
Chapter 8:

Cardiovascular Disease in Patients with ESRD

- Cardiovascular disease (CVD) is common in adult end-stage renal disease (ESRD) patients, with coronary artery disease (CAD) and heart failure (HF) being the most common conditions (Table 8.1).
- Even relatively young ESRD patients—those aged 22-44 and 45-64 years—experience significant cardiovascular morbidity (Figures 8.2.a and 8.2.b).
- The presence of cardiovascular diseases worsens both short and long-term survival in adult ESRD patients (Figure 8.3).
- Only about two-thirds of dialysis or transplant patients with acute myocardial infarction (AMI) received beta-blocker medication. Similarly, among ESRD patients with HF, fewer than half received angiotensin converting enzyme inhibitors (ACEIs) and angiotensin receptor blockers (ARBs). Although many ESRD patients with atrial fibrillation (AF) are at elevated risk of stroke, only about one-third of dialysis patients with AF were treated with warfarin (Table 8.3).

Introduction

Patients with ESRD are among the highest risk populations for cardiovascular diseases (CVDs)—a major cause of death in ESRD patients. The relationship between CVD and kidney disease is complex and bidirectional, and close attention to CVD is vital to the care of these patients. The presence of ESRD often complicates disease management of CVD, as it can influence both medical and procedural options, thereby adversely affecting a patient's prognosis.

The high prevalence of AMI, CAD, HF, and sudden death/cardiac arrhythmias should draw more attention of kidney disease 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.

This chapter provides an overview of CVDs among adult ESRD patients, using administrative claims data from Medicare. We focus on reporting the prevalence and outcomes of diagnosed major cardiovascular conditions, stratifying by type of renal replacement therapy (RRT) being received—hemodialysis (HD), peritoneal dialysis (PD), 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 primarily on data from the national Medicare population.

Methods

The findings presented in this chapter were drawn from data sources from the Centers for Medicare & Medicaid Services (CMS). Details of these are described in the [Data Sources](#) section of the [ESRD Analytical Methods](#) chapter.

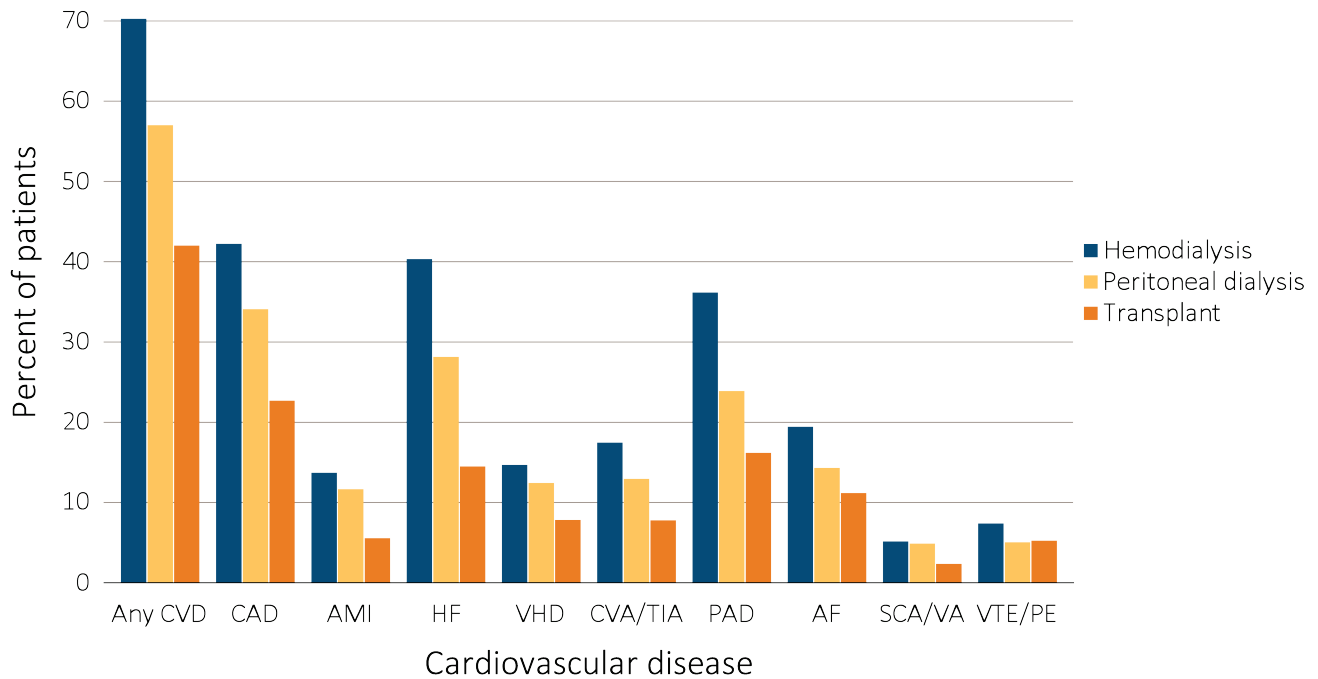
See the section addressing Chapter 8 in the [Analytical Methods Used in the ESRD Volume](#) section of the [ESRD Analytical Methods](#) chapter for an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter. Downloadable Microsoft Excel and PowerPoint files containing the data and graphics for these figures and tables are available on the [USRDS website](#).

Cardiovascular Disease Prevalence in ESRD Patients

As expected from findings in previous Annual Data Reports (ADRs), in 2015 ESRD patients had a high burden of CVD across a wide range of conditions (Figure 8.1). Stable CAD and HF were the two major leading CVDs 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 (AF), sudden cardiac arrest and ventricular arrhythmias (SCA/VA), and venous thromboembolism and pulmonary embolism (VTE/PE) were also common. In general, the prevalence of these cardiovascular diseases was highest among ESRD patients who received HD (69.8%), followed by PD (56.6%), and those with kidney transplants (41.6%).

vol 2 Figure 8.1 Prevalence of cardiovascular diseases in adult ESRD patients, by treatment modality, 2015

