

Chapter 4: Cardiovascular Disease in Patients with CKD

- The prevalence of cardiovascular disease (CVD) was 65.8% among patients aged 66 and older who had chronic kidney disease (CKD), compared to 31.9% among those who did not (Table 4.1).
- The presence of CKD worsens the short- and long-term prognosis for many common cardiovascular diseases. The adjusted two-year survival of patients with acute myocardial infarction (AMI) and without a diagnosis of CKD was 81%, compared with 71% for CKD Stage 1-2 patients and 56% for Stage 4-5 patients (Figure 4.2).
- The presence of cardiovascular disease also worsens the short- and long-term prognosis for patients with CKD. Over a two-year period, Medicare patients with both heart failure and CKD had an adjusted survival probability of 77.3%, compared to 89.9% for those with CKD alone (Figure 4.5).
- Atrial fibrillation (AF) was common among Medicare patients with CKD (24.6%). The prevalence of AF was higher among males, older persons, and patients with hypertension (HTN), advanced stages of CKD, and heart failure (HF). Nearly half of CKD patients with heart failure had a diagnosis of AF (Table 4.5).
- Angiotensin converting enzyme inhibitors (ACEs) and angiotensin receptor blockers (ARBs) are mainstays of heart failure therapy and were prescribed to 61.7% of CKD patients with HF, despite the risk of hyperkalemia. Although direct oral anticoagulants have been less studied among patients with CKD, these drugs were prescribed to 25.0% of patients with AF and CKD, as compared with 27.8% of patients with AF and no CKD (Table 4.4).

Introduction

Cardiovascular disease (CVD) remains the leading cause of death in the United States (U.S.) and most other developed countries (CDC, 2015). It accounts for approximately 39% of deaths among those on dialysis (see Volume 2, Chapter 5, *Mortality*). Among patients with CKD, death from CVD is far more common than progression to end-stage renal disease (ESRD; Gargiulo et al., 2015).

CKD has been identified as an independent risk factor for CVD, and experts have argued that it should be recognized as a coronary disease risk equivalent (Briasoulis and Bakris, 2013, Sarnak et al. 2003), similar to diabetes mellitus (DM). The complex relationship between CVD and kidney disease is thought to be due to shared traditional risk factors, such as DM, HTN, physical inactivity, left ventricular hypertrophy, smoking, family history, and dyslipidemia.

Non-traditional risk factors exert an additional influence when in the presence of CKD—some

examples include endothelial dysfunction, vascular medial hyperplasia, sclerosis and calcification, volume overload, abnormalities in mineral metabolism, anemia, malnutrition, inflammation, oxidative stress, and autonomic imbalance. In cardiorenal syndrome, dysfunction in the heart or kidney may directly induce dysfunction in the other organ. In particular, this continues to pose both a diagnostic and therapeutic challenge for managing fluid status when treating those with HF (Husain-Syed et al., 2015). Thus, characterizing the epidemiology of cardiovascular comorbidities is a critical step toward improving morbidity and mortality in the CKD population.

In this chapter, we review recent trends in the prevalence and outcomes of cardiovascular disease in CKD patients and compare these to outcomes of CVD in patients without CKD, focusing on the high-risk, elderly Medicare population.

Methods

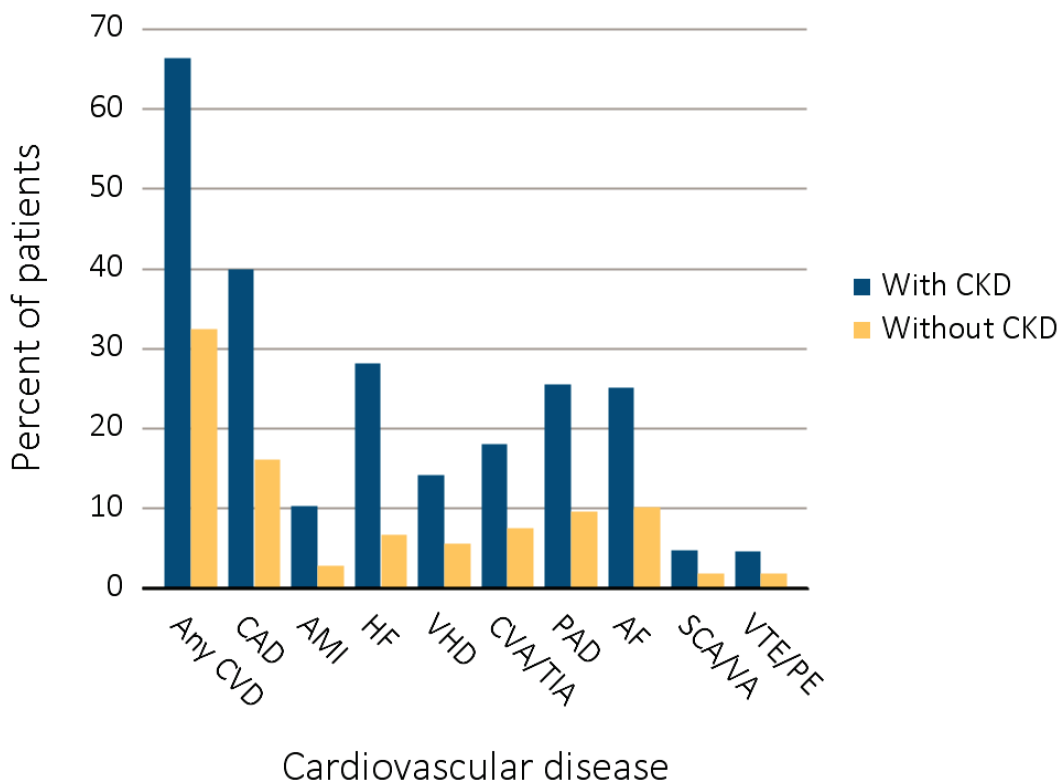
The findings presented in this chapter were drawn from data from the Medicare 5% sample’s fee-for-service patients aged 66 and older. Those in the cohort were alive, without end-stage renal disease, and residing in the U.S. on 12/31/2015, with fee-for-service coverage for the entire calendar year of 2015. CKD and CVD diagnoses were obtained via billing claims from the Medicare 5% sample. The overall study cohort for 2015 included 1,249,076 patients, of whom 146,663 had CKD. Details of this data are described in the [Data Sources](#) section of the [CKD Analytical Methods](#) chapter.

See the [CKD Analytical Methods](#) section of the [CKD Analytical Methods](#) chapter for an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter. Microsoft Excel and PowerPoint files containing the data and graphics for these figures and tables are available to download from the [USRDS website](#).

Cardiovascular Disease Prevalence and Outcomes in CKD

As shown in Figure 4.1, elderly CKD patients had a greater burden of cardiovascular disease than did their counterparts without a diagnosis of CKD. A wide range of conditions were more common in CKD patients aged 66 and older than in those without CKD, including stable coronary artery disease (CAD), acute myocardial infarction (AMI), heart failure (HF), valvular heart disease (VHD), stroke (cerebrovascular accident/transient ischemic attack, or CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AF), sudden cardiac arrest and ventricular arrhythmias (SCA/VA), and venous thromboembolism and pulmonary embolism (VTE/PE). Indeed, the prevalence of these cardiovascular conditions was double among those with CKD compared to those without (65.8% versus 31.9%). Part of this differential results from the older age of CKD patients (see Volume 1, Chapter 2, [Identification and Care of Patients with CKD](#)).

vol 1 Figure 4.1 Prevalence of common cardiovascular diseases in patients with or without CKD, 2015



Data Source: Special analyses, Medicare 5% sample. Abbreviations: AF, atrial fibrillation; AMI, acute myocardial infarction; CAD, coronary artery disease; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; HF, heart failure; 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 generally increases with age and presence of CKD (Table 4.1). The relationships with race, ethnicity, and sex are less straightforward.

