

Chapter 4: Cardiovascular Disease in Patients With CKD

- The prevalence of cardiovascular disease is 68.8% among patients aged 66 and older who have CKD, compared to 34.1% among those who do not have CKD (Table 4.1).
- The presence of CKD worsens the short- and long-term prognosis for many common cardiovascular diseases. The two-year survival of prevalent AMI patients without a diagnosis of CKD is 80%, compared to 69% for CKD Stage 1-2 patients and 53% for CKD Stage 4-5 patients (Figure 4.2).
- Over a two-year period, Medicare patients with both congestive heart failure and CKD have an adjusted survival probability of 76.0%, compared with 89.3% for those with CKD alone (Figure 4.5).
- Atrial fibrillation is common among Medicare patients with CKD (24.5%). The prevalence of atrial fibrillation is higher for males, those with more advanced stages of CKD, older persons, and is higher in the presence of hypertension, and congestive heart failure. Nearly half of CKD patients with congestive heart failure have a diagnosis of atrial fibrillation (Table 4.2).

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 approximately 41% of 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, suggesting that the risk of CKD is equivalent to individuals who have established coronary disease. 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). Thus, cardiovascular disease is 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% sample. The overall study cohort for 2014 includes 1,241,019 patients, of whom 138,176 have CKD.

Methods

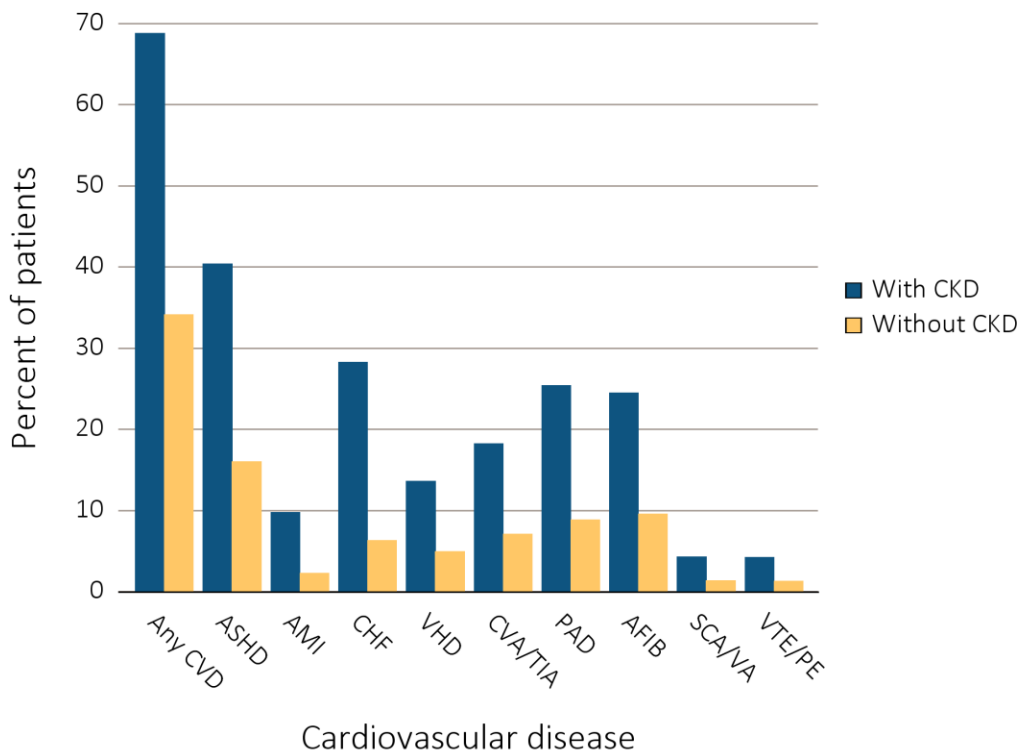
This chapter uses data from the Medicare 5% sample’s fee-for-service patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States on 12/31/2014 with fee-for-service coverage for the entire calendar year. See the section on [Chapter 4](#) in the *CKD Analytical 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), sudden cardiac arrest and ventricular arrhythmias (SCA/VA), and venous thromboembolism and pulmonary embolism (VTE/PE) 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 (68.8% versus 34.1%). Part of this differential is due to the older age of CKD patients (see [Volume 1, Chapter 2: Identification and Care of Patients With CKD](#)). The prevalence of both CKD and CVD increases with age.

vol 1 Figure 4.1 Prevalence of cardiovascular diseases in patients with or without CKD, 2014



Data Source: Special analyses, Medicare 5% sample. 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; VTE/PE, venous thromboembolism and pulmonary embolism.

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), the placement of implantable cardioverter defibrillators (ICD) and cardiac resynchronization (CRT) devices, and carotid artery stenting and carotid endarterectomy (CAS/CEA).

vol 1 Table 4.1 Prevalence of (a) cardiovascular comorbidities & (b) cardiovascular procedures, (%) by CKD status, age, race, & sex, 2014

