
Chapter 9: Cardiovascular Disease in Patients With ESRD

- Cardiovascular disease is common in adult ESRD patients, with atherosclerotic heart disease and congestive heart failure being the most common conditions (Table 9.1).
- Cardiovascular diseases are the leading cause of death in ESRD patients (Figure 9.1).
- Sudden death/cardiac arrhythmias account for almost 30% of all deaths in the Medicare ESRD population (Figure 9.1).
- Even relatively young ESRD patients (aged 22-44 and 45-64 years) experience significant cardiovascular morbidity (Figure 9.3).
- The presence of cardiovascular diseases worsens both short and long-term survival in adult ESRD patients (Figure 9.4).

Introduction

Patients with end-stage renal disease (ESRD) are among the highest risk populations for a number of cardiovascular diseases, and cardiovascular diseases are a major cause of death in ESRD patients. Presence of ESRD also often complicates disease management of cardiovascular disease, as it can influence both medical and procedural options, thereby adversely affecting a patient's prognosis. In this chapter, we focus on reporting the prevalence and outcomes of adult ESRD patients with diagnosed major cardiovascular conditions, stratifying by type of renal replacement therapy being received (hemodialysis, peritoneal dialysis, or kidney transplantation). For individual conditions, we compare the survival of ESRD patients with and without cardiovascular diseases. Given its role as the primary health care payer for ESRD patients, our analyses are based mostly on data from the national Medicare population.

Methods

This chapter uses data from the Centers for Medicare & Medicaid Services (CMS). Findings were primarily drawn from special analyses based on the

USRDS ESRD Database. Details of the data source are described in the [Data Sources](#) section of the *ESRD Analytical Methods* chapter.

See the section on [Chapter 9](#) in the *ESRD Analytical Methods* chapter for a detailed explanation of analytical methods used to generate the study cohorts, figures, and tables in this chapter.

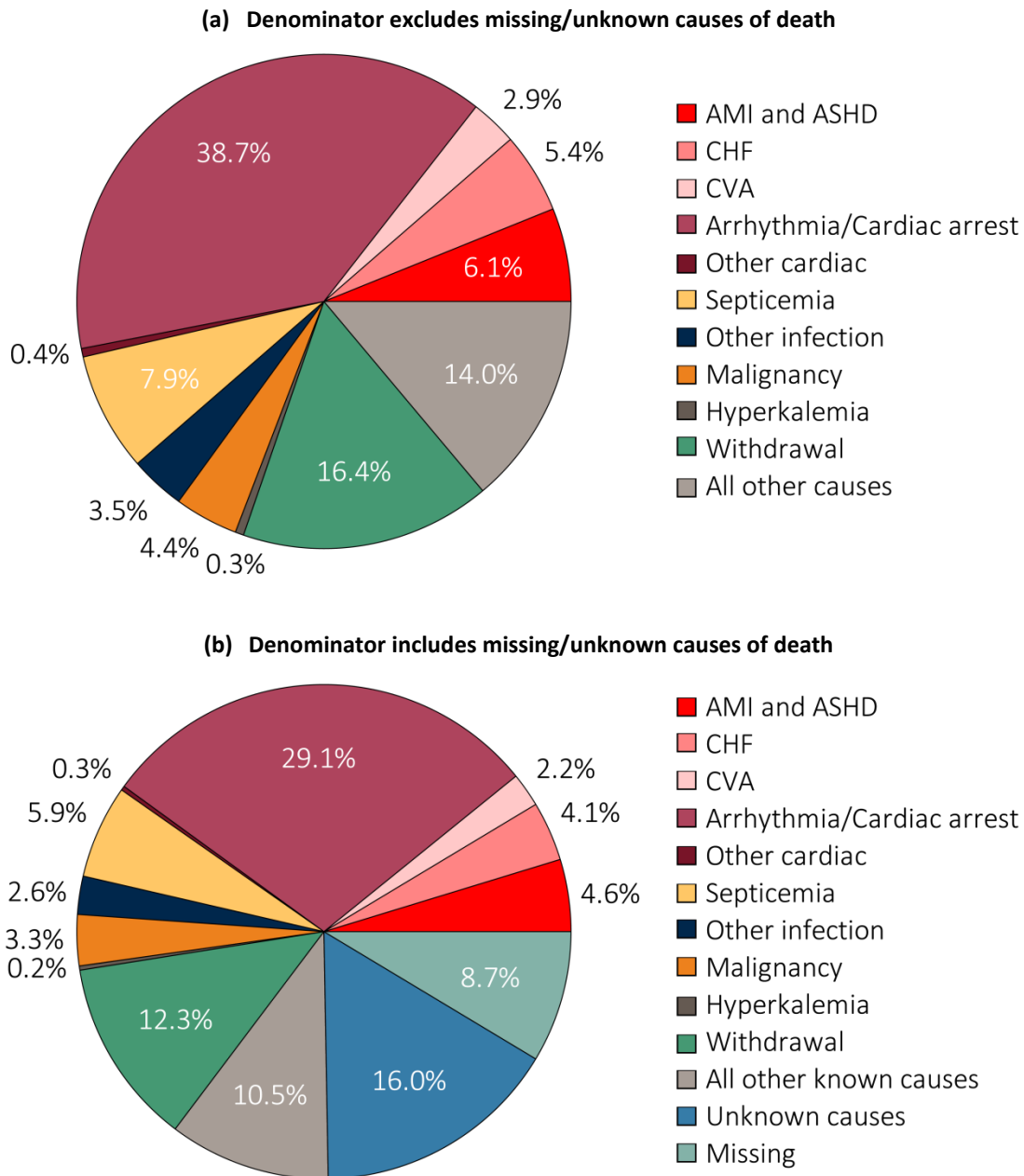
Cardiovascular Disease Prevalence and Outcomes in ESRD Patients

Figure 9.1 presents both the proportion of known causes of death and the proportion of total deaths among ESRD patients. As shown in Figure 9.1.a, cardiovascular diseases are a major cause of death in ESRD patients, contributing to more than half of all deaths with known causes. The category of arrhythmias and cardiac arrest alone is responsible for 38.7% of the deaths. Figure 9.1.b provides an alternate analysis in which deaths with unknown and missing causes are included in the denominator, and appear as separate categories. As shown in Figure 9.1.b, the categories of arrhythmias and cardiac arrest, congestive heart failure (CHF), acute myocardial infarction (AMI) and atherosclerotic heart disease (ASHD) are responsible for over one-third of the total deaths. A significant proportion (24.7%) of the deaths

is due to unknown causes or missing cause of death. We speculate that unidentified cardiovascular

conditions may well be the true underlying causes of death in this category.

