

# Chapter 5: Mortality

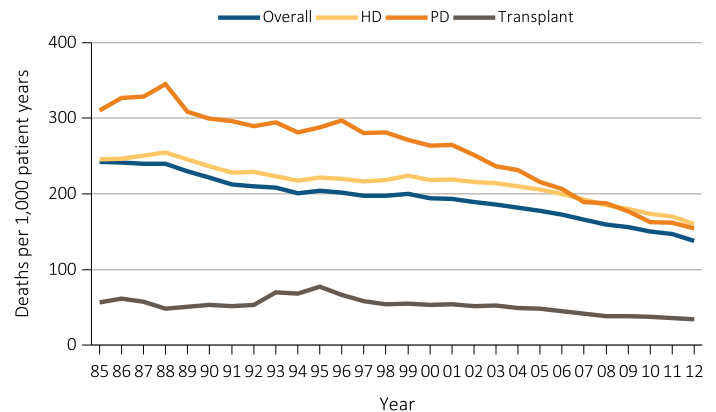
## Introduction

Data sources for mortality analyses in this chapter include both end-stage renal disease (ESRD) data and general population data. ESRD data are from the USRDS ESRD database. General population data are based on the Medicare 5 percent standard analytical files and US Census mortality data. Universal reporting to CMS of ESRD patient deaths is required as a condition of coverage for dialysis units and transplant centers.

## Mortality among ESRD Patients: Overall and by Modality

Overall mortality rates among ESRD patients continue to decline. Over the last two decades, the adjusted death rates fell by 9 percent from 1993 to 2002, and by 26 percent from 2003 to 2012 (Figure 5.1). The mortality rate for hemodialysis patients fell by 3 percent from 1993 to 2002 and by 25 percent from 2003 to 2012. Among peritoneal dialysis patients, mortality fell by 15 percent from 1993 to 2002 and by 35 percent from 2003 to 2012. Among transplant patients, mortality fell by 27 percent from 1993 to 2002 and by 35 percent from 2003 to 2012. Since 1993 the net reduction in mortality has been 28 percent for hemodialysis patients, 47 percent for peritoneal patients, and 51 percent for transplant patients.

vol 2 Figure 5.1 Adjusted all-cause mortality rates, overall and by modality



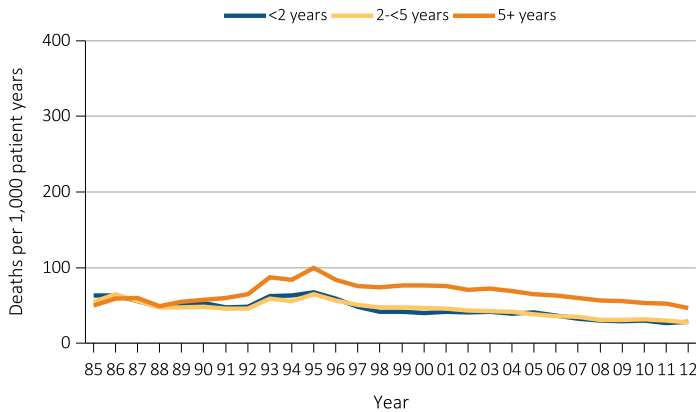
Data Source: Reference Tables H.2, H.8, H.9, and H.10, and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, and primary diagnosis. Ref: 2011 patients. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

## Mortality by Duration of ESRD

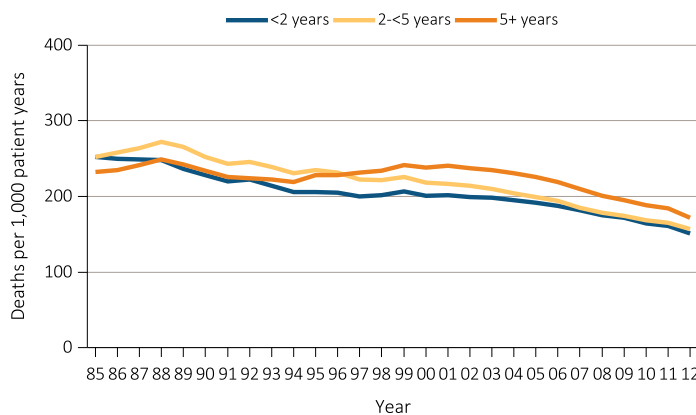
Mortality rates have declined over time across ESRD vintages (i.e., duration of ESRD) (Figure 5.2). Among peritoneal dialysis patients, mortality at vintages of less than 2 years is lower than at later vintages. Across all three modalities, mortality is slightly higher at vintages of 5 years and greater than at earlier vintages. Note that grouping patients by vintage of 0 to 2 years obscures the excess mortality seen early in the first year among hemodialysis patients (Figure 5.3).

