

Chapter 9: Cardiovascular Disease in Patients With ESRD

- Cardiovascular disease is common in ESRD patients, with atherosclerotic heart disease and congestive heart failure being the most common conditions.
- Cardiovascular diseases comprise the leading cause of death in ESRD patients.
- Even the relatively young population of dialysis patients (aged 22-44 and 45-64 years) experiences significant cardiovascular morbidity.
- Sudden death/cardiac arrhythmias account for 37% of all deaths in the Medicare ESRD population.
- Congestive heart failure (CHF) is a particularly common condition and its prevalence tends to be higher among ESRD patients who are older, White, male, and have diabetes mellitus.
- The presence of cardiovascular diseases worsens both short and long-term survival in ESRD patients.

Introduction

Cardiovascular disease is a significant comorbidity for patients along the entire spectrum of chronic kidney disease and end-stage renal disease (ESRD). ESRD patients are among the highest risk populations for a number of cardiovascular diseases. Presence of ESRD often complicates disease management and treatment, 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 ESRD patients with diagnosed major cardiovascular conditions, stratifying by type of renal replacement therapy being received (hemodialysis, peritoneal dialysis, and kidney transplantation). For individual cardiovascular conditions, we compare the survival of patients with and without the condition. Given its role as the primary health care payer for ESRD patients, our analyses are based mostly on data from the national Medicare population.

ANALYTICAL METHODS

We used a previously validated method for Medicare claims to identify comorbid conditions. This method was developed in diabetic patients, wherein a patient was considered diabetic if, within a one-year observation period, he or she had a qualifying ICD-9-CM diagnosis code of diabetes mellitus (DM) on

one or more Part A institutional claims (inpatient, skilled nursing facility, or home health agency), or two or more institutional outpatient claims and/or Part B physician/supplier claims (Herbert et al., 1999). With the same framework, we identified patients with comorbid conditions and procedures using the ICD-9-CM diagnosis codes over a one-year observation period. Specific ICD-9-CM codes used to define each condition are listed in the *ESRD Analytical Methods* chapter in the section on *Chapter 9: Cardiovascular Disease*.

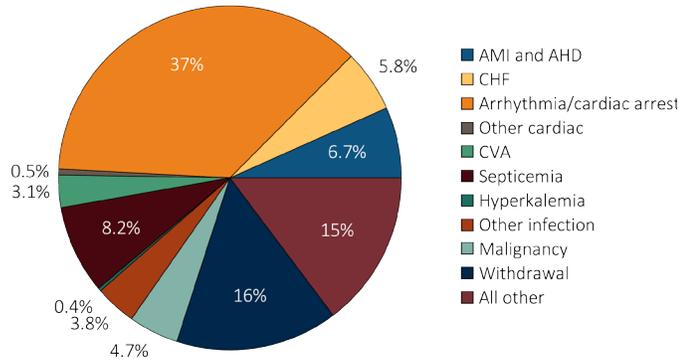
Also, see the *ESRD Analytical Methods* chapter for a detailed explanation of analytical methods used to generate the figures and tables in this chapter.

Cardiovascular Disease Prevalence and Outcomes in ESRD Patients

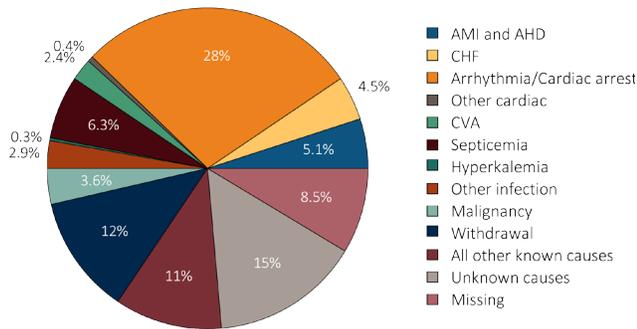
Figure 9.1 presents both the proportion of known causes of death and the proportion of total deaths among ESRD patients. As shown in Figure 9.1.a, cardiovascular diseases are a major cause of death in ESRD patients, contributing to more than half of all deaths with known causes. The category of arrhythmias and cardiac arrest alone is responsible for 37% 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.

