

Chapter 6: Mortality

- Mortality rates continue to decrease for dialysis and transplant patients, having fallen by 28% and 40%, respectively, since 1996.
- Adjusted mortality rates in 2013 per 1,000 patient-years were 138, 169, and 35 for ESRD, dialysis, and transplant patients, respectively. By dialysis modality, mortality rates were 172 for hemodialysis patients and 152 for peritoneal dialysis patients, per 1,000 patient-years.
- Patterns of mortality during the first year of dialysis differ substantially by modality. For hemodialysis patients, reported mortality is very high in month 2, but declines thereafter. In contrast, mortality rises slightly over the course of the year for peritoneal dialysis patients.
- The relationship between race and mortality differs considerably by age among dialysis patients. White dialysis patients younger than age 45 have mortality rates comparable to Black patients, but experience higher mortality in older ages.
- Dialysis patients continue to have substantially higher mortality, and fewer expected remaining life years, compared to the general population and Medicare populations with cancer, diabetes, or cardiovascular disease. However, the relative and absolute decline in mortality for dialysis patients in the past 15 years has been greater than for these other diagnostic groups.

Introduction

Mortality analyses in this chapter are based on 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 U.S. Census mortality data. Note that universal reporting of ESRD patient deaths to the Centers for Medicare & Medicaid (CMS) is required via CMS form 2746 as a condition of coverage for dialysis units and transplant centers. In addition, mortality ascertainment is augmented by Social Security Death Master File data to the extent allowed by regulation.

For analyses in this chapter, the term “incident” refers to patients new to ESRD, while “prevalent” refers to patients receiving ESRD treatment on a specific date, and “period prevalent” includes patients treated for ESRD over a period of time. Modality is assigned as of the earliest date within the range used in the analysis, without use of the 60-day stable modality rule (i.e., the requirement of 60 days on a modality for change in modality assignment) or the 90-day rule for outcomes (attribution of outcomes for up to 90 days after a change in modality).

The decline in mortality shown in this chapter has important implications for both patients and resource allocation, as increasing ESRD patient lifespan is likely contributing to the ongoing increase in the size of the prevalent ESRD population.

ANALYTICAL METHODS

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Mortality Among ESRD Patients, Overall and by Modality

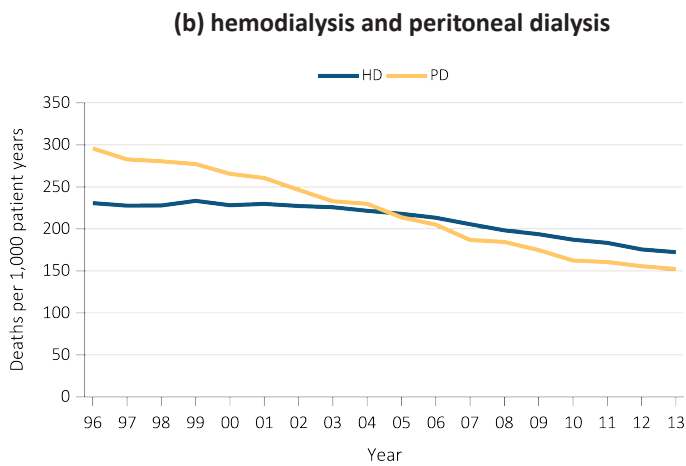
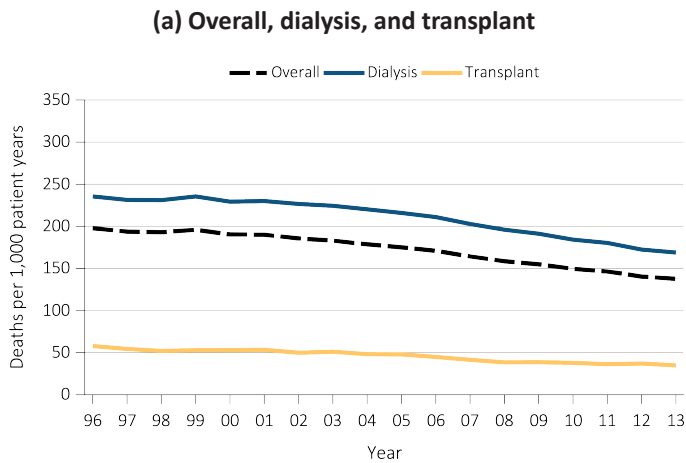
Overall mortality rates among ESRD (dialysis and transplant) patients continue to decline, with steeper declines in more recent years. Over the last two decades, the adjusted death rate fell by 7% from 1996 to 2003, and by 23% from 2004 to 2013 (Figure 6.1.a). The trend was similar for dialysis (hemodialysis and peritoneal dialysis) patients, with the mortality rate falling by 5% from 1996 to 2003 and by 23% from 2004 to 2013. Among transplant patients, mortality fell by 12% from 1996 to 2003 and by 28% from 2004 to 2013. Since 1996, the net reduction in mortality was 30% for

