Residential Area Life Expectancy: Association With Outcomes and Processes of Care for Patients With ESRD in the United States

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Background: The effects of underlying noncodified risks are unclear on the prognosis of patients with end-stage renal disease (ESRD). We aimed to evaluate the association of residential area life expectancy with outcomes and processes of care for patients with ESRD in the United States.

Study Design: Retrospective cohort study.

Setting & Participants: Adult patients with incident ESRD between 2006 and 2013 recorded in the US Renal Data System (n = 606,046).

Predictor: The primary exposure was life expectancy in the patient's residential county estimated by the Institute for Health Metrics and Evaluation.

Outcomes: Death, placement on the kidney transplant wait list, living and deceased donor kidney transplantation, and posttransplantation graft loss.

Results: Median life expectancies of patients' residences were 75.6 (males) and 80.4 years (females). Compared to the highest life expectancy quintile and adjusted for demographic factors, disease cause, and multiple comorbid conditions, the lowest quintile had adjusted HRs for mortality of 1.20 (95% CI, 1.18-1.22); placement onto the waiting list, 0.68 (95% CI, 0.67-0.70); living donor transplantation, 0.53 (95% CI, 0.51-0.56); posttransplantation graft loss, 1.35 (95% CI, 1.27-1.43); and posttransplantation mortality, 1.29 (95% CI, 1.19-1.39). Patients living in areas with lower life expectancy were less likely to be informed about transplantation, be under the care of a nephrologist, or receive an arteriovenous fistula as the initial dialysis access. Results remained consistent with additional adjustment for zip code–level median income, population size, and urban-rural locality.

Limitations: Potential residual confounding and attribution of effects to individuals based on residential area–level data.

Conclusions: Residential area life expectancy, a proxy for socioeconomic, environmental, genetic, and behavioral factors, was independently associated with mortality and process-of-care measures for patients with ESRD. These results emphasize the underlying effect on health outcomes of the environment in which patients live, independent of patient-level factors. These findings may have implications for provider assessments

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There is significant geographic variation in the health status of the general population in the United States. The source of this variation is complex but includes regional differences in prominent health indicators such as morbidity, mortality, and physical and mental disability. In addition, there is notable regional variation in social determinants of health, including environmental and behavioral risk factors, access to health care and healthy food, educational attainment, and socioeconomic status.[1-4] As an indicator of this variation, at the extremes, estimated life expectancy from birth in rural West Virginia and Mississippi is approximately 65 years (similar to countries such as Haiti, Afghanistan, and Ghana), whereas life expectancy in Gunnison, CO, and Fairfax, VA, is approximately 82 years (similar to countries with the longest life expectancies, including Spain, Australia, and Japan).[5] Increasingly, empirical studies illustrate that factors such as individual behavior and environmental conditions are primary sources of this variation.[6-9]

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One of the implications of these regional health variations is that patients treated in a given health care context may have highly variable "baseline risk" that may be associated with their residential communities. These risks associated with specific residential communities may be a proxy for a variety of genetic, social, medical, and environmental conditions associated with the patient's prognosis that are independent of health care providers' quality of care. This is important because the association of risk factors with patients' residences is rarely codified or considered in diagnoses, yet may be significant predictors of patients' outcomes. Moreover, the use of "report cards," used to assess the performance of health care providers, has proliferated during the past decade.[10-12] These performance assessments have increased ramifications to health care providers' reputations and are increasingly incorporated by regulatory agencies and private and public insurers to determine reimbursement levels and credentialing. To date, value-based purchasing policies by the US Centers for Medicare & Medicaid Services do not account for variations in the underlying health of residential communities.[13,14]

In the end-stage renal disease (ESRD) population, several studies have evaluated the association of area-level (ecologic) factors such as median household income level, social deprivation, and income inequality on ESRD outcomes.[15-20] Results of these studies generally demonstrate significant but relatively modest associations between socioeconomic indicators with ESRD mortality. However, there are limited data examining the association of these factors with processes of care and outcomes across treatment modalities, including kidney transplantation. Moreover, most studies have focused specifically on socioeconomic indicators as correlates of ESRD outcomes that may depict only one of many dimensions of underlying risks in this population.

