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The Timing of Specialist Evaluation in Chronic Kidney Disease and Mortality

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Background: **Care for chronic renal failure involves management of complications and preparation for possible dialysis. Patients often are not evaluated by nephrologists in a timely manner.**

Objective: **To identify factors associated with late evaluation by a nephrologist and to assess whether late evaluation is associated with worse survival once patients develop end-stage renal disease (ESRD).**

Design: **National prospective cohort study.**

Setting: **81 dialysis facilities throughout the United States.**

Patients: **828 patients with new-onset ESRD.**

Measurements: **Time from first evaluation by a nephrologist to initiation of dialysis, classified as late (<4 months), intermediate (4 to 12 months), or early (>12 months); rate of death, from initiation of dialysis to an average of 2.2 years of follow-up; and demographic, clinical, and laboratory characteristics.**

Results: **After adjustment for potential confounders, late evaluation was more common among black men than white men (44.8% vs. 24.5%; $P < 0.05$), uninsured patients than insured patients (56.7% vs. 29.0%; $P < 0.05$) and patients with severe comorbid disease than those with mild comorbid disease (35.0% vs. 23.0%; $P < 0.05$). Compared with patients who had early evaluation, the risk for death was greater among patients evaluated late and was graded (hazard ratio, 1.3 [95% CI, 0.87 to 2.06] for patients with intermediate evaluation and 1.8 [CI, 1.21 to 2.61] for those with late evaluation) after adjustment for dialysis method, demographic characteristics, and socioeconomic status in Cox proportional hazards regression analysis. After additional adjustment for such factors as the presence and severity of comorbid conditions, the association remained graded (hazard ratio, 1.2 [CI, 0.73 to 1.82] for patients evaluated at an intermediate point and 1.6 [CI, 1.04 to 2.39] for those evaluated late).**

Conclusions: **Late evaluation of patients with chronic renal failure by a nephrologist is associated with greater burden and severity of comorbid disease, black ethnicity, lack of health insurance, and shorter duration of survival.**

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See editorial comment on pp 542-543.

In the United States, approximately 300 000 persons have treated end-stage renal disease (ESRD) and an estimated 800 000 persons have a serum creatinine concentration of 177 μmol/L (2.0 mg/dL) or greater (1, 2). Annual U.S. spending related to treatment of ESRD exceeds $15 billion (3). Yet, outcomes for patients with ESRD remain relatively poor, with a 5-year survival rate of about 29% for patients undergoing dialysis (4). Whether better care of patients with ESRD earlier in their disease course improves outcomes is under increased investigation (5, 6). Many patients with chronic kidney disease may benefit from beginning their care with primary care physicians. As in the management of other chronic diseases, primary care physicians must decide whether evaluation by a specialist might improve care and, if so, when in the disease course specialist evaluation is most appropriate.

Although 39% of patients undergoing hemodialysis and 52% of those undergoing peritoneal dialysis are evaluated by a nephrologist more than 1 year before dialysis, 25% and 16%, respectively, of such patients are seen less than 1 month before dialysis (7). One argument for early evaluation by a nephrologist is that management of chronic renal insufficiency and its complications, such as anemia and renal osteodystrophy, may be improved. Early evaluation might facilitate improved patient education about dialysis; provide more time to make an informed choice about the type of dialysis; and allow timely placement of permanent vascular access, which is associated with better dialysis and fewer complications compared with temporary access (8, 9).

Late evaluation is associated with a higher risk for unplanned first dialysis, more complications, higher hospital costs, and longer duration of hospitalization in the first 3 months of dialysis (10–13). Most previous studies of late evaluation were done in countries other than the United States, involved only one center, or have had relatively short follow-up (10, 11, 13–16). We sought to determine the patient factors that are associated with late evaluation by a nephrologist in the United States and the effect of late evaluation on mortality.

