Late Initiation of Dialysis among Women and Ethnic Minorities in the United States

ANNAMARIA T. KAUSZ,* GREGORIO T. OBRADOR,*‡ PRADEEP ARORA,* ROBIN RUTHAZER,† ANDREW S. LEVEY,* and BRIAN J. G. PEREIRA*
*Division of Nephrology and †Clinical Care Research, New England Medical Center, Boston, Massachusetts; and ‡Panamerican University School of Medicine, Mexico City, Mexico.

Abstract. The ideal timing of initiation of renal replacement (RRT) therapy has been debated. It is currently recommended that RRT be instituted once the GFR falls below 10.5 ml/min per 1.73m^2, unless edema-free body weight is stable or increased, the normalized protein nitrogen appearance rate is 0.8 g/kg per d or greater, and there are no clinical signs or symptoms of uremia. However, the mean estimated GFR at initiation of dialysis in the United States is 7.1 ml/min per 1.73m^2. Factors that are associated with timing of initiation of dialysis in the United States are not clear. A cross-sectional study was performed to determine the factors that are associated with late initiation of dialysis as defined by GFR at initiation of less than 5 ml/min per 1.73m^2 among patients who began dialysis in the United States between 1995 and 1997. Data were obtained from the U.S. Renal Data System, and GFR was estimated using the formula derived from the Modification of Diet in Renal Disease Study. Twenty-three percent of patients started dialysis late. In the multivariate analysis, women (odds ratio [OR] = 1.70), Hispanics and Asians (OR = 1.47 and 1.66, respectively, compared with Caucasians), uninsured patients (OR = 1.55 compared with private insurance), and employed patients (OR = 1.20) were more likely to start dialysis late. Patients with diabetes, cardiac disease, peripheral vascular disease, and poor functional status were less likely to start dialysis late compared with patients without these comorbid conditions. Certain nonclinical patient characteristics, notably female gender, race, and lack of insurance, are related to an increased likelihood of late initiation of dialysis. These factors may reflect reduced access to care. Additional studies are indicated to determine the potential impact of reduced access to care and whether late initiation of dialysis results in adverse clinical and economic outcomes among patients with end-stage renal disease in the United States.

The impact of timing of initiation of dialysis on outcomes among dialysis patients remains unclear. The National Kidney Foundation Dialysis Outcome Quality Initiative (NKF-DOQI ™) guidelines for initiation of renal replacement therapy recommend that dialysis be initiated when the GFR falls below 10.5 ml/min per 1.73m^2, unless edema-free body weight is stable or increased, the normalized protein nitrogen appearance rate is 0.8 g/kg per d or greater, and there are no clinical signs or symptoms of uremia (1). Using the equation recently developed from the Modification of Diet in Renal Disease (MDRD) Study (2), we recently showed that the mean estimated GFR at the commencement of dialysis in the United States is 7.1 ml/min per 1.73m^2 (3).

We undertook this cross-sectional analysis to determine whether demographic, socioeconomic, clinical, or geographic factors are associated with the timing of initiation of dialysis. Late initiation of dialysis may be related to potentially remediable factors, which, if identified, may be targeted to continue improving the care and potentially the survival of the growing population of patients with end-stage renal disease (ESRD).

Materials and Methods

Data Collection

A detailed description of the data sources has been reported previously (3). Briefly, the September 1997 update of the Medical Evidence (Medevid) Standard Analysis File of the United States Renal Data System (USRDS), which contains the information provided on the Health Care Financing Administration (HCFA) form 2728, was used for this analysis. This file provides the following information on all patients beginning or returning to ESRD treatment in the United States: demographic and insurance information, comorbid conditions, cause of ESRD, functional status, employment (status 6 mo before initiation of dialysis), ESRD treatment modality, and laboratory information (obtained within 45 d before initiation of dialysis). All adult patients (18 yr or older) who began first ESRD therapy with dialysis in the United States since April 1995, with sufficient data available to perform all of the analyses described below, were included in the study. Duplicated 2728 forms were excluded. No attempt to impute missing data was made.