	# Patients	(a) Cardiovascular comorbidities									
		% Patients									
		Overall	66-69	70-74	75-84	85+	White	Blk/Af Am	Other	Male	Female
Any CVD											
Without CKD	1,102,843	34.1	20.3	28.8	41.2	54.4	35.0	30.4	25.3	37.4	31.6
Any CKD	138,176	68.8	55.6	61.4	70.3	79.1	69.8	64.7	61.8	72.4	65.5
Atherosclerotic heart disease (ASHD)											
Without CKD	1,102,843	16.0	9.9	14.3	19.7	22.5	16.5	12.9	12.2	21.3	11.9
Any CKD	138,176	40.3	32.1	36.7	42.6	44.0	41.4	33.9	36.5	47.9	33.4
Acute myocardial infarction (AMI)											
Without CKD	1,102,843	2.2	1.5	1.9	2.6	3.2	2.3	1.8	1.4	2.9	1.7
Any CKD	138,176	9.8	8.7	9.0	9.9	10.7	10.1	8.3	7.9	11.7	8.0
Congestive heart failure (CHF)											
Without CKD	1,102,843	6.2	3.0	4.3	7.3	13.7	6.3	7.3	4.5	6.4	6.1
Any CKD	138,176	28.2	20.7	22.2	27.7	37.4	28.3	30.4	23.0	28.8	27.7
Valvular heart disease (VHD)											
Without CKD	1,102,843	4.9	2.4	3.7	6.3	8.8	5.2	3.3	3.4	4.7	5.0
Any CKD	138,176	13.6	8.2	10.0	14.1	18.1	14.2	10.3	10.4	13.6	13.5
Cerebrovascular accident/transient ischemic attack (CVA/TIA)											
Without CKD	1,102,843	7.1	3.8	5.7	9.0	11.8	7.1	7.7	5.4	7.1	7.1
Any CKD	138,176	18.2	13.8	15.4	19.0	21.3	18.1	20.4	15.5	18.5	17.9
Peripheral artery disease (PAD)											
Without CKD	1,102,843	8.8	4.2	6.4	10.5	18.6	8.9	9.6	6.6	8.9	8.8
Any CKD	138,176	25.3	18.6	21.6	25.6	31.2	25.6	24.7	22.2	26.7	24.1
Atrial fibrillation (AFIB)											
Without CKD	1,102,843	9.5	4.0	6.7	12.3	19.1	10.2	4.8	5.1	10.7	8.6
Any CKD	138,176	24.5	14.1	17.8	25.6	33.1	26.3	15.0	16.0	27.0	22.2
Cardiac arrest and ventricular arrhythmias (SCA/VA)											
Without CKD	1,102,843	1.3	0.9	1.2	1.6	1.6	1.4	1.1	0.8	1.8	1.0
Any CKD	138,176	4.2	3.6	4.1	4.6	4.1	4.3	4.4	3.0	5.8	2.8
Venous thromboembolism and pulmonary embolism (VTE/PE)											
Without CKD	1,102,843	1.2	0.8	1.0	1.5	1.9	1.3	1.5	0.7	1.2	1.3
Any CKD	138,176	4.2	3.9	3.8	4.2	4.5	4.1	5.4	3.0	4.0	4.3

Table 4.1 continued on next page.

vol 1 Table 4.1 Prevalence of (a) cardiovascular comorbidities & (b) cardiovascular procedures, (%) by CKD status, age, race, & sex, 2014 (continued)

	# Patients	(b) Cardiovascular procedures									
		% Patients					White	Blk/Af Am	Other	Male	Female
Overall	66-69	70-74	75-84	85+							
Revascularization – percutaneous coronary interventions (PCI)											
Without CKD	176,023	2.0	3.0	2.3	1.8	1.2	2.0	1.5	2.0	2.0	2.0
Any CKD	55,737	3.1	4.6	4.0	3.1	1.9	3.1	2.6	3.2	3.3	2.9
Revascularization – coronary artery bypass graft (CABG)											
Without CKD	176,023	1.1	1.7	1.4	1.1	0.2	1.1	0.8	1.2	1.4	0.7
Any CKD	55,737	1.7	2.9	2.5	1.9	0.5	1.8	1.0	1.8	2.2	1.1
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)											
Without CKD	68,844	0.5	0.8	0.8	0.6	0.2	0.5	0.4	0.4	0.8	0.3
Any CKD	38,963	0.8	1.3	1.3	0.9	0.3	0.7	0.9	0.8	1.2	0.4
Carotid artery stenting and carotid artery endarterectomy (CAS/CEA)											
Without CKD	272,967	0.6	0.7	0.7	0.6	0.2	0.6	0.3	0.3	0.6	0.5
Any CKD	76,849	0.8	1.0	1.2	0.9	0.4	0.9	0.4	0.5	1.0	0.6

Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States on 12/31/2014 with fee-for-service coverage for the entire calendar year. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; Blk/Af Am, Black African American; CABG, coronary artery bypass grafting; CAS/CEA, carotid artery stenting and carotid endarterectomy; 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; VTE/PE, venous thromboembolism and pulmonary embolism. (a) The denominators for overall prevalence of all cardiovascular comorbidities are Medicare enrollees aged 66+ by CKD status. (b) The denominators for overall prevalence of PCI and CABG are Medicare enrollees aged 66+ with ASHD by CKD status. The denominators for overall prevalence of ICD/CRT-D are Medicare enrollees aged 66+ with CHF by CKD status. The denominators for overall prevalence of CAS/CEA are Medicare enrollees aged 66+ with ASHD, CVA/TIA, or PAD by CKD status.

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.i and Figures 4.3.a through 4.3.d illustrate survival in patients with cardiovascular disease and undergoing cardiovascular procedures, respectively, 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 80%, compared to 69% for CKD Stage 1-2 patients and 53% for CKD Stage 4-5 patients. All of these analyses are unadjusted for age. Older age is also associated with higher mortality and thus would attenuate the unadjusted findings presented here.

vol 1 Figure 4.2 Survival of patients with a prevalent cardiovascular disease, by CKD status, 2013-2014

