CKD Analytical Methods

Contents

Introduction

In this chapter we describe the datasets and methods used for the analyses contained in Volume 1 of the 2014 USRDS Annual Data Report (ADR), which focuses on chronic kidney disease (CKD) prior to end-stage renal disease (ESRD). Data management and preparation, database definitions, and the data sources used for ESRD analyses are described in the 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 are from the National Health and Nutrition Examination Survey (NHANES). Diagnoses, demographic characteristics, and health care procedures for patients with CKD, acute kidney injury (AKI) and related comorbidities are obtained from the standard Centers for Medicare and Medicaid Services (CMS) Medicare 5 percent sample claims files and beneficiary summary files. Patients in the 5 percent files are matched to the USRDS ESRD databases to obtain the date of first service, which is 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.

Centers for Medicare and Medicaid Services Medicare 5 Percent Sample

These files contain billing data from final action claims, those in which all adjustments have been resolved, submitted to Medicare for reimbursement by health care providers on behalf of Medicare beneficiaries. CMS and its contractors produce 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. As of 2012, we receive the Master Beneficiary Summary File (formerly the Denominator file) with demographic information on each beneficiary in the sample, as well as dates of enrollment in the various Medicare programs (Hospital Insurance [Part A], Supplemental Medical Insurance [Part B], Medicare Advantage managed care plans [Part C] and Prescription Drug Benefit [Part D]). Institutional claims for beneficiaries in the 5 percent sample are received in five files based on the type of medical service: inpatient, outpatient, home health agency, hospice, and skilled nursing facility care. Physician and supplier claims (also referred to as carrier claims) are received in one file for durable medical equipment and another for all other Part B covered services. These files collectively are called the Medicare 5 percent files in this ADR. The USRDS 2014 ADR includes all claims up to December 31, 2012, that were submitted and processed by June of 2013.

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 search the USRDS ESRD databases for the beneficiaries in the Medicare 5 percent files. The date of ESRD is 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 is used as the date when ESRD began for analyses in this Volume. See Volume 2 for more information on how the Medical Evidence form is 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 supplement this date of death for patients in the Medicare 5 percent file who experience 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, several restrictions are applied to the raw Medicare 5 percent files to create a sample cohort. 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 the 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 is to reimburse health care providers for services performed for beneficiaries; items that are not necessary to facilitate payment for services generally are 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, Part C provides managed care plans, 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 are often limited to beneficiaries that are enrolled in both Parts A and B and are not enrolled in a Medicare Advantage plan (Part C). In some analyses, the cohort will be limited to patients who meet these restrictions on a certain date, such as January 1 of the reported year. In other cases the sample may be limited to beneficiaries meeting those enrollment restrictions during the entire calendar year.

In most analyses that are 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 is then determined from claims in the year following the entry period (year two). Prevalence analyses, however, are not subject to this requirement and often use 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 are restricted to beneficiaries that are age-eligible for Medicare and, therefore, aged 65 and older. Beneficiaries under the age of 65 may qualify 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 necessarily representative of the U.S. population of the same age. In contrast, 98 percent of the U.S. population aged 65 and older is eligible for Medicare (McBean, 2012). However, unlike the chapter figures and tables, the reference tables for this Volume include all adult (age 20 or older) Medicare beneficiaries regardless of reason for entitlement, except for ESRD patients.

ESRD

Since the focus of this volume is on patients that do not have ESRD, patients under age 65 who are only eligible for Medicare due to ESRD are excluded. Most analyses restrict the sample to beneficiaries that do 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 censor 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 is 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, a patient is considered diabetic if, within a one-year observation period, he or she has a qualifying ICD-9-CM diagnosis code of diabetes mellitus (DM) on one or more Part A institutional claims (inpatient, skilled nursing facility, or home health agency), or two or more institutional outpatient claims and/or Part B physician/supplier claims (Herbert et al., 1999). This algorithm—one inpatient claim, or two outpatient claims with specified diagnosis codes—is 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 diagnosis codes used to define them. Additionally, the overall grouping of cardiovascular disease (CVD) includes patients with at least one of these individual conditions: atherosclerotic heart disease, congestive heart failure, cerebrovascular accident/transient ischemic attack, peripheral vascular disease, dysrythmias, or other cardiac conditions. Analyses within individual chapters also define additional conditions using the same algorithm, 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 use 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 the public-use data files in two-year cycles. Data for this chapter comes from 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 is 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 is self-reported and categorized as non-Hispanic White, non-Hispanic African American, or other.