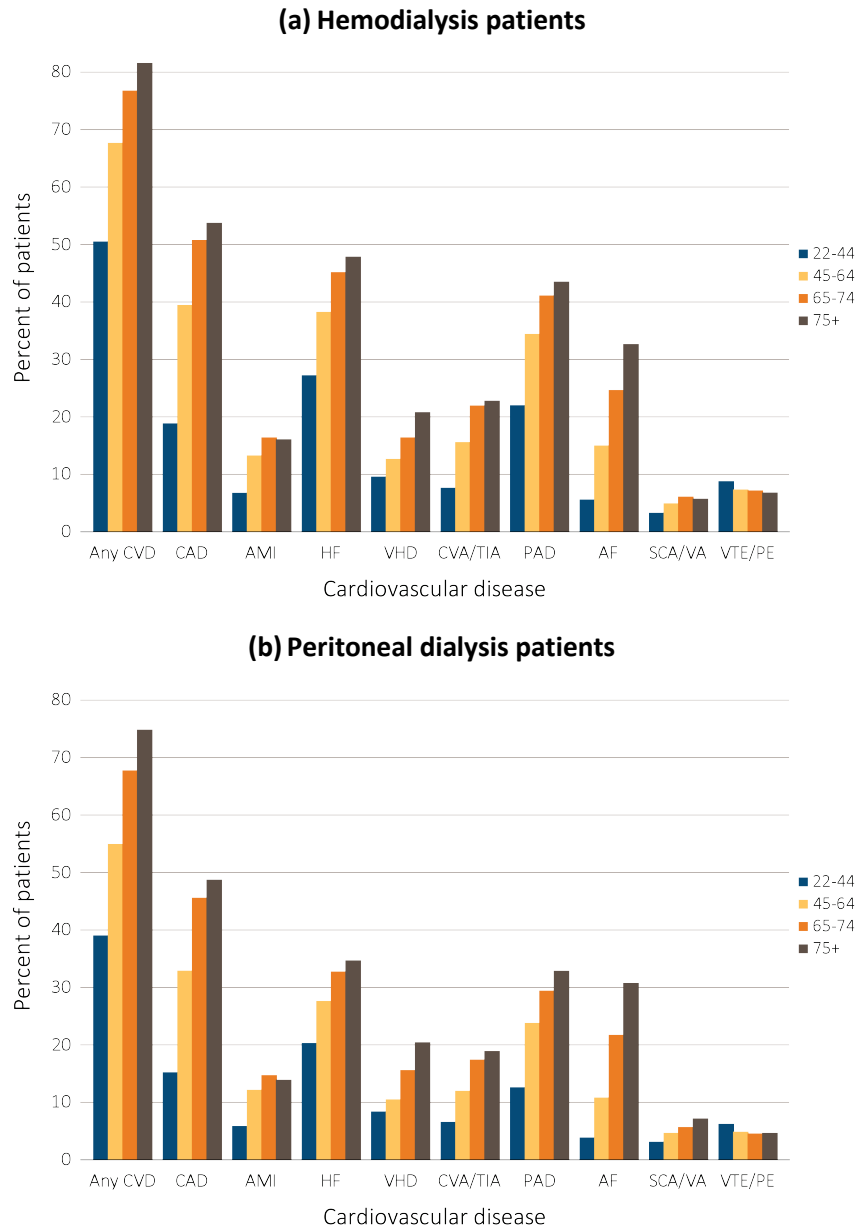


Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2015 to December 31, 2015, and ESRD service date is at least 90 days prior to January 1, 2015. Abbreviations: AF, atrial fibrillation; AMI, acute myocardial infarction; CAD, coronary artery 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.

Peritoneal dialysis patients had a lower burden of certain cardiovascular conditions, including CAD, HF, and PAD, as compared to their HD counterparts. Not surprisingly, older ESRD patients tended to have a higher prevalence of cardiovascular conditions than did younger patients, whether they were receiving HD or PD (Figures 8.2.a and 8.2.b). It is notable that the prevalence of these conditions was high even among HD patients 22-44 years of age (50.1%), although a

much higher prevalence was observed among those 45 years or older (67.2% to 81.1%). The same pattern was true for PD patients. Coronary artery disease was the most common condition, with a prevalence exceeding 50% in HD 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 for either HD or PD patients.

vol 2 Figure 8.2 Prevalence of cardiovascular diseases in adult ESRD patients, by age, 2015



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis and peritoneal dialysis patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2015 to December 31, 2015, and ESRD service date is at least 90 days prior to January 1, 2015. Abbreviations: AF, atrial fibrillation; AMI, acute myocardial infarction; CAD, coronary artery disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; HD, hemodialysis; HF, heart failure; PAD, peripheral arterial disease; PD, peritoneal dialysis; SCA/VA, sudden cardiac arrest and ventricular arrhythmias; VHD, valvular heart disease; VTE/PE, venous thromboembolism and pulmonary embolism.

In Table 8.1, we present the relationships between age, race, and sex, and prevalent CVDs in adult ESRD patients. As noted earlier, advancing age was associated with higher prevalence of cardiovascular conditions. However, the relationships with race and sex were less definitive. The prevalence of major procedures for treating CVD in ESRD patients is also reported in Table 8.1, 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 was low in ESRD patients relative to other major procedures.

vol 2 Table 8.1 Prevalence of (a) cardiovascular comorbidities & (b) cardiovascular procedures in adult ESRD patients, by treatment modality, age, race, & sex, 2015