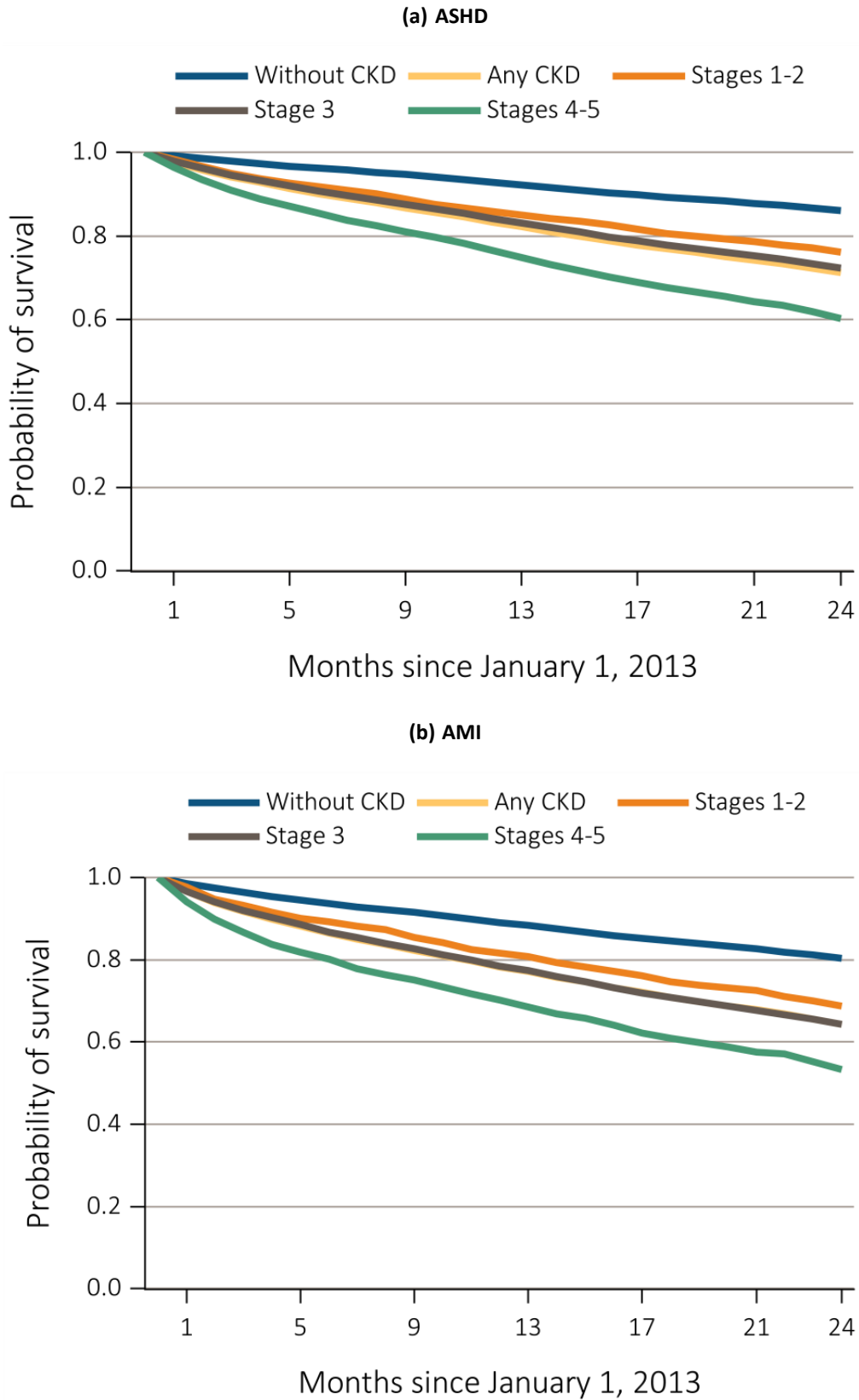


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vol 1 Figure 4.2 Survival of patients with a prevalent cardiovascular disease, by CKD status, 2013-2014
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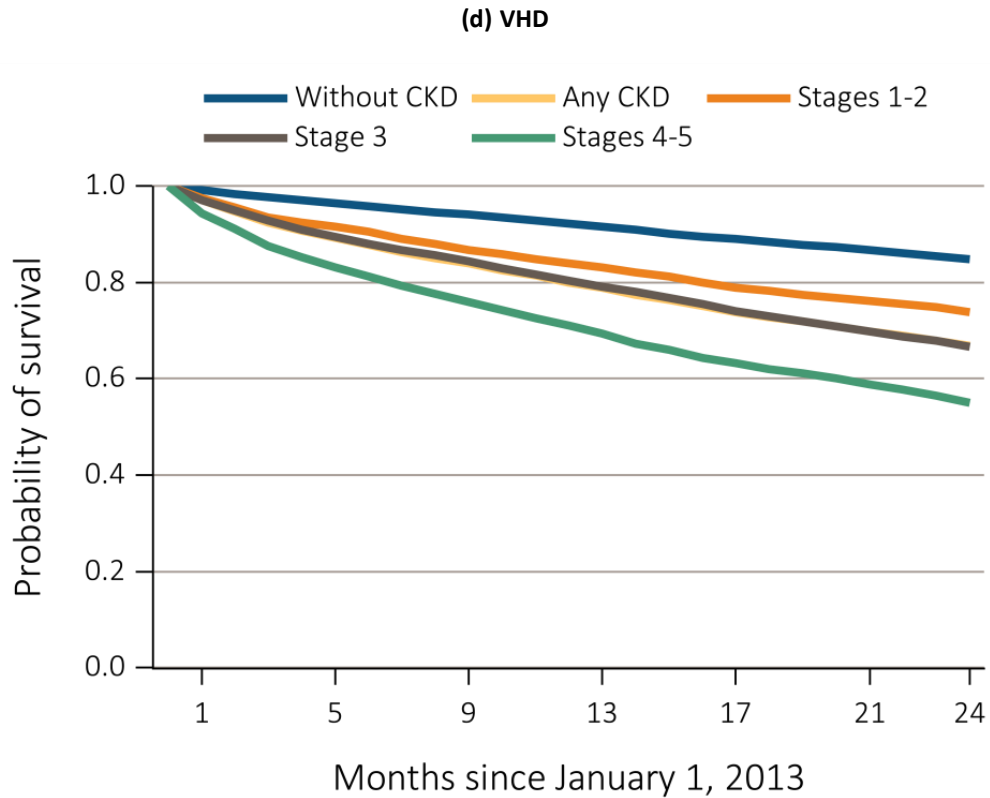
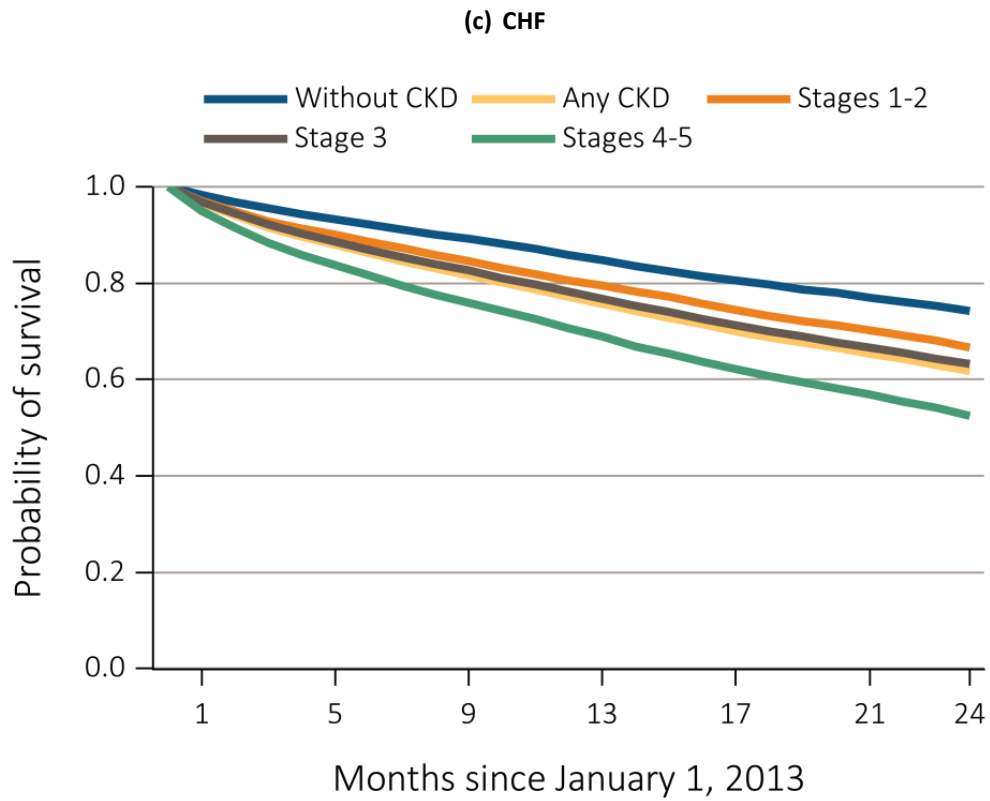