METHODS

Study Design and Sample

We conducted a national, concurrent, prospective cohort study as part of the Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study. (For a list of all investigators on the CHOICE Study, see the Appendix.) Between October 1995 and June 1998, 1041 patients undergoing incident dialysis were enrolled at 81 dialysis clinics in 19 states (79 clinics affiliated with Dialysis Clinics Incorporated and 2 clinics affiliated with Beth Israel Medical System) (17). Median time from initiation of dialysis to enrollment was 45 days, and 98% of enrollment took

Context

In the United States, the 5-year survival of patients undergoing dialysis is 29%. Early nephrologist evaluation is associated with better outcomes, but 25% of patients first see a nephrologist within a month of beginning dialysis.

Contribution

Late nephrology evaluation (<4 months before start of dialysis) was most common among black men, uninsured patients, and patients with severe comorbid illness. The later the first evaluation by a nephrologist, the greater the risk for death.

Clinical Implications

Clinicians need a system to remind them to refer patients at an early stage of chronic renal failure, especially black men, the uninsured, or patients with severe comorbid illness.

–The Editors

places within 4 months of initial dialysis. Patients were excluded if they were younger than 18 years of age or did not speak English or Spanish.

The Johns Hopkins University School of Medicine Institutional Review Board and the review boards of each clinical center approved the CHOICE protocol. The CHOICE Study was designed to examine the choices that patients and providers make in initiation and maintenance of renal replacement therapy, particularly the choice of hemodialysis versus peritoneal dialysis.

Data Collection

At enrollment, patients completed a baseline questionnaire on medical and social history and provided the month and year in which they first visited a nephrologist. Demographic data, insurance information, the assigned cause of renal failure, baseline laboratory values, and the date of initial dialysis were obtained from the Center for Medicare & Medicaid Services medical evidence form. A trained research nurse abstracted medical records to determine the Index of Disease Severity score for 19 medical conditions. The Index of Physical Impairment score, a measure of impairment in 11 areas, was assessed by clinic staff. The Index of Physical Impairment and Index of Disease Severity were combined to form the Index of Coexistent Disease, a measure of the burden and severity of comorbid disease that is scored from 0 or 1 (mild coexistent disease) to 3 (severe coexistent disease) (18–21). Information from clinic reports and the Center for Medicare and Medicaid Services were used to determine the date of death.

The time between first evaluation by a nephrologist and the date of first dialysis is referred to as the "time of evaluation" and was categorized as late (<4 months), intermediate (4 to 12 months), or early (>1 year). The 4-month cutoff for late evaluation has been used in other studies (13, 22). The 12-month cutoff for early evaluation was chosen because some experts recommend 1 year as the minimal time necessary to prepare a patient adequately for dialysis (23). We reviewed available medical records for patients having late evaluation and a 10% sample of remaining charts. In 13 cases, time of evaluation was adjusted from late to intermediate or early evaluation.

Three hundred thirty-four patients did not answer the question on time of evaluation. On the basis of medical record review, 70 of these patients were categorized as having early evaluation and 51 as having intermediate evaluation. For 182 of the 334 patients, the medical records showed no definite evidence to indicate evaluation by a nephrologist more than 4 months before dialysis. These patients, along with 31 patients without available medical records, were categorized as having missing data. The total sample comprises 828 patients.

Statistical Analysis

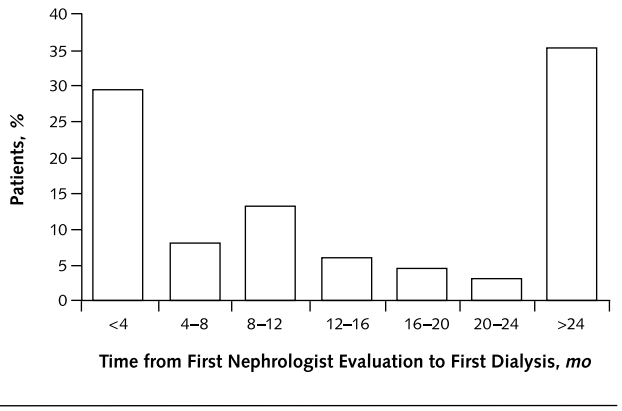
Characteristics of the sample stratified by time of evaluation were compared by using chi-square tests and analysis of variance, as appropriate. Distributions of patients according to the time of evaluation were compared by using the Wilcoxon rank-sum test for two-category comparisons and the Kruskal–Wallis test for multiple comparisons.

