General Health of End Stage Renal Disease Program Beneficiaries

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A telephone survey of a national sample of 515 Medicare End Stage Renal Disease Program beneficiaries was conducted to obtain information on their health status and its determinants. The Medical Outcomes Study Short Form-36 (SF-36) was applied during the interview process to obtain the health-status information. The reliability of each SF-36 health-status dimension was at least 0.85, and the validity of seven of the eight dimensions was high. Weighted least-squares regression results showed that health-status levels were often lower among older patients and Hispanic persons, and sometimes lower for those with low incomes. The implications of using the SF-36 for health-status measurement are also described.

INTRODUCTION

Over the last few years, there has been increasing interest in expanding the methods used to assess health status among end stage renal disease (ESRD) patients. Early studies focused mainly on determinants of mortality or on the adequacy of dialysis as measured with clinical data. More recently the Institute of Medicine and others concluded that functional status and health-related quality of life should figure more prominently in studies of the health status of ESRD patients (Schrier et al., 1994; Kurtin et al., 1992).

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Shortly before and since the Institute of Medicine study, generic health-status measures such as the Karnofsky Index, the Sickness Impact Profile (SIP), and the Medical Outcomes Study SF-36 questionnaire were applied to ESRD patients at various dialysis centers around the country (Kurtin et al., 1992; Laupacis et al., 1991 and 1992; Levin et al., 1993; Meyer et al., 1994). Disease-specific measures such as the RAND Kidney Disease Quality of Life (KDQoL) measure (Hays et al., 1994) and the Kidney Disease Questionnaire (Laupacis et al., 1992) were also applied. Generic measures are appropriate when comparisons are made across settings or diseases, but the disease-specific measures are necessary when the research focus is on symptoms, complaints, or other problems that are more particular to ESRD patients (Guyatt, Feeny, and Patrick, 1993; Kutner, 1994).

Among the generic health-status instruments, the SF-36 is the one most often reported in the ESRD literature. According to its developers, the SF-36 "was constructed to represent eight of the most important health concepts included in the Medical Outcomes Study and other widely used health surveys" (Medical Outcomes Trust, 1994). These concepts and the survey items related to them are presented in Table 1.

The SF-36 is much shorter than most alternatives, and its reliability has been demonstrated in many populations (McHorney et al., 1994). However, neither the SF-36 nor its generic or disease-specific alternatives have been used to investi-

Table 1
Description of the SF-36 Health–Status Dimensions[1]

Health–Status Dimension	Items in the Health-Status Dimension	Meaning of Abbreviated Item Wording	Meaning of Lowest Possible Score (0)	Highest Possible Score (100)
Physical Functioning	10	Vigorous activities Moderate activities Lifting, carrying groceries Climbing several flights of stairs Climbing one flight of stairs Bending, kneeling, stooping Walking more than one mile Walking several blocks Walking one block Bathing or dressing	Limited a lot in performing all physical activities	Performs all types of physical activities, including the most vigorous, without limitations because of health
Role Limitations Resulting from Physical Problems	4	Cut down amount of time Accomplished less Were limited in kinds of activities Had difficulty performing activities	Problems with work or other daily activities as a result of physical health	No problems with work or other daily activities as a result of physical health
Bodily Pain	2	Severity of pain Interference due to pain	Very severe and extremely limiting pain	No pain or limitations because of pain
General Health Perceptions	5	My health is excellent As healthy as anybody I know Health excellent, very good, etc. Get sick easier than others Expect health to get worse	Believes personal health is poor and likely to get worse	Believes personal health is excellent
Vitality	4	Feel full of pep Have a lot of energy Feel worn out Feel tired	Feels tired and worn out all the time	Feels full of pep and energy all the time
Social Functioning	2	Extent interfered with social activities Time interfered with social activities	Extreme and frequent interference with normal social activities because of physical and emotional problems	Performs normal social activities without interference resulting from physical or emotional problems
Role Limitations Resulting from Emotional Problems	3	Cut down amount of time Accomplished less Didn't do activities as carefully	Problems with work or other daily activities as a result of emotional problems	No problems with work or other daily activities as a result of emotional problems
General Mental Health	5	Very nervous person Downhearted and blue Down in dumps Been a happy person	Feelings of nervousness and depression all the time	Feels peaceful, happy, and calm all the time

SOURCE: Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M., Abt Health Care Research Foundation, Cambridge, MA, 1995.

gate health-status differences among socioeconomic subgroups of ESRD patients who are of important clinical and programmatic interest, namely minorities, the elderly, and low-income patients.

The ESRD population has been aging over time and those over age 60 are the fastest-growing segment (Held et al., 1990; U.S. Department of Health and Human Services, 1995). As with black and Hispanic ESRD patients, older patients may reach end stage organ failure with more serious illness and subsequently have lower quality of life (Kurtin and Nissenson, 1993). Thus, older patients are often viewed as less appropriate candidates for transplantation (Kjellstrand et al., 1989), leaving dialysis and other medical and social services as the means for improving their health status and quality of life. Unless they are eligible for and apply for Medicaid, low-income patients may delay seeking treatment and therefore be more seriously ill when the underlying cause of ESRD is first diagnosed. This may reduce their quality of life as well. Unfortunately, very little is known about the less clinical aspects of health status among older, low-income, and minority ESRD patients.

In this article we report a study of the application of the SF-36 in a telephone survey of a national sample of 515 ESRD patients across the continental United States. This patient sample includes those whose first ESRD service was obtained in the first calendar quarter of 1992 and who survived long enough to be surveyed in mid-1995. Because ESRD is often a terminal condition, the annual mortality rate of ESRD patients is high, and many ESRD patients from the 1992 cohort died before the survey was conducted. Therefore, the sample of patients we analyzed is not representative of all new ESRD patients from the first-quarter 1992 cohort. Nevertheless, we provide information on the health status of surviving ESRD patients that was not previously available for a national sample.

The focus of the analyses we conducted with data from the sample of survivors is on measurement and analytic issues. A description of the methods used to collect health-status information in the telephone survey is offered. This is followed by an assessment of the reliability and validity of the use of the SF-36 as a measurement tool in a cohort of ESRD patients. Once reliability and validity have been established, the focus shifts to a description of the health status of various types of patients (e.g., those with functioning transplants versus those on dialysis). This information may be useful to others who are considering the SF-36 as a measurement tool and to those who are interested in comparing the characteristics of their patients with a broader national sample.

After examining the health status of ESRD patients, the results of multivariate analyses are described to show associations between health status and patients' age, race, and income, controlling for the risk of death associated with the underlying cause of ESRD and other factors. The results of the multivariate analyses indicate that general health status does indeed vary by age group, race, and income status. Some implications of these findings are then described.

DATA SOURCES

Data for this investigation were collected and merged from two sources, the Medicare ESRD Patient Management and Medical Information System (PMMIS) files and the telephone survey already mentioned. The Medicare PMMIS files supplied information about demographic factors, the underlying cause of ESRD,

hospitalization history, the existence of comorbidities, complicating conditions, and contraindications to transplantation. The telephone survey was used to collect information on health status, education, and household income. The demographic and socioeconomic factors, along with the clinical measures obtained from the PMMIS, were included as independent variables in multivariate models designed to identify the significant predictors of health status.

To obtain information on health status, the telephone survey included the SF-36 questionnaire to solicit information on eight dimensions of general health status: physical functioning, role limitations resulting from physical problems, bodily pain, general health, vitality, social functioning, role limitations because of emotional problems, and mental health (Table 1). These eight dimensions were measured and scored in a standardized manner using methods suggested by the Medical Outcomes Trust (1994). Scores on each health dimension may range from 0 to 100. Higher scores reflect better health status. A copy of the SF-36 telephone survey instrument is available upon request.

