A scab is a beautiful thing—a coin
the body has minted, with an invisible motto:
In God We Trust.
Our body loves us,
and, even while the spirit drifts dreaming,
works at mending the damage we do.
JOHN UPDIKE, “Ode to Healing”

Chapter Six
morbidity & hospitalization
Morbidity sustained by ESRD patients has typically been assessed by characterizing all-cause and cause-specific hospitalization rates as well as rates for events such as acute myocardial infarction and revascularization. Since it is rarely possible to obtain comparison data on other populations, the magnitude of ESRD patient morbidity has been difficult to put into perspective. Further complicating any possible comparisons is the relative complexity of the ESRD population, since ESRD patients are frequently disabled because of their disease. Geographic variations in hospitalization rates and in local aspects of care delivery should also be considered.

To meet these challenges of comparing hospitalization rates in different populations, we have used the five percent general Medicare claims data set, which is available to researchers. This dataset provides information on a national level, and contains data on patients age 65 or older, who make up almost 47 percent of the ESRD population. In addition, the general Medicare data also contain information on the disabled population younger than 65, allowing us to provide perspective on younger ESRD patients.

Analyses of these populations do not, however, take into consideration the burden of comorbidity in the dialysis population. People carrying a diagnosis of chronic kidney disease constitute an important comparative group. Since the publication of the guidelines for the National Kidney Foundation’s Kidney Disease Outcomes Quality Initiative (K/DOQI), it has been estimated that almost 20 million Americans have some degree of chronic kidney damage. Because few health plans have information on kidney function linked to their event data, this population has been difficult to study. We have developed a diagnosis coding method to define, in the general Medicare data, patients with a diagnosis of chronic kidney disease, which appears to represent an estimated glomerular filtration rate of 32.1 ml/min (see Figures p.18–25 in the Précis), or Stage 3–4 kidney disease as defined by the NKF. We use this population as a comparison group throughout this chapter.

We first address trends, by diabetic status and modality, in hospitalization rates and major procedures. Hospitalization rates in peritoneal dialysis patients are higher than in hemodialysis patients, while transplanted patients have the lowest rates, due in part to their younger age and the nature of the kidney function replacement. We also provide information on vascular access procedures, infectious complications, and cardiovascular complications.

In the spread on high- and low-risk patient populations we compare admissions in the general Medicare population—for patients with and without chronic kidney disease—to those of patients on dialysis. While the majority of these analyses are restricted to patients age 65 and older, we have included a comparison of the younger disabled populations and their counterparts on dialysis. The likelihood of hospitalization is, as expected, highly influenced by patient characteristics, as well as by other anthropometric and biochemical data available at the initiation of dialysis. On all levels, patients without chronic kidney disease have admission rates that are one-fourth to one-fifth those of the dialysis population. Individuals with a diagnosis of chronic kidney disease have rates that are about half those of the dialysis population.

For this year’s chapters on hospitalization and mortality (Chapters Six and Nine) we have developed several parallel spreads to investigate the predictive value of Medical Evidence form data in terms of the likelihood of first hospitalization and death. To produce comparative data, we use separate Cox regression models to illustrate interactions. Analyses of the impact of anemia and dialysis therapy on the risk of hospitalization use cohorts of incident patients who survive nine months, with characterization of patient comorbidity, dialysis therapy, and hemoglobin levels during the entry period for months four to nine. The models for diabetics versus non-diabetics, males versus females, and whites versus black are shown in order to assess the predictors within each group. For some patient characteristics the relative risks appear to have similar relationships within groups (e.g. age, comorbidity and severity of disease). For others, such as body mass index and dialysis therapy, the relative risks within groups are not as consistent, suggesting that interactions may play an important role. The interaction models shown allow comparisons across groups by presenting the data as adjusted death rates. These models include relationships between body mass index, dialysis therapy, diabetic status, and race/ethnicity.

On the final spread we look at hospitalization patterns in patients with less common diseases, providing data on
hospital admissions and hospital days per patient year compared to those in the overall ESRD population.

