Chapter six

Outcomes: hospitalization & mortality

There is an element of death in life, and I am astonished that one pretends to ignore it: death, whose unpitying presence we experience in each turn of fortune we survive because we must learn how to die slowly. We must learn to die: all of life is in that.

Rainer Maria Rilke, Selected Letters of Rainer Maria Rilke

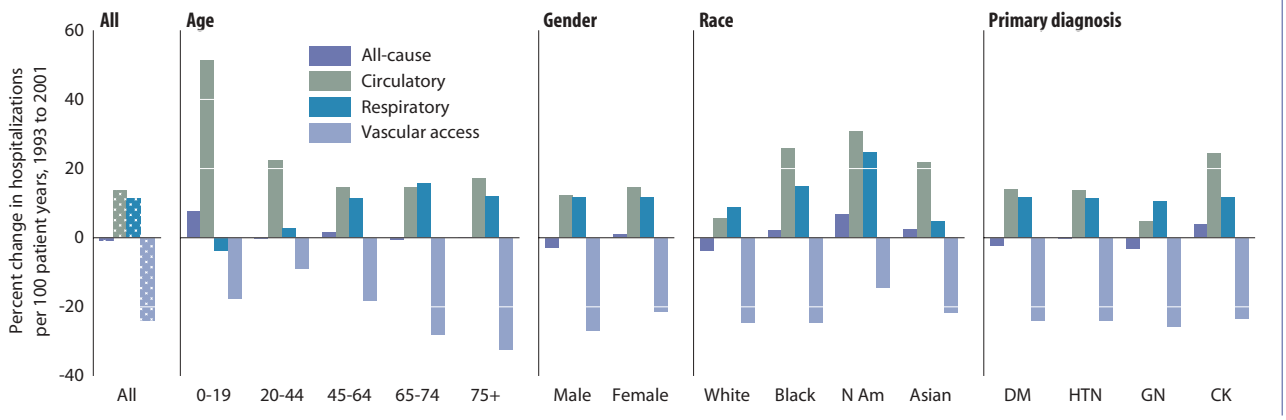
Hospitalizations are the primary manifestation of morbidity through which we can examine the disease burden of patients with ESRD. In this chapter we juxtapose data on hospitalization and mortality, looking at their relation to primary diagnoses, patient vintage, and modality. ■ The graph on this spread shows that all-cause hospitalization rates for prevalent dialysis patients decreased barely 1 percent between 1993 and 2001. Admissions for vascular access did fall 24 percent, but those related to circulatory and respiratory diseases grew 13.5 and 11.5 percent. Circulatory admission rates in children grew 51 percent over the period, a particularly striking increase. This shift from vascular access to circulatory and respiratory hospitalizations has been accompanied by a 15–20 percent reduction in total hospital days per year, a reduction occurring as well in the general Medicare population. ■ Hospitalization rates by dialysis patient vintage have fallen since 1991 for patients with less than two years on the therapy, but have increased for those of longer vintage. With these changes, there is now less difference in rates by vintage than in 1991. This may reflect the decline in rates of hospitalization for vascular access, which is more frequent in newer patients, and the growth in circulatory and respiratory hospitalizations, both associated with longer time on therapy. ■ We show in Chapter Three that incident patients are carrying a greater degree of comorbidity than ever before. Despite this, however, their survival rates—across modalities and primary diagnoses—are improving. In addition, because the survival data shown here are adjusted only for age, gender, race, and primary cause of ESRD, the improvement may be even greater if the disease burden is taken more directly into account. ■ These incident-based analyses provide a simpler picture of trends and progress in the ESRD program than comparisons of overall prevalent mortality, which can be misleading in part because the prevalent dialysis population is comprised of patients who have spent different lengths of time on the therapy. Progress can be clarified, therefore, by incorporating patient vintage into mortality analyses. We present data here showing that, while overall prevalent mortality rates have fallen only 10 percent since 1980, changes by patient vintage have been more dramatic. The mortality rate has fallen 22 percent for patients with less than two years on dialysis, and 15 percent for those on the therapy two to five years. The rate for patients dialyzing five or more years, in contrast, has

CHAPTER HIGHLIGHTS ■ **Figure 6.1** Between 1993 and 2001, overall hospitalization rates fell just 1 percent, while circulatory and respiratory hospitalizations grew 13.5 and 11.5 percent. Hospitalizations for vascular access, in contrast, fell 24.1 percent. ■ **Figure 6.7** Since 1988, mortality rates have fallen 21 percent for patients on dialysis less than two years, while increasing 7 percent for those on the modality five or more years. ■ **Figure 6.18** Since 1989, prevalent mortality rates have declined 8.4 and 6 percent for hemodialysis and peritoneal dialysis, respectively. When vintage is considered, however, rates fell 17 and 28 percent for those on the modality less than two years, while increasing 7 and 15 percent for those on the modality five years or more.

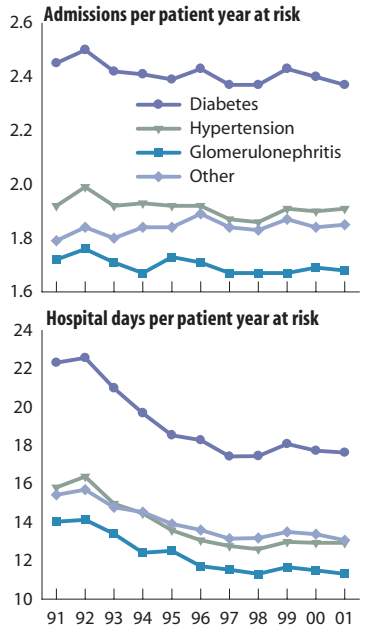
grown 7 percent. ■ The declining mortality rate for the newest patients is consistent with improvements in incident patient survival, while the increased rate for patients of longer vintage suggests that deaths are now occurring later in the course of therapy. These data show the need for greater attention to factors that develop over time, such as calcification with poor mineral balance, lipid disorders, and diabetic and cardiovascular complications. The frequency of ischemic heart disease and congestive heart failure, for example, make sudden death a central problem for the dialysis population. ■ Rates of cause-specific hospitalization and mortality have also been changing significantly. Hospitalizations for infectious complications, for example, have risen during the last eight years, and to a greater extent in females than in males. These increases appear related to vascular access complications. As suggested in an earlier ADR, more frequent use of dialysis catheters is associated with higher infectious hospitalization rates. These catheters may exacerbate the inflammatory state of dialysis patients, raising mortality rates in patients of longer vintage. Though declining death rates in newer patients may reflect improved care, this cannot overcome the markedly increased inflammatory exposure over time due to dialysis catheters and their associated complications, which may also contribute to cardiovascular complications and lipid disorders. ■ This year we give new attention to hospitalizations and mortality related to sepsis, a frequent complication of catheter use in dialysis patients. Rates of hospitalization due to sepsis are up to three times higher in hemodialysis patients than in those on peritoneal dialysis, and since 1991 have risen much more dramatically. This parallels recent increases in catheter use (see Figure 5.19). Mortality rates after a sepsis event are also high, comparable to those seen with myocardial infarction. Particularly striking is the finding that the mortality rate at six months after a diagnosis of septicemia is seven times higher than in patients without such an event, and still 2.6 times higher five years after the event. Sepsis appears to be as powerful a risk factor as a low serum albumin, and the two may in fact be related through inflammatory mediators which influence albumin synthesis. ■ While ESRD patient survival is improving, the observations in this chapter suggest areas for potential quality improvements—reducing the use of dialysis catheters, improving diabetic and cardiovascular care, and addressing abnormalities in mineral metabolism that contribute to cardiovascular morbidity.