The SF-36 was chosen to measure health status for reasons noted by Kurtin et al. (1992). First, the SF-36 addressed a wide variety of health-status dimensions (however, it addressed fewer dimensions than disease-specific alternatives). Second, the SF-36 has been used reliably in other studies of ESRD patients (e.g., Kurtin et al., 1992; Levin et al., 1993; Meyer et al., 1994), leading one to expect that its reliability would be high in this study as well. Third, the SF-36 is much shorter than other health-status measurement alternatives, such as the SIP and the disease-specific measures already mentioned. Thus, respondent burden can be minimized. Finally, the SF-36 is easy to apply in a telephone survey, it is easy to score, and its scores are easy to interpret.

SURVEY AND STATISTICAL METHODS

Sampling Frame and Procedures

The sampling frame for the telephone survey included ESRD patients whose first Medicare ESRD service dates were in the first calendar quarter of 1992, who were still alive when the survey could be fielded (April-June, 1995), and who were 18-69 years of age (N = 5,594). Children were excluded because ESRD is relatively rare among those under age 18 (Rettig and Levinsky, 1991). Patients age 70 and over were excluded because kidney transplantation is rare among this group, and the survey was originally fielded to collect information on the predictors of kidney transplantation. Thus, for the analyses reported in this article, older patients are denoted as those age 60-69, and their health status is compared with patients in younger age groups.

Because of the original focus on kidney transplantation, those whose names appeared on one or more kidney transplant waiting lists were oversampled, representing about 40 percent of the sample. Telephone numbers were available from a directory look-up service for 57 percent (n = 3,168) of the patients in the sampling frame. The remaining 43 percent of patients either had unlisted phone numbers or had no telephones. To adjust for the potential bias associated with the lack of phone numbers for many ESRD patients, the telephone-matched file was subdivided into 10 strata based on the proportions of patients in the entire ESRD population (not just those with telephone numbers) in 5 age groups and 2 race categories (black and other than black). From each stratum, an age-race proportionate

random sample was then selected. This stratification allowed us to extract a sample of beneficiaries whose responses could be weighted to represent the surviving ESRD cohort, including those with and without available phone numbers.

Survey Process

After receiving approval from the relevant Institutional Review Board and the Federal Government regarding the methods used to deal appropriately with human subjects, the telephone survey interviews were conducted. These interviews were made evenings and weekends by trained, supervised interviewers during the months of April-June, 1995. Trained coders entered survey data into electronic data sets. All survey items were checked to ensure coding accuracy. A computer-generated data-cleaning process was also used to check for out-of-range or inconsistent values, and errors were corrected by referring to the original completed questionnaire. This process was iterative in nature, being repeated until no further errors were found.

Reliability and Validity Tests

The reliability and validity of the eight SF-36 health-status dimensions were estimated to determine whether information about these dimensions would be useful in subsequent analyses of the predictors of health status. As in other studies of ESRD patients (e.g., Kurtin et al., 1992; Meyer et al., 1994), reliability was estimated by Chronbach's alpha, a standard measure of the internal consistency of survey scales (Chronbach, 1951). Chronbach's alpha is an estimate of the ratio of the true variance of the SF-36 scale scores to the observed variance of those scores. Its value may vary from 0 to 1.0. As the ratio estimated by Chronbach's alpha approaches 1.0, there is less random error contributing to the variance of the observed scale scores of interest, meaning greater reliability in the data collection process (Carmines and Zeller, 1979).

The validity of the SF-36 health-status scores was tested in three ways for this study. First, to address construct validity, we conducted several Student's *t*-tests. These *t*-tests compared weighted mean scores for (1) patients who received a kidney transplant versus those who did not, (2) patients whose underlying cause of ESRD was diabetes versus others, and (3) patients who said their health status at the time of the survey was somewhat better or much better than it was 4 weeks earlier versus others. The literature suggests that patients with a functioning graft are healthier than those on dialysis (Health Care Financing Administration, 1987), either because of the transplant or because healthier patients are accepted for transplantation (Gaylin et al., 1993). Thus, if construct validity is evident, we would expect higher weighted mean SF-36 scores for those who had received transplants. Higher weighted mean scores would also be expected for those with less severe ESRD (i.e., for those whose ESRD was not caused by diabetes), and for those who were feeling better at the time of the survey than 4 weeks earlier.

The second validity test that was completed addressed the discriminant validity of the SF-36 scales. If the application of the survey instrument had discriminant validity in this study, one would expect the SF-36 items used to construct each health-status dimension to load heavily on (i.e., be highly correlated with) latent factors describing those dimensions in a factor analysis. In addition, if discriminant validity is high, items related to one health-status dimension should not load heavily on other latent

factors (Pai and Wan, to be published). The factor analyses that were conducted in this study used a varimax rotation to ensure that the underlying latent factors were orthogonal. This was done because none of the SF-36 items was designed to address more than one health-status dimension (Ware and Sherbourne, 1992), and rotation facilitated interpretation of the results.

The third validity analysis addressed both discriminant validity and construct validity. This analysis involved the calculation of correlation coefficients between two sets of SF-36 scale scores. The first set of scores included those calculated according to methods suggested by the Medical Outcomes Trust (1994). The second set of scores was estimated using methods described by Dillon and Goldstein (1984), who show how to estimate factor scores using observed data, a correlation matrix, and factor loadings that are obtained from a factor analysis. If the SF-36 was applied in a valid manner, these two sets of scores should be very highly correlated.

Regression Models

Weighted least-squares regression analyses were used to investigate relationships between the Medical Outcomes Study (MOS)-derived scores for the eight SF-36 summary scales and age, race, and household income, controlling for other socioeconomic and clinical factors. The weights adjusted for oversampling those on a transplant waiting list, black persons, and older patients, and for survey non–response. (The survey response rate was 61.7 percent.) The weighted least-squares regression analyses were estimated using the SUDAAN software package (Research Triangle Institute, 1991), to ensure that standard errors would be estimated appropriately, given the deviation from simple random sampling.

Two regression models were estimated for each of the 8 SF-36 health-status dimensions, leading to 16 total regressions. The first eight regressions were estimated for patients who had a functioning kidney transplant when the survey was conducted. Eight regressions were also estimated for patients who were on dialysis when the survey was fielded.

Health-Status Determinants

The major independent variables of interest in the regression analyses were the age-group, race, and household-income indicators. Three age-group indicators were used in the regression models (i.e., 35-44 years, 45-59 years, and 60-69 years), allowing comparisons to younger patients, those age 18-34. These age-group indicators are similar to those typically reported in the health services literature. Two race indicators were used to differentiate between black persons who are not Hispanic, Hispanic persons, and others, as is common in the recent ESRD literature (e.g., Kallich et al.; 1993; Eggers, 1995; Ozminkowski et al., to be published). Given the nature of the income distribution in our data, four household income indicators were used (i.e., ≤ $10,000, $10,001-19,999, $20,000-39,999, and missing income). These allowed comparisons between those at varying levels of poverty or income class to those with household incomes that were above the median in the United States for the study period (that median was about $40,000). The missing-income indicator was used to maximize the number of observations in the regressions and account for the 8.9 percent of respondents who decided not to report their incomes.

In addition to the age-group, income, and race indicators, other socioeconomic measures were included in the regression mod-

els. These were measured with binary indicators that adjusted for gender and educational status. A priori, one might expect better health among females than males, because Shibue et al. (1987) found that females had better survival rates on dialysis than males. With regard to educational status, we expected health status to be higher for those with at least a high school education versus others, because better-educated patients may be more likely to comply with ESRD treatment regimen.