vol 2 Figure 9.1 Causes of death in ESRD patients, 2011-2013

(a) Denominator excludes missing/unknown causes of death



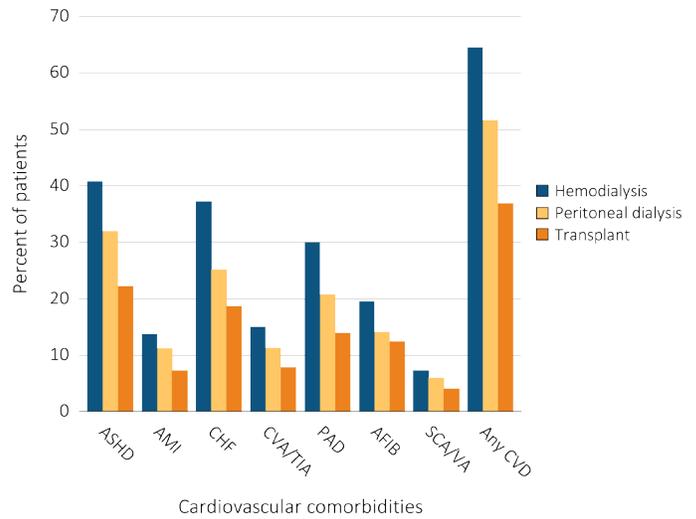
(b) Denominator includes missing/unknown causes of death



Data Source: Special analyses, Reference Table H12. (a) Denominator includes other causes of death and excludes missing/unknown causes of death (23.5% of patients have unknown or missing causes of death). (b) Denominator includes all 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 from 2746, or have the form but are missing or have recording errors in the primary cause of death field. Abbreviations: AHD, atherosclerotic heart disease; AMI, acute myocardial infarction; CHF, congestive heart failure; CVA, cerebrovascular accident; ESRD, end-stage renal disease.

ESRD patients have a high burden of cardiovascular disease across a wide range of conditions (Figure 9.2). Stable atherosclerotic heart disease (ASHD) and congestive heart failure (CHF) are the two major leading cardiovascular diseases present in ESRD patients. However, acute myocardial infarction (AMI), cerebrovascular accident/transient ischemic attack (CVA/TIA), peripheral arterial disease (PAD), atrial fibrillation (AFIB), sudden cardiac arrest and ventricular arrhythmias (SCA/VA) are also common. The prevalence of these cardiovascular diseases is highest among ESRD patients who receive hemodialysis followed by peritoneal dialysis and those with a kidney transplant.

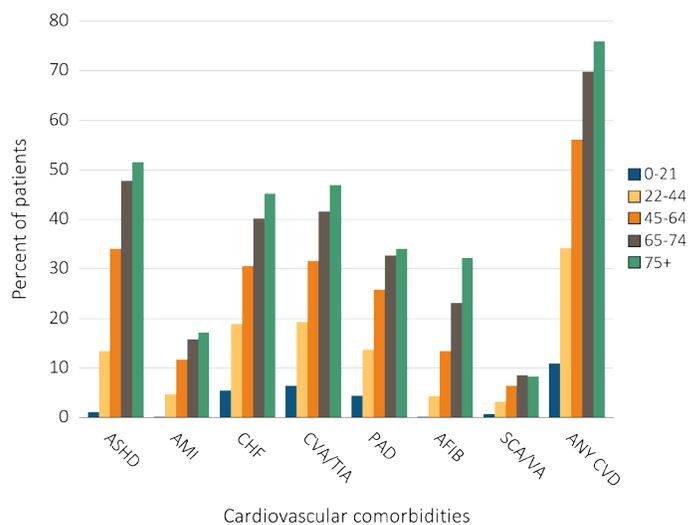
vol 2 Figure 9.2 Prevalence of cardiovascular diseases in ESRD patients, by treatment modality, 2013



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. 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.