all ESRD patients, including 28% for dialysis patients and 40% for transplant patients.

By dialysis modality, among hemodialysis patients the adjusted mortality rate fell by 2% from 1996 to 2003 and by 22% from 2004 to 2013. Among peritoneal dialysis patients, the mortality rate fell by 21% from 1996 to 2003 and by 34% from 2004 to 2013 (Figure 6.1.b). The net reductions in mortality from 1996 to 2013 were 25% for hemodialysis patients and 49% for peritoneal patients.

Adjusted mortality rates in 2013 were 138, 169, and 35 per 1,000 patient-years for ESRD, dialysis, and transplant patients, respectively. By dialysis modality, mortality rates were 172 for hemodialysis patients and 152 for peritoneal dialysis patients, per 1,000 patient-years.

vol 2 Figure 6.1 Adjusted all-cause mortality (deaths per 1,000 patient-years) by treatment modality (a) overall, dialysis, and transplant, and (b) hemodialysis and peritoneal dialysis, for period-prevalent patients, 1996-2013

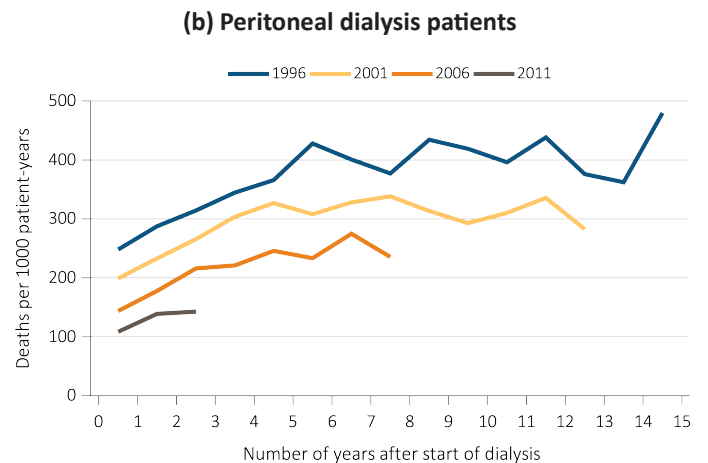
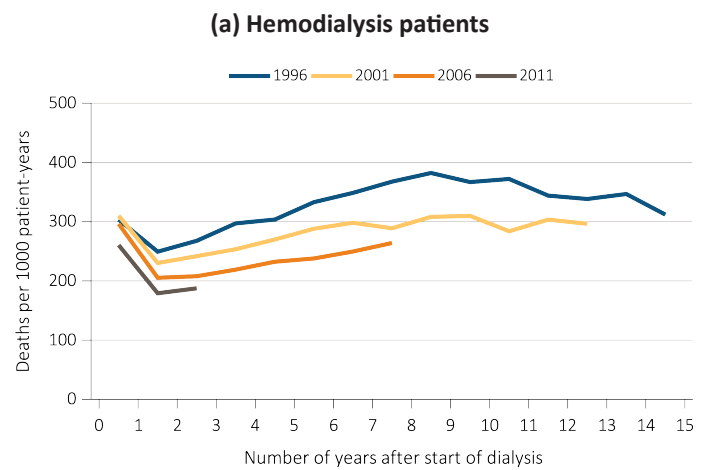


