Chapter 5: Mortality

- In 2016, adjusted mortality rates for ESRD, dialysis, and transplant patients were 134, 164, and 29 per 1,000 patient-years. By dialysis modality, mortality rates were 166 for hemodialysis (HD) patients and 154 for peritoneal dialysis (PD) patients, per 1,000 patient-years (Figure 5.1).
- Between 2001 and 2016, adjusted mortality rates decreased for dialysis patients by 29%. The net reductions in mortality from 2001 to 2016 were 28% for HD patients and 43% for PD patients (Figure 5.1).
- Between 2001 and 2016, unadjusted (crude) mortality rates decreased by 2% for transplant recipients. After accounting for changes in population characteristics (primarily increasing age), trends in post-transplant mortality were much more pronounced, with adjusted mortality rates decreasing by 40% (Figure 5.1).
- Patterns of mortality during the first year of dialysis differed substantially by modality. For HD patients, reported mortality was highest in month two, but declined thereafter; this effect was more pronounced for patients aged 65 and older. In contrast, mortality for PD patients was relatively low initially, but rose slightly over the course of the year (Figure 5.3).
- Dialysis patients over the age of 65 continued to have substantially higher mortality compared to the general population and Medicare populations with cancer, diabetes, or cardiovascular disease. The relative decline in mortality for dialysis patients in the past 20 years has been similar to that of Medicare patients with cancer and diabetes, and greater than for Medicare patients with cerebrovascular disease or an acute myocardial infarction (Table 5.5, Figure 5.5).
- The decline in mortality shown in this chapter has important implications for both patients and resource allocation. Increasing lifespan among ESRD patients is a primary reason for continued growth in the prevalent ESRD population.

Introduction

Kidney disease is among the 10 leading causes of premature mortality in the United States—persons with end-stage renal disease (ESRD) have a shortened life expectancy as compared to their peers without kidney disease. Examining trends related to death from this chronic condition is essential to guide and evaluate efforts in reducing the risk of death and increasing the potential life span.

There are many points in the life cycle of kidney disease in which to make an impact. These include promoting healthy lifestyle habits, delaying disease progression and the resulting need to initiate renal replacement therapy for compromised individuals, and more widely applying the best practices known to prolong health and quality of life.

In this chapter, we examine and highlight the variables that contribute to ESRD mortality. Common chronic comorbidities, particularly cardiovascular diseases, and acute conditions such as infections are linked to higher rates of death. Treatment modality also has an impact—transplant recipients have improved life expectancy as compared to those on dialysis. Increasing length of time on dialysis is also related to higher mortality rates. Regional differences in mortality rates vary substantially, and may indicate avenues for targeted intervention. Thus, attending to the trends and interrelationships between renal disease and mortality is an important component of reducing the public health burden of ESRD.

Methods

The findings presented in this chapter are based on data from multiple data sources, including the Centers for Medicare & Medicaid Services (CMS), the Organ Procurement and Transplantation Network (OPTN),

the Centers for Disease Control and Prevention (CDC), the U.S. Census, and the National Vital Statistics Report. Details of these are described in the *Data Sources* section of the *ESRD Analytical Methods* chapter.

Mortality analyses in this chapter were based on both ESRD data and general population data. ESRD data were from the USRDS ESRD Database. General population data were based on the Medicare 5% standard analytical files and U.S. Census mortality data. Note that universal reporting of ESRD patient deaths to the CMS is required via CMS form 2746 as a condition of coverage for dialysis units and transplant centers. In addition, mortality ascertainment was augmented by Social Security Death Master File data to the extent allowed by regulation (which differs by state).

For an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter, see the section on *Chapter 5* within the *ESRD Analytical Methods* chapter. Note that the reference population for each adjusted rate is described within the footnote of each table or figure; e.g., for Figure 5.1, the reference population consists of period prevalent ESRD patients in 2011. Downloadable Microsoft Excel and PowerPoint files containing the data and graphics for these figures and tables are available on the *USRDS website*.

Mortality among ESRD Patients: Overall and by Modality

Overall mortality rates among ESRD (dialysis and transplant) patients have consistently declined over the last 15 years, with rates levelling during recent years. Between 2001 and 2016, the unadjusted death rate (not shown) for the ESRD population decreased by 27%, from 187 to 136 per 1,000 patient-years, while the adjusted death rate (Figure 5.1.a) decreased by 29%. The unadjusted death rate for the dialysis population decreased by 27%, while the adjusted death rate decreased by 29%. The unadjusted death rate for the transplant population decreased by 2%, while the adjusted death rate decreased by 40%.

