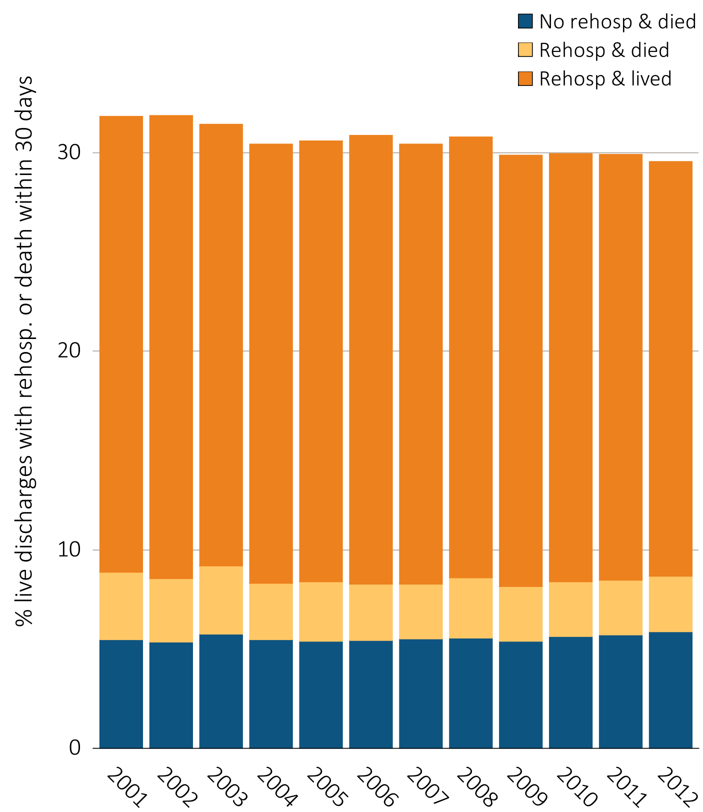


Data source: Medicare 5 percent sample. January 1, 2012 point prevalent patients age 66 and older. Adj: age/sex/race/prior year hospitalization/comorbidities. Ref: all patients, 2012. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus. This graphic also appears as Figure 3.4.

One consistent finding regarding hospitalization in the CKD population is an increasing rate of both overall and cause-specific admissions with advancing stages of CKD. When data are adjusted for age, race, sex, prior year hospitalization, and several comorbidities, CKD patients are hospitalized at a rate of 0.40 admissions per patient year overall—0.35 for Stages 1-2, 0.40 for Stage 3, and 0.55 for Stages 4-5 (0.39 where stage is not specified). The USRDS has observed for more than a decade that rates of hospitalization for cardiovascular disease and infection also rise with CKD stage (Go et al., 2004). In general, hospitalizations in CKD patients also increase in the presence of underlying comorbidities, such as DM 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, reducing Medicare payments to hospitals with excess readmissions (CMS, 2010). Rates of rehospitalization for CKD patients are higher than those for patients without diagnosed CKD. In 2012, 24 percent of patients with CKD were readmitted within 30 days, compared to 17 percent of those without CKD. As shown in Figure i.9, these rates have not changed significantly in the past decade, which is of major concern.

vol 1 **Figure i.9 Adjusted percentage 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, 2001-2012**



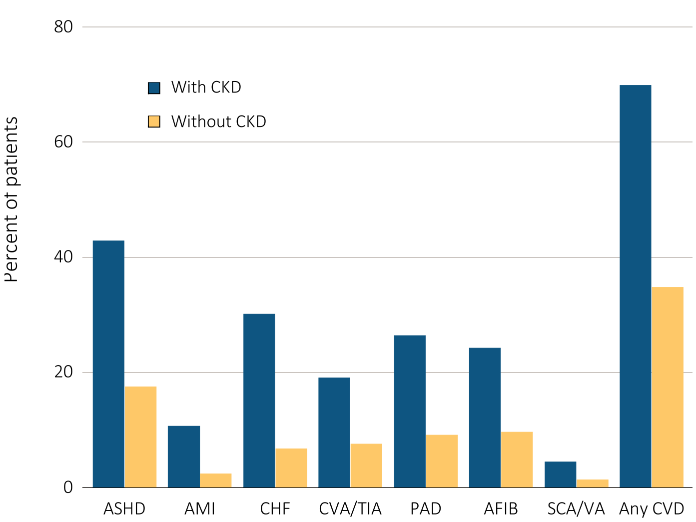
Data source: Medicare 5 percent sample. January 1 of each reported year point prevalent, Medicare patients age 66 and older with CKD (defined during the prior year) discharged alive from an all-cause index hospitalization between January 1 and December 1 of the reported year. Adj: age/sex/race. Ref: 2012. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized. This graphic also appears as Figure 3.14.