Based on the literature, several clinical measures were also included in the regression models. These included binary indicators for:

- The use of hemodialysis.
- Switching dialysis type sometime before the survey was fielded.
- The occurrence of a previous kidney transplant.
- The existence of any contraindications to transplantation (i.e., morbid obesity, heart or peripheral vascular disease, transient ischemic attack, hepatitis, cirrhosis of the liver, pulmonary edema, or chronic obstructive pulmonary disease).
- The occurrence of hospitalization within 180 days of the first ESRD service date.
- The existence of either:

  (a) High-risk ESRD (resulting from diabetes).

  (b) Medium-risk ESRD (because of hypertension) with high-risk complicating conditions (i.e., heart disease, uncontrolled hypertension, diabetes, or pulmonary disease).

  (c) Medium-risk ESRD with intermediate-risk complicating conditions (i.e., malignancy) or low-risk complicating conditions, or without complications.

  (d) Low-risk ESRD (not resulting from diabetes or hypertension) with high-risk complications.

Diamond, Held, and Palumbo (1984) and Held et al. (1990) showed that mortality tended to be higher for patients in these risk categories, compared with those with low-risk ESRD and no complicating conditions. These authors also showed that hospitalization early in the course of ESRD was associated with lower survival rates. The findings from the National Kidney Dialysis and Kidney Transplantation Study showed that those who had a previous rejected transplant typically returned to dialysis in worse health status than when they left dialysis. That study also showed that health status may be higher among hemodialysis patients, compared with those on peritoneal dialysis (Health Care Financing Administration, 1987). (However, others [Kurtin and Nissenson, 1993] note that associations between dialysis type and health status tend to vary according to the health-status measure that is used.) Health status was expected to be higher for those who did not switch dialysis types, because switching may be for medical reasons or because of patient preferences associated with perceptions of health status.

Next, to ensure that data from all 515 patients would be used in the regression analyses, we added a binary indicator to denote those whose dialysis type was missing from the PMMIS records ($n = 67$).

With several variables used to control for socioeconomic factors, ESRD severity, and transplant suitability, the potential exists for problematic collinearities between factors such as: income and educational level, race, or age group; race and having hypertension as the underlying cause of ESRD; the ESRD severity measures, and having contraindications to transplantation. Such collinearities would result in unstable regression parameter estimates that were used to measure relationships between health status and socioeconomic and other factors. To

address this issue, we conducted tests of collinearity between the variables included in the regression models, using the condition index suggested by Belsley, Kuh, and Welsch (1980) as the measure of collinearity.

RESULTS

Descriptive Statistics for the Sample

Adjusting for survey non-response and for the particulars of the sampling process already described, Table 2 provides the weighted proportions and standard deviations for the covariates used in the regression analyses. These values reflect the characteristics of ESRD patients who remained alive for at least 3 years after their initial ESRD service date. Thus, these characteristics may differ from those reported in other studies that address the incidence of ESRD shortly after the ESRD diagnosis was made, or the prevalence of ESRD as measured with samples that include those who died in the analyses of interest.

Table 2 shows that about 54 percent of the survey sample were male, 38 percent were black persons who were not Hispanic, 5 percent were Hispanic persons, and 32 percent were 60-69 years of age. About 72 percent of the sample had a high school diploma or higher educational level, and about 38 percent lived in households with incomes less than or equal to $10,000 (in 1995 dollars). Diabetes was the primary cause of ESRD for about 29 percent of the sample. About 56 percent of the patients had one or more contraindications to transplantation, and about 66 percent used hemodialysis when on dialysis. About 31 percent were hospitalized sometime in the 180 days immediately following their first ESRD service date, and about 50 percent said their health at the time of the telephone survey was somewhat better or much better than it had been in the previous 4 weeks.

Reliability and Validity Test Results

Table 3 shows that the SF-36 items were used reliably in this study. Chronbach's alpha measures for the SF-36 health-status dimensions ranged from 0.85 to 0.88, denoting very high reliability. These measures have a smaller range than the reliability estimates obtained by Kurtin et al. (1992) and Meyer et al. (1994), whose reliability estimates ranged from 0.62 to 0.90 and 0.77 to 0.93, respectively. The smaller range of reliability estimates in our study may be the result of the much larger sample size, which could have led to smaller variances in the scale scores. The smaller range in our study also indicates a slightly higher degree of reliability for some health-status dimensions (e.g., general mental health and vitality) and a slightly lower degree of reliability for other dimensions (e.g., physical functioning), compared with those other studies.

We also found the construct validity and discriminant validity of seven of the eight SF-36 health-status dimensions to be high. As shown in Table 4, most mean values for the SF-36 health-status dimensions were higher, and often significantly higher, for those whose health status was expected to be higher a priori (i.e., among transplant recipients, those without diabetes, and those who said their health status was better at the time of the survey than 1 week earlier). In addition, the factor-analysis results (which are not reported here but are available from the authors upon request) showed that seven of the eight health-status dimensions were easily identifiable in the factor analysis, and the survey items contained in those seven dimensions were more highly correlated with those dimensions than with other dimen-

Table 2
Descriptive Statistics for the Variables Included in the Regression Analyses[1]

Variable	Weighted Proportion	Weighted Standard Deviation
Gender Is Male	0.54	1.64
Race is Black, not Hispanic	0.38	1.59
Race is Hispanic	0.05	0.74
Age 30-44 years	0.21	1.33
Age 45-59 years	0.35	1.57
Age 60-69 years	0.32	1.54
Had at Least a High School Diploma	0.72	1.46
Household Income Less than $10,000	0.38	1.59
Household Income $10,001-29,999	0.19	1.29
Household Income $30,000-39,999	0.17	1.24
Did Not Report Household Income	0.09	0.94
Had High-Risk ESRD (i.e., from Diabetes)	0.29	1.49
Had Intermediate-Risk ESRD (Because of Hypertension) with High-Risk Complications (e.g., Uncontrolled Hypertension, Heart Disease, Diabetes, or Pulmonary Disease)	0.20	1.32
Had Intermediate-Risk ESRD with Intermediate-Risk Complications (e.g., Malignancy), or with No Complications	0.07	0.87
Had Low-Risk ESRD (Not Because of Diabetes or Hypertension) with High-Risk Complications	0.29	1.49
Had One or More Contraindications to Transplantation (e.g., Morbid Obesity, Heart or Peripheral Vascular Disease, Hepatitis, Cirrhosis of the Liver, Transient Ischemic Attack, Pulmonary Edema, or Chronic Obstructive Pulmonary Disease)	0.56	1.63
Had a Previous Transplant	0.04	0.18
Was Hospitalized Sometime in 180 Days Immediately Following First ESRD Service Date	0.31	1.51
Used Hemodialysis	0.66	1.55
Ever Switched Dialysis Type	0.12	1.06
Information on Switching Dialysis Type is Missing	0.13	1.12
Health Status at Time of Survey Was Much Better or Somewhat Better than in Previous 4 Weeks	0.50	1.64

[1] $n = 515$.

NOTE: ESRD is end stage renal disease.

SOURCE: Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M., Abt Health Care Research Foundation, Cambridge, MA, 1995.

sions. The problematic health-status dimension was the one that addressed social functioning. Table 4 shows that the mean scores for this dimension were significantly higher for transplant versus dialysis patients, for those with lower-risk ESRD versus those whose ESRD was the result of diabetes, and for those who said their health status had improved in the 4 weeks prior to the survey date; these results suggest adequate construct validity. However, the correlation between the scores on this dimension that were based upon the factor loadings and the standardized scores that were calculated according to MOS instructions was much lower (0.46) than the correlations between these two sets of scores for the other dimensions (which ranged from 0.70 for vitality to 0.94 for the role-emotional dimension)[1]. Moreover, the factor-analysis results (avail-

[1] Detailed results of these correlation analyses are available upon request from the author.

