Chapter IX

Hospitalization

Hospitalization rates reflect a number of important aspects of ESRD therapy. However, hospitalization data are imperfectly reported at both patient and aggregate levels due to the way in which the data are obtained (see Chapter XIV). The frequency and duration of reported hospitalizations are influenced both by the health insurance system and patient needs. For this chapter, Medicare billing records contained in the PMMIS files (see Chapters I and XIV) are the source of hospitalization data despite their incompleteness due to a variety of factors, including Medicare eligibility rules.

Prior to 1991, information on zero (same-day admit/discharge) and one-night hospitalizations were not entered into the PMMIS files, resulting in an under count of admissions that could potentially bias longitudinal comparisons. This practice was changed in 1991, and the PMMIS data now include all available information on hospital admissions.

In comparison to previous USRDS reports on trends in hospitalization, the ability to make meaningful aggregate comparisons has improved. The completeness of available data has changed since the last USRDS report on hospitalization in 1991, although some of the limitations encountered in the past are still problems today. For example, patients in their first year of ESRD who have Medicare as their secondary payer may have their hospital stays covered by another source first, with Medicare being the secondary payer. This may result in hospitalization profiles for patients that are incomplete during the first 18 months. Such limitations, while somewhat less important for comparisons made in the aggregate, inhibit investigations into the use of serial hospitalizations as a measure of illness severity, longitudinal comorbidity, quality of life, and monetary cost of ESRD, at least on a per-patient basis.

The first part of this chapter describes the hospitalization rates of prevalent dialysis patients, defined as the number of admissions per year at risk for hospitalization. Only *dialysis* patients that have never been transplanted are included in these analyses. Summaries by age, race, sex, and modality are given based on the reference tables in Section H of this report, and apply to data collected over the years 1990 through 1992.

The second part of this chapter introduces the standardized hospitalization rate (SHR), a new comparison measure constructed based on hospital admission rates. The SHR is an adaptation of the standardized mortality ratio (SMR) methodology described in Chapters V and XIV. In this chapter, the median SHR and SMR among dialysis units within the United States Department of the Census’s nine census regions are compared. In addition, the relationship between SHR's and SMR's is investigated at the dialysis unit level.

We note that the analyses in this chapter are meant to be descriptive, not definitive, and thus serve only to generate hypotheses for detailed study. Hypothesis testing, confidence intervals, etc. are reserved for future, more in-depth analyses of these data.

Identifying Trends in Hospitalization

Both the yearly number of hospital admissions and the hospital days per patient are important measures in the study of hospitalization in *dialysis* patients. Figures IX-1 and IX-2 describe the distribution of hospital admissions and days for patients prevalent on January 1 or incident during 1992, by patient age under or over 65.

Both distributions are positively skewed, the distribution of days more so than admissions. More patients have zero admissions and zero days than any other number. Figure IX-1 shows that approximately 75 percent of the patients in both age groups had fewer than three hospital admissions, while 95 percent had five or fewer. The median number of admissions is 1 per year in both groups, while the mean number of admissions in the older and younger age groups are 1.6 and 1.5 respectively. In terms of hospital days, we see in Figure IX-2 that 33 percent and 42 percent of the patients in the older and younger age groups had zero hospital days while 10 percent had 30 or more days in both groups. The median and mean for hospital days were respectively 6 and 14.1 for patients age 65+ and 3 and 12.2 for patients less than 65.

As expected, these graphics indicate that younger patients tend to have less hospitalization, measured on either scale.

In order to account for the different lengths of follow-up available for different patients, we computed the rate per year at risk for hospitalization. For the purposes of making comparisons between populations, we computed an aggregated rate, defined as the ratio of total hospital admissions or days to total time at risk within a patient population.

In order to stabilize the estimated rate, we pooled three years of data and calculated the ratio of the total number of hospital admissions experienced by each population over a three-year period to the total number of years at risk for hospitalization.

In most cases, we restrict our comparisons to rates based on admissions since corresponding rates based on hospital days are highly correlated. In addition, admission rates tend to exhibit greater stability than those based on days, in part due to more accurate recording and the fact that the distribution of hospital admissions tends to have a shorter right-hand tail (see Figures IX-1 and IX-2). For the admissions rates, the years at risk for hospitalization for each patient are determined by subtracting the time actually spent in the hospital from the total time on observation. This calculation explicitly accounts for the fact that one is not at risk for a new hospitalization while already in the hospital. Rates for hospital days appear in Figure IX-11 and in the Reference Tables and use the full years at risk, including time spent in the hospital.

The patient populations under study include *dialysis* patients prevalent on January 1, 1990 or incident after that date until December 31, 1992, with exclusion of patients who received a transplant prior to enrollment in Medicare. Patients who start follow-up or die during a year are at risk for only a portion of the year, and patients who switch modalities during the year are assigned to the new modality at the start of the next year. For reasons discussed earlier, the exclusion of one-night hospitalizations in the year 1990 results in an under count of admissions and to a lesser extent hospital days for that year. However, since the rates are calculated on data pooled over a