Data Source: Reference Tables H.2_adj, H4_adj, H.8_adj, H.9_adj, and H.10_adj; and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, ethnicity, primary diagnosis and vintage. Ref: period prevalent ESRD patients, 2011. Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

Mortality by Duration of Dialysis, Including Trends Over Time

Among hemodialysis patients, from 1996-2011 the average yearly death rate was highest during the first year, then dropped to its lowest point during the second year, and then tended to rise for more than 5 years afterward (Figure 6.2). Among peritoneal dialysis patients, mortality rates tended to increase over the first five years after starting dialysis. For both hemodialysis and peritoneal dialysis patients, mortality rates tended to be higher after 5 years than between 2-5 years on dialysis. The patterns of death rates according to time since dialysis initiation have been fairly similar over calendar time (comparing cohorts based on calendar year of initiation of treatment), within modality.

vol 2 Figure 6.2 Adjusted all-cause mortality (deaths per 1,000 patient-years) 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, 1996, 2001, 2006, and 2011



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

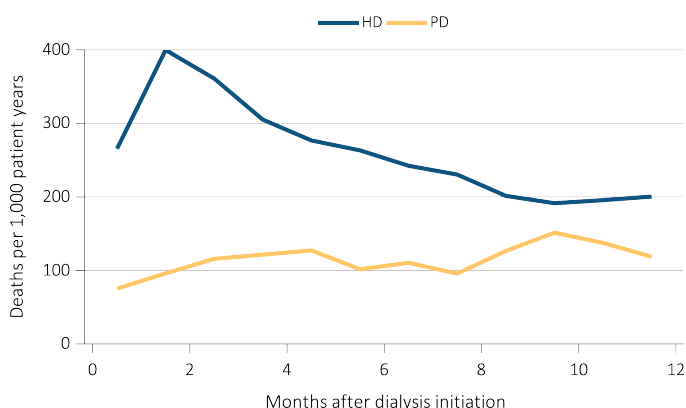
Mortality During the First Year of ESRD

Among patients starting hemodialysis in 2012, reported all-cause mortality peaked at 400 deaths per 1,000 patient-years in month 2, and decreased thereafter to 200 per 1,000 patient-years in month 12 (Figure 6.3). Note that the steep rise in hemodialysis mortality rates between months 1 and 2 may reflect 'data reporting issues'; e.g., some patients who die soon after starting dialysis related to ESRD might not be registered as being ESRD and included in the CMS database (Foley et al., 2014). The extent to which this occurs is currently unknown.

Among patients with peritoneal dialysis as initial renal replacement modality, mortality does not peak early but instead tends to increase gradually during the first year on dialysis. Mortality at month 12 among these patients was 119 per 1,000 patient-years. Peritoneal dialysis patients may not experience an early peak in mortality, in part, because patients beginning ESRD via peritoneal dialysis are a highly selected group, in many cases being younger, healthier, and having undergone substantial pre-ESRD planning.

Post-transplant mortality among the <2% of patients who initiate ESRD treatment with a kidney transplant peaks in month 1, followed by a generally decreasing trend for the remainder of the first year (not shown).

vol 2 Figure 6.3 Adjusted mortality (deaths per 1000 patient-years) by treatment modality and number of months after treatment initiation among ESRD patients, 2012



Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) mortality among 2012 incident ESRD patients during the first year of therapy. Ref: incident ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Mortality by Age and Race

Mortality rates among ESRD patients increase with rising age, as expected. Mortality rates differ by race, but this difference is not constant within age groups or by modality. For example, White patients on dialysis had comparable mortality rates to Black/African American patients among those aged 0-44 years old, but higher mortality than Blacks at older ages.