Major procedures performed for the treatment of CVD were more common among CKD patients,

including percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), 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) annual incidence of cardiovascular procedures, by CKD status, age, race, & sex, 2015

	# Patients	% Patients									
		Overall	66-69	70-74	75-84	85+	White	Blk/Af Am	Other	Male	Female
(a) Cardiovascular comorbidities											
Any CVD											
Without CKD	1,102,413	31.9	18.9	27.0	39.0	52.1	32.8	28.0	23.3	35.3	29.3
Any CKD	146,663	65.8	52.0	58.5	67.6	76.4	66.9	61.7	57.7	69.8	62.1
Coronary artery disease (CAD)											
Without CKD	1,102,413	15.6	9.6	13.9	19.4	22.4	16.1	12.3	11.7	20.8	11.6
Any CKD	146,663	39.4	30.9	35.8	41.6	43.6	40.5	33.3	34.8	47.0	32.3
Acute myocardial infarction (AMI)											
Without CKD	1,102,413	2.2	1.5	2.0	2.7	3.4	2.3	1.9	1.4	2.9	1.7
Any CKD	146,663	9.7	8.3	9.1	9.7	10.9	10.0	8.2	7.3	11.5	8.0
Heart failure (HF)											
Without CKD	1,102,413	6.1	3.0	4.3	7.2	13.6	6.2	6.9	4.2	6.4	5.9
Any CKD	146,663	27.6	20.0	21.7	27.2	37.1	27.9	29.3	21.8	28.2	27.2
Valvular heart disease (VHD)											
Without CKD	1,102,413	5.0	2.4	3.8	6.6	9.2	5.3	3.3	3.3	4.9	5.1
Any CKD	146,663	13.6	8.1	10.0	14.2	18.5	14.2	10.3	10.7	13.6	13.6
Cerebrovascular accident/transient ischemic attack (CVA/TIA)											
Without CKD	1,102,413	6.9	3.7	5.6	8.9	11.7	7.0	7.5	5.2	6.9	6.9
Any CKD	146,663	17.5	12.7	15.0	18.6	20.5	17.5	18.6	15.4	17.7	17.3
Peripheral artery disease (PAD)											
Without CKD	1,102,413	9.1	4.3	6.7	11.0	19.1	9.2	9.7	6.5	9.3	8.9
Any CKD	146,663	24.9	17.5	20.6	25.5	31.6	25.3	24.4	20.9	26.5	23.5
Atrial fibrillation (AF)											
Without CKD	1,102,413	9.6	4.1	6.9	12.5	19.6	10.3	4.8	5.1	10.8	8.7
Any CKD	146,663	24.6	14.2	17.9	25.9	33.7	26.4	14.7	16.0	27.3	22.1
Cardiac arrest and ventricular arrhythmias (SCA/VA)											
Without CKD	1,102,413	1.3	0.9	1.3	1.7	1.7	1.4	1.1	0.8	1.9	1.0
Any CKD	146,663	4.2	3.5	4.0	4.6	4.2	4.3	4.4	2.8	5.7	2.8
Venous thromboembolism and pulmonary embolism (VTE/PE)											
Without CKD	1,102,413	1.3	0.8	1.1	1.5	1.9	1.3	1.5	0.6	1.2	1.3
Any CKD	146,663	4.1	3.8	3.6	4.1	4.6	4.1	5.1	2.4	4.0	4.2

Table 4.1 continued on next page.

vol 1 Table 4.1 Prevalence of (a) cardiovascular comorbidities & (b) annual incidence of cardiovascular procedures, by CKD status, age, race, & sex, 2015 (continued)**(b) Cardiovascular procedures**

	# Patients	% Patients									
		Overall	66-69	70-74	75-84	85+	White	Blk/Af Am	Other	Male	Female
Revascularization – percutaneous coronary interventions (PCI)											
Without CKD	171,640	1.6	2.3	1.8	1.4	1.0	1.6	1.4	1.5	1.6	1.6
Any CKD	57,788	2.4	3.0	2.9	2.5	1.7	2.4	2.2	2.2	2.5	2.1
Revascularization – coronary artery bypass graft (CABG)											
Without CKD	171,640	1.1	1.6	1.4	1.1	0.3	1.1	0.5	1.1	1.3	0.7
Any CKD	57,788	1.6	2.9	2.4	1.8	0.4	1.7	1.2	1.8	2.1	1.0
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)											
Without CKD	67,366	0.5	0.8	0.8	0.7	0.2	0.5	0.6	0.5	0.8	0.4
Any CKD	40,545	0.9	1.3	1.4	1.0	0.5	0.9	1.0	0.9	1.3	0.6
Carotid artery stenting and carotid artery endarterectomy (CAS/CEA)											
Without CKD	269,224	0.6	0.7	0.7	0.7	0.3	0.6	0.4	0.5	0.6	0.5
Any CKD	79,790	0.7	0.9	1.1	0.8	0.4	0.8	0.4	0.5	0.9	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 12/31/2015 with fee-for-service coverage for the entire calendar year. Abbreviations: AF, atrial fibrillation; AMI, acute myocardial infarction; Blk/Af Am, Black African American; CABG, coronary artery bypass grafting; CAD, coronary artery disease; CAS/CEA, carotid artery stenting and carotid endarterectomy; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; HF, heart failure; 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 were Medicare enrollees aged 66+ by CKD status. (b) The denominators for overall prevalence of PCI and CABG were Medicare enrollees aged 66+ with CAD by CKD status. The denominators for overall prevalence of ICD/CRT-D were Medicare enrollees aged 66+ with HF by CKD status. The denominators for overall prevalence of CAS/CEA were Medicare enrollees aged 66+ with CAD, CVA/TIA, or PAD by CKD status.

The presence of CKD also worsens the short- and long-term prognosis for many common cardiovascular diseases and for patients who undergo cardiovascular procedures. Figures 4.2.a through 4.2.i and Table 4.2 illustrate survival among patients with CVD. Figures 4.3.a through 4.3.d and Table 4.3 illustrate survival among patients undergoing cardiovascular procedures. Results were stratified by the presence of CKD and its severity, and adjusted for age and sex. In general, CKD patients had a lower probability of survival for all of the conditions reported, with late

stages of CKD being associated with the worst outcomes. For example, the adjusted two-year survival of AMI patients without a diagnosis of CKD was 81%, compared to 71% for CKD Stage 1-2 patients and 56% for CKD Stage 4-5 patients (see Table A for CKD stage definitions). This pattern also held for patients who underwent common major procedures for the treatment of CVD. The adjusted two-year survival of patients undergoing PCI without a diagnosis of CKD was 85%, compared to 76% for CKD Stage 1-2 patients and 64% for CKD Stage 4-5 patients.

Table A. ICD-9-CM and ICD-10-CM codes for Chronic Kidney Disease (CKD) stages

ICD-9-CM code ^a	ICD-10-CM code ^a	Stage
585.1	N18.1	CKD, Stage 1
585.2	N18.2	CKD, Stage 2 (mild)
585.3	N18.3	CKD, Stage 3 (moderate)
585.4	N18.4	CKD, Stage 4 (severe)
585.5	N18.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis ^b)
CKD Stage- unspecified	CKD Stage- unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others for ICD-9-CM and A18.xx, E08.xx, E11.xx and others for ICD-10-CM.

^a For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used. ^b In USRDS analyses, patients with ICD-9-CM code 585.6 or ICD-10-CM code N18.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5 or N18.5

vol 1 Figure 4.2 Probability of survival of patients with a prevalent cardiovascular disease, by CKD status, adjusted for age and sex, 2014-2015

