5

Mount McKinley, Denali National Park, Alaska

MORTALITY

Assessing mortality in the ESRD population is a unique challenge, in that two sources of death records are available to the USRDS Coordinating Center (CC).

Universal reporting to CMS of ESRD patient deaths is required as a condition of coverage for dialysis units and transplant centers. Since all ESRD patients have Social Security numbers, the CC can also link patients to the National Death Index files, which are added to the Medicare and Social Security enrollment databases. The USRDS was formerly able to report deaths only from day 90 of treatment, as Medicare did not cover services for those younger than 65; now, however, the comprehensive tracking of all ESRD patient deaths allows the USRDS to identify all deaths occurring after the first outpatient dialysis session.

Between 1993 and 2003 there was little improvement in first-year death rates in the ESRD population. Between 2003 and 2009, however, these rates fell more than 14 percent, while second-year death rates declined 16.5 percent. Month-by-month mortality rates in the first year of hemodialysis have shown similar improvements, overall and for deaths due to cardiovascular disease and infection. Progress has been made as well in mortality due to infection, and to a greater extent than seen with cardiovascular deaths. Mortality due to other causes, in contrast, has increased since 1999, a finding which requires further investigation. Still striking are the high rates of all-cause mortality in the early months of therapy, and the fact that mortality in the dialysis population remains ten times greater than among Medicare patients of similar age without kidney disease.

In the prevalent population, mortality rates have declined nearly 25 percent over the last two decades, and 19 percent since 2000.

Despite these improvements, however, only 51 percent of dialysis patients, and 82 percent of those who receive a preemptive transplant, are still alive three years after the start of ESRD therapy — numbers that help illustrate the extreme vulnerability of these patients when compared to the general population. Among dialysis patients age 65 and older, for example, mortality is twice as high as for patients in the general population who have diabetes, cancer, congestive heart failure, CVA/TIA, or AMI.

Patients with kidney disease are clearly at a high risk of death and, as shown in the hospitalization data, have very high event rates as well. In Chapter Three

Our dead never forget the beautiful world that gave them being. They still love its winding rivers, its great mountains and its sequestered vales, and they ever yearn in tenderest affection over the lonely-hearted living, and often return to visit and comfort them.

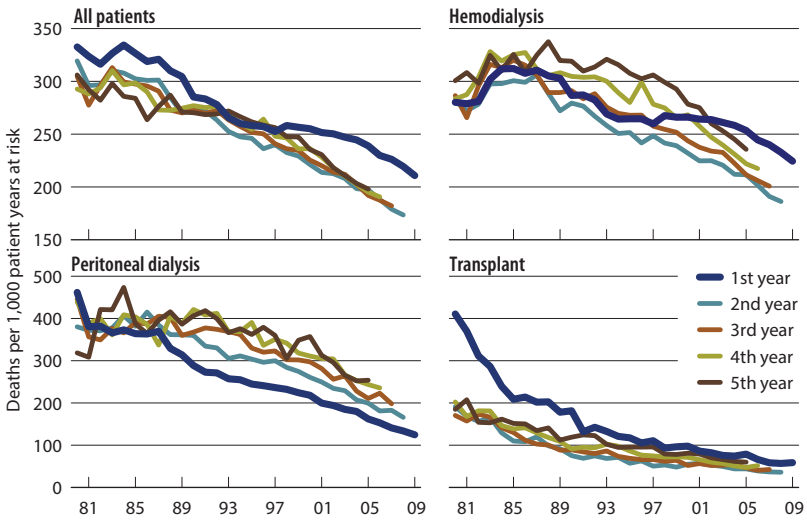
CHIEF SEATTLE

MORTALITY
introduction

we examine hospitalization rates by interdialytic interval; here we look at the interval in terms of mortality. Deaths due to infection, for example, peak on the day after the first run of the week. Thrice-weekly treatment may be inadequate for addressing the critical problems of persistent fluid overload, hypertension, and left ventricular hypertrophy. Recent publication of the Frequent Hemodialysis Trial (NEJM Nov 2010), comparing treatment of three days per week to that of six days, demonstrated significant reductions in left ventricular hypertrophy and hyperphosphatemia among patients receiving more frequent therapy. Mortality comparisons still need to be considered, as do questions of how more frequent sessions might be implemented across the country. In the meantime, there should be a focus on improving care and outcomes through medication interventions and reductions in the use of dialysis catheters, with their high rates of associated complications. » **Figure 5.1;** see page 438 for analytical methods. *Incident ESRD patients. Adj: age/gender/race/primary diagnosis; ref: incident ESRD patients, 2005.*