Unadjusted percentages of patients having late evaluation were calculated for different characteristics. Multivariate logistic regression was performed to determine the presence, magnitude, and independence of the association between patient characteristics and late evaluation. We considered the potential effect of multiple centers on our analyses (24). Given the possibility of confounding by clinic, all logistic regression analyses were conditioned on clinic (25). Patient characteristics in the multivariate conditional logistic regression model that were significantly associated ($P < 0.10$) with late evaluation in univariate analysis were considered potential confounders. Adjusted percentages were calculated on the basis of the adjusted odds ratios derived from logistic regression (26) and the relevant unadjusted frequencies of reference group in each analysis. A Hosmer–Lemeshow test was used to assess model adequacy.

We used Cox proportional hazards regression to test the presence, strength, and independence of the association between time of evaluation and mortality. Survival time was calculated from the date of first dialysis. Patients were considered to be under observation from time of enrollment until death or 30 April 2000. Patients were censored if they received a transplant, changed to a non-CHOICE clinic, or declined to participate further in the study.

To account for the possibility that differing standards of care at the various clinics explained differences in survival, all proportional hazards models were stratified by clinic (27). We first included nonmodifiable risk factors in

Figure 1. **Time from first evaluation by a nephrologist to first dialysis.**



the regression models (demographic characteristics and socioeconomic status) and then added potentially modifiable risk factors (smoking, exercise, comorbid conditions and disease severity, and laboratory values) to examine whether these factors explained associations between time of evaluation and mortality. Factors included in the final Cox proportional hazards model were significantly associated with mortality ($P < 0.10$) in univariate analysis or had been shown in the literature to have a clinically important association with mortality. Sex and type of dialysis were included a priori. Some modifiable factors may appear in the causal pathway between late evaluation and mortality. Their addition to the model might explain any observed associations. Thus, hematocrit less than 0.3 and hypoalbuminemia (serum albumin level < 36 g/L) were added to the model as potentially modifiable risk factors because previous studies have shown a relationship between these factors and ESRD mortality (28, 29). The glomerular filtration rate, which was calculated according to the Modification of Diet in Renal Disease equation (30), was included to adjust for renal function.

We performed sensitivity analyses to explore the effect of assumptions about missing data on time of evaluation and the effect of alternative categorizations of evaluation time. Statistical analyses were performed by using Stata software, version 6.0 (Stata Corp., College Station, Texas).

Role of the Funding Source

The project was funded by a grant from the Agency for Healthcare Research and Quality (Dr. Powe, principal investigator), the Robert Wood Johnson Clinical Scholars Program (Dr. Kinchen), and the National Institute of Diabetes and Digestive and Kidney Diseases (Drs. Powe and Klag). No funding source had a role in the design, conduct, or reporting of the study.

Table 1. **Patient Characteristics, Stratified by Time of Evaluation by a Nephrologist**

Characteristic	All Patients (n = 828)	Early Evaluation (n = 399)	Intermediate Evaluation (n = 184)	Late Evaluation (n = 245)	P Value
Men, %	55.2	56.6	57.6	51.0	>0.2
Black ethnicity, %	27.5	21.1	33.2	33.9	0.001
Age < 65 y, %	64.9	68.2	65.2	59.2	0.067
Employed before dialysis, %	27.9	29.9	23.9	27.6	>0.2
Group health insurance, %	31.5	38.4	26.6	24.1	<0.001
Uninsured, %	5.6	5.0	3.9	8.0	0.151
Attended college, %	37.1	44.0	28.1	32.8	<0.001
Peritoneal dialysis, %	25.2	31.3	23.4	16.7	<0.001
Hypertension, %	95.3	96.0	97.3	92.7	0.056
Diabetes mellitus, %	52.4	46.9	63.7	53.1	0.001
Mean Index of Coexistent Disease score	1.9	1.8	2.0	2.1	<0.001
Urine excretion ≥ 1 cup/d, %	79.1	86.7	86.4	75.4	0.001
Glomerular filtration rate < 0.07 mL · s^{-2} · m^{-2}, %	52.1	51.7	42.5	59.4	0.021
Exercise one or more times per week, %	20.9	26.3	17.5	14.9	0.001
Hematocrit < 0.3, %	61.8	56.0	66.0	68.1	00.008
Serum albumin level < 36 g/L, %	66.2	60.5	63.3	77.9	<0.001
Serum creatinine concentration ≥ 884 μmol/L (≥10 mg/dL), %	25.1	23.8	24.9	27.3	>0.2
Received erythropoietin before dialysis, %	23.0	25.3	31.5	12.7	<0.001
Vascular access established > 45 d before hemodialysis, %	33.5	45.4	39.7	13.4	<0.001
Mean duration of smoking, *y*	15.7	15.4	15.7	16.3	>0.2