vol 2 Table 6.1 Adjusted all-cause mortality (deaths per 1,000 patient-years) by patient age and race among ESRD patients, 2012

Age	Race	ESRD	Dialysis	Transplant
0-21	White	12	31	4
	Black/African American	20	35	4
	Other	14	29	7
22-44	White	37	62	9
	Black/African American	48	60	10
	Other	24	38	6
45-64	White	99	143	30
	Black/African American	98	114	29
	Other	71	99	21
65-74	White	197	245	70
	Black/African American	167	183	71
	Other	137	171	61
75+	White	359	382	136
	Black/African American	275	283	132
	Other	239	254	112

Data Source: Special analyses, USRDS ESRD Database. Adjusted (sex and primary diagnosis) all-cause mortality among 2012 period prevalent patients. Ref: 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 deaths due to cardiovascular disease (CVD), which comprises 41% of the deaths and 53% of the deaths with known causes. The cause of death information (based on CMS 2746) is missing or unknown for 23% of dialysis patients and 68% of transplant patients.

vol 2 Table 6.2 Unadjusted percentages of deaths due to cardiovascular disease (CVD), infection, other specified causes, and with missing data, by modality among ESRD patients, 2012

Modality	Cause-specific mortality			
	CVD	Infection	Other cause	Missing cause
ESRD	39%	9%	26%	26%
Dialysis	41%	9%	27%	23%
Transplant	11%	6%	16%	68%

Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) all-cause mortality among 2012 prevalent patients. Ref: period prevalent ESRD patients, 2011. Abbreviations: CVD, cardiovascular disease; ESRD, end-stage renal disease.

Survival Probabilities for ESRD Patients

Despite improvements in survival on dialysis over the years, adjusted survival for hemodialysis patients who were incident in 2008 is only 55% at three years after ESRD onset (Table 6.3.a). For peritoneal dialysis patients, adjusted survival is 66% at three years. These results illustrate the extreme vulnerability of these patients relative to the general population.

Survival has improved between the 2000 and 2008 incident ESRD cohorts for all modalities. For example, five-year survival rose from 35% to 40% among hemodialysis patients, from 37% to 50% among peritoneal dialysis patients, from 66% to 75% among deceased donor transplant patients, and from 75% to 87% 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.

In the 2008 incident ESRD cohort, adjusted survival was consistently higher (Table 6.3.b) among younger patients, among Asians and Blacks compared to other races, and patients among with primary cause of ESRD designated as glomerulonephritis compared to patients with diabetes or hypertension.

vol 2 Table 6.3 Adjusted survival (%) by (a) treatment modality and incident cohort year (year of ESRD onset), and (b) age, sex, race, and primary cause of ESRD, for ESRD patients in the 2008 incident cohort (initiating ESRD treatment in 2008)

	(a) Treatment modality and incident cohort year (year of ESRD onset)				
	3 months	12 months	24 months	36 months	60 months
Hemodialysis					
2000	91.0	74.4	60.6	50.1	34.5
2002	91.0	74.6	61.1	50.7	35.9
2004	91.0	74.8	61.9	51.8	37.3
2006	91.1	75.4	63.0	53.4	38.8
2008	91.4	76.3	64.4	54.7	40.2
Peritoneal dialysis					
2000	94.7	80.3	64.3	52.8	37.3
2002	95.8	82.9	68.4	57.0	41.6
2004	96.1	84.8	71.8	60.8	45.7
2006	96.9	86.4	73.7	62.4	47.1
2008	97.4	88.5	76.4	66.4	50.3
Deceased-donor transplant					
2000	94.5	88.1	82.7	77.9	65.8
2002	95.1	89.9	84.4	79.5	68.8
2004	96.1	90.4	85.5	79.8	69.7
2006	96.0	91.4	86.9	82.7	72.4
2008	96.8	92.8	88.7	84.6	74.6
Living donor transplant					
2000	97.0	93.2	88.7	84.9	74.8
2002	97.6	94.2	90.0	86.3	77.6
2004	98.2	95.3	92.4	88.9	81.8
2006	98.6	96.3	93.7	90.8	83.5
2008	98.7	97.1	94.9	92.2	86.9

Data Source: Reference Tables I.1_adj-I.36_adj. Adjusted survival probabilities, from day one, 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.

