He was excellent indeed, madam: the king very lately spoke of him admiringly and mourningly: he was skillful enough to have lived still, if knowledge could be set up against mortality.

*William Shakespeare,*

*All’s Well That Ends Well*
Since 1988, first-year death rates for all incident dialysis patients have fallen 38.5%, with the greatest decrease (63.7%) occurring in patients on peritoneal dialysis (fig 8.1). Death rates for transplant patients, consistently much lower than those for patients on dialysis, fell 93% in the same period. Rates have decreased for all age groups of both hemodialysis and peritoneal dialysis patients, with younger patients consistently having lower death rates than their older counterparts. Declines in first-year death rates have been comparable for male and female patients on both modalities—approximately 48% for hemodialysis, and 64% for peritoneal dialysis (figs 8.4–5).

In terms of race, first-year death rates have declined most in Asian patients, 58.3% for hemodialysis and 71.9% for peritoneal dialysis. The rate for white hemodialysis patients shows a slightly higher decline (48%) than that for blacks and Native Americans, 43.1% and 38.8% respectively. This trend is somewhat different for peritoneal patients, however, with the decrease for blacks being 64% compared to 61.7% in whites and 53.9% in Native Americans (figs 8.6–7).

Death rates for diabetics, hypertensive patients, and patients with other renal diseases have begun to converge for hemodialysis patients, but this is not the case for the peritoneal dialysis population, in which diabetics continue to have the highest rates of death (figs 8.8–9). Differences by modality are also apparent in first, second-, and third-to-fifth year death rates (fig 8.10). These patterns suggest that the two dialysis modalities are not proportional to one another over time, a fact that complicates comparisons between them.

The association over time between death rates and hematocrit levels varies by diabetic status (figs 8.16–18). While the death rates decline with higher hematocrits in both diabetics and non-diabetics, they tend to flatten out as hematocrit levels reach 33%. The consistently lower death rates at higher hematocrit levels support the DOQI target range of 33–36%.

In figures 8.1–15 and 8.19–21 data are adjusted for age, race, gender, and/or diabetic status; they are not, however, adjusted for other clinical factors, such as comorbidity and disease severity, which may influence the death rates. Adjustments for these latter factors, however, are made in figures 8.16–18, which show associations between hematocrit and mortality.

Figures 8.22–32 present death rates for prevalent patient cohorts. Since these cohorts consist of patients with varying amounts of time on ESRD and varying modality histories, and are affected as well by the selection bias related to transplantation, the graphs should be interpreted with caution.

Overall, the fall in death rates has been concurrent with improvements in dialysis therapy and anemia treatment, and with changes in membrane use from cuprophane to synthetic membranes (see Chapter Ten).
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Figure 8.1
First-year death rates by modality
incident patients, adjusted for age, gender, race, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.

Reference population: the average 1997 incident patient in each modality.

Figure 8.2
First-year death rates by age group
incident hemodialysis patients, adjusted for gender, race, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.

Reference population: the average 1997 incident hemodialysis patient in each age group.

Figure 8.3
First-year death rates by age group
incident peritoneal dialysis patients, adjusted for gender, race, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.

Reference population: the average 1997 incident peritoneal dialysis patient in each age group.
Figure 8.4
First-year death rates by gender
incident hemodialysis patients, adjusted for age, race, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.
Reference population: the average 1997 incident hemodialysis patient of each gender.

Figure 8.5
First-year death rates by gender
incident peritoneal dialysis patients, adjusted for age, race, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.
Reference population: the average 1997 incident peritoneal dialysis patient of each gender.

Figure 8.6
First-year death rates by race
incident hemodialysis patients, adjusted for age, gender, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.
Reference population: the average 1997 incident hemodialysis patient of each race.
Figure 8.7
First-year death rates by race
incident peritoneal dialysis patients, adjusted for age, gender, & primary diagnosis of diabetes

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.

Reference population: the average 1997 incident peritoneal dialysis patient of each race.

Figure 8.8
First-year death rates by primary diagnosis
incident peritoneal dialysis patients, adjusted for age, gender, & race

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.

Reference population: the average 1997 incident peritoneal dialysis patient of each primary diagnosis.

Figure 8.9
First-year death rates by primary diagnosis
incident hemodialysis patients, adjusted for age, gender, & race

The number of deaths per 100 patient years in 1988, and the percent change in values between 1988 and 1997, are shown in the legend.

Reference population: the average 1997 incident hemodialysis patient of each primary diagnosis.
### Table 8.1

#### Expected remaining lifetimes (years) by race & gender

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<tr>
<th>Age</th>
<th>White</th>
<th>Black</th>
<th>Nat. American</th>
<th>Asian</th>
<th>Transplant</th>
<th>White</th>
<th>Black</th>
<th>Nat. American</th>
<th>Asian</th>
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<td>1.9</td>
<td>1.9</td>
<td>2.1</td>
<td>2.1</td>
</tr>
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</table>


### Figure 8.11

**Five-year survival curves by age group & gender**

Incident dialysis patients, 1993, adjusted for race & primary diagnosis of diabetes

Reference population: the average 1997 incident dialysis patient of the same gender and age group.
Figure 8.12
Five-year survival by race & gender
incident dialysis patients, 1993, adjusted for age & primary diagnosis of diabetes
Reference population: the average 1997 incident dialysis patient of the same gender and race.

Figure 8.13
Five-year survival by primary diagnosis & gender
incident dialysis patients, 1993, adjusted for age & race
Reference population: the average 1997 incident dialysis patient of the same gender and primary diagnosis.