vol 2 Figure 5.2 Adjusted all-cause mortality rates, by ESRD vintage

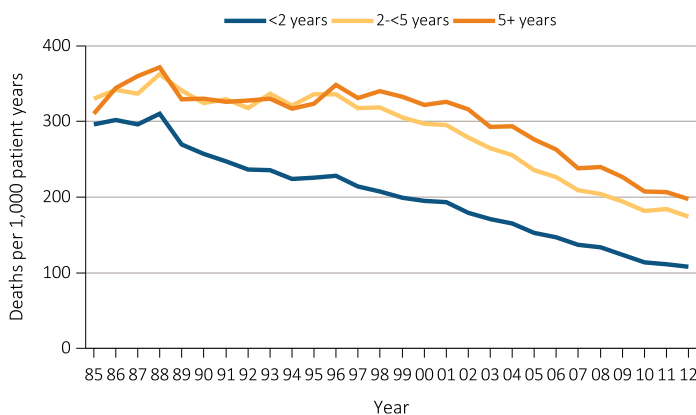
(a) Transplant



(b) Hemodialysis



(c) Peritoneal dialysis



Data Source: Reference Tables H.4, H.8, H.9, and H.10, and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, and primary diagnosis. Ref: 2011 patients. Abbreviation: ESRD, end-stage renal disease.

## Mortality in First Year of Hemodialysis: All-Cause and Cause-Specific

In the first year of hemodialysis, all-cause mortality, cardiovascular disease mortality, and mortality due to other causes peak in month two, then decrease thereafter (Figure 5.3). For example, among 2011 incident hemodialysis patients:

- All-cause mortality reached 421 deaths per 1,000 patient years in month two, then decreased to 193 by month 12.
- Cardiovascular mortality peaked at 163 deaths per 1,000 patient years, then decreased to 79 in month 12.
- Mortality due to infection peaks in months 2 and 3, at 35 and 38 per 1,000 patient years respectively, and falls to 17 in month 12.

The very early patterns (steep rise in mortality rates from month 0 to 2) may reflect data reporting issues; some patients who die soon after starting dialysis may not be properly documented and included in the CMS database (Foley et al., 2014).

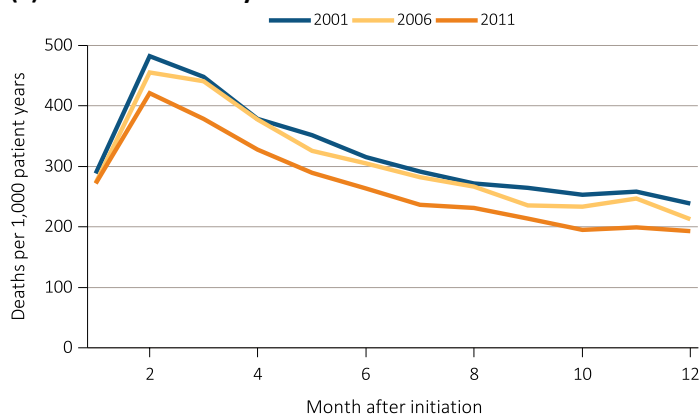
Month-by-month mortality rates in the first year of hemodialysis have shown improvements over time, overall and for deaths due to cardiovascular disease and infection. Compared to 2001 incident hemodialysis patients, rates of death during the first year of treatment for 2011 decreased by 19 percent for all-cause mortality, by 30 percent for cardiovascular death, and by 56 percent for death due to infection. In contrast, mortality due to other causes increased by 12 percent since 2001, a finding which requires further investigation.