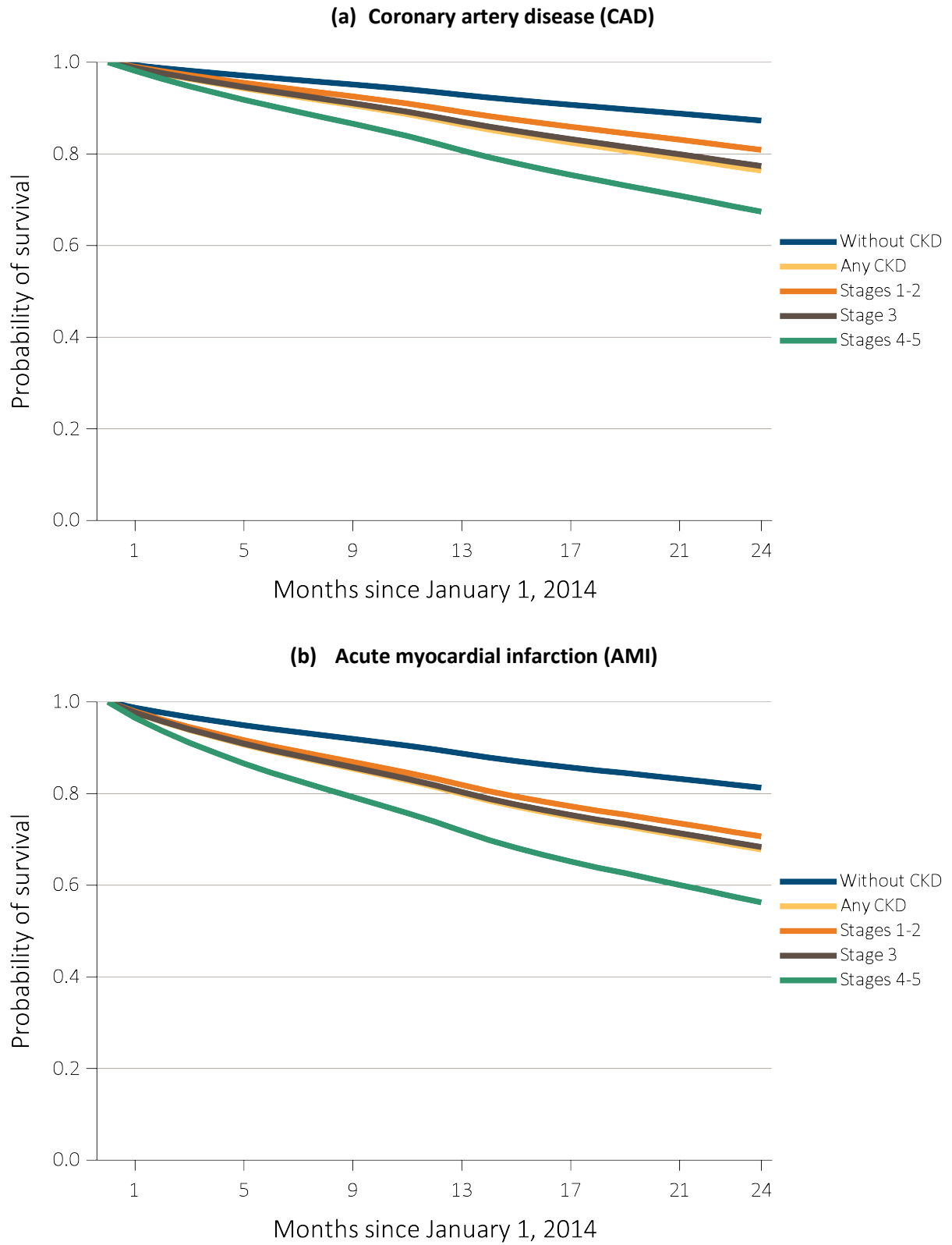


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vol 1 Figure 4.2 Probability of survival of patients with a prevalent cardiovascular disease, by CKD status, adjusted for age and sex, 2014-2015 (continued)

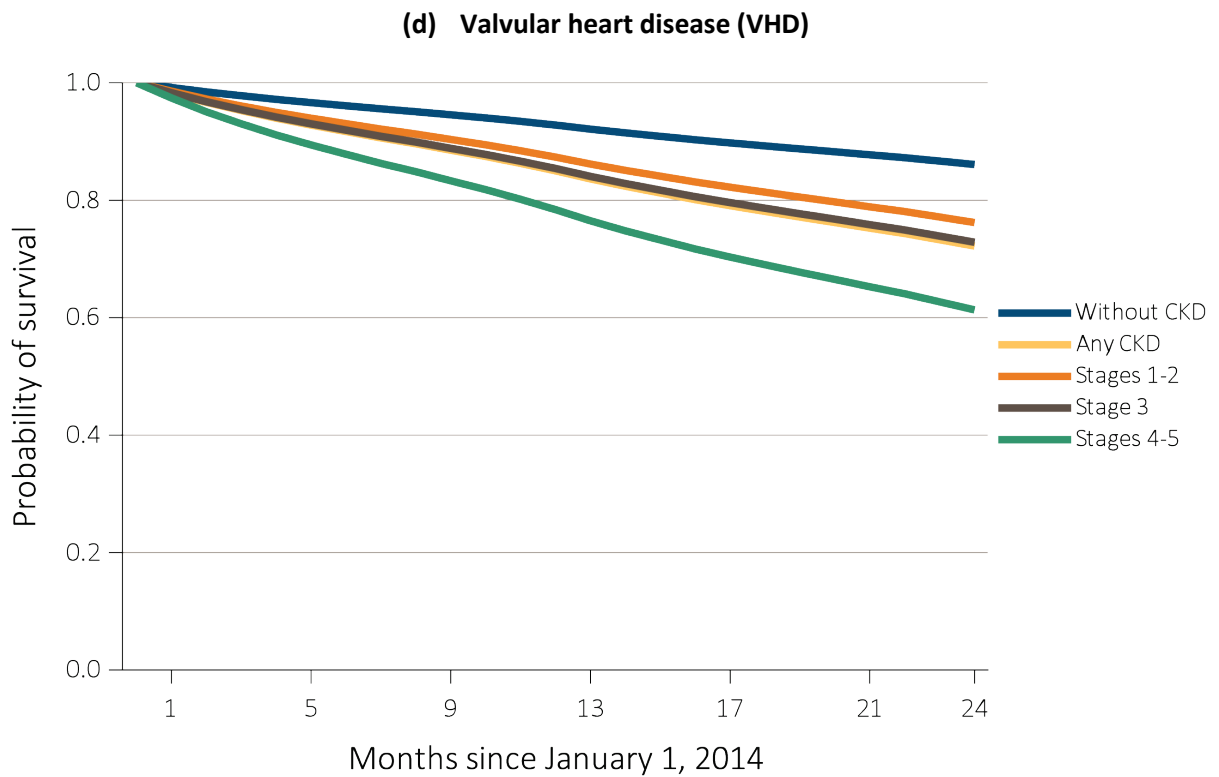
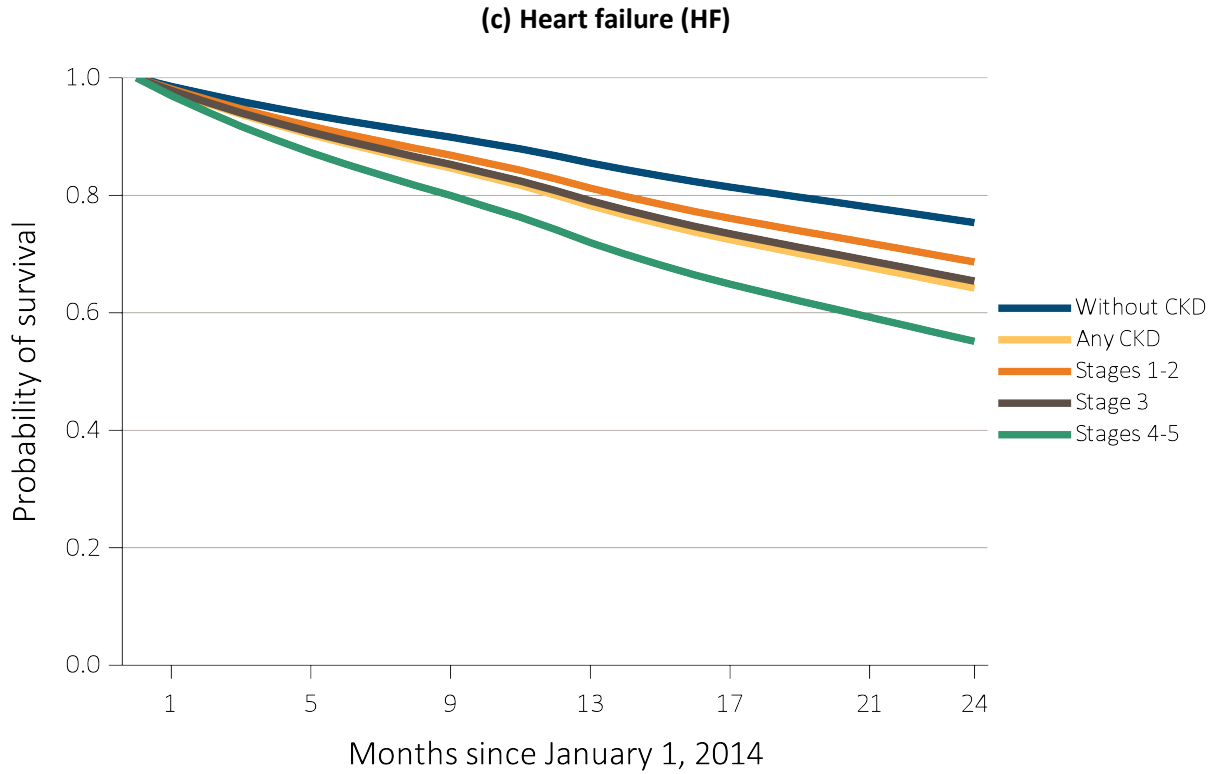