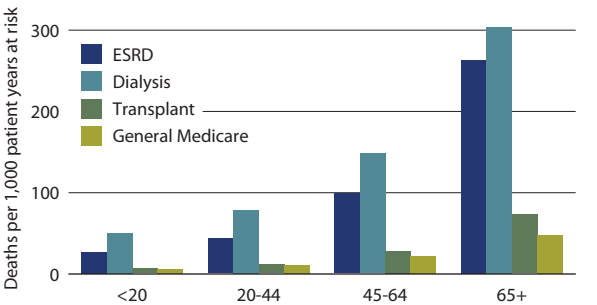
vol 2
5.1

Adjusted all-cause mortality rates (from day 90), by modality & year of treatment

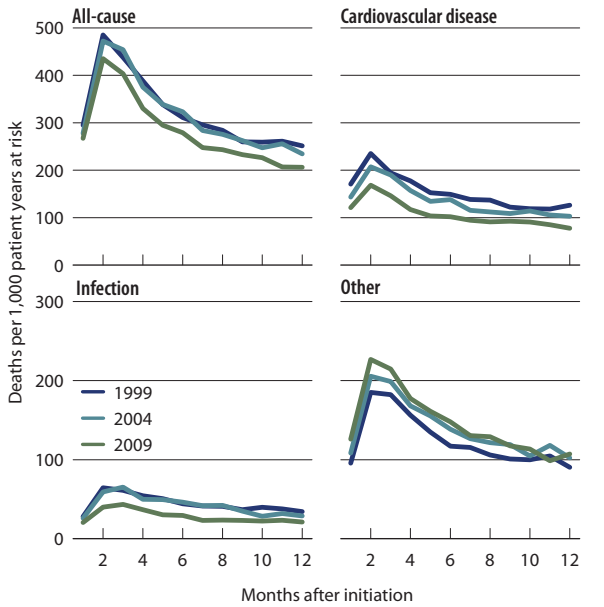


Adjusted rates of all-cause mortality are 6.3–8.2 times greater for dialysis patients than for individuals in the general population. For renal transplant patients, rates approach those of the general population, yet remain 1.1–1.5 times higher. Rates rise by age, reaching 264 per 1,000 patient years at risk for ESRD patients age 65 and older, and 304 for dialysis patients of the same age. » **Figure 5.2;** see page 438 for analytical methods. *Prevalent ESRD & general Medicare (non-ESRD) patients. Adj: gender/race; ref: Medicare patients, 2010.*

vol 2 **5.2** **Adjusted all-cause mortality in the ESRD & general populations, by age, 2010**

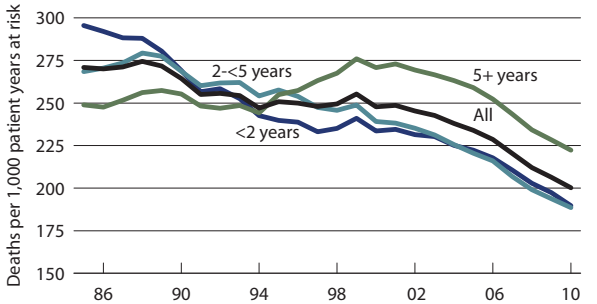


vol 2 **5.3** **Adjusted all-cause & cause-specific mortality (from day one) in the first year of hemodialysis**



In the first year of hemodialysis, all-cause mortality and mortality due to cardiovascular disease or to other causes peak in month two following initiation, then fall. For incident hemodialysis patients in 2009, for example, all-cause mortality reached 435 deaths per 1,000 patient years at risk in month two, then fell to 206 in month 12. Cardiovascular mortality peaked at 169, and decreased to 78. Mortality due to infection peaks in months 2 and 3, at 40–43 per 1,000 patient deaths. » **Figure 5.3;** see page 438 for analytical methods. *Incident hemodialysis patients defined on the day of dialysis onset, without the 60-day rule. Adj: age/gender/race/Hispanic ethnicity/primary diagnosis; ref: incident hemodialysis patients, 2005.*

vol 2 **5.4** **Adjusted all-cause mortality in prevalent hemodialysis patients, by vintage**