Percentage of Dialysis Patients by Number of Hospital Admissions, by Age, 1992

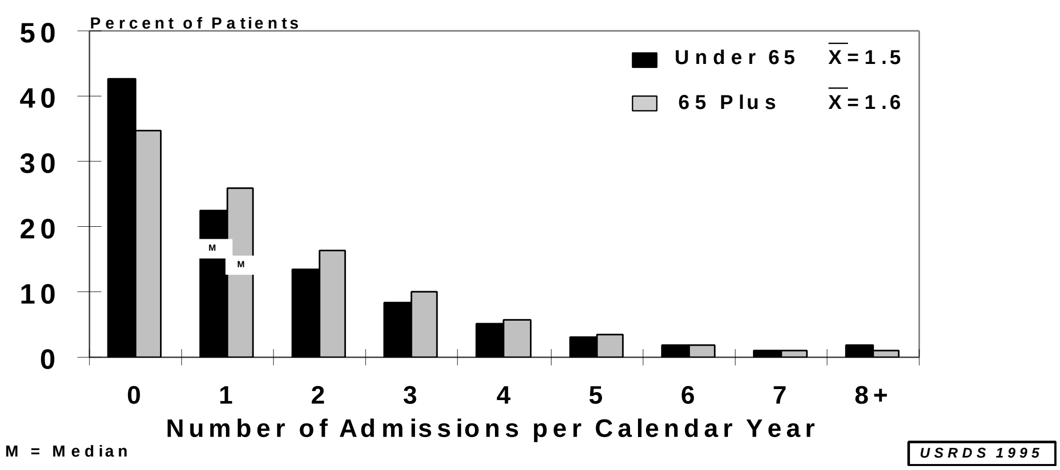

Figure IX-1

Percentages of dialysis patients with the given number of hospital admissions in a single year by age, 1992. Mean and median are also denoted. Only Medicare dialysis patients never transplanted. Source: Special Analysis.

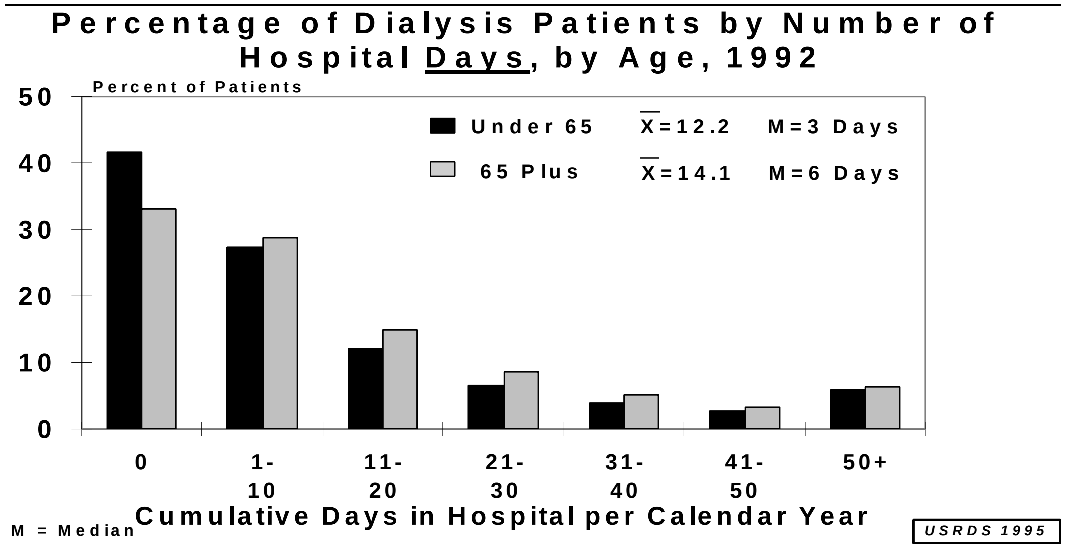

Figure IX-2

Percentages of dialysis patients with the given number of total days hospitalized in a single year by age, 1992. Mean and median are also denoted. Only Medicare dialysis patients never transplanted. Source: Special Analysis.

period of three years, the bias due to this under count is likely to be reduced.

Figure IX-3 shows the rates computed for all *dialysis* patients by age in addition to the death rate for each of the age groups. As expected, hospitalization rates for patients aged 65 years or older tend to be the highest. Rates are approximately the same between the ages of 20- 64, and drop again for the youngest age group. However, this variation is quite small, especially compared to the steep increase seen in the death rate as patients age. Yet, this pattern is consistent with results reported in the USRDS 1991 Annual Data Report, although the rates reported here are not strictly comparable due to differences in entry criteria and methods of computation. (Since hospital admissions are restricted to dialysis patients never transplanted,