## Survival Probabilities for ESRD Patients

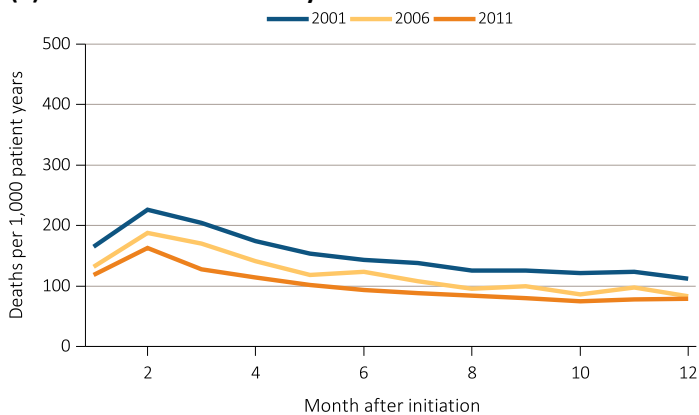
Despite improvements in survival on dialysis over the years, only 54 percent of hemodialysis patients, and 65 percent of peritoneal dialysis patients, are alive three years after ESRD onset (adjusted survival among patients starting dialysis in 2007 table 5.1.a.), which illustrates the extreme vulnerability of these patients relative to the general population. For dialysis patients, adjusted survival probability increased gradually between 1999 and 2007. For example, five-year survival improved during this period by 6 percent (to 40 percent) and 13 percent (to 49 percent) among hemodialysis and peritoneal dialysis patients, respectively.

vol 2 Figure 5.3 Adjusted mortality in the first year of hemodialysis, by year of initiation of dialysis

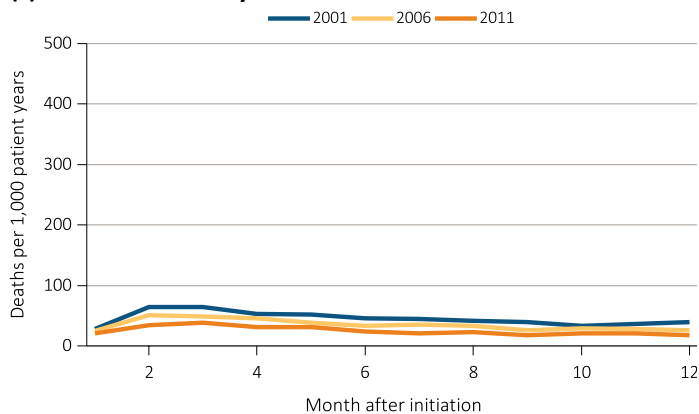
(a) All-cause mortality



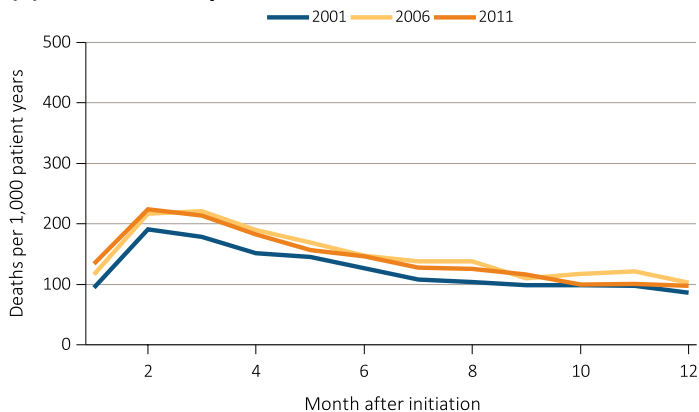
(b) Cardiovascular mortality



(c) Infection mortality



(d) Other mortality



Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) all-cause and cause-specific mortality in the first year of hemodialysis. Ref: incident hemodialysis patients, 2011.

vol 2 Table 5.1 Adjusted survival probabilities among ESRD patients, by months after initiation of treatment