Through the 1980s, patients newer to dialysis had higher mortality rates than those on treatment for five years or more. This trend began to change in the early 1990s, and in 2010 the rate of 222 per 1,000 patient years in patients receiving hemodialysis therapy for five or more years was 17 percent higher than the rate of 190 in patients treated for less than two years. » **Figure 5.4;** see page 438 for analytical methods. *Period prevalent hemodialysis patients. Adj: age/gender/race/primary diagnosis; ref: hemodialysis patients, 2005.*

vol 2
5.a Adjusted survival probabilities, from day one, in the ESRD population

	6 months	12 months	24 months	36 months	48 months	60 months
Dialysis						
1997	0.84	0.75	0.59	0.47	0.38	0.30
1999	0.84	0.74	0.60	0.48	0.38	0.31
2001	0.84	0.75	0.60	0.49	0.40	0.32
2003	0.84	0.74	0.61	0.50	0.40	0.33
2005	0.84	0.75	0.62	0.51	0.42	0.35
Hemodialysis						
1997	0.84	0.74	0.59	0.47	0.38	0.30
1999	0.84	0.74	0.59	0.48	0.38	0.31
2001	0.83	0.74	0.60	0.49	0.39	0.32
2003	0.83	0.74	0.60	0.49	0.40	0.33
2005	0.84	0.74	0.61	0.51	0.42	0.35
Peritoneal dialysis						
1997	0.89	0.80	0.62	0.49	0.37	0.29
1999	0.90	0.80	0.63	0.50	0.39	0.31
2001	0.91	0.82	0.67	0.54	0.43	0.34
2003	0.92	0.84	0.69	0.56	0.45	0.37
2005	0.93	0.86	0.72	0.60	0.49	0.41
Transplant						
1997	0.91	0.88	0.83	0.77	0.72	0.65
1999	0.92	0.89	0.85	0.79	0.73	0.67
2001	0.93	0.90	0.85	0.80	0.74	0.68
2003	0.94	0.91	0.86	0.81	0.76	0.71
2005	0.94	0.91	0.87	0.82	0.78	0.73
2005 cohort						
Dialysis	0.84	0.75	0.62	0.51	0.42	0.35
Hemodialysis	0.84	0.74	0.61	0.51	0.42	0.35
Peritoneal dialysis	0.93	0.86	0.72	0.60	0.49	0.41
Transplant	0.94	0.91	0.87	0.82	0.78	0.73
0-19	0.92	0.88	0.82	0.75	0.70	0.66
20-44	0.94	0.90	0.81	0.74	0.68	0.62
45-64	0.90	0.83	0.71	0.61	0.52	0.44
65-74	0.83	0.73	0.58	0.46	0.35	0.27
75+	0.73	0.59	0.42	0.29	0.20	0.14
Male	0.85	0.75	0.62	0.51	0.42	0.35
Female	0.84	0.75	0.62	0.51	0.43	0.36
White	0.83	0.74	0.59	0.48	0.39	0.32
Black/African American	0.86	0.77	0.64	0.55	0.46	0.39
Other	0.89	0.82	0.71	0.62	0.54	0.46
Diabetes	0.86	0.76	0.61	0.49	0.39	0.32
Hypertension	0.85	0.77	0.64	0.54	0.45	0.38
Glomerulonephritis	0.89	0.83	0.73	0.63	0.55	0.48
Other	0.78	0.68	0.56	0.47	0.40	0.34

While six- and twelve-month survival probabilities have remained stable since 1997 in the hemodialysis population, they have improved somewhat for both peritoneal dialysis and transplant patients. Five-year survival has improved across all modalities — from 0.30 to 0.35 for hemodialysis, from 0.29 to 0.41 for peritoneal dialysis, and from 0.65 to 0.73 for transplant.