In the current study, our primary aim was to assess the association of outcomes and processes of care for a national cohort of patients with ESRD in the United States associated with patients' residential area life expectancies. We specifically investigated residential area life expectancy based on the premise that life expectancy is a proxy for a wide array of socioeconomic, environmental, genetic, and behavioral factors that are not typically captured in administrative data or medical records. Our hypothesis was that patients who resided in areas with lower life expectancy had poorer outcomes and processes of care relative to patients residing in areas with higher life expectancy independent of standard demographic and clinical conditions.

Methods

The study population consisted of all patients with incident ESRD from 2006 to 2013 between the ages of 18 and 70 years in the US Renal Data System (USRDS). Seventy was selected as a maximum inclusion age criterion because processes of care and outcomes related to transplantation are relatively low above this age threshold. The primary exposure variable of the study was sex-specific life expectancy in patients' residential areas based on the county (derived from a patient's residential zip code) in the year of ESRD onset. Life expectancy of patients' residential areas was based on data from the Institute for Health Metrics and Evaluation (IHME), which includes estimated life expectancy from birth in each US county by year.[21] We also merged data by residential zip code with US 2010 census data to include zip-code–level median income and county population size.[22] Finally, we merged data with the 2013 National Center for Health Statistics to obtain the Urban-Rural Classification Scheme (categorized on a scale of 1-6 from most urban to rural) for counties based on the Office of Management and Budget.[23]

We evaluated several primary processes of care and outcomes for incident patients with ESRD.[24,25] Processes of care of interest were derived from the Medicare 2728 form and included the following fields: "Has the patient been informed of kidney transplant options?," "Was the patient under care of a nephrologist?," "What access was used on first outpatient dialysis?," and "First ESRD event modality type." The primary outcomes of the study were time to death following ESRD initiation, placement on the deceased donor waiting list, living donor transplantation, and posttransplantation graft failure or death.

For processes of care, we used multivariable logistic models for binary responses. Patients with missing response variables were excluded from analyses. All models were adjusted for patient demographic characteristics (age, sex, race, and ethnicity), year of ESRD onset, body mass index, primary ESRD disease cause, history of hypertension, need for assistance with daily living, inability to ambulate, drug dependence, cerebrovascular disease, chronic obstructive pulmonary disease, congestive heart disease, malignant neoplasm, other cardiac disease, atherosclerotic heart disease, amputation, alcohol dependence, tobacco use, and peripheral vascular disease. Outcomes were evaluated using Cox proportional hazards models with inception at time of ESRD onset for pretransplantation models and transplantation date for posttransplantation outcomes and adjustment for factors outlined in logistic models. We used both quintiles of residential life expectancy and life expectancy on a continuous scale as exposure variables. For continuous models, we used nonlinear splines to evaluate the association with primary outcomes. Because patients were categorized by residential area, we conducted analyses accounting for potential clustering within county using generalized estimating equations for binary outcomes and a robust sandwich variance estimator for Cox models.

For time to death following ESRD onset, we generated Kaplan-Meier plots and Cox models censored at the minimum of date of transplantation or last follow-up date of September 1, 2014. We also generated models for time to death only censored at last follow-up date. For this model, we also tested for the presence of effect modification based on age, sex, race, and primary diagnosis. Time to placement on the waiting list was censored at the minimum of death, last follow-up, or living donor transplantation. Time to living donor transplantation was censored at minimum of death or last follow-up date. Overall graft loss was defined as either return to dialysis therapy, retransplantation, or death. Time to overall graft loss and death were also censored at last follow-up date. A summary of the specific cohorts, inception times, and censoring for all survival models are included in Table S1. Model assumptions were assessed using evaluation of martingale residual plots. To assess whether outcomes were affected by competing events, we repeated analyses using cumulative incidence functions and competing-risks multivariable models. The majority of causes of death were either missing or labeled as "other." However, we categorized classes of known causes of death and life expectancy quintile group. All hypotheses were evaluated using 2-sided tests with an a priori type I error probability of 0.05. All analyses were conducted using SAS (version 9.4; SAS Institute). Patient informed consent was not required given the use of secondary deidentified data, and the study was approved by the Cleveland Clinic Institutional Review Board.