vol 2 Figure 9.1 Causes of death in ESRD patients, 2012-2014

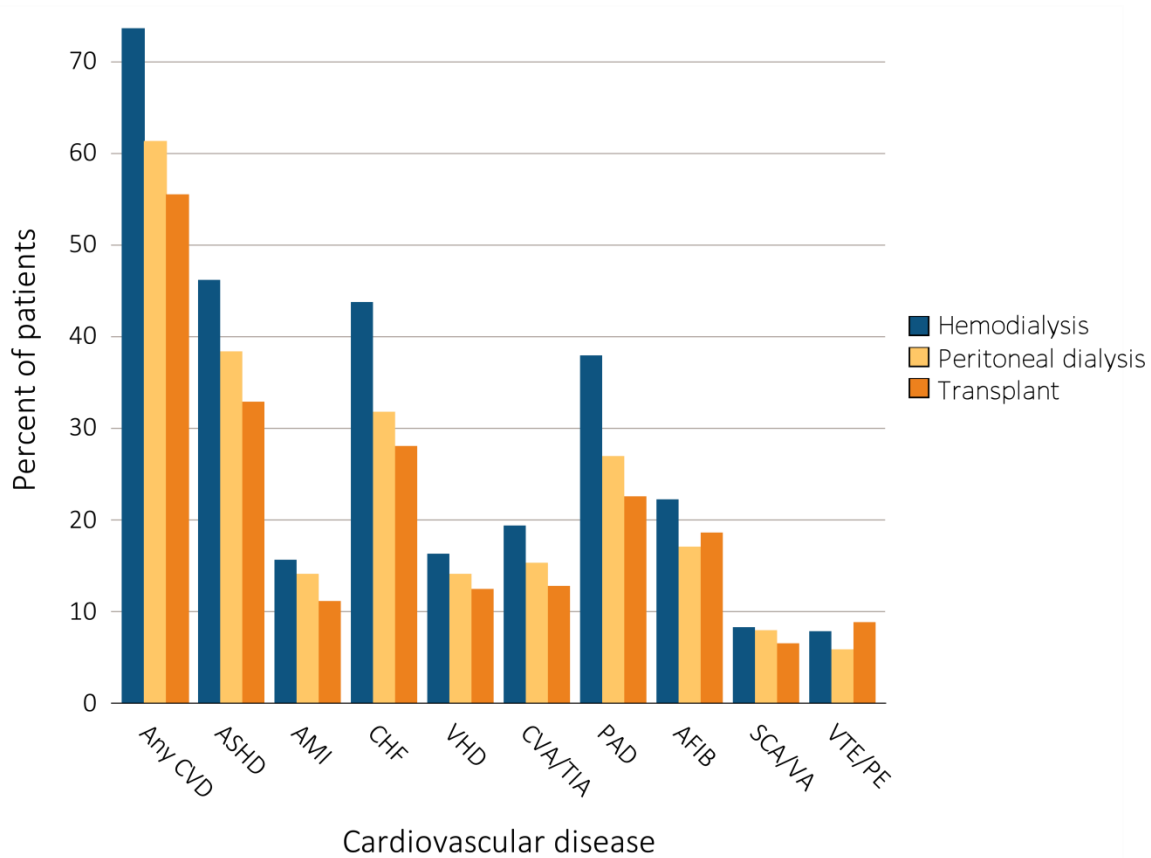


Data Source: Special analysis using Reference Table H12. (a) Denominator includes other causes of death and excludes missing/unknown causes of death (24.7% of patients have unknown or missing causes of death). (b) Denominator includes other known causes, unknown causes of death, and records that are missing the cause of death. Unknown causes include records from the CMS 2746 ESRD death notification form that specifically designate an unknown cause of death. Missing includes records in the ESRD database that are missing the CMS 2746, or have the form but are missing or have recording errors in the primary cause of death field. Abbreviations: ASHD, atherosclerotic heart disease; AMI, acute myocardial infarction; CHF, congestive heart failure; CVA, cerebrovascular accident.

ESRD patients have a high burden of cardiovascular disease across a wide range of conditions (Figure 9.2). Stable ASHD and CHF are the two major leading cardiovascular diseases present in adult ESRD patients. However, acute myocardial infarction (AMI), valvular heart disease (VHD), 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 also common. VTE/PE are presented for the first time in this chapter, and while lower than other cardiovascular diseases, its presence is non-trivial. In general, the prevalence of these cardiovascular diseases is highest among ESRD patients who receive hemodialysis (73.6%) followed by peritoneal dialysis (61.3%) and those with a kidney transplant (55.4%).

vol 2 Figure 9.2 Prevalence of cardiovascular diseases in adult ESRD patients, by treatment modality, 2014

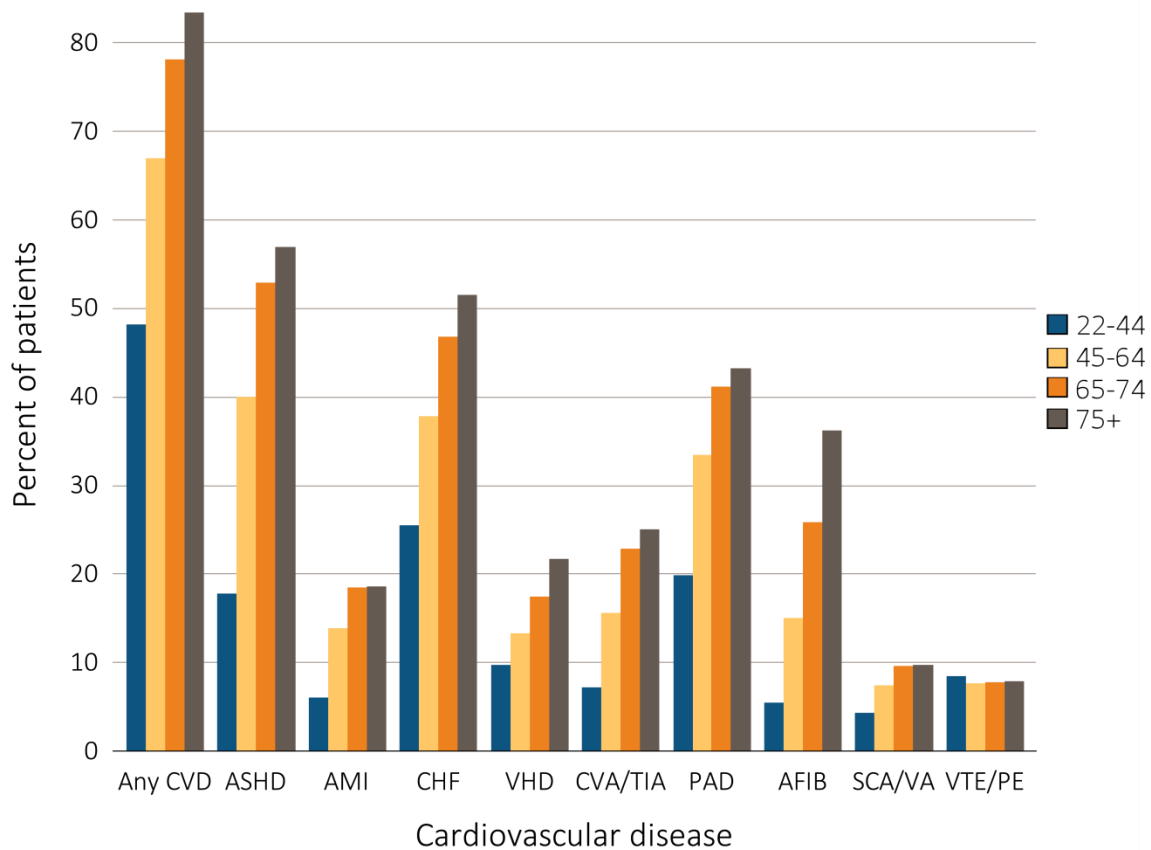


Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, with Medicare as primary payer on January 1, 2014, who are continuously enrolled in Medicare Parts A and B from January 1, 2013 to December 31, 2013, and ESRD service date is at least 90 days prior to January 1, 2014. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; 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.