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vol 1 Figure 4.2 Probability of survival of patients with a prevalent cardiovascular disease, by CKD status, adjusted for age and sex, 2014-2015 (continued)

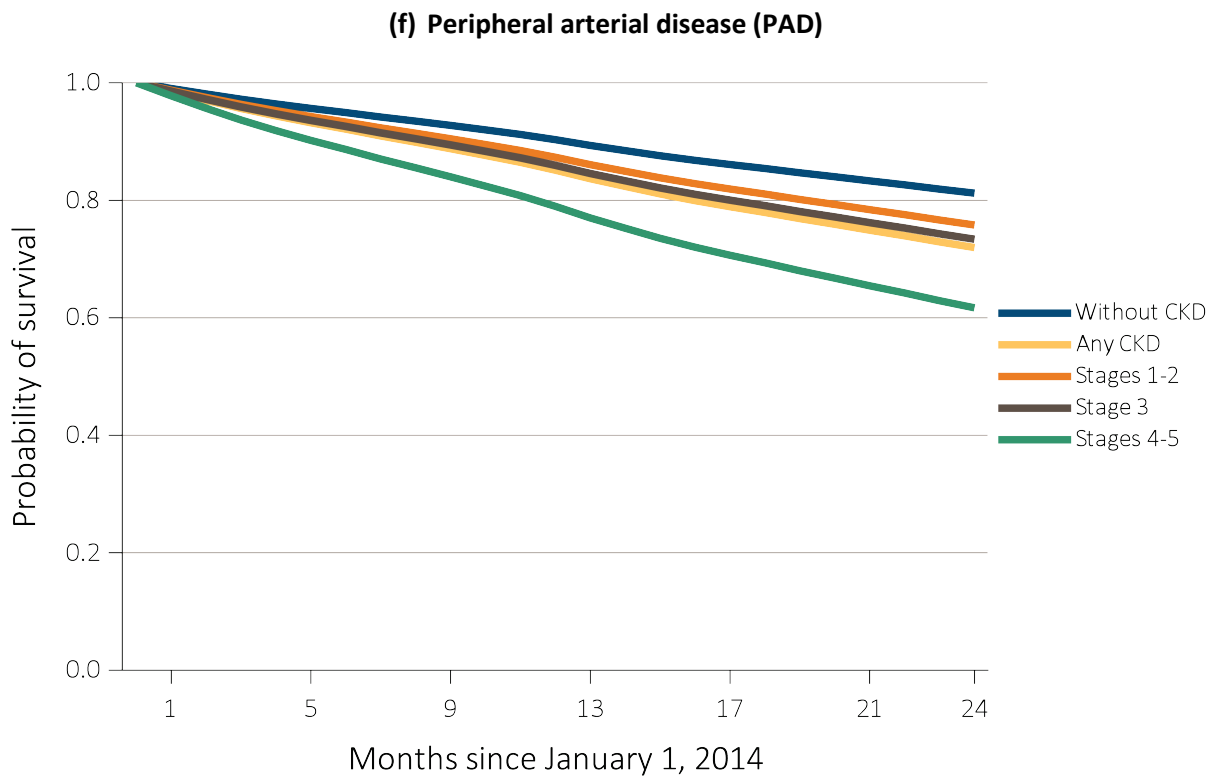
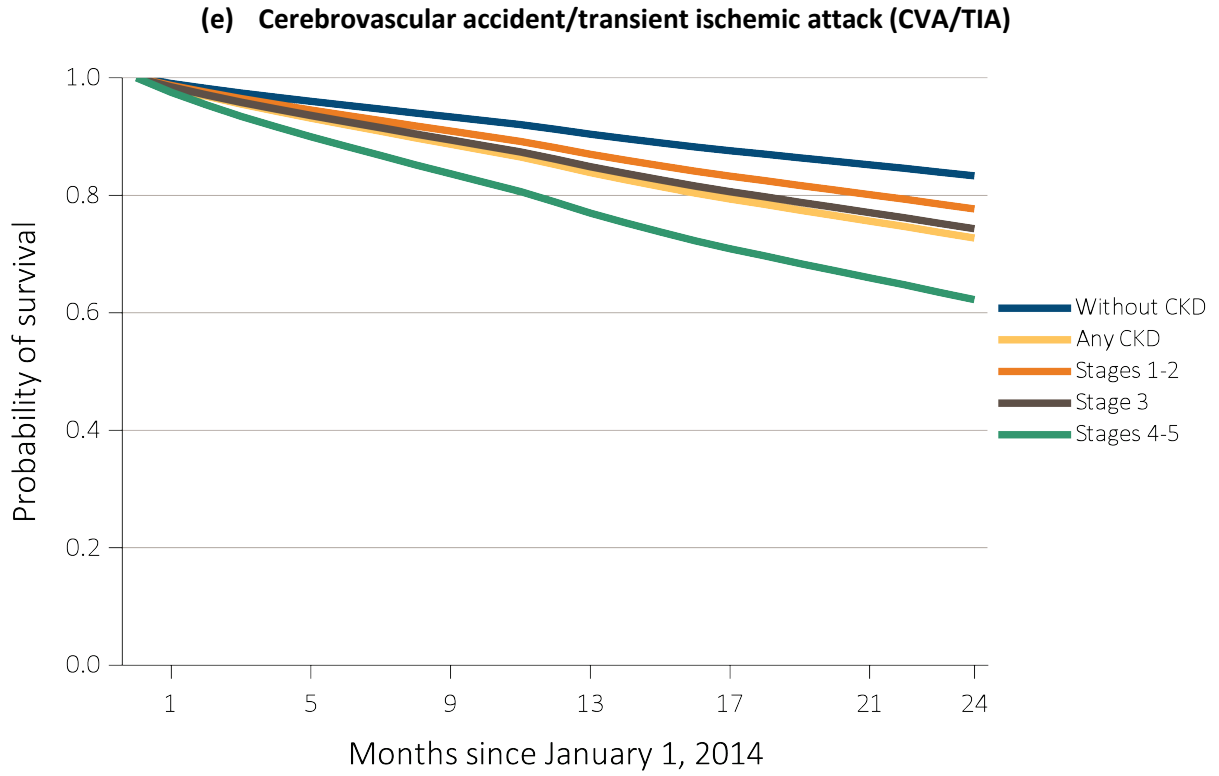


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vol 1 Figure 4.2 Probability of survival of patients with a prevalent cardiovascular disease, by CKD status, adjusted for age and sex, 2014-2015 (continued)