Table 3
Reliability of the SF-36 Scales

Health-Status Dimension	Sample Size	Reliability (Chronbach's Alpha)
Physical Functioning	515	0.86
Role Limitations Resulting from Physical Problems	515	0.86
Bodily Pain	515	0.86
General Health Perceptions	515	0.87
Vitality	515	0.85
Social Functioning	515	0.86
Role Limitations Because of Emotional Problems	514	0.88
General Mental Health	515	0.86

SOURCE: Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M., Abt Health Care Research Foundation, Cambridge, MA, 1995.

able upon request) showed that the two SF-36 items that were used for the social-functioning dimension did not load heavily on any of the eight health-status dimensions that one would expect to find in a factor analysis. Because of the mixed validity findings for the social-functioning dimension, the results described for that dimension should be viewed with caution.

Health Status—Mean SF-36 Scores

The weighted mean values of the eight SF-36 scales are shown for all patients, then separately for the categories of patients used in the validity tests, in Table 4. The mean values that were based on the entire sample of 515 patients varied from 44.21 to 73.81. As noted earlier, mean scores were usually higher for the types of patients who were expected to be healthier a priori. For the entire sample and for each subgroup of patients shown in the table, mean values were higher for the social-functioning, role-emotional, and mental health scales, than for scales more closely related to physical health and vitality.

The studies that we found in the literature showed SF-36 scale means only for dialysis patients. The results provided for dialysis patients in Table 4 are fairly similar to those reported in the literature for many, but not all, health-status dimensions. For example, the means reported in this study are very similar to those reported in Meyer et al. (1994) for seven health-status dimensions. However, the mean score for the role-emotional scale was much higher in this study (72.2) than in Meyer et al. (55.2).

Transplant Regression Models

The results of the weighted least-squares regressions are presented for transplant recipients in Table 5. Overall, these regressions performed moderately well. All of the *p*-values for the regression *F*-statistics were less than 0.01, and with one exception, the adjusted R^2 values were typical of regressions based on cross-sectional data, ranging from 0.04 (for general health perceptions) to 0.15 (for general mental health). The regression with the lowest R^2 value was the one that addressed bodily pain; its adjusted R^2 value was only 0.002. The adjusted R^2 for the bodily-pain regression was low because that regression included no statistically significant health-status determinants.

It should be noted that the number of significant variables in the bodily-pain regression and in the other regressions was not affected by collinearity problems. None of the condition index values for the variables in the transplant regressions exceeded 3.71. Belsley, Kuh, and Welsch (1980) note that problematic collinearities are usually associated with much higher condition index values (e.g., exceeding 20.00).

Table 4
Construct Validity *t*-test Results for the SF-36 Scale, with Variable Means and Standard Deviations in Parentheses

Health-Status Dimension	Overall (n = 515)	Transplant Patients (n = 211)	Dialysis Patients (n = 304)	Underlying Cause of ESRD is Not Diabetes (n = 368)	Underlying Cause of ESRD is Diabetes (n = 147)	Patients Whose Health Is Much Better or Somewhat Better Now than 4 Weeks Ago (n = 259)	Patients Whose Health Is About the Same, Somewhat Worse, or Much Worse Now than 4 Weeks Ago (n = 256)
Physical Functioning	57.20 (99.77)	** 69.86 (28.23)	53.10 (28.96)	** 62.89 (28.44)	52.64 (31.90)	62.52 (28.32)	57.39 (31.06)
Role Limitations Because of Physical Problems	44.21 (130.30)	** 60.49 (39.78)	39.42 (37.76)	** 51.03 (40.64)	40.62 (37.19)	** 53.60 (39.46)	42.45 (39.71)
Bodily Pain	63.22 (97.60)	** 76.40 (25.37)	59.34 (29.13)	66.70 (28.94)	65.20 (28.80)	** 70.11 (25.90)	62.52 (31.18)
General Health Perceptions	47.68 (78.53)	** 58.03 (24.59)	43.66 (22.93)	** 52.25 (25.02)	42.80 (22.33)	** 54.17 (22.89)	44.88 (25.19)
Vitality	46.47 (82.57)	** 57.99 (23.97)	42.34 (23.77)	49.93 (24.92)	45.81 (25.20)	** 53.53 (23.52)	43.92 (25.65)
Social Functioning	69.41 (97.75)	** 82.41 (24.61)	65.74 (30.08)	* 74.31 (27.87)	68.22 (31.73)	** 77.23 (25.68)	67.86 (31.59)
Role Limitations Because of Emotional Problems	73.81 (123.00)	78.71 (36.32)	72.20 (37.95)	73.56 (38.87)	78.12 (34.74)	76.12 (37.23)	73.59 (37.58)
General Mental Health	72.77 (68.44)	** 76.99 (19.17)	72.12 (21..34)	74.05 (21.13)	74.28 (19.29)	75.86 (18.66)	72.35 (22.29)

* $0.01 < p \leq 0.05$ for comparison to patients in adjacent column to the right.

** $p \leq 0.01$ for comparison to patients in adjacent column to the right.

NOTE: ESRD is end stage renal disease.

SOURCE: Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M., Abt Health Care Research Foundation, Cambridge, MA, 1995.

Table 5
Results from Weighted Least-Squares Regressions for Those with Functioning Grafts[1]

Variable	Health-Status Dimension							
	Physical Functioning	Role Limits Because of Physical Problems	Bodily Pain	General Health Perceptions	Vitality	Social Functioning	Role Limits Because of Emotional Problems	General Mental Health
Intercept	** 194.74	** 314.18	** 42.25	62.48	** 126.08	** 162.92	* 134.42	** 132.37
Age 35-44 Years	-7.69	** -24.09	-7.72	-1.12	0.02	2.05	1.34	0.05
Age 45-59 Years	*-11.88	** -25.09	-10.28	0.65	-3.81	-4.51	-1.35	1.54
Age 60-69 Years	*-16.46	** -38.71	-6.42	5.77	-4.92	-5.25	-3.02	3.38
Household Income Less than $10,000	-4.98	* -16.69	-3.94	-1.11	-9.96	-5.09	-1.27	-1.71
Household Income $10,001-19,999	-10.81	* -19.71	-0.56	-3.04	-10.58	-8.37	-4.66	-7.43
Household Income $20,000-39,999	-4.27	-10.29	-7.83	-2.45	-6.79	-6.37	-5.01	* -9.83
Income Data Missing	0.73	-5.66	-4.31	-3.19	5.30	-1.78	3.64	-4.13
Race is Black, Not Hispanic	-5.15	3.60	-0.89	0.61	-2.68	-3.63	-4.13	-1.90
Hispanic Race	** -17.69	-1.40	-3.76	-4.26	-3.56	** -19.85	-11.01	* -9.21
Male	2.31	-3.25	6.11	-4.33	3.26	0.52	6.36	5.42
Had at Least High School Education	-0.07	-2.65	3.97	* 9.75	* 12.29	-0.64	1.24	5.10
Had High-Risk ESRD (i.e., from Diabetes)	-4.30	-8.58	-2.80	-8.32	*-10.70	-3.19	15.05	4.66
Had Intermediate-Risk ESRD (i.e., from Hypertension) with High-Risk Complications	-9.02	-15.36	-10.16	-9.27	*-14.09	-7.38	-5.75	** -13.07
Had Intermediate-Risk ESRD with Intermediate-Risk or Low-Risk Complications or No Complications	-18.02	-29.02	-11.73	-13.15	-17.20	-9.02	-26.89	-6.73
Had Low-Risk ESRD (i.e., Not Resulting from Diabetes or Hypertension) with High-Risk Complications	-1.92	-3.96	-2.64	-1.53	*-10.64	3.43	4.52	-2.73
Had One or More Transplant Contraindications	**-12.16	-9.89	-7.11	-1.14	-0.63	-6.95	-9.19	-4.70

See notes at end of table.