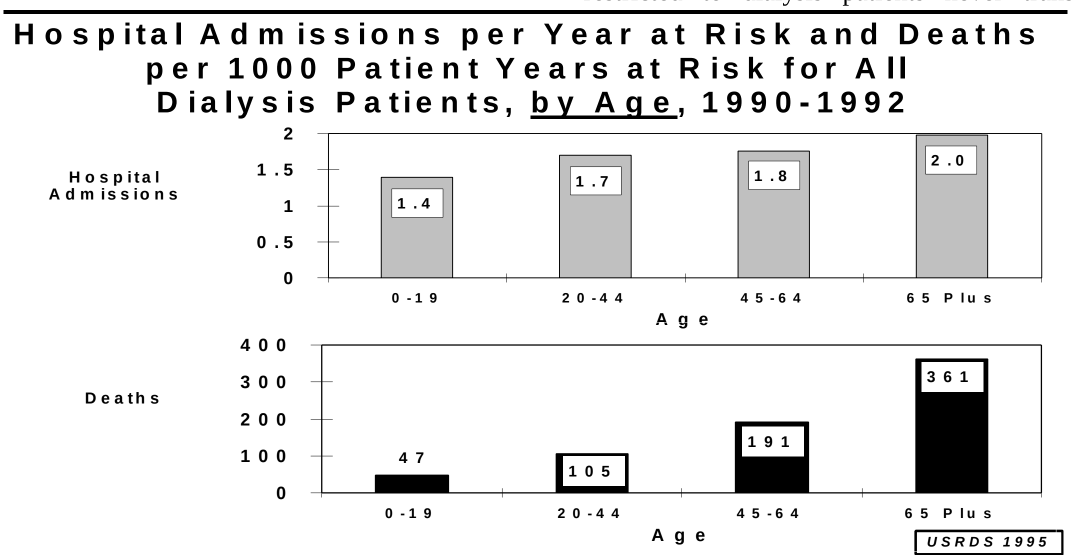

Figure IX-3

Number of hospital admissions per patient year at risk and number of deaths per 1000 patient years at risk for dialysis patients, by age, 1990-1992. Medicare dialysis patients never transplanted only. Source: Reference Tables H.1-H.2 and D.17.

Hospital Admissions per Year at Risk for Dialysis Patients, <u>by Modality and Age</u>, 1990-1992

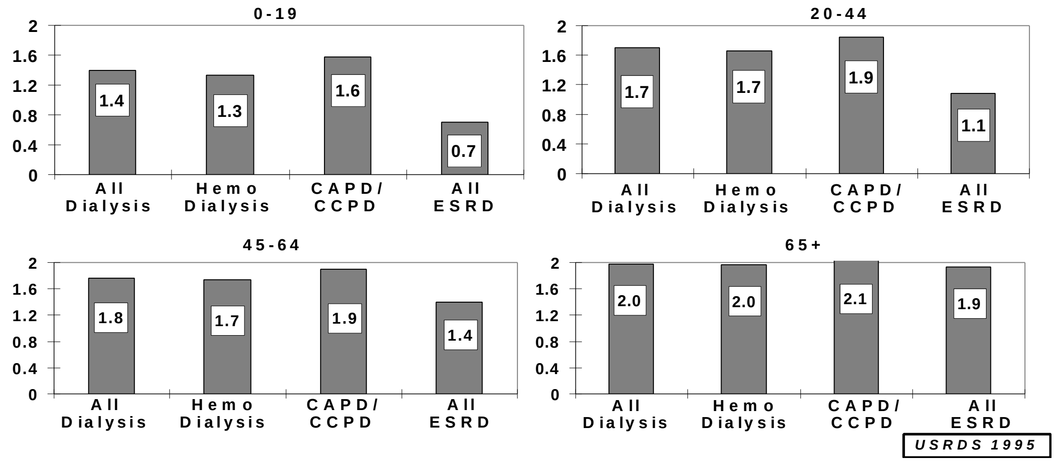

Figure IX-4

Number of hospital admissions per patient year at risk for ESRD patients by method of treatment for each age cohort, 1990-1992. Patients are grouped by treatment type based on the treatment method they were using on January 1 of each year. Those patients who switched modalities during a year are reclassified at the beginning of the following year. Medicare patients only. Source: Reference Tables H.1-H.6.

possibly the younger patients reported here are more severely ill than are the patients excluded).

Figure IX-4 shows the admission rates by modality, stratified upon age. The rates increase with age for each treatment modality. Hospitalization rates among CAPD patients are higher than for hemodialysis patients in each age group. These results are consistent with the findings of Habach and Port (1995), who report such comparisons for 1988 through 1990. The differences reported here are smaller, perhaps due to improvements in connection devices and associated medications for peritonitis risk in CAPD patients. Generally, hospitalization rates for CAPD patients have been steadily falling while those for hemodialysis patients have remained relatively stable in recent years. These trends over time could be due to a variety of explanations, including reduced hospitalizations among CAPD patients or changes in the frequency of switching between modalities.

Actual differences between rates for CAPD and hemodialysis patients might be larger than are reported because we have used an “intent to treat” assignment of dialysis modality. That is, hospitalizations for patients who switch in the middle of the calendar year are not attributed to their new modality until January 1 of the following year. It is well known that CAPD patients switch to hemodialysis approximately three times as often as hemodialysis patients switch to CAPD. Since hemodialysis patients tend to incur less hospitalizations, rates for CAPD patients may be biased downward while rates for hemodialysis patients are likely to be biased upward (although much less so) since a switch to CAPD likely increases the hospitalization rate.

Figure IX-5 shows relations by age, race, and sex. It is important to note that the rates for patients aged 0-19 are, relative to the other age groups, based on very small sample sizes. This is especially true for Asians and Native Americans; hence, interpretation of these rates should be done very cautiously. In addition, the rates for the youngest age group are likely to be affected due to patient selection: *dialysis* patients in the 0-19 age group who have never been transplanted are among the least healthy of all dialysis patients, and hence are likely to have higher hospitalization rates.

In general, the results indicate that females have higher hospitalization rates than males, the exception being the Asian and Native American groups aged 0-19 where hospitalization among males appears to be higher. It is unclear whether this difference is real or due to instability in the calculated rates.