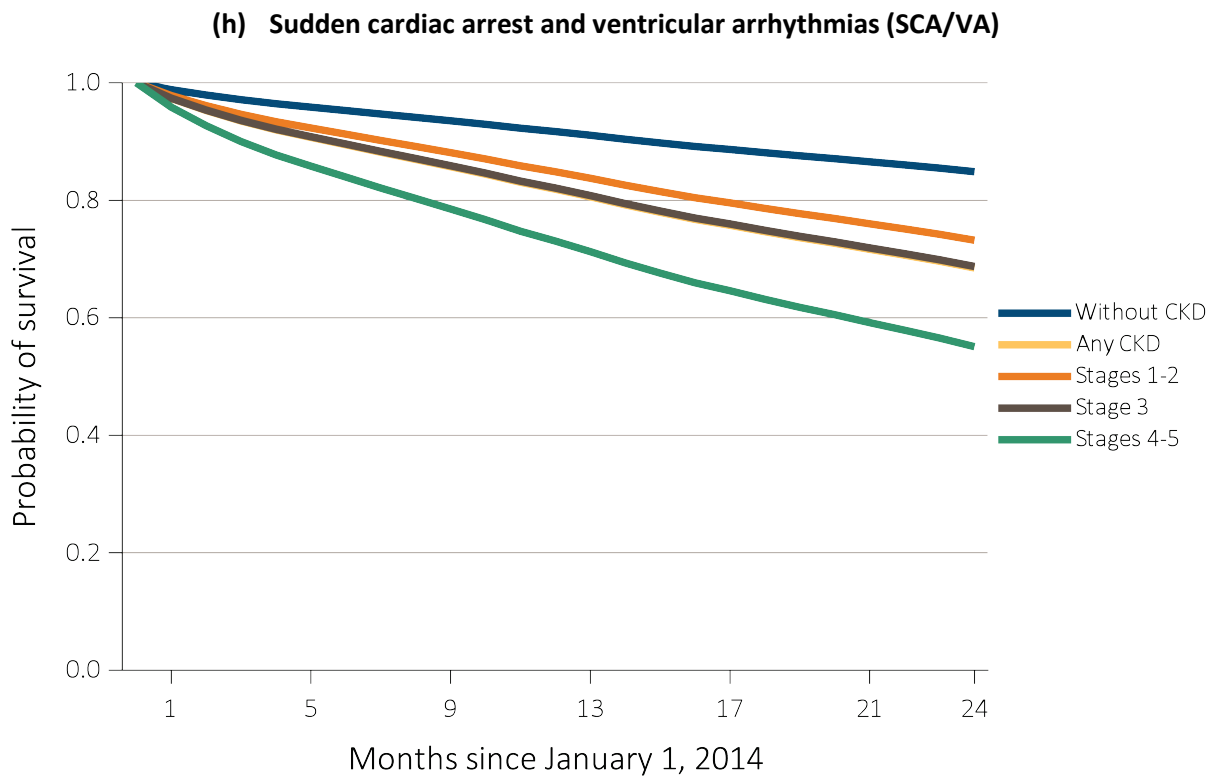
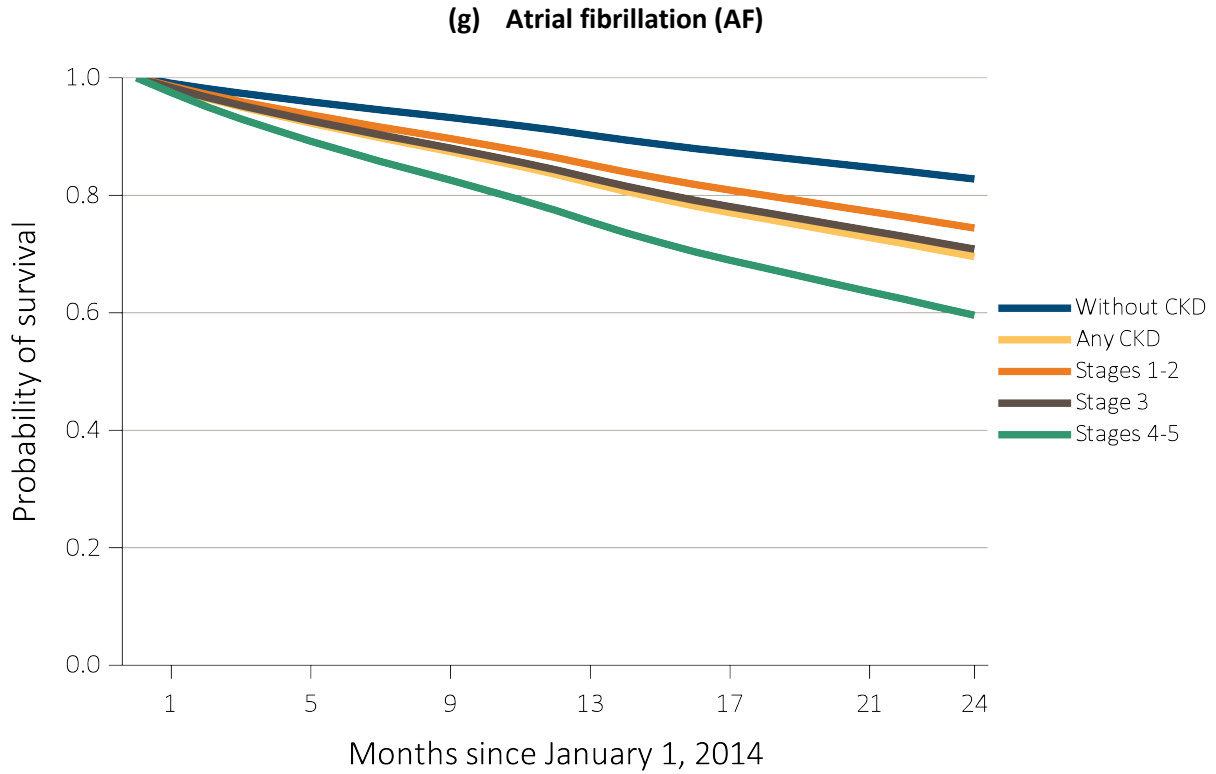
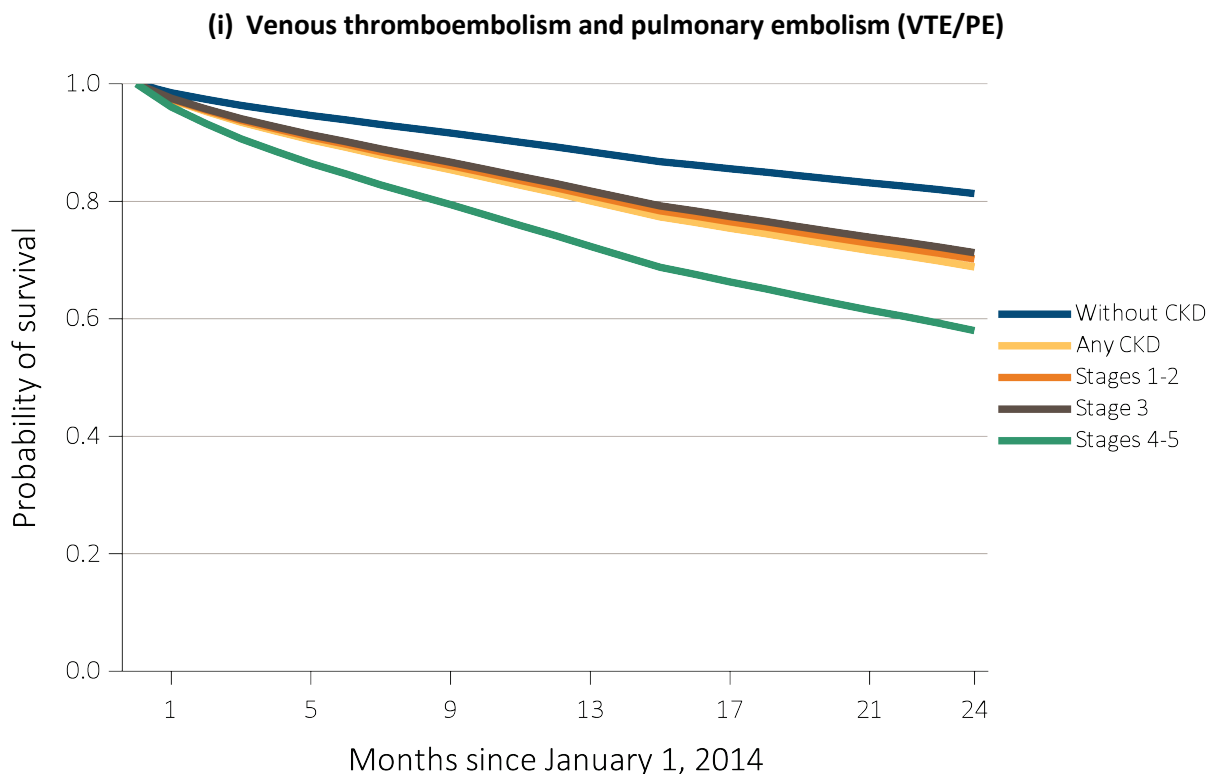


Figure 4.2 continued on next page.

vol 1 Figure 4.2 Probability of survival of patients with a prevalent cardiovascular disease, by CKD status, adjusted for age and sex, 2014-2015 (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 12/31/2013, with fee-for-service coverage for the entire calendar year. Abbreviations: CKD, chronic kidney disease.

vol 1 Table 4.2 Two-year survival of patients with a prevalent cardiovascular disease, by CKD status, adjusted for age and sex, 2014-2015

Cardiovascular Disease	CKD Status				
	No CKD (%)	CKD (%)	Stages 1 to 2 (%)	Stage 3 (%)	Stages 4 to 5 (%)
CAD	87.3	76.4	80.9	77.4	67.4
AMI	81.3	67.8	70.7	68.3	56.3
HF	75.3	64.2	68.6	65.4	55.1
VHD	86.1	72.2	76.2	72.9	61.3
CVA/TIA	83.3	72.7	77.7	74.3	62.2
PAD	81.2	72.0	75.8	73.4	61.7
AF	82.8	69.6	74.4	70.8	59.6
SCA/VA	84.9	68.5	73.2	68.7	55.1
VTE/PE	81.3	68.8	70.2	71.3	58.0

