Geographic Concentration of Poverty and Arteriovenous Fistula Use among ESRD Patients

William M. McClellan,*† Haimanot Wasse,* Ann C. McClellan,† James Holt,‡ Jenna Krisher,§ and Lance A. Waller‖

*Division of Nephrology, Emory University, Atlanta, Georgia; †Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, Georgia; ‡Centers for Disease Control and Prevention, Atlanta, Georgia; §Division of Adult and Community Health, ESRD Network 6, Raleigh, North Carolina; and ‖Department of Biostatistics and Bioinformatics, Rollins School of Public Health, Emory University, Atlanta, Georgia

ABSTRACT

There is substantial geographic variability in both incident and prevalent arteriovenous fistula (AVF) use among patients with ESRD. This study examined the degree to which these variations associate with poverty in the county of a patient's treatment center. We performed a cross-sectional study including 28,135 patients treated by 1127 hemodialysis centers in five ESRD networks (16 states) between June 1, 2005 and May 31, 2006. We used the 2000 U.S. Census to categorize county-level poverty and ascertained incident AVF use from the Medicare CMS 2728 form. We calculated the 30-month slope of change in AVF prevalence from monthly facility reports collected between 2003 and 2005. More than 33% of treatment centers were located in high-poverty counties. County poverty inversely associated with incident AVF use (P for trend = 0.001). In contrast, substantial increases in prevalent AVF rates from 30.9 to 38.6% ($P < 0.001$) among treatment centers did not associate with county poverty ($P = 0.9519$). In conclusion, the concentration of poverty in the county where a treatment is located associates with incident AVF use by patients with ESRD but not with subsequent improvement in AVF use among prevalent patients. These results suggest that the Medicare ESRD program may mitigate poverty effects on AVF use.

J Am Soc Nephrol 21: ●●●–●●●, 2010. doi: 10.1681/ASN.2009121235

The Medicare ESRD program was established in 1972 by Public Law 92-603, which authorized Medicare to reimburse the costs of ESRD care for all individuals eligible for Social Security benefits. The legislation was enacted to improve access to hemodialysis care and eliminate rationing of this lifesaving therapy. Before the program, access to hemodialysis was often allocated by criteria that included age, gender, employment status, psychologic health, and the perceived usefulness of one's role in society.[1–3] Substantial variations in care provided within the program have been reported for different gender, race, and geographic groups. For example, use of an arteriovenous fistula (AVF) for hemodialysis vascular access, which is associated with decreased morbidity and mortality, varies by a patient's race and gender, and low use clusters geographically.[4,5]

The reasons why AVF use differs among patient groups and geographic regions are unclear, and it has been suggested that poverty may contribute to these variations.[6] This study examines the degree to which incident and prevalent AVF use are associated with the poverty in the county where a treatment center is located. We hypothesized that increasing community poverty would have similar

Received December 10, 2009. Accepted May 3, 2010.

Published online ahead of print. Publication date available at www.jasn.org.

Correspondence: Dr. William McClellan, Emory University School of Medicine, Renal Division, Rollins School of Public Health, Room 476, 1518 Clifton Road, Atlanta, GA 30322. Phone: 404-727-6976; Fax: 404-727-8737; E-mail: wmcclel@sph.emory.edu

Copyright © 2010 by the American Society of Nephrology

Table 1. U.S. census characteristics of counties within a geographic concentration of county-level poverty

	N (%) Centers	Median Income ($)	Rural (%)	Poverty (%)	Minority (%)	< HS (%)
Extremely high poverty (concentrated)	35 (3.1%)	23,505	37.1	31.0	50.2	34.1
Very high poverty (concentrated)	83 (7.4%)	27,997	39.8	23.0	42.2	30.6
High poverty (concentrated)	162 (14.4%)	33,484	12.3	17.9	41.3	25.5
Extremely high poverty (spatial outlier)	1 (0.1%)	29,949	0	30.1	10.1	23.2
Very high poverty (spatial outlier)	25 (2.2%)	30,302	0	22.8	45.5	28.6
High poverty (spatial outlier)	66 (5.9%)	38,810	1.5	17.3	49.1	21.8
Other	403 (35.8%)	37,371	10.2	13.1	31.5	22.8
Low poverty (spatial outlier)	67 (5.9%)	42,771	8.9	10.1	18.2	19.8
Very low poverty (spatial outlier)	21 (1.9%)	59,362	0	5.7	20.8	13.0
Low poverty (concentrated)	122 (10.8%)	44,643	11.5	9.5	22.7	15.2
Very low poverty (concentrated)	142 (12.6%)	57,491	2.1	5.5	18.4	12.5
R^{2a}		65.0%	10.0%	86.5%	14.7%	34.8%
P^b		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[a]The proportion of the variance in the mean treatment center estimates that is explained by county-level poverty.
[b]Test for equality of means across poverty strata.

effects on both incident and prevalent AVF use, reducing the proportions of patients within a treatment center with these related quality-of-care indicators.