Table 5 — Continued
Results from Weighted Least-Squares Regressions for Those with Functioning Grafts[1]

Variable	Health-Status Dimension							
	Physical Functioning	Role Limits Because of Physical Problems	Bodily Pain	General Health Perceptions	Vitality	Social Functioning	Role Limits Because of Emotional Problems	General Mental Health
Patient Used Hemodialysis Before Transplantation	-3.33	-10.66	-4.97	5.94	-3.18	-5.67	-14.72	* -6.45
Patient Switched Dialysis Types Before Transplantation	4.87	15.42	5.02	4.83	** 13.36	9.95	11.50	1.41
Dialysis Type Information Missing	6.77	-1.26	-2.06	* 11.87	-0.64	0.51	-0.90	-2.66
Patient was Hospitalized Within 180 Days After First ESRD Service Date	-6.54	-5.66	-4.57	** -10.88	** -10.99	-6.38	-4.25	-6.30
Health at Time of Survey Was Much Better or Somewhat Better than 4 Weeks Earlier	** 11.93	7.41	-1.20	* 9.24	** 10.23	6.51	0.78	3.46
Regression p-value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Adjusted R^2	0.143	0.104	0.002	0.044	0.140	0.109	0.059	0.152

* $0.01 < p \leq 0.05$

** $p \leq 0.01$

[1] $n = 211$

NOTE: ESRD is end stage renal disease.

SOURCE: Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M., Abt Health Care Research Foundation, Cambridge, MA, 1995.

Age/Income/Race Effects Among Transplant Recipients

Table 5 shows that age was a significant determinant of health status in two of the eight regressions conducted for those with a functioning graft (i.e., for regressions dealing with physical functioning and role limitations resulting from physical problems). In every instance in which a significant association was found, the sign of the age group coefficients indicated lower health status for older patients, relative to beneficiaries 18-34 years of age. For example, Table 5 shows that the mean physical functioning score was 16.46 points lower for those 60-69 years than for those 18-34 years, adjusting for all of the other variables in the regression model. Table 5 also shows that the mean score on the scale that addressed role limits resulting from physical problems was 38.71 points lower for those 60-69 years of age than for those 18-34 years, controlling for other factors. Age group was not a significant determinant of the health-status dimensions that addressed general health perceptions, bodily pain, vitality, social functioning, role limits resulting from emotional problems, and general mental health.

Next, Table 5 shows a significant association between household income and the health-status dimensions that addressed role limits resulting from physical problems and general mental health. In each of these cases, those with incomes greater than or equal to $40,000 had higher health status than those with lower incomes. For example, Table 5 shows that mean general mental health scores were 9.83 points lower for those with incomes of $20,001-39,999, compared with those with incomes of $40,000 and higher. The largest income-related health-status association was found in the regression that addressed role limits resulting from physical problems. In that regression, those with household incomes of $10,001-19,999 had a mean scale score that was 19.71 points lower than those with incomes greater than $40,000. For those with a functioning transplant, household income was unrelated to health-status dimensions that addressed physical functioning, bodily pain, general health perceptions, vitality, social functioning, and role limits resulting from emotional problems.

With regard to race, the results from the regressions conducted for transplant recipients showed no significant differences in health status between black persons and the reference group, which included Caucasians, Asians, and other patients who were neither black nor Hispanic. Hispanic persons, however, tended to have worse health status than those in the reference group (Table 5). For example, mean mental health scores were 9.21 points lower for Hispanic persons, mean physical-functioning scores were 17.69 points lower for Hispanic persons, and mean social-functioning scores were 19.85 points lower for Hispanic persons, controlling for other factors.

Other Health Correlates Among Transplant Recipients

Relationships between health status and other factors are also noted in Table 5. First, the table shows no significant relationships between gender and health status. With regard to educational status, having a high school education was significantly and positively related to health status in only two regressions, those that addressed general health perceptions and vitality.

Next, there were several instances in which health status was associated with the severity of the underlying cause of ESRD and the existence of complicating conditions. For example, compared with those with low-risk ESRD and no complica-

tions, those whose ESRD resulted from diabetes had a significantly lower mean score on the vitality dimension. Those with intermediate-risk ESRD (i.e., resulting from hypertension) and high-risk complications had significantly lower mean scores on dimensions addressing vitality and general mental health. Those with low-risk ESRD and high-risk complications had a mean score on the vitality dimension that was 10.64 points lower than those with low-risk ESRD and no complications.

Table 5 also shows that those who had one or more contraindications to transplantation had a significantly lower mean score on the physical-functioning dimension, compared with those without any contraindications. Next, those who used hemodialysis before receiving a transplant had a significantly lower mean score on the general mental-health-status dimension, compared with those who used peritoneal dialysis. Surprisingly, those who switched dialysis types sometime before the survey had a significantly higher mean score on one dimension, that which addressed vitality, compared with those who did not switch dialysis type. Next, those who were hospitalized within 180 days of their first ESRD service date had significantly lower mean scores on two dimensions, those addressing general health perception and vitality, compared with those who were not hospitalized, all other things being equal. Finally, those who reported that their overall health status was higher when the survey was completed (compared with 4 weeks earlier) had higher mean scores on the physical functioning, general health perception, and vitality scales than those who said their overall health status was unchanged or worse.

Dialysis Regression Models

Table 6 provides the regression results for those on dialysis at the time of the interviews ($n = 304$). Like the transplant regressions, these regressions performed moderately well. All regression p-values were less than 0.01. With one exception, adjusted R^2 values ranged from 0.05 to 0.20. The regression with the lowest adjusted R^2 value (0.02) was the one pertaining to role limits resulting from emotional problems. That regression had only one significant coefficient, which pertained to those for whom dialysis type was missing. Such patients had lower health status, on average, compared with the reference category of peritoneal dialysis.

Like the transplant regressions, those estimated for dialysis patients were not affected by collinearity problems. None of the condition index values exceeded 5.25.

Age/Income/Race Effects for Dialysis Patients

Table 6 shows that five of the eight regressions that were estimated for dialysis patients included statistically significant coefficients for one or more age-group coefficients. All of the age-group coefficients were negative in sign, implying lower levels of health for those over 18-34 years of age. For example, those 45-59 years of age had mean scores for physical functioning, bodily pain, general health perceptions, vitality, and general mental health that were at least 10 points lower than those 18-34 years of age ($p < 0.01$ in each case). The only health-status dimensions that were not significantly related to age group were those that addressed role limitations resulting from physical problems, social functioning, and role limits resulting from emotional problems.