5.1.a By modality and year of initiation of treatment

	3 months	12 months	24 months	36 months	60 months
<b>Dialysis</b>					
1999	91.2	74.9	61.0	50.0	34.5
2001	91.2	75.1	61.8	51.2	36.0
2003	91.2	75.1	62.2	51.8	37.1
2005	91.4	75.7	63.0	53.4	39.0
2007	91.7	76.4	64.4	54.9	40.4
<b>Hemodialysis</b>					
1999	90.9	74.5	60.7	49.8	34.2
2001	90.9	74.6	61.2	50.7	35.6
2003	90.9	74.5	61.6	51.3	36.5
2005	91.1	75.1	62.4	52.7	38.4
2007	91.4	75.8	63.7	54.2	39.8
<b>Peritoneal dialysis</b>					
1999	94.3	79.6	63.7	51.7	36.4
2001	95.5	82.0	67.2	55.5	39.3
2003	96.2	84.0	68.9	57.6	43.0
2005	96.4	85.8	72.5	61.9	45.9
2007	96.9	87.6	74.9	64.7	49.2
<b>Deceased-donor transplant</b>					
1999	94.3	88.6	83.9	78.3	66.5
2001	95.0	89.6	83.3	77.8	65.9
2003	95.8	90.1	84.7	79.6	69.2
2005	95.8	90.0	85.3	80.7	71.3
2007	96.8	92.5	88.4	84.1	73.7
<b>Living donor transplant</b>					
1999	97.3	94.2	90.7	85.5	76.3
2001	97.5	93.8	89.9	85.8	76.2
2003	98.3	95.8	92.2	88.2	79.9
2005	98.3	95.6	92.5	89.1	81.4
2007	99.2	97.6	95.5	93.0	87.0

Data Source: Reference Tables I.1-I.36, and special analyses, USRDS ESRD Database. Adjusted survival probabilities, from day one, without the 60 day rule, in the ESRD population. Ref: incident ESRD patients, 2011. Adjusted for age, sex, race, Hispanic ethnicity, and primary diagnosis. Abbreviation: ESRD, end-stage renal disease.

In the 2007 incident cohort, survival over the first five years of therapy is consistently highest in the transplant population and among younger patients, Blacks/African Americans (compared to Whites), and patients with a primary diagnosis of glomerulonephritis (compared to patients with diabetes or hypertension) (Table 5.1.b).

**vol 2 Table 5.1 Adjusted survival probabilities among ESRD patients, by months after initiation of treatment**

**5.1.b By modality and age, sex, race, and primary cause of ESRD, for patients initiating ESRD treatment in 2007**

	3 months	12 months	24 months	36 months	60 months
<b>2007 cohort</b>					
Dialysis	91.7	76.4	64.4	54.9	40.4
Hemodialysis	91.4	75.8	63.7	54.2	39.8
Peritoneal dialysis	96.9	87.6	74.9	64.7	49.2
Deceased-donor transplant	96.8	92.5	88.4	84.1	73.7
Living donor transplant	99.2	97.6	95.5	93.0	87.0
<b>Age</b>					
0-19	98.4	95.5	91.9	89.7	87.0
20-44	97.7	91.9	85.9	81.0	73.0
45-64	95.4	85.0	75.7	67.3	53.3
65-74	91.0	74.2	60.8	49.9	33.0
75+	84.6	60.4	43.4	31.5	15.8
<b>Sex</b>					
Male	91.7	76.9	64.9	55.4	41.3
Female	91.9	76.8	65.2	55.9	41.6
<b>Race</b>					
White	91.0	75.2	62.9	53.3	38.8
Black/African American	93.2	79.1	68.0	59.0	45.3
Native American	95.1	84.7	71.6	61.6	46.8
Asian	94.6	83.8	74.9	66.9	53.7
Other	91.1	72.1	55.4	44.2	26.1
<b>Primary cause of ESRD</b>					
Diabetes	92.7	77.6	64.4	53.7	37.2
Hypertension	92.0	77.9	66.4	57.4	43.6
Glomerulonephritis	94.3	83.4	73.9	66.3	53.8
Other	88.2	70.0	59.6	52.0	41.6

Data Source: Reference Tables I.1-I.36 and special analyses, USRDS ESRD Database. Adjusted survival probabilities, from day one, without the 60 day rule, in the ESRD population. Ref: 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 contrast between the ESRD and general populations is striking with respect to expected remaining lifetime (Table 5.2). One of the most compelling differences in expected remaining lifetime between the general and ESRD populations is found among dialysis patients

in their 30s, 40s, and 50s, who are expected to live less than one-third as long as their counterparts without ESRD. Transplant patients fare considerably better, with expected remaining lifetimes estimated at 83-87 percent of those of the general population.