In preceding chapters we have presented information showing the increasing complexity of ESRD patients entering treatment during the last twenty years. In this context, the relative stability of the adjusted admission rates in the last decade is remarkable (Figure 6.1). Since 1991, hospitalization rates per 1,000 patient years have remained relatively constant, even when these rates are adjusted for age, gender, race, and diabetic status. This stability suggests that the population’s increasing complexity, not addressed in this analysis, has not been manifested in higher hospitalization rates, which would have been expected based on the increasing disease burden. Factors offsetting the expected increase in hospitalization rates may include improved dialysis therapy and anemia correction. More detailed evaluations are needed to determine the associations between improved therapy under current practice guidelines and adjusted hospitalization rates over time.

Figure 6.2 illustrates the age distribution, diabetic status, and hospitalization rate of general Medicare patients. Although these patients are age 65 and older, their hospitalization rates are only a quarter of those in ESRD patients of all ages.
In the past five years, hospital days per admission have remained constant for hemodialysis patients (Figure 6.3). The length of stay for peritoneal dialysis patients is one to 1.5 days higher, has declined slightly for both peritoneal dialysis and transplant patients. Hospital days per patient year at risk are also highest for patients on peritoneal dialysis (Figure 6.4).

In terms of racial and ethnic differences, blacks tend to have the highest number of hospital days per admission and per patient year in the peritoneal dialysis and transplant populations, while whites have the greatest number of days among hemodialysis patients. The converging of rates for blacks and whites on hemodialysis after 1999 may be partially explained by changes in the selection of patients for peritoneal dialysis and by technological advances in peritoneal dialysis therapies.

Hospitalization rates for peritoneal dialysis catheter complications are highest for diabetic patients, and rates for infection (overall) are higher in peritoneal dialysis than in hemodialysis patients, regardless of diabetic status (Figures 6.7–8). In contrast, heart catheterization rates for diabetic females age 65–74 and on peritoneal dialysis, are 44 percent lower than for their counterparts on hemodialysis. Such results should be examined in light of previous studies showing that diabetic females age 65 or older and on peritoneal dialysis have higher death rates than do similar patients treated with hemodialysis.

Figures 6.3–4 period prevalent patients. Figures 6.5–6 period prevalent patients, 1998–2000 combined. Figure 6.7 period prevalent hemodialysis patients, 2000. Inpatient hospitalization claims data are obtained from Part A institutional claims. ICD-9-CM codes are as follows: for vascular access procedures, 38.95, 39.27, 39.42, 39.43, 39.93, & 39.94; for infection, vascular access, 996.62; for cardiovascular procedures overall, all codes between 35 & 40, excluding those for vascular access procedures & excluding 39.95 for heart catheterization, 37.21, 37.22, & 37.23; for amputation, 84–84.19, 21.4, 64.3, 67.4, 71.4, 77.59, & 84.91. Diagnosis codes for infection (overall) are provided in Appendix A. Figure 6.8 period prevalent peritoneal dialysis patients, 2000. Inpatient hospitalization claims data are obtained from Part A institutional claims. Principal ICD-9-CM procedure codes identical to those used in Figure 6.7 are used to determine occurrences of overall cardiovascular procedures, heart catheterizations, & amputations. Diagnosis codes are used to determine diagnoses classified as overall infection, peritonitis, or catheter complications. Peritonitis is noted by an ICD-9-CM diagnosis code of 567.2 or 567.9, while catheter complications are determined by an ICD-9-CM diagnosis code of 996.56, 996.62, 996.68, or 996.73. Diagnosis codes for infection overall are provided in Appendix A.
6.7 - Principal procedures & diagnoses, by age & gender: hemodialysis

- Vascular access procedures (mean rate for all patients: 202)
- Infections, overall (mean rate for all patients: 422)
- Infections, vascular access (mean rate for all patients: 110)
- Cardiovascular procedures, overall (mean rate for all patients: 299)
- Heart catheterizations (mean rate for all patients: 36)
- Amputations (mean rate for all patients: 64)

6.8 - Principal procedures & diagnoses, by age & gender: peritoneal dialysis

- Catheter complications (mean rate for all patients: 294)
- Infections, overall (mean rate for all patients: 586)
- Infections, peritonitis (mean rate for all patients: 105)
- Cardiovascular procedures, overall (mean rate for all patients: 183)
- Heart catheterizations (mean rate for all patients: 32)
- Amputations (mean rate for all patients: 61)
Hospitalization rates per 1,000 patient years at risk are highest in diabetic patients, and lowest in those with cystic kidney disease or other congenital diseases (Figure 6.9).