Table 6 also shows that scores on three of the eight health-status dimensions were significantly related to household-income category. With one exception, however,

Table 6
Results from Weighted Least-Squares Regressions for Dialysis Patients[1]

Variable	Health-Status Dimension							
	Physical Functioning	Role Limits Because of Physical Problems	Bodily Pain	General Health Perceptions	Vitality	Social Functioning	Role Limits Because of Emotional Problems	General Mental Health
Intercept	** 160.21	77.31	83.94	** 169.69	* 98.05	** 143.90	** 192.56	** 182.00
Age 35-44 Years	-9.39	-12.71	-13.46	** -16.70	** -14.87	-12.79	-6.55	-7.26
Age 45-59 Years	** -21.32	-12.70	* -16.77	** -20.62	** -17.28	-13.23	-12.81	** -10.07
Age 60-69 Years	-12.26	-0.81	-8.27	** -17.02	-10.62	-11.52	-3.76	-6.30
Household Income Less than $10,000	-3.74	-1.22	0.17	-3.61	-1.45	-0.37	-14.41	** -11.15
Household Income $10,001-19,999	-1.76	6.91	-4.15	-5.82	-3.04	-0.89	-6.40	-5.99
Household Income $20,000-39,999	-9.90	-8.63	-8.26	-8.10	-6.05	-10.43	-7.85	-7.32
Income Data Missing	* -17.71	-16.23	-12.22	* -12.26	-7.19	-8.57	-14.78	** -17.92
Race is Black, Not Hispanic	* 9.70	3.08	4.42	2.96	* 7.97	-4.33	4.61	4.87
Hispanic Race	-4.61	-16.57	-0.09	-7.91	2.37	* -14.47	-1.94	-6.74
Male	3.71	-0.60	0.52	-1.45	1.56	-2.63	3.60	1.21
Had at Least High School Education	7.72	1.79	6.23	5.33	3.08	0.39	0.42	2.57
Had High-Risk ESRD (i.e., from Diabetes)	-6.75	-6.36	4.46	** -12.70	-1.11	2.20	3.93	-8.46
Had Intermediate-Risk ESRD (i.e., from Hypertension) with High-Risk Complications	-6.50	9.91	0.60	* -9.69	-3.95	8.94	2.79	* -10.91
Had Intermediate-Risk ESRD with Intermediate-Risk Complications	-1.72	-1.15	8.01	-7.40	-8.75	-4.43	-6.97	-9.84
Had Low-Risk ESRD (i.e., Not Resulting from Diabetes or Hypertension) with High-Risk Complications	1.18	-3.90	2.62	-4.66	-1.44	1.69	12.24	-2.14

See notes at end of table.

Table 6—Continued
Results from Weighted Least-Squares Regressions for Dialysis Patients[1]

Variable	Health-Status Dimension							
	Physical Functioning	Role Limits Because of Physical Problems	Bodily Pain	General Health Perceptions	Vitality	Social Functioning	Role Limits Because of Emotional Problems	General Mental Health
Had One or More Transplant Contraindications	-4.56	-0.12	1.47	-5.51	* -6.89	-9.06	-2.76	-0.94
Patient Was Hospitalized Within 180 Days After First ESRD Service Date	-3.80	-2.93	-2.03	4.32	-4.36	3.28	-4.90	0.72
Patient Used Hemodialysis	-0.42	5.94	-3.73	5.86	* 10.74	4.98	-11.66	-0.53
Patient Switched Dialysis Types	-5.90	-3.11	-0.25	-2.64	-3.39	-7.97	-10.86	-3.24
Dialysis Type Information Missing	-14.89	2.64	-7.06	-6.07	-0.92	0.001	* -25.04	-1.17
Health at Time of Survey Was Much Better or Somewhat Better than 4 Weeks Earlier	3.94	** 15.45	** 13.10	** 14.28	** 9.83	** 11.04	6.69	** 8.34
Had Previous Transplant	5.22	-1.12	9.88	1.43	4.28	0.21	-4.35	-2.25
Regression *p*-value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Adjusted R^2	0.17	0.10	0.07	0.2	0.13	0.05	0.02	0.06

* $0.01 < p \leq 0.05$

** $p \leq 0.01$

[1] $n = 304$

NOTE: ESRD is end stage renal disease.

SOURCE: Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M., Abt Health Care Research Foundation, Cambridge, MA, 1995.

the problematic income category tended to be those who did not report their incomes. In the regressions pertaining to physical functioning, general health perceptions, and general mental health, those who failed to report their incomes had mean scores that were at least 12 points lower than those whose household incomes were greater than or equal to $40,000. In the regression pertaining to general mental health, those with incomes of $10,000 or less had a mean score that was about 11 points lower than those with incomes greater than or equal to $40,000.

With regard to race, black persons tended to have better health status than those in the reference category. Significantly higher scores were found for black persons in the regressions that addressed physical functioning and vitality. These findings are not surprising, in light of earlier research that showed better survival for black persons on dialysis, compared with persons of other races (Held, Pauly, and Diamond, 1987; Held et al., 1990). Similar tendencies were not found for Hispanic ESRD beneficiaries. Compared with Caucasian people and other persons who were neither black nor Hispanic, Hispanic persons had a significantly lower mean score on the social-functioning scale. The mean scores were lower for Hispanic persons but not significantly so, for six of the remaining seven dimensions as well.

Other Health Correlates Among Dialysis Patients

Relationships between the health status of dialysis patients and other factors are also noted in Table 6. First, neither gender nor educational level significantly influenced scores on any of the health-status dimensions. Next, among dialysis patients, variables that measured the relative severity of ESRD and the existence of complications were significant in only two regressions: those that addressed general health perceptions and general mental health. In the general-health-perceptions regression, beneficiaries with higher-risk ESRD (i.e., because of diabetes) had lower health status than those with low-risk ESRD and no complications. In both regressions those with intermediate-risk ESRD (because of hypertension) and high-risk complications had significantly lower health status than those with low-risk ESRD and no complications.

Next, in the vitality regression, we found significantly lower health status among those who had one or more contraindications to transplantation, compared with those without contraindications. Finally, no relationships were found between health status and being hospitalized within the 180 days immediately following the date of the patient's first ESRD service.

With regard to dialysis type, those on hemodialysis at the time of the survey had significantly higher scores on the vitality dimension than did peritoneal dialysis patients. Switching dialysis types was not associated with any of the health-status dimension mean scores. Those with unknown dialysis types had a significantly lower mean score on the role-emotional dimension.

As in the transplant regressions, patients who said their overall health status was better at the time of the survey versus 4 weeks earlier had significantly higher mean scores for several dimensions, compared with those who said their health status was about the same or worse at the time of the survey. The only dimensions for which this was not the case were those addressing physical functioning and role limitations because of emotional problems.

Finally, no relationships were found between health status and returning to dialysis after a failed transplant.

SUMMARY, DISCUSSION, AND LIMITATIONS

This study described the analysis of telephone survey and other data related to the general health status of a national sample of Medicare ESRD program beneficiaries. Previous studies focused primarily on measuring health status among patients at one or a small number of dialysis centers (e.g., Kurtin et al., 1992; Meyer et al., 1994) or used samples that may not have been representative of surviving ESRD patients across the country (e.g., Health Care Financing Administration, 1987). With the exception of the HCFA study just referenced, little could be found that addressed the general health status of transplant recipients. Thus, the results reported in this article may be useful for making comparisons in future studies that address the general health status of dialysis and transplant patients.

In this analysis, the SF-36 was applied in a reliable and valid way, with just one concern about the validity of its social-functioning scale. Validity tests for the social-functioning scale were inconclusive. One validity test was based on mean social-functioning scores across subgroups of patients; this test suggested adequate construct validity. However, other tests that were based on factor analyses suggested lower discriminant and construct validity for that health-status dimension. Thus, results pertaining to the social-functioning dimension should be viewed with caution.

The bivariate analyses that we conducted showed substantial differences in the SF-36 mean scores for transplant versus dialysis patients for seven of the eight health-status dimensions (Table 4). These dimensions addressed physical functioning, role limits resulting from physical problems, bodily pain, general health perceptions, vitality, social functioning, and general mental health. The high transplant-dialysis patient differences imply that these dimensions should at least be considered, as resources and programs are applied at dialysis centers to increase the health status of ESRD patients. However, as two of the reviewers of this manuscript noted, it does not necessarily follow that where there is greater burden there will be greater benefits of treatment. Our results show differences in health status that others may wish to consider when deciding how to spend treatment dollars, but definitive conclusions on how to spend additional treatment resources cannot be made on the basis of these data alone.