6.1 · Percent change in hospitalization rates for prevalent dialysis patients, 1993–2001, by demographic characteristics & diagnosis

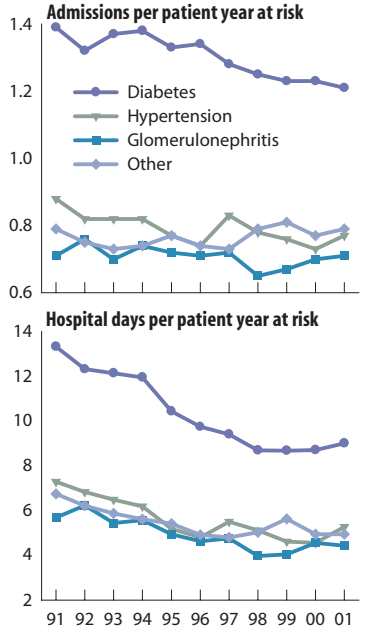
period prevalent dialysis patients; rates for all patients are adjusted for age, gender, race, & primary diagnosis; rates by age are adjusted for gender, race, & primary diagnosis; rates by gender are adjusted for age, race, & primary diagnosis; rates by race are adjusted for age, gender, & primary diagnosis; rates by primary diagnosis are adjusted for age, gender, & race. Direct comparison of adjusted rates is appropriate only within each graph, not between graphs. Dialysis patients, 2001, used as reference cohort.



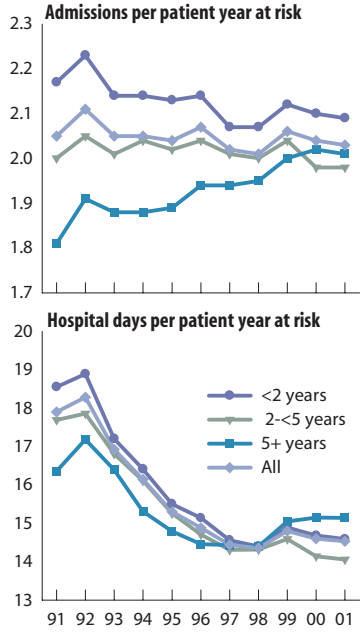
6.2 · Adj. hospital admissions & days: dialysis



6.3 · Adj. hospital admissions & days: transplant



6.4 · Adj. hosp. admits & days, by vintage: dialysis



Overall hospitalization & mortality

Hospital admissions per patient year for dialysis patients are highest in patients with a primary diagnosis of diabetes (Figure 6.2). Overall admission rates have remained relatively constant since 1991. Hospital days per patient year, in contrast, have decreased in the same period, 19 and 21 percent for patients whose ESRD is caused by glomerulonephritis and diabetes, respectively. Admissions and days for transplant patients show similar trends across primary diagnosis groups (Figure 6.3).

Admission rates for patients on dialysis five years or longer increased 11 percent between 1991 and 1998, and hospital days increased in 1999; rates of both admissions and days have since leveled off (Figure 6.4).

Figures 6.5–6 show five-year survival probabilities in two cohorts of incident patients. In both cohorts, transplant patients were more than two times as likely to survive five years than their counterparts on dialysis. Survival probabilities for peritoneal dialysis patients from the earlier cohort were slightly lower than those in hemodialysis patients, but this difference is not apparent in the later cohort. Diabetic patients, regardless of modality, tend to have the lowest five-year survival.

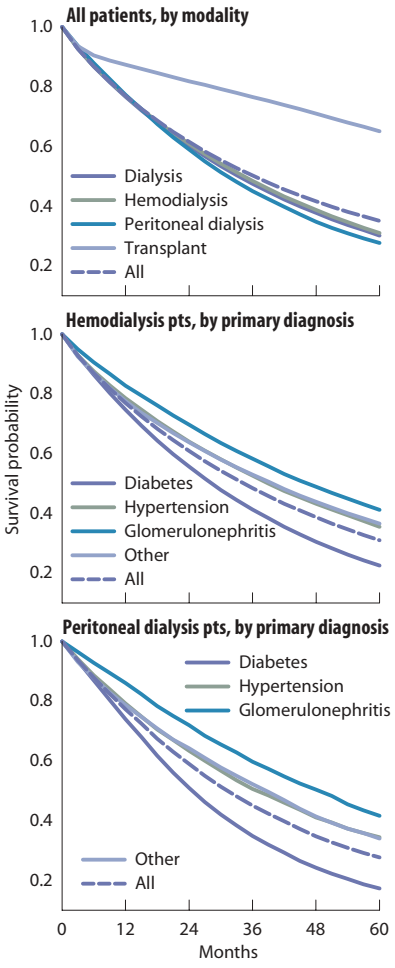
Overall prevalent mortality rates for dialysis patients have fallen 10 percent since 1988 (Figure 6.7). Rates for patients with five or more years on dialysis increased from 1985 to 1988, fell slightly until 1994, and since then have grown 12 percent—from 259 to 291 deaths per 1,000 patient years. For patients with a vintage of less than two years, in contrast, mortality has fallen 23 percent since 1985.

The poor long-term survival of ESRD patients continues to be an area of concern. Expected remaining lifetimes for dialysis patients are only one-third to one-sixth those of the general U.S. population (Table 6.a). Differences are most dramatic for white females, with those on dialysis expected to live only one-fifth to one-sixth as long. The higher survival rate of black ESRD patients is reflected, in contrast, in the slightly smaller difference between their expected lifetimes and those of the general population.

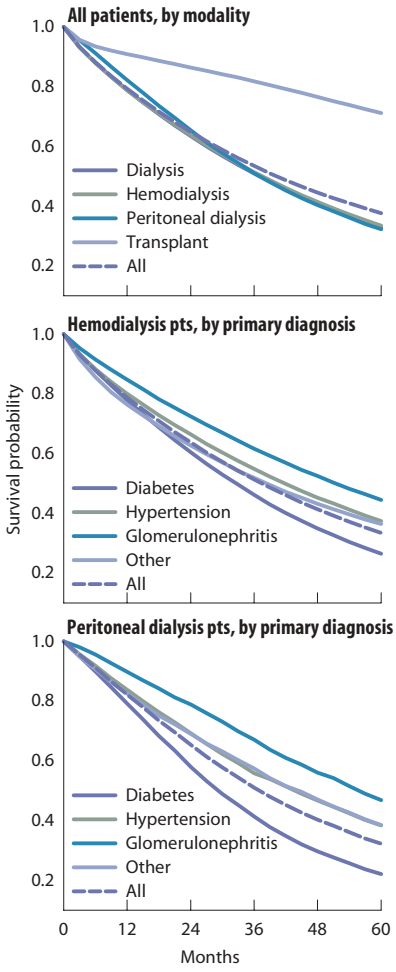
Expected lifetimes for transplant patients are 2–3 times higher than those of patients on dialysis. Here again the greatest differences between the populations are seen among white females, with transplant patients older than 30 expected to live more than three times longer than their counterparts on dialysis. Among black male patients, in contrast, those with transplants are expected to live just twice as long as those on dialysis. Despite the better survival of transplant patients, however, their expected remaining lifetimes are still considerably shorter than those of the general U.S. population.

■ ***Figure 6.2*** *period prevalent dialysis patients; adjusted for age, gender, & race. Dialysis patients, 2001, used as reference cohort.* ■ ***Figure 6.3*** *period prevalent transplant patients; adjusted for age, gender, & race. Transplant patients, 2001, used as reference cohort.* ■ ***Figure 6.4*** *period prevalent dialysis patients; adjusted for age, gender, race, & primary diagnosis. Dialysis patients, 2001, used as reference cohort.* ■ ***Figures 6.5–6*** *incident dialysis patients & patients receiving a first transplant in the calendar year. All probabilities are adjusted for age, gender, & race; overall probabilities are also adjusted for primary diagnosis. All ESRD patients, 1996, used as reference cohort. Modality determined on first ESRD service date; excludes patients transplanted or dying during the first 90 days.* ■ ***Figure 6.7*** *period prevalent dialysis patients; rates adjusted for age, gender, race, & primary diagnosis. Dialysis patients, 2001, used as reference cohort.* ■ ***Table***

6.5 · Adjusted survival: 1987–1991 incident pts



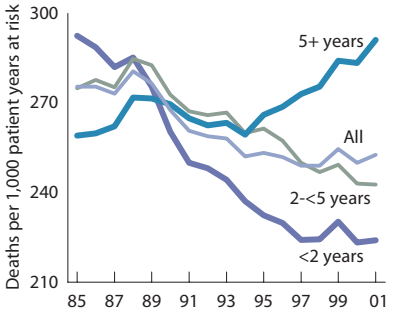
6.6 · Adjusted survival: 1992–1996 incident pts



U.S. data: from the National Vital Statistics Reports, Expectation of Life, 1999, Table A (www.cdc.gov/nchs/data/nvsr/nvsr50/nvsr50_06.pdf; provides information only for whites & blacks). ESRD data: prevalent dialysis & transplant patients, 2001.