The identification of CKD is 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 calculate 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). From NHANES data we use the urine albumin creatinine ratio (ACR) to measure albuminuria but do not have information regarding the other markers of kidney damage. Also, the NHANES only includes a single measurement of both serum creatinine (sCR, used to generate eGFR) and ACR, so we cannot address the three-month persistence criteria for defining CKD.

The eGFR (measured in ml/min/1.73 m2) is 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 is 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) are 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 percent. Participants with self-reported diabetes mellitus (SR DM) are those who report having been told by a doctor that they have diabetes or sugar diabetes (other than during pregnancy). In NHANES 2005–2012, participants answering "borderline" are classified as non-diabetic to agree with NHANES III coding. Control of DM is assessed as an HbA1c less than 7 percent.

Patients with hypertension (HTN) are 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) is 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 are classified as aware of their HTN if they report having been told they have high blood pressure, as treated for their HTN if they report currently taking a prescription medication to control HTN, and as in control of their HTN if their current blood pressure is ≤140/≤90 (≤130/≤80 for CKD or SR DM).

Participants who self-report any of the following diseases are considered to have self-reported cardiovascular disease (SR CVD): angina, myocardial infarction, stroke, coronary heart disease, or congestive heart failure. Hyperlipidemia is measured in the medical examination. We assess whether total cholesterol falls into one of three categories: <200 (desirable), 200–239 (borderline high), and ≥240 (high). Individuals are 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 1.8-1.10 are calculated using logistic regression, incorporating the sampling weight and survey design. Each figure displays results of seven logistic models. The model for age includes 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) includes age (20-39/40-59/60+), sex (male/female), race (White/Black/other) and the risk factor shown (yes vs. no). Ninety-five percent confidence intervals are displayed.

Chapter 2: Identification and Care of Patients with CKD

All of the analyses in the P*revalence of Recognized CKD* and *Prevalence & Odds of a CKD Diagnosis Code* sections of this chapter include point prevalent patients who survived all of the reported year (2012 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 are then censored in the analysis if they die, develop ESRD, switch to a Medicare Advantage plan (Part C), or disenroll from Parts A and B during year two.

Table 2.1 presents the distribution of comorbidities in the fee-for-service, age-eligible Medicare population. These include diabetes mellitus (DM), CKD, stroke (cerebrovascular accident [CVA] and transient ischemic attack [TIA]), and congestive heart failure (CHF). 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 2012. Comorbidities included are DM, hypertension (HTN), CHF, and cancer. Each comorbidity is 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 2012. Comorbidities included are DM, HTN and cardiovascular disease (CVD). Logistic regression is 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 (2012) datasets. NHANES data includes the 2011-2012 survey years and is restricted to participants aged 65 or older. NHANES CVD is 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 is defined by claims as having at least one of the following comorbidities: CVA, PVD, ASHD, CHF, dysrhythmia or other cardiac comorbidities. Values for cells with 10 or fewer patients are suppressed and marked with an asterisk.

Figures 2.3–2.6 show statistics on laboratory testing for serum creatinine and urine albumin among various patient populations and by various patient characteristics. For these analyses, a one-year period is used to define comorbid conditions (year one) and then laboratory testing is assessed in the following year (year two, the year reported in the figures). Patients must have Medicare Parts A and B coverage, no Part C participation (Medicare Advantage plans), no ESRD, and be alive for all of year one, through to January 1 of year two. Additionally, the sample is limited to patients residing in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories. First urinary microalbumin measurement is 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 is 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 unadjusted probabilities across time from 2000-2012 for patients with (Figure 2.4) and without (Figure 2.3) CKD. The Kaplan-Meier method is used to calculate the unadjusted cumulative probability of having a claim for each type of laboratory test, from 1/1 through 12/31 of year two, with patients censored at death, development of ESRD, switch to a Medicare Advantage plan (Part C) or loss of Parts A or B coverage. Figures 2.5 and 2.6 show the adjusted probabilities for 2012 by age, sex, race, and a variable for DM and HTN status for those with (Figure 2.6) and without (Figure 2.5) CKD. The four categories of this combined DM and HTN variable are (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. The Kaplan-Meier method – corrected group prognosis methodology is used to calculate the adjusted cumulative probability for each patient characteristic category shown in the figures. Adjustments were age (65-<75/75-<85/85+), sex (male/female), and race (White/Black/Native American/Asian /Hispanic/other/unknown). Probabilities presented for one factor are adjusted for the other factors.