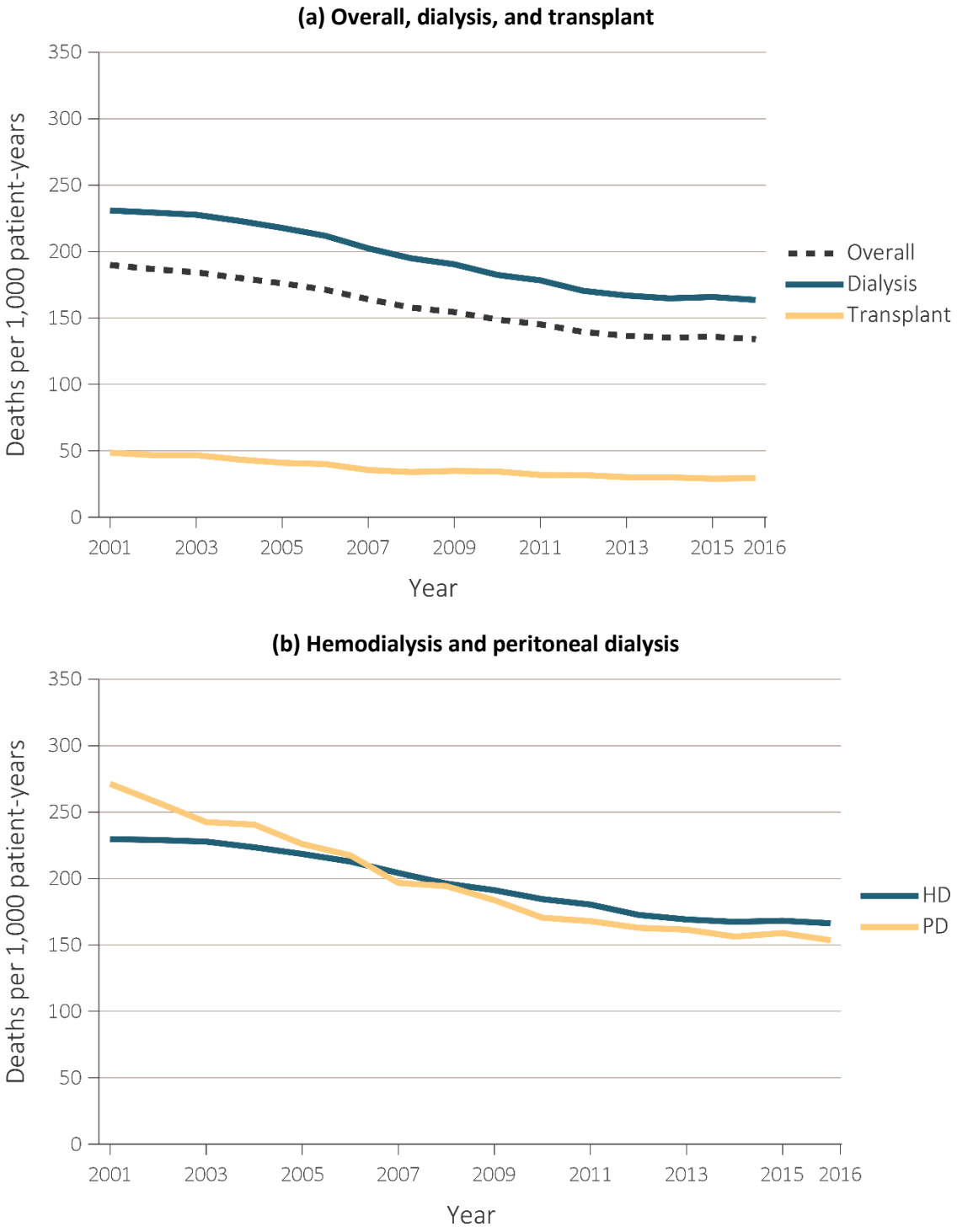
Differences between the unadjusted and adjusted rates largely reflect changes in the age distribution of the ESRD population. Death rates for dialysis and transplant patients decreased by over 30% between 2001 and 2016 within most age groups, and the adjusted rate reflects this decrease. The unadjusted rate was affected by both this decrease and by the fact that the ESRD population was older in 2016 than in 2001, which offsets the effect. For example, patients over the age of 65 comprised 43% of the dialysis population in 2001 and 44% in 2016; in the same years, transplant recipients over the age of 65 comprised 8% and 24% of the transplant recipient population. Thus, the increase in age among transplant patients masked overall improvements in mortality.

From 2001 to 2006, the adjusted mortality rate decreased by 10%, and by 18% from 2007 to 2016 for the ESRD population (Figure 5.1.a). The trend was similar for dialysis (HD and PD) patients, with the adjusted mortality rate decreasing by 8% from 2001 to 2006 and by 19% from 2007 to 2016 (Figure 5.1.a). Among transplant patients, adjusted mortality decreased by 18% from 2001 to 2006 and by 17% from 2007 to 2016.

Among HD patients, the adjusted mortality rate decreased by 7% from 2001 to 2006 and by 19% from 2007 to 2016. Among PD patients, the mortality rate decreased by 20% from 2001 to 2006 and by 22% from 2007 to 2016 (Figure 5.1.b). The net reductions in mortality from 2001 to 2016 were 28% for HD patients and 43% for PD patients.

Adjusted mortality rates in 2016 were 134, 164, and 29 per 1,000 patient-years for ESRD, dialysis, and transplant patients. By dialysis modality, mortality rates were 166 per 1,000 patient-years for HD patients and 154 for PD patients.

vol 2 Figure 5.1 Adjusted all-cause mortality by treatment modality (a) overall, dialysis, and transplant, and (b) hemodialysis and peritoneal dialysis, for period-prevalent patients, 2001-2016



Data Source: Reference Tables H.2_adj, H.4_adj, H.8_adj, H.9_adj, and H.10_adj; and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, ethnicity, primary diagnosis and vintage. Reference population: period prevalent ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Mortality by ESRD Network

There are geographic differences in mortality rates for each modality. Table 5.1 shows adjusted and unadjusted death rates within each of the 18 regional ESRD networks in the United States. The between-network variability was lower after adjustment for age, ethnicity, race, sex, diagnosis, and vintage, indicating that regional differences in these factors explain some, but not all of the between-region differences in mortality rates.

Variation in ESRD mortality rates among the 18 ESRD Networks remained substantial (Table 5.1). Adjusting for differences in age, sex, race, ethnicity, diagnosis, and vintage, the rate was lowest at 121.3 per 1,000 patient-years at risk in Network 15 (AZ, CO, NV, NM, UT, and WY), and highest at 152.2 in Network 13 (AR, LA, and OK), 25% higher than Network 15.

vol 2 Table 5.1 Unadjusted and adjusted all-cause mortality by ESRD network and modality, 2014-2016, ranked by network ESRD adjusted mortality

		Deaths per 1000 patient-years							
		Total ESRD		Hemodialysis		Peritoneal dialysis		Transplant	
Network	States* in Network	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted
13	AR, LA, OK	**152.2**	149.6	190.2	190.8	163.4	137.9	31.8	33.9
8	AL, MS, TN	**148.8**	147.8	183.1	186.2	174	139.8	35.5	37.5
9	IN, KY, OH	**146.2**	164	179.4	220.3	164.9	159.8	33.3	38.9
14	TX	**143.1**	134.1	174.1	169.5	162.4	122.6	30.1	29.3
3	NJ, PR, VI	**141.2**	142.4	178.1	192	158.8	122.5	29.7	32.3
6	NC, SC, GA	**139.3**	136.4	171.7	172.5	158.6	121.3	30.3	33.1
7	FL	**139**	149.6	176.2	198.2	153.5	132.8	28.4	33.6
5	MD, DC, VA, WV	**133.7**	134.9	170.7	182.4	156.3	135.2	30.8	32.3
4	DE, PA	**132.8**	144.9	167.7	201.7	154.5	143.6	29.8	36.8
10	IL	**131.8**	135.5	168.8	188.7	160.7	136.4	28.4	32
12	IA, KS, MO, NE	**131.5**	139.5	170.4	203.8	160.4	162	27.8	32.4
11	MI, MN, ND, SD, WI	**130.4**	136.9	167.4	203.5	154.7	144.4	31.3	37.5
2	NY	**128**	132.6	157.7	178.2	145.8	145.2	28.2	32.3
18	S. CA	**125.9**	120.7	152.4	156	132.2	101	26	27.2
16	AK, ID, MT, OR, WA	**124.8**	126.8	156.8	187.4	140.4	131.9	28.9	33.2
17	N. CA, HI, GU, AS, MP	**124.5**	119.6	157.2	162.2	130.3	104.3	25.8	28.5
1	CT, MA, ME, NH, RI, VT	**123.5**	129.9	156	197.6	154.7	138.2	29	32.5
15	AZ, CO, NV, NM, UT, WY	**121.3**	123.4	156.2	173.2	140.4	121.6	28	32.7
	Overall	**134.3**	136.9	167.6	184.1	153.7	130.7	29.5	33.1

*Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, sex, race, ethnicity, vintage, and primary diagnosis) all-cause mortality among 2014-2016 period prevalent patients. Reference population: period prevalent ESRD patients, 2011. * Includes 50 states, Washington, D.C. (DC), Puerto Rico (PR), Guam (GU), American Samoa (AS), U.S. Virgin Islands (VI), and Northern Mariana Islands (MP). Northern and Southern California (CA) split into Networks 17 and 18. Abbreviations: ESRD, end-stage renal disease; N, Northern; S, Southern.*

Mortality by Duration of Dialysis, Including Trends over Time

Among HD patients, from 1997-2012 the average death rate was highest during the first year following dialysis initiation, dropped to its lowest point during the second year, and tended to rise for more than five years thereafter (Figure 5.2.a). Mortality on HD tended to be higher after five years than between two to five years after dialysis initiation. Death rate patterns by time-since-dialysis-initiation have been similar over time, when comparing cohorts based on calendar year of treatment initiation.

Among PD patients, mortality rates generally increased over the first five years after dialysis initiation (Figure 5.2.b). As with HD patients, PD patient mortality rates tended to be higher after five years than between two to five years on dialysis. Death rate patterns by time-since-dialysis-initiation have also been similar over time for PD patients.

vol 2 Figure 5.2 Adjusted all-cause mortality by treatment modality, cohort (year of ESRD onset), and number of years after start of dialysis among incident (a) hemodialysis patients and (b) peritoneal dialysis patients, 1997, 2002, 2007, and 2012

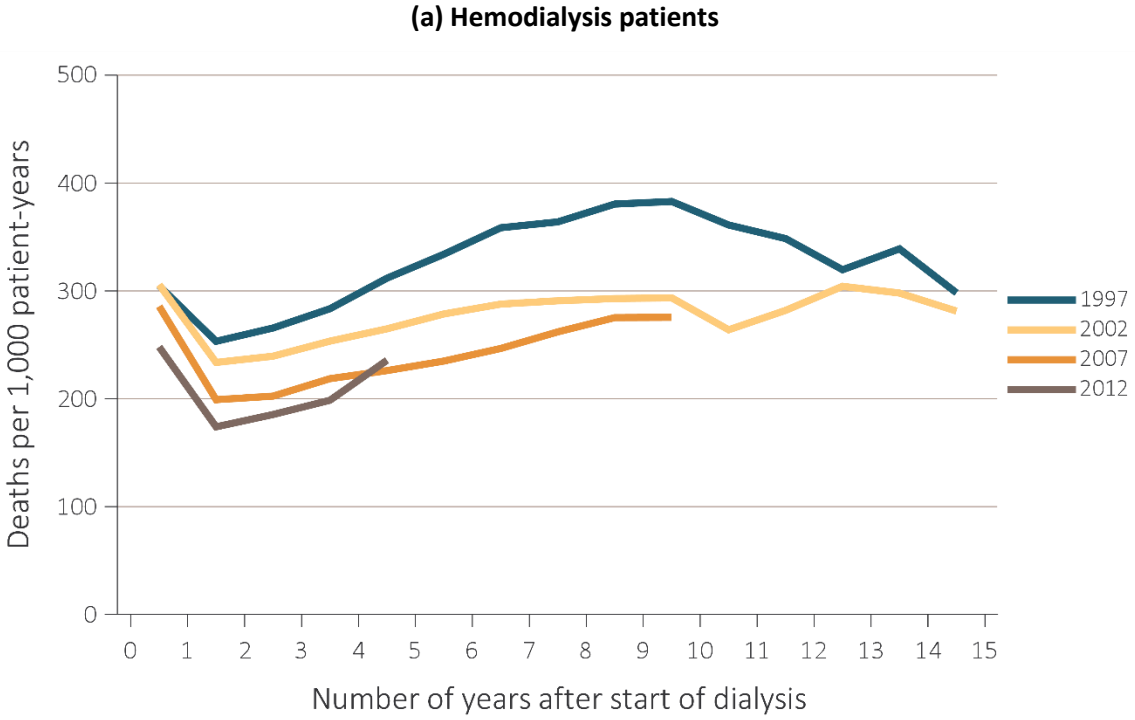
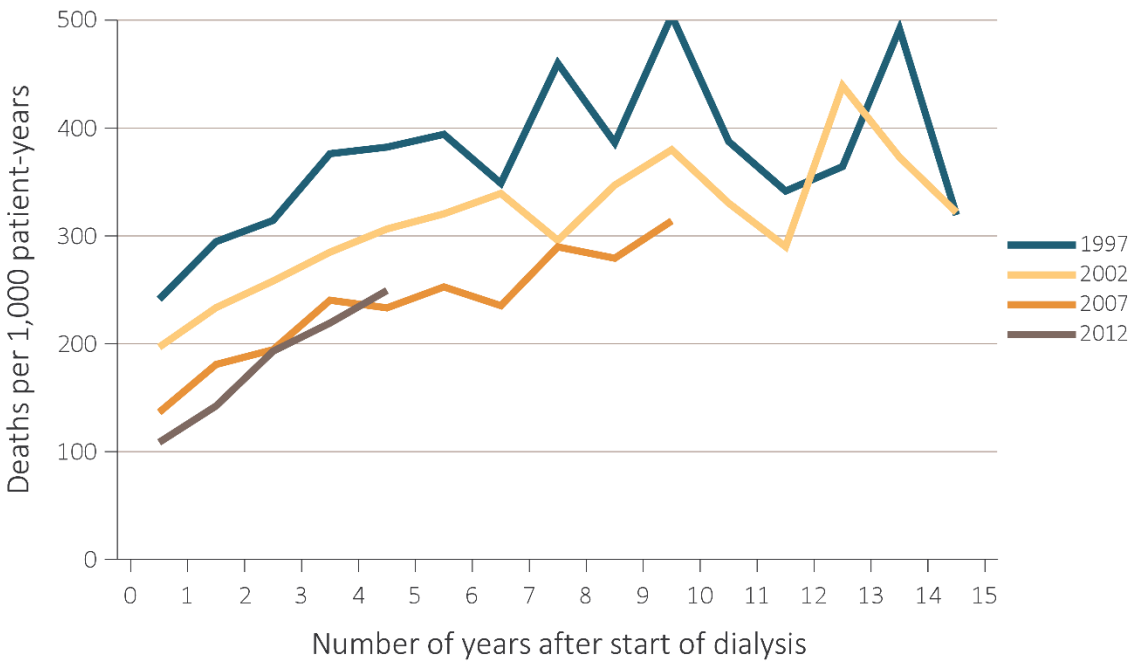