Not surprisingly, older ESRD patients tend to have a higher prevalence of cardiovascular conditions (Figure 9.3). It is notable, however, that the prevalence of these conditions is high even among those 22-44 years of age (48.2%), although a much higher prevalence is observed among those 45 years or older

(66.9% to 83.4%). ASHD is the most common condition, with its prevalence exceeding 50% in ESRD patients aged 65 years and older, followed by CHF, PAD, AFIB, CVA/TIA, and VHD. The presence of VTE/PE did not vary as much by age.

vol 2 Figure 9.3 Prevalence of cardiovascular diseases in adult ESRD patients, by age, 2014



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, with Medicare as primary payer on January 1, 2014, who are continuously enrolled in Medicare Parts A and B from January 1, 2013 to December 31, 2013, and ESRD service date is at least 90 days prior to January 1, 2014. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; 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 relationships between age, race or ethnicity, and sex with the prevalence of cardiovascular diseases in adult ESRD patients are displayed in Table 9.1. As noted earlier, advancing age is associated with higher prevalence of cardiovascular conditions. However, the relationships with race or ethnicity and sex are less definitive. The prevalence of major procedures for treating cardiovascular disease in ESRD patients is also reported in Table 9.1, including percutaneous

coronary intervention (PCI), coronary artery bypass grafting (CABG), placement of implantable cardioverter defibrillators (ICD) and cardiac resynchronization therapy with defibrillator (CRT-D) devices, and carotid artery stenting (CAS) and carotid endarterectomy (CEA). The prevalence of CAS/CEA is low in ESRD patients relative to other major procedures.

vol 2 Table 9.1 Prevalence of (a) cardiovascular comorbidities & (b) cardiovascular procedures in adult ESRD patients, (%) by treatment modality, age, race, & sex, 2014

(a) Cardiovascular Comorbidities											
	# Patients	% Patients									
		Overall	22-44	45-64	65-74	75+	White	Blk/Af Am	Other	Male	Female
Atherosclerotic heart disease (ASHD)											
Hemodialysis	191,559	46.2	18.9	41.4	54.1	57.4	50.8	40.3	44.0	46.8	45.4
Peritoneal dialysis	15,225	38.3	16.1	34.9	49.4	53.8	41.8	31.6	32.3	43.4	32.8
Transplant	14,918	32.9	8.9	28.1	42.6	49.4	35.8	26.0	30.3	35.5	28.9
Acute myocardial infarction (AMI)											
Hemodialysis	191,559	15.6	6.4	14.2	18.8	18.7	17.4	13.5	14.7	16.0	15.2
Peritoneal dialysis	15,225	14.1	5.4	13.4	18.2	18.8	15.8	11.2	9.2	15.9	12.2
Transplant	14,918	11.1	3.3	9.9	14.6	15.0	12.2	8.6	10.2	11.7	10.2
Congestive heart failure (CHF)											
Hemodialysis	191,559	43.8	27.8	39.7	48.4	52.4	45.1	42.8	38.5	42.0	45.9
Peritoneal dialysis	15,225	31.7	19.6	29.5	38.0	40.7	32.1	32.4	25.5	33.4	29.9
Transplant	14,918	28.1	10.3	22.1	36.3	44.9	29.3	25.9	24.0	28.2	27.9
Valvular heart disease (VHD)											
Hemodialysis	191,559	16.3	10.4	13.7	17.6	21.6	17.6	14.9	14.2	15.4	17.4
Peritoneal dialysis	15,225	14.1	8.7	12.3	16.1	21.2	14.9	12.9	11.3	14.3	14.0
Transplant	14,918	12.5	4.7	8.7	16.4	22.4	13.5	10.4	9.9	11.9	13.3
Cerebrovascular accident/transient ischemic attack (CVA/TIA)											
Hemodialysis	191,559	19.4	7.6	16.2	23.5	25.2	19.6	19.5	15.9	17.7	21.4
Peritoneal dialysis	15,225	15.3	6.7	12.7	21.0	22.1	16.5	13.5	10.5	15.2	15.4
Transplant	14,918	12.8	3.2	10.2	16.5	21.8	13.6	11.1	10.9	12.2	13.8
Peripheral artery disease (PAD)											
Hemodialysis	191,559	37.9	21.7	35.3	42.9	44.1	39.9	36.3	31.5	37.9	38.0
Peritoneal dialysis	15,225	26.9	13.2	24.9	33.8	35.8	29.8	22.0	18.7	28.9	24.8
Transplant	14,918	22.6	9.4	19.3	28.6	32.1	23.9	20.5	16.9	23.7	20.8
Atrial fibrillation (AFIB)											
Hemodialysis	191,559	22.2	5.9	15.6	25.9	36.1	26.5	17.0	19.5	22.8	21.5
Peritoneal dialysis	15,225	17.0	3.9	11.1	23.6	35.6	20.0	10.4	14.4	20.3	13.4
Transplant	14,918	18.6	2.3	11.6	26.3	38.0	21.2	12.5	15.7	19.7	16.8
Cardiac arrest and ventricular arrhythmias (SCA/VA)											
Hemodialysis	191,559	8.3	4.5	7.6	9.6	9.6	8.4	8.3	7.2	8.9	7.5
Peritoneal dialysis	15,225	7.9	4.0	7.0	10.1	11.1	8.4	7.6	4.8	9.2	6.6
Transplant	14,918	6.5	2.9	4.7	8.9	9.9	6.9	5.9	4.2	7.2	5.4
Venous thromboembolism and pulmonary embolism (VTE/PE)											
Hemodialysis	191,559	7.8	8.8	7.7	7.7	7.7	7.1	9.2	5.3	7.2	8.7
Peritoneal dialysis	15,225	5.8	7.2	5.4	5.7	5.6	5.5	7.2	2.8	5.3	6.4
Transplant	14,918	8.8	6.3	7.6	10.2	11.9	9.0	9.2	5.6	8.4	9.5

Table 9.1 continued on next page.

vol 2 Table 9.1 Prevalence of (a) cardiovascular comorbidities & (b) cardiovascular procedures in adult ESRD patients, (%) by treatment modality, age, race, & sex, 2014 (continued)