In the 2005 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.a;** see page 438 for analytical methods. *Incident dialysis patients defined on the day of dialysis onset, without the 60-day rule, from day one of dialysis to December 31, 2010; transplant patients receiving a first transplant in the calendar year, followed from day of transplant to December 31, 2010. Adj: age/gender/race/Hispanic ethnicity/primary diagnosis; ref: incident ESRD patients, 2005.*

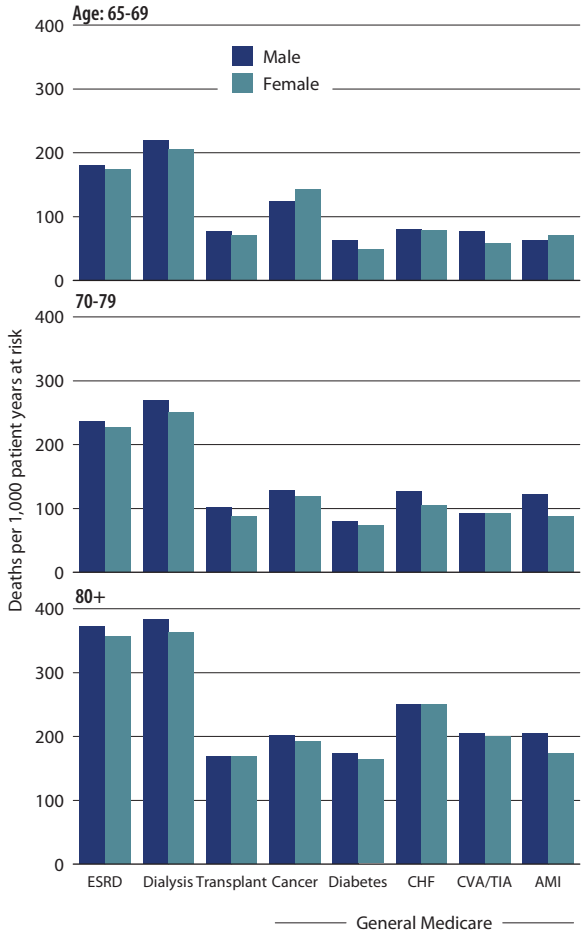
vol 2
5.b Unadjusted & adjusted mortality rates in the ESRD & general populations, age 65 & older, (per 1,000 patient years at risk)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Unadjusted																
ESRD	321	322	318	322	325	317	315	309	302	297	292	282	271	261	254	245
Dialysis	336	339	337	342	347	340	339	336	330	327	325	316	306	298	292	283
Transplant	99	94	87	99	93	98	94	90	92	88	86	82	82	75	78	77
General Medicare																
Cancer	151	150	146	142	139	138	132	128	125	121	122	119	117	115	113	111
Diabetes	92	93	93	94	94	90	87	85	82	77	79	76	74	74	71	71
CHF	205	205	208	208	206	208	202	197	196	189	192	191	190	196	183	189
CVA/TIA	155	156	156	158	154	153	151	145	143	134	137	135	133	133	125	129
AMI	148	149	149	155	155	157	156	152	153	149	150	148	145	155	146	153
Adjusted																
ESRD	377	371	361	361	363	356	354	344	329	323	291	300	290	281	280	270
Dialysis	386	381	372	373	377	370	368	359	345	337	311	320	311	304	303	294
Transplant	186	188	198	204	174	207	184	174	175	177	139	151	138	127	150	116
General Medicare																
Cancer	246	240	228	228	225	215	204	204	190	184	183	180	174	166	169	160
Diabetes	164	158	155	158	151	143	140	134	131	119	120	118	111	112	107	104
CHF	198	193	193	189	184	180	174	168	165	154	155	153	153	152	144	144
CVA/TIA	160	162	157	158	155	151	153	144	141	132	133	129	132	127	120	121
AMI	157	154	149	156	160	148	149	141	140	131	130	135	133	134	127	134

Since 1995, unadjusted mortality among prevalent ESRD patients has fallen 23.7 percent, to 245 deaths per 1,000 patient years. Mortality adjusted for age, gender, race, and comorbidity (defined in the previous year), however, has fallen 28.4 percent, to 270. In the dialysis population, the unadjusted rate has fallen 15.6 percent, to 283, while the adjusted rate is now 23.7 percent lower than in 1995, falling to 294 in 2010. » **Table 5.b;** see page 438 for analytical methods. *January 1 point prevalent ESRD & general Medicare patients age 65 & older. Adj: age/gender/race/comorbidity; ref: ESRD patients, 2005.*