In Figure 6.10 we compare hospitalization rates for patients age 65 and older: general Medicare patients without chronic kidney disease (CKD), those with the disease, and dialysis patients. Across each of the age groups shown, rates of hospitalization for congestive heart failure, ischemic heart disease, and other cardiovascular diseases are between four and eight times higher in the dialysis population.

In the general Medicare population the highest hospitalization rates are clustered in the south and Gulf Coast areas of the U.S., while in the dialysis population higher rates are also seen in the western and northeastern states (Figure 6.11). Note that even the highest rates (442+) in the general population map are within the lowest quintile (below 1,698) for the map showing dialysis patient admissions.

Figures 6.12–15 show that higher hospitalization rates for patients on dialysis, compared to general Medicare patients, are consistent regardless of diabetic status, gender, age, and race/ethnicity.

Hospitalization rates for general Medicare patients carrying a diagnosis of chronic kidney disease are more than twice those of patients without the disease. And since the CKD population is more than ten times larger than the population with ESRD, the care of these patients within the general Medicare system clearly requires considerable resources.

Figure 6.9 prevalent dialysis patients age 65 & older, 1999, unadjusted. Figure 6.10 prevalent patients age 65 & older, 1999. Figure 6.11 admissions per 1,000 patient years at risk, prevalent patients age 65 & older, 1999, by HSA. Figures 6.12–13 prevalent patients age 65 & older, 1999. Figure 6.14 prevalent patients 1999. Figure 6.15 prevalent patients age 65 & older, 1999.
6.12 - by diabetic status, patients age 65 & older

6.13 - by gender, patients age 65 & older

6.14 - by age

6.15 - by race/ethnicity, patients age 65 & older
Since 1995 all providers have been required to complete the Medical Evidence form (2728) for each patient. This form includes information on patient age, gender, race, comorbidity, height, weight, serum albumin, and serum creatinine. Using the 1998–1999 incident cohort, we looked at this information to find predictors of the first hospitalization after the initiation of dialysis. We calculated body mass index from the height and weight on the Medical Evidence form, and estimated the glomerular filtration rate using the MDRD formula. Select comorbid conditions and activity level variables on the Medical Evidence form are included in the models for Table 6.a. We also developed a two-way interaction model, which is used to produce the adjusted hospitalization rates in the figures.

Predictors of first hospitalization are presented in Table 6.a, for which we have run separate main effects models for diabetics and non-diabetics. After adjustments for severity of disease, body mass index, estimated glomerular filtration rate, and serum albumin, age has less of an impact on overall morbidity. Because older patients are more likely to have greater comorbidity, to start dialysis with higher estimated glomerular filtration rates, and to have higher body mass indices, these adjustments decrease the effect of age on the risk of hospitalization.

Patients with higher eGFRs have higher risks of first hospitalization. Compared to eGFRs less than five ml/min, for instance, ratios of seven ml/min and above are associated with risks 14–20 percent higher in diabetic patients, and 11–26 percent higher in non-diabetics. These trends are present in both genders and across racial/ethnic groups (Figure 6.17), and are consistent with the increased comorbidity seen in patients with higher eGFRs (see Figures 2.29–34).

The higher risk of first hospitalization with increasing eGFR levels suggests that the greater comorbidity associated with higher eGFRs confounds the analysis. As shown in Chapter Two (Figures 2.30–31), there is a clear relationship between eGFR at the initiation of dialysis and increasing comorbidity, suggesting that more complicated patients start dialysis earlier. Higher hospitalization rates after initiation are consistent with this selection bias.

The influence of BMI on the risk of first hospitalization is significant (Figure 6.18 & Table 6.a). Compared to patients with a BMI at initiation of 20–<25 kg/m², patients with a BMI less than 20 have an 8–9 percent higher risk of hospitalization, while the risk decreases for non-diabetic patients with a BMI of 25–<30 and for dia-