■ ***Figures 6.2–3*** *The intention of Figures 2–3 is to provide rates reflective of the age, gender, & racial distributions of the 2001 dialysis & transplant cohort. Because different reference cohorts are used, comparisons of rates between these two figures are not appropriate. See Figure 6.14 or reference tables E.2, E.5, E.8, & E.11 for rates which can be compared between dialysis & transplant.*

6.7 · Adjusted mortality rates, by vintage: dialysis



6.a · Expected remaining lifetimes (years) of the general U.S. population, & of prevalent dialysis & transplant patients

General U.S. population

	All races			White			Black		
Age	All	M	F	All	M	F	All	M	F
0	76.7	73.9	79.4	77.3	74.6	79.9	71.4	67.8	74.7
1	76.3	73.5	78.9	76.8	74.1	79.3	71.5	67.9	74.7
5	72.4	69.6	75.0	72.9	70.2	75.4	67.6	64.1	70.9
10	67.4	64.7	70.1	67.9	65.3	70.5	62.7	59.2	66.0
15	62.5	59.8	65.1	63.0	60.3	65.5	57.8	54.3	61.0
20	57.7	55.0	60.2	58.2	55.6	60.7	53.1	49.6	56.2
25	53.0	50.4	55.4	53.4	50.9	55.8	48.5	45.2	51.4
30	48.2	45.7	50.5	48.6	46.2	50.9	43.9	40.7	46.6
35	43.5	41.1	45.7	43.9	41.5	46.1	39.3	36.3	41.9
40	38.8	36.5	41.0	39.2	36.9	41.3	34.8	31.9	37.4
45	34.3	32.0	36.3	34.6	32.4	36.6	30.6	27.8	33.0
50	29.8	27.7	31.7	30.1	28.0	32.0	26.6	24.0	28.7
55	25.5	23.5	27.3	25.7	23.8	27.5	22.8	20.4	24.7
60	21.5	19.6	23.1	21.6	19.8	23.2	19.3	17.2	20.9
65	17.7	16.1	19.1	17.8	16.1	19.2	16.0	14.3	17.3
70	14.3	12.8	15.4	14.4	12.9	15.5	13.0	11.6	14.0
75	11.2	10.0	12.1	11.2	10.0	12.1	10.4	9.2	11.1
80	8.5	7.5	9.1	8.5	7.5	9.1	8.2	7.3	8.6
85	6.3	5.5	6.6	6.2	5.5	6.6	6.2	5.6	6.5
90	4.6	4.1	4.8	4.5	4.0	4.7	4.8	4.4	4.8
95	3.4	3.0	3.5	3.2	2.9	3.3	3.6	3.5	3.6
100	2.6	2.4	2.7	2.3	2.2	2.4	2.8	2.8	2.7

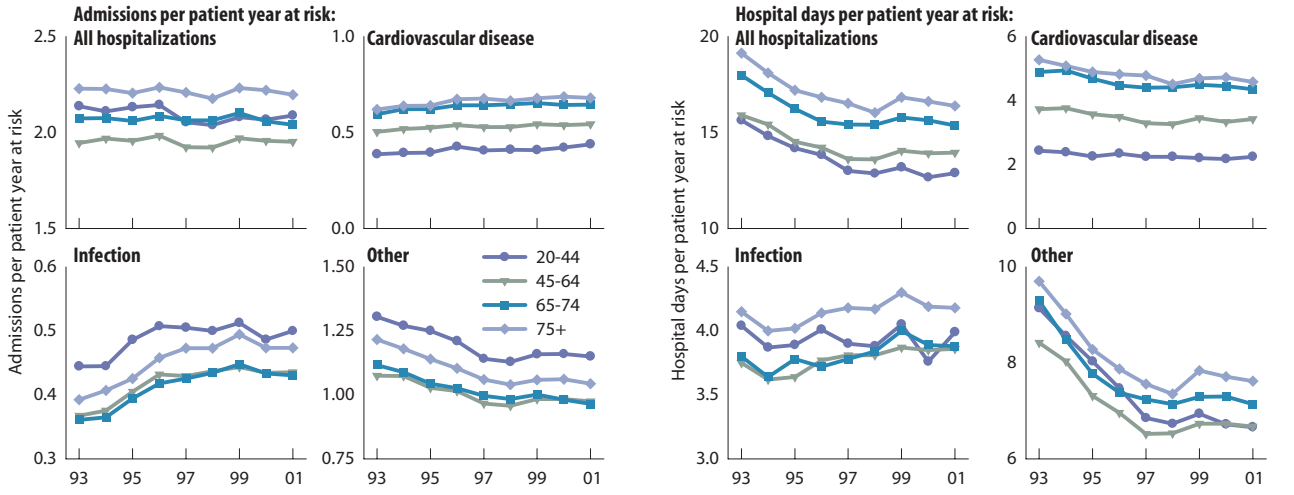
ESRD: Dialysis

	White		Black		N Am		Asian	
Age	M	F	M	F	M	F	M	F
0–14	19.8	18.5	20.1	18.1	22.5	23.0	30.6	29.5
15–19	17.0	15.8	18.4	16.5	18.9	18.7	24.5	24.0
20–24	14.5	13.5	16.2	14.3	15.9	16.0	21.5	21.1
25–29	12.3	11.3	14.2	12.6	13.7	13.6	18.6	18.5
30–34	10.1	9.6	12.3	11.0	11.7	11.7	15.7	15.9
35–39	8.6	8.2	10.7	9.7	9.8	10.0	13.1	13.5
40–44	7.4	7.2	9.3	8.4	8.3	8.6	11.0	11.5
45–49	6.3	6.0	7.7	7.3	7.0	7.3	9.0	9.5
50–54	5.3	5.1	6.7	6.3	6.0	6.5	7.6	8.0
55–59	4.6	4.5	5.6	5.5	5.3	5.4	6.4	6.7
60–64	3.9	3.8	4.7	4.8	4.4	4.7	5.3	5.7
65–69	3.2	3.2	4.0	4.0	3.7	4.0	4.5	4.9
70–74	2.8	2.8	3.4	3.3	3.2	3.4	3.7	4.1
75–79	2.4	2.4	2.8	2.8	2.5	2.8	3.1	3.3
80–84	2.0	2.0	2.3	2.3	2.1	2.3	2.6	2.8
85+	1.7	1.7	1.9	1.9	1.7	1.8	2.0	2.2