		(b) Cardiovascular Procedures									
		% Patients									
	# Patients	Overall	22-44	45-64	65-74	75+	White	Blk/Af Am	Other	Male	Female
Revascularization – percutaneous coronary interventions (PCI)											
Hemodialysis	88,440	4.9	4.0	5.7	5.4	3.6	5.1	4.5	5.5	5.0	4.8
Peritoneal dialysis	5,836	6.9	7.6	7.6	6.6	5.8	7.1	6.2	5.9	7.2	6.4
Transplant	4,905	4.2	4.8	5.0	3.9	3.5	4.2	3.6	6.3	4.3	4.1
Revascularization – coronary artery bypass graft (CABG)											
Hemodialysis	88,440	1.6	1.8	2.3	1.7	0.7	1.7	1.4	2.4	1.9	1.2
Peritoneal dialysis	5,836	3.4	3.5	4.1	3.6	1.9	3.4	3.3	3.4	3.6	3.1
Transplant	4,905	1.5	1.1	2.0	1.2	1.2	1.6	0.7	3.1	1.7	1.0
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator devices (ICD/CRT-D)											
Hemodialysis	83,841	0.7	0.7	0.7	0.8	0.5	0.7	0.7	0.7	0.9	0.5
Peritoneal dialysis	4,828	0.8	0.6	0.8	0.9	0.9	1.1	0.4	0.0	0.9	0.7
Transplant	4,187	0.7	0.5	1.0	0.5	0.6	0.6	0.9	0.9	0.9	0.5
Carotid artery stenting and carotid artery endarterectomy (CAS/CEA)											
Hemodialysis	120,105	0.4	0.1	0.3	0.5	0.4	0.5	0.2	0.2	0.3	0.4
Peritoneal dialysis	7,759	0.7	0.0	0.3	1.1	1.0	0.8	0.3	0.2	0.7	0.7
Transplant	6,603	0.4	0.3	0.2	0.4	0.7	0.5	0.1	0.0	0.3	0.6

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, with Medicare as primary payer on January 1, 2014, who are continuously enrolled in Medicare Parts A and B from January 1, 2013 to December 31, 2013, and ESRD service date is at least 90 days prior to January 1, 2014. (a) The denominators for all cardiovascular comorbidities are patients described above by modality. (b) The denominators for PCI and CABG are patients with ASHD by modality. The denominator for ICD/CRT-D is patients with CHF by modality. The denominator for CAS/CEA is patients with ASHD, CVA/TIA, or PAD by modality. Abbreviations: AfIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; Af Am, African American; Blk, black; CABG, coronary artery bypass grafting; CAS/CEA, carotid artery stenting and carotid artery endarterectomy; CHF, congestive heart failure; 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.

The presence of cardiovascular diseases is known to decrease short- and long-term survival for ESRD patients. For example, in a classic study from the USRDS by Herzog et al. in 1998, one-year mortality after AMI approached 60% in patients on long-term dialysis. Figures 9.4.a through 9.4.m illustrate two-year survival curves in adult ESRD patients with and without individual cardiovascular diseases.

In general, ESRD patients have lower survival when cardiovascular disease conditions are present. A pattern of lower survival is observed in patients who undergo PCI, ICD/CRT-D placement, and CAS/CEA, but survival appears similar between patients who undergo CABG

procedures and those who do not. The ESRD patients who undergo these procedures are being compared both with those who have any cardiovascular conditions but do not undergo these procedures and those without any cardiovascular conditions. These descriptive results in the adult ESRD population require careful interpretation. For example, the survival differences across therapies may be the consequence of confounding-by-indication due to selection of patients for the various procedures. Careful comparative effectiveness research with appropriate statistical methods would be necessary to evaluate whether these procedures improve or worsen patient prognoses among similar/equivalent patient groups comparing those that undergo the procedure versus those that do not.

vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014

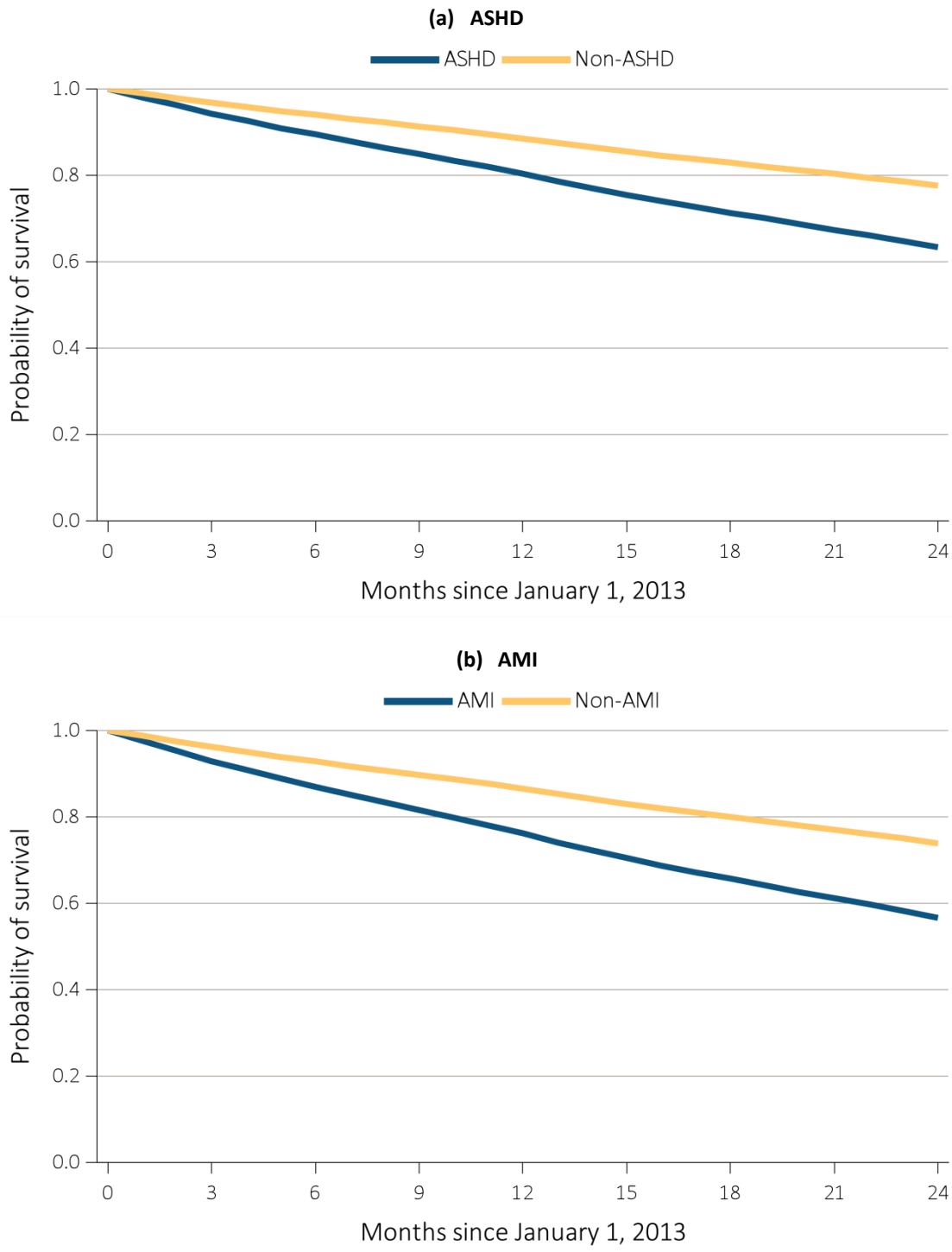


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vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014 (continued)