RESULTS

We estimated individual and facility incident AVF rates for 28,135 incident patients with complete information, representing 93.1% of the 30,327 individuals whose initial dialysis dates were within the study time frame from June 1, 2005 to May 31, 2006. These patients were treated by 1127 hemodialysis centers that met our inclusion criteria. Among these treatment centers, 280 (24.8%) were located in areas of concentrated high poverty and another 92 (8.2%) were located in counties whose high poverty rates were spatial outliers. The network-specific distributions of counties where at least one hemodialysis center was located in either concentrated or a spatial outlier poverty was 2.1 and 22.6% for NW 5; 25.8 and 0% for NW 6; 44.9 and 0% for NW 8; 0 and 21.4% for NW11; and 75.3 and 0% for NW 13. As the degree of concentrated poverty where a treatment center was located decreased, the county median income increased, and the proportions of minorities, rural counties, the population living below the poverty level, and those without a high school education all decreased (Table 1).

The association between patient characteristics in a facility and the concentration of poverty in the county where the treatment center is located is shown in Table 2. The dialysis populations in areas of concentrated poverty are younger, with mean ages in the most compared with least areas of poverty concentration of 60.5 and 65.3 years, respectively (Table 2). Facility populations in counties with higher concentrations of poverty were more likely to be female, black, and disabled, to report no health insurance at the start of hemodialysis, and to be somewhat less likely to have ESRD attributed to diabetes.

Facility-specific measures of AVF care varied substantially among facilities. The facility mean (SD) AVF rate for incident patients was 11.8% (10.1%), the 25th to 75th intraquartile range (IQR) was between 4.8 and 16.7%, and the range was from 0 to 100%. The facility-specific mean (SD) baseline prevalent AVF rate was 30.8% (12.8%) of patients, with an IQR between 21.4 and 38.2% and a range from 0 to 100%. The mean (SD) 30-month slope for change in facility prevalent AVF rates was 0.29%/mo (0.46%), with an IQR between 0.05 and 0.54%/mo and a range from −3.5 to 3.6%/mo.

Table 2. Characteristics of ESRD treatment center incident patients by county poverty level

	Age	Male (%)	Black (%)	DM ESRD (%)	Disabled (%)	No Health Insurance (%)
Extremely high poverty (concentrated)	60.5	49.7	73.5	38.6	13.0	12.7
Very high poverty (concentrated)	62.0	49.6	63.6	46.3	11.5	12.2
High poverty (concentrated)	61.3	50.5	61.7	44.3	12.2	10.9
Extremely high poverty (spatial outlier)	70.2	65.3	4.1	32.6	0	8.2
Very high poverty (spatial outlier)	58.7	54.0	75.2	31.2	4.8	15.9
High poverty (spatial outlier)	61.3	53.4	64.0	42.0	16.8	6.0
Other	62.4	52.7	55.9	45.7	11.7	9.5
Low poverty (spatial outlier)	64.3	53.1	33.2	43.9	10.8	7.4
Very low poverty (spatial outlier)	63.8	53.7	36.5	42.8	8.7	5.3
Low poverty (concentrated)	64.9	55.3	26.0	41.7	10.3	4.4
Very low poverty (concentrated)	65.3	55.2	28.6	40.2	9.6	4.5
P^a	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

[a]Test for equality of means across poverty strata.