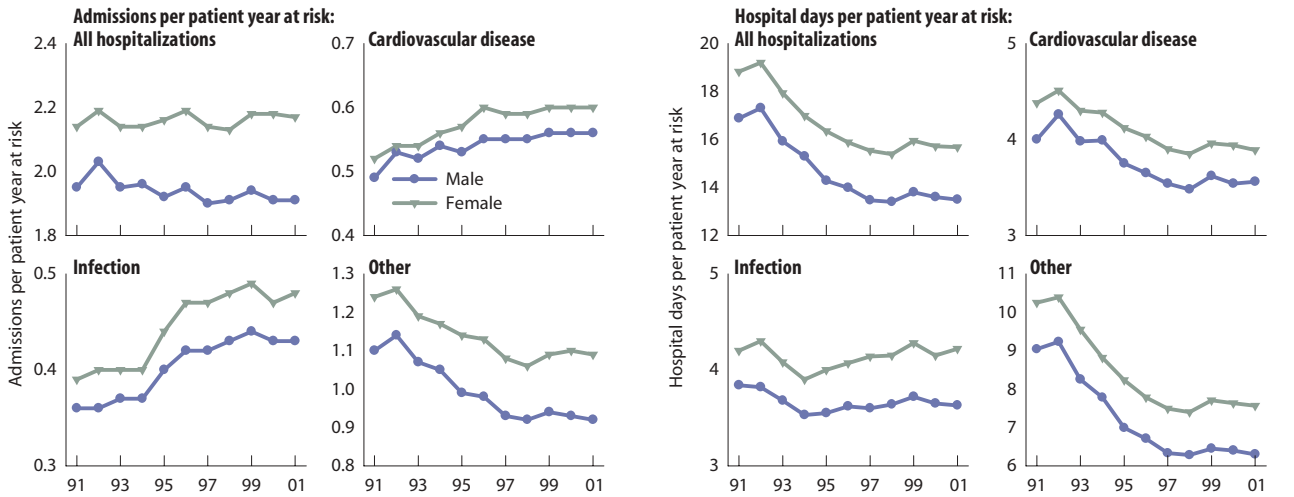
ESRD: Transplant

White		Black		N Am		Asian	
M	F	M	F	M	F	M	F
50.4	51.3	45.9	45.4	49.4	46.1	56.6	57.0
39.2	40.3	36.6	36.4	39.2	36.7	45.4	46.3
35.3	36.5	33.1	33.1	35.4	33.2	41.4	42.5
31.5	32.9	29.7	29.9	31.9	30.0	37.6	38.8
27.5	29.0	26.0	26.5	28.0	26.3	33.5	34.8
24.1	25.7	22.7	23.4	24.5	23.1	29.7	31.3
20.9	22.8	19.7	20.6	21.4	20.3	26.0	27.8
17.9	19.9	16.8	17.8	18.4	17.5	22.6	24.4
15.3	17.4	14.1	15.1	15.7	14.7	19.3	21.1
12.8	15.0	11.7	12.9	13.5	12.8	16.4	18.3
10.6	12.8	9.7	11.1	11.5	10.9	13.9	15.7
8.8	10.9	8.1	9.6	9.9	9.8	11.8	13.7
7.1	9.1	6.6	8.1	8.2	8.4	10.0	12.0
6.1	7.7	5.6	7.3	7.1	8.5	8.9	10.5

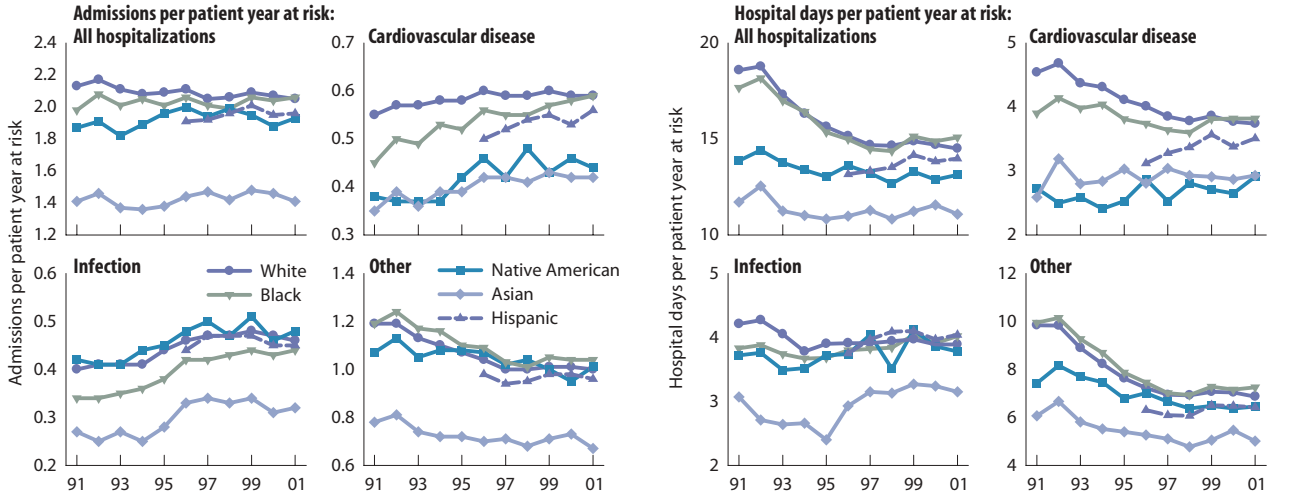
6.8 · Adjusted cause-specific hospital admissions & days, by age: prevalent dialysis patients



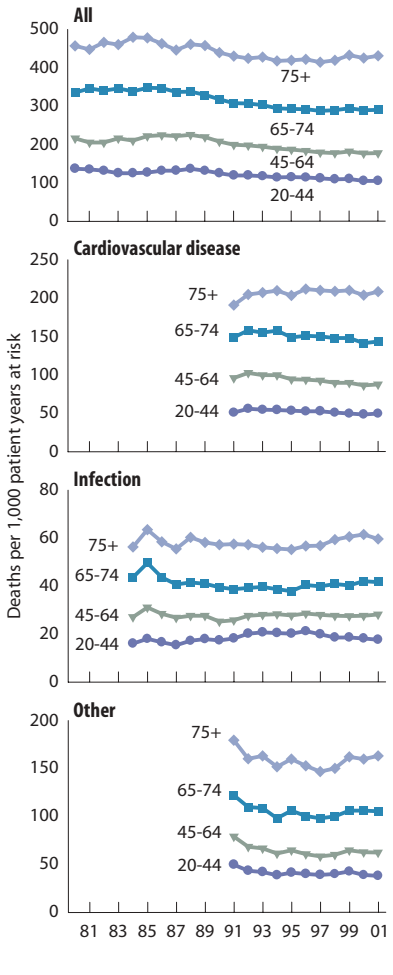
6.9 · Adjusted cause-specific hospital admissions & days, by gender: prevalent dialysis patients



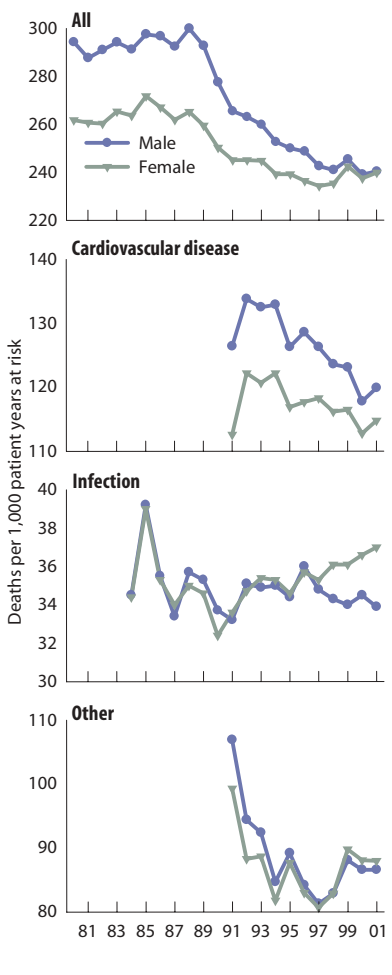
6.10 · Adjusted cause-specific hospital admissions & days, by race/ethnicity: prevalent dialysis patients



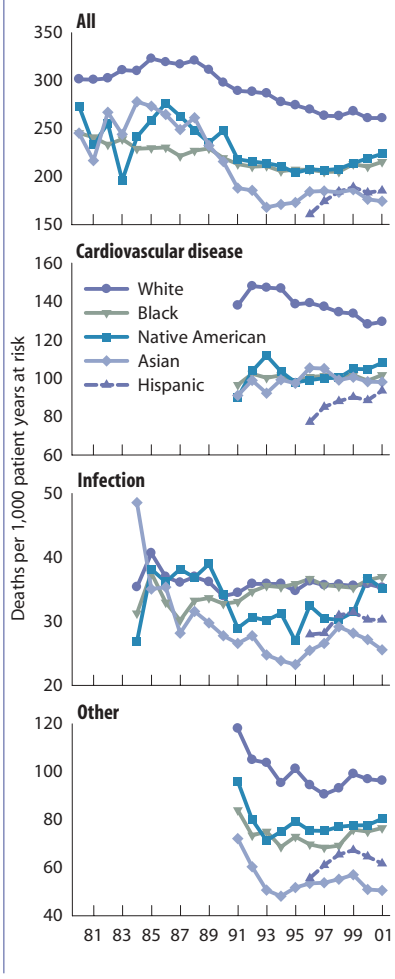
6.11 · Adj. cause-specific mortality, by age: dial.