	# Patients	(a) Cardiovascular comorbidities												
		Percentage of patients (%)												
		Overall	22-44	45-64	65-74	75+	White	Black	AI/AN	Asian	NH/PI	Other	Male	Female
Any CVD														
Hemodialysis	216,384	69.8	50.1	67.2	76.3	81.1	72.2	67.6	61.2	66.4	61.8	65.4	68.2	72.0
Peritoneal dialysis	21,462	56.6	38.6	54.5	67.3	74.4	58.7	53.4	51.3	48.4	57.5	44.7	60.0	52.7
Transplant	72,535	41.6	18.4	37.5	54.8	65.8	42.8	39.4	40.9	34.5	36.7	36.7	43.6	38.6
Coronary artery disease (CAD)														
Hemodialysis	216,384	41.8	18.4	39.0	50.3	53.3	46.0	36.6	35.6	41.8	38.8	39.6	42.1	41.4
Peritoneal dialysis	21,462	33.7	14.8	32.5	45.2	48.3	36.8	27.6	29.0	29.7	30.7	26.3	38.7	27.8
Transplant	72,535	22.3	5.9	19.7	31.5	38.1	23.7	18.7	24.3	19.2	20.6	18.4	25.2	17.9
Acute myocardial infarction (AMI)														
Hemodialysis	216,384	13.3	6.3	12.8	16.0	15.6	14.9	11.4	11.5	11.9	13.4	10.5	13.4	13.2
Peritoneal dialysis	21,462	11.2	5.4	11.7	14.3	13.5	12.3	9.4	8.0	8.0	12.7	7.9	12.9	9.3
Transplant	72,535	5.1	1.9	4.8	6.8	7.9	5.5	4.2	6.1	3.3	5.6	3.6	5.8	4.2
Heart failure (HF)														
Hemodialysis	216,384	39.9	26.8	37.8	44.7	47.4	40.5	39.9	31.0	35.6	34.7	34.1	37.8	42.7
Peritoneal dialysis	21,462	27.7	19.9	27.2	32.3	34.2	27.6	29.1	26.9	21.8	28.5	23.7	29.5	25.7
Transplant	72,535	14.1	5.9	12.3	18.7	24.5	13.8	15.8	13.3	11.4	14.0	8.6	14.4	13.6
Valvular heart disease (VHD)														
Hemodialysis	216,384	14.3	9.2	12.2	16.0	20.4	15.5	13.0	9.9	14.0	11.1	14.4	13.1	15.8
Peritoneal dialysis	21,462	12.0	8.0	10.1	15.2	20.0	12.9	10.3	11.3	10.8	11.0	2.6	12.2	11.8
Transplant	72,535	7.4	2.5	5.5	10.7	16.1	7.9	6.4	3.8	6.2	5.6	6.0	7.1	7.8
Cerebrovascular accident/transient ischemic attack (CVA/TIA)														
Hemodialysis	216,384	17.1	7.2	15.2	21.5	22.4	17.4	17.1	10.8	15.4	14.5	13.1	15.4	19.2
Peritoneal dialysis	21,462	12.5	6.1	11.6	17.0	18.5	13.5	11.1	8.8	9.7	11.0	13.2	12.5	12.6
Transplant	72,535	7.3	2.2	5.8	10.8	14.1	7.6	7.0	6.1	5.5	5.4	5.6	7.2	7.5
Peripheral artery disease (PAD)														
Hemodialysis	216,384	35.7	21.6	34.0	40.7	43.1	37.7	34.1	30.9	29.0	27.3	31.8	35.4	36.1
Peritoneal dialysis	21,462	23.5	12.2	23.4	29.0	32.4	25.4	20.5	21.4	16.2	23.2	13.2	26.0	20.5
Transplant	72,535	15.8	6.3	14.5	20.7	25.3	16.1	15.5	18.4	11.5	13.0	17.3	17.1	13.8
Atrial fibrillation (AF)														
Hemodialysis	216,384	19.0	5.2	14.6	24.2	32.2	22.7	14.5	10.4	18.9	16.7	17.3	19.5	18.4
Peritoneal dialysis	21,462	13.9	3.4	10.4	21.3	30.3	16.1	9.0	9.2	12.9	15.8	5.3	16.5	10.8
Transplant	72,535	10.7	1.5	7.2	17.1	26.6	11.9	7.9	8.2	8.1	8.9	4.9	11.9	9.0
Cardiac arrest and ventricular arrhythmias (SCA/VA)														
Hemodialysis	216,384	4.7	2.9	4.5	5.7	5.3	4.8	4.9	3.3	3.3	3.2	3.4	5.2	4.2
Peritoneal dialysis	21,462	4.5	2.7	4.2	5.2	6.7	4.6	4.5	2.5	2.9	4.8	0.0	5.4	3.4
Transplant	72,535	1.9	0.7	1.6	2.7	3.7	1.9	2.1	1.7	1.3	1.2	1.7	2.1	1.6
Venous thromboembolism and pulmonary embolism (VTE/PE)														
Hemodialysis	216,384	7.0	8.3	6.9	6.8	6.4	6.3	8.2	4.2	4.5	4.3	6.3	6.3	7.9
Peritoneal dialysis	21,462	4.6	5.8	4.4	4.1	4.2	4.4	5.7	1.3	1.9	5.7	2.6	4.4	4.9
Transplant	72,535	4.8	3.4	4.5	5.8	6.5	4.7	5.8	3.8	2.0	3.3	3.8	4.9	4.8

Table 8.1 continued on next page.

vol 2 Table 8.1 Prevalence of (a) cardiovascular comorbidities & (b) cardiovascular procedures in adult ESRD patients, by treatment modality, age, race, & sex, 2015 (continued)

(b) Cardiovascular procedures

Percentage of patients (%)

	# Patients	Overall	22-44	45-64	65-74	75+	White	Blk/Af Am	AI/AN	Asian	NH/PI	Other	Male	Female
Revascularization – percutaneous coronary interventions (PCI)														
Hemodialysis	90,475	3.7	3.5	4.1	3.9	2.8	3.9	3.4	3.4	4.0	4.4	4.6	3.7	3.6
Peritoneal dialysis	7,224	5.5	5.1	6.8	4.5	4.1	5.9	4.1	4.3	6.4	2.9	*	5.3	5.7
Transplant	16,152	2.4	4.1	2.6	2.0	2.1	2.5	1.7	3.2	1.8	6.0	3.1	2.4	2.3
Revascularization – coronary artery bypass graft (CABG)														
Hemodialysis	90,475	1.8	2.0	2.4	1.8	0.7	1.9	1.5	2.6	1.9	2.5	2.0	2.1	1.4
Peritoneal dialysis	7,224	3.4	3.7	4.3	3.3	1.5	3.6	2.7	4.3	3.5	11.4	*	3.9	2.7
Transplant	16,152	1.3	0.8	1.6	1.3	0.8	1.4	1.3	1.6	1.1	0.0	3.1	1.5	1.1
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator devices (ICD/CRT-D)														
Hemodialysis	86,319	0.8	0.7	0.9	0.9	0.6	0.8	0.7	0.7	1.0	0.6	0.8	1.0	0.6
Peritoneal dialysis	5,947	0.8	0.9	1.0	0.6	0.6	0.8	0.9	0.0	0.0	1.5	*	0.7	0.9
Transplant	10,206	0.6	0.3	0.8	0.6	0.5	0.6	0.7	1.0	0.3	1.5	0.0	0.7	0.4
Carotid artery stenting and carotid artery endarterectomy (CAS/CEA)														
Hemodialysis	127,063	0.4	0.1	0.3	0.5	0.5	0.5	0.2	0.2	0.1	0.4	0.5	0.4	0.4
Peritoneal dialysis	9,893	0.5	0.0	0.4	0.8	0.5	0.6	0.3	0.0	0.2	0.0	0.0	0.5	0.5
Transplant	23,416	0.3	0.0	0.2	0.5	0.3	0.4	0.2	0.4	0.6	0.7	0.0	0.3	0.3

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2015 to December 31, 2015, and ESRD service date is at least 90 days prior to January 1, 2015. (a) The denominators for all cardiovascular comorbidities are patients described above by modality. (b) The denominators for PCI and CABG are patients with CAD by modality. The denominator for ICD/CRT-D is patients with HF by modality. The denominator for CAS/CEA is patients with CAD, CVA/TIA, or PAD by modality. *Values for cells with 10 or fewer patients are suppressed. Abbreviations: AF, atrial fibrillation; AI/AN, American Indian or Alaska Native; 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 artery endarterectomy; 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; NH/PI, Native Hawaiian or Pacific Islander; 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 CVDs 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 8.3.a through 8.3.i and Table 8.2 illustrate adjusted two-year survival in adult ESRD patients with and without individual CVDs. Figures 8.4.a through 8.4.d and Table 8.3 illustrate adjusted two-year survival in adult ESRD patients with and without completed cardiovascular procedures.

In general, ESRD patients have lower survival when CVD conditions are present. A pattern of lower survival was observed in those who underwent PCI, ICD/CRT-D placement (Figures 8.4.a and 8.4.c), and CAS/CEA (Figure 8.4.d), but survival appeared similar

between patients who had CABG procedures, (Figure 8.4.b) and those who did not.