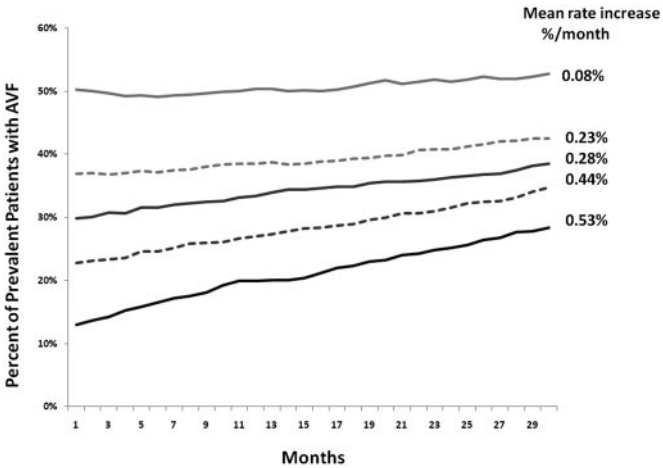

Figure 1. Change over time in proportion of prevalent hemodialysis patients using an AVF stratified by quintile of baseline AVF use among facilities in ESRD networks 5, 6, 8, 11, and 13 based on monthly reports to each network by all individual treatment centers.

Facility incident AVF rates and changes in prevalent AVF were not independent of one another. There were modest but statistically significant correlations between incident AVF rates and baseline AVF prevalence rates ($r = 0.2099$, $P < 0.001$) and incident AVF rates and rate of increase in prevalent AVF ($r = 0.1618$, $P < 0.001$). The baseline prevalent AVF rate was inversely correlated with the rate of increase in prevalent AVF ($r = -0.3764$, $P < 0.001$; Figure 1).

The increased concentration of poverty in a treatment center's county was associated with both lower incident ($P = 0.001$) and baseline prevalent ($P < 0.005$) AVF rates (Table 3). In contrast, prevalent AVF rates increased substantially over the 30 months of observation (Figure 2), from 30.9 to 38.6% ($P < 0.001$), and there was no significant association between county poverty concentration and the mean facility slope for change in prevalent AVF ($P = 0.9519$; Table 3).

DISCUSSION

Our main finding was, as the degree and concentrations of poverty in an area surrounding a treatment center declined, incident AVF use increased and lower prevalent AVF rates 30 months earlier were also seen in these centers. Although it is no surprise that centers in poor communities recorded less effective AVF care for incident patients, we did not expect our observation that the center-specific rate of increase in prevalent AVF use over the 30-month period before our measurement of incident AVF rates would be independent of poverty. These observations suggest that, whereas high poverty decreases predialysis AVF placement, increases in AVF use among a treatment center's prevalent patient population can be independent of local poverty.

AVF provides safe, adequate hemodialysis therapy and is associated with improved survival,[7–13] and we have previously reported that both individual and treatment center first-year increased mortality was associated with the absence of an incident AVF in this population.[6] This superiority is reflected in the National Kidney Foundation's Clinical Practice Guidelines for Vascular Access, which recommends early placement and use of an AVF among patients expected to require hemodialysis.[14] Despite these advantages and attendant recommendations, there is considerable variability in AVF use among hemodialysis patients and geographic regions in the United States. Hirth and colleagues[15] reported over a decade ago on the considerable variation in AVF rates among census regions. We previously reported that treatment centers with low rates of AVF use among incidence patients tended to cluster geographically and that these center-to-center and regional variations could not be accounted for by individual patient characteristics.[6] Our report extends these observations by describing that individual and treatment center incident AVF rates are associated with the degree of poverty in the county where the treatment center is located.

There are many potential explanations as to why higher proportions of individuals living in poverty might contribute to lower incident AVF rates.[16,17] For example, local poverty might influence the availability of health care resources relevant to the creation of an AVF, including trained surgeons and specialized surgical centers. The knowledge of local primary care physicians might vary with geographic poverty, leading to delays in early referral for AVF placement. Poorer communities might negatively influence opinions, attitudes, and beliefs among individuals with advanced kidney disease about the utility of early AVF surgery. In addition, lower population density and rural location may have influenced these associations. These are important issues that could not be explored in our data, and further study to understand the community attributes associated with poverty that influence the association with AVF is needed.

The absence of an association between local poverty and the rate of increase in prevalent AVF use was unexpected and suggests that poverty effects on AVF placement are not immutable. One possible mechanism that may contribute to the attenuation of a local poverty effect is programs conducted to promote improved AVF care. Reports of previous quality improvement interventions that were associated with reductions in geographic variations in the quality of ESRD care support this hypothesis.[18] Previous ESRD quality improvement interventions have been associated with reduction in gender and racial disparities and with reductions in regional variations in hemodialysis adequacy and anemia control.[19] Observational studies[20] and controlled evaluations[21,22] found an independent effect of these interventions on improved quality of care. Finally, these changes in quality of ESRD care were associated with improved survival[23] and a decreased center-to-center variability in care.[24]