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 12/31/2013, with fee-for-service coverage for the entire calendar year. Abbreviations: AF, atrial fibrillation; AMI, acute myocardial infarction; CAD, coronary artery disease; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; HF, heart failure; 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 Probability of survival of patients with a cardiovascular procedure, by CKD status, adjusted for age and sex, 2013-2015

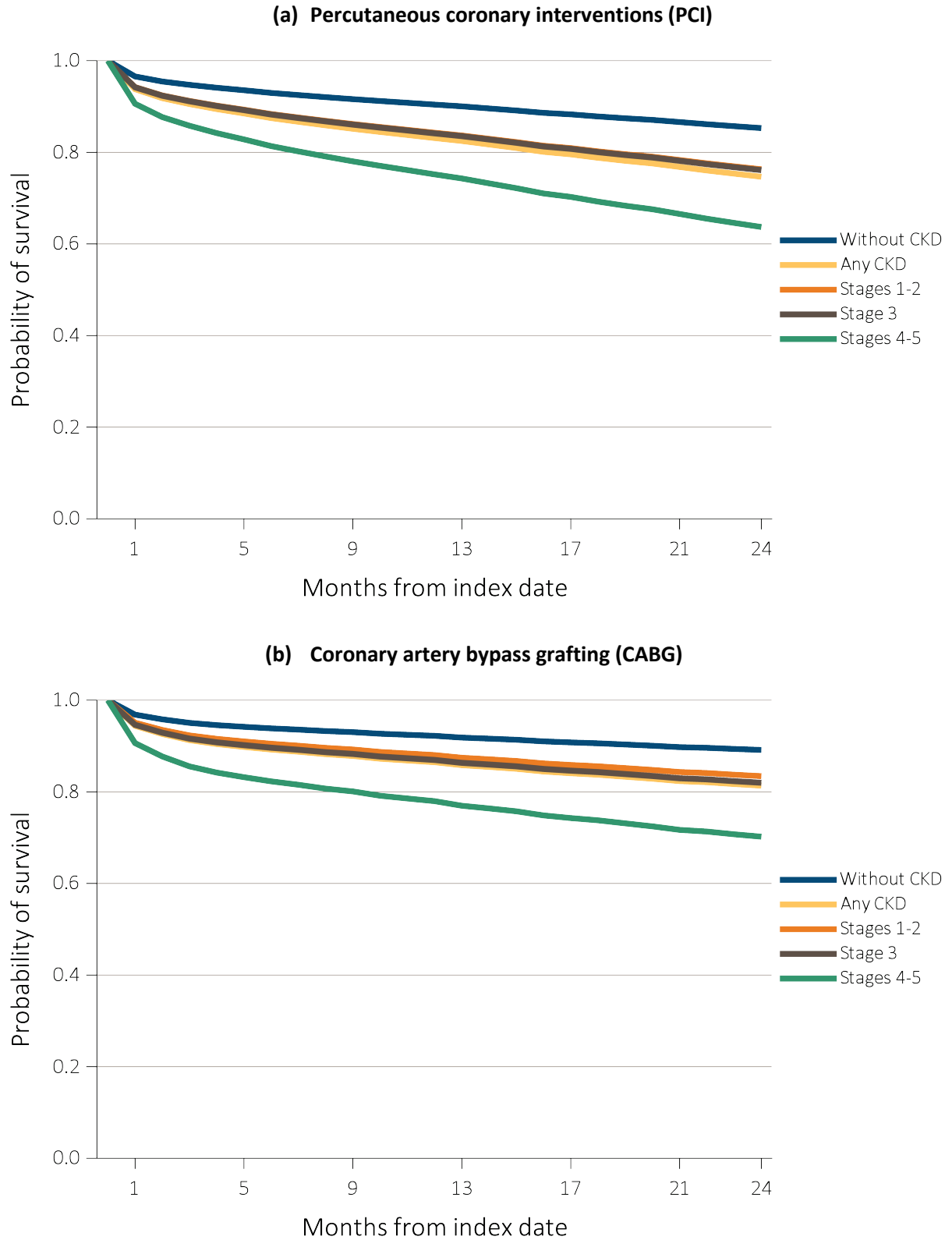
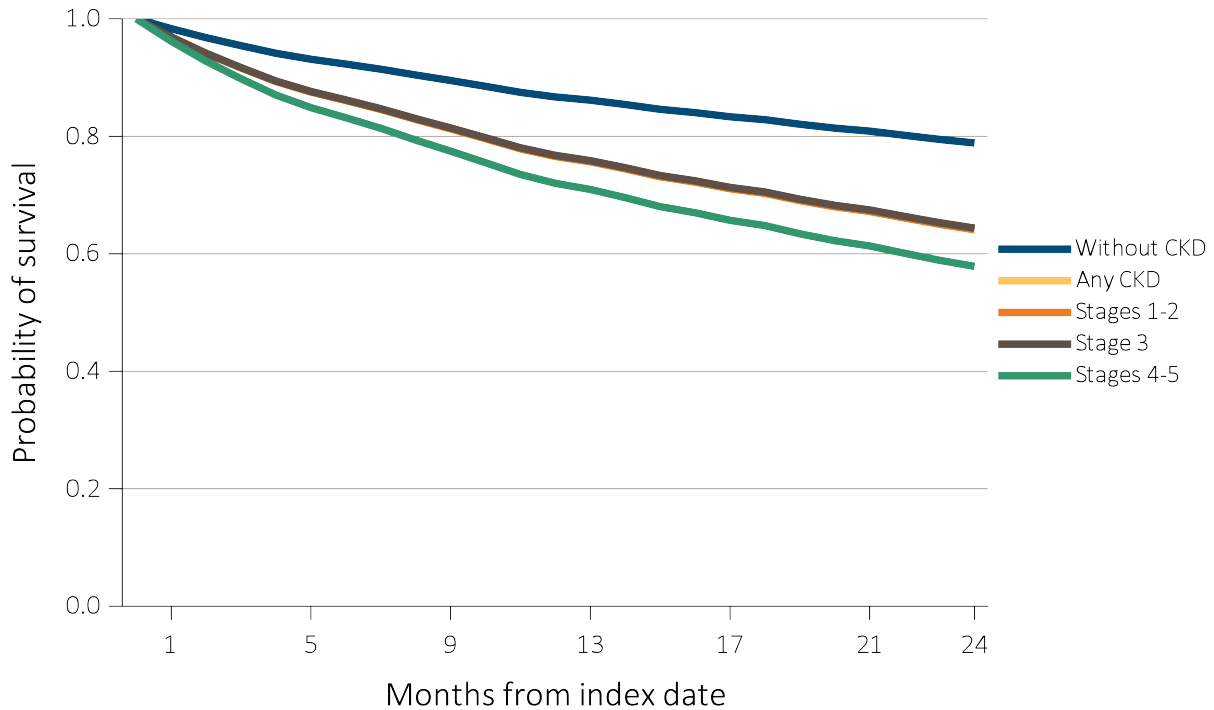


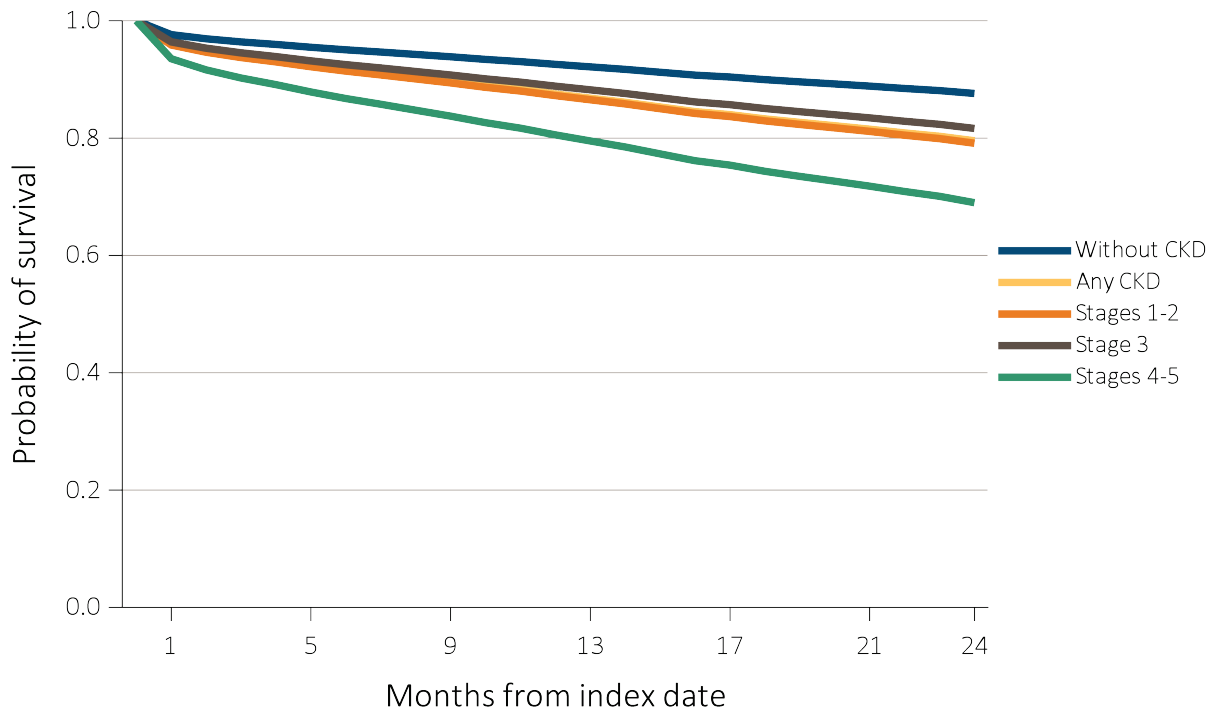
Figure 4.3 continued on next page.