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vol 1 Figure 4.2 Survival of patients with a prevalent cardiovascular disease, by CKD status, 2013-2014
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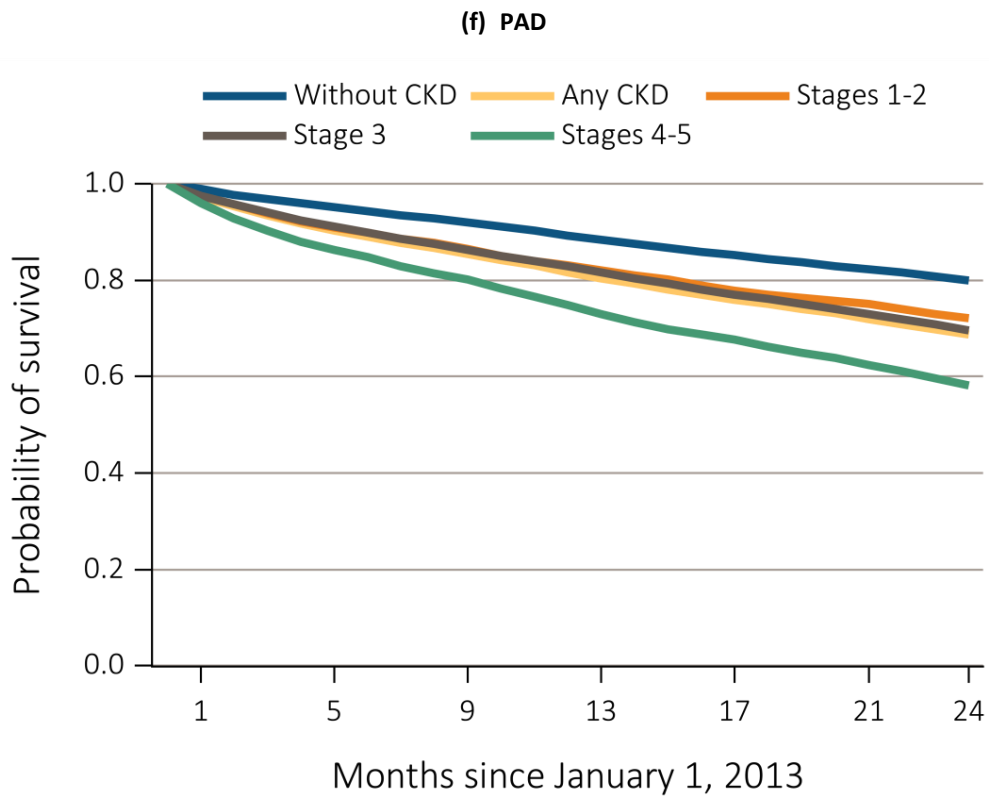
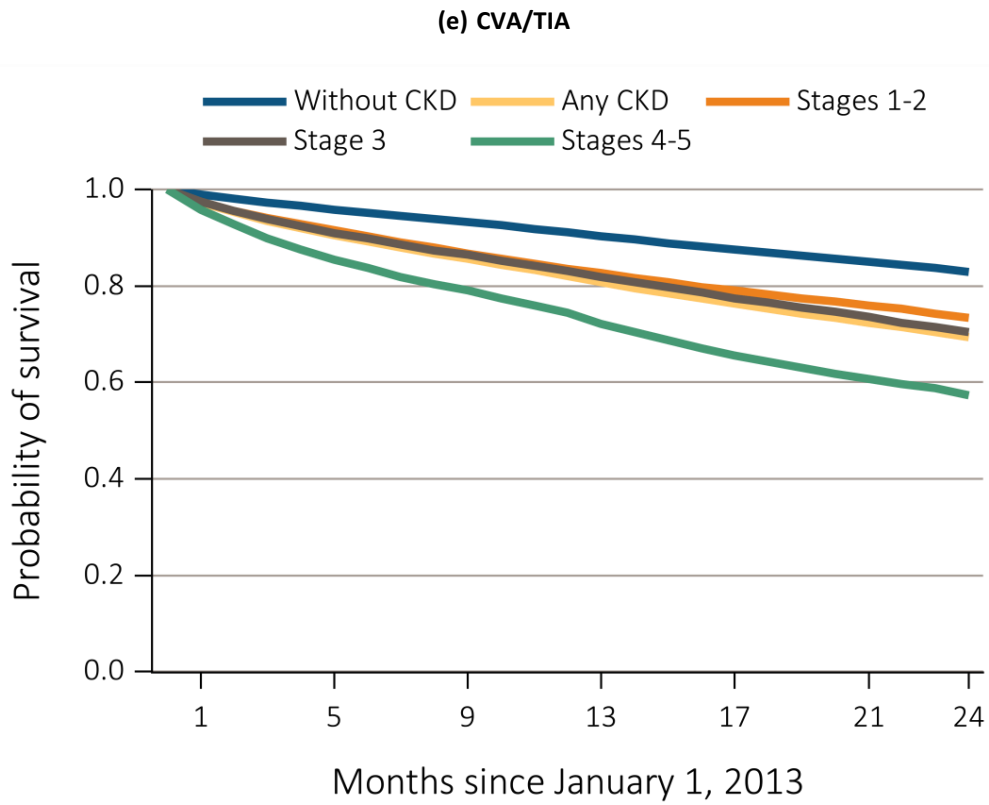


