And your eyes in the shadowy red room,
scent of the forest entering, various time
calling and the light of wood along the
ceiling and over us birds calling and their circuit
eyes.
And in our bodies the eyes of the dead
and the living
giving us gifts at hand, the glitter of all
their eyes.

Muriel Rukeyser
“Eyes of Night-Time”
The single largest cause of hospitalizations in the U.S. Medicare population is congestive heart failure. CHF is a major cause of morbidity and mortality in elderly patients, and, as we show here, is a key component of cardiovascular morbidity and mortality across the spectrum of renal disease (here including dialysis and transplant patients, and elderly non-ESRD patients with CKD). Figures 9.1–2 show that the incidence and prevalence of CHF in prevalent patients have been fairly constant over the last decade. Prevalent CHF was reported in 48.1 and 55.8 percent of CKD and hemodialysis patients in 2005. It is noteworthy that the prevalence of CHF in prevalent CKD patients actually exceeds that occurring in some ESRD cohorts. As CHF is a powerful independent predictor of mortality in all patient populations, it should be no surprise that CKD patients are also characterized by high rates of mortality. In some respects, the survival characteristics of an elderly CKD population more closely resemble those of ESRD patients than of other elderly patients without renal disease.

Figures 9.3–4 summarize the characteristics of incident and prevalent patients with CHF. In all groups, hypertension is the most common cardiovascular comorbidity. And in each of the prevalent cohorts, more than 50 percent of patients are diabetic, emphasizing the strong known association of diabetes mellitus and CHF in the general population.

We next provide a detailed overview of the likelihood of developing CHF in incident and prevalent patients. The cumulative probability of CHF in the incident population is highest in CKD and hemodialysis patients, at six months reaching 26.8 and 30.3 percent, respectively. At two years it rises to 39.5 percent in CKD patients, and 55.9 percent, 40.8 percent, and 18.2 percent in hemodialysis, peritoneal dialysis, and renal transplant patients. And by three years, approximately two-thirds of incident hemodialysis patients develop CHF.

In each cohort, progressively older age and diabetes are both associated with a higher likelihood of the disease. In the incident peritoneal dialysis population, for example, the three-year probability of CHF is 43.2 percent for non-diabetic patients, but 61.7 percent for those with diabetes. In the prevalent population, the probability of CHF in patients age 20–44 is 41.3 percent for those on hemodialysis and 34.4 percent for those on peritoneal dialysis, but only 10.9 percent for those with a transplant.

In relation to cardiovascular comorbidity, the greatest probability of developing CHF is associated with a history of myocardial infarction—at three years, 60.9 percent for CKD patients, 74.7 percent for those on hemodialysis, and 70.9 and 43.9 percent for those on peritoneal dialysis or with a functioning transplant. Although patients across the spectrum of renal disease are at risk for CHF, those with a history of AMI clearly have a heightened vulnerability. We show similar trends for the prevalent population, though here the overall probability of CHF is greatest for those on hemodialysis—29.4 percent at one year, compared to 20.3 percent for those on peritoneal dialysis, 17.3 percent for those with CKD, and only 5.0 percent in transplant recipients.

Next we examine the diagnostic evaluation of patients and their treatment. One goal of the Cardiovascular Special Studies Center is to moni-
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use in hemodialysis patients with CHF.
The final spread looks back to our chapter in the 2006 ADR, as it focuses on cardiac device therapy: ICDs and CRT-D. As reported previously by the CVSSC, sudden cardiac death is the single largest cause of mortality in dialysis patients, and an important contributor to death in all patients with CKD. In the general population, device therapy has become an increasingly important aspect of the treatment of patients with CHF.

One clinical point of note is the extraordinary difficulty of distinguishing between CHF and circulatory congestion (“volume overload”) in patients with diminished renal function. Particularly in dialysis patients, it can be a Herculean task for practitioners to accurately distinguish between CHF and volume overload, because they may be clinically indistinguishable. Similarly, the accurate identification of dialysis patients with “diastolic heart failure” (versus circulatory congestion) is a daunting challenge.

For the impact of treatment guidelines relating to cardiovascular disease in patients with renal disease. In April, 2005, the National Kidney Foundation published its K/DOQI Clinical Practice Guidelines for Cardiovascular Disease in Dialysis Patients. Guideline 6 recommends that all dialysis patients with diagnosed CHF be evaluated by echocardiography; Guideline 2.1.b recommends evaluation for coronary artery disease in dialysis patients with CHF who are unresponsive to changes in target dry weight. We thus illustrate here trends in the use of echocardiography and evaluation of ischemic heart disease, and look as well at the use of coronary revascularization, cardiovascular medications, and implantable cardioverter defibrillators (ICDs) and cardiac resynchronization therapy + defibrillator (CRT-D).