**vol 2 Table 5.2 Expected remaining lifetime (years) of the general U.S. population, prevalent dialysis patients and transplant patients, by sex and age**

Ages	ESRD patients, 2012						General U.S. population, 2010		
	Dialysis			Transplant			All	M	F
0-14	22.3	23.2	21.3	61.0	60.1	62.5	72.9	70.5	75.3
15-19	19.9	20.6	19.0	48.7	47.9	50.0	59.5	57.1	61.7
20-24	17.0	17.7	16.1	44.7	44.0	45.9	54.7	52.4	56.9
25-29	14.9	15.5	14.1	40.7	40.0	41.8	50.0	47.8	52.0
30-34	13.4	13.8	12.7	36.8	36.1	37.9	45.2	43.1	47.2
35-39	12.0	12.3	11.5	32.8	32.1	33.9	40.5	38.5	42.4
40-44	10.5	10.6	10.2	28.9	28.2	30.0	35.9	33.9	37.7
45-49	8.9	9.0	8.7	25.1	24.4	26.2	31.4	29.6	33.2
50-54	7.6	7.6	7.6	21.6	20.9	22.7	27.2	25.4	28.8
55-59	6.5	6.4	6.5	18.3	17.7	19.3	23.1	21.5	24.5
60-64	5.5	5.4	5.6	15.4	14.8	16.4	19.1	17.7	20.3
65-69	4.6	4.5	4.8	12.9	12.4	13.8	15.5	14.2	16.5
70-74	3.9	3.8	4.1	10.8	10.4	11.5	12.1	11.0	12.9
75-79	3.3	3.2	3.5	9.1	8.7	9.7	9.1	8.2	9.7
80-84	2.7	2.6	2.9	a	a	a	6.5	5.8	6.9
85+	2.2	2.1	2.4	a	a	a	3.4	3.0	3.5
Overall	6.6	6.6	6.6	18.6	18.0	19.5	22.2	20.7	23.4

Data Source: Reference Table H.13; special analyses, USRDS ESRD Database; and Table 7 in National Vital Statistics Reports, Deaths: Final Data for 2010. Expected remaining lifetimes (years) of the general U.S. population and of prevalent dialysis and transplant patients. Prevalent ESRD population, 2012, used as weight to calculate overall combined-age remaining lifetimes. <sup>a</sup>cell values combine ages 75-85 and over. Abbreviation: ESRD, end-stage renal disease.

**Mortality Rates: Comparisons of ESRD Patients with the General Medicare Population**

Adjusted rates of all-cause mortality are 6.1 to 7.8 times greater for dialysis patients than for individuals in the general age-matched Medicare population (Figure 5.4). For renal transplant patients, rates are comparable to those of the general Medicare population less than 65 years old, but are 1.3 times higher among patients age 65 and older. (Note that patients on Medicare under the age of 65 are not representative of the general population.) Mortality rates rise with age, reaching 287 per 1,000 patient years for dialysis patients age 65 and older

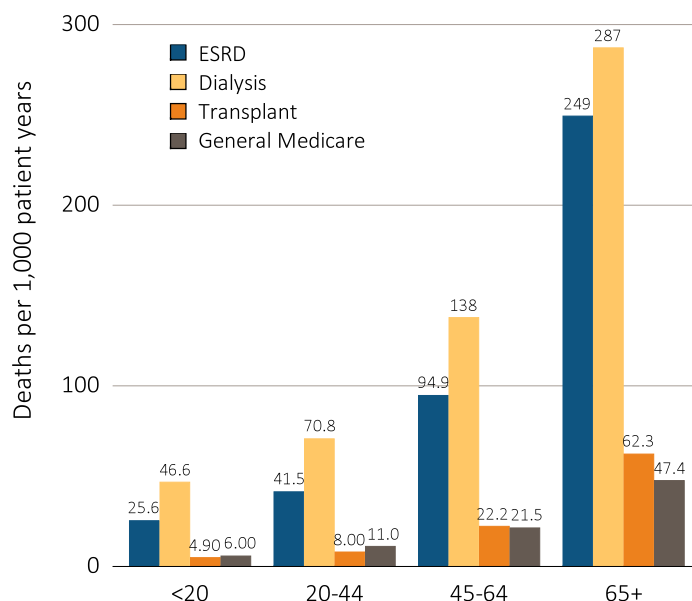
compared to 62.3 for transplant patients and 47.4 for the general Medicare population of the same age.