We compared the probability of survival of ESRD patients who underwent PCI and CABG with those who did not have these procedures, among patients with CAD (Figures 8.4.a and 8.4.b). The ESRD patients with HF who underwent ICD/CRT-D placement were compared with those who did not have this procedure (Figure 8.4.c). We also compared ESRD patients with CAD, CVA/TIA, or PAD who underwent CAS/CEA with those who did not have this procedure (Figure 8.4.d). These descriptive results in the adult ESRD population require careful interpretation. Comparative effectiveness research with appropriate statistical methods is necessary to evaluate whether these procedures improve or worsen patient prognoses.

vol 2 Figure 8.3 Probability of survival of adult ESRD patients with or without a cardiovascular disease, adjusted for age and sex, 2014-2015

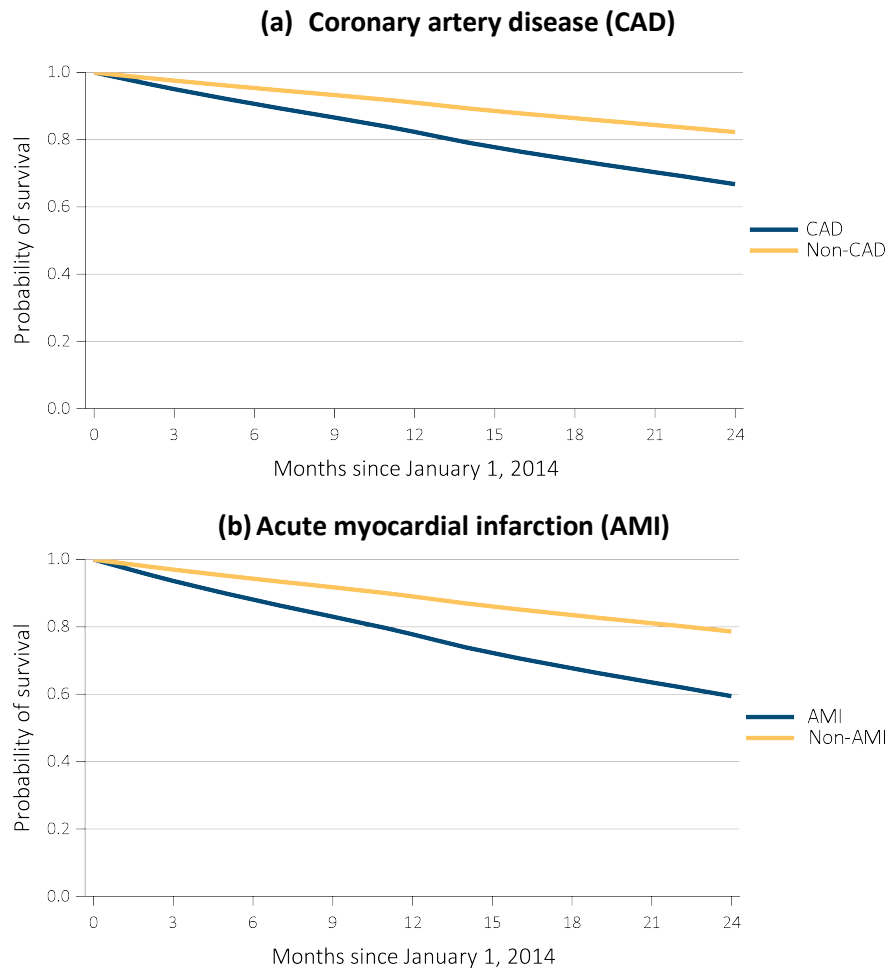


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vol 2 Figure 8.3 Probability of survival of adult ESRD patients with or without a cardiovascular disease, adjusted for age and sex, 2014-2015 (continued)

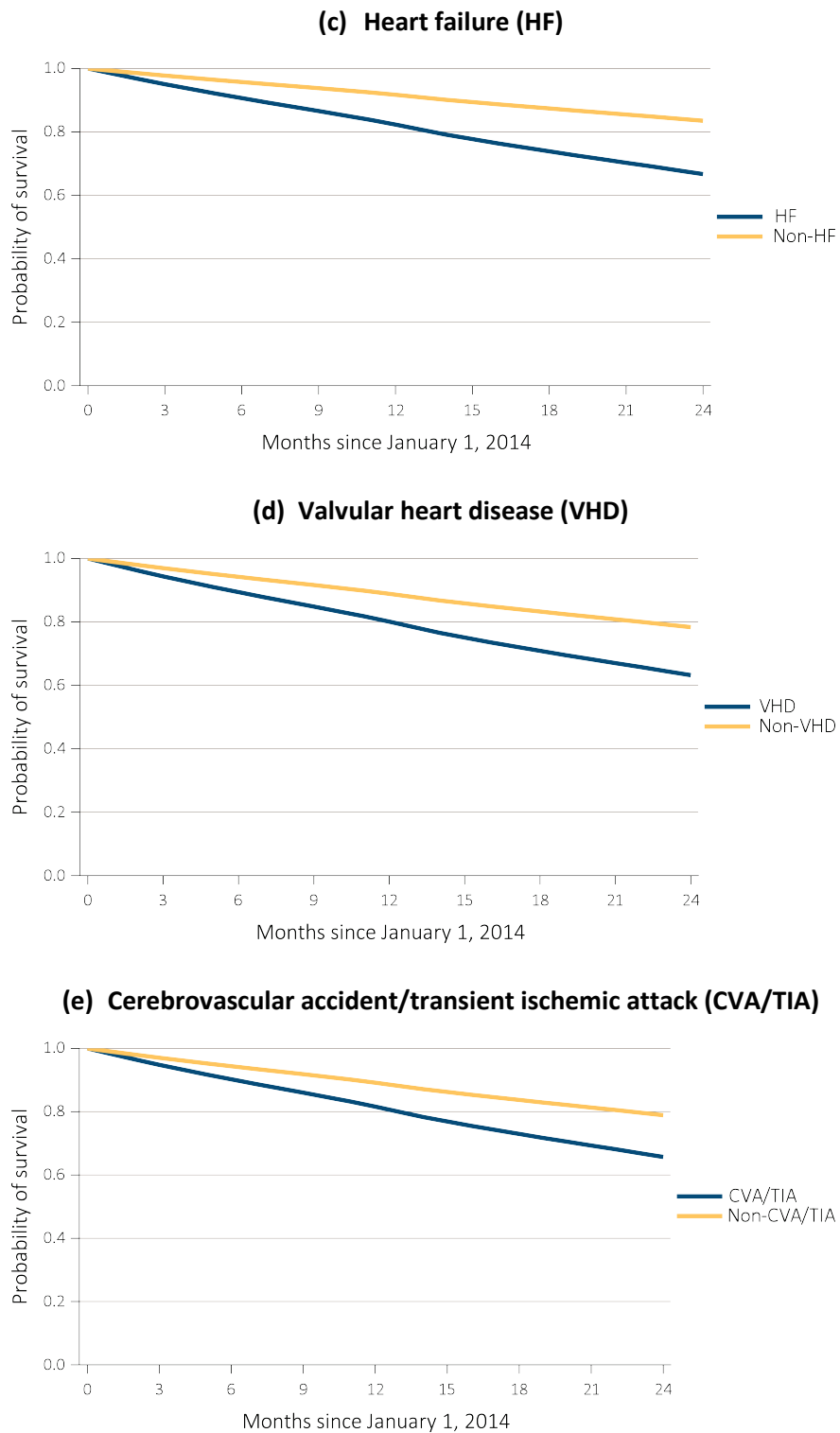


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vol 2 Figure 8.3 Probability of survival of adult ESRD patients with or without a cardiovascular disease, adjusted for age and sex, 2014-2015 (continued)