Similar efforts to improve the quality of AVF use have been conducted by Centers for Medicare and Medicaid Services (CMS) since 2004.[25] This program, Fistula First (FF), focused

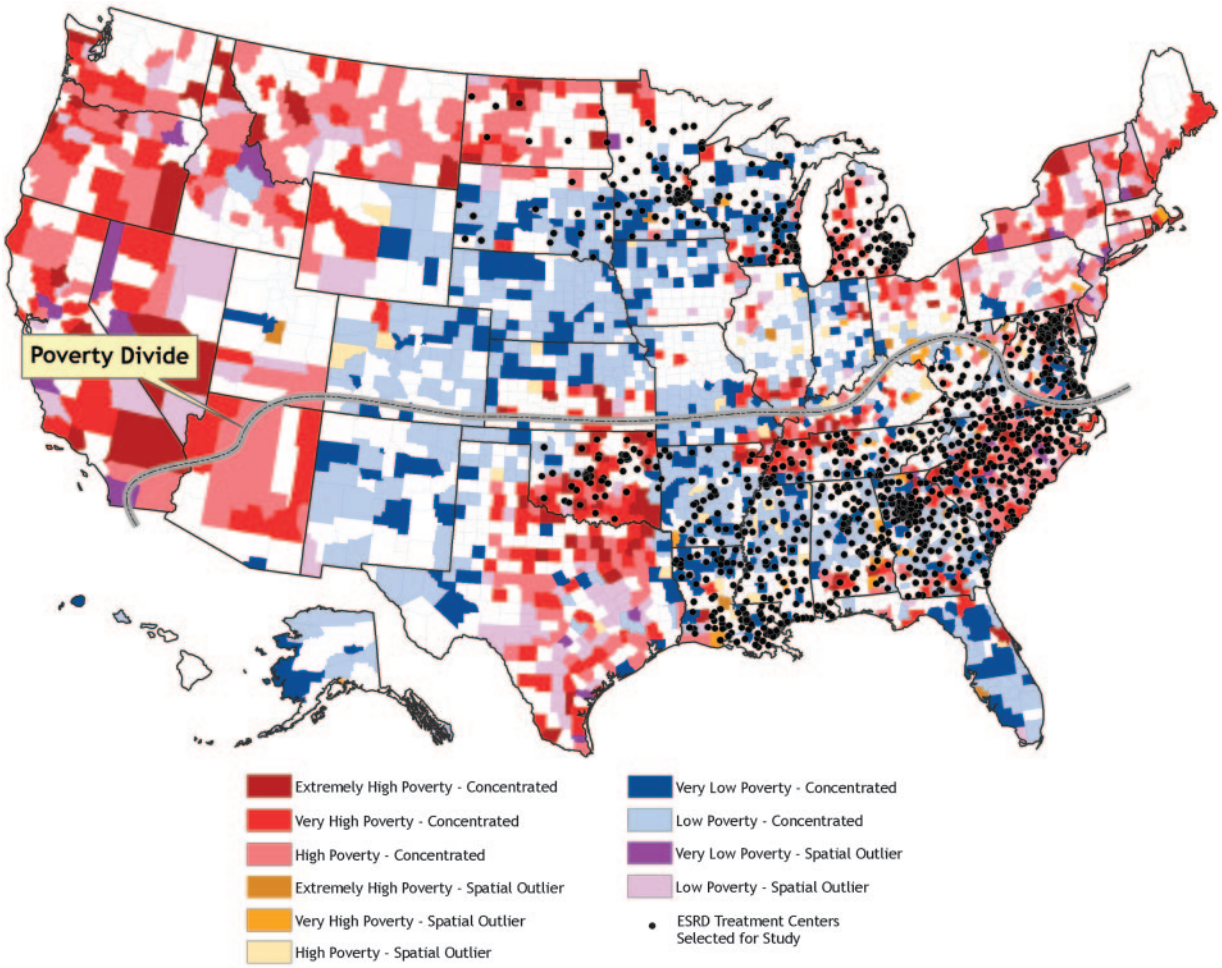

Figure 2. The communities where treatment centers are located are regionally and socioeconomically diverse. The map displays the concentration of county poverty for the entire United States and the location of treatment centers included in this analysis. White denotes counties with neither concentrated poverty nor concentrated affluence.

first on improving prevalent AVF rates to 40% of patients. After the inception of FF, a 4-year increase in prevalent rates to 50% was observed.[26] During the FF initiative, ESRD network staff actively contacted treatment centers to provide education about AVF to treatment center staff, disseminated quality improvement tools and resources to help improve the placement of AVF among prevalent patients, and provided continuing feedback about center-specific and regional performance on AVF care. Specific interventions advocated by network staff included designating a treatment center staff member to promote vascular access quality improvement; encouraging referrals specifically for an AVF; selecting surgeons based on AVF placement outcomes; providing AVF cannulation training for staff; and implementing monitoring and maintenance programs to ensure adequate access function.