Table 2.5 examines physician visits in the year after a diagnosis of CKD. Similar to the laboratory testing, the sample includes patients who are alive, without ESRD, do not have a Medicare Advantage plan, and have both Parts A and B coverage for all of 2011. The date of the earliest CKD claim (any CKD or Stage 3/4/5 [585.3–585.6]) in 2011 is used as the date of CKD diagnosis, and claims are then searched for services provided by primary care physicians, nephrologists, and cardiologists for 365 days following that date. Primary care visits are defined based on a physician specialty code of 01, 08 and 11; cardiologist visits are defined based on specialty code 06, and nephrology visits are defined based on specialty code 36. Adjusted cumulative probability is obtained from the corrected group prognosis method.

Chapter 3: Morbidity and Mortality

The analyses in this chapter use a one-year entry period to determine disease conditions prior to hospitalization, referred to as 'year one'. Patients are 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 are then searched for diagnoses as described in the *Identification of Major Comorbidities* section of this chapter. Additionally, patients must meet these criteria and be aged 66 or older on January 1 of the following year (year two). Mortality and hospitalization are then determined from January 2 to December 31 of year two. Analyses are 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 begins on January 1 of year two, and is 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 is 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 integrates 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 1995 to 2012, and Figure 3.2 shows rates for 2012 by CKD status and stage. Unadjusted mortality is 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 is based on a Cox regression model and adjusted for age (66-<70/70-<75/75-<85/85+ years), race (White, Black or African American/all others), sex, hospitalization in the prior year, and atherosclerotic heart disease (ASHD), anemia, congestive heart failure (CHF), chronic obstructive pulmonary disorder (COPD), stroke (CVA/TIA), cancer (other than non-melanoma skin cancer), diabetes mellitus (DM), dysrhythmias, gastrointestinal bleeding disorders (GI), hypertension (HTN), liver disease, other cardiac conditions, and peripheral vascular disease (PVD). See Table m.2 in the section on *Identification of Major Comorbidities* in this chapter for ICD-9-CM codes. All patients in 2010 are used as the reference cohort for Figure 3.1, while all patients in 2012 form the reference cohort for Figure 3.2. Table 3.1 and Figures 3.3 and 3.4 use the same cohort and modeling as Figures 3.1 and 3.2, but with slightly different covariates. Age, race, sex, prior hospitalization, anemia, cancer, COPD, GI, HTN and liver disease are the same as above, but instead of individual cardiovascular diseases (ASHD, CHF, CVA/TIA, dysrhythmias, PVD, and other cardiac conditions) and DM, a variable representing cardiovascular disease in combination with DM is included. The four categories are: patients without CVD and DM (reference group), patients with CVD but not DM, patients with DM but not CVD, and patients with both CVD and DM. All patients alive without ESRD and with Parts A and B coverage but not Part C on 1/1/2012 are used as the reference cohort.

Hospitalization

For the hospitalization analysis, additional processing is performed on the inpatient claims data. A patient's inpatient claims are ordered by date and compared