Table 2. **Association between Patient Characteristics and Late Evaluation by a Nephrologist**

Characteristic	Patients with Late Evaluation, %		Adjusted Odds for Late Evaluation (95% CI)
	Unadjusted Proportion (n = 713)	Adjusted Proportion (95% CI)*	
White man	24.5	Referent	1.0 (referent)
White woman	32.1	29.7 (20.8–38.5)	1.3 (0.81–1.93)
Black man	38.2	44.8 (30.6–59.2)	2.5 (1.36–4.47)
Black woman	34.8	38.1 (24.9–52.2)	1.9 (1.02–3.37)
Age ≥ 65 y	34.4	Referent	1.0 (referent)
Age < 65 y	27.0	26.9 (20.1–34.8)	0.7 (0.48–1.02)
No college education	32.4	Referent	1.0 (referent)
College education	26.8	32.4 (24.3–40.5)	1.0 (0.67–1.42)
Insured	29.0	Referent	1.0 (referent)
Uninsured	42.2	56.7 (37.2–74.3)	3.2 (1.45–7.07)
Index of Coexistent Disease score			
0 or 1 (mild)	23.0	Referent	1.0 (referent)
2 (moderate)	31.4	32.3 (23.7–43.0)	1.6 (1.04–2.53)
3 (severe)	36.2	35.0 (25.7–45.9)	1.8 (1.16–2.84)
Unmarried	33.0	Referent	1.0 (referent)
Married	27.0	28.3 (20.4–34.9)	0.8 (0.52–1.09)
No exercise	32.5	Referent	1.0 (referent)
Exercise at least once per week	21.6	22.4 (14.4–30.0)	0.6 (0.35–0.89)

* Adjusted for age, ethnicity, sex, education, lack of health insurance, Index of Coexistent Disease score, marital status, and exercise status.

RESULTS

Time of Evaluation

Thirty percent of patients were seen by a nephrologist less than 4 months before initiation of dialysis, 22% were seen 4 to 12 months before, and 48% were seen more than 1 year before (**Figure 1**). Median time from first evaluation by a nephrologist to first dialysis was 346 days.

Patient Characteristics and Time of Evaluation

Fifty-five percent of the patients were male, 27.5% were black, and 65% were younger than 65 years of age (**Table 1**). In univariate analysis, black patients ($P = 0.001$), patients without a college education ($P < 0.001$), and patients with higher ICED scores ($P < 0.001$) were more likely to have late evaluation. Median time to evaluation was longer for white than for black patients (392 days vs. 240 days; $P < 0.001$), younger than older patients (382 days vs. 260 days; $P = 0.042$) and college-educated patients than patients with no college education (512 days vs. 256 days; $P < 0.001$). Patients with late evaluation also were significantly less likely to have received erythropoietin before initiation of dialysis ($P < 0.001$) and were less likely to have had vascular access established more than 45 days before hemodialysis ($P < 0.001$).