Rates of hospitalization, and of rehospitalization within 30 days, are progressively higher with advancing CKD. The issue of rehospitalization has received more attention for patients in the general population than for those with CKD, despite the fact that the rate for CKD patients is almost 40 percent higher. The rate accelerates as patients approach ESRD, reaching 43 percent in the month prior to ESRD initiation (USRDS, 2013). These data show the substantial burden of disease and needed care in the CKD population, burdens also illustrated through the data on mortality and CVD in CKD patients.

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 CVD, and the presence of CKD often complicates CVD treatment and prognosis. This year we continue to examine Medicare data with respect to the interaction of CKD and CVD. Figure i.10 shows that the prevalence of any cardiovascular disease defined using Medicare claims is twice as high for those with CKD compared to those without (69.8 percent versus 34.8 percent).

vol 1 Figure i.10 Cardiovascular disease in patients with or without CKD, 2012



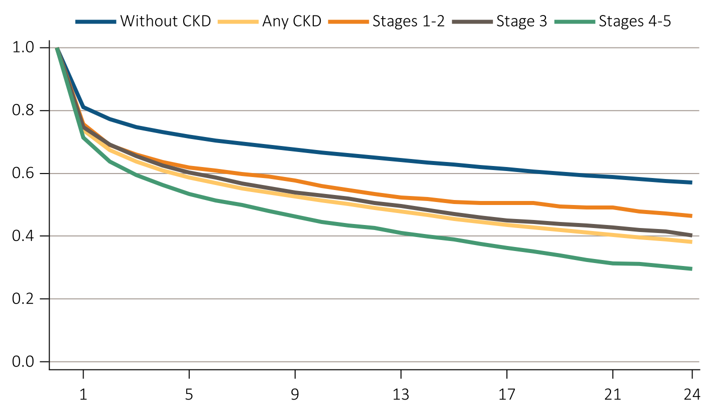
Data Source: Medicare 5 percent sample. Patients age 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2012 with fee-for-service coverage for the entire calendar year. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias. This graphic also appears as Figure 4.1.

It is of note that atherosclerotic heart disease (ASHD) is the most frequent CVD linked to CKD; its prevalence in CKD patients aged 66 years and older exceeded 40 percent in 2012. This data also shows that the proportion of CVD patients undergoing cardiovascular procedures was 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.

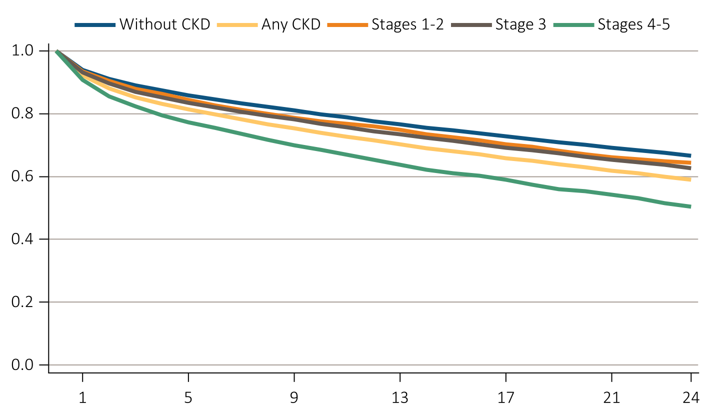
The presence of CKD worsens the short- and long-term prognosis for CVD and many interventions, as shown in Figure i.11.

vol 1 Figure i.11 Survival of patients with a cardiovascular diagnosis or procedure, by CKD status, 2010-2012