6.12 · Adj. cause-specific mortality, by gender: dial.



6.13 · Adj. cause-specific mortality, by race/eth.: dial.



Cause-specific hospitalization & mortality

Overall hospital admission rates have remained relatively steady since 1993, while rates of days spent in the hospital have decreased 12–18 percent, depending on patient age (Figure 6.8). Cause-specific admission rates have increased for both cardiovascular and infectious hospitalizations and decreased for other causes, which include vascular access.

Females are more likely to be admitted to the hospital. In 2001 their overall admission rates were 14 percent higher than those of their male counterparts, while their hospital days per year were 16 percent higher (Figure 6.9). Cause-specific rates of admissions and hospital days are higher for females as well.

When comparing rates of admission for cardiovascular and infectious hospitalizations between racial and ethnic groups, blacks and Asians had the highest increases (29–31 and 19–20 percent) from 1991 to 2001, while rates of hospital days for cardiovascular causes increased most in Asians and Hispanics (Figure 6.10).

Since 1980, all-cause mortality rates have fallen slightly for all age groups, with the largest changes occurring in patients age 20–44 and 45–64. As expected, mortality rates rise with increasing age, and they tend to be higher in males than in females. Whites have the highest mortality rates among the racial and ethnic groups (Figures 6.11–13).

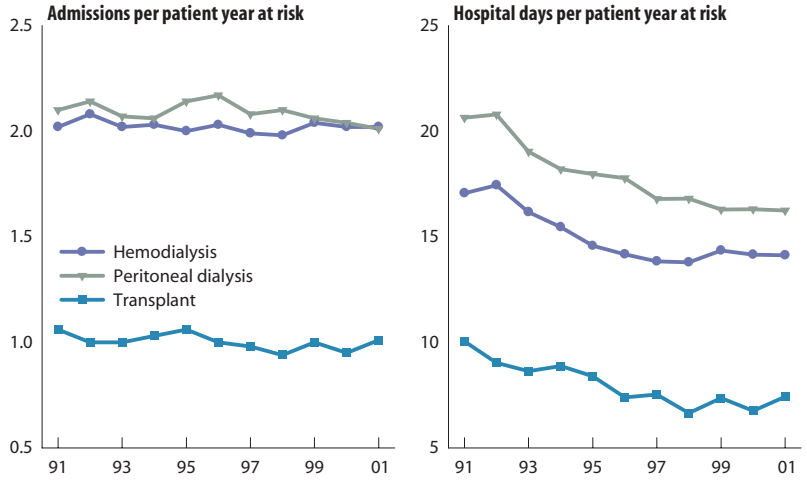
■ ***Figure 6.8*** *period prevalent dialysis patients age 20 & older; adjusted for gender, race, & primary diagnosis.* ■ ***Figure 6.9*** *period prevalent dialysis patients; adjusted for age, race, & primary diagnosis.* ■ ***Figure 6.10*** *period prevalent dialysis patients; adjusted for age, gender, & primary diagnosis. Rates for Hispanic patients are unadjusted.* ■ ***Figures 6.11–13*** *period prevalent dialysis patients; rates by age are adjusted for gender, race, & primary diagnosis; rates by gender are adjusted for age, race, & primary diagnosis; & rates by race are adjusted for age, gender, & primary diagnosis. Rates for Hispanic patients are unadjusted. The Death Notification form was revised in September 1990 to include more detailed categories for cause of death; prior to this time cardiovascular deaths were often classified as being of "other" causes. Because of this, data for cardiovascular & "other" deaths prior to 1991 have been omitted here.*

■ ***All figures*** *dialysis patients, 2001, used as reference cohort.* ■ *For Hispanic patients we present data beginning in 1996, the first full year after the April 1995 introduction of the revised Medical Evidence form, which contains more specific questions on race & ethnicity.*

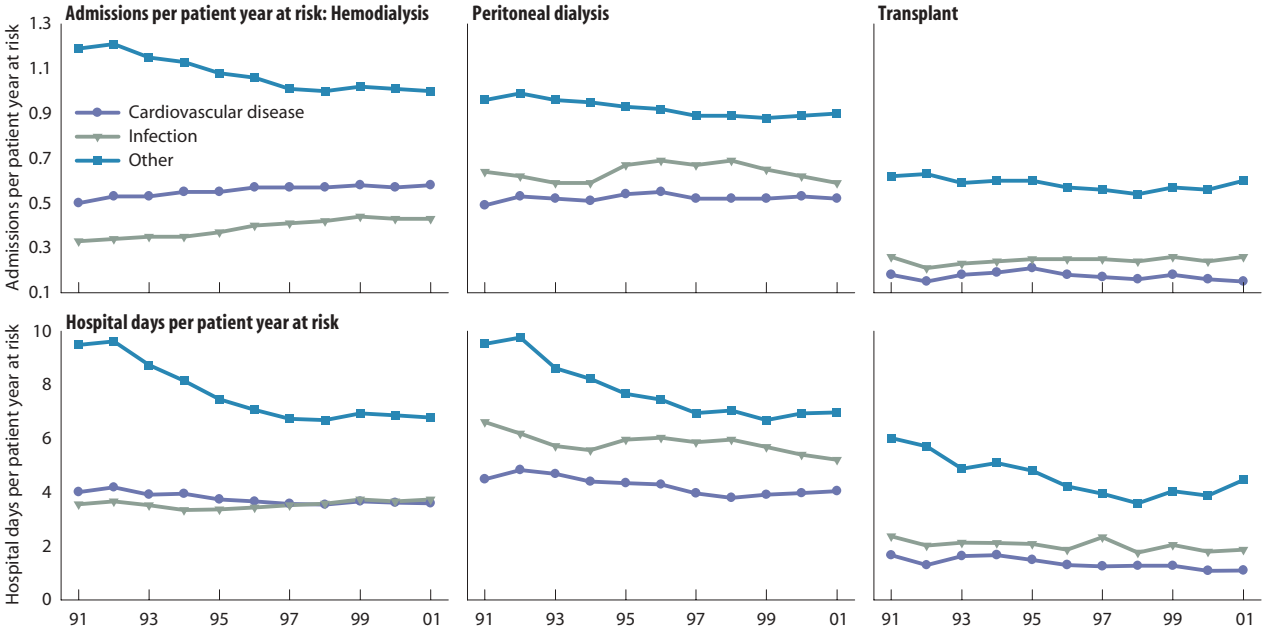
Hospitalization & mortality, by modality

Although the number of admissions per patient year has remained steady since 1991, the number of hospital days has declined 26 percent for transplant patients, and 17 and 21 percent for patients on hemodialysis and peritoneal dialysis (Figure 6.14). Transplant patients spend the fewest days in the hospital each year, and while hemodialysis and peritoneal dialysis patients are admitted with approximately the same frequency, patients on peritoneal dialysis have more hospital days.