In multivariate analysis, black patients were more likely than white patients to be evaluated late (42.4% vs. 27.7%). In particular, black men were more likely than white men to be evaluated late (44.8% vs. 24.5%) (**Table 2**). Likewise, uninsured patients, those who did not report regular exercise, and those with greater burden and severity of comorbid disease were more likely than their counterparts to have late evaluation.

Time of Evaluation and Mortality

Median duration of follow-up was 2.2 years, during which 201 patients died. Among patients undergoing early, intermediate, or late evaluation, respectively, 80, 52, and 69 died; median follow-up was 759 days, 799 days, and 709 days; 1-year mortality rate was 4.3%, 9.5%, 13.3%; and 2-year mortality rate was 14.6%, 22.4%, and 27.6%. At 3 years, 26.3% of patients who had early evaluation, 32.7% of those who had intermediate evaluation, and 37% of those who had late evaluation had died (**Figure 2**, *top*). No evidence suggested that the proportional hazards assumption in the multivariate model had been violated (27). The bottom panel of **Figure 2** shows cumulative mortality curves for patients with diabetes.

Patients with late evaluation had a 60% greater hazard of death after adjustment for type of dialysis (**Table 3**). The hazard ratio increased slightly when demographic and socioeconomic factors (education level, group health insurance, and employment status) were added and did not change when years of smoking, exercise status, and comorbid diseases (diabetes, arrhythmia, chronic obstructive pulmonary disease, cardiovascular disease, congestive heart failure, and neoplasms) were added. When ICED score rather than comorbid disease was added, the hazard ratio for late evaluation remained similar. The hazard ratio increased when serum albumin level less than 36 g/L, hematocrit less than 0.3, and glomerular filtration rate less than

0.07 mL · s^{-2} · m^{-2} were added to the model along with ICED score (hazard ratio, 2.3 [CI, 1.27 to 3.98]). All models showed a graded increase in hazard ratios from early to intermediate to late evaluation.

Subgroup Analyses of Time of Evaluation and Mortality

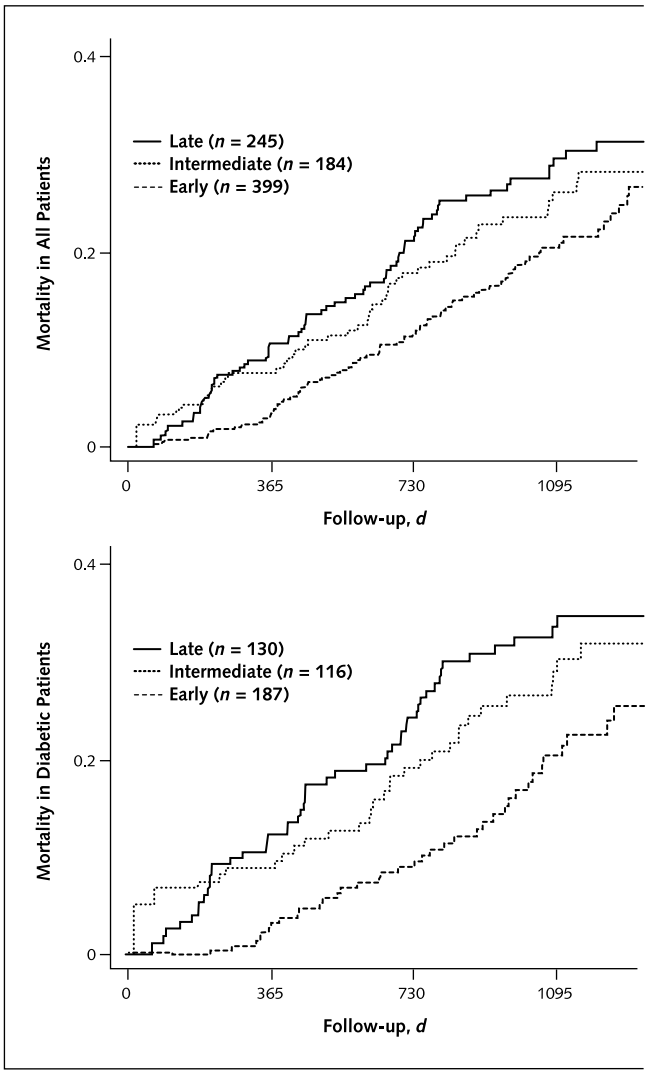
Separate regression analyses (**Table 4**) revealed that late evaluation was associated with greater hazard of death in diabetic patients compared with nondiabetic patients (model 4). Likewise, late evaluation was more strongly associated with death for patients with renal failure due to diabetes or hypertension than for those with renal failure due to other causes. In the sample, renal failure was due to diabetes (48.5%), hypertension (16.5%), glomerulonephritis (17.7%), and other causes (20.3%). Late evaluation was more strongly associated with death in black persons than white persons. In a 1-year analysis of a subgroup of patients whose records were reviewed for baseline type of vascular access, models with and without a variable for permanent versus temporary vascular access yielded similar hazard ratios. Permanent versus temporary access was associated with a decreased 1-year mortality rate (hazard ratio, 0.18 [CI, 0.04 to 0.85]).