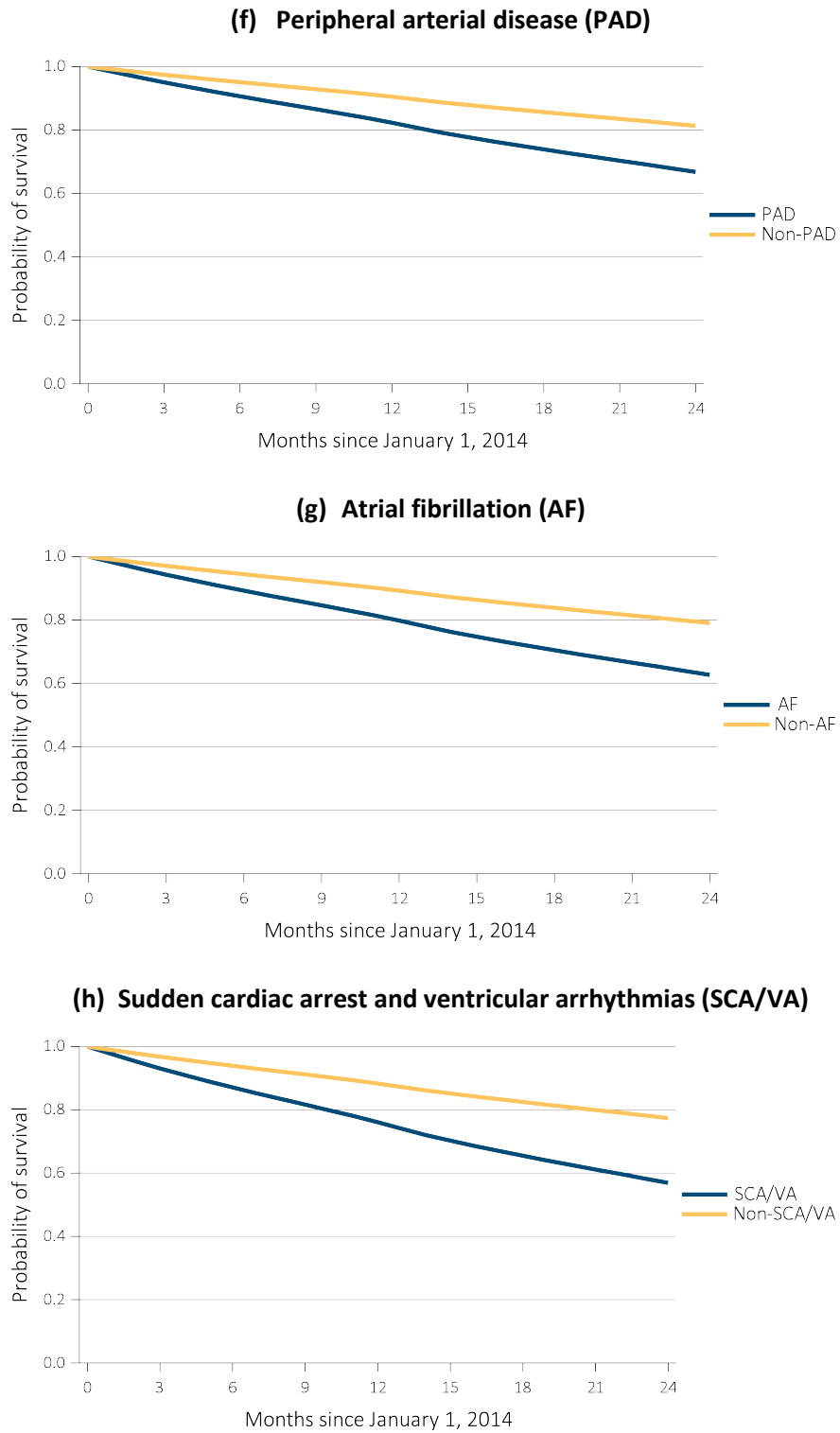
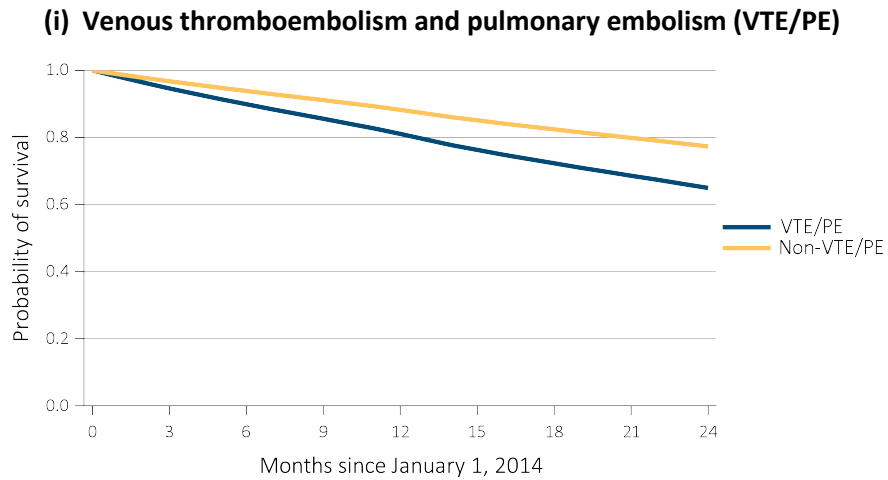


Figure 8.3 continued on next page.

vol 2 Figure 8.3 Probability of survival of adult ESRD patients with or without a cardiovascular disease, adjusted for age and sex, 2014-2015 (continued)



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

vol 2 Table 8.2 Two-year survival of adult ESRD patients with or without a cardiovascular disease, adjusted for age and sex, 2014-2015

Cardiovascular disease	Presence of cardiovascular disease	
	Survival when present (%)	Survival when not present (%)
CAD	66.8	82.3
AMI	59.4	78.6
HF	66.7	83.5
VHD	63.2	78.3
CVA/TIA	65.7	78.9
PAD	66.8	81.3
AF	62.7	79.0
SCA/VA	56.9	77.4
VTE/PE	65.0	77.3