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### Table 6.a - Relative risk of first hospitalization (with 95% confidence interval)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Diabetic</th>
<th>Non-diabetic</th>
<th>Diabetic</th>
<th>Non-diabetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>eGFR (ml/min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–&lt;7</td>
<td>1.06 (1.00, 1.13)</td>
<td>1.04 (1.00, 1.09)</td>
<td>1.06 (1.10, 1.14)</td>
<td>1.10 (1.07, 1.14)</td>
</tr>
<tr>
<td>7–&lt;10</td>
<td>1.14 (1.07, 1.20)*</td>
<td>1.11 (1.06, 1.16)*</td>
<td>1.14 (1.11, 1.18)*</td>
<td>1.14 (1.11, 1.18)*</td>
</tr>
<tr>
<td>10–</td>
<td>1.20 (1.14, 1.27)*</td>
<td>1.26 (1.20, 1.32)*</td>
<td>1.20 (1.14, 1.27)*</td>
<td>1.20 (1.14, 1.27)*</td>
</tr>
<tr>
<td>Albumin</td>
<td>0.85 (0.83, 0.87)*</td>
<td>0.85 (0.83, 0.87)*</td>
<td>0.85 (0.83, 0.87)*</td>
<td>0.85 (0.83, 0.87)*</td>
</tr>
</tbody>
</table>

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### Figure 6.17 - Hospitalization rates, by estimated glomerular filtration rate, race/ethnicity, & gender

#### 6.a - Hospitalization rates, by age, race/ethnicity, & gender

- **Diabetic**: Male Female
- **Non-diabetic**: Male Female
- **All**: Male Female

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### Figure 6.18 - Hospitalization rates, by estimated glomerular filtration rate, race/ethnicity, & gender

- **Diabetic**: Male Female
- **Non-diabetic**: Male Female
- **All**: Male Female

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* *p<0.001, ^p<0.01, ~p<0.05*
Differences in the relationship between body mass index and the risk of hospitalization are not uniform across racial and gender groups. Black patients, for example, show a more consistent decline in hospitalization rates as BMI levels increase from less than 20 kg/m² to 30 or above. In white males and in female patients, in contrast, the relationship appears to be significant only for very low BMIs, and it is blunted in white male patients. The pattern of hospitalization rates in the Hispanic population follows a U-shaped curve in which rates rise for patients with BMIs greater than 30, a trend not seen in non-Hispanics.

In Figure 6.19, hospitalization rates by age, gender, and race/ethnicity are presented for both diabetics and non-diabetics. Because these analyses are not adjusted for comorbidity or serum albumin, the relationship between age and hospitalization rate is more apparent than when separate risk models are used as in Table 6.a. This demonstrates the impact of adjusting for comorbidity and severity of disease.

Figures 6.16–19 incident dialysis patients, 1998–1999 combined. Rates by race are also adjusted for ethnicity, rates by ethnicity are also adjusted for race, & rates for all patients are also adjusted for race & ethnicity. Direct comparison of adjusted rates is appropriate only between rates within the “all” group, the three race groups, or the two ethnicity groups; see Appendix A for details.

Figure 6.16 adjusted for primary diagnosis, eGFR, & BMI. Table 6.a incident dialysis patients, 1998–1999 combined. Results are from separate main effects models for diabetics & non-diabetics, containing the following covariates: age, gender, race, Hispanic ethnicity, BMI, eGFR, albumin (a continuous variable), & Medical Evidence form comorbidities. Reference: 20–44 years old, female, white, non-Hispanic, BMI 20–<25 kg/m², eGFR <5 ml/min, no comorbidity. Figure 6.17 adjusted for age, primary diagnosis, & BMI. Figure 6.18 adjusted for primary diagnosis, age, & eGFR. Figure 6.19 adjusted for eGFR & BMI.
Predictors of all-cause hospitalization within the major gender, race, and renal diagnosis groups show important differences. First, as shown with the risk of first hospitalization (see Table 6.a), the relationship between hospitalization rate and age is highly influenced by adjustments for disease severity, comorbidity, and previous hospitalization days. Second, relative risks by comorbid conditions are remarkably similar between males and females, whites and blacks, and diabetics and non-diabetics (Tables 6.b–d). This is also true for rates by hemoglobin level and by the number of blood transfusions, hospital days, and vascular access procedures during the entry period.

Increasing amounts of dialysis therapy, however, do not appear to have the same relationship within these groups. In the diabetic population, for example, higher amounts of dialysis are not significantly associated with lower hospitalization rates, but in non-diabetic patients URRs greater than 70 percent are associated with a lower risk of hospitalization.