Sensitivity Analyses

The graded relationship between hazard ratios and time of evaluation did not change when we redefined late evaluation as less than 1 month to less than 5 months. When less than 1 month was considered late evaluation, the hazard ratio for death among patients receiving late evaluation increased (3.0 [CI, 1.53 to 5.71]).

Kaplan–Meier estimates of mortality in patients for whom time of evaluation was missing were more similar to those observed in patients having late evaluation than in those having early evaluation. If all patients with missing time of evaluation were included with patients who had early evaluation, the hazard ratio for late evaluation in the Cox proportional hazards models (using model 5) was attenuated slightly (hazard ratio, 1.4 [CI, 0.90 to 2.15]), but the graded relationship remained.

Figure 2. **Cumulative mortality in patients undergoing early, intermediate, or late evaluation by a nephrologist.**



Top. Cumulative mortality in the total sample. **Bottom.** Cumulative mortality in diabetic patients.

Table 3. **Relation between Time of Evaluation and Death***

Model	Adjustment Factors	Patients, *n*	Hazard Ratio (95% CI)		
			Early Evaluation	Intermediate Evaluation	Late Evaluation
1	Time of evaluation + type of dialysis	828	1.0 (referent)	1.4 (0.92–1.99)	1.6 (1.11–2.24)
2	Model 1 factors + demographic characteristics, education level, insurance status, and employment status	718	1.0 (referent)	1.3 (0.87–2.06)	1.8 (1.21–2.61)
3	Model 2 factors + health status (years of smoking, regular exercise, and number and severity of comorbid diseases)	686	1.0 (referent)	1.2 (0.73–1.82)	1.6 (1.08–2.45)
4	Model 2 factors + health status (years of smoking, regular exercise, Index of Coexistent Disease score)	686	1.0 (referent)	1.2 (0.73–1.82)	1.6 (1.04–2.39)
5	Model 4 factors + laboratory data (serum albumin level < 36 g/L, hematocrit < 0.3, glomerular filtration rate < 0.07 mL · s^{-2} · m^{-2})	462	1.0 (referent)	1.4 (0.68–2.68)	2.3 (1.27–3.98)

* Calculated by using Cox proportional hazards regression analysis.

Table 4. **Relation between Time of Evaluation and Mortality, by Subgroups from Cox Proportional Hazards Regression Analysis**

Subgroup	Hazard Ratio (95% CI)		
	Early Evaluation	Model 4: Intermediate Evaluation*	Model 4: Late Evaluation*
All patients	1.0 (referent)	1.4 (0.92–1.99)	1.6 (1.11–2.24)
Diabetes mellitus			
Yes	1.0 (referent)	1.6 (0.84–2.94)	2.4 (1.28–4.47)
No	1.0 (referent)	0.6 (0.23–1.61)	0.9 (0.42–1.97)
Ethnicity			
White	1.0 (referent)	1.0 (0.60–1.73)	1.5 (0.92–2.37)
Black	1.0 (referent)	1.8 (0.26–12.30)	6.9 (1.07–44.71)
Attributed cause of end-stage renal disease			
Hypertension or diabetes mellitus	1.0 (referent)	1.1 (0.59–1.93)	1.99 (1.14–3.46)
Glomerulonephritis or other	1.0 (referent)	1.0 (0.35–2.63)	0.6 (0.22–1.51)
Age			
<65 y	1.0 (referent)	1.4 (0.68–2.91)	1.5 (0.82–2.87)
≥65 y	1.0 (referent)	1.0 (0.46–1.99)	1.7 (0.86–3.22)