Prediction of GFR

GFR was estimated using the prediction equation recently developed from the MDRD Study and is based on patient demographic and laboratory data:

GFR (in ml/min per 1.73 m2) = 170 × [serum creatinine (mg/dl)]$^{-0.999}$ × [age (yr)]$^{-0.176}$ × [0.762 if female] × [1.180 if

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Correspondence to Dr. Brian J. G. Pereira, Division of Nephrology, New England Medical Center, Box 391, 750 Washington Street, Boston, MA 02111. Phone: 617-636-5224; Fax: 617-638-7119; E-mail: BPereira@Lifespan.org
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African American] × [blood urea nitrogen (mg/dl)]$^{-0.170}$ × [albumin (g/dl)]$^{+0.318}$

This equation provides a more accurate estimate of GFR than either measured creatinine clearance or other commonly used equations (2) and has been validated among patients at the onset of ESRD (4).

Definitions

Late initiation of dialysis was arbitrarily defined as initiation of dialysis with an estimated GFR of less than 5 ml/min per 1.73m^2. Hypoalbuminemia and severe anemia were defined as serum albumin of less than 3.5 mg/dl and hematocrit of less than 28%, respectively.

Statistical Analyses

Descriptive statistics of baseline characteristics by GFR at the initiation of dialysis of <5, 5 to 9.9, and ≥10 ml/min per 1.73m^2 were performed. Univariate logistic regression analyses were used to examine the relationship of individual demographic, clinical, and socioeconomic factors with late initiation of dialysis, defined as initiation of dialysis with an estimated GFR of less than 5ml/min per 1.73m^2.

A multivariate logistic regression model was constructed by exploring covariates that were of perceived clinical significance or had a significant association with late initiation of dialysis ($P \leq 0.10$) in the univariate analysis. Categorical variables included age (<40 = reference, 40 to 64, ≥65), race (Caucasian = reference, African American, Hispanic, Asian, or other), insurance status (private = reference, Medicare only, Medicaid only, Medicare and Medicaid, Veterans Affairs [VA] and other, or no insurance), and employment (employed/student/homemaker = reference, unemployed, and retired/disabled/medical leave of absence). Gender, diabetes (as cause of ESRD), poor functional status (inability to transfer and/or ambulate), cardiac disease (history of arrhythmia, congestive heart failure, ischemic heart disease, myocardial infarction, and/or cardiac arrest), history of peripheral vascular disease, history of hypertension, dialysis modality (hemodialysis *versus* peritoneal dialysis), hypoalbuminemia, and severe anemia were entered as dichotomous variables. ESRD networks (18 regional organizations contracted by the HCFA to provide oversight regarding quality of ESRD care and to maintain a patient-specific data registry) were entered as categorical variables. Network 6 was used as the reference category in the logistic regression analyses, as this network was almost identical to the national average in terms of proportions of patients in the various levels of GFR at initiation of dialysis.

The interaction between gender and race was explored, as this has been noted to be of significance in previous studies that assessed the impact of these two factors. The interaction term was not clinically significant and the addition of the interaction term did not change the effect of the other covariates, thus it was not included in the final presentation of the results. A multivariate linear regression analysis was also explored to determine the impact of demographic and socioeconomic factors on the GFR at initiation of dialysis. This model revealed similar relationships to timing of initiation of dialysis as the logistic regression analysis, with a lower r^2. Thus, the presentation of the results was limited to the results of the logistic regression analysis. Analyses were performed using SAS version 6.12 (SAS Institute Inc., Cary, NC).

Results

Of the 168,334 patients on whom information on the HCFA 2728 form was available, 90,897 (59%) had data for the calculation of estimated GFR and all of the covariates included in the multivariate models. Demographic and clinical characteristics of the overall population and the subpopulation of 90,897 patients were nearly identical, and this as well as details of the data selection process have been published previously (3). Twenty-three percent of patients started dialysis with an estimated GFR of less than 5 ml/min per 1.73m^2, 63% started dialysis with an estimated GFR between 5 and 9.9 ml/min per 1.73m^2, and 14% started with an estimated GFR of 10 ml/min per 1.73m^2 or greater.