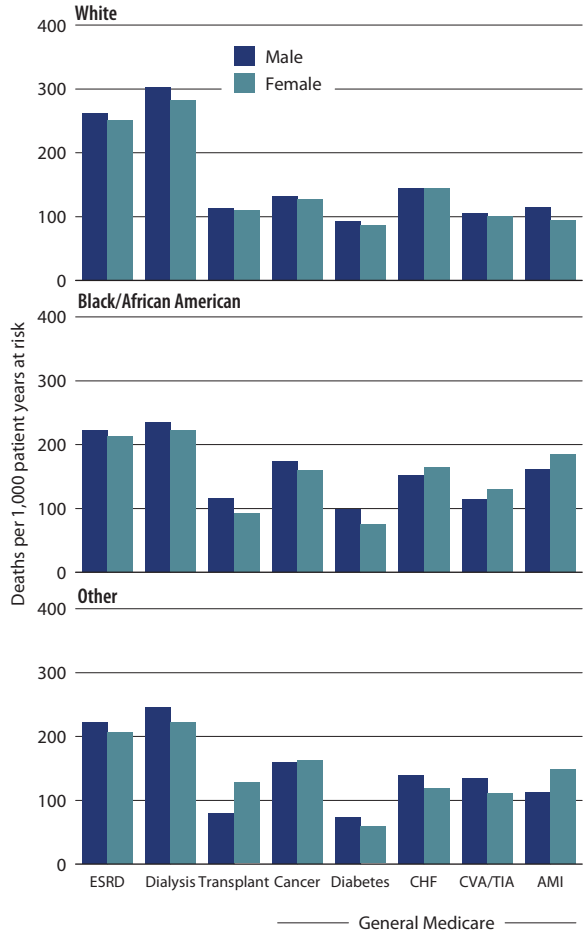
vol 2
5.5

Adjusted all-cause mortality in the ESRD & general populations, by age & gender, 2010



vol 2
5.6

Adjusted all-cause mortality in the ESRD & general populations, by race & gender, 2010



Adjusted rates of mortality in the prevalent ESRD population age 65 and older rise, not surprisingly, by age, are commonly greater in men than in women, and are 2–3 times greater for dialysis patients than for those with a transplant. In the transplant population, rates among patients age 65–79 are lower than rates of mortality among patients with cancer in the general Medicare population.

By race, the contrast in mortality rates between dialysis and transplant patients is even more pronounced. Rates among white and black/African American women on dialysis, for example, are 2.6 and 2.4 times greater than those seen in their counterparts with a transplant. For black/African American transplant patients of both genders, mortality is most often lower than that among patients with cancer, congestive heart failure, or acute myocardial infarction in the general population. » **Figures 5.5–6;** see page 438 for analytical methods. *January 1, 2010, point prevalent ESRD & general Medicare patients age 65 & older. Adj: age/gender/race/comorbidity; ref: 2010 ESRD patients.*

Maintenance hemodialysis is typically delivered three times a week, and concern has emerged that the two-day, or "long," interval may be associated with higher than expected rates of adverse outcomes. To explore this issue, we look here at mortality rates by different days of the hemodialysis week among prevalent adult hemodialysis patients in 2010.

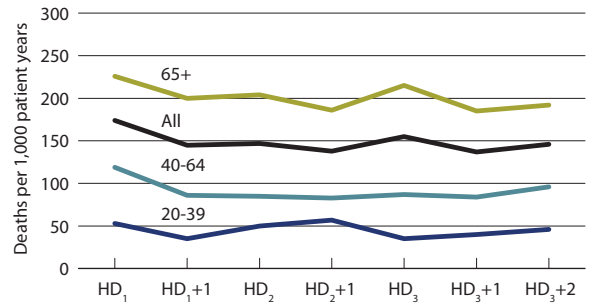
In the framework of the "hemodialysis week," HD_1, for example, is defined as Monday for patients dialyzed on Monday, Wednesday, and Friday (MWF) and as Tuesday for those treated on Tuesday, Thursday, and Saturday (TTS). $HD_3 + 2$, the second day of the long interval, is Sunday for MWS and Monday for TTS.

Mortality rates in the overall population are highest, at 174 per 1,000 patient years, on the day following the long interval (HD1), and a sawtooth pattern is apparent, with rates declining and increasing every two days thereafter. This pattern is replicated in patients age 65 and older, with rates varying between 185 and 226, but some differences are seen in younger age groups.