In Figures 6.20–22 we further evaluate interactions among dialysis therapy, gender, race, and diabetic status. Across interactions of gender, race, and diabetic status, there is a consistent relationship between a higher hemoglobin level in the entry period and a lower hospitalization rate (Figure 6.20). Interactions between dialysis therapy and gender, race, and diabetic status are not as consistent (Figure 6.21). As the URR increases, hospitalization rates for females decrease for males decrease to a URR of 70–75 percent and then increase at URRs of 75 percent and above.

Within each level of dialysis therapy, there is a consistent effect of BMI in whites and blacks (Figure 6.22). The effects are less dramatic, however, in patients of other races. Also, within the black population, URRs in patients with the highest BMIs does not appear to have the same relationship as URR in patients with lower BMI levels. Dialysis therapy and BMI therefore have different relationships to hospitalization in different populations.

To create Tables 6.b–d, patient cohorts are analyzed separately for the main effects of the listed predictors within males and females, within blacks and whites, and within diabetics and non-diabetics. For Figures 6.20–22 we then create an interaction model to assess the impact on hospitalization rates of age, gender, race, ethnicity, diabetic status, hemoglobin level, URR, and body mass index. Because different models are used, results in the figures should not be directly compared to those in the tables.
### Tables 6.b–d & Figures 6.20–22

**Hospitalization rates, by hemoglobin, gender, race, & diabetic status**

*Figures 6.20–22* are adjusted for age, ethnicity, BMI, & URR. *Table 6.20* results are from separate main effects models for males & females, containing the following covariates: age, race, diabetic status, Hispanic ethnicity, comorbidities, transfusions, hospitalization days, vascular access procedures, BMI, hemoglobin, & URR. Reference: 20–44 years old, white, non-diabetic, non-Hispanic, no comorbidity, no blood transfusions, no hospitalization days, no vascular access procedures, BMI 20–<25 kg/m², hemoglobin 11–<12 g/dl, URR 65–<70 percent. *Table 6.21* results are from separate main effects models for white & black patients, containing the following covariates: age, gender, diabetic status, Hispanic ethnicity, comorbidities, transfusions, hospitalization days, vascular access procedures, BMI, hemoglobin, & URR. Reference: 20–44 years old, female, non-diabetic, non-Hispanic, no comorbidity, no blood transfusions, no hospitalization days, no vascular access procedures, BMI 20–<25 kg/m², hemoglobin 11–<12 g/dl, URR 65–<70 percent. *Table 6.22* results are from separate main effects models for diabetic & non-diabetic patients, containing the following covariates: age, gender, race, Hispanic ethnicity, comorbidities, transfusions, hospitalization days, vascular access procedures, BMI, hemoglobin, & URR. Reference: 20–44 years old, female, white, non-Hispanic, no comorbidity, no blood transfusions, no hospitalization days, no vascular access procedures, BMI 20–<25 kg/m², hemoglobin 11–<12 g/dl, URR 65–<70 percent. *Figure 6.20* adjusted for age, ethnicity, BMI, & URR. *Figure 6.21* adjusted for age, ethnicity, BMI, & hemoglobin. *Figure 6.22* adjusted for age, gender, diabetic status, & hemoglobin.

Rates by race are also adjusted for ethnicity, rates by ethnicity are also adjusted for race, & rates for all patients are also adjusted for race & ethnicity. Direct comparison of adjusted rates is appropriate only between rates within the “all” group, the three race groups, or the two ethnicity groups; see Appendix A for details.
Rates of hospital admissions per patient year and hospital days per patient year for patients with rare diseases generally follow similar patterns within age and gender categories. In most instances rates are higher for older patients, while females tend to be admitted more frequently and spend more time in the hospital than males.

For patients with IgA nephropathy, Berger’s disease, and IgM nephropathy (Figures 6.23–24), and for those with systemic lupus erythematosus (Figures 6.27–28), rates show a pattern in which admissions and hospital days are higher for younger patients age 0–19 and for patients age 65 and older. The high hospitalization rate for lupus patients has not been explored, but may reflect vascular access complications due to an altered coagulation state. The degree of reactivation of lupus vasculitis has also not been carefully reviewed since the introduction of guidelines recommending that providers deliver greater amounts of dialysis therapy to all patients.