Patient Characteristics

The demographic, socioeconomic, and baseline laboratory characteristics of patients with different levels of estimated GFR at the initiation of dialysis are presented in Table 1. Compared with the group of patients with initiation of dialysis at an estimated GFR ≥ 10 ml/min/1.73m^2, the group of patients with an estimated GFR of less than 5 ml/min per 1.73m^2 included a higher proportion of non-Caucasians (53% *versus* 40%) and females (56% *versus* 41%) and a lower proportion of patients with diabetes mellitus (DM) as cause of ESRD (31% *versus* 55%) and patients with cardiovascular complications (32% *versus* 63%). Patients with late initiation of dialysis had lower serum albumin and hematocrit levels (3.1 mg/dl and 26%, respectively) compared with patients who started dialysis at an estimated GFR of 10 ml/min per 1.73m^2 or greater (3.3 mg/dl and 30%, respectively).

Univariate and Multivariate Analyses of Late Initiation of Dialysis

The results of the univariate analysis reflect the differences observed in Table 1. In the multivariate models, compared with patients who were younger than 40 yr, the odds ratio (OR) for late initiation of dialysis was lower for older age groups (OR, 0.93 and 0.69 for patients ages 40 to 64 and ≥65 yr, respectively). Compared with Caucasians, the likelihood of late initiation of dialysis was greater for Hispanics (OR = 1.47), Asians (OR = 1.66), and other races (OR = 1.88). Although African Americans had higher odds of late initiation of dialysis compared with Caucasians in the univariate analysis (OR = 1.38), this did not persist after adjusting for multiple socioeconomic, clinical, and demographic factors (OR = 1.01). Women had higher odds of late initiation of dialysis compared with men, after adjustment for multiple covariates (OR = 1.70) (Table 2).

Patients who initiated dialysis with hemodialysis had a greater odds of late initiation of dialysis compared with patients who started on peritoneal dialysis (OR = 1.44). Patients who did not have insurance (OR = 1.55) but not patients who were covered by Medicaid (OR = 0.94) had significantly greater odds of late initiation of dialysis compared with patients who had private insurance. The likelihood of late initiation of dialysis was lower among retired/disabled (OR = 0.76) or unemployed (OR = 0.83) patients compared with employed patients and also was lower among patients who had cardiac disease (OR = 0.61), peripheral vascular disease (OR = 0.75), and poor functional status (OR = 0.80) compared with patients who did not have these comorbid conditions.

Table 1. Demographic and clinical characteristics of patients with varying levels of GFR at the initiation of dialysis[a]

	GFR <5 ml/min per 1.73m^2 (N = 21,373)	GFR = 5 to 9.9 ml/min per 1.73m^2 (N = 56,858)	GFR ≥10 ml/min per 1.73m^2 (N = 12,666)
Mean age (SD)	57.4 (16.4)	62.2 (15.1)	65.6 (14.6)
Gender (% male)	44.4	54.4	59.4
Race (%)			
Caucasian	47.1	56.2	59.7
African American	32.1	28.3	27.1
Hispanic	13.2	10.6	9.8
Asian	3.0	1.9	1.4
other	4.7	3.0	2.0
Insurance status (%)			
private insurance	25.5	24.8	21.8
Medicare only	12.1	14.4	16.3
Medicaid only	13.5	10.9	9.6
Medicare and Medicaid	9.9	11.8	14.2
VA or other insurance(s)	26.4	31.9	34.2
none	7.4	6.2	3.9
Employment status (%)			
employed/student/homemaker	35.6	25.8	18.2
unemployed	22.5	17.9	16.1
other[b]	41.9	56.3	65.7
Cause of ESRD (%)			
diabetic nephropathy	30.5	46.7	55.0
hypertension	27.2	25.7	24.7
glomerulonephritis	20.2	12.7	7.7
other	22.1	14.9	12.7
Hemodialysis as initial modality(%)	89.6	86.6	85.7
Prevalence of comorbid conditions (%)			
cardiac disease	32.0	47.9	62.6
peripheral vascular disease	8.9	16.0	21.7
hypertension	71.8	74.4	71.2
poor functional status[c]	3.6	5.1	8
Clinical and laboratory parameters [mean (SD)]			
weight (kg)	72.6 (20.3)	73.4 (19.9)	70.2 (18.9)
body mass index (weight/height^2)	26.0 (6.8)	26.0 (6.6)	24.9 (6.4)
blood urea nitrogen (mg/dl)	118.6 (35.5)	91.4 (28.4)	75.1 (29.4)
serum creatinine (mg/dl)	13.3 (4.2)	7.7 (1.8)	4.5 (1.1)
serum albumin (g/dl)	3.1 (0.7)	3.2 (0.7)	3.3 (0.6)
hematocrit (%)	26 (6)	28 (5)	30 (5)