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 20-44 years of age, although a much higher prevalence is observed among those 45 years or older. ASHD is the most common condition, with its prevalence exceeding 50% in ESRD patients aged 75 years or older, followed by CHF, PAD, AFIB and CVA/TIA.

vol 2 Figure 9.3 Prevalence of cardiovascular diseases in ESRD patients, by age, 2013



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. 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.

The relationships between age, race or ethnicity, and sex with the prevalence of cardiovascular diseases in ESRD patients are displayed in Table 9.1. As noted earlier, aging 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), and the placement of implantable cardioverter defibrillators (ICD).

vol 2 Table 9.1 Prevalence of cardiovascular diseases & procedures in ESRD patients, by treatment modality, age, race, & sex, 2013

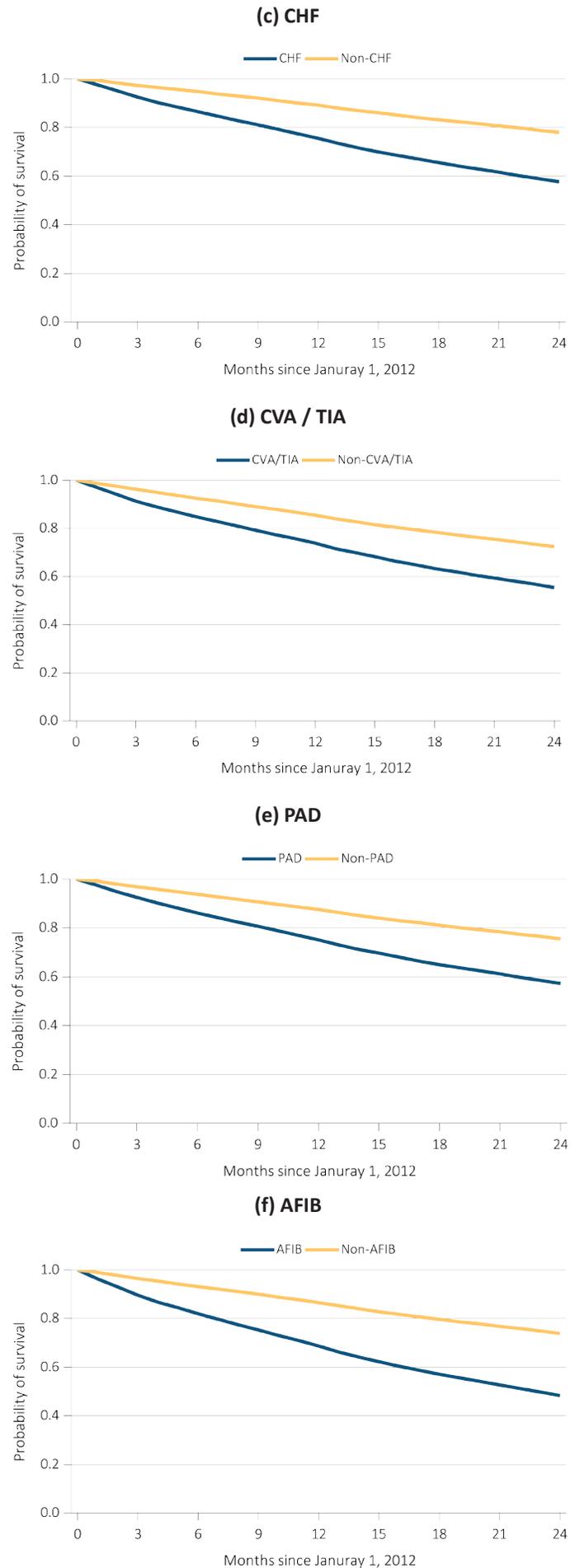
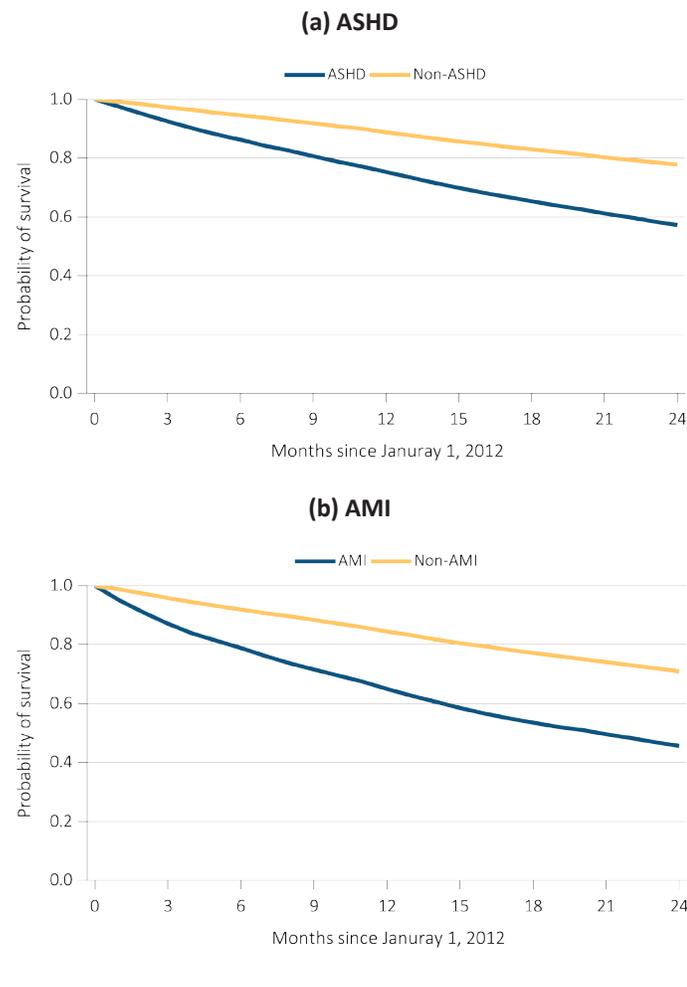
	# Patients	% Patients										
		Overall	0-21	22-44	45-64	65-74	75+	White	Blk / Af Am	Other	Male	Female
Cardiovascular Comorbidities^a												
Atherosclerotic heart disease (ASHD)												
Hemodialysis	147,373	40.8	2.5	15.6	36.8	49.7	52.1	45.1	36.0	38.4	40.9	40.7
Peritoneal dialysis	11,180	32.0	0.9	11.9	31.7	44.0	49.1	35.4	25.7	27.5	36.5	27.5
Transplant	23,465	22.3	0.4	6.1	19.3	36.8	43.2	24.0	19.0	18.3	24.0	19.7
Acute myocardial infarction (AMI)												
Hemodialysis	147,373	13.7	0.0	5.4	12.5	16.5	17.4	15.1	12.1	12.1	13.7	13.6
Peritoneal dialysis	11,180	11.2	0.5	4.1	11.1	15.6	17.2	12.6	9.0	8.1	12.8	9.6
Transplant	23,465	7.3	0.0	2.3	6.8	11.2	13.5	7.9	6.1	6.1	7.8	6.5
Congestive heart failure (CHF)												
Hemodialysis	147,373	37.2	10.7	22.4	33.7	42.2	45.9	37.8	37.1	32.0	35.4	39.4
Peritoneal dialysis	11,180	25.2	6.5	16.0	23.8	32.0	35.5	25.5	25.6	21.3	27.2	23.3
Transplant	23,465	18.7	2.2	6.9	15.5	29.1	39.5	19.1	18.8	13.8	18.9	18.4