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2013 to December 31, 2013, and whose first ESRD service date is at least 90 days prior to January 1, 2013, and survived past 2013. Abbreviations: AF, atrial fibrillation; AMI, acute myocardial infarction; CAD, coronary artery 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 2 Figure 8.4 Probability of survival of adult ESRD patients with or without a completed cardiovascular procedure, adjusted for age and sex, 2014-2015

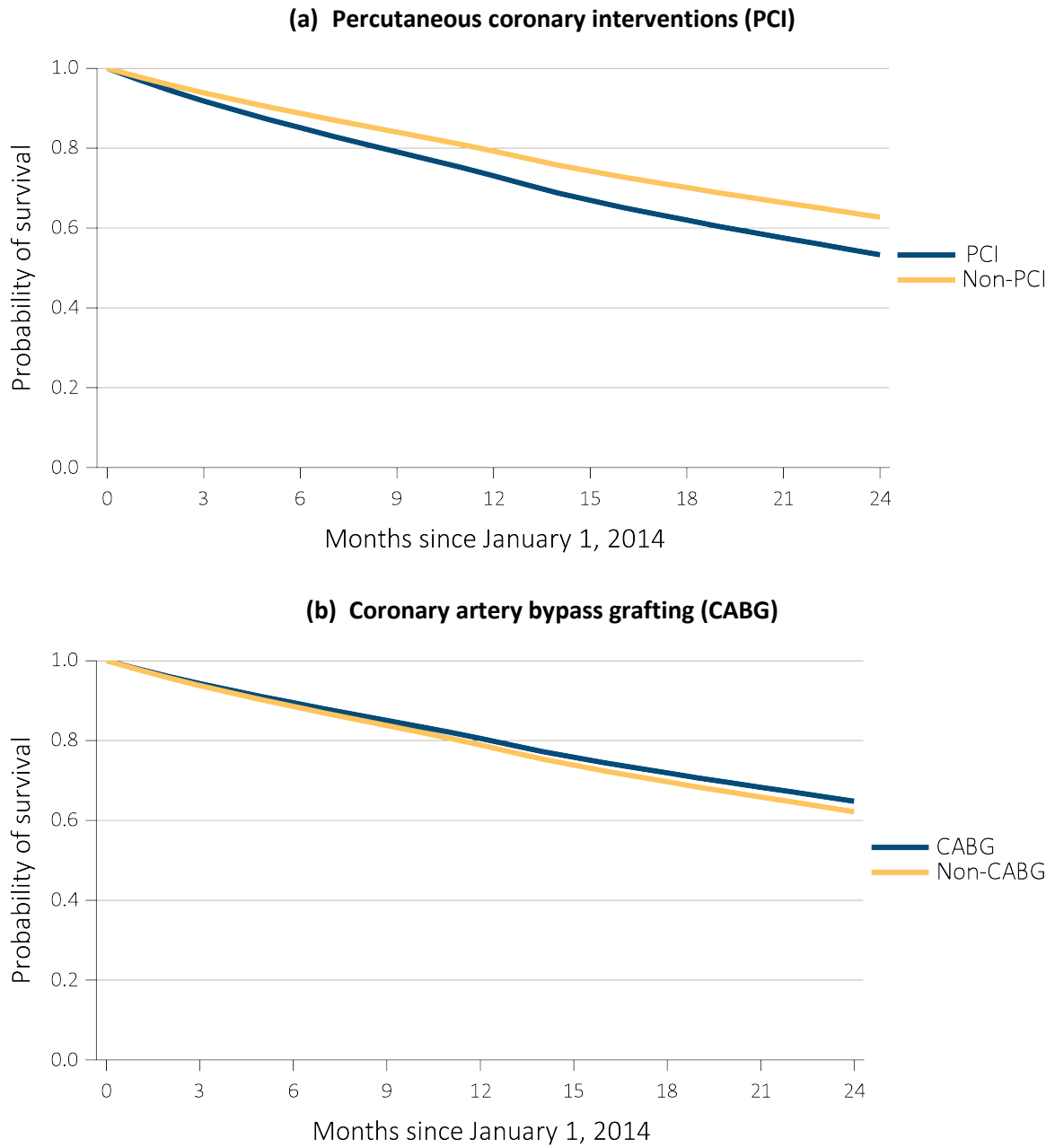
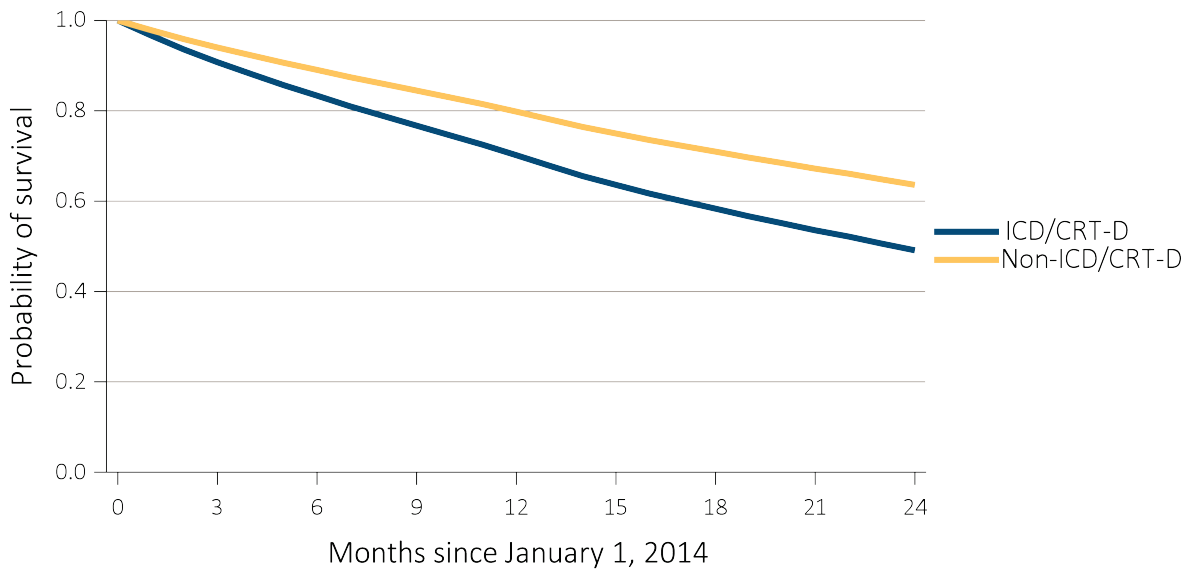