Hospitalization rates are lowest among Asians at all age levels, while rates are among the highest for Native Americans at all age levels. Blacks are

Hospital Admissions per Year at Risk for Dialysis Patients by Race, Sex and Age, 1990-1992

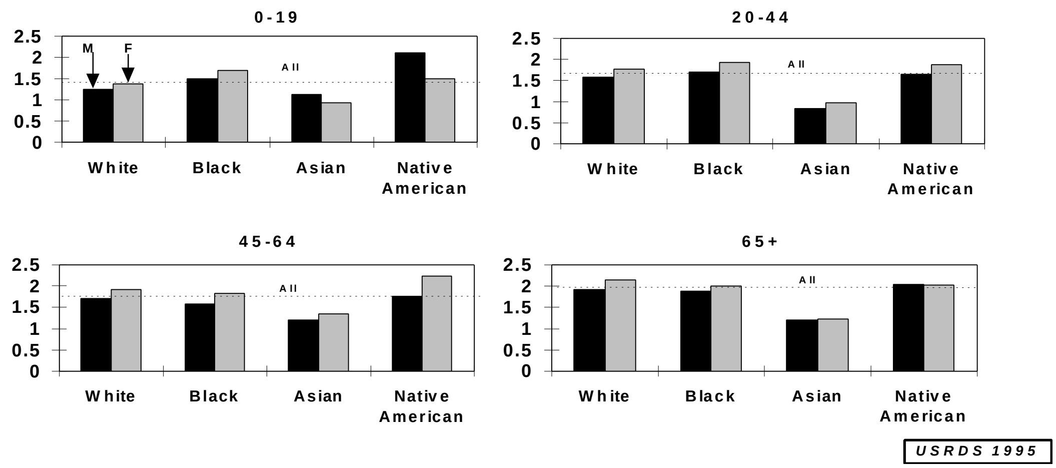

Figure IX-5

Number of hospital admissions per patient year at risk by sex and race for each age cohort, 1990-1992. Medicare dialysis patients never transplanted only. Source: Reference Tables H.7-H.9.

hospitalized more frequently than whites at younger ages, while the reverse occurs for ages 45-64 and 65+. This pattern corresponds to mortality results shown in Figures V-6 and V-7. The hospitalization rates among whites and blacks increase with age, while rates drop initially for Native Americans and Asians between the ages of 20-45 before rising again. Again, the pattern observed here may simply be due to rate instability rather than an actual trend, and thus should be interpreted cautiously.

Standardized Hospitalization Rate (SHR)

Methods

The standardized mortality ratio (SMR) is a ratio of the observed number of deaths for a given patient study group divided by expected number of deaths for that patient study group based on national death rates. Wolfe et al (1992) use the published USRDS national ESRD mortality rates given in deaths-per-patient-year by age, race, sex, and diagnosis group. These can then be used, for example, to compare mortality rates between groups of patients by simply computing the ratio of the observed number of deaths to the expected number within each group, the latter being adjusted for differences in age, race, sex, and diagnosis.

The expected number of deaths within a group is determined by multiplying the total patient-years observed within each age-race-sex- diagnosis category by the corresponding national rate, and then summing over all of the categories. An observed SMR larger (smaller) than 1.0 denotes potentially a higher (lower) mortality rate than the national ESRD norm. The rates are subject to random variation, however, and so should be interpreted cautiously. Further discussion of interpretation and evaluation of the SMR, including tests of statistical significance, can be found in Wolfe et al (1992) and also Wolfe (1994).

The USRDS produces hospitalization tables in a similar fashion to these mortality tables. Hence, we can calculate a standardized hospitalization ratio (SHR) using the rates in tables H.1-H.6. For example, to obtain the SHR for a specific dialysis unit in a specific year, the observed number of hospital admissions in patients treated during that time period is divided by the expected number of hospitalizations. The expected number of hospitalizations is calculated similarly to the expected number of deaths used in calculating the SMR. Specifically, the observed patient-years at risk for hospitalization in that unit is sub-divided by age, race, sex, and diagnosis, multiplied by the corresponding national rate for those groups, and then summed up over all groups to obtain the total expected number of hospitalizations in that unit for that year. This produces standardized hospitalization rates, adjusted for age, race, sex, and diagnosis, that share a similar interpretation to the adjusted SMR. That is, values of the SHR larger than 1.0 indicate hospitalization rates above the national norm while values below 1.0 denote lower rates.

Initial Analyses

The SHR's computed for the analyses of this section are based on data obtained for 1991- 1993. The data are for never-transplanted *dialysis* patients that were either:

- prevalent on January 1, 1991, treated for ESRD for at least 90 days prior to January 1, and had a Health Insurance Master (HIM) posting date by January 1. These filters define a population of patients that are eligible for Medicare and whose hospitalization records are recognized as ESRD and are passed on to HCFA PMMIS.

- incident during the calendar year, treated for at least 90 days, and whose HIM posting date occurs within the first 90 days of ESRD.

We again limit our investigation here to hospital admission rates. The data for 1991-1993 includes information on patients with same-day admission and discharge, thus avoiding the problem of excluding one-night hospitalizations associated with data collected prior to 1991.

In order to increase stability, the rates presented here are computed based on admissions and years at risk over the three year period 1991-1993. Also, units with fewer than twenty admissions in the period are excluded from most analyses to increase stability. Analyses are performed by census region as well as at the dialysis unit level based on unit-specific SHR's. Correlations between the admittance rates and rates based on hospital days at the unit level tend to be very high within each year, averaging 0.75. In each case a comparison is made to the corresponding adjusted SMR.

Figure IX-6 provides the median SHR and SMR for the dialysis units within each of the nine census regions, shown in Figure IX-7. Smaller units have been excluded from these analysis, so the unit-specific ratios are fairly stable. Use of the median value provides a snapshot of the typical dialysis unit in each region.