### Comparing ESRD with Comorbidity-Specific Medicare Patients, by Year

Since 1996, mortality adjusted for age, sex, and race fell 36 percent, from 350 to 223 in 2012 (Table 5.3). Among dialysis patients, adjusted mortality fell 31 percent, from 364 in 1996 to 252 in 2012. For transplant patients, adjusted mortality fell 38 percent, from 133 in 1996 to 83 in 2012.

Over the same time period, adjusted mortality fell 31 percent for cancer and 26 percent for diabetes, but somewhat less for cardiovascular conditions such as 14 percent for heart failure and 21 percent for CVA/TIA. No clear decline in mortality among AMI patients is evident.

vol 2 Figure 5.4 Adjusted all-cause mortality in the ESRD & general populations, by age, 2012



Data Source: Special analyses, USRDS ESRD Database and Medicare 5 Percent Sample. Adjusted for sex and race. Medicare data limited to patients with at least one month of Medicare eligibility in 2012. Ref: Medicare patients, 2012. Abbreviation: ESRD, end-stage renal disease.

vol 2 Table 5.3 Unadjusted & adjusted mortality rates in the ESRD & comorbidity-specific Medicare populations, age 65 & older (per 1,000 patient years), by calendar year

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
<b>Unadjusted</b>																	
ESRD	337	329	335	338	324	320	315	307	300	296	286	276	264	257	247	241	223
Dialysis	354	347	354	359	344	342	338	332	327	326	317	308	298	291	281	277	258
Transplant	97	89	97	92	93	91	91	90	83	80	77	79	72	75	74	72	66
<b>General Medicare</b>																	
Cancer	150	146	142	139	138	132	128	125	121	122	119	117	115	113	111	109	109
Diabetes	93	93	94	94	90	87	85	82	77	79	76	74	74	71	71	71	72
CHF	205	209	208	206	208	202	197	196	189	192	191	190	196	183	189	188	191
CVA/TIA	156	156	158	154	153	151	145	143	134	137	135	133	133	125	129	127	128
AMI	149	149	155	155	157	156	152	153	149	149	148	145	155	146	153	153	163
<b>Adjusted</b>																	
ESRD	350	341	346	345	329	324	318	309	300	294	284	274	263	255	246	240	223
Dialysis	364	356	361	363	346	343	337	330	322	319	310	299	290	284	275	270	252
Transplant	133	112	112	106	116	107	108	112	106	99	100	101	94	93	94	89	83
<b>General Medicare</b>																	
Cancer	144	141	140	133	129	126	122	118	112	116	113	107	106	105	102	100	99
Diabetes	87	89	88	86	82	80	78	76	70	72	69	66	66	63	63	62	64
CHF	166	170	167	164	160	157	154	153	145	146	144	143	145	137	138	137	143
CVA/TIA	130	130	128	124	122	124	117	116	109	111	108	107	106	100	101	100	103
AMI	131	131	136	138	133	135	133	133	124	126	128	125	131	122	127	125	137

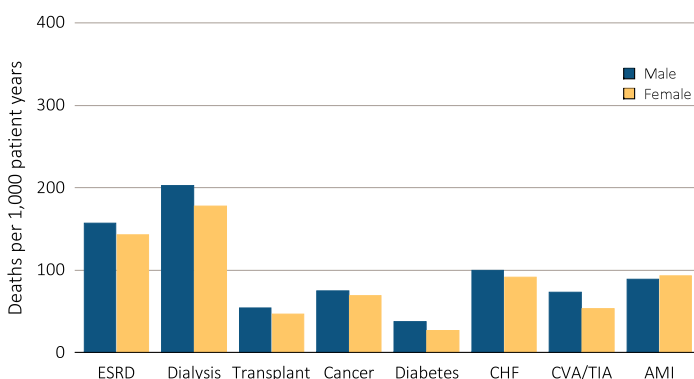
Data Source: Special analyses, USRDS ESRD Database and Medicare 5 percent sample. Unadjusted and adjusted (sex and race) mortality rates starting with January 1 point prevalent sample in the ESRD and general populations, age 65 and older (per 1,000 patient years at risk). Abbreviations: AMI, acute myocardial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