These patterns of hospitalization are in clear contrast to those found in patients with diseases such as Goodpasture’s syndrome (Figures 6.25–26), scleroderma (Figures 6.31–32), and multiple myeloma (Figures 6.35–36). Complications of Goodpasture’s such as recurrent pulmonary hemorrhage, vasculitis, and pulmonary infection have not been thoroughly addressed, and merit further investigation.

In patients with scleroderma, hospitalizations and hospital days are highest for patients age 75 and older. This may be explained by the major complications of the disease, which include severe hypertension and peripheral and cardiovascular diseases (Figures 6.31–32). Sudden death in this population is an important area to consider, since left ventricular hypertrophy is a common complication and myocardial fibrosis secondary to long standing LVH is associated with dysrhythmias.

Patients with Alport’s syndrome have relatively low hospitalization rates and numbers of hospital days, even after adjustments for age and gender (Figures 6.33–34). Morbidity in the Alport’s population should be more closely evaluated, as these patients tend to have fewer of the complications associated with chronic kidney disease than do other patients, such as those with diabetes or hypertensive ESRD.

Patients with multiple myeloma or light chain nephropathy, in contrast, have noticeably high rates of hospitalization, reflecting the highly evident morbidity associated with this form of bone marrow cancer (Figures 6.35–36). The frequency of...
complications such as pathologic fractures, infectious morbidity, and episodes of hypercalcemia have not been investigated in this population. Since light chains have been reported to deposit in vascular endothelial cells, cardiac complications of patients with light chain nephropathy should also be assessed in more detail, and compared to the typical atherosclerosis associated with diabetes and hypertension.

Rates of admissions per year and hospital days per year for patients with AIDS nephropathy are higher in younger patients (Figures 6.37–38). As AIDS patients survive longer other complications will need to be addressed, such as glucose intolerance, ischemic heart disease, and hepatitis C. We will investigate these areas in upcoming editions of the ADR.

Diseases are those indicated on the Medical Evidence form as the primary cause of ESRD.

Figures 6.23–38 period prevalent ESRD patients with a rare disease as the primary diagnosis of ESRD. 1996–2000 combined; overall adjusted rates are adjusted for age & gender, rates by age are adjusted for gender, & rates by gender are adjusted for age. For some diseases, age groups are combined because of the small number of younger or older patients with the disease. The common reference population used for all adjusted rates includes all 1999 ESRD patients with any one of the eight rare diseases as the primary diagnosis of ESRD. Consistent with rates throughout Chapter Six, patients dying of AIDS are excluded from rate calculations except in Figures 6.37–38.

Figures 6.29–30 other secondary GN/vasculitis includes polyarteritis, Wegener’s granulomatosis, Henoch-Schonlein syndrome, & vasculitis & its derivatives.
**Maps: National means & patient populations**

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<th>6.11</th>
</tr>
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<tr>
<td>M/care Dialysis</td>
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</tr>
<tr>
<td>Overall value for all patients</td>
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<tr>
<td>Total patients</td>
<td>1,105,103</td>
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<tr>
<td>Overall value for patients mapped</td>
<td>382</td>
<td>2,176</td>
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<tr>
<td>Patients dropped due to missing HSA/state</td>
<td>13,534</td>
<td>1,281</td>
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**Conclusions**

- Despite differences in age distribution and disability status, hospitalization rates for ESRD patients are more than four times greater than those in the general Medicare population.
- Differences in age, gender, race, and diabetic status do not explain the stability of hospitalization rates in ESRD patients over the last ten years.
- Compared to Medicare patients without chronic kidney disease, dialysis patients age 65 and older have all-cause hospitalization rates that are four to six times higher. Infections hospitalization rates are over seven times greater in non-diabetic dialysis patients, and five times greater in diabetics. Hospitalization rates in older dialysis patients are also more than eight times higher for congestive heart failure, four times higher for ischemic heart disease, and six times higher for other cardiovascular diseases.
- Information from the Medical Evidence form is highly predictive of hospitalizations in incident patients.
- Higher body mass indices in the dialysis population are generally associated with lower risks of hospitalization, a pattern that varies by gender, race, ethnicity, and diabetic status.
- In both diabetic and non-diabetic populations, higher estimated glomerular filtration rates at the initiation of dialysis are associated with a greater likelihood of hospitalization, a result which may reflect increased disease severity in these patients compared to those who initiate with lower eGFRs.
- The comorbid conditions reported on the Medical Evidence form—including the inability to ambulate in non-diabetic patients and the inability to transfer in diabetic patients—are highly predictive of hospitalizations.
- In predicting hospitalizations, there are significant differences among age, gender, race, and renal diagnosis.
  - Females generally have a higher risk of hospitalization than males.
  - Within the white and black ESRD populations, young diabetics have the highest hospitalization rates compared to other age groups.
  - In non-diabetics, increasing age is associated with an increased hospitalization rate.
  - Higher hemoglobin levels in hemodialysis patients are consistently associated with a lower risk of hospitalization.
- Compared to patients with URRs of 65–70 percent, all subpopulations have an increased risk of hospitalization as ratios fall below 60 percent.
- For males there is no independent decrease in hospitalization with URRs above 75 percent, while females have lower risks.
- First hospitalization rates vary by URR, gender, race, and diabetic status.
- Within each URR range, increasing BMI is generally associated with a lower risk of hospitalization. Within each BMI group, however, increasing URR is not necessarily associated with a lower risk.
- In patients with less common diseases, hospitalization rates for patients with Alport’s syndrome are among the lowest, while patients with AIDS and multiple myeloma have the highest rates.