[a] VA, Veteran's Affairs; ESRD, end-stage renal disease.
[b] Retired due to age, preference or disability and medical leave of absence.
[c] Unable to transfer or ambulate.

Time Trends in Late Initiation of Dialysis

There were decreasing odds for late initiation of dialysis from the years 1995 to 1997 (Table 2). The univariate analysis demonstrated that patients who started dialysis in 1996 and 1997 were less likely to start dialysis with a GFR of less than 5 ml/min per 1.73m^2 compared with patients who started dialysis in 1995 (OR = 0.96 and 0.89, respectively). After adjusting for multiple covariates, there continued to be lower odds of late initiation of dialysis in 1997 compared with 1995, although the difference was attenuated (OR = 0.91), but there was no significant difference in the odds of late initiation of dialysis between patients who began dialysis in 1995 and 1996.

Regional Patterns of Timing of Initiation of Dialysis

Our analysis revealed regional variation in the timing of dialysis initiation. The proportion of patients who started dialysis late ranged from 20.5% in Network 7 to 31.4% in Network 17. Network 13 had the highest proportion (17%) and Network 2 had the lowest proportion (8.8%) of patients who started with an estimated GFR of 10 ml/min per 1.73m^2 or greater. After

Table 2. Factors associated with GFR of <5 ml/min per 1.73m^2 at initiation of dialysis in the United States[a]

	Univariate Odds Ratio	95% CI	Multivariate Odds Ratio[a]	95% CI
Age (ref = <40 years)				
40 to 64	0.64	0.61, 0.67	0.93	0.88, 0.98
≥65	0.40	0.38, 0.42	0.69	0.64, 0.73
Female (ref = male)	1.55	1.50, 1.60	1.70	1.65, 1.76
Race (ref = Caucasian)				
African American	1.38	1.33, 1.43	1.01	0.97, 1.06
Hispanic	1.51	1.44, 1.59	1.47	1.38, 1.56
Asian	2.05	1.86, 2.26	1.66	1.49, 1.85
other	2.03	1.87, 2.20	1.88	1.72, 2.05
Diabetes as cause of ESRD (ref = non-DM)	0.47	0.46, 0.49	0.44	0.42, 0.45
Insurance status (ref = private)				
Medicare only	0.78	0.74, 0.82	1.03	0.97, 1.09
Medicaid only	1.21	1.15, 1.27	0.94	0.88, 1.00
Medicare and Medicaid	0.77	0.73, 0.82	0.88	0.82, 0.94
VA and other insurance(s)	0.78	0.75, 0.81	0.98	0.93, 1.03
none	2.08	1.96, 2.20	1.55	1.46, 1.66
Employment (ref = employed/student/homemaker)				
unemployed	0.88	0.84, 0.92	0.83	0.79, 0.88
retired, disabled, or medical leave of absence	0.50	0.48, 0.51	0.76	0.73, 0.80
Presence of comorbid conditions				
cardiac disease	0.46	0.4, 0.47	0.61	0.59, 0.64
peripheral vascular disease	0.47	0.45, 0.50	0.75	0.71, 0.79
hypertension	0.90	0.87, 0.93	1.03	0.99, 1.07
poor functional status[b]	0.63	0.59, 0.69	0.80	0.74, 0.87
Serum albumin <3.5 mg/dl (ref ≥3.5 mg/dl)	1.35	1.31, 1.40	1.50	1.45, 1.56
Hematocrit <28% (ref ≥28%)	2.05	1.99, 2.12	1.80	1.74, 1.86
Hemodialysis (ref = PD)	1.35	1.28, 1.42	1.4	1.37, 1.52
Year of initiation of dialysis (ref = 1995)				
1996	0.96	0.93, 0.99	0.97	0.94, 1.01
1997	0.89	0.85, 0.93	0.91	0.87, 0.95