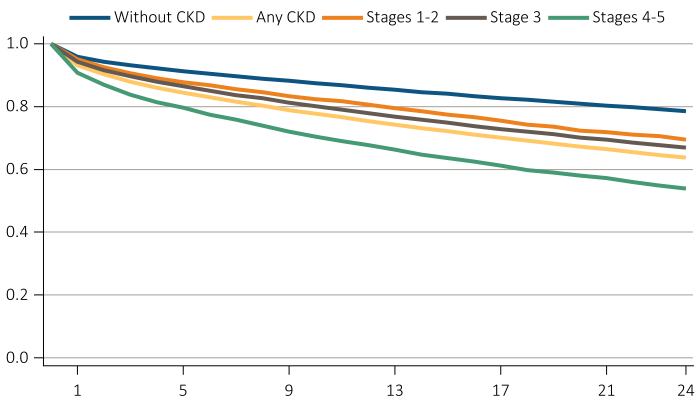
(a) AMI



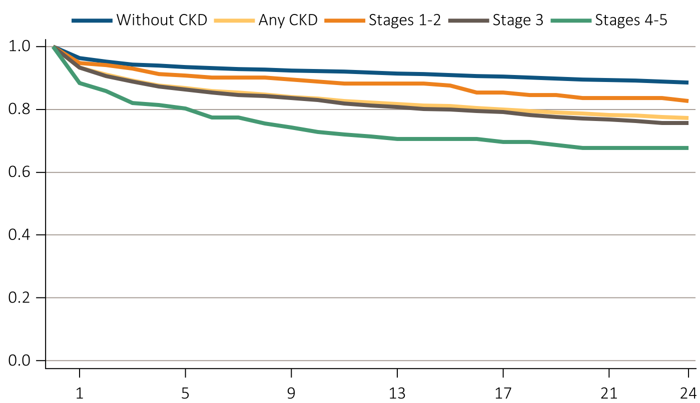
(b) CHF



(c) CVA/TIA



(d) CABG

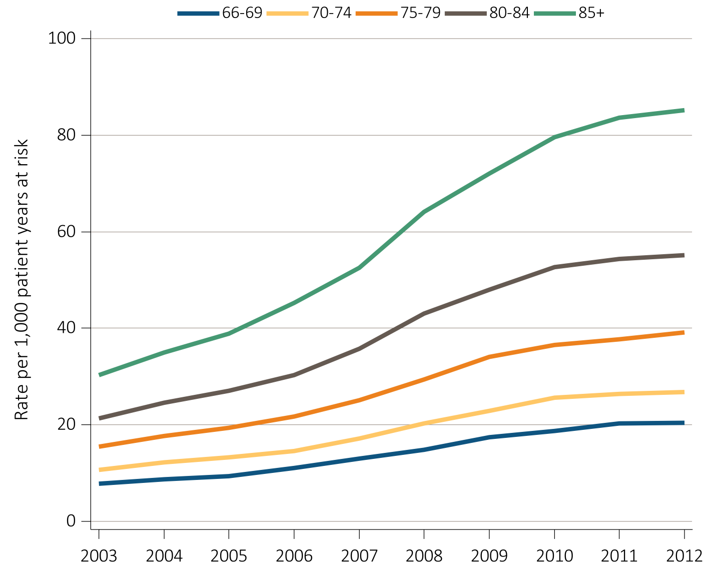


Data Source: Medicare 5 percent sample. Patients age 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2012 with fee-for-service coverage for the entire calendar year. Abbreviations: AMI, acute myocardial infarction; CABG, coronary artery bypass grafting; CHF, congestive 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

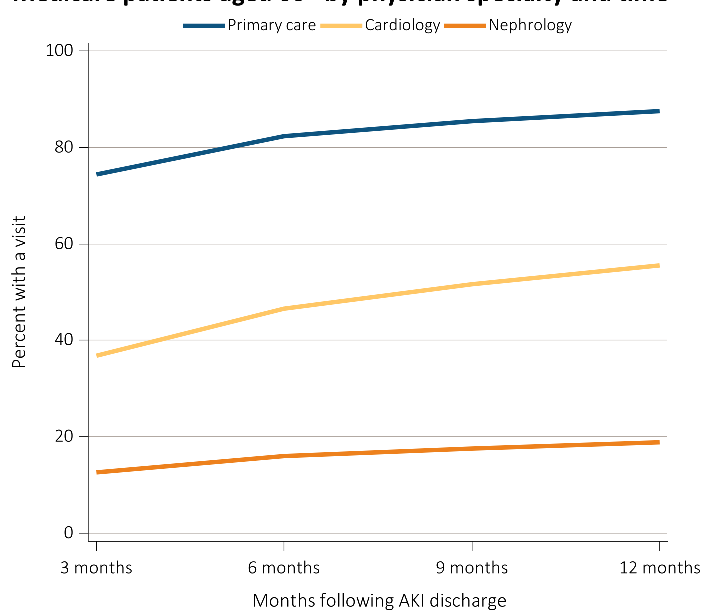
This year we continue to highlight AKI data in Chapter 5. Over the past decade, there has been a rising incidence in AKI hospitalizations among Medicare patients. The incident rate of AKI increases with age, as shown in Figure i.12. The probability of having a follow-up visit with a nephrologist within one year of an AKI hospitalization remains less than 20 percent, as shown in Figure i.13, while follow-up with serum creatinine testing after an AKI hospitalization is generally high (exceeding 90 percent by 12 months, as shown in Figure i.14).

