Chapter 4: Cardiovascular Disease in Patients With CKD

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

Introduction

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

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

Analytical Methods

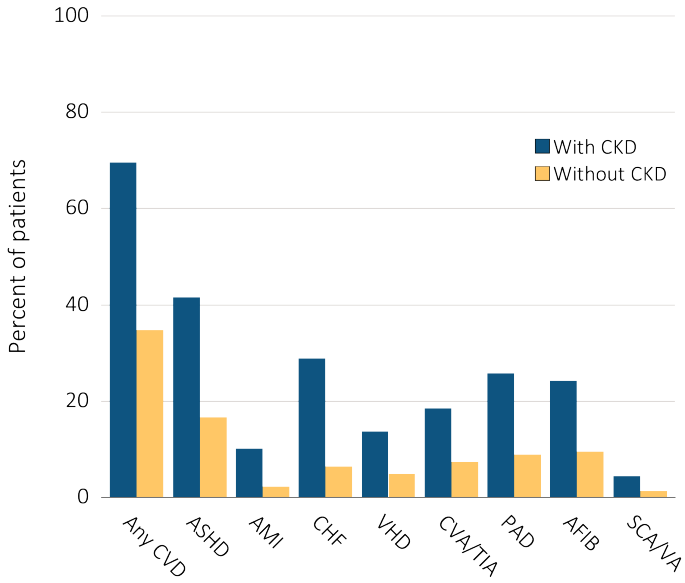
See the CKD Analytical Methods chapter for an explanation of analytical methods used to generate the study cohorts, figures, and tables in this chapter.

Cardiovascular Disease Prevalence and Outcomes in CKD

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

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

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

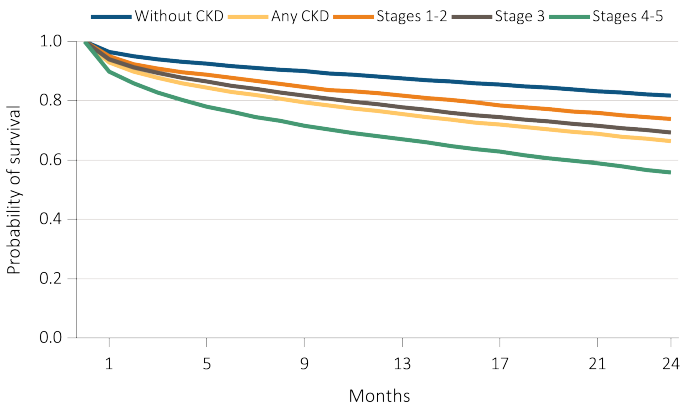


Data Source: Special analyses, Medicare 5 percent sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the U.S. on 12/31/2013 with fee-for-service coverage for the entire calendar year. Totals of patients for the study cohort: N=1,238,888; With CKD=132,840; Without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

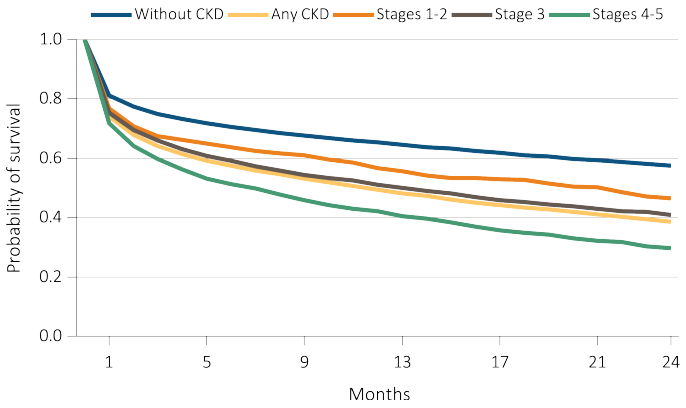
The presence of CKD also worsens the short- and long-term prognosis for many of these common cardiovascular diseases. Figures 4.2.a through 4.2.k illustrate survival in patients with cardiovascular disease stratified by the presence of CKD and its severity. In general, CKD patients have worse survival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