vol 1 Figure 4.3 Probability of survival of patients with a cardiovascular procedure, by CKD status, adjusted for age and sex, 2013-2015 (continued)

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



(d) Carotid artery stenting and carotid endarterectomy (CAS/CEA)



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 was the date of the first procedure claim, with fee-for-service coverage for the entire year prior to this date. Abbreviations: CKD, chronic kidney disease.

vol 1 Table 4.3 Two-year survival of patients with a cardiovascular procedure, by CKD status, adjusted for age and sex, 2013-2015

Cardiovascular Procedure	CKD Status				
	No CKD (%)	CKD (%)	Stages 1 to 2 (%)	Stage 3 (%)	Stages 4 to 5 (%)
PCI	85.3	74.7	76.3	76.1	63.7
CABG	89.1	81.3	83.4	82.0	70.2
ICD/CRT-D	78.9	64.4	64.1	64.4	57.9
CAS/CEA	87.6	79.5	79.1	81.6	69.0

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 was the date of the first 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.

Cardiovascular Disease and Pharmacological Treatments

For clinicians, pharmacological treatment of cardiovascular disorders in the CKD population is fraught with challenges given that many drugs are cleared by the kidneys. Patients with advanced renal dysfunction are often excluded from large clinical trials, so the risk-benefit ratios of their treatment with various medications are often unclear. Angiotensin converting enzyme inhibitors (ACEs) and angiotensin receptor blockers (ARBs) are mainstays of HF therapy and are frequently prescribed to CKD patients. In 2015, these drugs were prescribed to 61.5% of CKD patients, as compared with 55.1% of non-CKD patients who also had CVD. This difference may be explained in part by the fact that ACEs and ARBs are also used for their nephroprotective effects. Despite the potential clinical

benefits, these drugs must be prescribed with caution in this population due to increased risk of hyperkalemia.

Warfarin dose adjustment can be more difficult among patients with CKD, and renal failure is a risk factor for bleeding while on warfarin therapy. Although direct oral anticoagulants have not been as well studied as warfarin among patients with CKD, these drugs were used quite frequently in this group, particularly for stroke prevention in the context of AF (Table 4.4). Aspirin is commonly recommended to those with cardiovascular diseases such as CAD and PAD, regardless of the patient’s renal function. As it is most often purchased over the counter, however, prescribing rates for aspirin were low (<1%) for patients with all types of CVD; aspirin is omitted from Table 4.4.

vol 1 Table 4.4 Cardiovascular pharmacological treatments by (a) comorbidities and (b) procedures, by CKD status, 2015

(a) Cardiovascular comorbidities

	# Patients	% Patients					
		Beta-blockers	Statins	P2Y ₁₂ inhibitors	Warfarin	Direct Oral Anticoagulants	ACEs/ARBs
Any CVD							
Without CKD	239,800	57.1	63.0	16.6	15.2	9.8	55.1
Any CKD	66,354	68.0	68.0	20.7	18.3	10.9	61.5
Coronary artery disease (CAD)							
Without CKD	116,846	68.1	75.7	26.3	11.7	7.9	60.5
Any CKD	39,684	76.1	75.8	28.8	17.5	10.7	63.8
Acute myocardial infarction (AMI)							
Without CKD	16,545	77.6	78.2	39.8	14.1	9.9	65.2
Any CKD	9,666	83.5	79.0	39.7	19.1	12.3	65.4
Heart failure (HF)							
Without CKD	46,509	72.5	60.6	16.9	22.1	13.4	63.4
Any CKD	28,204	77.8	67.4	21.8	23.8	14.0	61.7
Valvular heart disease (VHD)							
Without CKD	37,493	60.5	61.9	13.7	18.6	11.1	56.0
Any CKD	13,585	74.9	69.8	21.5	24.6	14.1	62.6
Cerebrovascular accident/transient ischemic attack (CVA/TIA)							
Without CKD	52,488	51.3	68.1	25.0	12.8	8.0	55.6
Any CKD	17,830	67.4	73.1	30.0	16.8	10.9	62.1
Peripheral artery disease (PAD)							
Without CKD	69,923	50.2	58.7	18.2	11.5	6.8	53.3
Any CKD	25,460	67.0	68.0	25.7	16.3	9.8	60.8
Atrial fibrillation (AF)							
Without CKD	71,368	69.4	57.8	8.9	40.8	27.8	53.2
Any CKD	24,507	76.4	65.4	14.9	40.7	25.0	58.9
Cardiac arrest and ventricular arrhythmias (SCA/VA)							
Without CKD	9,951	73.6	64.2	17.0	16.7	12.5	60.9
Any CKD	4,205	82.0	70.9	25.4	26.0	15.2	65.1
Venous thromboembolism and pulmonary embolism (VTE/PE)							
Without CKD	9,580	44.4	49.2	6.9	57.7	23.9	46.0
Any CKD	4,137	60.9	58.6	11.9	54.5	23.4	55.5

Table 4.4 continued on next page.

vol 1 Table 4.4 Cardiovascular pharmacological treatments by (a) comorbidities and (b) procedures, (%) by CKD status, 2015 (continued)

(b) Cardiovascular procedures

	# Patients	% Patients					
		Beta-blockers	Statins	P2Y ₁₂ inhibitors	Warfarin	Direct Oral Anticoagulants	ACEs/ARBs
Revascularization – percutaneous coronary interventions (PCI)							
Without CKD	1,738	90.0	91.3	95.4	10.1	7.5	75.5
Any CKD	899	93.2	89.2	96.6	13.3	11.6	73.6
Revascularization – coronary artery bypass graft (CABG)							
Without CKD	1,167	93.8	92.9	38.6	20.0	9.3	68.2
Any CKD	607	92.9	92.1	41.7	22.7	12.0	68.5
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)							
Without CKD	263	88.6	75.7	22.4	31.9	24.7	78.7
Any CKD	284	91.2	73.9	34.5	35.9	21.5	75.7
Carotid artery stenting and carotid artery endarterectomy (CAS/CEA)							
Without CKD	1,034	58.3	80.8	52.9	8.8	9.4	62.2
Any CKD	408	71.6	85.3	50.5	15.0	10.8	72.1

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 12/31/2015 with fee-for-service and Part D coverage for the entire calendar year. Abbreviations: ACEs/ARBs, Angiotensin converting enzyme inhibitors and angiotensin receptor blockers; AF, atrial fibrillation; AMI, acute myocardial infarction; CAD, coronary artery disease; CABG, coronary artery bypass grafting; CAS/CEA, carotid artery stenting and carotid endarterectomy; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; HF, heart failure; 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.