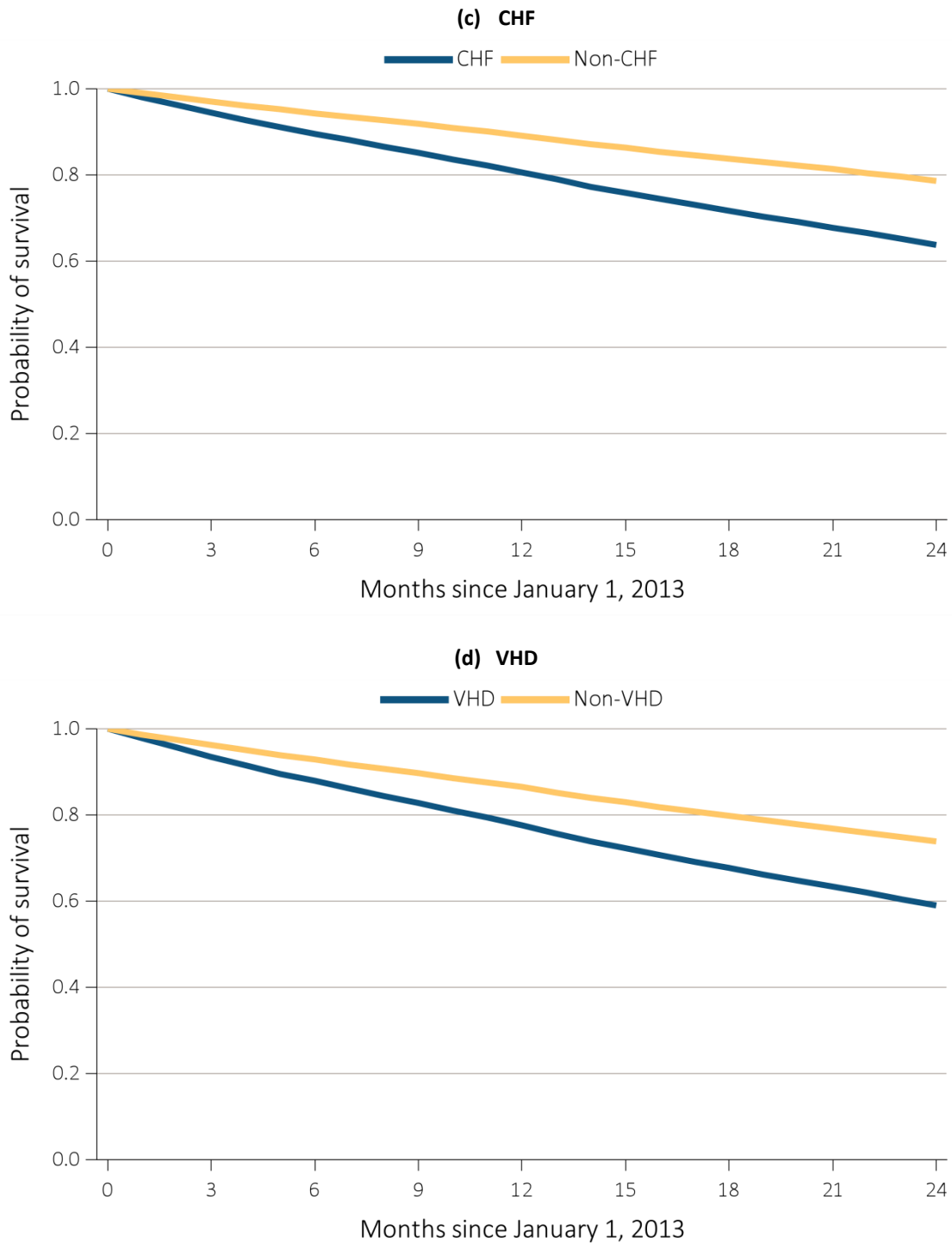


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vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014 (continued)

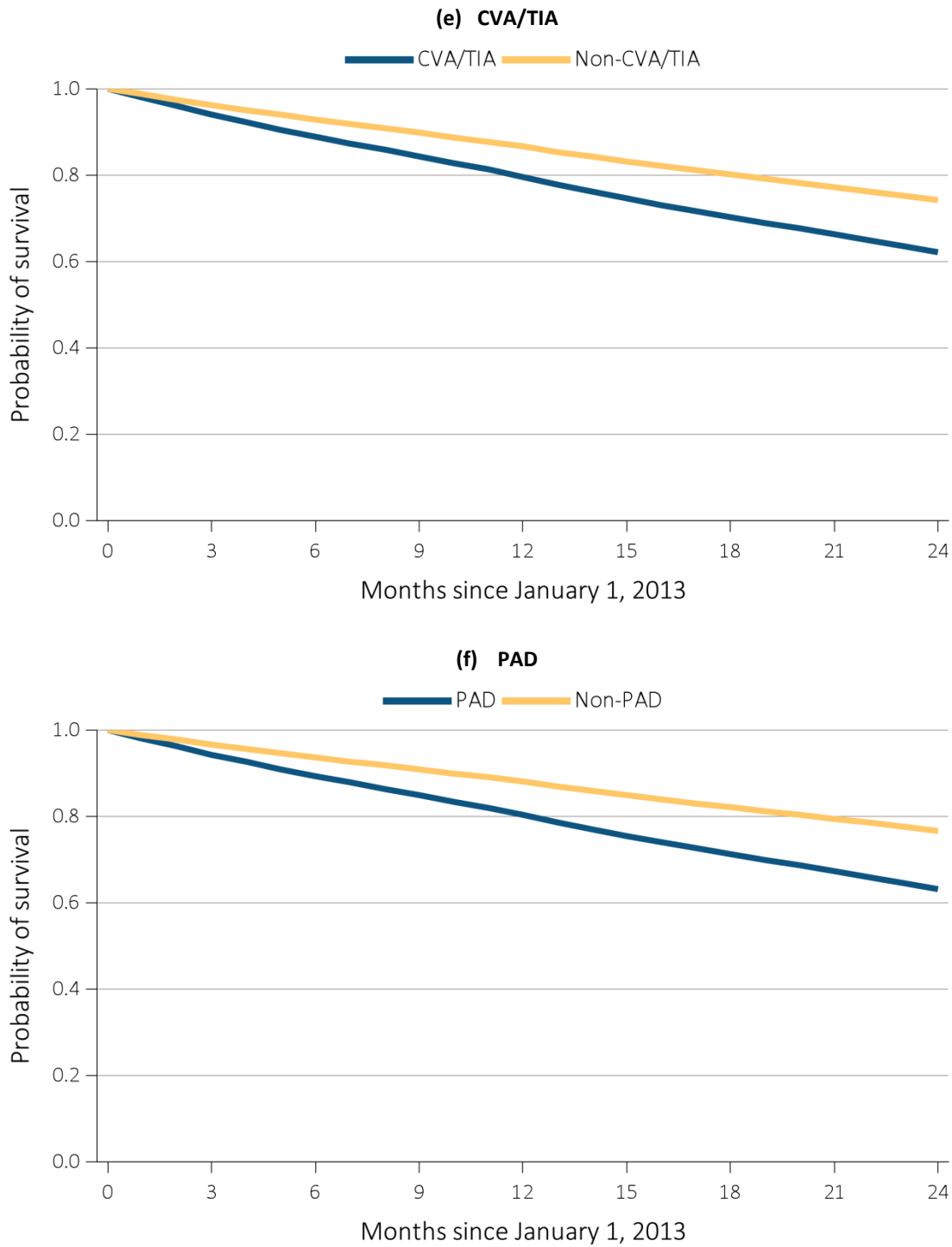


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vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014 (continued)