[a] Univariate and multivariate logistic regression analyses of 90,897 patients who began dialysis in the United States between April 1, 1995 and June 30, 1997, adjusted also for ESRD network. CI, confidence interval; DM, diabetes mellitus; PD, peritoneal dialysis.
[b] Unable to transfer or ambulate.

adjustment for multiple covariates, differences in the odds of late initiation of dialysis among the ESRD Networks persisted. Patients who belonged to the New England (Network 1), New York (Network 2), and Pacific (Network 17) networks had the highest odds of late initiation of dialysis (OR ranging from 1.30 to 1.47) compared with the reference network, whereas patients in Network 13 had the lowest odds of late initiation of dialysis (OR = 0.79).

Discussion

The level of renal function at which chronic dialysis should be initiated for the treatment of patients with chronic renal failure has been debated since the early years of dialysis. Proponents of elective early dialysis have suggested that timely initiation of renal replacement therapy attenuates the complications of chronic renal failure such as malnutrition and cardiovascular disease and consequently results in reduced morbidity, mortality, and cost (5–7). Opponents of early dialysis stress that a healthy nutritional status can be maintained with careful management until dialysis becomes inevitable and that early dialysis needlessly imposes the lifestyle restriction and costs of dialysis at an earlier time point (8–12). Furthermore, the patient would be exposed earlier to the myriad of other adverse consequences associated with dialysis, such as sepsis, hypotension, and repeated invasive interventions. Early dialysis could also adversely affect survival of the vascular access or peritoneal membrane. The level of GFR at which patients with chronic renal failure ideally should begin dialysis has not been agreed on. Nonetheless, the NKF DOQI™ guidelines have recommended that patients begin dialysis when the GFR falls below 10.5 ml/min per 1.73m^2, unless edema-free body weight is stable or increased, the normalized protein nitrogen appearance rate is 0.8 g/kg per d or greater, and there are no clinical signs or symptoms of uremia (1). We sought to examine the factors that are associated with late initiation of dialysis and chose the arbitrary GFR cutoff of less than 5 ml/min per $1.73m^2$ to define late initiation.

Nearly one fourth of the patients in this study began dialysis with a GFR of less than 5 ml/min per $1.73m^2$. Potential causes of late initiation of dialysis could be irreversible acute renal failure, absence or denial of uremic symptoms, absence of medical care among the uninsured, or limited understanding among primary care physicians regarding the process and timing of initiation of dialysis. Even among patients who are under the care of a nephrology team, initiation of dialysis may be delayed despite current recommendations to initiate dialysis early for a number of reasons. First, perceptions of patients and physicians about the psychosocial drawbacks of initiation of dialysis may outweigh the potential adverse consequences of advancing uremia (13). Second, there is a lack of consensus regarding appropriate timing of initiation of renal replacement therapy (6,10,13–15). Finally, there may be fear of denial of reimbursement for dialysis by private insurers and the HCFA if a particular threshold is not attained.

Our analysis demonstrated a significant association of gender and race with timing of initiation of dialysis; women and non-Caucasians demonstrated significantly higher odds for late initiation of dialysis compared with men and Caucasians. The possible causes for the influence of gender and race on timing of initiation of dialysis include reduced access to medical care and other economic factors unrelated to insurance, patient attitudes toward seeking or accepting medical care, physician referral patterns, and method of estimating the level of renal function.