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

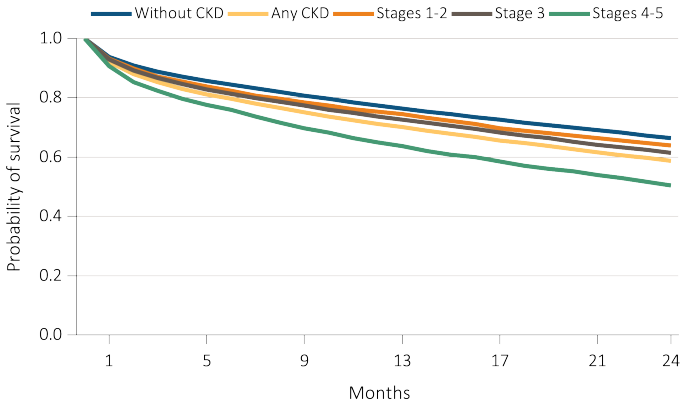
(a) ASHD



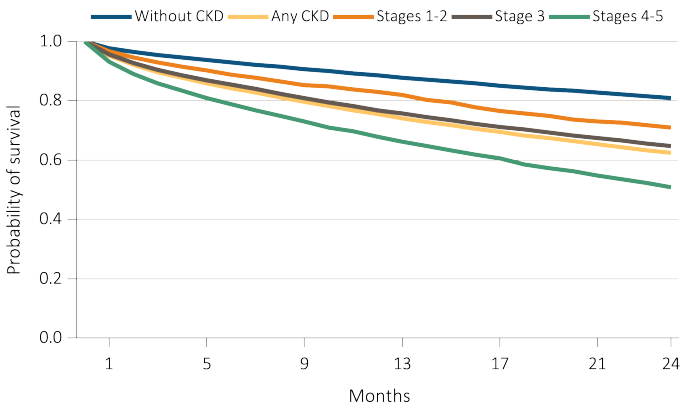
(b) AMI



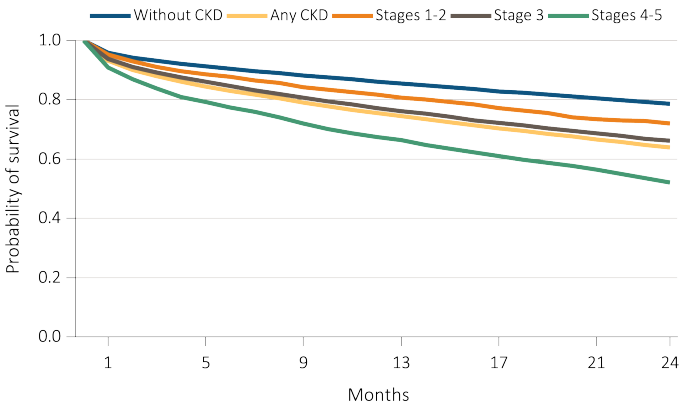
(c) CHF



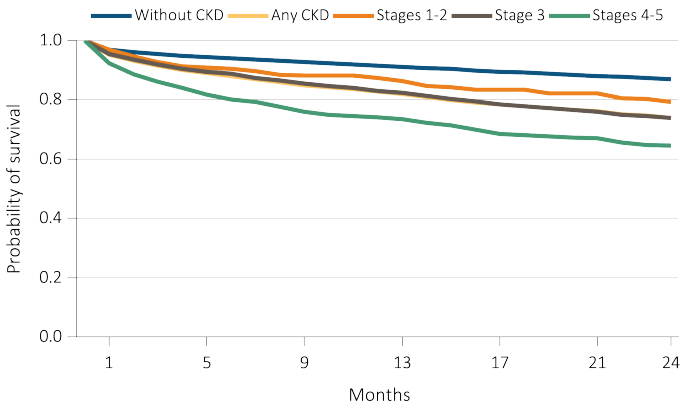
(d) VHD



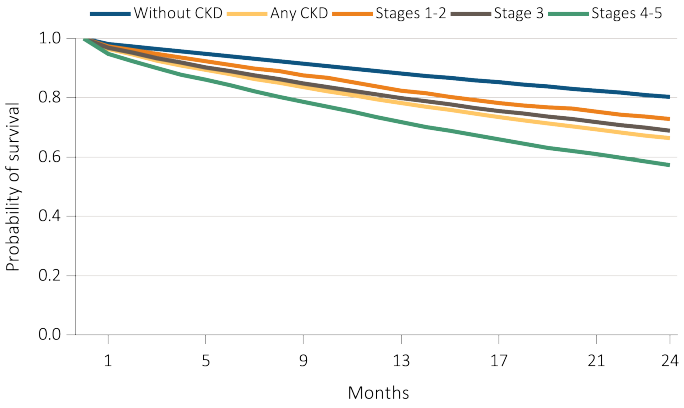
(e) CVA/TIA



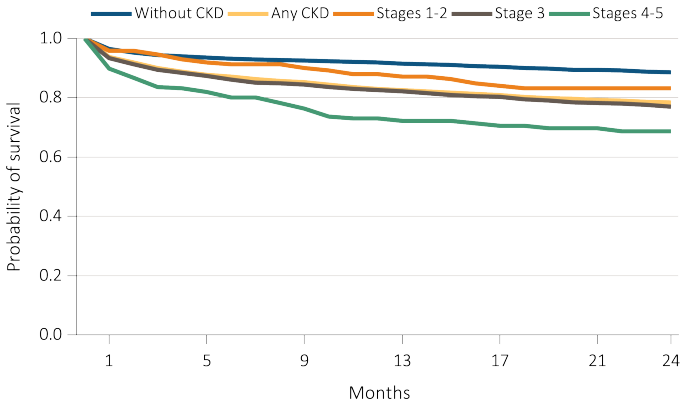
(i) PCI



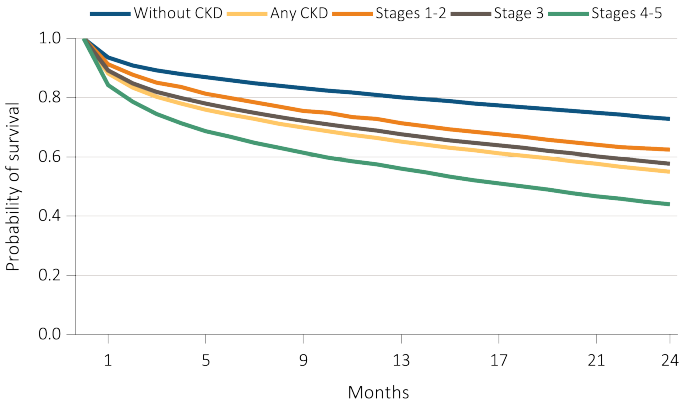
(f) PAD



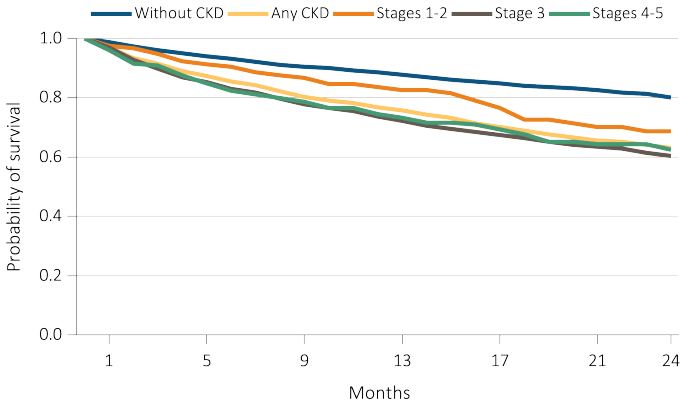
(j) CABG



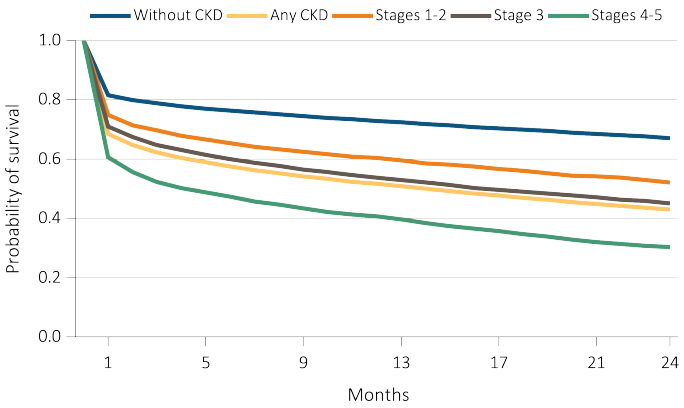
(g) AFIB



(k) ICD/CRT/D



(h) SCA/VA



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

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

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

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

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

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

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

Congestive Heart Failure and Chronic Kidney Disease

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

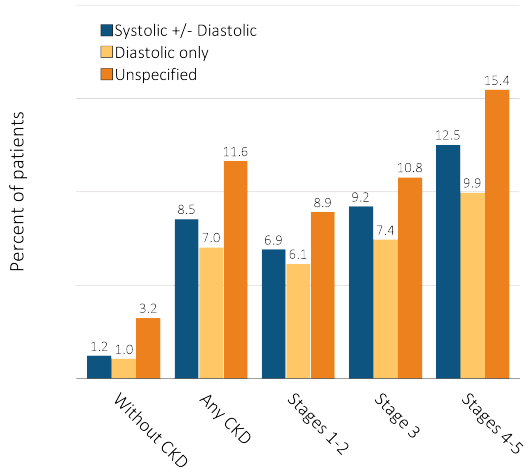