The fifth spread is a detailed analysis of survival after diagnosis of CHF in both incident and prevalent populations. We focus on temporal trends in one-year survival over more than a decade, and on survival of CHF patients after invasive therapies (coronary revascularization and ICD/CRT-D), and provide a brief overview of a previously unexplored topic, L-carnitine use in hemodialysis patients with CHF.

9.1 Incidence of CHF in prevalent patients point prevalent general Medicare (age 66 & older) & ESRD patients

9.2 Prevalence of CHF in prevalent patients point prevalent general Medicare (age 66 & older) & ESRD patients

figures 9.1–2 CKD: point prevalent general Medicare CKD patients (from the 5 percent sample), age 66 & older & enrolled in Medicare for at least one year; adjusted for age, gender, race, & diabetic status. ESRD: point prevalent ESRD patients with Medicare as primary payer; adjusted for age, gender, race, & dialysis vintage.

figures 9.3–4 Both incident and prevalent patients with CHF frequently have comorbid hypertension and diabetes. figure 9.9 The greatest probability of CHF at one year occurs in diabetic hemodialysis patients. figure 9.40 Between 1991 and 2004, one-year survival of prevalent patients has seen marginal improvement. figure 9.43 Survival of CKD and transplant recipients after percutaneous or surgical coronary revascularization is nearly identical, while outcomes after either procedure are worst for patients on dialysis.
Figures 9.3–4 summarize the characteristics of incident and prevalent CKD and ESRD patients with congestive heart failure (CHF).

Sixty-four and 61 percent, respectively, of incident hemodialysis and peritoneal dialysis patients are age 65 or older, in contrast to the transplant population, in which nearly 72 percent of patients are younger than 65. The incident CKD population studied here is comprised of patients age 66 and older; of these, 73 percent are age 75 and older.

The prevalent dialysis population with CHF tends to be somewhat younger—51 and 44 percent of hemodialysis and peritoneal dialysis patients with CHF, for example, are 65 or older.

In the incident hemodialysis, peritoneal dialysis, and transplant populations with incident CHF, there is a larger proportion of males than of females, at 52.1, 55.2, and 61.0 percent, respectively. In the CKD population, in contrast, the proportion of females is slightly higher, at 52.1 percent. Gender breakdowns in the prevalent populations tend to be similar to those found for incident patients.

Patient distribution by race also differs across populations. Eighty-five percent of incident CKD patients with incident CHF, for instance, are white, compared to just 61.4 percent of...
their counterparts with a transplant, and 64.6 and 77.2 percent of those on hemodialysis and peritoneal dialysis.

More than half the patients in each of the prevalent cohorts have diabetes, emphasizing the strong known association of diabetes mellitus and CHF in the general population. In the incident CKD cohort, however, the proportion of patients with no diabetes is nearly twice that of those with the disease—62.3 versus 37.7 percent.

In all groups of patients, the most common cardiovascular comorbid condition is hypertension, with proportions ranging from 75 to 78 percent and 51 to 89 percent, respectively, in the incident and prevalent cohorts.

Peripheral vascular disease (PVD) is the next most common condition, most evident in incident hemodialysis patients at 45.9 percent. The percent of patients with PVD in the incident CKD, peritoneal dialysis, and transplant cohorts is 27.3, 33.9, and 30.1, respectively.

**Figure 9.3** CKD: incident general Medicare CKD patients (from the 5 percent sample), age 66 & older, & enrolled in Medicare for at least one year; 2003–2005 combined. ESRD: incident Medicare dialysis & first transplant patients with Medicare as primary payor, 2003–2005 combined. **Figure 9.4** CKD: January 1, 2005, point prevalent general Medicare CKD patients (from the 5 percent sample), age 66 & older & enrolled in Medicare for at least one year. ESRD: January 1, 2005, point prevalent ESRD patients.
Probability of CHF in incident patients