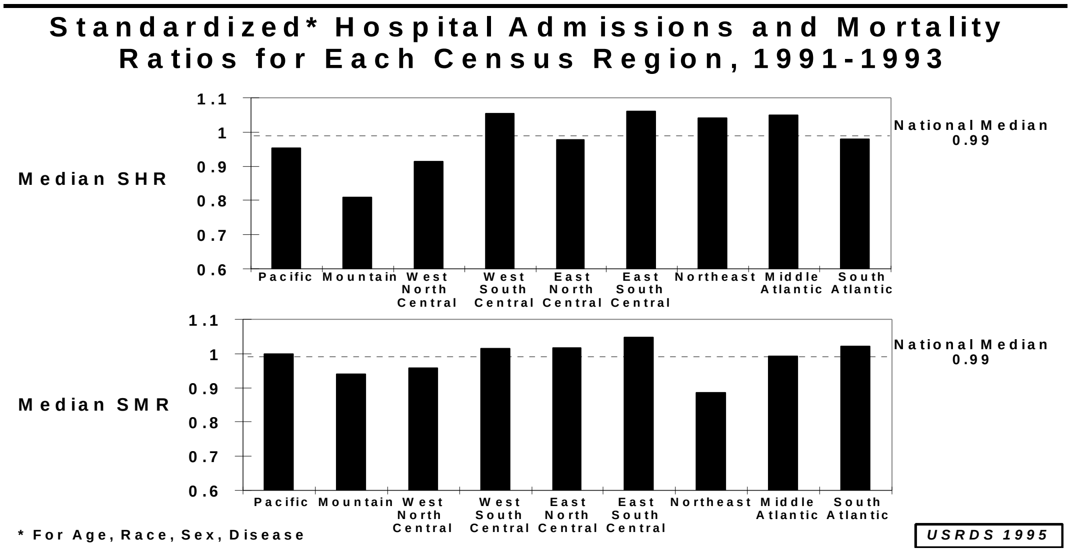

Figure IX-6

Median hospital admissions ratio and mortality ratio for each of the nine geographic census regions, 1991-1993. Rates are standardized for sex, race, age and primary disease causing ESRD. Rates are calculated by dividing the actual number of events (admissions for hospitalization and deaths for mortality) for each dialysis unit by the expected number of events for that unit. Expected events numbers are calculated for each facility based on national data so that rates can be compared from region to region. Units with fewer than twenty expected admissions in the three year period are excluded. Source: Special Analysis.

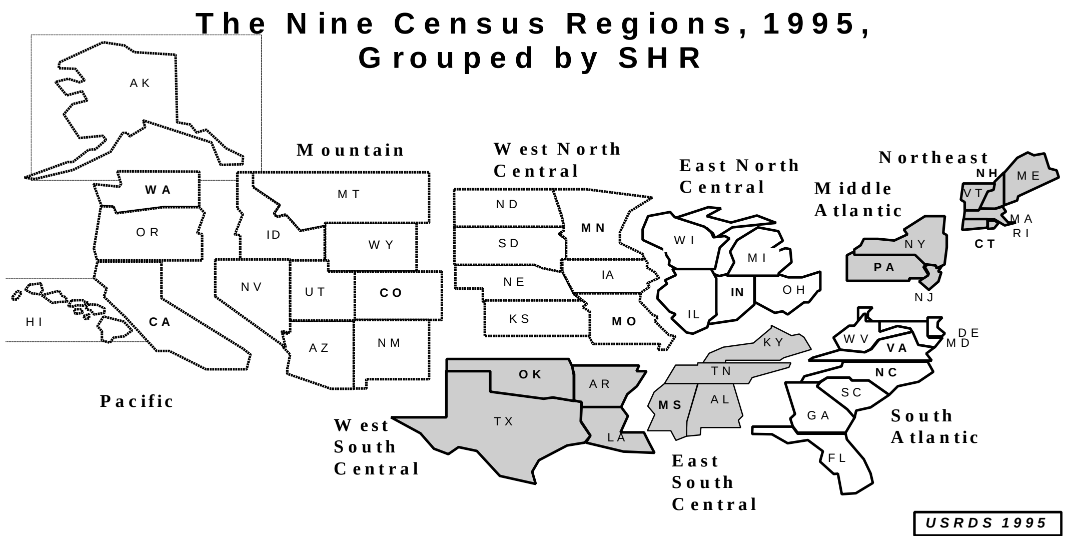

Figure IX-7

Map of the United States indicating the nine Census regions. Shading indicates those regions with median standard hospital admissions rates greater than one in the three year period, 1991-1993.

For four of the nine regions, the value of the SHR exceeded 1.0, indicating hospitalization rates above the ESRD norm. Regions having the lowest SHR values are the Pacific, Mountain, and West North Central Regions. This trend is consistent with trends observed in studies of non-ESRD patients (Gornick) as well as past studies of hospitalization among ESRD patients (1991 ADR).