It is encouraging to note that prevalent AVF use increased faster among facilities with the lowest baseline AVF prevalence, resulting in reduced center-to-center variability in prevalent AVF. The increase in prevalent AVF rate (30.9 to 38.6%) compares favorably to the difference between incident AVF rates in high poverty (9 to 10.8%) and low poverty (10.2 to 13.9%) areas. These observations suggest that facility-based quality improvement efforts overshadow and mitigate initial difference in AVF rates among communities with different socioeconomic conditions.

Our data do not allow us to evaluate the impact of these activities on geographic patterns of care or the extent to which they may have contributed to the absence of a poverty effect on treatment center specific increases in prevalent AVF rates. However, it is reasonable to suggest that the FF intervention, which included components that have been found effective in changing provider behavior, including feedback on performance[27] and active outreach,[28] and which was similar to earlier interventions by the ESRD networks,[21,22] may have had an independent effect on improvement in care.

There are limitations to our study. The main limitation is our paucity of individual-level poverty data, particularly for prevalent patients. This renders inferences about individual poverty and AVF status problematic, and one cannot necessarily infer from our data that the individuals in poor communi-

Table 3. Characteristics of pre-ESRD treatment care of incident patients and center-specific AVF improvement by geographically correlated poverty

	N	Baseline AVF (%)	Incident AVF (%)	AVF Slope (%/mo)	Nephrology Care (%)
Overall rates	1127	30.8	11.8	0.29	57.8
Geographically correlated poverty					
Extremely high poverty (concentrated)	35	29.0	9.0	0.32	54.0
Very high poverty (concentrated)	83	26.5	10.8	0.30	60.6
High poverty (concentrated)	162	28.7	10.2	0.29	61.9
Extremely high poverty (spatial outlier)	1	46.6	16.3	0.44	57.8
Very high poverty (spatial outlier)	25	29.4	6.9	0.26	57.4
High poverty (spatial outlier)	66	28.9	10.9	0.20	57.7
Other	403	31.6	13.9	0.29	65.0
Low poverty (spatial outlier)	67	29.4	13.9	0.37	70.4
Very low poverty (spatial outlier)	21	36.6	11.6	0.28	61.8
Low poverty (concentrated)	122	32.3	11.6	0.33	64.8
Very low poverty (concentrated)	142	31.9	10.2	0.28	63.7
R^{2a}		2.3%	3.2%	0.5%	2.5%
P^b		0.005	<0.001	0.9592	0.003

[a]The proportion of the variance in the mean treatment center estimates that is explained by county-level poverty.
[b]Test for equality of means across poverty strata.

ties that started dialysis without an AVF were necessarily poor themselves. A more detailed modeling strategy that included poverty information about individuals as well as the community and data to adjust for community and treatment center factors associated with AVF placement before the start of hemodialysis is clearly needed to fully understand these observations. Furthermore, we are unable to validate the accuracy of the reported incident vascular access as reported to CMS, and it is possible that it was over- or underestimated by the clinicians completing the forms. However, we would expect this misclassification to be nondifferential with relationship to patient baseline characteristics and treatment center. The primary strengths of this study are that it is a large, multi-network population-based patient sample, and it is unlikely that our conclusions are caused by selection bias.

Substantial variation exists among ESRD treatment centers with respect to AVF use, and this variation is associated with the degree of county-level poverty where a dialysis treatment center is located. This suggests that general economic conditions external to the ESRD system may be associated with care of hemodialysis patients. In contrast, the treatment center-specific improvement in prevalent AVF use, measured during a national systematic effort to improve AVF rates, was independent of county poverty. This second observation suggests that participation in the Medicare ESRD program may have mitigated the effect of poverty on disparities in ESRD treatment and that this mitigation may reflect participation of treatment centers in mandated quality improvement activities. We note, however, the lack of a significant difference in slopes means that, although all centers improved at the same rate, the level of absolute disparity remains unchanged. It is worth noting that, whereas the Medicate ESRD program seems to improve use of ESRD in all centers, additional effort may be needed to narrow disparities.