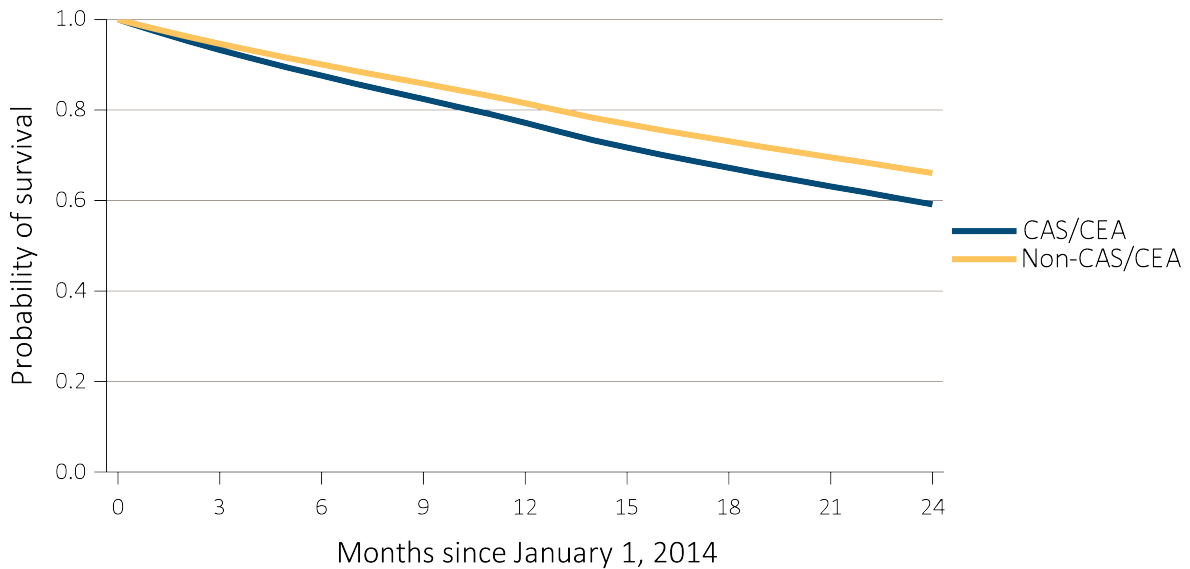
Figure 8.4 continued on next page.

vol 2 Figure 8.4 Probability of survival of adult ESRD patients with or without a completed cardiovascular procedure, adjusted for age and sex, 2014-2015 (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, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2013 to December 31, 2013, and whose first ESRD service date is at least 90 days prior to January 1, 2013, and survived past 2013.

vol 2 Table 8.3 Two-year survival of adult ESRD patients with or without a completed cardiovascular procedure, adjusted for age and sex, 2014-2015

Cardiovascular procedure	Presence of cardiovascular procedure	
	Survival when present (%)	Survival when not present (%)
PCI	53.3	62.7
CABG	64.8	62.2
ICD/CRT-D	49.1	63.6
CAS/CEA	59.2	66.1

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2013 to December 31, 2013, and whose first ESRD service date is at least 90 days prior to January 1, 2013, and survived past 2013. Abbreviations: CABG, coronary artery bypass grafting; CAS/CEA, carotid artery stenting and carotid artery endarterectomy; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PCI, percutaneous coronary interventions.

Cardiovascular Disease and Pharmacological Treatments

Medical therapy for CVD in the ESRD population is fraught with challenges. These patients are usually excluded from large clinical trials for conditions such as CAD, HF, and AF, and as a result, the risks and benefits of various medications in the ESRD population are often not well understood. Drug therapy may be limited by safety issues, such as risk of hyperkalemia with ACEI/ARB therapy, and intradialytic hypotension among HD patients. It is noteworthy that although administration of beta-blockers for AMI is a widely cited quality metric for cardiovascular care, only about two-thirds of dialysis or transplant patients with AMI received these drugs. Similarly, among ESRD patients with heart failure, less than half received ACEIs or ARBs.

Although many ESRD patients with AF are at elevated risk of stroke, only 33.9% of HD and 30.6% of PD patients with AF were treated with warfarin. One possible explanation for these relatively low rates is that ESRD patients on warfarin have a significantly increased risk of bleeding as compared to non-dialysis patients, and the benefit of warfarin in terms of stroke prevention has been called into question (Shah et al., 2014). Direct oral anticoagulants have not been well studied for stroke prevention in AF among ESRD patients, yet were nonetheless used in 5.7% of HD and 5.4% of PD patients. Patients purchase aspirin most commonly over the counter rather than by prescription, thus we could not be reliably assess aspirin use in this cohort.

vol 2 Table 8.4 Cardiovascular pharmacological treatments by (a) comorbidities and (b) procedures in adult ESRD patients, by modality, 2015

(a) Cardiovascular comorbidities

	# Patients	Percentage of patients (%)					
		Beta-blockers	Statins	P2Y ₁₂ inhibitors	Warfarin	Direct Oral Anticoagulants	ACEIs/ARBs
Any CVD							
Hemodialysis	151,130	60.2	46.6	19.7	13.6	2.0	36.4
Peritoneal dialysis	12,144	60.1	47.5	19.1	11.9	1.9	40.3
Transplant	30,158	58.2	52.5	13.5	15.0	4.8	33.0
Coronary artery disease (CAD)							
Hemodialysis	90,475	64.0	54.6	27.3	13.9	2.3	38.1
Peritoneal dialysis	7,224	62.7	54.8	27.4	11.6	1.9	40.8
Transplant	16,152	62.5	59.2	20.6	13.1	4.6	34.4
Acute myocardial infarction (AMI)							
Hemodialysis	28,770	68.5	60.0	36.4	15.5	2.6	42.0
Peritoneal dialysis	2,411	67.2	59.7	38.8	13.3	2.0	44.3
Transplant	3,723	67.7	63.2	30.6	16.4	5.9	37.5
Heart failure (HF)							
Hemodialysis	86,319	65.7	48.8	21.5	15.0	2.5	40.0
Peritoneal dialysis	5,947	65.7	49.0	21.1	13.1	2.3	43.6
Transplant	10,206	64.1	54.2	14.4	17.9	6.2	34.4
Valvular heart disease (VHD)							
Hemodialysis	30,888	63.3	47.7	21.5	18.8	2.8	38.7
Peritoneal dialysis	2,577	63.4	48.2	22.1	18.2	2.9	40.8
Transplant	5,365	60.2	52.4	13.0	19.8	6.3	33.3
Cerebrovascular accident/transient ischemic attack (CVA/TIA)							
Hemodialysis	36,896	63.4	55.7	27.3	14.7	2.4	39.2
Peritoneal dialysis	2,690	61.3	55.0	27.0	13.3	2.0	42.5
Transplant	5,328	58.9	58.0	21.1	15.3	5.2	34.5
Peripheral artery disease (PAD)							
Hemodialysis	77,324	59.8	49.3	24.3	14.2	2.1	36.0
Peritoneal dialysis	5,034	58.7	50.2	25.4	11.7	2.1	39.9
Transplant	11,431	58.9	53.9	17.9	13.9	4.4	34.5
Atrial fibrillation (AF)							
Hemodialysis	41,141	60.3	47.3	17.9	33.9	5.7	30.8
Peritoneal dialysis	2,979	59.2	46.5	16.9	30.6	5.4	34.4
Transplant	7,796	62.1	50.4	9.7	35.9	13.0	32.6
Cardiac arrest and ventricular arrhythmias (SCA/VA)							
Hemodialysis	10,245	67.1	50.1	24.6	20.9	3.5	38.0
Peritoneal dialysis	957	63.8	48.4	24.6	17.5	3.4	39.6
Transplant	1,400	66.2	55.0	17.3	22.3	7.8	35.2
Venous thromboembolism and pulmonary embolism (VTE/PE)							
Hemodialysis	15,078	58.5	42.8	18.2	39.9	5.2	33.5
Peritoneal dialysis	993	58.7	40.9	16.4	42.9	5.6	37.9
Transplant	3,497	56.0	48.0	8.3	48.2	11.1	30.9