The highest rates of hospitalization occur in the Northeast, Middle Atlantic, West South Central, and East South Central regions, the last one being the highest. There is moderate positive correlation of these rates with the SMR For example, the Mountain

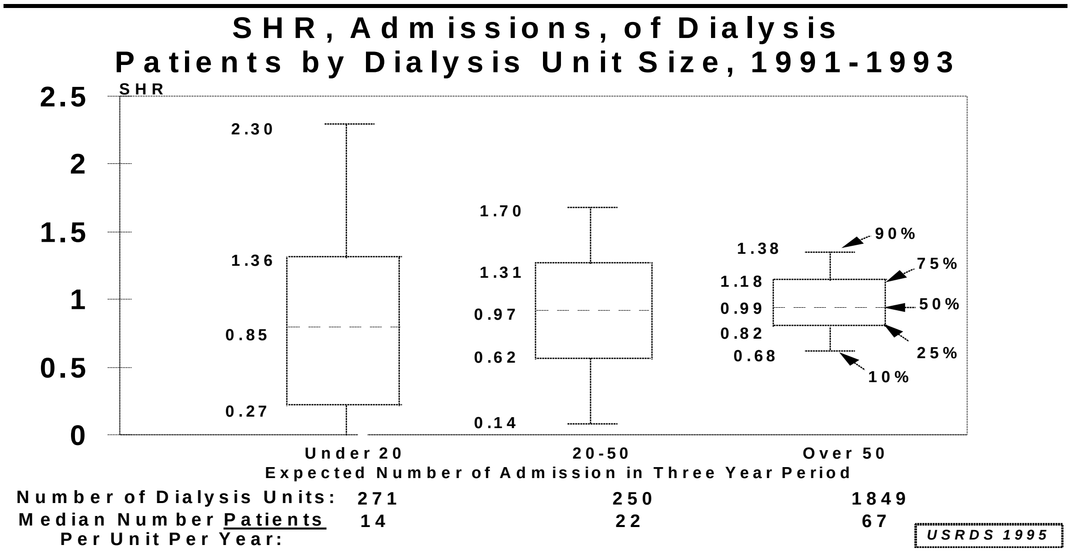

Figure IX-8

Distribution of hospital admissions rate for each dialysis unit size. Rates are standardized by sex, race, age and primary disease causing ESRD. Facility sizes are determined by the expected number of admissions for that unit in a three year period, 1991-1993. Those with fewer than twenty admissions in that time are in the smallest group; those with twenty to fifty are in the next group; and those units with more than fifty admissions are included in the last group. Rates are given for the 10th percentile, the 25th percentile, the median, the 75th percentile and the 90th percentile. Source: Special Analysis.

region has the lowest SHR and the second lowest SMR while the East South Central region has the highest measures for both. However, the Northeast has one of the highest SHR's, but also the lowest SMR. It is unclear which factors are primarily responsible for the geographic differences observed here; several major patient mix characteristics have been adjusted for, but it is likely that other factors are also important.

The SHR's can also be compared at the dialysis unit level. Figure IX-8 and Table IX-1 contain box plots and summary statistics describing the distribution of SHR's by unit size, measured here in terms of the expected number of yearly admissions between January 1, 1991 and December 31, 1993. It is readily apparent that the variability and skewness in the distribution of the SHR decreases with the increase in expected admissions. However, the median SHR does not change dramatically with unit size.

For units having 20 or fewer expected admissions, the expected number of dialysis patient hospital admissions ranged from a low of zero to a high of 28, with median and mean values of 0.85 and 1.12 respectively and 90 percent of the values falling below 2.3. For dialysis units having 50 or more expected admissions, the SHR range was 0 to 3.55, having median and mean values of 0.99 and 1.02 respectively and with 90 percent of units having values below 1.37.

We compared the SHR's computed for dialysis units having an expected number of admissions exceeding twenty to their corresponding SMR's. The restriction on the expected number of admissions is to help ensure rate stability. Similarly, three outlier units having SHRs greater than three are excluded. However, sensitivity analyses indicate that the inclusion or exclusion of these values did not affect the slope or R^2. The scatter plot in Figure IX-9 describes the results, and clearly demonstrates the degree of variability in this relationship. The fitted line represents the linear regression of SMR on SHR, SMR being the dependent variable. For these data, approximately 10 percent of the variability we see in the SMR can be explained by its (linear) relationship with the SHR, as measured by R^2. These results are not intended to imply the existence of a causal relationship; however, there is an obvious upward trend, meaning that there exists positive correlation between the two measures. The correlation between the two rates is 0.3 ($p < 0.0001$) as measured by the Spearman rank correlation coefficient (Lehmann).

Rank correlations provide a robust measure of the degree to which higher (lower) SHR's are associated with higher (lower) SMR's. For example, the trend observed in the scatter plot becomes more difficult to identify when the units having less than 20 expected admissions are included. The rank correlation

Summary Statistics for Unit-Specific SHRs*
by Expected Number of Hospital Admissions

Statistic	SHR: Unit Size (Expected Number of Admissions 1991-1993) Under 20	20-50	Over 50
Median	0.85	0.97	0.99
Mean	1.12	0.98	1.02
Standard Deviation	2.00	0.58	0.29
Minimum	0	0	0
Maximum	27.94	4.16	3.55
Median Number of Patients Per Year	14	22	67
Number of Units	271	250	1849

* Pooled 1991-1993

USRDS 1995

Table IX-1

Median, Mean, Standard Deviation, Maximum and Minimum standard hospital admission rates of dialysis patients by the number of expected admissions for each dialysis unit in a three year period, 1991-1993. Rates are standardized for age, race, sex and primary disease causing ESRD. Also includes the median number of patients per year for units in each group and number of units in each category. Source: Special Analysis.