Figure 9.5-9.10 CKD: incident general Medicare CKD patients (from the 5 percent sample), age 66 & older, & enrolled in Medicare for at least one year, 2001-2003 combined. ESRD: incident ESRD patients with Medicare as primary payor, age 20 & older, 2001-2003 combined. Patients with CHF at baseline excluded. Overall probabilities unadjusted; in graphs by age, gender, race, & diabetic status, data for one factor adjusted for the remaining three; data by comorbidity adjusted for age, gender, race, & diabetic status.
Probability of CHF in prevalent patients, overall

Probability of CHF in prevalent patients, by age

Probability of CHF in prevalent patients, by gender

Probability of CHF in prevalent patients, by race

Probability of CHF in prevalent patients, by diabetic status

Probability of CHF in prevalent patients, by comorbidity
The use of non-invasive stress tests and invasive coronary angiography in patients with incident congestive heart failure has increased (Figures 9.17–20). In 2004, for example, 26 percent of CKD patients with incident CHF received an evaluation for ischemic heart disease within one year of diagnosis, up from 18.7 percent in 1996; in the hemodialysis population, the percentage rose from 26.3 to 40.7. The lowest rates of testing are those for coronary angiography in CKD patients, a finding likely related to fears of contrast nephropathy as a complication. We suspect that efforts to ameliorate this result will be paralleled by increased use of diagnostic procedures employing radiocontrast media.

Paralleling this increased evaluation for ischemic heart disease is a rising use of coronary revascularization in CHF patients with CKD and ESRD (Figures 9.21–22). Reflecting national trends in the general population, the use of percutaneous versus surgical revascularization has grown. The cumulative percentage of hemodialysis patients receiving PCI in the first three years, for example, has nearly doubled, from 4.4 percent in the 1996 cohort...
to 8.4 percent in 2002 patients, while use of surgical revascularization has grown just from 4.2 to 5.2 percent.

Medicare Current Beneficiary Survey data provide a snapshot of the use of potentially cardioprotective medications in diabetic and non-diabetic beneficiaries (Figure 9.23). The largest changes have occurred in the prescription of ACE-I/s/ARBs and lipid lowering agents to diabetic patients, between 1992 and 2003 rising from 25.9 to 63.3 percent and 11.0 to 51.0 percent, respectively.

As shown in Figure 9.24, the use of cardiac device therapy has increased, but, even in the most recent cohort year of 2004, relatively few patients with CHF and diminished renal function received either ICD or CRT-D devices. In that year, within one year of CHF diagnosis, 1.0 percent of CKD patients, 1.2 percent of hemodialysis patients, 2.1 percent of peritoneal dialysis patients, and 0.7 percent of transplant recipients received an ICD/CRT-D.
Survival after CHF in incident patients, by race

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<th>Transplant</th>
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<tr>
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Survival after CHF in incident patients, overall incident general Medicare (age 66 & older) & ESRD (age 20 & older) patients

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Survival after CHF in incident patients, by age incident general Medicare (age 66 & older) & ESRD (age 20 & older) patients

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Survival after CHF in incident patients, by gender incident general Medicare (age 66 & older) & ESRD (age 20 & older) patients

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Survival after CHF in incident patients, by diabetic status incident general Medicare (age 66 & older) & ESRD (age 20 & older) patients

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<tr>
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Survival after CHF in incident patients, by comorbidity incident general Medicare (age 66 & older) & ESRD (age 20 & older) patients

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<td>PVD</td>
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Survival after diagnosis of CHF in prevalent patients

**Figure 9.31-36** CKD: January 1, 2003 point prevalent general Medicare CKD patients (from the 5 percent sample) with incident CHF; age 66 & older, & enrolled in Medicare for at least one year. ESRD: January 1, 2003 point prevalent Medicare ESRD patients with incident CHF; age 20 & older. Overall probabilities unadjusted; in graphs by age, gender, race, & diabetic status, data for one factor adjusted for the remaining three; data by comorbidity adjusted for age, gender, race, & diabetic status.

**Survival after CHF in prevalent patients, overall** point prevalent general Medicare (age 66 & older) & ESRD (age 20 & older) patients

**Survival after CHF in prevalent patients, by age** point prevalent general Medicare (age 66 & older) & ESRD (age 20 & older) patients

**Survival after CHF in prevalent patients, by gender** point prevalent general Medicare (age 66 & older) & ESRD (age 20 & older) patients

**Survival after CHF in prevalent patients, by comorbidity** point prevalent general Medicare (age 66 & older) & ESRD (age 20 & older) patients

**Survival after CHF in prevalent patients, by diabetic status** point prevalent general Medicare (age 66 & older) & ESRD (age 20 & older) patients