(b) Age, sex, race, and primary cause of ESRD

2008 cohort	3 months	12 months	24 months	36 months	60 months
Age					
0-21	98.5	95.3	93.2	91.8	88.7
22-44	97.6	91.8	86.4	81.7	73.8
45-64	95.3	85.6	76.4	68.3	54.5
65-74	91.1	75.0	61.8	50.9	34.1
75+	85.1	62.2	45.6	33.2	17.1
Sex					
Male	91.8	77.6	65.9	56.4	42.4
Female	92.0	77.9	66.5	57.2	42.8
Race					
White	91.2	76.3	64.2	54.6	40.2
Black/African American	93.1	79.7	69.1	60.1	46.1
Native American	92.5	78.6	65.8	55.9	42.4
Asian	95.3	85.1	75.4	67.0	53.9
Other	90.1	71.6	57.7	47.2	34.4
Primary cause of ESRD					
Diabetes	92.9	78.3	65.2	54.3	37.9
Hypertension	92.2	78.8	67.7	58.6	44.6
Glomerulonephritis	94.4	83.8	74.6	66.8	55.1
Other	90.1	71.6	57.7	47.2	34.4
All patients	91.9	77.7	66.2	56.8	42.6

Data Source: Reference Tables I.1-I.36. Adjusted survival probabilities, from day one, 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.

vol 2 Table 6.4 Expected remaining lifetime (years) by age, sex, and treatment modality of prevalent dialysis patients, prevalent transplant patients, and the general U.S. population (2012), based on USRDS data and the National Vital Statistics Report (2013)

Age	ESRD patients, 2013				General U.S. population, 2012	
	Dialysis		Transplant		Male	Female
	Male	Female	Male	Female	Male	Female
0-14	24.1	22.4	59.2	61.2	70.7	75.4
15-19	20.9	19.3	46.8	48.6	59.7	64.4
20-24	18.1	16.5	42.5	44.2	55.0	59.5
25-29	15.8	14.3	38.6	40.2	50.3	54.6
30-34	14.1	13.0	34.7	36.4	45.7	49.7
35-39	12.5	11.7	30.8	32.4	41.0	45.0
40-44	10.8	10.3	26.9	28.6	36.4	40.3
45-49	9.1	8.8	23.2	24.8	31.9	35.6
50-54	7.7	7.7	19.8	21.3	27.7	31.1
55-59	6.5	6.6	16.6	18.1	23.7	26.8
60-64	5.5	5.7	13.8	15.2	19.8	22.6
65-69	4.5	4.8	11.4	12.7	16.2	18.5
70-74	3.8	4.0	9.4	10.4	12.8	14.7
75-79	3.2	3.5	7.7a	8.6a	9.8	11.3
80-84	2.6	2.9			7.1	8.4
85+	2.1	2.4			4.9	5.8

Data Source: Reference Table H.13; special analyses, USRDS ESRD Database; and National Vital Statistics Report. "Table 7. Life expectancy at selected ages, by race, Hispanic origin, race for non-Hispanic population, and sex: United States, 2012 (2015)." Expected remaining lifetimes (years) of the general U.S. population and of period prevalent dialysis and transplant patients. ^acell values combine ages 75+. 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 are striking (Table 6.4). Dialysis patients younger than 80 years old are expected to live less than one-third as long as their counterparts without ESRD, and dialysis patients aged 80 years and older are expected to live less than one-half as long as their counterparts without ESRD. Transplant patients fare considerably better, with expected remaining lifetimes for people under the age of 75 estimated at 67% to 84% of expected lifetimes in the general population.