to identify overlapping claims (two claims covering the same time frame), consecutive claims (one claim's admission date is 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 are consolidated into one claim with dates, diagnoses, and procedures combined. Analyses exclude 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 are 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 include the following variables as adjustments: age (66-<70/70-<74/75-<85/85+), race (White/Black/other), sex (male/female), hospitalization in the prior year, no DM or CVD (reference group), DM only, CVD only, both DM and CVD, anemia, COPD, cancer (other than non-melanoma skin cancer), GI bleeding disorders, HTN, and liver disease. A model-based adjustment method is used, with a generalized linear model using a Poisson distribution and log link function. The sample includes data from the current and previous two years, with respective weights of 1.0, 0.25 and 0.125. Adjusted rates reflect the distribution of a reference cohort, specified below in the discussion of the respective figures. With this method, the parameter estimates from the model are used to calculate an estimated admission rate for each patient in the reference cohort. Overall adjusted rates are 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 3.5 - 3.7 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, comorbidities are ascertained in 2011 for the analysis of hospital admissions in 2012. All patients must be 66 or older and not have ESRD on 1/1/2012, have Medicare Parts A and B coverage for all of 2011 and on 1/1/2012, and not participate in a Medicare Advantage plan from 1/1/2011 through 1/1/2012. Rates presented by one factor are adjusted for the others. The reference cohort includes Medicare patients in 2011, 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 cause of hospitalization	All codes except those 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 3.8 - 3.10 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 are 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 focus 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, are 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 is identified; the latter date (12/1) is a cutoff to allow a 30-day follow-up period after discharge to evaluate rehospitalization. The unit of analysis is a hospital discharge rather than a patient. Hospital stays are 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 are 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. Figure 3.11 shows results for 2012 for patients with and without CKD before the index hospitalization, Figure 3.12 illustrates this by age group, Figure 3.13 by race group, and Figure 3.15 for cardiovascular-related hospitalization instead of all-cause. Table 3.3 shows the 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 3.14 displays annual trends in rates of rehospitalization and/or death within 30 days after hospital discharge among CKD patients. Live hospital discharges from January 1 to December 1 of each year are included. Rates are adjusted for age, sex, and race using direct adjustment, and the reference group is discharges in 2011.

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 include atherosclerotic heart disease (ASHD), acute myocardial infarction (AMI), congestive heart failure (CHF), cerebrovascular accident/transient ischemic attack (CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AFIB), and sudden cardiac arrest and ventricular arrhythmias (SCA/VA). The same algorithm described in the Identification of Major Comorbidities section of this chapter (one inpatient or two outpatient claims with the specific diagnosis) is 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 chapter four of Volume 1 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; 422[a]; 425[a]; 428; V42.1[a]
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; 422[a]; 425[a]; 428 (not 428.2-428.4); V42.1[a]
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 include percutaneous coronary interventions (PCI), coronary artery bypass grafting (CABG), and the placement of implantable cardioverter defibrillators (ICD) and cardiac resynchronization devices with defibrillators (CRT-D). Procedures require only one claim with the procedure code. The presence of PAD is determined by the diagnosis or a claim for a procedure. Table m.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 chapter four of Volume 1 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 includes Medicare enrollees who are alive, aged 66 and older, reside in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, do not have ESRD on December 31, 2012, and who are continuously enrolled in Medicare Parts A and B and not enrolled in a Medicare Advantage plan (Part C) for all of 2012. Cardiovascular conditions, CKD, and CKD staging are determined from claims in 2012.

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 2012. The cohort is the same one used for Figure 4.1. However, the denominators for the cardiovascular procedures are not "all patients in the cohort", which is the denominator for the prevalence statistics. The percent with PCI and the percent with CABG are out of cohort members with ASHD, and the percent with ICD/CRT-D is 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 1/1/2009 through 12/31/2012 are 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 is considered the index date. To be retained in the analysis cohort, the patient must be aged 66 or older on the index date, reside in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, be 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 are excluded. Claims for the patient in the 365 days prior to the index date are then searched for a prior occurrence of the given condition/procedure, and these patients are excluded from the analysis. CHF in this figure excludes those with only diagnosis codes of 422, 425, and V42.1. CKD status and stage are also determined from the patient's claims in the 365 days prior to the index date. Patients are then followed from the index date until the earliest of date of death, three years after the index date, ESRD diagnosis, or December 31, 2012. The Kaplan-Meier method is used to estimate survival.

Type of heart failure for the calendar year is 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 is determined by searching all reported diagnoses on all claims for a given calendar day. Each day is 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 is then summed for the calendar year. The patient's type of heart failure for the year is then determined by a hierarchy similar to that applied for each calendar day: if the patient has any systolic heart failure and no diastolic-only heart failure, he/she is classified as systolic heart failure; if the patient had diastolic heart failure and no systolic, he/she is classified as diastolic heart failure; and if the patient had only unspecified heart failure, he/she is classified as unspecified heart failure. When a patient had both systolic and diastolic-only diagnosis days during the year, he/she is 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 includes Medicare enrollees who are alive, aged 66 and older, reside in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, who do not have ESRD on December 31, 2012, and who are continuously enrolled in Medicare Parts A and B and not enrolled in a Medicare Advantage plan (Part C) for all of 2012.