**Survival after CHF in prevalent patients, by diabetic status** point prevalent general Medicare (age 66 & older) & ESRD (age 20 & older) patients
Survival probability

Trends in survival after diagnosis of CHF in incident patients

- CKD
- Hemodialysis
- Peritoneal dialysis
- Transplant

Trends in survival after diagnosis of CHF in prevalent patients

- CKD
- Hemodialysis
- Peritoneal dialysis
- Transplant

Trends in one-year survival after CHF diagnosis in incident patients, by diabetic status

- Diabetic
- Non-diabetic

Trends in one-year survival after CHF diagnosis in prevalent patients, by diabetic status

- Diabetic
- Non-diabetic
Here we document temporal trends in the survival of CHF patients. Despite the development and increased use of new treatments to improve outcomes in these patients, one-year survival has been remarkably stable. In the 1996 and 2003 incident populations, for example, the probabilities of surviving one year were 0.54 and 0.60 for CKD patients, and 0.64 and 0.63 for those on hemodialysis. In the prevalent population, survival probabilities in these years were 0.66 and 0.73 for patients with CKD, and 0.65 and 0.68 for hemodialysis patients. Data do suggest a small improvement in unadjusted survival in CKD patients, peritoneal dialysis patients, and transplant recipients.

Figure 9.43 illustrates the three-year probability of survival after treatment for CHF. Among patients receiving either percutaneous or surgical coronary revascularization, survival is similar for those with CKD and with a functioning transplant, but considerably worse in those on dialysis. At two years, for instance, the probability of survival after percutaneous coronary revascularization is 0.72 for CKD patients, 0.71 for transplant recipients, and just 0.49 for dialysis patients. Comparable probabilities after surgical coronary revascularization are 0.69, 0.70, and 0.51. These adverse outcomes for dialysis patients have been a subject of long-term investigation by the CVSSC. After implantation of ICDs/CRT-D devices, probabilities of two-year survival are 0.73, 0.68, and 0.48; due to small patient cohorts, comparative survival data for CKD and renal transplant patients are not interpretable after 15 months.

Although not FDA-approved for this indication, L-carnitine has been suggested as a possible treatment for CHF in dialysis patients. Use of intravenous L-carnitine in incident CHF patients on hemodialysis has dropped over time, and the unadjusted probability of two-year survival is nearly identical for patients who do and do not receive the medication, at 0.55 and 0.57, respectively (Figures 9.44–45).
implantable cardioverter defibrillators/CRT-Ds: use & survival

Cardiovascular disease, cerebrovascular disease, & coronary revascularization in pts receiving ICDs/CRT-Ds first ICD/CRT-D recipients

Demographics & comorbidity of patients receiving ICDs/CRT-Ds first ICD/CRT-D recipients

In these figures we present new data related to a long-term interest of the CVSSC: implantable cardioverter defibrillators. This year we have included CRT-D therapy with ICD, showing the expanding use of these hybrid devices.

In 1991, only 27 dialysis patients and four transplant patients received an ICD (Figure 9.46; CRT-D devices were developed much later). By 2005, the most recent year for which data are available, the numbers had grown to 1,723 and 123, respectively. In the 1991–2005 period, a total of 6,952 dialysis patients and 562 transplant patients received an ICD or CRT-D. Use of these devices, however, remains low. In 2005, just 0.6 percent of the dialysis population, 0.2 percent of those with a renal transplant, and 0.6 percent of CKD patients received a new ICD or CRT-D device. The largest increase in use has occurred in dialysis and CKD patients, with similar, smaller increases seen in non-CKD patients and transplant recipients.

CHF is the most prevalent comorbid cardiovascular condition in patients receiving device therapy, followed by a history of acute myocardial infarction (Figure 9.47). Approximately 60 percent of dialysis patients receiving device therapy are 65 or older, and, across cohorts, at least 70 percent are male (Figure 9.48). The apparent underutilization of device therapy in women has been documented, in prior publications, in both the general and dialysis populations.