* Model 4 included time of evaluation, type of dialysis, demographic characteristics, socioeconomic status, years of smoking, exercise status, and Index of Coexistent Disease score.

DISCUSSION

We studied a nationally representative sample of U.S. patients with incident, dialysis-dependent ESRD over a median of 2.2 years. Late evaluation of chronic kidney disease was a predictor of death after we controlled for type of dialysis, demographic characteristics, and socioeconomic factors. We also controlled for comorbid conditions by using the ICED, which reflects not only the diagnosis of at least one comorbid disease but the extent to which the disease is controlled. The ICED has been validated as a predictor of death in patients with ESRD (31). After adjustment for ICED score, the relationship between late evaluation and death was similar. Finally, when we adjusted for measures of renal function, hematocrit, and serum albumin level, the magnitude of the relationship increased. A graded relationship between timing of evaluation and mortality, in which hazard ratios increased from early to intermediate to late evaluation, was observed in all analyses.

Higher ICED scores, lower serum albumin level, and lower hematocrit were associated with late evaluation. It is possible that sicker patients are less likely to be referred (32), but delay in nephrology evaluation itself may contribute to poor health status through inattention to modifiable risk factors. For example, as renal function deteriorates, protein intake decreases (33). Patients who have late evaluation also may have less opportunity to receive appropriate nutritional counseling that would help avoid hypoalbuminemia (22). Similarly, patients who had late evaluation were less likely to have received erythropoeitin, which was associated with a lower hematocrit. Thus, a lower hematocrit may, in part, be an outcome of late evaluation. Because ICED measures the severity of comorbid disease, the higher ICED scores of patients who had late evaluation might have been decreased if earlier care had improved overall health status.

Other studies have examined whether late evaluation by a nephrologist is associated with greater mortality. One local study (11) limited to 4 months of follow-up found no statistically significant difference in mortality between patients who had late evaluation and those who had early evaluation (7% vs. 4%, respectively). A Brazilian study (14) that excluded diabetic persons found that patients with earlier diagnosis of ESRD had greater survival than patients with late diagnosis, but the adjusted hazard ratio was not statistically significant. In a single-center French study (13), multivariate analysis revealed no difference in mortality between patients who had late evaluation and those who had early evaluation. However, that sample differed from ours in that it included a smaller proportion of diabetic patients (26% versus 52% in our study) and black patients. Of note, in our subgroup analyses, the relationship between time of evaluation and mortality is largely restricted to diabetic patients. Ritz and colleagues (34) suggested that earlier evaluation by nephrologists and diabetologists may improve outcomes in patients with diabetic nephropathy. In contrast, other studies (10, 15, 16) that were also limited by number of centers or conducted outside the United States have shown an association between time of evaluation and mortality.

Our findings focus attention on the potential value of pre-ESRD care in improving outcomes of ESRD. Eknoyan and associates (35) noted that "A major determinant of poor outcomes of maintenance dialysis patients is the debilitated state of many individuals with ESRD at the time that they commence dialysis therapy." Pre-ESRD care has room for improvement. A recent study from Michigan (36) found that 73% of patients had initiation of dialysis on hospital admission and 69% used temporary vascular access. Obrador and coworkers (37) viewed the high prevalence of hypoalbuminemia and severe anemia and low levels of use of erythropoietin among U.S. patients undergoing incident dialysis as evidence of less-than-optimal pre-ESRD care.