vol 1 **Figure i.12 Unadjusted rates of first hospitalization with AKI for Medicare patients aged 66+ by age and year, 2003-2012**



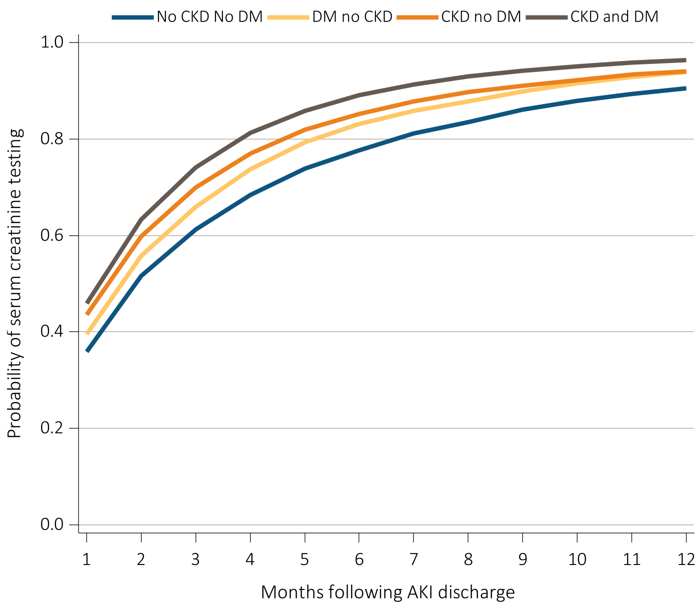
Data Source: Medicare 5 percent sample. Age as of January 1 of specified year. All patient-years at risk for Medicare patients aged 66 or older who had both Medicare Parts A & B, no Medicare Advantage plan (Part C/HMO), no ESRD by first service date from Medical Evidence form, and were alive on January 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. This graphic also appears as Figure 5.2.

vol 1 **Figure i.13 Outpatient physician visits within one year of live discharge from first AKI hospitalization in 2011 for Medicare patients aged 66+ by physician specialty and time**



Data Source: Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan (Part C/HMO), no ESRD by first service date from Medical Evidence form on 1/1/2011, and were discharged alive from a first AKI hospitalization in 2011. 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. This graphic also appears as Figure 5.9.

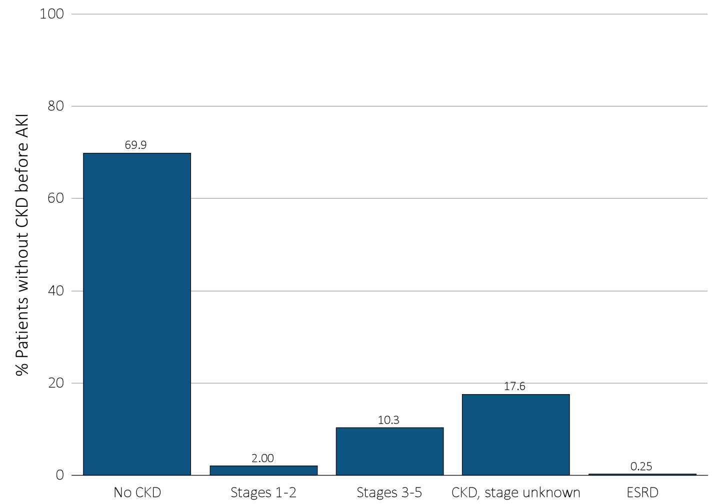
vol 1 Figure i.14 Cumulative probability of a claim for a serum creatinine test within one year of live discharge from first AKI hospitalization in 2011 for Medicare patients aged 66+, by CKD, DM and time



Data Source: Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan (Part C/HMO), no ESRD by first service date from Medical Evidence form on 1/1/2011, and were discharged alive from a first AKI hospitalization in 2011. 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; This graphic also appears as Figure 5.11.