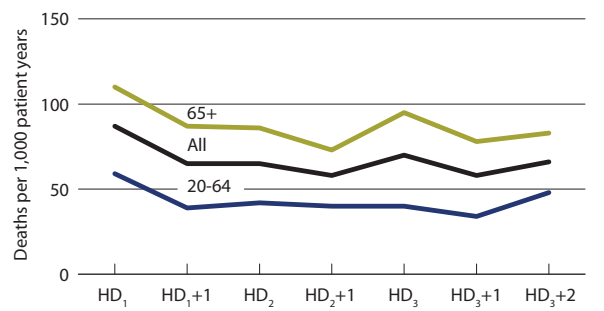
In patients age 20–39, mortality rates are highest on $HD_2 + 1$ (57), lowest on HD_3 (35), and the sawtooth pattern is absent. For ages 40–64, rates are substantially higher on HD_1 (119), stable between $HD_1 + 1$ (86) and $HD_3 + 1$ (84), and intermediate on $HD_3 + 2$ (96).

Figures 5.8 and 5.9 show corresponding analyses for mortality rates attributed to cardiovascular disease and infection. Rates are highest on HD_1 (87) for cardiovascular disease, and on $HD_1 + 1$ (17.7) for infection. » **Figures 5.7–9;** see page 438 for analytical methods. *January 1, 2010 point prevalent Medicare hemodialysis patients alive on January 31. Includes patients age 20 & older receiving hemodialysis three times weekly on a Monday–Wednesday–Friday or Tuesday–Thursday–Saturday schedule; HD_1, HD_2, & HD_3, are the first, second, & third hemodialysis sessions. Rates for all patients are adjusted for age, gender, race, Hispanic ethnicity, & primary diagnosis; rates by age are adjusted for the other four factors. Ref: all included hemodialysis patients in 2010.*

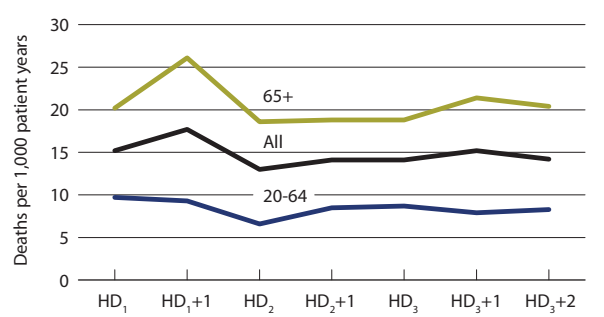
vol 2 **5.7** **Annualized all-cause mortality rates on different days of the dialysis week, by age, 2010**



vol 2 **5.8** **Annualized cardiovascular mortality rates on different days of the dialysis week, by age, 2010**



vol 2 **5.9** **Annualized rates of mortality due to infection on different days of the dialysis week, by age, 2010**



vol 2
5.c **Annualized all-cause mortality rates (per 1,000 patient years) on days after the long & short interdialytic intervals & on days without dialysis, 2010**

	Events on day after long interdialytic interval	Events on day after short interdialytic interval	Events on days without dialysis
All patients	174	151	142
Age: 20-39	53	43	44
40-64	119	86	88
≥65	226	209	191
Male	175	154	141
Female	172	148	143
White	191	169	162
Black/Af Am	147	123	107
Other	130	119	112
Hispanic	127	108	114
Diabetes	193	161	152
Hypertension	168	154	137
Glomerulonephritis	126	125	122
Other	156	132	131
ESRD duration			
< 4 years	155	140	129
≥ 4 years	199	167	159

Day of the dialysis week

HD_1	Monday for patients on a Monday–Wednesday– Friday schedule; Tuesday for patients on a Tuesday–Thursday–Saturday schdule.
HD_1+1	Tuesday or Wednesday for the respective shedules.
HD2	Wednesday or Thursday, respectively.
HD_2+1	Thursday or Friday, respectively.
HD3	Friday or Saturday, respectively.
HD_3+1	Saturday or Sunday, respectively.
HD_3+2	Sunday or Monday, respectively.

Interdialytic intervals

1 Day after long interdialytic interval: Monday for patients with a Monday–Wednesday–Friday dialysis schedule; Tuesday for patients with a Tuesday–Thursday–Saturday dialysis schedule.