Although the bivariate analyses showed very general relationships between health status and just a few other factors (e.g., transplantation status, cause of ESRD), the multivariate analyses showed how health status was associated with several demographic and socioeconomic factors, controlling for differences across sample members in severity of illness. The study reported in this article is the first one we know of to estimate the importance of predictors of health status in a multivariate framework. The results indicated that age and race were often associated with health status, and that income sometimes was associated with health status. However, none of the independent variables in the regression models was significantly associated with all eight health-status dimensions.

Those who are interested in leveling health status across the demographic and socioeconomic categories might focus on the dimensions where the regression coefficients are both large and statistically significant for these categories. For the surviving transplanted patients in the 1992

cohort, these dimensions included physical functioning (which varied by age and race), role limits resulting from physical problems (which varied by age and income), and general mental health (which varied by race and income). For surviving dialysis patients, these dimensions included physical functioning, bodily pain, general health perceptions, vitality, and general mental health (all of which varied by age). General mental health status also varied by income among dialysis patients.

Making the move from regression findings to policy or medical practice should be done with caution, however, because areas of need for large groups of patients may not correspond to areas of need for smaller groups or for individual patients. In addition, there may be limits to the amount of need that can be ameliorated in the typical treatment context. Thus, transplant and dialysis providers are encouraged to do their own assessments of the general health status of their patients and then confer with those patients about ways to meet the observed needs. The results reported in this article may be used to specify hypotheses worthy of testing in future analyses. These results are also valuable for providing baseline data on health-status predictors among a cohort of surviving patients.

Value and Limitations

As with any empirical research, the value of the information presented here should be viewed in the context of the decisions made about patient sampling, data limitations, and statistical methods. These decisions often influence empirical findings and help cast the discussion of the implications of those findings.

With regard to sampling, we noted earlier that the patient sample we selected is representative of surviving ESRD patients from the calendar-one, 1992 cohort of new ESRD patients. It is not representative of all patients from that cohort, because many died between the time of their first ESRD service in 1992 and when the survey was fielded. A better, yet prohibitively expensive (for us), way to obtain health-status information from ESRD patients would be to identify a cohort of interest very shortly after they receive their first Medicare ESRD service, and then survey that cohort early and periodically. Generally speaking, this strategy is analogous to that used for the Medicare Current Beneficiary Survey (MCBS), which is applied every 4 months to a cohort of other Medicare beneficiaries (U.S. Department of Health and Human Services, 1994). Because there is a 3-month waiting period for Medicare ESRD coverage (U.S. Department of Health and Human Services, 1995) and because our survey was fielded about 3 years after Medicare coverage began for the 1992 ESRD cohort, the information we report is similar to what one might find in the 9th or 10th wave of a thrice-yearly panel survey designed like the MCBS, if that survey included SF-36 health-status questions asked of ESRD patients. Like our study, such a panel survey would provide health-status information at a given point in time for a cohort of ESRD patients. In addition, a panel survey would provide information that could be used to track how health status changes over time for a representative cohort of patients.

With regard to data limitations, it should be noted that imperfect controls were applied for severity of the underlying cause of ESRD and for the occurrence of complicating conditions and contraindications to transplantation. These controls were based primarily on *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis codes found in the PMMIS data. Over time the

availability of diagnosis codes has increased in the PMMIS data, and by the time we received data for the 1992 cohort (in late 1994), these data were fairly complete. However, even a complete listing of diagnosis codes cannot provide as much detail about severity of illness, prognosis, and response to treatment as one would ideally like to have when studying predictors of health status. A more complete picture of illness severity, prognosis, and response to treatment might come from medical records, but medical records data from a national sample would be very difficult, if not impossible, to obtain in a timely manner. Thus, one is left with the need to control for medical factors with imperfect data.

The imperfect controls for illness severity that were applied here would be problematic if we failed to account for other health-status determinants that are highly correlated with the socioeconomic factors included in the regression models. If so, some bias would remain in the estimated associations between general health status and the socioeconomic factors included in those models. There is no way to address this issue empirically—it is a limitation inherent in using claims or administrative data for analyses of this type. Thus, it is worth recognizing a list of unmeasured factors that may be associated with general health status that could not be accounted for here. Among dialysis patients these include the clinically assessed adequacy of dialysis, whether dialyzers were reused, whether high-flux/high-efficiency dialyzers were used, nutritional habits, compliance with treatment regimen, anemia control, and health-status levels prior to ESRD (Kurtin and Nissenson, 1993). Schwab (1994) notes that dialysis access failures caused by fistula thrombosis and infection are leading causes of morbidity among hemodialysis patients. Among transplant patients, reactions to or compliance with immunosuppressive drug treatment influence health status. Little is known about the relationship between these factors and socioeconomic status, and more research should be done in these areas.

In terms of the implications of the results reported here, one might note that the multivariate analyses found a relatively small number of statistical associations between health status and the independent variables in the regression models. As an extreme example, the regressions conducted for two health-status dimensions among transplant recipients (i.e., those related to bodily pain and role limits because of emotional problems) included no statistically significant independent variables, at the traditional 0.05 significance level. However, it can be seen in Tables 5 and 6 that most of the insignificant health-status determinants had small regression coefficients. In fact, the mean absolute values of the insignificant regression coefficients in the transplant regressions ranged from 3.72 (for general mental health) to 8.38 (for role limits resulting from physical problems). For the dialysis regressions, the range was from 4.21 (for general mental health) to 6.87 (for role limits resulting from emotional problems). Power analyses that were conducted later showed that the sample size used in the transplant regressions allowed for 80-percent power to detect significant health-status differences of ±5.23-10.85 points, depending on the health-status dimension. For the dialysis regressions, there was 80-percent power to detect significant differences of ±4.85-8.62 points, depending on the dimension. Thus, sufficient power was available to detect small- to medium-size differences in health status across groups, but many of the nonsignificant associations were even smaller.

The unexpectedly small associations found for many of the insignificant health-

status predictors suggests that a larger sample would be required to find significant relationships between health status and many of the factors included in the regression models. Large samples will not be available to many dialysis and transplant providers who wish to replicate this research on their own patient samples, but it is not clear that the ability to find very small differences in health status across patient groups is necessary. The clinical value of information about small differences is unknown, but we presume that doctors would be more interested in the larger differences, especially those that might be amenable to changes in treatment style. Thus, there is still likely to be value in assessing the general health status of ESRD patients in the treatment setting.

Next, one might wonder if the lower-than-expected number of significant findings in the regression analyses provides evidence that the significant findings that were obtained may be because of chance alone. This is not likely. For example, in the transplant regressions, there were 168 comparisons being made (i.e., 21 independent variables *8 regressions = 168). By chance alone one would expect to find about 8 significant regression coefficients, at the traditional alpha level of 0.05 (i.e., 168*0.05 is approximately equal to 8). However, Table 5 shows 25 significant regression coefficients, many more than would be expected by chance alone. Similarly, one would expect to find 9 significant regression coefficients by chance alone in the dialysis regressions, based on 22 independent variables and 8 regressions. Table 6 shows 26 significant regression coefficients, again, many more than would be expected by chance alone. Thus, the results reported in those tables are not merely because of chance and should be considered in substantive terms.

Finally, a useful complement to this study would obtain and analyze data on symptoms and problems more specific to ESRD among a national sample of patients. These include diet and sleep problems, restlessness, fear of technology, family-support issues, and perceptions of the loss of control or level of autonomy that patients want and have in the treatment process (Meyer et al., 1994; Nissenson, 1994). Such studies would provide a more complete description of the health-status determinants among ESRD patients.

Other instruments address many of these symptoms and problems; examples have been described by Hays et al. (1994) and Laupacis et al. (1992). The greater specificity offered by these instruments comes at a cost, however. Those instruments include many more items than the SF-36, making them impractical for use in a short telephone survey and equally impractical for widespread use in treatment settings.