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vol 1 Figure 4.2 Survival of patients with a prevalent cardiovascular disease, by CKD status, 2013-2014
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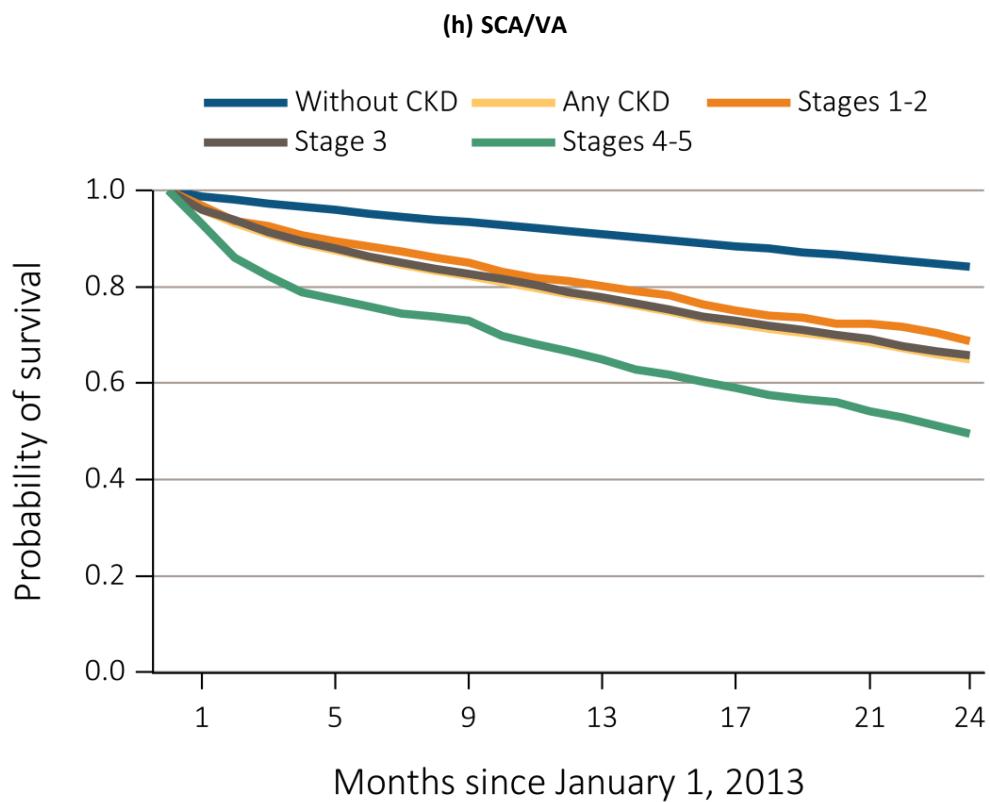
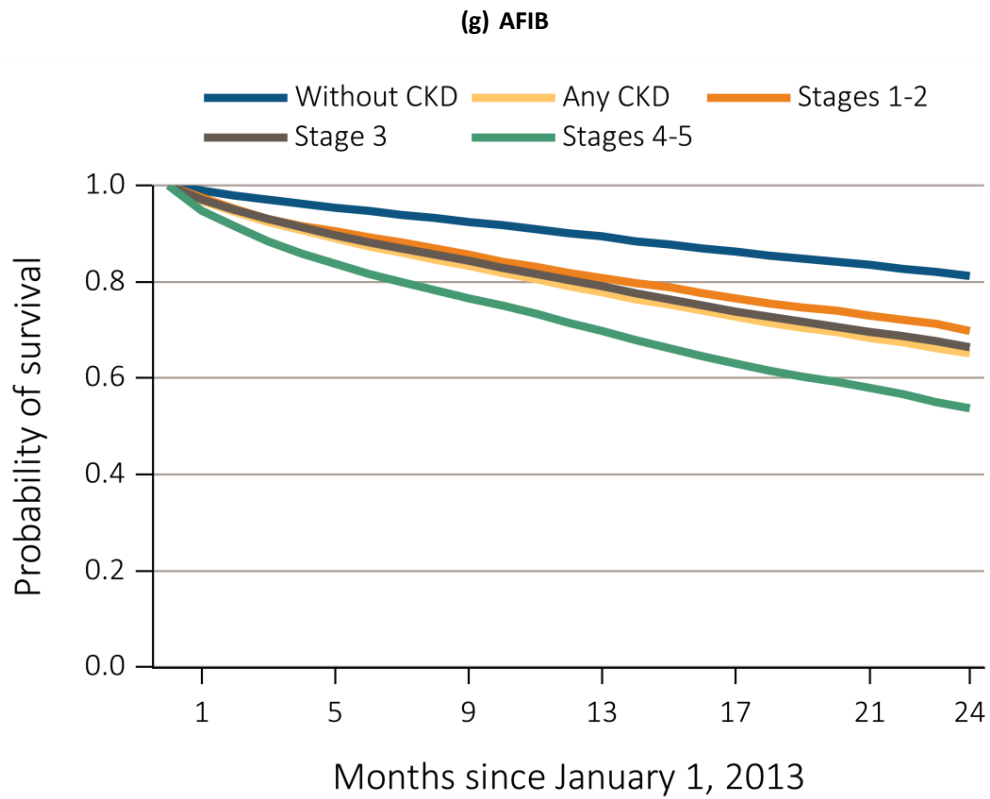
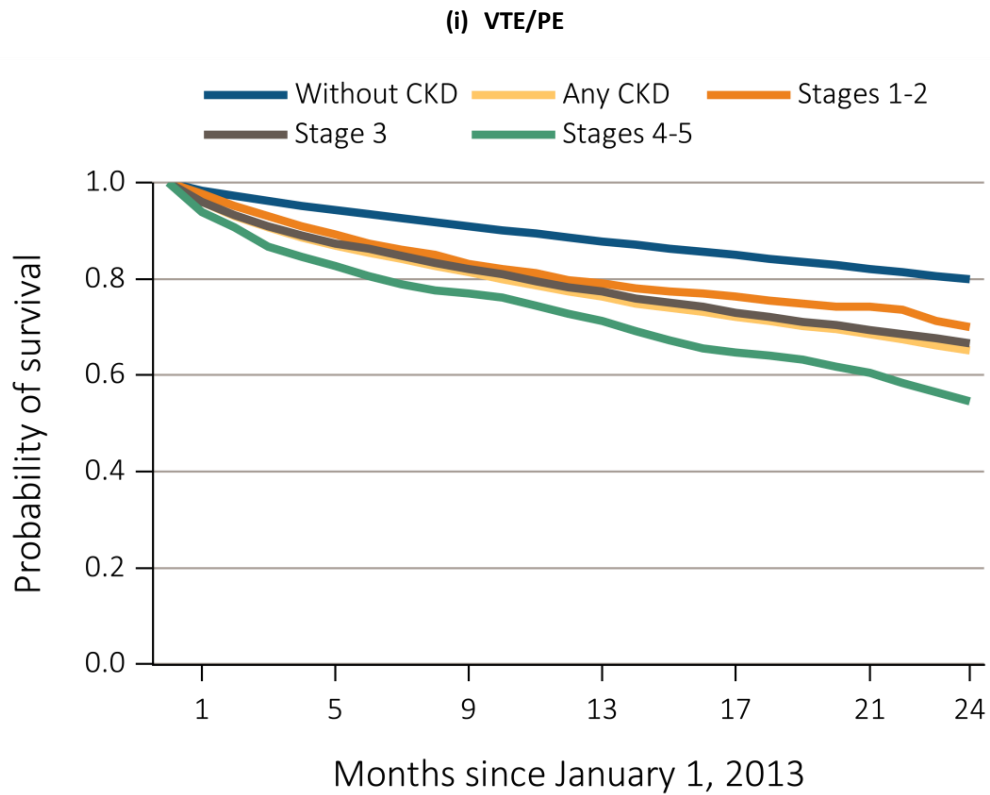