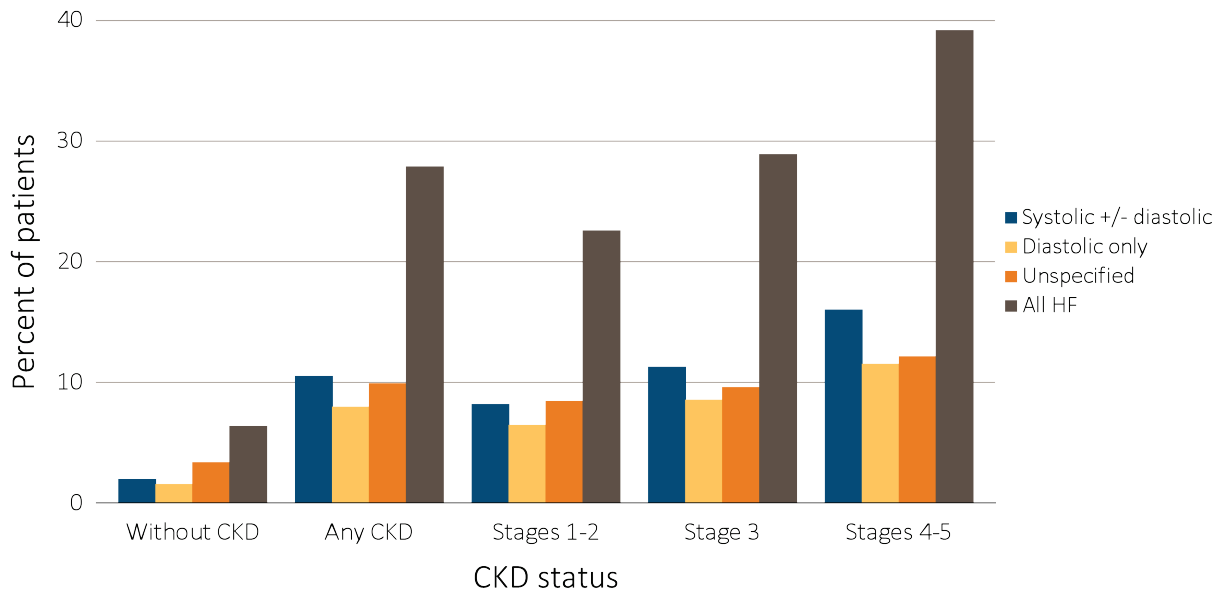
Heart Failure and CKD

Heart failure (HF) is among the more frequently diagnosed cardiovascular diseases in the CKD population. In 2015, the prevalence of HF 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, we further examined key characteristics of HF in CKD patients after stratifying HF based on presence or absence of left ventricular systolic dysfunction (i.e., “systolic” heart failure with decreased ejection fraction, “diastolic” heart failure with preserved ejection fraction, or unspecified; Figure 4.4). For ease of reporting and consistency with clinical approaches for categorizing the disease, systolic HF includes

patients with left ventricular systolic dysfunction, regardless of the presence of concomitant diastolic dysfunction. Patients with isolated diastolic HF were treated separately, since long-term risk assessments and treatments vary for this group.

All types of HF were more common among those with CKD than among non-CKD patients. The relative proportion of CKD patients with systolic HF was higher than with diastolic HF, and increased with greater severity of CKD Stage. The percentage of patients without CKD who had unspecified HF was slightly higher than for systolic or diastolic HF. For patients with CKD, the percentage with unspecified HF was slightly lower than with systolic HF (Figure 4.4).

vol 1 Figure 4.4 Heart failure in patients with or without CKD, 2015

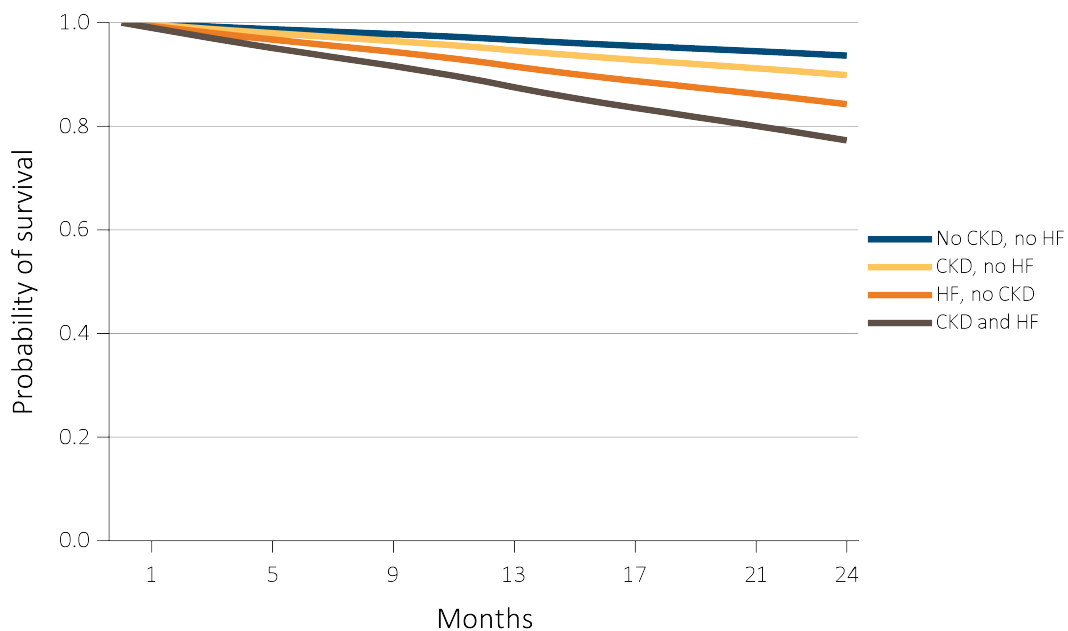


Data Source: Special analyses, Medicare 5% sample. Patients aged 66 and older, alive, without end-stage renal disease, and residing in the United States on 12/31/2015 with fee-for-service coverage for the entire calendar year. Abbreviation: CKD, chronic kidney disease.

The presence of HF reduced the probability of survival among patients both 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 HF and CKD had an adjusted survival probability of 77.3%, as compared to 84.3% for those with HF alone, 89.9% for those with CKD alone, and 93.6% for those without HF or CKD.

vol 1 Figure 4.5 Adjusted survival of patients by CKD and heart failure status, 2014-2015



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 12/31/2013 with fee-for-service coverage for the entire calendar year. Survival was adjusted for age, sex, race, diabetic status, and hypertension status. Abbreviations: CKD, chronic kidney disease.

Atrial Fibrillation and CKD

Atrial fibrillation (AF) 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 AF among CKD patients is also high, being present in approximately one-quarter of the population.

In 2015, the prevalence of AF increased with more advanced stages of CKD, age, male sex, white race, hypertension, and heart failure (Table 4.5). In patients

with CKD, the presence of HF increased the prevalence of AF to about half of all patients. Patients with AF and CKD have an increased risk of stroke and bleeding, making the use of oral anticoagulants challenging, as demonstrated by recent reports. Warfarin was prescribed to 40.8% of patients without CKD and 40.7% of patients with CKD, while direct oral anticoagulants were prescribed to 27.8% of patients without CKD and 25.0% of patients with CKD (Table 4.4).

vol 1 Table 4.5 Prevalence of atrial fibrillation by stage of CKD, age, race, sex, and diabetic, hypertension, and heart failure status, 2015

	Stage of CKD					Total
	No CKD	Stages 1-2	Stage 3	Stages 4-5	Unknown stage	All CKD stages
# Patients	1,102,413	16,008	75,595	13,951	41,109	146,663
Atrial fibrillation (Overall)	9.6	21.5	25.5	27.7	23.1	24.6
Age						
66-69	4.1	11.5	15.5	16.9	13.0	14.2
70-74	6.9	16.9	18.5	21.6	16.4	17.9
75-84	12.5	22.8	26.4	28.4	25.1	25.9
85+	19.6	32.5	34.0	33.6	33.6	33.7
Sex						
Male	10.8	24.3	28.6	30.6	25.1	27.3
Female	8.7	18.7	22.7	25.2	21.2	22.1
Race						
White	10.3	23.4	27.4	30.2	24.7	26.4
Black/African American	4.8	12.7	14.9	17.2	14.0	14.7
Other	5.1	13.6	16.8	17.6	15.2	16.0
Comorbidity						
No diabetes	8.8	20.7	25.0	27.8	22.9	24.2
Diabetes	12.9	22.2	26.1	27.5	23.5	25.1
No hypertension	3.9	11.9	15.5	16.3	11.1	13.3
Hypertension	14.2	22.5	26.4	28.3	25.0	25.8
No heart failure	7.3	13.4	14.9	14.5	14.4	14.5
Heart failure	44.6	49.5	52.1	48.2	50.8	51.0

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 12/31/2015 with fee-for-service coverage for the entire calendar year. Abbreviations: CKD, chronic kidney disease.

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