Cerebrovascular accident/transient ischemic attack (CVA/TIA)												
Hemodialysis	147,373	15.0	2.8	5.5	12.5	19.0	20.3	15.0	15.4	13.0	13.5	16.9
Peritoneal dialysis	11,180	11.3	1.4	5.5	9.9	16.6	17.4	12.0	10.7	7.6	11.0	11.6
Transplant	23,465	7.8	0.6	2.4	6.2	13.0	17.5	8.2	7.5	5.2	7.6	8.1
Peripheral artery disease (PAD)												
Hemodialysis	147,373	30.0	10.3	16.3	28.5	34.6	34.9	31.2	29.3	23.9	29.9	30.0
Peritoneal dialysis	11,180	20.7	5.6	10.7	20.7	27.7	26.8	22.3	18.4	15.2	22.3	19.0
Transplant	23,465	13.9	0.7	5.0	12.7	21.3	25.0	14.6	13.0	10.2	15.0	12.3
Atrial fibrillation (AFIB)												
Hemodialysis	147,373	19.5	0.7	5.0	14.5	23.3	32.0	23.2	15.3	17.2	19.7	19.2
Peritoneal dialysis	11,180	14.1	0.0	3.8	10.4	21.0	32.1	16.4	9.8	11.2	16.8	11.5
Transplant	23,465	12.4	0.0	1.8	8.3	22.4	34.7	13.9	9.3	9.7	13.6	10.5
Cardiac arrest and ventricular arrhythmias (SCA/VA)												
Hemodialysis	147,373	7.3	0.4	3.8	6.9	8.8	8.1	7.2	7.5	6.0	7.5	6.9
Peritoneal dialysis	11,180	6.0	2.3	3.2	5.7	7.9	8.6	6.1	6.3	3.6	6.7	5.3
Transplant	23,465	4.0	0.2	1.0	3.2	7.0	8.8	4.2	3.8	3.5	4.5	3.4
Cardiovascular Procedures^b												
Revascularization – percutaneous coronary interventions (PCI)												
Hemodialysis	60,125	5.3	0.0	4.8	6.3	5.4	4.0	5.6	4.7	6.3	5.4	5.2
Peritoneal dialysis	3,578	6.2	0.0	5.4	6.1	7.3	5.3	6.8	5.3	3.1	6.0	6.4
Transplant	5,228	5.2	0.0	5.6	7.0	4.4	2.6	5.4	4.5	5.5	5.4	4.8
Revascularization – coronary artery bypass graft (CABG)												
Hemodialysis	60,125	1.8	0.0	2.2	2.5	1.8	0.7	1.7	1.7	2.4	2.0	1.4
Peritoneal dialysis	3,578	2.6	0.0	2.9	2.8	2.8	2.0	2.7	2.5	2.2	3.4	1.6
Transplant	5,228	2.0	0.0	2.0	2.5	1.7	1.7	2.1	1.5	3.1	2.0	2.0
Implantable cardioverter defibrillators & cardiac resynchronization therapy with defibrillator (ICD/CRT-D)												
Hemodialysis	54,775	0.8	0.0	0.9	0.9	0.9	0.5	0.8	0.7	0.8	1.0	0.4
Peritoneal dialysis	2,818	1.0	0.0	0.3	1.0	1.1	1.2	0.9	1.2	0.6	1.1	0.8
Transplant	4,384	1.0	0.0	0.0	1.3	1.0	0.7	1.1	0.7	0.5	1.3	0.4