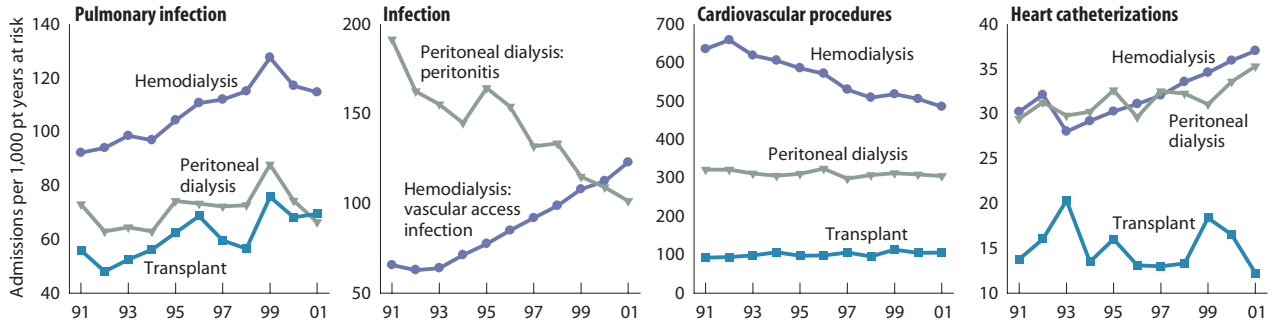
6.14 · Adjusted hospital admissions & days, by modality: prevalent patients



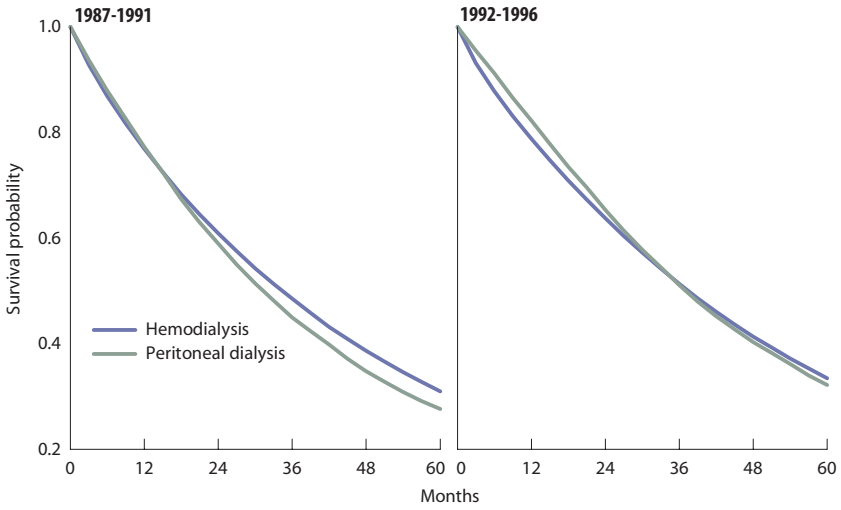
6.15 · Adjusted cause-specific hospital admissions & days, by modality: prevalent patients



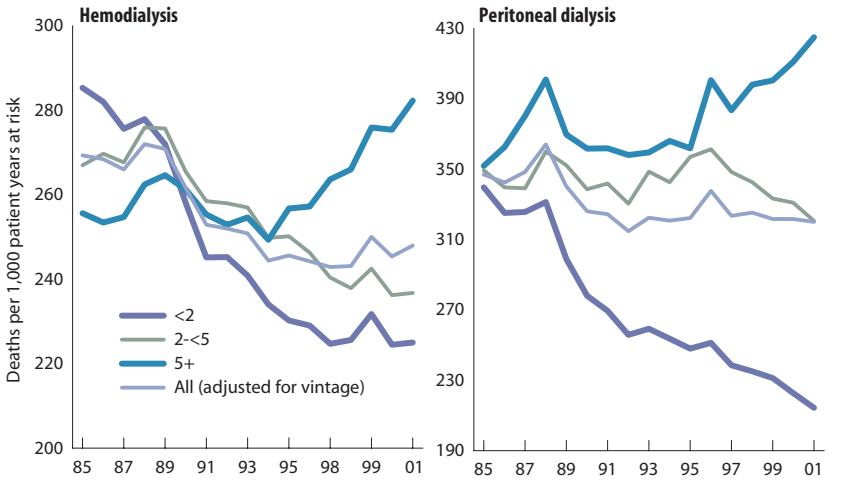
6.16 · Adjusted admissions for principal procedures & diagnoses, by modality: prevalent patients



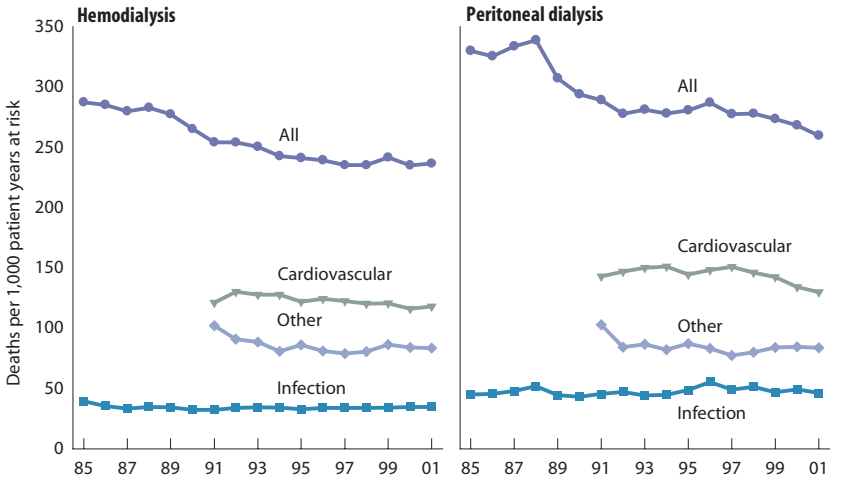
6.17 · Adjusted five-year survival, by modality: incident patients



6.18 · Adjusted all-cause mortality, by patient vintage: prevalent patients



6.19 · Adjusted cause-specific mortality, by modality: prevalent patients



Causes other than cardiovascular disease and infection account for the greatest numbers of admissions and days (Figure 6.15). Among hemodialysis patients, however, admissions per patient year since 1991 have grown 16 percent for cardiovascular disease, and 30 percent for infections.

Admissions for peritonitis in peritoneal dialysis patients have decreased 47 percent since 1991 (Figure 6.16). Those for vascular access infections in hemodialysis patients, however, have nearly doubled. And while admissions for cardiovascular disease have increased for hemodialysis patients, those for cardiovascular/vascular access procedures have dropped 24 percent.

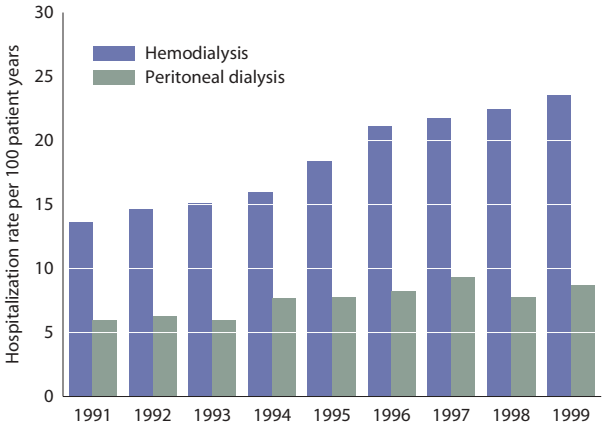
Compared to the 1987–1991 period, five-year survival probabilities for patients incident in 1992–1996 increased slightly—from 31 to 33 percent for hemodialysis patients, and from 28 to 32 percent for peritoneal dialysis (Figure 6.17).

The relation of patient vintage—the length of time a patient has been on ESRD therapy—to mortality has changed significantly since the early 1980s (Figure 6.18). For hemodialysis, longer vintages were first associated with lower mortality rates, and shorter vintages with higher rates. But around 1994 these patterns began to shift. Longer vintages are now associated with steadily increasing mortality rates, while rates are lowest among patients treated on hemodialysis less than two years. For peritoneal dialysis, patients of longer vintages have consistently had the highest mortality rates, and these increased after 1995. Patients in their first two years of therapy have the lowest rates, which have fallen 32 percent since 1984.