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vol 1 Figure 4.2 Survival of patients with a prevalent cardiovascular disease, by CKD status, 2013-2014
(continued)



Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States 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; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias; VHD, valvular heart disease; VTE/PE venous thromboembolism and pulmonary embolism.

vol 1 Figure 4.3 Survival of patients with a cardiovascular procedure, by CKD status, 2012-2014

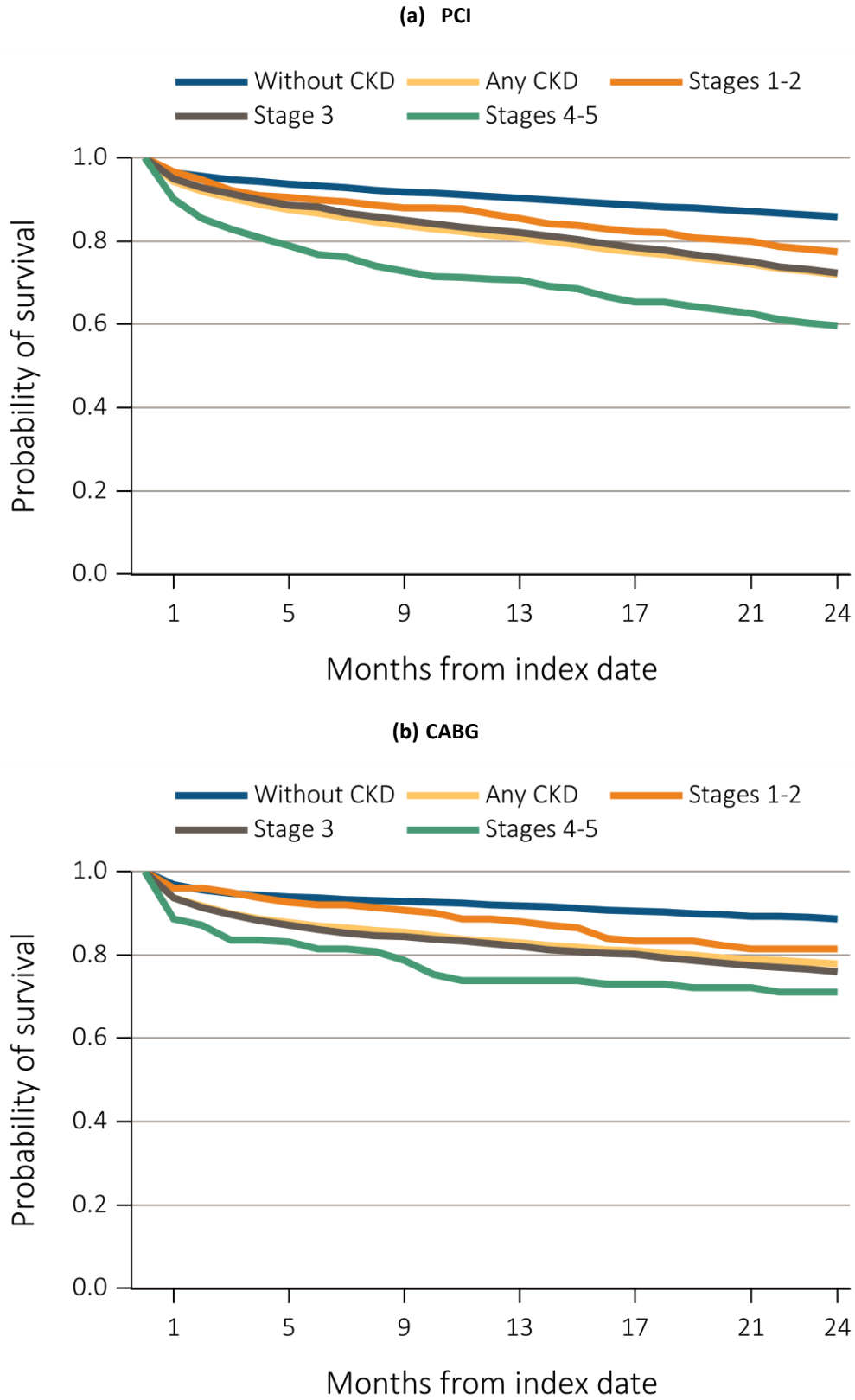
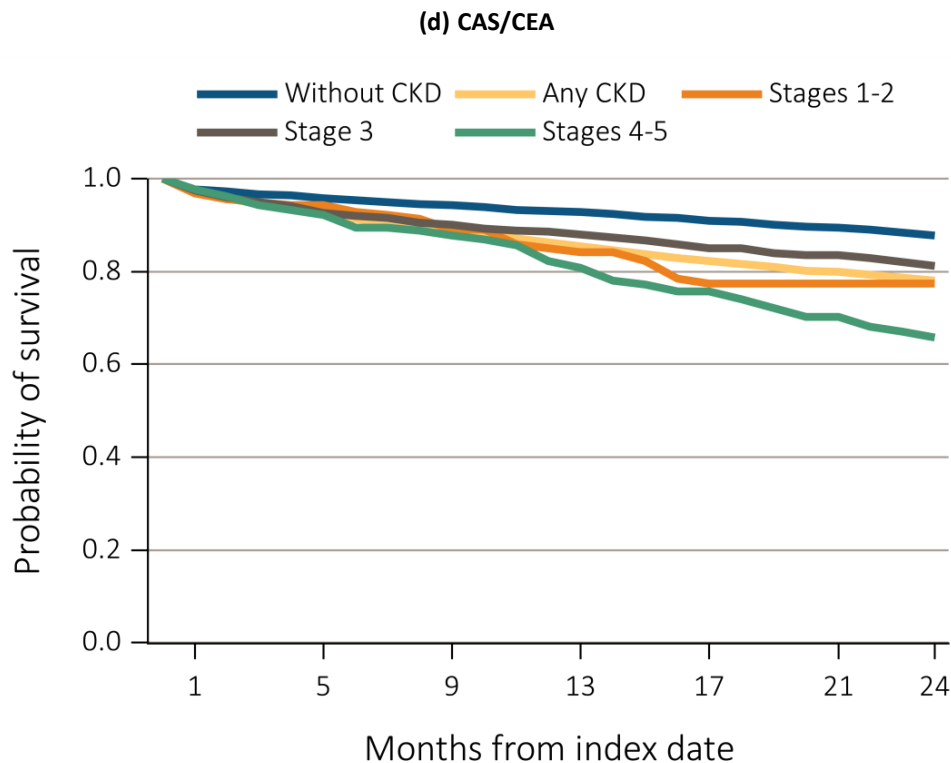
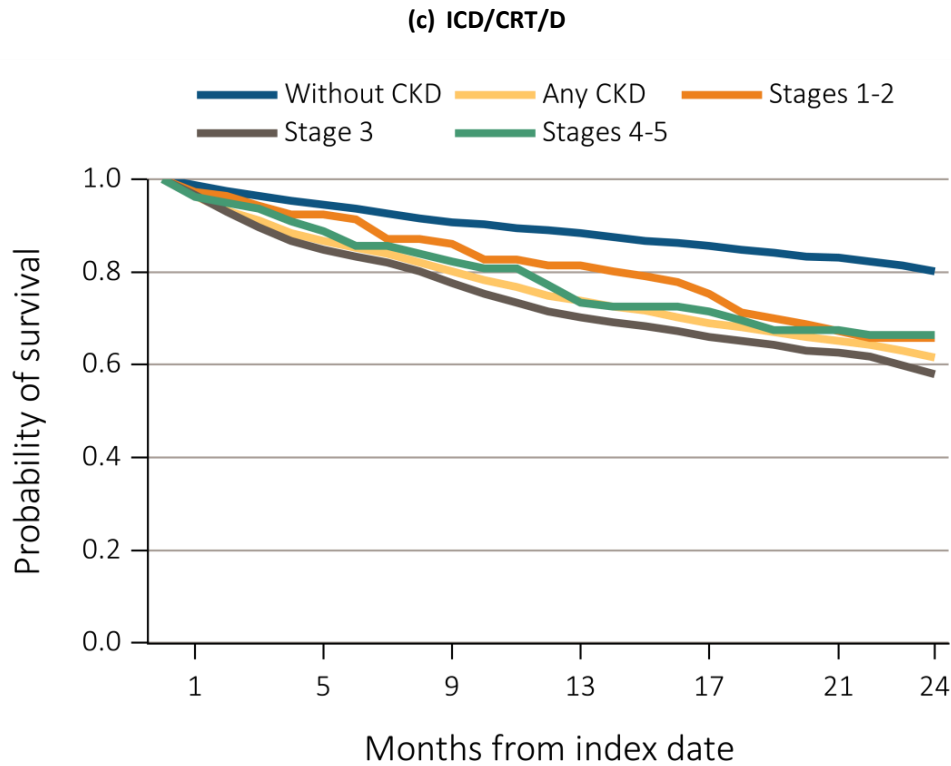