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; Af Am, African American; Blk, black; CABG, coronary artery bypass grafting; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; ICD/CRT-D, implantable cardioverter defibrillators/cardiac resynchronization therapy with defibrillator devices; PAD, peripheral arterial disease; PCI, percutaneous coronary interventions; SCA/VA, sudden cardiac arrest and ventricular arrhythmias. ^aThe denominators for all cardiovascular comorbidities are patients described above by modality. ^bThe denominators for PCI and CABG are patients with ASHD by modality. The denominator for ICD/CRT-D is patient with CHF by modality.

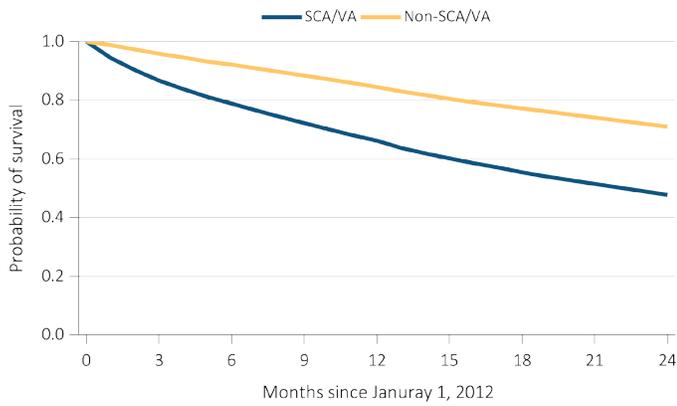
The presence of cardiovascular diseases worsens short- and long-term prognoses for ESRD patients. Figures 9.4.a through 9.4.j illustrate two-year survival curves in ESRD patients with and without individual cardiovascular diseases.