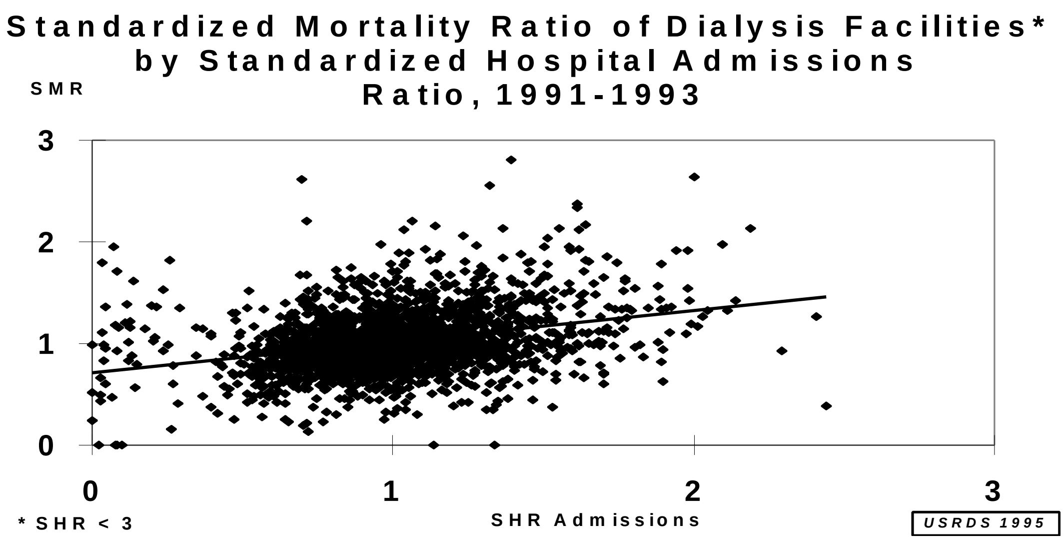

Figure IX-9

Plot of mortality ratios by hospital admissions ratios for each dialysis unit, 1991-1993. Ratios are standardized by age, race, sex and primary disease causing ESRD. Line represents linear regression of SMR on SHR, treating SMR as the dependent variable. The intercept is at 0.71 and the slope is 0.31. The adjusted R-Squared value is 0.10. Units with fewer than twenty expected admissions in the three year period are excluded. Three units with SHRs exceeding three are arbitrarily excluded based on visual inspection of outliers. Source: Special Analysis.

coefficient remains relatively unaffected, however.

In Figure IX-10, the SHR distributions, by whether a dialysis unit operates for profit (yes/no) and/or type of unit (hospital or free standing), are shown in box plots. Standardized hospitalization ratios, admissions per year (SHR), when adjusted for age, race, sex and cause of ESRD are highest for patients treated in freestanding for-profit dialysis units. (Median SHR = 1.03). Both hospitals (not-for-profit) and not-for-profit freestanding units have slightly lower hospitalization ratios at approximately 0.95 or 0.96, as seen in Table IX-2. However, the ratios for hospitals tend to vary more than those of the free standing dialysis units as indicated by the box charts. The ranges from the 10th to the 90th percentiles were 0.78 and 0.97 for profit units and hospitals, respectively.

The dialysis policy literature has for years debated whether hospital outpatient dialysis units have a "sicker" (more comoribid conditions and more severe conditions) patient population than do the freestanding units. If we take hospitalization rates as a measure of patient case- mix severity beyond age and diabetes, these estimates suggest that the freestanding for-profit units have a higher severity mix than do the not-for-profit dialysis units. If on the other hand, one takes hospitalization rates as a measure of resources used to produce good patient health, then these data suggest that freestanding for-profit-units use a higher level of inpatient treatment resource than do the not-for-profit units.

This is an intriguing observation since the units will generally receive no reimbursement for dialysis treatments provided to their patients in a hospital. It might also be argued that dialysis units do not admit patients to the hospital; physicians do, and their financial incentives have to be considered as well. In some situations, physicians who see patients in an outpatient dialysis unit may also have an arrangement with a hospital to provide inpatient dialysis which would complicate the interpretation of these hospitalization statistics. Clearly much more information is needed to discern among these many hypotheses.

The comparison of SHRs to SMRs is also interesting. Not-for-profit free standing dialysis units have reported lower mortality than do either the free standing for- profit units or the hospital units. Again, depending on how one interprets the SHR, the SMR's become interesting indicators of outcomes. If SHRs indicate patient severity (beyond age, sex, race and diagnosis), then freestanding units (both profits and not-for-profit) have outcomes (mortality) that is in line with the severity of the patients. Hospital units, under this interpretation,