Figures 9.49–52 document the use of stress testing, coronary angiography, and echocardiography in the months prior to implantation of ICD or CRT-D devices. Comparable numbers of patients in each cohort, for example, receive either stress testing or coronary angiography: in the one month prior to implantation, 44.9 percent of CKD patients, and 49.1 percent of those on dialysis. The range is slightly wider for echocardiography, from 47.4 percent of non–CKD patients to 58.1 percent of those with CKD. Looking at patient survival after implantation of these devices, we define secondary prevention as use of the device in patients identified as survivors of cardiac arrest, ventricular fibrillation, or ventricular tachycardia (Figure 9.53). There is essentially no difference in survival for these indications among the non-CKD, dialysis, or renal transplant populations. The two-year survival probability for CKD patients receiving device therapy for primary prevention is 0.66, versus 0.60 for secondary prevention; for dialysis patients, probabilities are 0.40 and 0.39, respectively. These observational data document the expanding use—particularly in dialysis and elderly Medicare beneficiaries with CKD—of implantable cardiac rhythm management devices. Both of these groups, particularly dialysis patients, sustain high mortality even after implantation of these devices. It is imperative that future clinical trials investigate the efficacy of ICD and CRT-D devices in these special, high-risk populations.

Figure 9.46 CKD & non-CKD: prevalent general Medicare patients (from the 5 percent sample), age 66 & older, & enrolled in Medicare for at least one year prior to January 1 of each year, 1993–2005. ESRD: period prevalent patients, age 20 & older, with Medicare as primary payor. Figure 9.47–53 recipients of first ICD/CRT-D during 1996–2005: 66 & older (CKD & non-CKD patients, from the general Medicare 5 percent sample) or 20 & older (ESRD patients) on the date of ICD/CRT-D & with Medicare as primary payor. Survival probabilities are unadjusted. *Age groups for CKD & non-CKD patients: 66–74 & 75+.
Diagnostic testing in each month prior to implantation of ICD/CRT-D

9.49 Stress testing prior to ICD/CRT-D use first ICD/CRT-D recipients

9.50 Coronary angiography prior to ICD/CRT-D use first ICD/CRT-D recipients

9.51 Stress testing/coronary angiography prior to ICD/CRT-D use first ICD/CRT-D recipients

9.52 Echocardiograms prior to ICD/CRT-D use first ICD/CRT-D recipients

9.53 All-cause survival after implantation of ICD/CRT-D first ICD/CRT-D recipients

2007 USRDS Annual Data Report
characteristics of patients with CHF

Across the spectrum of renal disease, both incident and prevalent patients with CHF frequently have comorbid hypertension and diabetes.

probability of CHF in incident & prevalent patients

The probability of CHF in incident patients is greatest at six months for CKD and hemodialysis patients. From 12 to 36 months it remains highest in hemodialysis patients, and is lower but comparable in peritoneal dialysis and CKD patients. The lowest probability is seen in transplant recipients. The greatest probability of CHF at one year occurs in diabetic hemodialysis patients. The probability of CHF is higher in all diabetic subgroups. The probability of CHF in prevalent patients at two years ranges from a high of 0.46 in hemodialysis patients to a low of 0.14 in renal transplant recipients.

diagnosis & treatment of CHF

Between 1996 and 2004 there was a progressive increase in the use of diagnostic testing (stress tests/coronary angiograms) for detection of ischemic heart disease. Use of coronary revascularization has increased over time, but there has been a greater increase in the use of percutaneous compared to surgical coronary revascularization in patients with ESRD. Use of cardioprotective drugs in Medicare beneficiaries has grown over time, particularly that of ACE-Is/ARBs and lipid lowering agents.

survival after diagnosis of CHF

The 18-month survival probability among incident hemodialysis, peritoneal dialysis, and CKD patients is comparable after the onset of CHF, at approximately 0.53 versus 0.87 for renal transplant recipients. In the prevalent population, the probability of two-year survival after a diagnosis of CHF is 0.69 for renal transplant recipients, 0.59 for CKD patients, 0.49 for hemodialysis patients, and 0.39 for patients on peritoneal dialysis.

survival after diagnosis & treatment of CHF; L-carnitine

Between 1991 and 2004, there was marginal improvement in one-year survival of prevalent patients. Survival of CKD and transplant patients after percutaneous or surgical coronary revascularization is nearly identical, while outcomes after either procedure are worst for patients on dialysis. The unadjusted survival of hemodialysis patients with CHF does not differ with L-carnitine use.

ICD's/CRT-Ds: use & survival

The largest proportional increase in the use of implantable cardioverter defibrillators or CRT-D devices has occurred in dialysis and CKD patients. Survival of non-CKD, dialysis and transplant patients is similar for primary or secondary indications of ICD/CRT-D use. In CKD patients, however, there is slightly better survival for patients receiving device therapy for primary versus secondary prevention.