CONCISE METHODS

Study Setting and Design

This is a secondary analysis of data collected by the U.S. ESRD Network Program.

Study Population

The study population included individuals ≥18 years of age who started hemodialysis between June 1, 2005 and May 31, 2006 in ESRD Network (NW) 5 (District of Columbia, Maryland, Virginia, and West Virginia), NW 6 (North Carolina, South Carolina, and Georgia), NW 8 (Alabama, Mississippi, and Tennessee), NW 11 (North Dakota, South Dakota, Minnesota, Wisconsin, and Michigan), and NW 13 (Louisiana and Oklahoma). The participating networks provided data for these analyses as part of a voluntary, ad hoc effort to identify factors associated with facility-to-facility variations in AVF rates. This information, in turn, is used to guide interventions to improve AVF use in the respective ESRD populations. Analyses for this purpose had identified geographic clustering of poorly performing treatment centers[6] that led to our hypothesis that the degree of poverty in the area where a treatment center was located[29] might be associated with AVF rates. The analyses of these data were approved by the Emory University School of Medicine Institutional Review Board.

Concentration of County Poverty

We used a previously described index calculated from 2000 U.S. Census poverty data to characterize the geographic concentration of poverty of the county in which each treatment center was located into 11 groups (Figure 1).[29] The characterization of each counties' spatial poverty situation depended on (*1*) the magnitude of the county's location above or below the mean poverty level, calculated by a standardized *z* score for poverty (z = [county mean poverty level − mean poverty level across all counties]/SD of county poverty across all

counties) and (*2*) the tendency of poverty rates in a particular county to be either similar or dissimilar to the poverty rates of nearby counties.

Specifically, the characterization of the degree of poverty was determined as follows: counties whose poverty rates fell between 1 and 2 SD above the mean were classified as "high" poverty counties; counties whose rates fell between 2 and 3 SD above the mean were classified as "very high" poverty counties; and counties whose rates equaled or exceeded 3 SD above the mean were classified as "extremely high" poverty counties. Conversely, counties whose rates fell between 1 and 2 SD below the mean were classified as "low" poverty counties; and counties whose rates fell between 2 and 3 SD below the mean were classified as "very low" poverty counties. There were no counties whose rates exceeded at least 3 SD below the mean; thus, there were no "extremely low" poverty counties.

The second characteristic, relating to spatial situation (or clustering), was determined through the use of local Moran's I scores, a type of local indicator of spatial association. Details of local indicator of spatial association and our implementation of local Moran's I have been published.[30,31] Counties were considered to be part of a spatial "concentration" if their poverty rates were significantly positively correlated with those of nearby or surrounding counties. This characterization of "highly correlated" was based on having a standardized local Moran's I >2.0. Counties were considered to be "spatial outliers" if their poverty rates were significantly negatively correlated with those of nearby or surrounding counties; in this case, the inclusive definition was having a standardized local Moran's I score less than or equal to -2.0.

Thus, high and low poverty were defined as "concentrated" where very high or low *z* scores for poverty rates (>2 SD above or below the mean poverty rate for U.S. counties) were highly correlated with those of nearby or surrounding counties. A high or low "spatial outlier" was defined as a substantially high or low *z* score for poverty rates that differed significantly from nearby or surrounding counties. Finally, "Other " was defined as counties where either (*1*) *z* scores for poverty rates were weakly correlated (positively or negatively) with the *z* scores for nearby counties or (*2*) counties' poverty rates were positively or negatively correlated with nearby counties' rates but the *z* scores for poverty rates were intermediate. County poverty data were obtained from the 2000 U.S. Census.

Incident AVF and Predialysis Nephrology Care

Incident AVF use and predialysis nephrology care were ascertained from the CMS 2728 form that is completed for each incident patient and attested as accurate by a physician. Predialysis nephrology care was categorized as present if the answer was either "6 to 12 months" (27.2%) or "$>$12 months" (24.2%).

Baseline AVF Use and Change over Time

ESRD networks collected monthly data about facility-specific AVF use from every Medicare-certified outpatient dialysis facility in the United States for 30 consecutive months during 2003 to 2005 as part of a national intervention to improve AVF use. The data included the proportion of patients using an AVF on the last hemodialysis treatment of each month. The first reported prevalence was defined as the baseline rate, and the percent AVF use in each of the 30 months was regressed against time in months to obtain a rate of change (% prevalent AVF/mo) for each treatment center.