Figure 5.2 continued on next page.

vol 2 Figure 5.2 Adjusted all-cause mortality by treatment modality, cohort (year of ESRD onset), and number of years after start of dialysis among incident (a) hemodialysis patients and (b) peritoneal dialysis patients, 1997, 2002, 2007, and 2012 (continued)

(b) Peritoneal dialysis patients



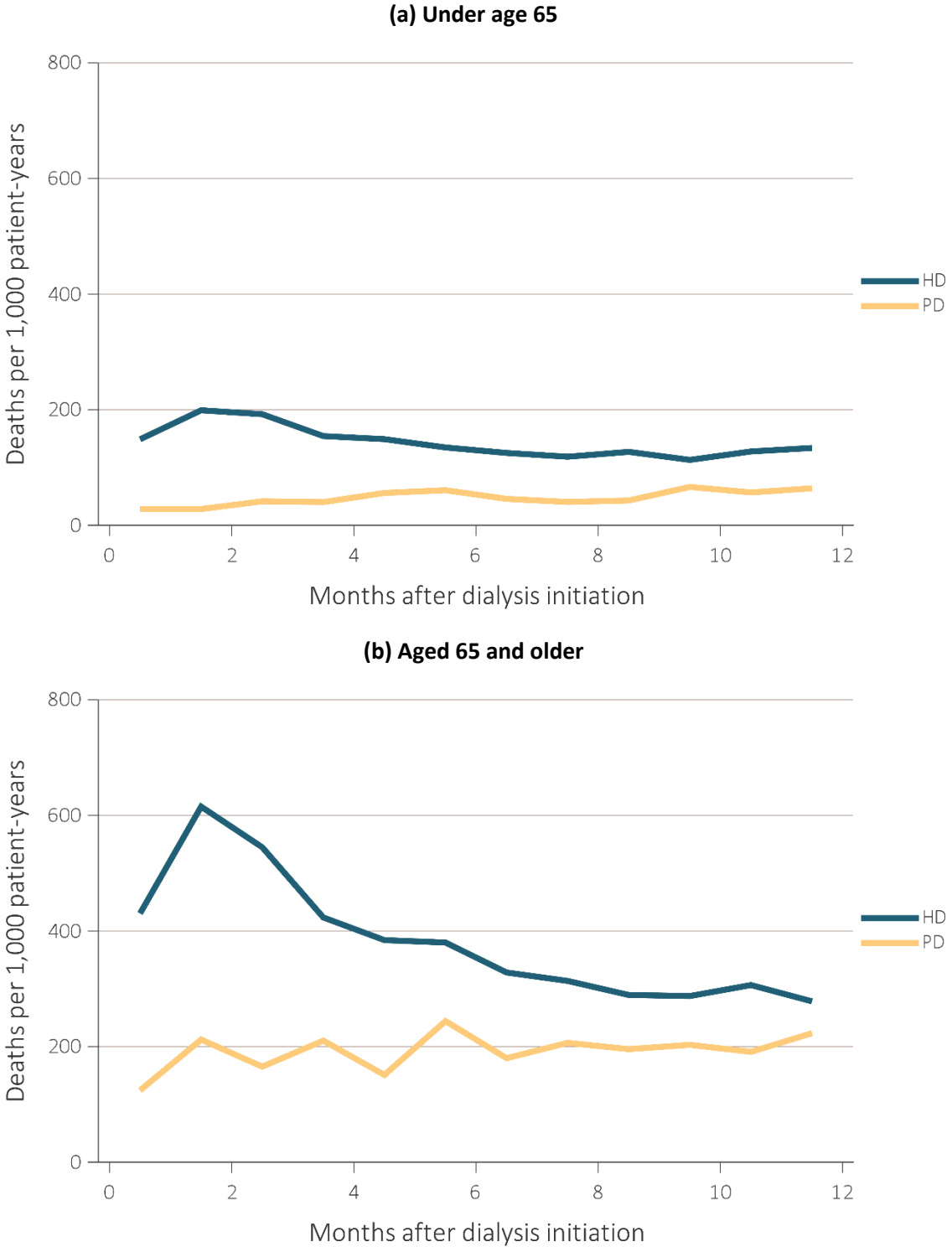
Data Source: Special analyses, USRDS ESRD Database. Adjusted for age, sex, race, and primary diagnosis. Reference population: period prevalent ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

Mortality during the First Year of ESRD

Among patients starting HD in 2015, the decrease in mortality during the first year was sharper for patients aged 65 and over (Figure 5.3); this pattern is similar to that previously reported by Robinson et al. (2014). Among patients under the age of 65, mortality dropped from 200 deaths per 1,000 patient-years in month 2 to 134 in month 12. Among patients aged 65 and over, mortality dropped from 615 deaths per 1,000 patient-years in month 2 to 278 in month 12. Note that the steep rise in HD mortality rates between months 1 and 2 may reflect data reporting issues. For example, some patients who die soon after starting dialysis related to ESRD might not be registered as having ESRD on CMS form 2728, and therefore, would not be included in the CMS database (Foley et al., 2014). The extent to which this occurs is currently unknown.