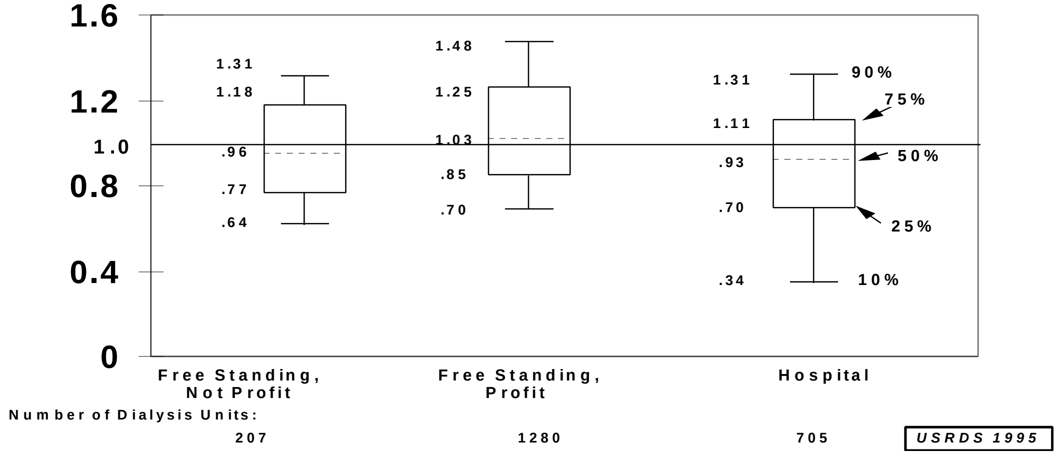

Figure IX-10

Distribution of hospital admissions rates by type of unit, 1991-1993. Units are divided into three types: free standing dialysis units operating for a profit, free standing dialysis units not operating for a profit, and hospitals. Rates are standardized for age, race, sex and primary disease causing ESRD. Units with fewer than ten admissions in the three year period are excluded. Rates are given for the 10th percentile, the 25th percentile, the median, the 75th percentile and the 90th percentile. Source: Special Analysis.

have higher mortality than their severity indicator (SHRs) would suggest. If, however, SHRs measure the mix of input resources used with patient severity having an assumed constant grouping average across all three groupings, then patients of hospital outpatient dialysis units use less inpatient resources with the same outcomes as do the patients of freestanding for profit dialysis units. Again, more information is required on patient comorbid status and other unmeasured indicators regarding the practice of nephrology.

SMRs and SHRs* by Dialysis Unit Type, 1991-1993

Units with >20 Expected Admission per Year

Statistic	Free Stand, Not-For-Profit	Free Stand, For-Profit	Hospital
SHR Admissions	0.95	1.03	0.96
SMR	0.94	1.01	1.01

* Single rate calculated for all units of each type

USRDS 1995

Table IX-2

Hospital admission and mortality rates calculated across each of the three types of dialysis unit. Rates are standardized for sex, race, age and primary disease causing ESRD. Units with fewer than twenty expected admissions are excluded. Source: Special Analysis.

Correlations* of SMRs and SHRs Across Years, 1991-1993

Units with >5 Expected Admission per Year

Statistic	1991 vs. 1992	1991 vs. 1993	1992 vs. 1993
SHR Admissions	0.59	0.49	0.61
SMR	0.22	0.22	0.20

* Spearman Rank Correlation

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Table IX-3

Spearman Rank Correlations of hospital admissions rate and mortality rate. Rates are standardized for sex, race, age and primary disease causing ESRD. Correlations compared rates between 1991 and 1992, between 1991 and 1993, and between 1992 and 1993. Units with fewer than five expected admissions per year are excluded. Source: Special Analysis.

Time Trends in the SHR

The unit specific SHR has a relatively stable value across years. Table IX-3 describes all pairwise rank correlations between the SHR's within a dialysis unit over the three year period. The correlation for 1991 vs. 1992 and 1992 vs. 1993 are seen to be approximately the same, averaging about 0.6. The correlation between 1991 and 1993 is lower, but is still quite high at 0.49.

These correlations indicate that a dialysis unit with a high SHR in one year is likely to have a high SHR over the next two years. This is in marked contrast to the correlation between the SMR's for those units in the same period of time, which is

Changes in Median SHRs of Admissions and Days Over Three Years, 1991-1993

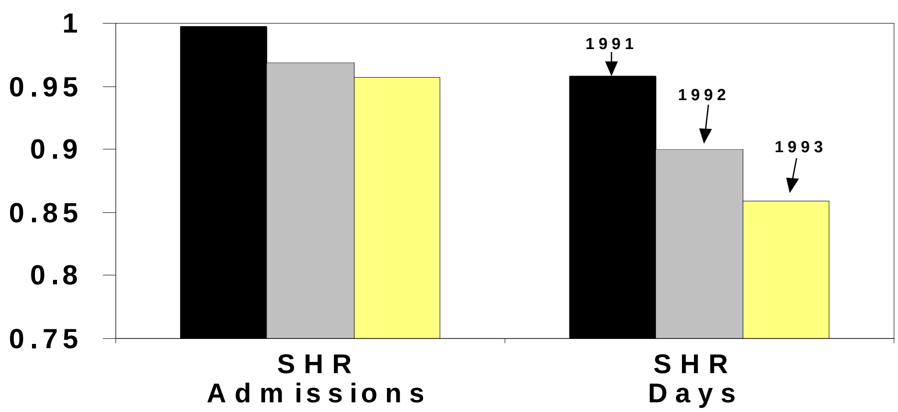

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Figure IX-11

Changes in the median hospital admissions and days rates for all dialysis units over time, 1991-1993. Rates are standardized for age, race, sex and primary disease causing ESRD. SHR for days includes days of hospitalization in the years at risk. Source: Special Analysis.

relatively constant at approximately 0.21. Note, however, that the level of correlation across years within each measure is relatively constant, possibly suggesting that their predictive properties are similar. The lower correlation seen in the SMR is due, in part, to the fact that it is based on fewer events (i.e. deaths vs. hospitalizations) and is hence subject to greater variability.

The SHR has declined in recent years. As seen in Figure IX-11, the median SHR for all dialysis units, measured in terms of hospital admissions or in terms of hospital days, declined between 1991 and 1993. These results indicate that *dialysis* patients are experiencing less hospitalization overall with each passing year, with fewer admissions per year and an even greater reduction in the number days spent in the hospital per year. These trends are consistent with both the overall national trend of decreasing hospitalization and the national trend of decreasing mortality among ESRD patients.

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