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

COMPARISON TO THE GENERAL MEDICARE POPULATION

Dialysis patients over the age of 75 years experienced mortality rates 3.9 times higher for males and 3.8 times higher for females than for males and females in the general Medicare population (Table 6.5). Among kidney transplant patients, mortality rates were 2.5-3.3 times higher than for the general Medicare population aged 65-74, and 1.4 times higher at age 75 and older.

vol 2 Table 6.5 Adjusted mortality (deaths per 1,000 patient-years) by age, sex, treatment modality, and Medicare comorbidity among ESRD patients and people covered by Medicare in 2013, based on USRDS and CMS data, 2013

Age	Sex	Dialysis	Transplant	All Medicare	Cancer	Diabetes	CHF	CVA/TIA	AMI
65-74	Male	235	68	27	75	42	107	75	91
	Female	214	60	18	69	31	99	56	96
75+	Male	357	126	91	135	109	232	167	202
	Female	321	122	85	139	104	229	156	212

Data Source: Special analyses, USRDS ESRD Database and Medicare 5 percent sample. Adjusted for race. Medicare data limited to patients with at least one month of Medicare eligibility in 2013. Ref: Medicare patients, 2013. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CMS, Centers for Medicare & Medicaid; CVA/TIA, cerebrovascular accident/transient ischemic attack; ESRD, end-stage renal disease.

COMPARISON TO COMORBIDITY-SPECIFIC MEDICARE PATIENTS

From 1996 to 2013, adjusted mortality among ESRD patients aged 65 years and older declined by 48%, from 338 to 174 per 1,000 patient-years (Table 6.6). Among dialysis patients, adjusted mortality fell 37%, from 349 to 219. Among transplant patients, adjusted mortality fell 9%, from 79 to 72. The decline in mortality for dialysis patients was greater than for other major diagnostic groups, including cancer, diabetes, CHF, CVS/TIA, and AMI. Adjusted mortality fell 34% for cancer and 32% for diabetes, but somewhat less for cardiovascular conditions, at 23% for heart failure, 27%

for cerebrovascular accident/transient ischemic attack (CVA/TIA), and 20% for acute myocardial infarction (AMI).

In 2013, mortality rates among dialysis patients aged 65 years and older ranged from 1.7 times higher than for heart failure patients to 4.0 times higher than for patients with diabetes. For transplant patients aged 65 and older, the mortality rate was within the range of mortality rates for Medicare patients with the other listed conditions.

vol 2 Table 6.6 Adjusted mortality (deaths per 1,000 patient-years) by calendar year, treatment modality, and Medicare comorbidity among ESRD patients and comorbidity-specific Medicare populations aged 65 & older, 1996-2013

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Decline 1996-2012
Modality																			
ESRD	338	357	382	390	375	382	380	391	406	335	280	271	261	266	257	265	222	174	48%
Dialysis	349	368	392	402	389	399	400	415	437	365	310	307	298	313	307	328	288	219	37%
Transplant	79	87	110	82	73	76	81	118	100	95	82	74	96	91	91	94	85	72	9%
Medicare data comorbidities																			
Cancer	80	76	76	82	77	68	69	66	61	61	60	58	57	55	52	52	53	54	32%
Diabetes	170	155	154	155	154	141	143	138	132	131	130	134	131	128	125	120	128	131	23%
CHF	124	117	116	126	116	105	111	102	97	96	98	95	90	89	89	84	92	91	27%
CVA/TIA	157	132	126	148	142	118	128	119	109	106	118	113	117	109	121	117	127	125	20%
AMI	338	357	382	390	375	382	380	391	406	335	280	271	261	266	257	265	222	174	48%

Data Source: Special analyses, USRDS ESRD Database, and Medicare 5 percent 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). Ref: 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.

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.

National Vital Statistics Report. Table 7. Life expectancy at selected ages, by race, Hispanic origin, race for non-Hispanic population, and sex: United States, 2012. 2015;63(9):29. http://www.cdc.gov/nchs/data/nvsr/nvsr63/nvsr63_09.pdf. Accessed October 2, 2015.

Notes