Among patients with PD as the initial renal replacement modality, mortality did not peak early, but instead tended to increase gradually during the first year on dialysis. Among PD patients under the age of 65, mortality increased from 28 deaths per 1,000 patient-years in month 1 to 64 deaths per 1,000 patient-years in month 12. Among patients aged 65 and over, mortality increased from 124 deaths per 1,000 patient-years in month 1 to 223 deaths per 1,000 patient-years in month 12. PD patients may not experience an early peak in mortality, in part, because patients beginning ESRD via PD are a highly selected group, in many cases being younger, healthier, and having undergone substantial pre-ESRD planning, most often associated with an elective start of dialysis. Post-transplant mortality among the less than 2% of patients who initiated ESRD treatment with a kidney transplant followed a generally decreasing trend over the first year (not shown).

vol 2 Figure 5.3 Adjusted mortality by treatment modality and number of months after treatment initiation among ESRD patients (a) under age 65 and (b) aged 65 and over, 2015



Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) mortality among 2015 incident ESRD patients during the first year of therapy. Reference population: incident ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Mortality by Age, Sex, and Race

Mortality rates among ESRD patients increased with age, as expected. Among dialysis patients, males aged 0-44 years tended to have lower adjusted mortality than females, but higher adjusted mortality at ages 65 and over (Table 5.2.b).

Mortality rates differed by race, but this difference was not constant within age groups or by modality (Table 5.2.a). For example, among patients aged 0-21 years, White patients on dialysis had lower mortality rates than Black patients. However, Black patients 45 years and older had a consistent survival advantage on dialysis compared to Whites. As demonstrated by Yan et al. (2013), Hispanics had mortality rates similar to other non-White race groups. Therefore, combining them with non-Hispanic Whites is likely to have resulted in lowering the otherwise higher mortality rate observed among the overall White population on dialysis.

vol 2 Table 5.2 Adjusted all-cause mortality (a) by age and race, and (b) by age and sex, among ESRD patients, 2015

(a) Age and race (deaths per 1,000 patient-years)

Age	Race	ESRD	Dialysis	Transplant
0-21	White	8	26	3
	Black/African American	19	36	4
	Other	9	14	9
22-44	White	34	66	8
	Black/African American	45	56	10
	Other	16	31	3
45-64	White	113	162	31
	Black/African American	102	116	33
	Other	80	108	22
65-74	White	217	257	71
	Black/African American	182	197	70
	Other	146	170	54
75+	White	387	407	123
	Black/African American	295	303	99
	Other	262	273	81

(b) Age and sex (deaths per 1,000 patient-years)

Age	Sex	ESRD	Dialysis	Transplant
0-21	Male	10	26	3
	Female	15	33	5
22-44	Male	38	58	9
	Female	45	70	9
45-64	Male	100	137	32
	Female	100	135	30
65-74	Male	195	239	71
	Female	188	223	66
75+	Male	364	388	121
	Female	339	356	118

Data Source: Special analyses, USRDS ESRD Database. (a) Adjusted (race and primary diagnosis) all-cause mortality among 2015 period prevalent patients. (b) Adjusted (sex and primary diagnosis) all-cause mortality among 2015 period prevalent patients. Reference population: period prevalent ESRD patients, 2011. Abbreviation: ESRD, end-stage renal disease.

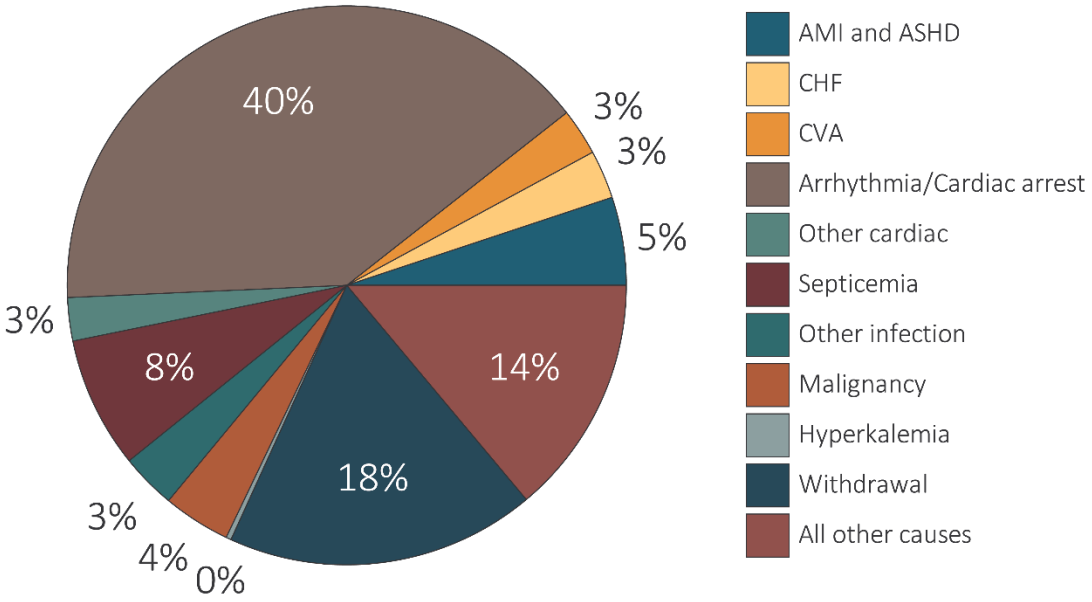
Cause-Specific Mortality Rates

The largest category of known cause-specific mortality for dialysis patients is death due to cardiovascular disease. Arrhythmia and cardiac arrest comprised 40% of known causes of death among dialysis patients, and 17% of the known causes of death among transplant recipients. The cause of death information (based on CMS form 2746) was missing or unknown for 27% of dialysis patients and 74% of transplant patients. Note that lacking cause of death information does not imply that the date of death is missing. The date of death comes from several potential sources, including OPTN transplant data (see "Death date determination" in the ESRD Analytical Methods chapter). For example, in 2015 the form 2746 was the source of date of death for 86% of dialysis patients, but only 34% of transplant patients. Most of the other death dates came from the CMS enrollment database, which does not include cause of death information. Figures 5.4.a and 5.4.b show the distributions of deaths in 2015, excluding missing and unknown causes as categories, while Figures 5.4.c and 5.4.d show the distributions including deaths where the causes were missing or unknown. Cardiovascular causes—including arrhythmias, cardiac arrest, congestive heart failure (CHF), acute myocardial infarction (AMI), and atherosclerotic heart disease (ASHD)—were responsible for 48% of deaths among dialysis patients and 28% of deaths among transplant recipients. Given these rates, it is plausible that cardiovascular conditions (e.g., sudden cardiac death due to cardiac arrhythmia) may indeed have been the true underlying cause of death among many patients in the missing and unknown categories.