### Comparing ESRD with Comorbidity-Specific Medicare Patients by Age

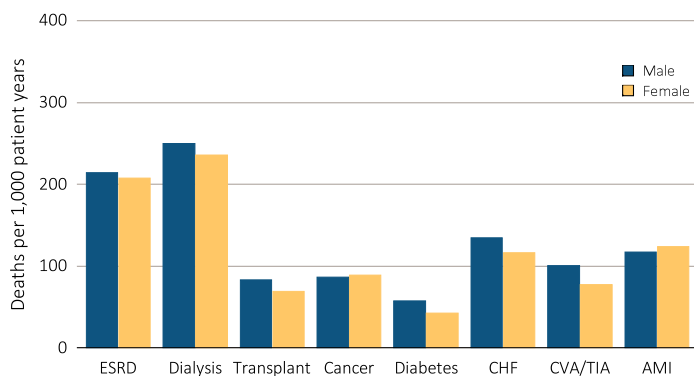
Among prevalent ESRD patients age 65 and older, adjusted mortality rates rise by age, not surprisingly (Figure 5.5). For dialysis patients, mortality rates are 2–3 times higher than for transplant patients and higher than for all general Medicare comorbidity-specific groups shown. In the transplant population, mortality rates within each age group are lower than for general Medicare patients with cancer or several of the other comorbidities shown.

**vol 2 Figure 5.5 Adjusted all-cause mortality in the ESRD, dialysis, transplant, and comorbidity-specific Medicare population, by age and sex, in 2012**

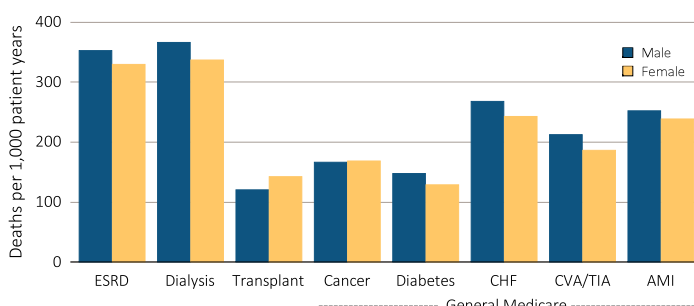
**(a) Ages 65-69**



**(b) Ages 70-79**



**(c) Age 80+**



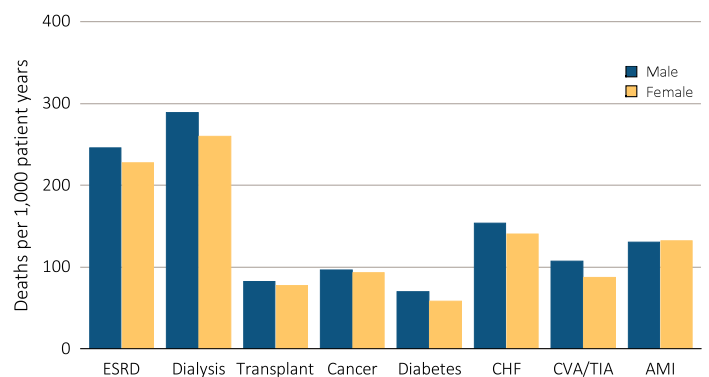
*Data Source: Special analyses, USRDS ESRD Database and Medicare 5 percent sample, 2012. All-cause mortality in the ESRD and Medicare populations with specific comorbid conditions identified in the preceding year, by age and sex, point prevalent sample on January 1, 2012, adjusted for race. Ref: ESRD patients, 2012. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.*

### Comparing ESRD With Comorbidity-Specific Medicare Patients by Race

Adjusted mortality rates are generally higher in men than women (Figure 5.6). Among ESRD patients, men have 1 to 8 percent higher mortality rates than women, with the lowest ratio among Black/African Americans and the highest among White patients. Within each race group, death rates among dialysis patients are higher than for general Medicare patients with any of the other comorbidities shown.