2 Day after short interdialytic interval: Wednesday and Friday for patients with a Monday–Wednesday–Friday dialysis schedule; Thursday and Saturday for patients with a Tuesday–Thursday–Saturday dialysis schedule.

3 Days without dialysis: Other respective weekdays.

Here we summarize all-cause mortality rates on three types of days of the hemodialysis week: after the single long interval dialysis day, after the two short interval days, and on the four days without dialysis. Mortality rates in 2010 were 174 for the first category, 151 for the second, and 142 for the third.

Analyses of subgroups defined by age, gender, race, ethnicity, and cause of ESRD show similar patterns except for patients age 20–39 (with rates of 53, 43, and 44 in the three categories) and those age 40–64 (119, 86, and 88). For all subgroups, however, rates are highest on the day after the long interval. » **Table 5.c;** see page 438 for analytical methods. *January 1, 2010 point prevalent Medicare hemodialysis patients alive on January 31. Includes patients age 20 & older receiving hemodialysis three times weekly on a Monday–Wednesday–Friday or Tuesday–Thursday–Saturday schedule. Rates for all patients, & groups by ESRD duration, are adjusted for age, gender, race, Hispanic ethnicity, & primary diagnosis; rates by age, gender, & primary diagnosis are adjusted for the other four factors. Rates by race & ethnicity are adjusted for age, gender, & primary diagnosis. Ref; all included hemodialysis patients in 2010.*

MORTALITY & SURVIVAL

adjusted all-cause first-year mortality (from day 90, per 1,000 patient years at risk; Figure 5.1)

» hemodialysis · 225 » peritoneal dialysis · 125 » transplant · 59

adjusted all-cause fifth-year mortality (from day 90, per 1,000 patient years at risk; Figure 5.1)

» hemodialysis · 236 » peritoneal dialysis · 254 » transplant · 60

adjusted all-cause mortality in the ESRD & general populations, 2010 (per 1,000 patient years at risk; Figure 5.2)

age <20	» ESRD · 27	» dialysis · 51	» transplant · 7.0	» general Medicare · 6.2
age 20–44	· 43.9	· 78.7	· 12.0	· 11.3
age 45–64	· 99	· 148.5	· 28.4	· 22.0
age 65+	· 264	· 304	· 73.4	· 48.1

adjusted all-cause & cause specific mortality from day one in the first year of hemodialysis, 2010 (per 1,000 patient years at risk; Figure 5.3)

month two after initiation	» all-cause · 435	» cardiovascular disease · 169	» infection · 40	
month 12 after initiation	» all-cause · 206	· 78	· 21	

adjusted all-cause mortality in prevalent hemodialysis patients, by vintage, 2010 (per 1,000 patient years at risk; Figure 5.4)

» <2 years · 190 » 2–<5 years · 189 » 5+ years · 222

adjusted five-year survival probabilities among incident ESRD patients, 2010 (from day one; Table 5.a)

» dialysis · 0.35 » hemodialysis · 0.35 » peritoneal dialysis · 0.41 » transplant · 0.73

» age 0–19 · 0.66 » 20–44 · 0.62 » 45–64 · 0.44 » 65–74 · 0.27 » 75+ · 0.14

» male · 0.35 » female · 0.36

» white · 0.32 » black/African American · 0.39 » other race · 0.46

primary diagnosis » diabetes · 0.32 » hypertension · 0.38 » glomerulonephritis · 0.48 » other · 0.34

MORTALITY IN THE GENERAL & ESRD POPULATIONS

mortality rates in prevalent patients age 65 & older, 2010 (per 1,000 patient years at risk; Table 5.b)

unadjusted	» ESRD · 245	» dialysis · 283	» transplant · 77
adjusted for age, gender, race, & comorbidity	» ESRD · 270	» dialysis · 294	» transplant · 116

MORTALITY RATES BY INTERDIALYTIC INTERVAL

annualized all-cause mortality rates on different days of the dialysis week, by age (per 1,000 patient years; Figure 5.7)

day of week HD_1 (Monday or Tuesday)	» all · 174	» 20–39 · 53	» 40–64 · 119	» 65+ · 226
day of week HD_2 (Wednesday or Thursday)	· 147	» 20–39 · 50	· 85	· 204
day of week HD_3 (Friday or Saturday)	· 155	» 20–39 · 35	· 87	· 215