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 and ICD/CRT-D placement, 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 ESRD population may be the consequence of confounding-by-indication, and comparative effectiveness research with appropriate statistical adjustments would be necessary to evaluate whether these procedures improve patient prognoses when they are indicated.

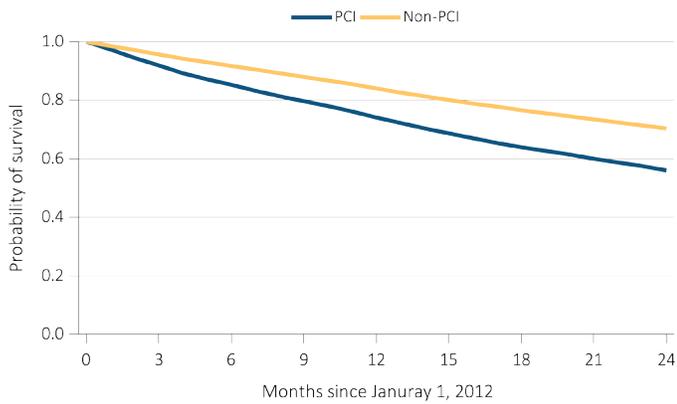
vol 2 Figure 9.4 Probability of survival of ESRD patients with or without a cardiovascular disease or undergoing a cardiovascular procedure, 2011-2013



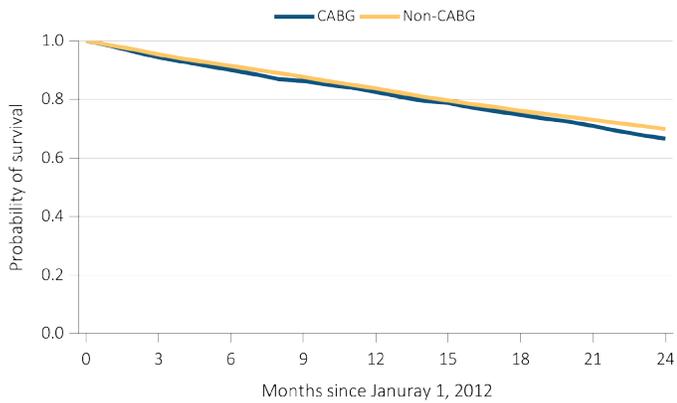
(g) SCA / VA



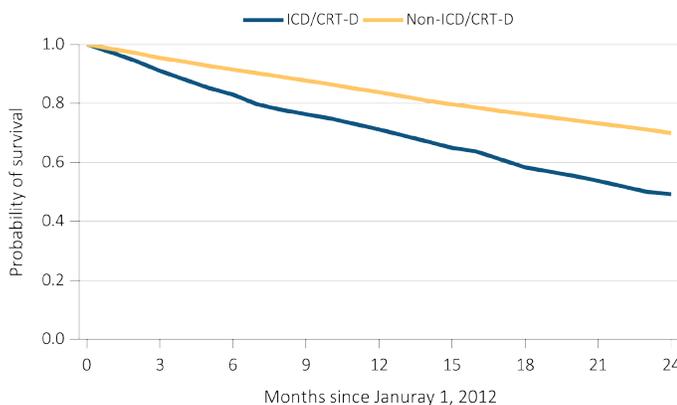
(h) PCI



(i) CABG



(j) ICD / CRT / D



Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July 1, 2010 to December 31, 2010, and whose first ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2011. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CABG, coronary artery bypass grafting; 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.