We recognize that while medical terminology calls for use of the term heart failure, since not all heart failure is congestive, this chapter uses the term congestive heart failure based on the data source — CMS 2746, ESRD Death Notification form.

vol 2 Figure 5.4 Unadjusted percentages of deaths in 2015 by cause, with and without missing data, by modality among dialysis patients and transplant recipients

(a) Dialysis patients, denominator excludes missing/unknown causes of death



(b) Transplant patients, denominator excludes missing/unknown causes of death

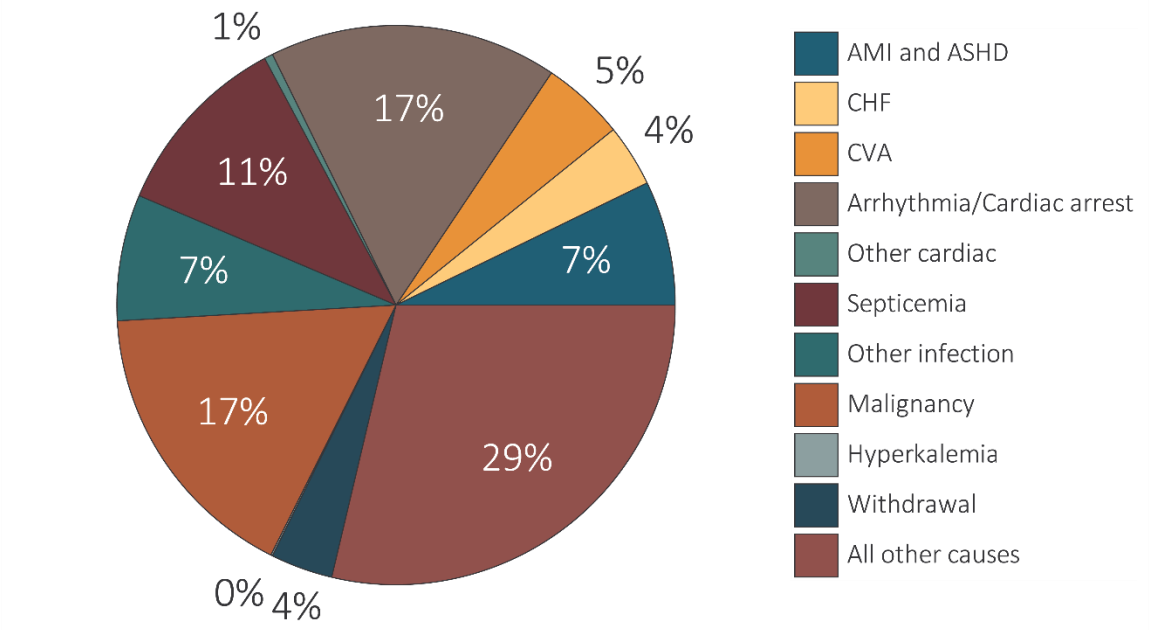
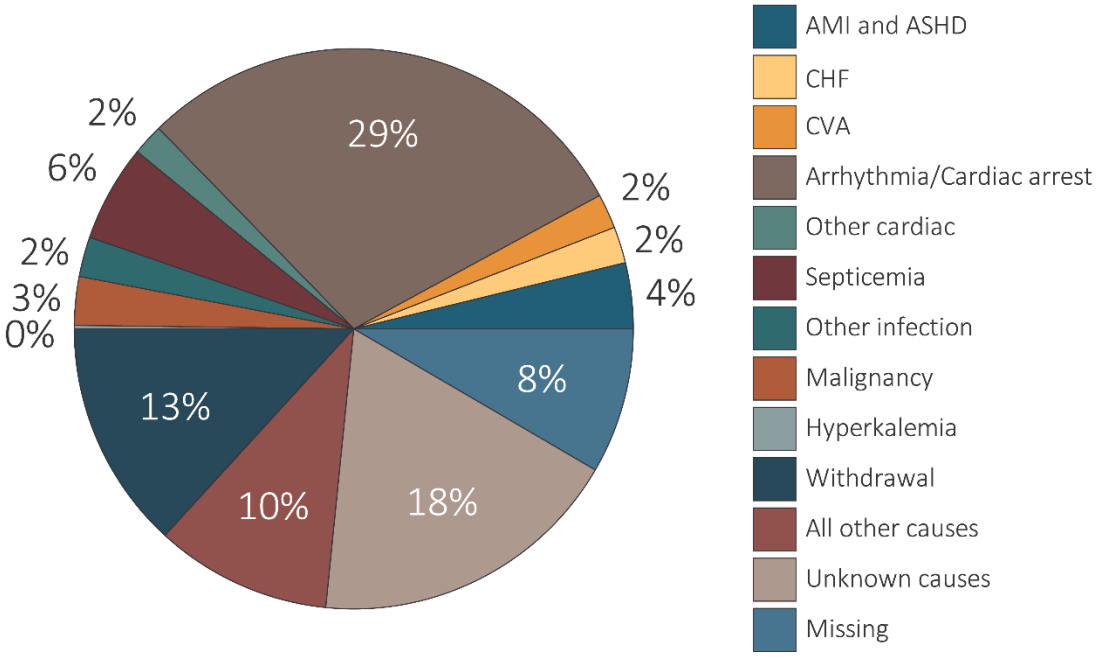