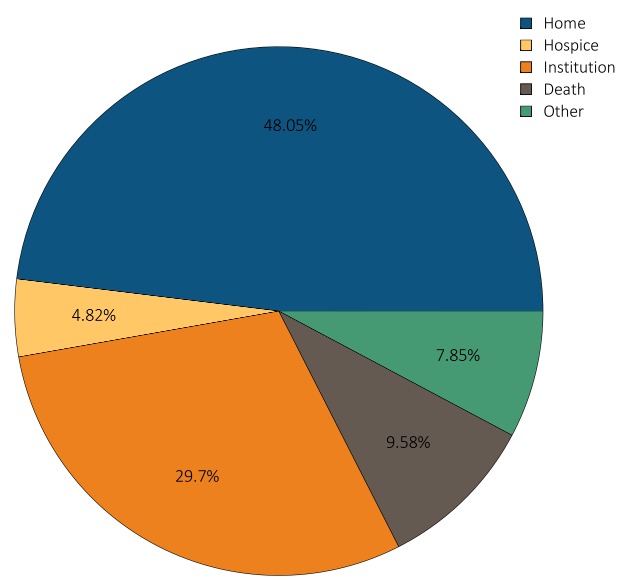
AKI is associated with decline in both renal and functional status. Specifically, nearly 30 percent of patients without claims for CKD in the year before an AKI hospitalization have claims for CKD in the 365 days following their AKI discharge, as presented in Figure i.15. Figure i.16 shows the discharge status from the AKI hospitalization claim for patients with AKI. Approximately 30 percent of patients that were not admitted from a long-term care facility are discharged to an institution (e.g., short and long-term nursing facilities, rehabilitation hospitals) rather than to home.

vol 1 Figure i.15 Renal status one year following discharge from AKI hospitalization in 2010-2011, among surviving Medicare patients aged 66+ without kidney disease prior to AKI hospitalization, by CKD stage and ESRD status



Data Source: Medicare 5 percent sample. Medicare patients aged 66 and older who had both Medicare Parts A & B, no Medicare Advantage plan (Part C/HMO), did not have ESRD, were discharged alive from a first AKI hospitalization in 2010 or 2011, 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 I. This graphic also appears as Figure 5.13.

vol 1 Figure i.16 Hospital discharge status of first AKI hospitalization for Medicare patients aged 66+, 2012



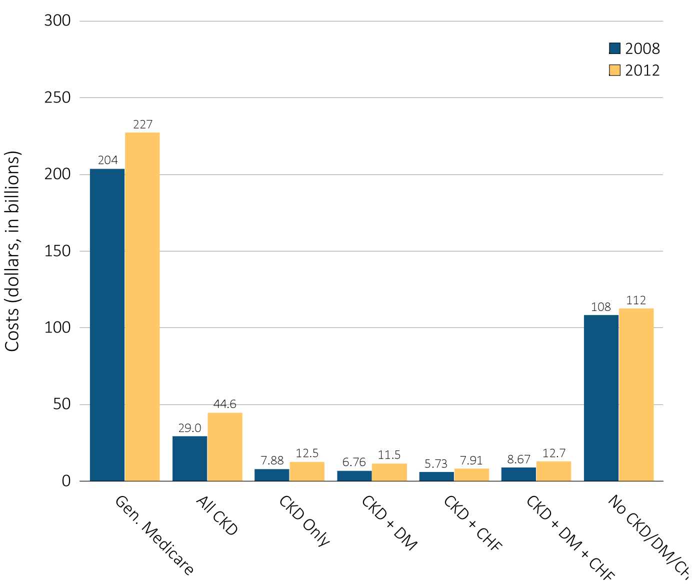
Data Source: Medicare 5 percent sample. Medicare patients aged 66 or older who had both Medicare Parts A & B, no Medicare Advantage plan (Part C/HMO), did not have ESRD on 1/1/2012 and had a first AKI hospitalization in 2012. Institution includes short-term skilled nursing facilities, rehabilitation 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. Abbreviation: AKI, acute kidney injury. This graphic also appears as Figure 5.14.

Chapter 6: Costs of CKD

Chapter 6 contrasts the expenditures of the Medicare program on health care services for enrollees overall, with spending for those with CKD, DM, and CHF. Determining the financial impact of CKD on the health care system is challenging on several levels. First, the considerable under-recognition of CKD reduces the estimated CKD-related total expenditures. Furthermore, the costs of managing CKD are influenced by its interactions with CVD, DM, stroke, infections and other comorbidities. Thus, it is not possible to attribute health care expenditures to mutually exclusive diagnostic categories. In this ADR, we present only Medicare Parts A and B cost data (estimated from the five percent Medicare sample). The costs associated with the recognized CKD population are considerable, and increase with worsening CKD stage; this is consistent with the rising burden of CVD and other chronic diseases with advancing CKD.

Figure i.17 displays 2008-2012 global cost comparisons between the general Medicare population and patients with recognized CKD, or comorbid CKD with DM and/or CHF. More detailed analyses presented in Chapter 6 of this volume illustrate the disproportionate extent of Medicare expenditures when the sizes of these cohorts are considered.

vol 1 **Figure i.17 Overall Medicare Parts A and B costs for fee-for-service patients aged 65 and older, by CKD, DM, CHF, and year, 2008 and 2012**



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

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