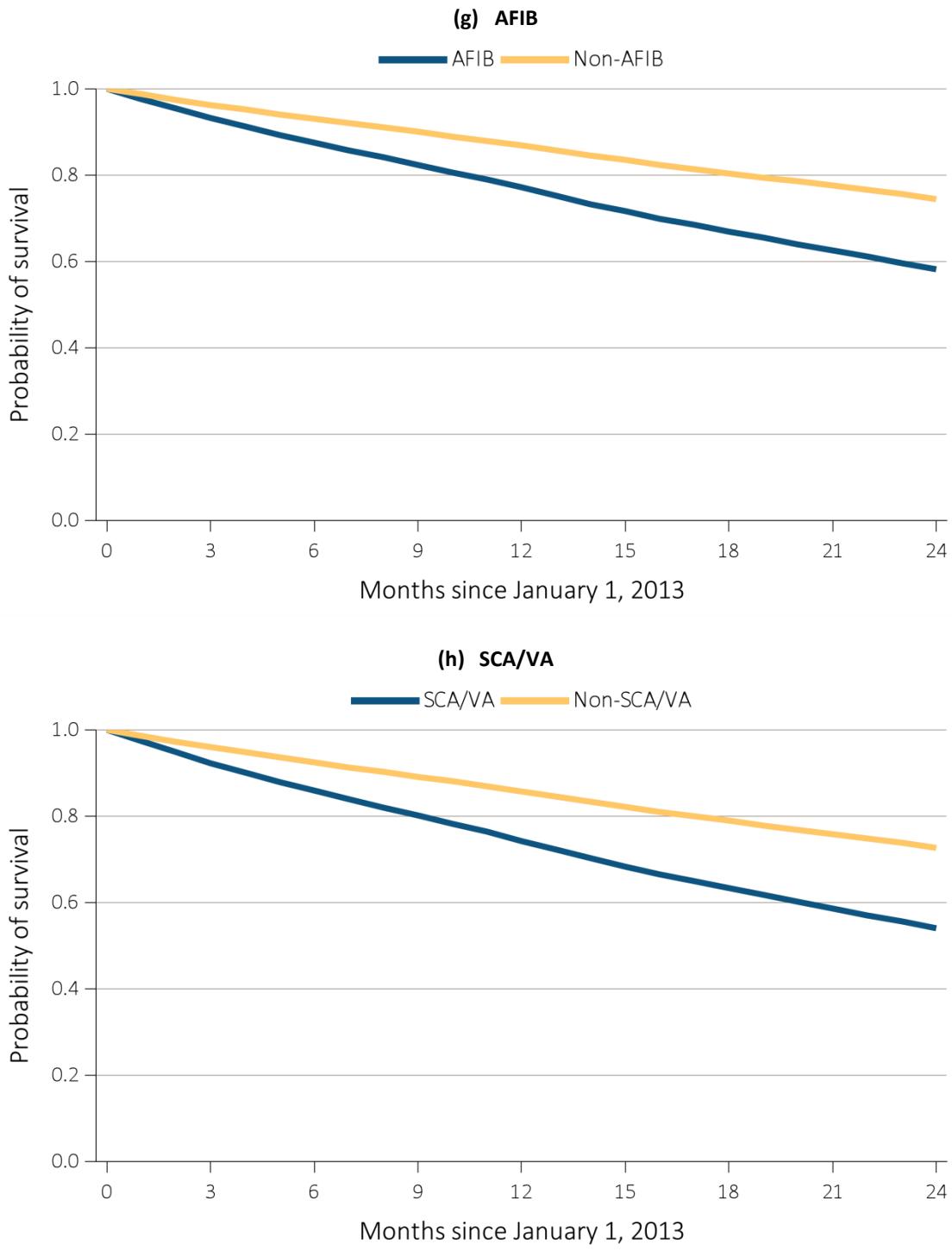


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vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014 (continued)

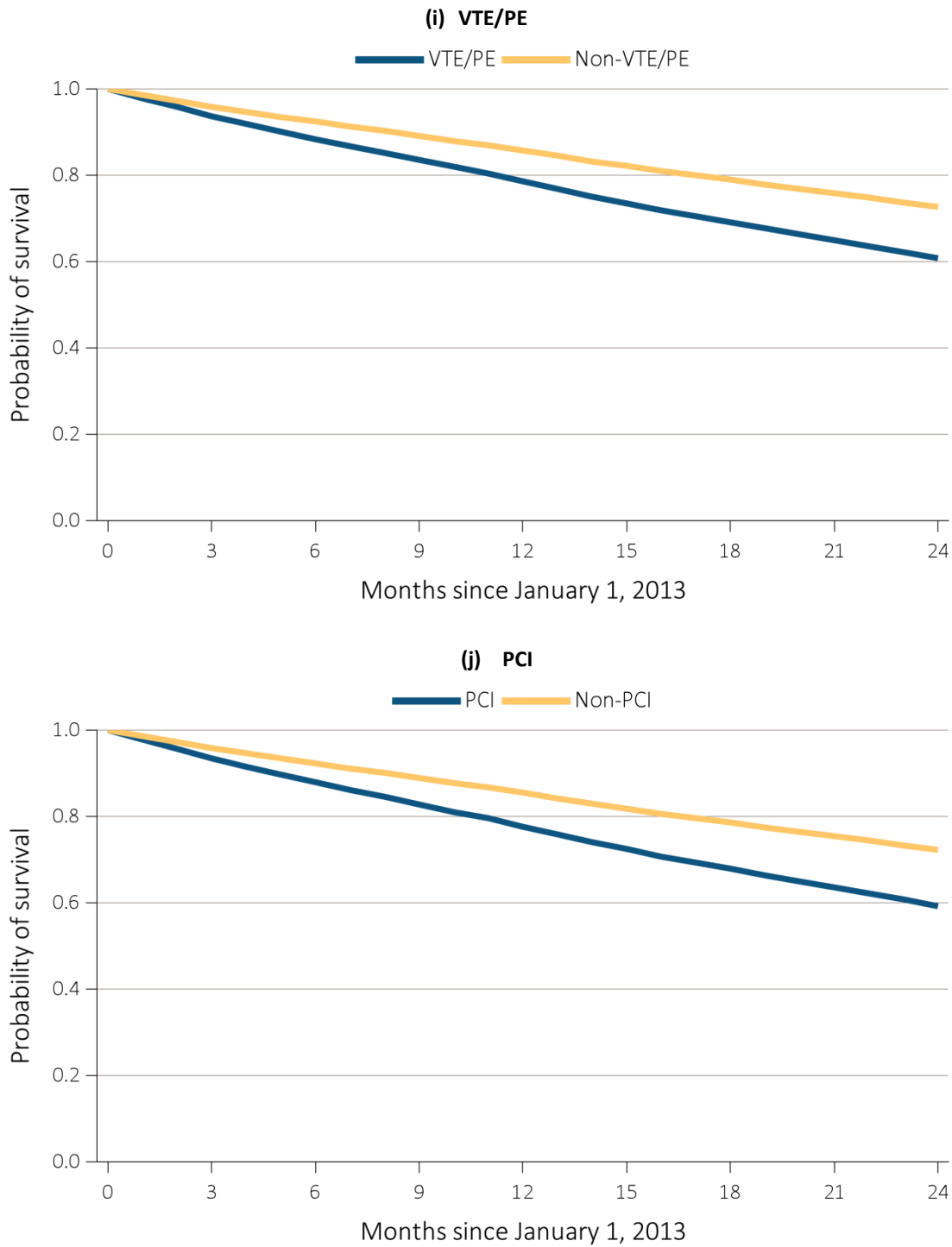


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vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014 (continued)