Patient Information

De-identified patient information obtained from the CMS 2728 form included race, gender, age, body mass index, and diabetes as primary cause of ESRD, heart failure, atherosclerotic heart disease, peripheral vascular disease, history of amputation, and functional status. Individuals were defined as uninsured and unemployed based on their insurance or employment status 6 months before dialysis.

Follow-up

Network follow-up for each patient began on the day of first dialysis and continued until August 2006. Patients were censored at the time of transplant, transfer from the treatment center, death, or at the end of the study.

Statistical Analysis

Differences in characteristics of communities and treatment centers by poverty level were tested by ANOVA and linear regression. Correlations were examined using Spearman's rank correlation coefficient. The associations between community poverty and facility-specific quality-of-care indicators, *i.e.,* incident AVF rate and facility-specific improvement in prevalent AVF use, were examined by ANOVA and linear regression without adjustment for other covariates, because we lacked any information about individual patient suitability for AVF placement.[32] These analyses were performed using SAS version 9.1.

ACKNOWLEDGMENTS

This work was supported in part by a National Institutes of Health Career Development Award K23 DK65634 and a Robert Wood Johnson Foundation Harold Amos Medical Faculty Development Award (to H.W.).

DISCLOSURES

The analyses on which this publication is based were performed under Contract HHSM-500-2006-NW006C entitled End Stage Renal Disease Networks Organization for the States of North Carolina, South Carolina, and Georgia, sponsored by the Centers for Medicare & Medicaid Services, Department of Health and Human Services. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the Centers for Medicare & Medicaid Services, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government. The authors assume full responsibility for the accuracy and completeness of the ideas presented. This article is a direct result of the Health Care Quality Improvement Program initiated by the Centers for Medicare & Medicaid Services, which has encouraged identification of quality improvement projects derived from analysis of patterns of care, and therefore required no special funding on the part of this contractor.