Figure 8.14
Five-year survival by modality & gender
incident dialysis patients, 1993, adjusted for age, race, & primary diagnosis of diabetes
Reference population: the average 1997 incident dialysis patient of the same gender and modality.
Figure 8.15
First-, second-, third-, & fourth-year death rates
per 100 patient years at risk, incident dialysis patients, by state, adjusted for age, gender, race, & primary diagnosis of diabetes

Reference population: the average 1997 incident dialysis patient.
Figure 8.16
Associations between mortality & hematocrit level by years of follow-up
incident dialysis patients, 1993–1996 combined, adjusted for patient characteristics, comorbidity, & severity of disease in the entry period

Figure 8.17
Associations between mortality & hematocrit level by years of follow-up
incident peritoneal dialysis patients, 1993–1996 combined, adjusted for patient characteristics, comorbidity, & severity of disease in the entry period

Figure 8.18
Associations between mortality & hematocrit level by years of follow-up
incident hemodialysis patients, 1993–1996 combined, adjusted for patient characteristics, comorbidity, & severity of disease in the entry period
Figure 8.19
All-cause death rates
per 100 patient years at risk, incident patients, by state, adjusted for age, gender, race, & diabetic status

While all-cause death rates have clearly decreased since 1992, an analysis that includes more detailed adjustments is required to understand the geographic patterns. Death rates are influenced not only by age, gender, race, and diabetic status, but by dialysis therapy, hematocrit level, membrane use, transplant rates, and modality change rates. The complexity of comparing hemodialysis and peritoneal dialysis, particularly over varying lengths of follow-up time, should also be considered. Reference population: the average 1997 incident patient of the same modality.
Figure 8.20
Infectious death rates
per 100 patient years at risk, incident patients, by state, adjusted for age, gender, race, & diabetic status

The distribution of infectious death rates parallels the pattern of insertion rates for central venous catheters (Fig 4.15). Rates of peritonitis and catheter complications should be investigated for their possible contribution to the geographic variation in infectious death rates, as should the effect of recently improved peritoneal dialysis delivery systems (which reduce the risk of contamination) and the differences between CAPD and CCPD. Reference population: the average 1997 incident patient of the same modality.
Figure 8.21
Cardiac death rates
per 100 patient years at risk, incident patients, by state, adjusted for age, gender, race, and diabetic status.

### Table 8.2

<table>
<thead>
<tr>
<th>Cause of Death Category</th>
<th>Deaths per 1000 Patient Years</th>
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<tbody>
<tr>
<td>Acute myocardial infarction</td>
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<tr>
<td>Cardiac arrest, cause unknown</td>
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</tr>
<tr>
<td>Cardiac, other</td>
<td>30</td>
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<tr>
<td>Atherosclerotic heart disease</td>
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<tr>
<td>Cardiac arrhythmia</td>
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<tr>
<td>Cardiomyopathy</td>
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</tr>
<tr>
<td>Pericarditis, including cardiac tamponade</td>
<td>0</td>
</tr>
<tr>
<td>Pulmonary edema due to exogenous fluid</td>
<td>0</td>
</tr>
<tr>
<td>Valvular heart disease</td>
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</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
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</tr>
<tr>
<td>Atherosclerotic heart disease</td>
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</tr>
<tr>
<td>Cardiac arrhythmia</td>
<td>0</td>
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<tr>
<td>Cardiomyopathy</td>
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<tr>
<td>Pericarditis, including cardiac tamponade</td>
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<tr>
<td>Pulmonary edema due to exogenous fluid</td>
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</tr>
<tr>
<td>Valvular heart disease</td>
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</tr>
<tr>
<td>Infection</td>
<td>0</td>
</tr>
<tr>
<td>AIDS</td>
<td>0</td>
</tr>
<tr>
<td>Fungal peritonitis</td>
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</tr>
<tr>
<td>Hepatitis B</td>
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</tr>
<tr>
<td>Infection, other</td>
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</tr>
<tr>
<td>Other viral hepatitis</td>
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</tr>
<tr>
<td>Pulmonary infection, bacterial</td>
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</tr>
<tr>
<td>Pulmonary infection, fungal</td>
<td>0</td>
</tr>
<tr>
<td>Pulmonary infection, other</td>
<td>0</td>
</tr>
</tbody>
</table>

### Figure 8.22

Cause-specific death rates by modality
prevalent diabetic patients aged 20 & older, 1996–1998 combined, unadjusted

### Figure 8.23

Cause-specific death rates by modality
prevalent non-diabetic patients aged 20 & older, 1996–1998 combined, unadjusted

Comparisons of prevalent death rates across modalities should be made with caution, as the rates may be influenced by patient time on ESRD, transplant rates, comorbidity, disease severity, dialysis therapy, and hematocrit level.
Figure 8.24
Cause-specific death rates by race
prevalent male hemodialysis patients aged 20 & older, 1996–1998 combined, unadjusted

Figure 8.25
Cause-specific death rates by race
prevalent female hemodialysis patients aged 20 & older, 1996–1998 combined, unadjusted

Figure 8.26
Cause-specific death rates by race
prevalent male peritoneal dialysis patients aged 20 & older, 1996–1998 combined, unadjusted
Figure 8.27: Cause-specific death rates by race: prevalent female peritoneal dialysis patients aged 20 & older, 1996–1998 combined, unadjusted.

Figure 8.28: Cause-specific death rates by race: prevalent male transplant patients aged 20 & older, 1996–1998 combined, unadjusted.

Figure 8.29: Cause-specific death rates by race: prevalent female transplant patients aged 20 & older, 1996–1998 combined, unadjusted.
Figure 8.30
Cause-specific death rates by age group
prevalent hemodialysis patients, 1996–1998 combined, unadjusted

Figure 8.31
Cause-specific death rates by age group
prevalent peritoneal dialysis patients, 1996–1998 combined, unadjusted

Figure 8.32
Cause-specific death rates by age group
prevalent transplant patients, 1996–1998 combined, unadjusted