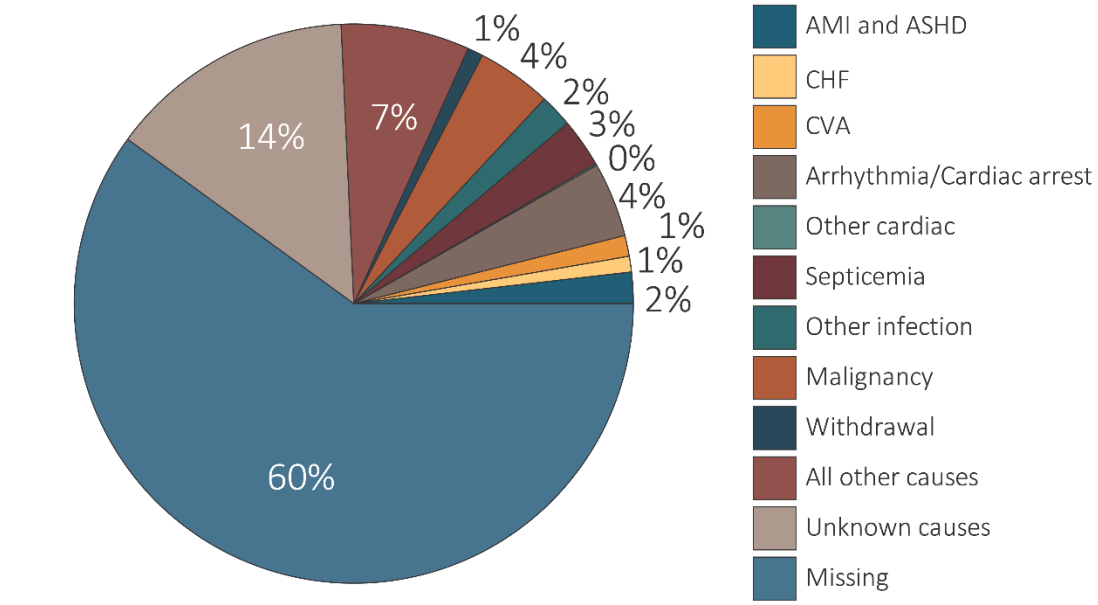
Figure 5.4 continued on next page

vol 2 Figure 5.4 Unadjusted percentages of deaths in 2015 by cause, with and without missing data, by modality among dialysis patients and transplant recipients (continued)

(c) Dialysis patients, denominator includes missing/unknown causes of death



(d) Transplant recipients, denominator includes missing/unknown causes of death



Data Source: Special analysis using Reference Table H.12_Dialysis and H.12_Tx. Mortality among 2015 prevalent patients. (a) Dialysis patients, denominator excludes missing/unknown causes of death. (b) Transplant recipients, denominator excludes missing/unknown causes of death. (c) Dialysis patients, denominator includes missing/unknown causes of death. (d) Transplant recipients, denominator includes missing/unknown causes of death. Abbreviations: AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CVA, cerebrovascular accident.

Survival Probabilities for ESRD Patients

Survival has improved between the 2003 and 2011 incident ESRD cohorts for all modalities. For example, five-year survival rose from 37% to 42% among HD patients, from 43% to 52% among PD patients, from 69% to 77% among deceased-donor transplant patients, and from 78% to 84% among living-donor transplant patients. Adjusted survival was consistently higher in the transplant population than in dialysis patients, and among living-donor transplant recipients than deceased-donor recipients.

Despite improvements in survival on dialysis over the years, adjusted survival for HD patients who were incident in 2011 is only 57% at three years after ESRD onset (Table 5.3). For PD patients, adjusted survival is 70% at three years. For deceased-donor and living-donor recipients, three-year survival is 86% and 91% respectively. The average three-year survival among an age- and sex-matched general population is considerably higher. The general population matched to HD patients' age and sex distribution has a 92% three-year survival, and the general population matched to PD patients' age and sex distribution has a 95% three-year survival. For the age and sex distribution among both deceased-donor and living-donor recipients, the matched three-year survival in the general population was 98% (calculated using the Social Security Administration "Period Life Table 2015").

vol 2 Table 5.3 Adjusted survival by treatment modality and incident cohort year (year of ESRD onset)

	3 months (%)	12 months (%)	24 months (%)	36 months (%)	60 months (%)
Hemodialysis					
2003	91.0	74.8	61.8	51.4	36.6
2005	91.2	75.4	62.7	53.0	38.6
2007	91.6	76.3	64.2	54.6	40.0
2009	91.8	77.5	65.7	56.2	41.6
2011	92.1	78.3	66.8	57.4	42.0
Peritoneal dialysis					
2003	96.3	83.9	69.0	57.7	42.9
2005	96.5	85.6	72.2	61.6	45.7
2007	96.9	87.5	74.8	64.5	48.8
2009	97.4	87.8	76.6	66.7	51.5
2011	97.7	89.7	79.0	69.5	52.1
Deceased-donor transplant					
2003	95.7	89.9	84.5	79.5	69.2
2005	95.6	89.7	84.9	80.3	71.0
2007	96.7	92.2	88.1	83.7	73.3
2009	96.7	92.0	88.2	84.0	75.1
2011	97.1	93.9	90.4	86.4	76.8
Living-donor transplant					
2003	98.1	95.3	91.3	86.9	77.9
2005	98.2	95.2	91.7	88.2	80.3
2007	99.0	97.0	94.3	91.0	83.5
2009	98.9	97.1	94.4	91.1	84.1
2011	98.9	96.3	94.3	91.2	84.1

Data Source: Reference Tables I.1_adj-I.36_adj. Adjusted survival probabilities, from day one, in the ESRD population. Reference population: incident ESRD patients, 2011. Adjusted for age, sex, race, Hispanic ethnicity, and primary diagnosis. Abbreviation: ESRD, end-stage renal disease.

Expected Remaining Lifetime: Comparison of ESRD Patients to the General U.S. Population

The differences in expected remaining lifetime between the ESRD and general populations were striking (Table 5.4). Dialysis patients younger than 80 years old were expected to live less than one-third as long as their counterparts without ESRD, and dialysis patients aged 85 years and older were expected to live around one-half as long as their counterparts without ESRD. Transplant patients fared considerably better, with expected remaining lifetimes for people under the age of 75 estimated at 69% to 85% of expected lifetimes in the general population.

vol 2 Table 5.4 Expected remaining lifetime (years) by age, sex, and treatment modality of prevalent dialysis patients, prevalent transplant patients (2016), and the general U.S. population (2015), based on USRDS data and the National Vital Statistics Report (2015)

	ESRD patients 2016				General U.S. population 2015	
	Dialysis		Transplant			
Age	Male	Female	Male	Female	Male	Female
0-14	23.3	20.9	60.3	59.3	70.6	75.4
15-19	21.4	18.7	47.6	49.1	59.6	64.3
20-24	18.5	15.8	43.7	45.2	54.9	59.4
25-29	16.0	14.0	39.6	41.1	50.2	54.6
30-34	14.1	12.7	35.3	37.1	45.6	49.8
35-39	12.4	11.4	31.2	33.1	41.0	45.0
40-44	11.0	10.2	27.4	29.1	36.5	40.3
45-49	9.3	8.7	23.6	25.2	32.0	35.7
50-54	7.9	7.6	20.0	21.7	27.7	31.2
55-59	6.7	6.6	16.8	18.2	23.7	26.8
60-64	5.6	5.7	14.0	15.2	19.9	22.7
65-69	4.6	4.8	11.4	12.5	16.3	18.6
70-74	3.8	4.1	9.3	10.1	12.9	14.8
75-79	3.3	3.6	7.6[a]	8.3[a]	9.8	11.4
80-84	2.7	3.0			7.2	8.4
85+	2.2	2.4			3.8	4.4

Data Source: Reference Table H.13; special analyses, USRDS ESRD Database; and National Vital Statistics Report. "Table 3. Life expectancy at selected ages, by race and Hispanic origin, and sex: United States, 2015 (2017)." Expected remaining lifetimes (years) of the general U.S. population and of period prevalent dialysis and transplant patients. [a]Cell values combine ages 75+. Abbreviation: ESRD, end-stage renal disease.