Figure 4.3 shows the distribution of heart failure type by CKD status in 2012 and uses the same study cohort as in Table 4.2. The denominators are the total numbers of patients in each CKD status or stage group, and the numerators are the numbers of patients with the given heart failure type within that CKD status or stage group.

Table 4.3 shows the results of two separate Cox models of two-year all-cause mortality in two separate groups of patients—those with CKD (panel a) and those with CHF (panel b). CHF, CKD, DM and HTN statuses are determined from claims for 2010; the study cohort includes Medicare enrollees who are alive and aged 66 or older on December 31, 2010, reside in the 50 states, the District of Columbia, Puerto Rico, or the U.S. territories, are continuously enrolled in Medicare Parts A and B, and are not enrolled in a Medicare Advantage plan for all of 2010. Patients with ESRD on or before December 31, 2010 are excluded. Follow-up began on 1/1/2011 and continued until death or 12/31/2012. The sample for Panel a is all patients in the cohort who had CKD in 2010, while the sample for Panel b is all patients in the cohort with CHF in 2010. Type of heart failure is determined by the same procedure as the previous figures using claims from 2010. Codes used to define DM and HTN can be found in Table m.2 of this chapter. Age is defined as of 12/31/2010.

Chapter 5: Acute Kidney Injury

The manner of defining acute kidney injury (AKI) has been changed for the 2014 ADR. In prior years, a patient 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. For this year's ADR, in order to qualify as having an AKI hospitalization patients must have a diagnosis code for AKI associated with their inpatient stay (not necessarily as the primary diagnosis). As in prior years, this chapter is only concerned with in-hospital AKI. Dialysis during the AKI hospitalization is defined using diagnosis, procedure, and revenue center codes. The inpatient claims file is 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) are searched for HCPCS codes 90935, 90937, 90945, and 90947 with service dates that correspond to the patient's inpatient stay. Patients with ESRD prior to the inpatient stay are not counted as having AKI.

Characteristics of Patients with AKI

The cohort used for Figures 5.1-5.4 and Table 5.1 is different this year compared to prior years' ADRs. Previously, these statistics were shown for patients who had an AKI hospitalization in a given calendar year and were alive, without ESRD, continuously enrolled in Medicare Parts A and B, and not enrolled in a Medicare Advantage plan (Part C) for the entire year. Given the relatively high death rates for AKI patients, both during the hospital stay and within

the first several months following discharge, we removed the requirement for the patient to be alive without ESRD for the entire calendar year of the AKI hospitalization. In this year's ADR, the cohort sample for Figures 5.1-5.4 and Table 5.1 includes 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) are determined as described in the Identification of Major Comorbidities section of this chapter and Tables m.1 and m.2, using claims from a one-year entry period (year one, the calendar year before the year in which hospitalization is assessed for AKI) and then assessing hospitalization in the following year (year two, the year reported in the figures and tables). While a patient can have more than one hospitalization with AKI during a given calendar year, the figures and table in this section count only the first AKI hospitalization per patient, per year. Each calendar year forms a separate cohort; so a patient can have 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, uses the numerator of Panel a as its denominator, showing the fraction of cohort patients who had at least one AKI hospitalization that received a dialysis procedure during that AKI hospitalization. Note that these percentages do not take into account each patient's individualized time at risk—for example, a patient who dies in February is still included in the denominator for the entire year, even though he/she is not at risk of having an AKI hospitalization after February. These percentages answer the question—what percent of people (meeting the cohort inclusion criteria in the previous paragraph) alive on January 1 experience an AKI hospitalization during the year. Table 5.1 also uses 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 use 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 is counted as an event, and years at risk are 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 is as of January 1 of year two, while CKD and DM status is determined by claims in year one. A Cox proportional hazard model with no covariates, stratified by the variable of interest, is used to estimate survival, and the rate is 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 results from two Cox proportional hazard models—one for time to first AKI hospitalization and one for time to first AKI hospitalization when that hospitalization included dialysis treatment. Each model includes the following covariates: age (66-<70/70-<75/75-<79/80-<85/85+ years), race (White/Black or African American/ all others), sex (male/female), and a variable representing CKD in combination with DM. The four categories of the combined DM and CKD variable are: 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 are from the 'time to first-AKI' model, while the lighter bars are from the 'time to first-AKI when that hospitalization included dialysis' model. The cohort used is the same as the 2012 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 no Medicare Advantage plan on 1/1/2012. Each patient is followed from January 1, 2012, 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, 2012.