REFERENCES

1. Iglehart JK: The American health care system. The End Stage Renal Disease Program. *N Engl J Med* 328: 366–371, 1993
2. Blagg CR: The early history of dialysis for chronic renal failure in the United States: a view from Seattle. *Am J Kidney Dis* 49: 482–496, 2007
3. Lockridge RS Jr: The direction of end-stage renal disease reimbursement in the United States. *Semin Dial* 17: 125–130, 2004
4. Hopson S, Frankenfield D, Rocco M, McClellan W: Variability in reasons for hemodialysis catheter use by race, sex, and geography: Findings from the ESRD Clinical Performance Measures Project. *Am J Kidney Dis* 52: 753–760, 2008
5. Pisoni RL, Arrington CJ, Albert JM, Ethier J, Kimata N, Krishnan M, Rayner HC, Saito A, Sands JJ, Saran R, Gillespie B, Wolfe RA, Port FK: Facility hemodialysis vascular access use and mortality in countries participating in DOPPS: An instrumental variable analysis. *Am J Kidney Dis* 53: 475–491, 2009
6. McClellan WM, Wasse H, McClellan AC, Kipp A, Waller LA, Rocco MV: Treatment center and geographic variability in pre-ESRD care associate with increased mortality. *J Am Soc Nephrol* 20: 1078–1085, 2009
7. Tonelli M, Muirhead N: Access type as a predictor of dialysis adequacy in chronic hemodialysis patients. *Asaio J* 46: 279–282, 2000
8. Palevsky PM, Washington MS, Stevenson JA, Rohay JM, Dyer NJ, Lockett R, Perry SB: Barriers to the delivery of adequate hemodialysis in ESRD Network 4. *Adv Ren Replace Ther* 7: S11–S20, 2000
9. Ifudu O, Mayers JD, Matthew JJ, Fowler A, Friedman EA: Haemodialysis dose is independent of type of surgically-created vascular access. *Nephrol Dial Transplant* 13: 2311–2316, 1998
10. Pastan S, Soucie JM, McClellan WM: Vascular access and increased risk of death among hemodialysis patients. *Kidney Int* 62: 620–626, 2002
11. Lorenzo V, Martn M, Rufino M, Hernandez D, Torres A, Ayus JC: Predialysis nephrologic care and a functioning arteriovenous fistula at entry are associated with better survival in incident hemodialysis patients: An observational cohort study. *Am J Kidney Dis* 43: 999–1007, 2004
12. Xue JL, Dahl D, Ebben JP, Collins AJ: The association of initial hemodialysis access type with mortality outcomes in elderly Medicare ESRD patients. *Am J Kidney Dis* 42: 1013–1019, 2003
13. Astor BC, Eustace JA, Powe NR, Klag MJ, Fink NE, Coresh J: Type of vascular access and survival among incident hemodialysis patients: The Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study. *J Am Soc Nephrol* 16: 1449–1455, 2005
14. Vascular Access Work Group: Clinical practice guidelines for vascular access. *Am J Kidney Dis* 48[Suppl 1]: S176–S247, 2006
15. Hirth RA, Turenne MN, Woods JD, Young EW, Port FK, Pauly MV, Held PJ: Predictors of type of vascular access in hemodialysis patients. *JAMA* 276: 1303–1308, 1996
16. Powe NR: Let's get serious about racial, ethnic disparities. *J Am Soc Nephrol* 19: 1271–1275, 2008
17. Norris K, Nissenson AR: Race, gender, and socioeconomic disparities in CKD in the United States. *J Am Soc Nephrol* 19: 1261–1270, 2008
18. McClellan WM, Frankenfield DL, Frederick PR, Helgerson SD, Wish JB, Sugarman JR: Improving the care of ESRD patients: A success story. *Health Care Financ Rev* 24: 89–100, 2003
19. Sehgal AR: Impact of quality improvement efforts on race and sex disparities in hemodialysis. *JAMA* 289: 996–1000, 2003
20. McClellan WM, Frankenfield DL, Frederick PR, Flanders WD, Alfaro-Correa A, Rocco M, Helgerson SD: Can dialysis therapy be improved? A report from the ESRD Core Indicators Project. *Am J Kidney Dis* 34: 1075–1082, 1999
21. Sehgal AR, Leon JB, Siminoff LA, Singer ME, Bunosky LM, Cebul RD: Improving the quality of hemodialysis treatment: A community-based randomized controlled trial to overcome patient-specific barriers. *JAMA* 287: 1961–1967, 2002
22. McClellan WM, Hodgin E, Pastan S, McAdams L, Soucie M: A randomized evaluation of two health care quality improvement program (HCQIP) interventions to improve the adequacy of hemodialysis care of ESRD patients: Feedback alone versus intensive intervention. *J Am Soc Nephrol* 15: 754–760, 2004
23. Wolfe RA, Hulbert-Shearon TE, Ashby VB, Mahadevan S, Port FK: Improvements in dialysis patient mortality are associated with improvements in urea reduction ratio and hematocrit, 1999 to 2002. *Am J Kidney Dis* 45: 127–135, 2005
24. Fink JC, Zhan M, Blahut SA, Soucie M, McClellan WM: Measuring the efficacy of a quality improvement program in dialysis adequacy with changes in center effects. *J Am Soc Nephrol* 13: 2338–2344, 2002
25. Centers for Medicare & Medicaid Services: *2007 Annual Report, End Stage Renal Disease Clinical Performance Measures Project,* Baltimore, Department of Health and Human Services, Centers for Medicare & Medicaid Services, Office of Clinical Standards & Quality, Baltimore, 2007
26. Spergel LM: Has the Fistula First Breakthrough Initiative caused an increase in catheter prevalence? *Semin Dial* 21: 550–552, 2008
27. Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD: Audit and feedback: Effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2: CD000259, 2006
28. O'Brien MA, Rogers S, Jamtvedt G, Oxman AD, Odgaard-Jensen J, Kristoffersen DT, Forsetlund L, Bainbridge D, Freemantle N, Davis DA, Haynes RB, Harvey EL: Educational outreach visits: Effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 4: CD000409, 2007
29. Holt JB: The topography of poverty in the United States: A spatial analysis using county-level data from the Community Health Status Indicators project. *Prev Chronic Dis* 4: A111, 2007
30. Anselin L: Local indicators of spatial association—LISA. *Geograph Analysis* 27: 93–115, 1995
31. Waller LA, Gotway CA: *Applied Spatial Statistics for Public Health Data*, Hoboken, NJ, John Wiley & Sons, 2004
32. Kleinbaum D, Klein G, Pryor M, Rihl E: *Logistic Regression: A Self-Learning Text*, 2nd Ed., New York, Springer-Verlag, 2002