Mortality Rates: Comparisons of ESRD Patients to the Broader Medicare Population

Comparison to the General Medicare Population

The ESRD-free population eligible for Medicare coverage while under the age of 65 tends to be non-representative of the general population under the age of 65. For this reason, Table 5.6 focuses on comparisons between the ESRD population and the general Medicare population using age groups beginning at age 65, where the Medicare population is more representative. Male and female dialysis patients over the age of 75 years experienced mortality rates 3.9 times higher than their peers in the general Medicare population (Table 5.5). Among kidney transplant patients aged 65-74, mortality rates were 2.3-3.0 times higher than for the general Medicare population, and 1.4-1.5 times higher for those aged 75 and older.

vol 2 Table 5.5 Adjusted mortality (deaths per 1,000 patient-years) by age, sex, treatment modality, and comorbidity among ESRD patients and the general Medicare population, 2015

Age	Sex	Dialysis	Transplant	All Medicare	Cancer	Diabetes	CHF	CVA/TIA	AMI
65-74	Male	225	65	28	72	41	111	74	90
	Female	211	54	18	65	30	97	58	100
75+	Male	345	129	88	131	106	223	156	182
	Female	316	111	81	131	99	221	148	187

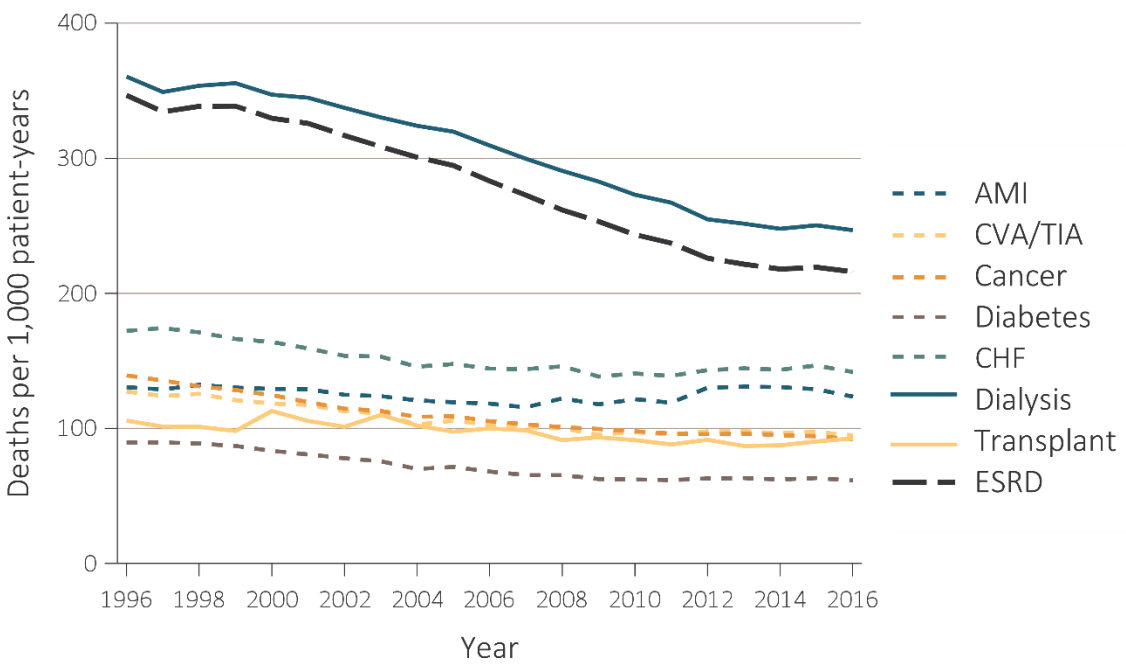
Data Source: Special analyses, USRDS ESRD Database and Medicare 5% sample. Adjusted for race. Medicare data limited to patients with at least one month of Medicare eligibility in 2015. Reference population: Medicare patients, 2015. Abbreviations: AMI, acute myocardial infarction; CHF, heart failure; CMS, Centers for Medicare & Medicaid Services; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.

Comparison to Comorbidity-Specific Medicare Patients

From 1996 to 2016, adjusted mortality among ESRD patients aged 65 years and older declined by 38%, from 347 to 216 per 1,000 patient-years (Figure 5.5). Among dialysis patients, adjusted mortality fell 32%, from 361 to 247. Among transplant patients, adjusted mortality fell 12%, from 106 to 93. The decline in mortality for dialysis patients was greater than for heart failure (CHF), cerebrovascular accident/transient ischemic attack (CVA/TIA), and acute myocardial infarction (AMI). Adjusted mortality fell 34% for patients with cancer and 31% for patients with diabetes mellitus (DM), but had a lower reduction for cardiovascular conditions, at 18% for CHF, 25% for CVA/TIA, and 5% for AMI.

In 2016, mortality rates among dialysis patients aged 65 years and older ranged from 1.7 times higher than for CHF patients without kidney disease, to 4.0 times higher than patients with DM, but no ESRD. For transplant patients aged 65 and older, the mortality rate was within the same range as Medicare patients with the other listed conditions.

vol 2 Figure 5.5 Adjusted mortality (deaths per 1,000 patient-years) by calendar year, treatment modality, and comorbidity among ESRD patients and comorbidity-specific Medicare populations aged 65 & older, 1996-2016



Data Source: Special analyses, USRDS ESRD Database and Medicare 5% sample. Unadjusted and adjusted (sex and race) mortality rates starting with the January 1 point prevalent sample in the ESRD and general populations, aged 65 and older (per 1,000 patient-years at risk). Reference population: period prevalent ESRD patients, 2012. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.

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