In general, the distribution of age and sex show similar patterns among patients with both CHF and CKD when compared with those with CHF without CKD. However, the proportion of Blacks/African Americans and diabetic patients is higher among patients with both CHF and CKD. These patterns were consistent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

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

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

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

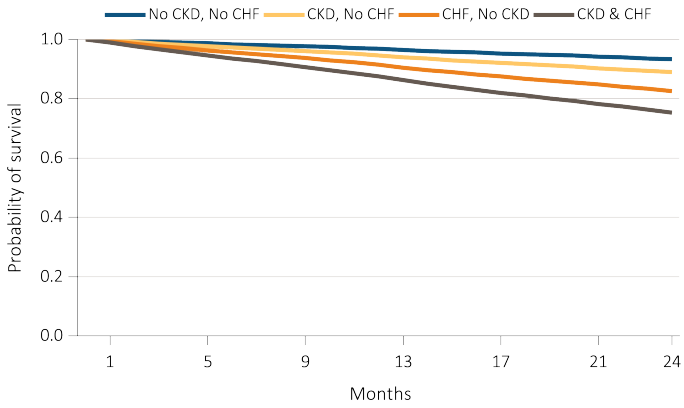
vol 1 Figure 4.3 Heart failure in patients with or without CKD, 2013



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

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

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



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

Atrial Fibrillation and Chronic Kidney Disease

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

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

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

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

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Notes