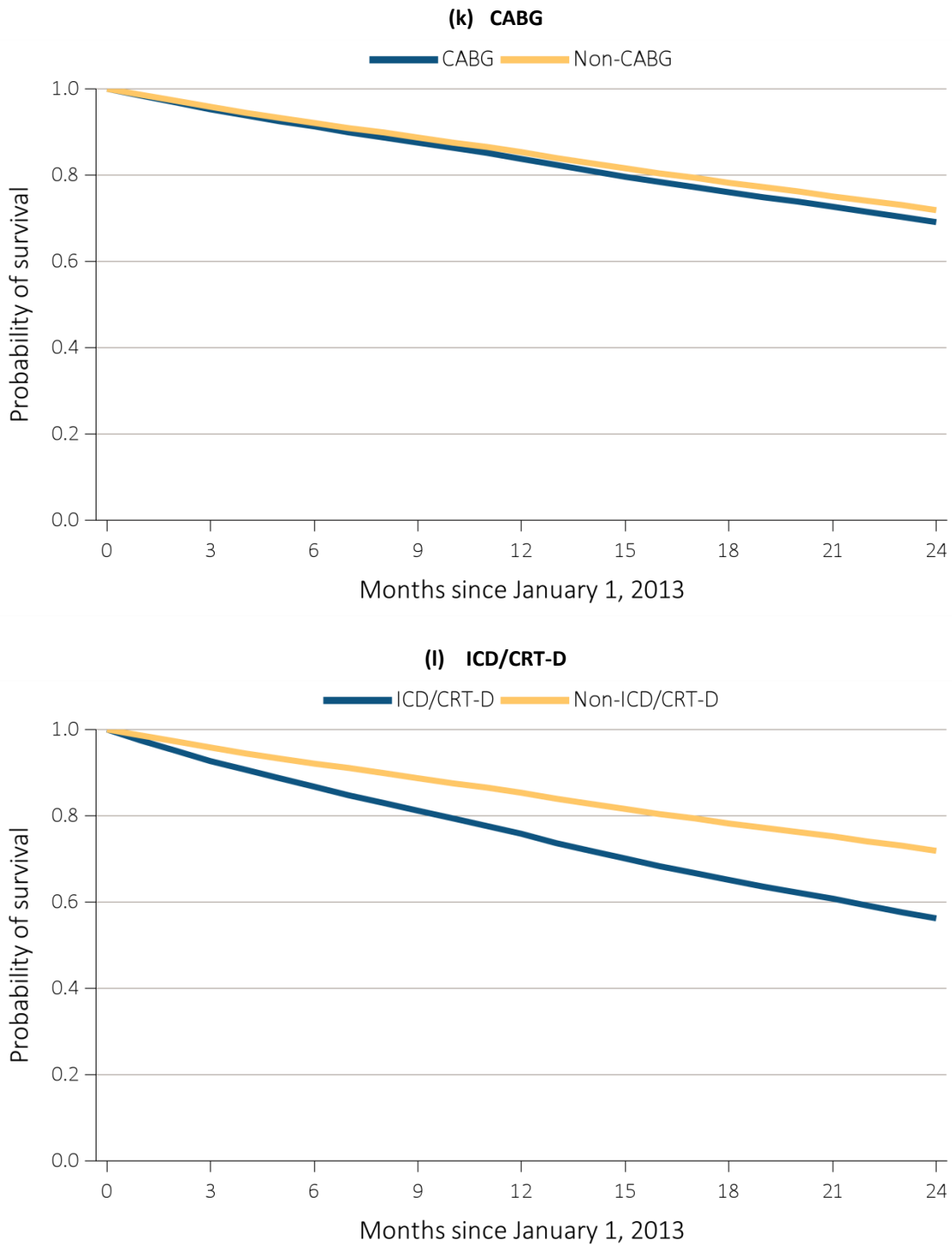
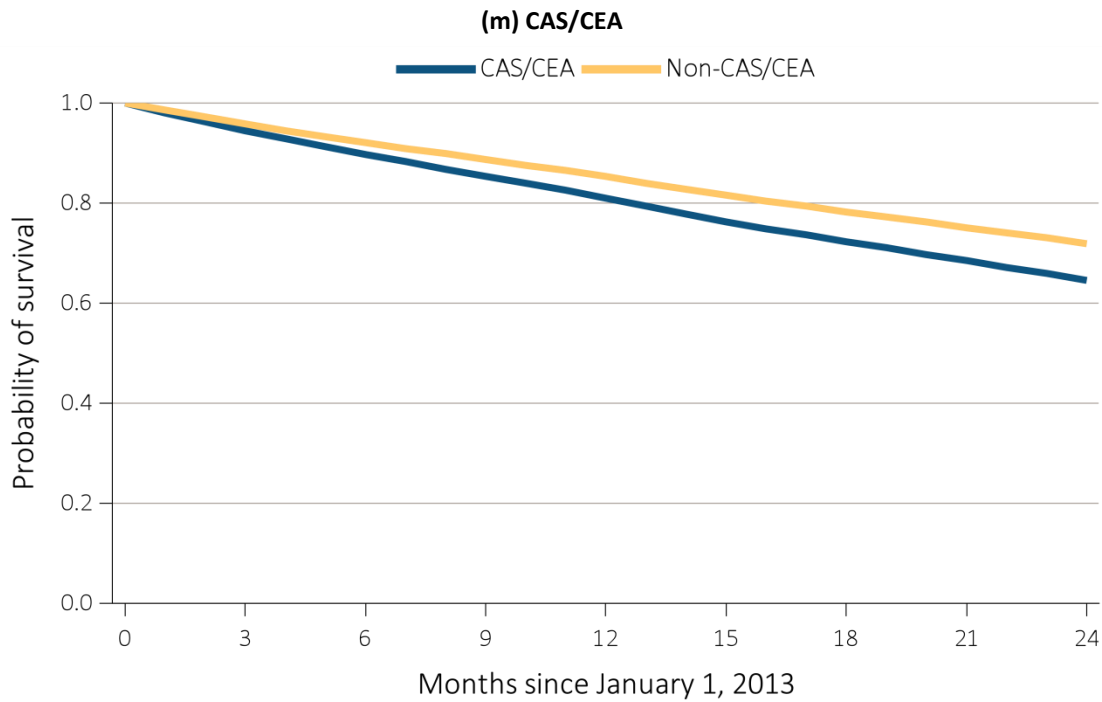


Figure 9.4 continued on next page.

vol 2 Figure 9.4 Probability of survival of adult ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, adjusted for age and sex, 2013-2014 (continued)



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, with Medicare as primary payer on January 1, 2012, who are continuously enrolled in Medicare Parts A and B from January 1, 2011 to December 31, 2011, and whose first ESRD service date is at least 90 days prior to January 1, 2012, and survived past 2012. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CABG, coronary artery bypass grafting; CAS/CEA, carotid artery stenting and carotid artery endarterectomy; CHF, congestive heart failure; CVA/TIA, cerebrovascular accident/transient ischemic attack; 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.