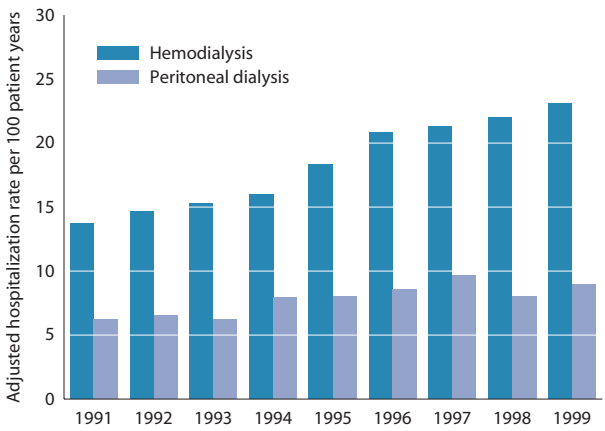
■ ***Figures 6.14–16*** *period prevalent patients; rates adjusted for age, gender, race, & primary diagnosis. ESRD patients, 2001, used as reference cohort.* ■ ***Figure 6.17*** *incident dialysis patients; rates adjusted for age, gender, race, & primary diagnosis. All ESRD patients, 1996, used as reference cohort. Modality determined on first ESRD service date; excludes patients transplanted or dying during the first 90 days.* ■ ***Figures 6.18–19*** *period prevalent dialysis patients; rates adjusted for age, gender, race, & primary diagnosis. Dialysis patients, 2001, used as reference cohort. The Death Notification form was revised in September 1990 to include more detailed categories for cause of death; prior to this time cardiovascular deaths were often classified as being of "other" causes. Because of this, data for cardiovascular & "other" deaths prior to 1991 have been omitted here.*

Overall first-year hospital admission rates for septicemia, by modality

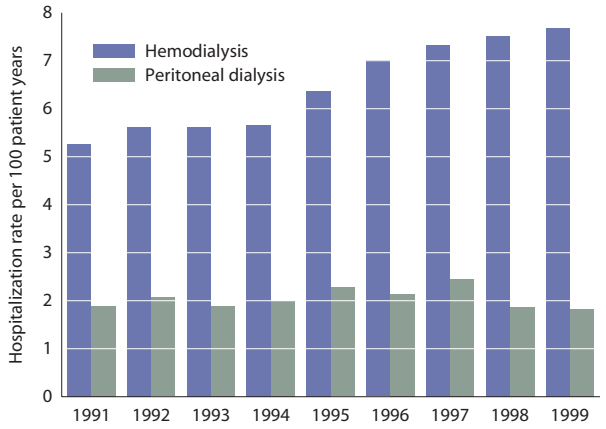
6.20 · raw rates



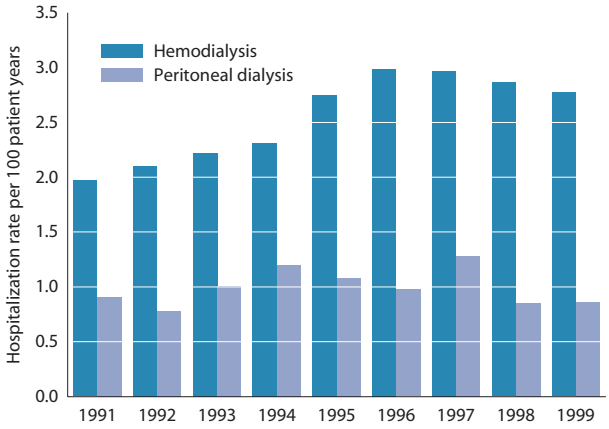
6.21 · adjusted rates



6.22 · Raw first-year first hosp. rates, by modality: staphylococcal organisms



6.23 · Raw first-year first hosp. rates, by modality: gram negative organisms



Sepsis

The ability of dialysis patients to combat infection is impaired by factors including older age, diabetes, and chronic kidney disease itself, and is further complicated by the fact that maintenance dialysis requires access, usually by means of a foreign body. The clinical epidemiology of septicemia in dialysis populations remains poorly defined; available literature does suggest that hemodialysis patients are at greater risk of septicemia than those on peritoneal dialysis. In hemodialysis patients, the lowest rates are seen with native arteriovenous fistulas, followed by synthetic grafts and central venous catheters.

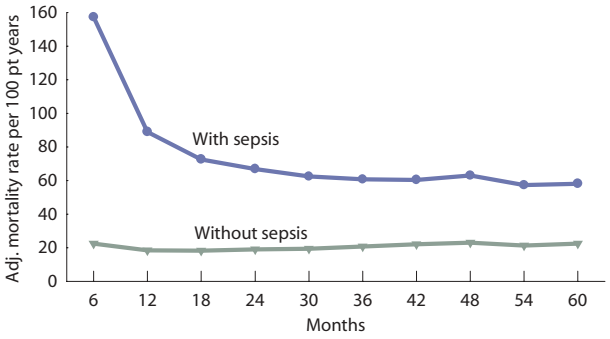
Overall septicemia rates in the first year of dialysis have grown from 13.5 per 100 patient years in 1991 to 23.5 in 1999 (Figures 6.20–21). Increased rates in hemodialysis patients are due more to staphylococcal than gram-negative species (Figures 6.22–23). Far lower rates are seen in peritoneal dialysis patients, in whom rates rose from 1991 to 1997, and then began to drop.

Adjusted rates of mortality after septicemia are high, similar to those seen after myocardial infarction (Figure 6.24). Although mortality rates decrease as time elapses after septicemia, throughout the first five years they remain more than twice those of subjects without septicemia. Septicemia is followed by high rates of cardiovascular disease, with myocardial infarction and congestive heart failure rates climbing rapidly, followed by a partial decline (Figures 6.26–27). On an absolute basis, congestive heart failure is the most frequent cardiovascular event after septicemia.

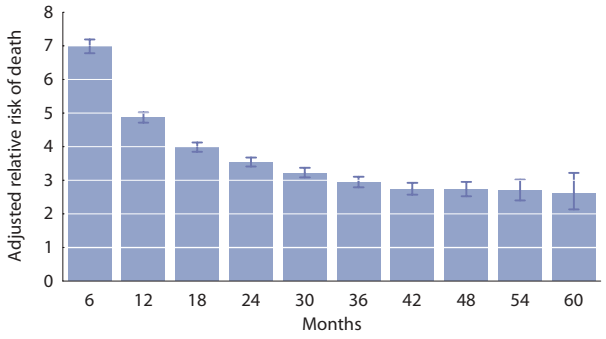
Septicemia could be a marker of poor predialysis care, a rapid fall in renal function, unmeasured comorbidity at dialysis inception, or more severe levels of measured comorbidity; it could also be the result of another life-threatening condition. As such, its adverse prognosis could be a bystander effect. Septicemia is, however, the primary admission diagnosis in approximately half of all admissions that include septicemia. This suggests that a bystander effect cannot fully account for the adverse events seen in this study.