**vol 2 Figure 5.6 Adjusted all-cause mortality in the ESRD, dialysis, transplant, and comorbidity-specific Medicare population, by race and sex, in 2012**

**(a) White**



**(b) Black/African American**

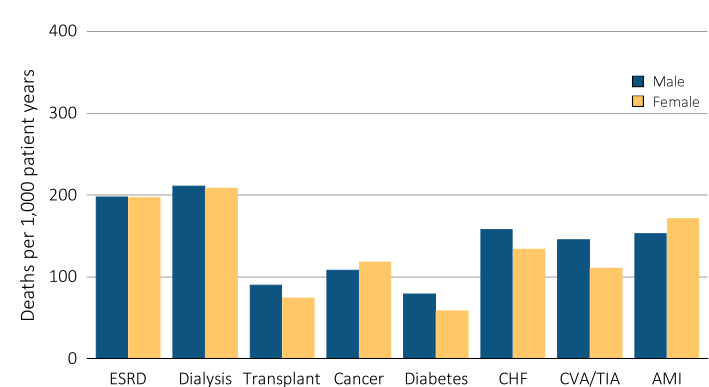
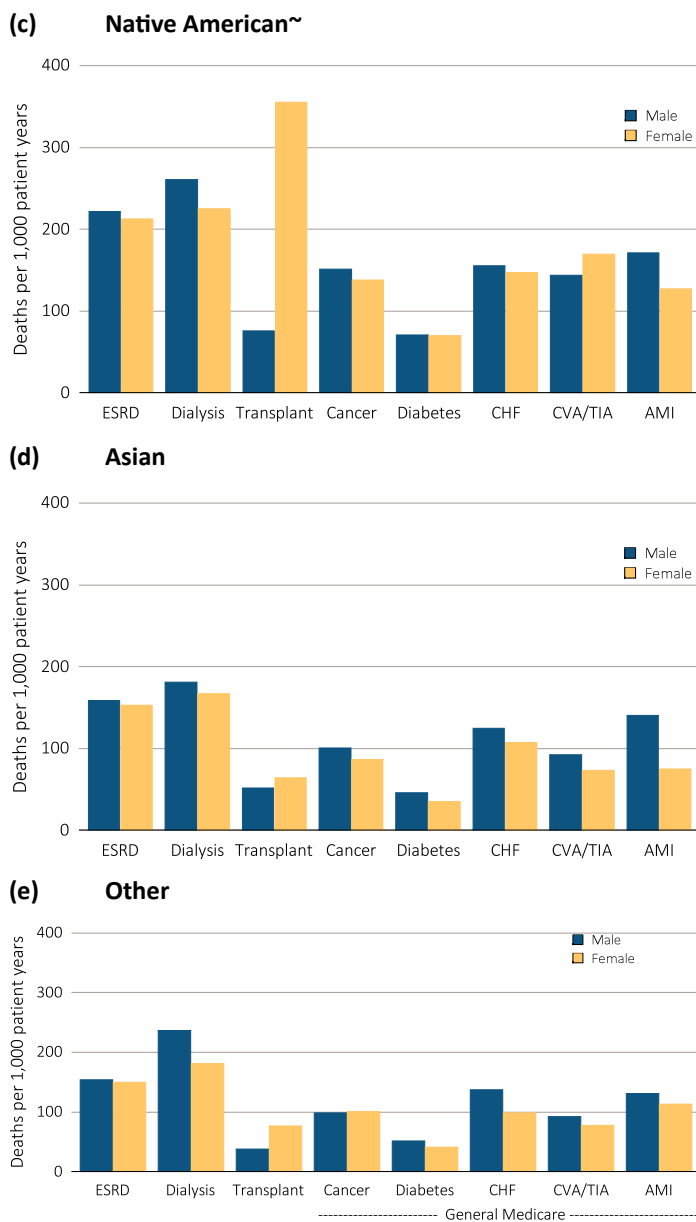


Figure 5.6 continued on next page.

**vol 2 Figure 5.6 Adjusted all-cause mortality in the ESRD, dialysis, transplant, and comorbidity-specific Medicare population, by race and sex, in 2012 (continued)**



Data Source: Special analyses, USRDS ESRD Database and Medicare 5 percent sample, 2012. All-cause mortality in the ESRD and Medicare populations with specific comorbid conditions identified in the preceding year, by race and sex, point prevalent sample on January 1, 2012, adjusted for age group. ~ Estimates shown are imprecise due to small sample size and may be unstable over time. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.

## References

Foley RN, Chen SC, Solid CA, Gilbertson DT, Collins AJ. Early mortality in patients starting dialysis appears to go unregistered. *Kidney Int* 2014;86(2):392-398.