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vol 1 Figure 4.3 Survival of patients with a cardiovascular procedure, by CKD status, 2012-2014 (continued)



Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States 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: CABG, coronary artery bypass grafting; CAS/CEA, carotid artery stenting and carotid endarterectomy; CKD, chronic kidney disease; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PCI, percutaneous coronary interventions.

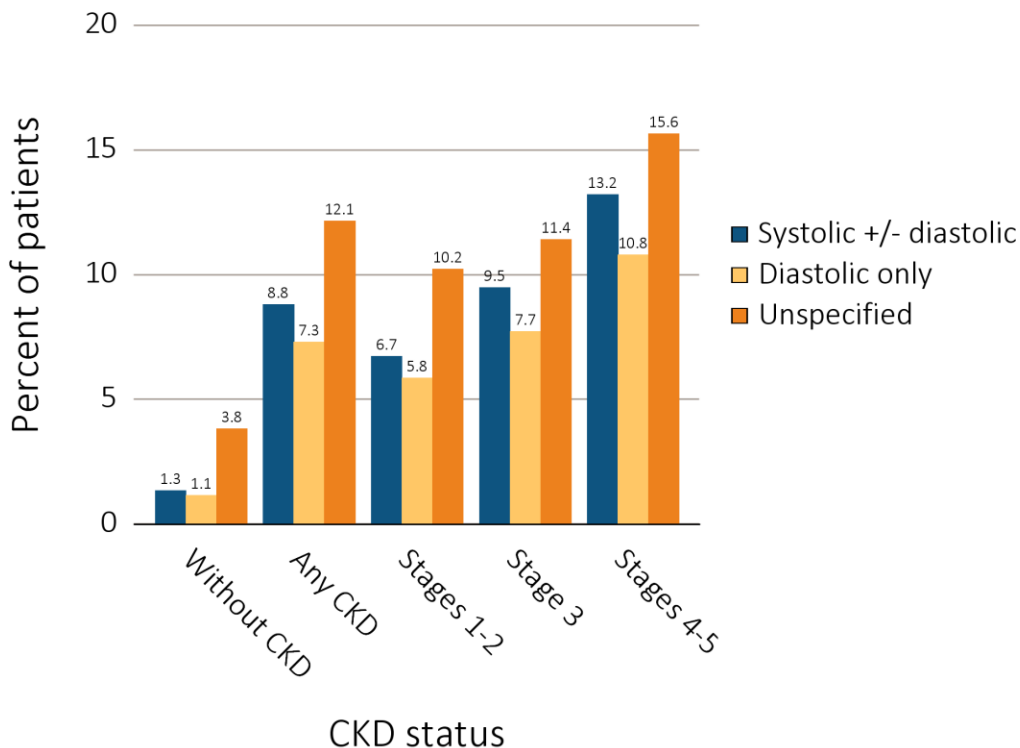
Congestive Heart Failure and Chronic Kidney Disease

Congestive heart failure (CHF) is among the more frequently diagnosed cardiovascular diseases among CKD patients. In 2014, the prevalence of CHF in CKD patients aged 66 and older was close to 30%, compared to 6% among patients without CKD (Table 4.1). Given its importance in this population, key characteristics of CHF in CKD patients are further examined in Figure 4.4 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.