Why are so many patients evaluated late by a nephrologist? Possible reasons include asymptomatic renal failure presenting with ESRD, noncompliance with referrals, acute renal failure, lack of access to any medical care, and the attitudes of primary care physicians about referral of patients with chronic renal insufficiency to specialists (6). We did not determine the cause of late evaluation. It should not be inferred from our data that the referral practices of primary care physicians are responsible for most late evaluations. In France, among patients who presented late, 42% had been referred but lost to follow-up, 18% were asymptomatic, and 40% had not been referred even though they had known about renal insufficiency for 2 to 11 years and were followed by a family physician (38). Campbell and colleagues (10) interviewed U.S. physicians who made late referrals. Half of the physicians discussed the need for better communication and feedback from nephrologists, about 40% feared being negatively evaluated by the nephrologist, and approximately 90% indicated that they had no training "in the timing or indications for referral of ESRD patients." New practice guidelines for the treatment of chronic kidney disease call for patients with a glomerular filtration rate less than 0.3 $mL \cdot s^{-2} \cdot m^{-2}$ to be referred to a nephrologist (39). Recommendations for timing of evaluation by a nephrologist may be important on the basis of the effect on initial morbidity and length of hospital stay alone, but the additional finding that late evaluation affects mortality, particularly among diabetic patients, provides important evidence to guide clinical practice. It is not known whether care by a nephrologist compared with a non-nephrologist delays the need for dialysis. These questions and differences in mortality may be addressed in a proposed 7-year prospective study funded by the National Institutes of Health (40).

Our study has limitations. First, information on timing of nephrology evaluation was gained primarily by patient report. We attempted to verify the self-reported data by review of medical records. The median time of evaluation is similar to that seen in two studies that used medical records to determine time of evaluation (13, 20). Second, 334 patients did not respond to the question on time of evaluation. All available medical records for these patients were reviewed, and 121 of these patients were classified as having early or intermediate evaluation. A sensitivity analysis in which all patients with missing values were included as having early evaluation yielded similar results. Third, we cannot be sure that patients with acute renal failure were excluded; however, when analysis was restricted to patients in whom renal failure was attributed to diabetes or hypertension, the findings were essentially unchanged. Fourth, we have no information on frequency of visits to a nephrologist. Fifth, we cannot prove that the differences in mortality are not due to lead time bias; that is, patients who have early evaluation may start dialysis earlier in their disease than do patients with late evaluation. We attempted to account for lead time bias by including glomerular filtration rate in the final regression analysis, and the association between late evaluation and mortality remained. Mean glomerular filtration rate did not differ significantly by time of evaluation (0.070 vs. 0.073 $mL \cdot s^{-2} \cdot m^{-2}$ in patients with early and late evaluation). Finally, because the patients were evaluated mainly in nonprofit settings, our results may not be generalizable to all U.S. dialysis clinics.

In summary, in a representative sample of U.S. patients undergoing incident dialysis, late evaluation for dialysis was associated with a greater burden and severity of comorbid disease, being a black man, and lack of health insurance. Late evaluation also was associated with worse survival, particularly for diabetic patients and black patients. These findings should lead to increased attention to the role of pre-ESRD care in improving outcomes of patients with ESRD.

APPENDIX

The Choices for Healthy Outcomes in Caring for ESRD is a patient outcomes research team studying dialysis care. The investigators are Neil R. Powe, MD; John Sadler, MD; Michael Klag, MD; Brad Astor, PhD; Gerard Anderson, PhD; Eric Bass, MD; William Briggs, MD; Ronald Brookmeyer, PhD; Josef Coresh, MD, PhD; Nancy Fink, MPH; Klemens Meyer, MD; Andrew Levey, MD; Nathan Levin, MD; J. Craig Longenecker, MD, PhD; Haya Rubin, MD, PhD; Paul Whelton, MD; and Albert Wu, MD, and the Clinical Liaison Committee: Thomas Depner, MD; Frederic Finkelstein, MD; H. Keith Johnson, MD; K. Shashi Kant, MD; Alan Kliger, MD; Klemens Meyer, MD; Richard Sherman, MD; Edward Schroeder, MD; Pradip Teredesai, MD; John Van Stone, MD; and Philip Zager, MD.

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