The MDRD Study equation adjusts for age, gender, race, and nutritional status (2). These adjustments are not routinely incorporated into physicians' interpretation of the serum creatinine concentration. Failure to account for lower muscle mass in women and elderly patients or higher muscle mass in African Americans (16,17), athletes, and younger patients may lead to systematic differences in the interpretation of residual renal function and consequently in the timing of initiation of renal replacement therapy among these patients. Among women, use of serum creatinine may lead to overestimation of the residual renal function and thus late initiation of dialysis if residual renal function were to be measured or calculated more accurately. Among African Americans, use of serum creatinine without taking into account greater muscle mass would result in underestimation of residual renal function and thus initiation of dialysis before the recommended level if residual renal function were to be measured more accurately. For example, using the MDRD equation, a serum creatinine of 7 mg/dl represents a GFR of 11 ml/min per $1.73m^2$ for a 50-yr-old African American man but a GFR of 9.6 ml/min per $1.73m^2$ for a Caucasian man of the same age, whereas for 50-yr-old women, this represents a GFR of 7.3 ml/min per $1.73m^2$ among Caucasians and 8.6 ml/min per $1.73m^2$ among African Americans. General practitioners may assume that patients with a particular serum creatinine level have similar residual renal function regardless of age, gender, lean body mass, race, and nutritional status; this can lead to delays in referral for care and in initiation of renal replacement therapy. We described in an earlier report that African Americans have a higher creatinine level and a lower level of residual renal function at the initiation of dialysis compared with Caucasians (3), which suggests that the impact of higher muscle mass on the creatinine concentration is not accounted for appropriately. In the current study, African Americans did not have higher odds for late initiation of dialysis after controlling for a variety of socioeconomic and clinical variables. However, patients of other racial groups were found to have higher odds for late initiation of dialysis. Either the MDRD equation does not adequately correct for muscle mass among patients of these racial groups or, alternatively, other factors that were not adjusted for contribute to late initiation of dialysis.

We previously reported that gender and racial differences exist in certain aspects of pre-ESRD care. Compared with males and Caucasians, females and patients of non-Caucasian races were more likely to have hypoalbuminemia and severe anemia at the initiation of dialysis and less likely to receive erythropoietin before initiation of dialysis (18). Others have also described gender and racial differences in other areas of management of patients' chronic renal failure. Women are less likely to receive a renal transplant but more likely to donate a kidney (19,20). African Americans are less likely to be put on a waiting list for transplantation (21,22), have a longer average waiting time to receive transplants (23), receive a lower average delivered dose of dialysis (24), and are less likely to choose peritoneal dialysis (25). A recent study of patients with renal failure showed that racial differences in the use of aggressive cardiac interventions existed in the pre-ESRD phase of chronic renal failure but diminished once the inherent repeated medical evaluations of dialysis took place (26). These observations are consistent with previous reports regarding gender and racial variation in the management of cardiovascular diseases and use of other medical interventions. Aggressive treatment for chest pain and myocardial infarction is recommended less often for women than for men (27,28). Similarly, African Americans and Hispanics are less likely to receive aggressive cardiac interventions and have lower rates for other surgical procedures, such as carotid endarterectomy and appendectomy (27,29–31). Overall, these variations in practices suggest less frequent intensive and possibly discretionary medical care for women and racial minorities.

Potential general reasons for the gender and racial differences in medical care include (*1*) less research in the female and minority populations, (*2*) inadequate patient education regarding the available treatment options, (*3*) inability or unwillingness to present for care because of cultural or economic reasons, and (*4*) variations in patient and/or physician interpretation of severity of symptoms. Whether differences related to race are partly due to discriminatory practices is not known, but ethnic variations in risk aversion may provide a partial explanation (32). Racial variation in care may be influenced by clinical factors, such as severity or location of disease, comorbid conditions, and operative risk, which cannot be easily evaluated in retrospective studies, and differences in decision making, which may influence the seeking and acceptance of medical care (33). Diverse ethnic beliefs in disease susceptibility and treatment effectiveness, varying tolerance of the inconvenience of seeking care, and previous negative experiences with health care may lead to a reduced acceptance of medical advice and conventional care (33,34), potentially resulting in delayed management of medical conditions, including late initiation of dialysis.