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 starts with the 2010 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 1/1/2010. The first AKI hospitalization in 2010 is identified. Age is as of 1/1/2010 and comorbidities are 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 are 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 includes only those patients with at least one AKI hospitalization in 2010 who are discharged alive. Follow-up begins on the date of discharge listed on the claim for the AKI hospitalization and continues 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 are 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 as patients with a first AKI hospitalization in 2010 or 2011. Patients are alive, aged 66 or older, without ESRD, with Parts A and B coverage and no Medicare Advantage plan on January 1 of the year of their AKI hospitalization. Those who are discharged alive from their AKI hospitalization are 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 is 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 is not censored at the start of ESRD. For the mortality model, survival time is 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 examine physician visits after a live discharge from an AKI hospitalization. Claims are 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 are 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 the specified laboratory test. A first serum creatinine measurement is defined as the first claim with an Healthcare Common Procedure Coding System (HCPCS) code of 80047, 80048, 80049, 80050, 80053, 80054, 80069, or 82565. Likewise, first urinary microalbumin measurement is defined as the first claim with an HCPCS code of 82042, 82043, 82044, or 84156. Patients are 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 2010 or 2011. Patients are alive, aged 66 or older, without ESRD, with Parts A and B coverage, and no Medicare Advantage plan on January 1 of the year of their AKI hospitalization, and do not have any claims with a diagnosis of CKD in the 365 days prior to that AKI admission. Renal status after AKI is determined from claims occurring between discharge from the AKI hospitalization and 365 days after discharge. CKD stage is 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 2012. The cohort includes all patients who experienced an AKI hospitalization during 2012 and who are 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, 2012. 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) are 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) are 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 are those whose 'patient discharge status' is 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 is 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 not available in time to include in the analyses. Consequently, costs in this year's chapter only refer to expenditures under the Medicare Part A (Hospital Insurance) and Part B (Supplemental Medical Insurance) programs. Analyses of costs from Medicare Part D will be available again in the 2015 ADR.

The cohort used for this chapter continues the methodology introduced in the 2010 ADR, which only tabulates CKD costs for patients with at least one CKD diagnosis among their claims in the year prior to the reported year (year one). For example, the total costs of CKD for 2012 (year two) includes all costs incurred by patients with a CKD diagnosis in 2011 (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 is used to create all the tables and figures in this chapter. Each year's cohort includes patients aged 65 and older who are alive and without ESRD on January 1 of the reported year (year two). Cohort members are 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 are aggregated for the reported year (year two). Patient years at risk are 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 yields the per person per year (PPPY) costs. Since these total costs and number of patients are based on the 5 percent Medicare files, counts and expenditures are multiplied by 20 to represent 100 percent of Medicare fee-for-service Parts A and B expenditures for age-eligible patients who are 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 split 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, 2011, and ended on January 7, 2012, it spanned 10 days, with 3 days in 2011 and 7 days in 2012. Seventy percent of that claim's total expenditure amount would be added 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 is determined as of December 31 of year one. Race and sex are provided by the Master Beneficiary Summary File.

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 (age 65 and older) cohort presented in Chapter 2. Each year's cohort includes 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 is calculated as of December 31 of the reported year. Race and sex are 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 are 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 are 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 Chapter 1: CKD in the General Population in this chapter. For Table B.8, CKD is defined as 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 is 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 three months of each other, 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 is 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 and B Medicare expenditures for point prevalent (December 31) general Medicare patients, also derived from the 5 percent Medicare sample. Methods for these tables are the same as those described in the Chapter 6: Costs of 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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