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 4.4).

vol 1 Figure 4.4 Heart failure in patients with or without CKD, 2014

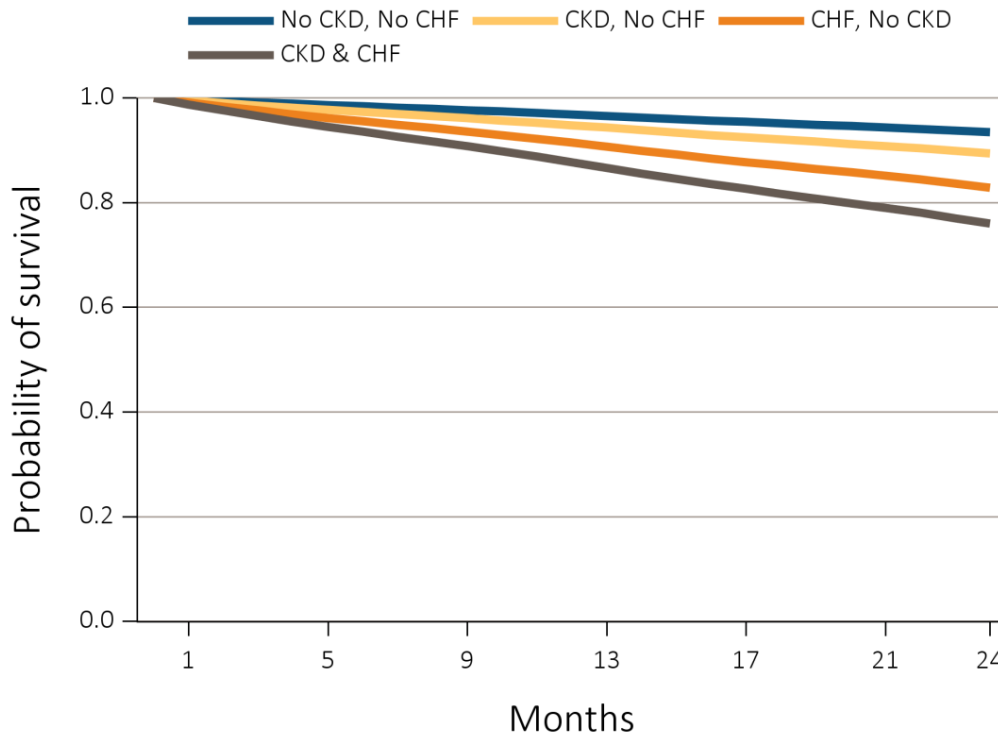


Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States on 12/31/2014 with fee-for-service coverage for the entire calendar year. Abbreviation: CKD, chronic kidney disease.

The presence of CHF worsens survival among patients with and without CKD (Figure 4.5), 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 76.0%, as compared with 82.9% for those with CHF alone, 89.3% for those with CKD alone, and 93.4% for those without CHF or CKD.

vol 1 Figure 4.5 Adjusted survival of patients by CKD and CHF status, 2013-2014



Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States on 12/31/2012 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 4.2). 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.

vol 1 Table 4.2 Prevalence of AFIB by stage of CKD, age, race, sex, diabetic status, hypertension status, and CHF status, 2014

	Stage of CKD				Total
	Stages 1-2	Stage 3	Stages 4-5	Unknown stage	All CKD stages
N	14,364	67,122	13,746	42,944	138,176
AFIB (Overall)	20.9	25.0	27.9	23.7	24.5
Age					
66-69	11.8	14.4	17.8	13.8	14.1
70-74	15.8	18.2	20.6	17.4	17.8
75-84	22.0	26.1	28.8	25.0	25.6
85+	32.2	33.1	34.2	32.9	33.1
Sex					
Male	23.5	27.9	30.1	25.9	27.0
Female	18.4	22.4	26.1	21.7	22.2
Race					
White	22.7	26.8	30.4	25.4	26.3
Black/African American	13.4	15.4	17.5	13.9	15.0
Other	13.2	16.1	19.6	15.6	16.0
Comorbidity					
Non-diabetes	20.3	25.1	28.3	23.7	24.4
Diabetes	21.5	24.9	27.7	23.7	24.5
Non-hypertension	11.0	14.8	17.8	11.7	13.2
Hypertension	21.8	25.7	28.4	25.3	25.5
No Heart Failure (CHF)	12.7	14.7	14.4	14.9	14.5
Heart Failure (CHF)	48.9	50.9	48.6	49.0	49.9

Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States on 12/31/2014 with fee-for-service coverage for the entire calendar year. Abbreviations: AFIB, atrial fibrillation; CHF, congestive heart failure; CKD, chronic kidney disease.

References

- Briasoulis A, Bakris GL. Chronic kidney disease as a coronary artery disease risk equivalent. *Curr Cardiol Rep* 2013;15(3):340.
- Centers for Disease Control and Prevention. National Center for Health Statistics. "Leading Causes of Death: Deaths: Final Data for 2013, Table 10." <http://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm>. Accessed: September 4, 2015.
- Gargiulo R, Suhail F, Lerma E. Cardiovascular disease and chronic kidney disease. *Dis Mon* 2015;61(9):403-413.
- Husain-Syed F, McCullough PA, Birk HW, Renker M, Brocca A, Seeger W, Ronco C. Cardio-Pulmonary-Renal Interactions: A Multidisciplinary Approach. *J Am Coll Cardiol*. 2015;65(22):2433-2448.
- Olesen JB, Lip GY, Kamper AL, Hommel K, Køber L, Lane DA, Lindhardsen J, Gislason GH, Torp-Pedersen C. Stroke and Bleeding in Atrial Fibrillation with Chronic Kidney Disease. *N Engl J Med* 2012;367:625-635.