The value of lengthy instruments may lie in special research studies designed to learn more about health status of ESRD patients. An example is the Dialysis Outcomes and Practice Patterns Study currently being conducted for Amgen, Inc. That study is using the KDQoL short-form (which still has more than 100 items) to address health status and quality of life among ESRD patients. An attractive feature of the KDQoL is that it incorporates the SF-36 and expands upon it. Thus, multivariate analyses of health-status predictors presumably could be conducted as part of a research project using the KDQoL, to compare the relative ability of the SF-36 and a more specific quality-of-life measure to account for health-status differences between patient groups. The results would provide additional baseline information about the health status of ESRD patients and may offer lessons for practitioners about better ways to measure and improve the health status of their patients.

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REFERENCES

Belsley, D.A., Kuh, E., and Welsch, R.E.: *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity.* New York: John Wiley & Sons, Inc., 1980.

Carmines, E.G., and Zeller, R.A.: *Reliability and Validity Assessment.* Beverly Hills, CA: Sage Publications, 1979.

Chronbach, L.J.: Coefficient Alpha and the Internal Structure of Tests. *Psychometrika* 16(2):297-313, 1951.

Diamond, L., Held, P.J., and Palumbo, M.J.: *Developing a Workable Casemix Index That Relates Cost: Experience for Patients With Chronic Renal Failure.* Urban Institute Working Paper 3064-11. Washington, DC: The Urban Institute, 1984.

Dillon, W.R., and Goldstein, M.G.: *Multivariate Analysis: Methods and Applications.* New York: John Wiley & Sons, Inc., 1984.

Eggers, P.W.: Racial Differences in Access to Kidney Transplantation. *Health Care Financing Review* 17(2):89-104, Winter 1995.

Gaylin, D.S., Held, P.J., Port, F.K., et al.: The Impact of Comorbid and Sociodemographic Factors on Access to Transplantation. *Journal of the American Medical Association* 269(5):603-608, 1993.

Guyatt, G.H., Feeny, D.H., and Patrick, D.: Measuring Health-Related Quality of Life. *Annals of Internal Medicine* 118(5):622-629, 1993.

Hays, R., Kallich, J.D., Mapes, D.L., et al.: *Kidney Disease Quality of Life* (Version 1.3). Santa Monica: CA: The RAND Corporation, 1994.

Health Care Financing Administration: *Health Care Financing Special Report: Findings from the National Kidney Dialysis and Kidney Transplantation Study.* Office of Research and Demonstrations, Health Care Financing Administration. Baltimore, MD: October 1987.

Held, P.J., Pauly, M., and Diamond, L.: Survival Analysis of Patients Undergoing Dialysis. *Journal of the American Medical Association* 257(5):645-650, 1987.

Held, P.J., Friedrich, K.P., Blagg, C.R., and Agodoa, L.Y.C.: The United States Renal Data System's 1990 Annual Report: Executive Summary. *American Journal of Kidney Diseases* 16(6 Supplement):5-12, 1990.

Kallich, J.D., Adams, J.L., Lindsay Barton, P., and Spritzer, K.L.: *Access to Cadaveric Kidney Transplantation.* Santa Monica, CA: The RAND Corporation, 1993.

Kjellstrand, C.M., Erickson, F., Traneus, A., et al.: The Wish for Renal Transplantation. *Trans American Society for Artificial Internal Organs* 35(35):619-621, 1989.

Kurtin, P., and Nissenson, A.R.: Variation in End-Stage Renal Disease Patient Outcomes: What We Know, What We Should Know, and How Do We Find It Out? *Journal of the American Society of Nephrology* 3:1738-1747, 1993.

Kurtin, P.S., Ross Davies, A., Meyer, K.B., et al.: Patient-Based Health Status Measures in Outpatient Dialysis: Early Experiences in Developing an Outcomes Assessment Program. *Medical Care* 30(5):MS136-MS149, 1992.

Kutner, N.: Assessing End-Stage Renal Disease Patients' Functioning and Well Being: Measurement Approaches and Implications for Clinical Practice. *American Journal of Kidney Diseases* 24(2):321-333, 1994.

Laupacis, A., Wong, C., Churchill, D., et al.: The Use of Generic and Specific Quality of Life Measures in Hemodialysis Patients Treated with Erythropoietin. *Controlled Clinical Trials* 12:168S-179S, 1991.

Laupacis, A., Muirhead, N., Keown, P., and Wong, C.: A Disease-Specific Questionnaire for Assessing Quality of Life in Patients on Hemodialysis. *Nephron* 60(2):302-306, 1992.

Levin, N.W., Lazarus, J.M., Nissenson, A.R., et al.: National Cooperative rHu Erythropoietin Study in Patients with Chronic Renal Failure: An Interim Report. *American Journal of Kidney Diseases* 22(2):3-12, 1993.

McHorney, C.A., Ware, J.E., Lu, J.F.R., et al.: The MOS 36-Item Short Form Health Survey (SF-36) III: Tests of Data Quality, Scaling Assumptions, and Reliability Across Diverse Patient Groups. *Medical Care* 32(5):40-56, 1994.

Medical Outcomes Trust: *How to Score the DF-36 Health Survey.* Boston, MA. 1994.

Meyer, K.B., Espindle, D.M., DeGiacome, J.M., et al.: Monitoring Dialysis Patients' Health Status. *American Journal of Kidney Diseases* 24(2):267-279, 1994.

Nissenson, A.R.: Measuring, Managing, and Improving Quality in the End-Stage Renal Disease Treatment Setting: Peritoneal Dialysis. *American Journal of Kidney Diseases* 24(2):368-375, 1994.

Ozminkowski, R.J., White, A.J., Hassol, A., and Murphy, M.: Minimizing Racial Disparity Regarding Receipt of a Cadaver Kidney Transplant. *American Journal of Kidney Diseases*, to be published.

Pai, C.W., and Wan, T.T.H.: Confirmatory Analysis of Health Outcome Indicators: The 36-Item Short-Form Health Survey (SF-36). *Journal of Rehabilitation Outcomes Measurement*, to be published.

Research Triangle Institute: *Software for Survey Data Analysis (SUDAAN)*, Version 5.30. Research Triangle Park, NC: 1991.

Rettig, R.A., and Levinsky, N.G., eds.: *Kidney Failure and the Federal Government*. Washington, DC: National Academy Press, 1991.

Schrier, R.W., Burrows-Hudson, S., Diamond, L., et al.: Measuring, Managing, and Improving Quality in the End-Stage Renal Disease Treatment Setting: Committee Statement. *American Journal of Kidney Diseases* 24(2):383-388, 1994.

Schwab, S.J.: Assessing the Adequacy of Vascular Access and Its Relationship to Patient Outcome. *American Journal of Kidney Diseases* 24(2):316-320, 1994.

Shibue, T., Kondo, K., Iwaki, Y., and Terasaki, P.L.: Effect of Sex on Kidney Transplants. In Terasaki, P., ed.: *Clinical Transplants 1987*. Los Angeles, CA: UCLA Tissue Typing Laboratory, 1987.

U.S. Department of Health and Human Services: Medicare Current Beneficiary Survey, Public Use Documentation. Health Care Financing Administration. Baltimore, MD. 1994.

U.S. Department of Health and Human Services: Medicare and Medicaid Statistical Supplement, 1995. *Health Care Financing Review*. Baltimore, MD: Health Care Financing Administration, 1995.

Ware, J.E., and Sherbourne, C.D.: The MOS 36-Item Short Form Health Survey (SF-36): I. Conceptual Framework and Item Selection. *Medical Care* 30(6):473-483, 1992.

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