Congestive Heart Failure Among ESRD Patients

Congestive heart failure (CHF) is a highly prevalent cardiovascular disease among ESRD patients. Presence of CHF in the ESRD population adds further complexity to the vexing problem of fluid management in these patients, in the absence of renal function and lack of use of objective, validated methods for volume status assessment. Key characteristics of CHF in ESRD patients are further examined in Table 9.2 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. For ease of reporting and consistency in studying clinical approaches, systolic CHF includes 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. We analyze CHF using these categories of systolic dysfunction and diastolic dysfunction identified through ICD-9-CM diagnosis codes. For systolic heart failure, we use 428.2x; for diastolic heart failure, 428.3x; for both systolic and diastolic heart failure, 428.4x; and unspecified heart failure, 398.91, 428.xx (excluding 428.2x-428.4x), 402.x1, 404.x1, and 404.x3). The use of these codes has limitations and the separation of these different categories should be considered cautiously without further clinical data available.

In general, the prevalence of CHF increases with age, and peaks in those patients between the ages of 45 and 64 years old. Among younger age groups, the prevalence of CHF is more common for patients treated with peritoneal dialysis. The prevalence of CHF is higher among men than it is among women, and higher among Whites than other races. Finally, ESRD patients with diabetes mellitus experience an extremely high prevalence of CHF, with over 70% of patients having systolic dysfunction, diastolic dysfunction, or unspecified.

Summary

This chapter provides an overview of cardiovascular diseases primarily among Medicare ESRD patients, using claims data. The relationship between cardiovascular disease and kidney disease is complex and bidirectional, and close attention to cardiovascular comorbidity is vital to the care of these patients. The high prevalence of CHF and sudden death/cardiac arrhythmias should draw more attention of researchers and clinicians alike to improving outcomes in this complex patient population. The conventional paradigm of thrice-weekly hemodialysis, with wide fluctuations in fluid status, electrolytes and blood pressure, with frequent episodes of intradialytic hypotension and resultant ‘myocardial stunning’, have been highlighted in recent literature. High early-in-the-week mortality observed

among patients on thrice weekly hemodialysis is also almost certainly the consequence of what has been referred to as the ‘unphysiology’ of intermittent hemodialysis, and should remain the concern of patients, providers, researchers, payers, and policy makers alike. Patients with ESRD bring unique challenges that should not detract health care practitioners from delivering the high quality cardiovascular care that they deserve.

References

Herbert PL, Geiss LS, Tierney EF, Engelgau MM, Yawn BP, McBean AM. Identifying persons with diabetes using Medicare claims data. *Am J Med Qual* 1999;14(6):270-277.

vol 2 Table 9.2 Characteristics of patients with heart failure, by treatment modality, 2013

	Systolic +/- Diastolic heart failure				Diastolic only heart failure				Heart failure, unspecified			
	HD		PD		HD		PD		HD		PD	
	N	%	N	%	N	%	N	%	N	%	N	%
Age												
0-21	7	0.0	1	0.1	1	0.0	0	0.0	11	0.0	6	0.5
22-44	887	6.3	100	12.4	774	6.2	63	11.2	1,852	7.5	156	13.2
45-64	5,047	35.7	303	37.5	4,413	35.1	231	41.2	9,295	37.7	474	40.1
65-74	4,034	28.5	241	29.8	3,565	28.4	142	25.3	6,643	26.9	307	26.0
75+	4,170	29.5	164	20.3	3,811	30.3	125	22.3	6,858	27.8	238	20.2
Sex												
Male	8,431	59.6	476	58.8	5,484	43.6	264	47.1	12,573	51.0	611	51.7
Female	5,714	40.4	333	41.2	7,080	56.4	297	52.9	12,086	49.0	570	48.3
Race												
White	7,708	54.5	555	68.6	6,547	52.1	344	61.3	12,720	51.6	755	63.9
Black/African American	5,756	40.7	216	26.7	5,386	42.9	187	33.3	10,683	43.3	344	29.1
Other	681	4.8	38	4.7	631	5.0	30	5.3	1,256	5.1	82	6.9
Diabetes												
No	4,029	28.5	323	39.9	3,505	27.9	203	36.2	7,095	28.8	439	37.2
Yes	10,116	71.5	486	60.1	9,059	72.1	358	63.8	17,564	71.2	742	62.8

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis and peritoneal dialysis patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

Notes