**Patient populations & analytical methods**

- Figures 6.1, 6.3–15, and 6.23–38 include rates for various subsets of period prevalent ESRD cohorts. Part A institutional inpatient claims are used for the analyses. Only patients in the 50 states, the District of Columbia, Puerto Rico, or the Territories are included, and the following are excluded: patients with AIDS as a primary or secondary cause of death (except in Figures 6.37–38), non-Medicare patients, and patients with MSP or HMO status, as detailed in Appendix A.
- For the general Medicare population (Figures 6.2 and 6.10–15), a two-year entry period (1996–1997 for 1998 patients and 1997–1998 for 1999 patients) is used to characterize patients as diabetic/non-diabetic and CKD/non-CKD. Only patients meeting these criteria are selected: non-ESRD, no HMO coverage, alive, and with Medicare Part A or B coverage. Patients are classified as diabetic or CKD based on entry-period claims: at least one inpatient, home health, or skilled nursing claim, at least two outpatient claims, or at least two Part B claims for the condition are required for classification as a diabetic or CKD patient. See Appendix A for further details.
- Adjusted rates in Figures 6.1–2 and 6.23–38 are computed by the direct adjustment method. Reference populations include 1999 period prevalent ESRD patients (Figures 6.1–2), and all 1999 ESRD patients with one of the eight rare diseases as the primary cause of ESRD (Figures 6.23–38).
- Figures 6.1–15 and 6.23–38: calculation of unadjusted hospital day and admission rates follows the methodology for computing time at risk, total days, and total admissions described in Appendix A.
- Figures 6.16–19 display adjusted first-year first hospitalization rates obtained from the model-based adjustment method described in Appendix A. The Cox proportional hazards model is used with all possible two-way interactions of the following variables: age, gender, race, primary cause of ESRD, ethnicity, BMI, and eGFR.
- In Figures 6.20–22, patients are characterized during a six-month entry period and followed up to one year. Adjusted first-year first hospitalization rates are obtained using a model-based adjustment method with the Cox proportional hazards model and direct adjustment. All possible two-way interactions of the following variables are included in the model: age, gender, race, diabetic status, ethnicity, BMI, URR, and hemoglobin.
- For Table 6a, separate Cox proportional hazards models are used for diabetics and non-diabetics, and for Tables 6b–d, results are from separate main effects models for males and females, whites and blacks, and diabetics and non-diabetics, respectively. The covariates used as main effects in the models are listed in the figure captions.
- Direct comparison of adjusted rates is appropriate when rates are adjusted for the same factors. Figures 6.16–19 and 6.22 are adjusted for the factors listed in the captions, and rates are presented for all patients, by race, and by ethnicity. Rates for all patients are also adjusted for race and ethnicity, rates by race are also adjusted for ethnicity, and rates by ethnicity are also adjusted for race. Therefore, comparison of rates within each figure is appropriate only within the “all” group, within the three race groups, or within the two ethnicity groups. Similarly, in Figures 6.20–21, rates presented by gender are also adjusted for race and diabetic status, rates by race are also adjusted for gender and diabetic status, and rates by diabetic status are also adjusted for gender and race. Within each figure, rates are comparable only within gender, race, or diabetic status groups.