Other observations of interest that arose from this analysis are the association of insurance, age, comorbid conditions, and employment status with timing of initiation of dialysis. Although insurance status had a significant association with initiation of dialysis in univariate analyses, this association was not striking in the adjusted analysis. In the United States, age and employment status are closely linked to insurance status. Given that age is related to the presence and severity of comorbid conditions, it is likely to be more strongly associated with timing of initiation of dialysis than insurance status, thus the reduction of the significance of insurance status on timing of initiation of dialysis after adjustment for age. The only insurance factor that remained significantly associated with late initiation of dialysis was the lack of any insurance. This is consistent with reduced access to care as a factor that leads to late initiation of dialysis. Patients who do not have insurance or who are otherwise unable to pay are less likely to seek medical care (33,35) and thus more likely to present for urgent initiation of dialysis once they are symptomatic. In addition, the uninsured may be less frequently referred for procedures and other services than the insured (36). The somewhat lower odds of late initiation of dialysis for patients who have both Medicaid and Medicare compared with patients who have private insurance seen in the adjusted analysis may reflect reduced financial barriers to obtaining health care. Freeman's analysis of data from the National Center for Health Statistics demonstrated that patients who have Medicaid are more likely to use both ambulatory and hospital services than are patients who have private or no insurance (35). He hypothesized that the copay with private insurance may present a sufficient financial difficulty to present a barrier to seeking health care, whereas patients who do not have insurance may have no financial resources.

The observation that older patients and patients with comorbid conditions are less likely to initiate dialysis late was not surprising. Most of the recommendations for deciding when to initiate dialysis take into account patient symptoms, which are likely to occur earlier among elderly patients and those with other underlying illnesses. Moreover, older patients and patients with cardiac or peripheral vascular disease and other chronic conditions are more likely to be under the regular care of a physician and thus more likely to be referred for dialysis in a timely fashion. The comorbid condition assessment provided to the USRDS is imprecise, as recently shown in a comparison of comorbidity data on the HCFA 2728 form with prospectively collected data from the Choices for Healthy Outcomes in ESRD Study. The rate of correct identification of the particular condition ranged from 15 to 83% (sensitivity), although if the condition was marked as present, fewer than 10% were incorrect (specificity of 91 to 100%) (37). This error leads to biasing the estimate of the effects toward zero, or no effect; thus, the effect estimate that is statistically obtained is a minimal estimate. It is unlikely that the proportion of patients who are misclassified as not having a comorbid condition is markedly different between patients who start dialysis late *versus* early. Thus, the direction of the relationship between presence of a comorbid condition and late initiation of dialysis, if not the magnitude, is accurate, and it is likely that the effect size is greater than obtained.

That unemployed or retired/disabled patients were less likely than employed patients to start dialysis late may represent a "healthy worker" type of effect, although not in the classical sense of that term (38). Patients who are well enough to work are less likely to have symptoms of uremia that predicate the initiation of dialysis, even though they may have reduced renal function. Alternatively, steadily employed patients may have a greater reluctance to accept the time-consuming and disruptive dialysis procedure, unless symptoms of uremia are present.

Overall, it seems that women and certain non-Caucasian racial groups have later initiation of dialysis, which may in part be associated with differential access to or provision of medical care. Lack of physician awareness of possible gender and race effects on the presentation and management of illnesses, inaccurate assessment of renal function leading to overestimation of residual renal function, inadequate recognition of and efforts to overcome cultural barriers to medical care, and lack of financial resources to pay for medical care are potentially remediable factors that may account for this discrepancy.

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