Table 8.4 continued on next page.

vol 2 Table 8.4 Cardiovascular pharmacological treatments by (a) comorbidities and (b) procedures in adult ESRD patients, by modality, 2015 (continued)**(b) Cardiovascular procedures**

	# Patients	Percentage of patients (%)					ACEIs/ ARBs
		Beta-blockers	Statins	P2Y ₁₂ inhibitors	Warfarin	Direct Oral Anticoagulants	
Revascularization – percutaneous coronary interventions (PCI)							
Hemodialysis	3,353	75.1	72.4	78.0	12.0	2.0	50.3
Peritoneal dialysis	395	71.4	66.8	73.4	12.4	3.3	50.9
Transplant	384	75.0	74.5	75.5	11.7	7.0	41.9
Revascularization – coronary artery bypass graft (CABG)							
Hemodialysis	1,625	74.0	72.3	38.6	16.8	2.3	46.6
Peritoneal dialysis	248	72.2	73.0	35.9	16.1	3.6	46.8
Transplant	218	71.6	72.0	31.2	18.8	3.2	39.4
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)							
Hemodialysis	717	76.4	56.3	31.2	23.6	4.7	50.6
Peritoneal dialysis	49	77.6	53.1	36.7	16.3	4.1	59.2
Transplant	65	78.5	69.2	18.5	30.8	10.8	43.1
Carotid artery stenting and carotid artery endarterectomy (CAS/CEA)							
Hemodialysis	471	62.4	59.7	43.7	11.0	2.8	41.8
Peritoneal dialysis	51	66.7	66.7	41.2	13.7	2.0	43.1
Transplant	75	57.3	62.7	36.0	16.0	5.3	48.0

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients aged 22 and older, who are continuously enrolled in Medicare Parts A, B, and D, and with Medicare as primary payer from January 1, 2015 to December 31, 2015, and ESRD service date is at least 90 days prior to January 1, 2015. Abbreviations: ACEIs/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; 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.

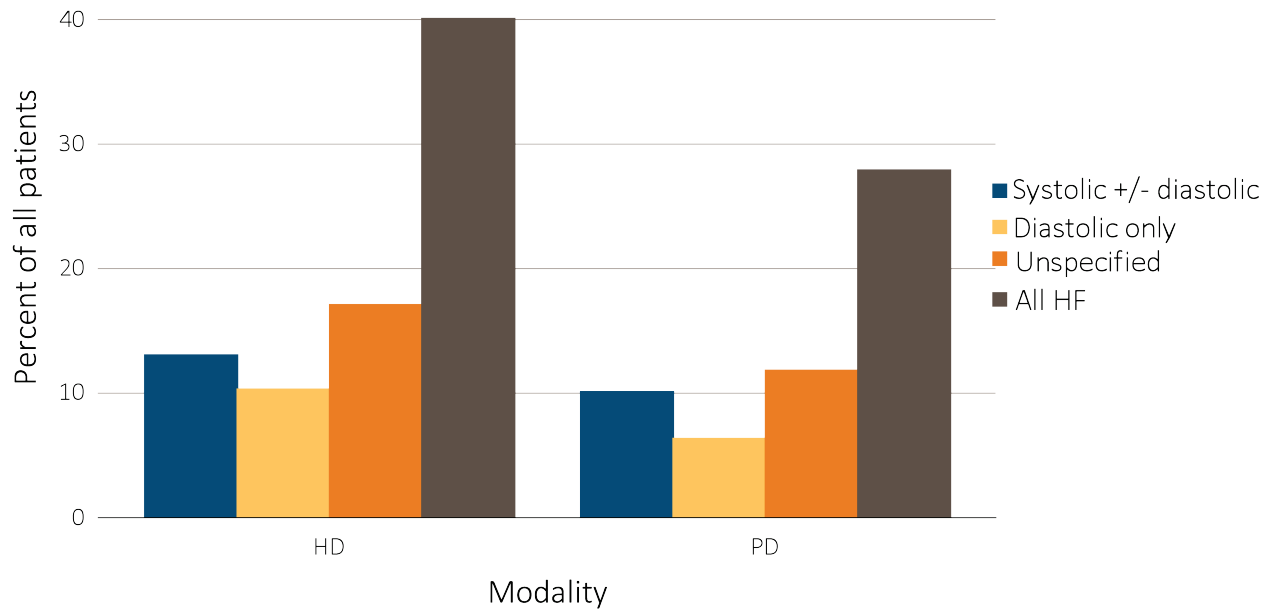
Heart Failure among ESRD Patients

Heart failure (HF) is a highly prevalent CVD among ESRD patients. Presence of HF adds further complexity to fluid management in ESRD patients, especially given the absence of renal function and clinical challenges with volume status assessment. Heart failure in ESRD patients is further examined in Figure 8.5 by stratifying HF according to left ventricular systolic dysfunction (i.e., heart failure with reduced ejection fraction), left ventricular diastolic dysfunction (i.e., heart failure with preserved ejection fraction), and unspecified cardiac dysfunction. Note that for ease of reporting and consistency in studying clinical approaches, we include in the systolic HF grouping all patients with systolic dysfunction, regardless of the presence of concomitant diastolic

dysfunction. Patients with isolated diastolic HF were analyzed separately, since treatments and prognoses are markedly different for this group.

Among adult ESRD patients, the largest percentage of patients had unspecified HF, and the relative proportion of patients with systolic HF was slightly higher than diastolic HF (Figure 8.5). This pattern was true for both HD and PD patients. The percentage of patients experiencing each type of heart failure was slightly higher among HD patients compared to PD patients. We identified categories of systolic dysfunction and diastolic dysfunction through ICD-9-CM and ICD-10-CM diagnosis codes, which have limitations as sole source data. Thus, these findings should be considered cautiously in the absence of further, confirmatory clinical data.

vol 2 Figure 8.5 Heart failure in adult ESRD patients by modality, 2015



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis and peritoneal dialysis patients aged 22 and older, who are continuously enrolled in Medicare Parts A and B, and with Medicare as primary payer from January 1, 2015 to December 31, 2015, and ESRD service date is at least 90 days prior to January 1, 2015. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

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