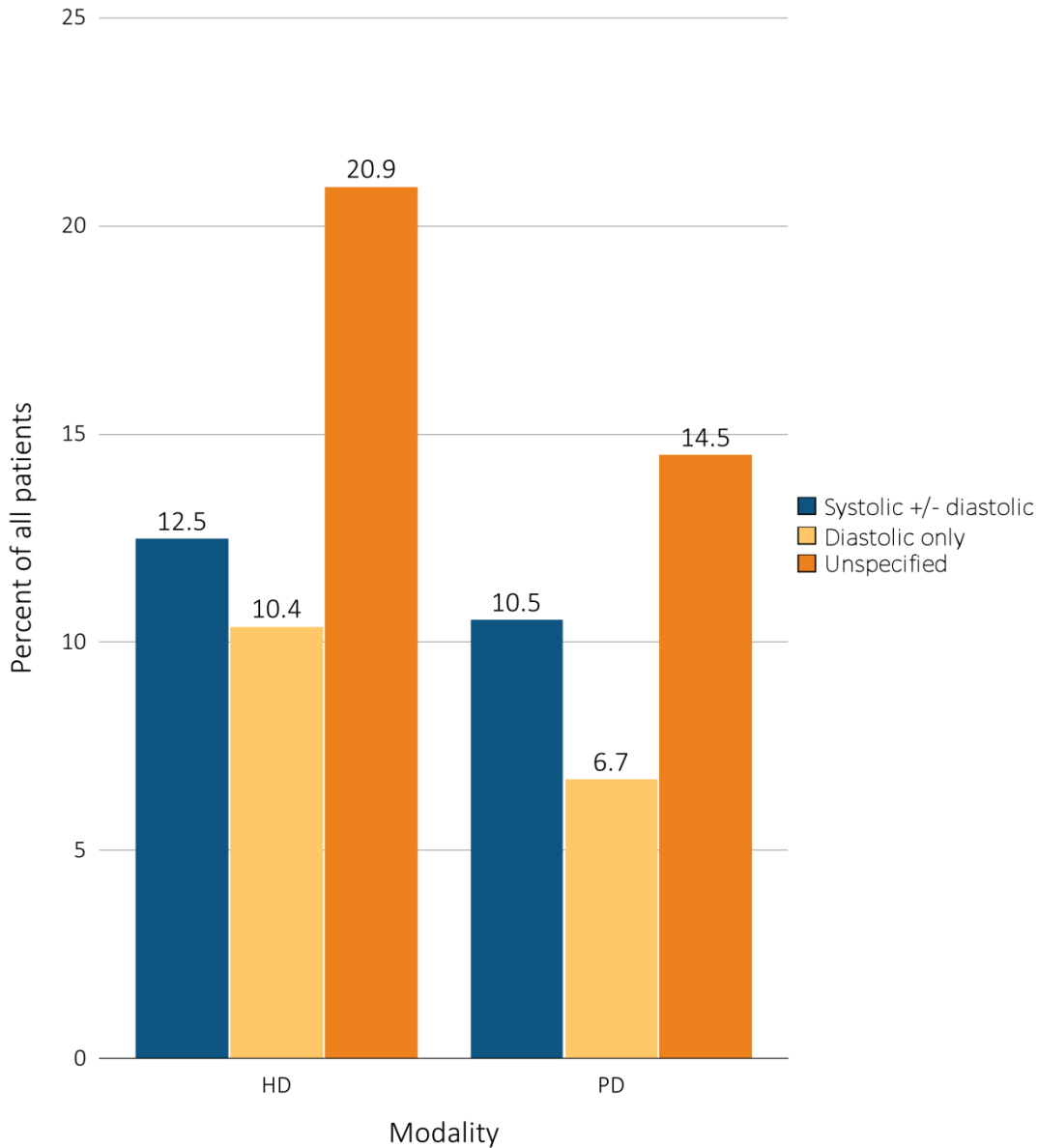
Congestive Heart Failure Among ESRD Patients

Congestive heart failure (CHF) is a highly prevalent cardiovascular disease among ESRD patients. Presence of CHF adds further complexity to fluid management in ESRD patients, especially given the absence of renal function and clinical challenges with volume status assessment. CHF in ESRD patients is further examined in Figure 9.5 by stratifying CHF according to systolic dysfunction (i.e., heart failure with decreased ejection fraction), diastolic dysfunction (i.e., heart failure with preserved ejection fraction), or unspecified cardiac dysfunction. (Note: For ease of reporting and consistency in studying clinical approaches, systolic CHF includes all patients with systolic dysfunction, regardless of the presence of concomitant diastolic

dysfunction. Patients with isolated diastolic CHF are analyzed separately since treatments and prognoses are markedly different for this group.)

Among adult ESRD patients, the largest percent of patients have unspecified CHF and the relative proportion of patients with systolic CHF is slightly higher than diastolic CHF (Figure 9.5). This pattern is true for both hemodialysis and peritoneal dialysis patients. The percentage of patients experiencing each type of heart failure is slightly higher among hemodialysis patients compared to peritoneal dialysis patients. As we identified categories of systolic dysfunction and diastolic dysfunction through ICD-9-CM diagnosis codes, the findings should be considered cautiously without further clinical data available given the limitations of these codes.

vol 2 Figure 9.5 Heart failure in adult ESRD patients by modality, 2014



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis and peritoneal dialysis patients aged 22 and older, with Medicare as primary payer on January 1, 2014, who are continuously enrolled in Medicare Parts A and B from January 1, 2013 to December 31, 2013, and ESRD service date is at least 90 days prior to January 1, 2014. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

Summary

This chapter provides an overview of cardiovascular diseases among adult ESRD patients, using administrative claims data from Medicare. The relationship between cardiovascular disease and kidney disease is complex and bidirectional, and close attention to cardiovascular disease is vital to the care of these patients. The high prevalence of AMI, ASHD, CHF and sudden death/cardiac arrhythmias should

draw more attention of researchers and clinicians. Improving outcomes in this complex patient population remains challenging, and the presence of ESRD should not detract health care practitioners from delivering the high quality cardiovascular care that they deserve.

References

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Herzog CA, Ma JZ, Collins AJ. Poor long-term survival after acute myocardial infarction among patients on long-term dialysis. *N Engl J Med* 1998;339(12):799-805.

Notes