Mortality after first septicemia event

6.24 · Adjusted mortality rates

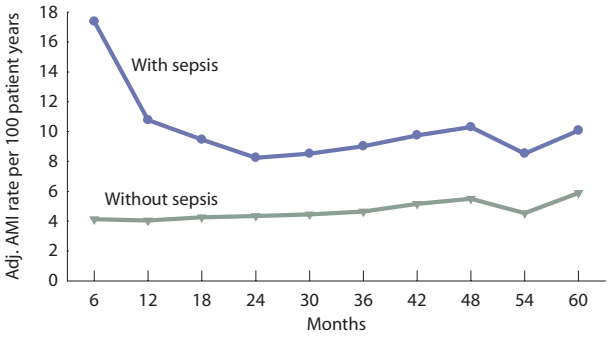


6.25 · Adjusted relative risk of death

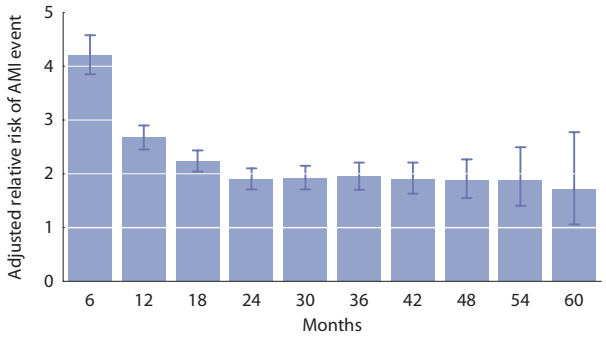


Acute myocardial infarctions after first septicemia event

6.26 · Adjusted AMI event rates

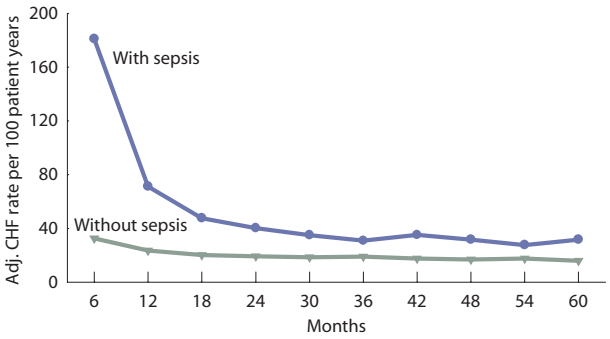


6.27 · Adjusted relative risk of AMI event

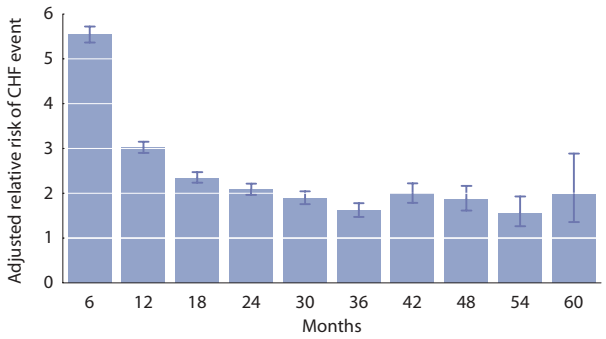


Congestive heart failure after first septicemia event

6.28 · Adjusted CHF event rates



6.29 · Adjusted relative risk of CHF event



Despite these limitations, an event labeled septicemia in this study clearly had grave prognostic connotations. Rising septicemia rates may well have contributed to the recent leveling off in mortality improvements in the U.S. dialysis population. If true, these findings suggest that prevention and treatment of bacterial infections in dialysis patients are important clinical areas for improvement.

■ ***Figures 6.20–23*** *incident dialysis patients with 90-day rule; adjusted rates are adjusted for age, gender, race, & primary diagnosis. Patients with Medicare as a secondary payor or enrolled in an HMO on day 90, & those with septicemia claims overlapping the start date of the followup period, are excluded.* ■ ***Figures 6.24–29*** *incident dialysis patients with 90-day rule, 1996–1999 combined; adjusted for modality, age, gender, race, & primary diagnosis. Patients with Medicare as a secondary payor or enrolled in an HMO on day 90, & those with septicemia, AMI, or CHF claims overlapping the start date of the followup period, are excluded. Reference group: patients without sepsis.*

chapter summary

INTRODUCTION ■ **Figure 6.1** Between 1993 and 2001, overall hospitalization rates declined approximately 1 percent, while circulatory and respiratory hospitalizations increased 13.5 and 11.5 percent. Hospitalizations for vascular access, in contrast, fell 24.1 percent. **OVERALL HOSPITALIZATION & MORTALITY** ■ **Figure 6.2** Between 1991 and 2001, admission rates fell slightly for dialysis patients with a primary diagnosis of diabetes, glomerulonephritis, or hypertension, while the number of hospital days for these patients fell 18–21 percent. ■ **Figure 6.3** Admission rates for transplant patients with a primary diagnosis of diabetes or hypertension fell approximately 13 percent between 1991 and 2001, while the number of hospital days for these patients fell 28–32 percent. ■ **Figure 6.4** Between 1991 and 2001, hospital admission rates increased 11 percent for patients on dialysis for five or more years; the number of hospital days for these patients, however, declined 7 percent. ■ **Figures 6.5–6** Patient survival improved between the 1987–1991 and 1992–1996 incident cohorts—as much as 16.5 percent for all peritoneal dialysis patients, 17.3 percent for diabetic patients on hemodialysis, and 28 percent for diabetic patients on peritoneal dialysis. ■ **Figure 6.7** Since 1988, adjusted mortality rates have fallen 21 percent for patients on dialysis less than two years, while increasing 7 percent for those on the modality five or more years. ■ **Table 6.a** Expected lifetimes for transplant patients are 2–3 times higher than for patients on dialysis. **CAUSE-SPECIFIC HOSPITALIZATION & MORTALITY** ■ **Figures 6.8–10** Rates of cardiovascular admissions have increased slightly since 1991, while those of infectious hospitalization have grown 12–21 percent. Rates for other causes of hospitalization, including vascular access, have declined 9–14 percent. By race, Asian patients have the lowest hospitalization rates and the shortest length of stay. ■ **Figure 6.12** Since 1980, overall prevalent mortality rates have declined 18.3 percent for males, and 8.4 percent for females. ■ **Figure 6.13** Since 1980, mortality rates by race have declined 13.5 percent for whites, 12.3 percent for blacks, 18.2 percent for Native Americans, and 29 percent for Asians, despite the increasing comorbidity and complexity of the dialysis population. **HOSPITALIZATION & MORTALITY, BY MODALITY** ■ **Figure 6.14** Overall hospital admissions for hemodialysis, peritoneal dialysis, and transplant patients have remained relatively constant, while the number of hospital days has declined for patients of all modalities. ■ **Figure 6.15** Since 1991, cardiovascular hospitalization rates have increased 16 percent for patients on hemodialysis, while declining an equal amount for transplant patients. Infectious hospitalization rates grew 30 percent for hemodialysis patients, and declined 8 percent for those on peritoneal dialysis. ■ **Figure 6.16** Between 1991 and 2001 hospitalizations for pulmonary infections increased 24 percent in hemodialysis and transplant patients, while falling 9 percent in those on peritoneal dialysis. Hospitalizations for peritonitis in peritoneal dialysis patients fell 47 percent, but rates for vascular access infections in hemodialysis patients grew 87 percent. ■ **Figure 6.17** Compared to that of the 1987–1991 cohort, five-year survival of patients incident in 1992–1996 improved 6.5 percent for hemodialysis patients, and 14 percent for those on peritoneal dialysis. ■ **Figure 6.18** Since 1989, overall prevalent mortality rates have declined 8.4 and 6 percent for hemodialysis and peritoneal dialysis patients, respectively. When vintage is taken into consideration, however, rates have fallen 17 and 28 percent for those on the modality less than two years, while increasing 7 and 15 percent for those on the modality five years or more. ■ **Figure 6.19** Overall mortality rates between 1985 and 2001, when not adjusted for vintage, fell 18 percent for hemodialysis patients, and 21 percent for those on peritoneal dialysis. **SEPSIS** ■ **Figures 6.20–23** Between 1991 and 1999, adjusted hospitalization rates for septicemia increased 69 percent in hemodialysis patients and 44 percent for those on peritoneal dialysis. Rates of hospitalization for septicemia were 2.2–2.7 times greater in patients on hemodialysis. ■ **Figures 6.24–25** The risk of early mortality is seven times greater in patients with a septicemia hospitalization than in those without, and at five years the risk remains almost 2.5 times greater. ■ **Figures 6.26–27** The risk of acute myocardial infarction following a septic episode is four times greater than for non-septic patients, and at five years this risk remains almost twice as high. ■ **Figures 6.28–29** Congestive heart failure hospitalizations following a septic episode are almost 5.5 times more likely than in non-septic patients, and at five years the risk of heart failure is still almost twice as high.