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Original Investigation

Early Dialysis and Adverse Outcomes After Hurricane Sandy

Nicole Lurie, MD, MSPH,[1] Kristen Finne, BA,[1] Chris Worrall, BS,[2] Maria Jauregui, BA,[3] Tanayott Thaweethai, BS,[3] Gregg Margolis, PhD, NREMT-P,[1] and Jeffrey Kelman, MD, MMSc[2]

Background: Hemodialysis patients have historically experienced diminished access to care and increased adverse outcomes after natural disasters. Although "early dialysis" in advance of a storm is promoted as a best practice, evidence for its effectiveness as a protective measure is lacking. Building on prior work, we examined the relationship between the receipt of dialysis ahead of schedule before the storm (also known as early dialysis) and adverse outcomes of patients with end-stage renal disease in the areas most affected by Hurricane Sandy.

Study Design: Retrospective cohort analysis, using claims data from the Centers for Medicare & Medicaid Services Datalink Project.

Setting & Participants: Patients receiving long-term hemodialysis in New York City and the state of New Jersey, the areas most affected by Hurricane Sandy.

Factor: Receipt of early dialysis compared to their usual treatment pattern in the week prior to the storm.

Outcomes: Emergency department (ED) visits, hospitalizations, and 30-day mortality following the storm.

Results: Of 13,836 study patients, 8,256 (60%) received early dialysis. In unadjusted logistic regression models, patients who received early dialysis were found to have lower odds of ED visits (OR, 0.75; 95% CI, 0.63-0.89; $P = 0.001$) and hospitalizations (OR, 0.77; 95% CI, 0.65-0.92; $P = 0.004$) in the week of the storm and similar odds of 30-day mortality (OR, 0.80; 95% CI, 0.58-1.09; $P = 0.2$). In adjusted multivariable logistic regression models, receipt of early dialysis was associated with lower odds of ED visits (OR, 0.80; 95% CI, 0.67-0.96; $P = 0.01$) and hospitalizations (OR, 0.79; 95% CI, 0.66-0.94; $P = 0.01$) in the week of the storm and 30-day mortality (OR, 0.72; 95% CI, 0.52-0.997; $P = 0.048$).

Limitations: Inability to determine which patients were offered early dialysis and declined and whether important unmeasured patient characteristics are associated with receipt of early dialysis.

Conclusions: Patients who received early dialysis had significantly lower odds of having an ED visit and hospitalization in the week of the storm and of dying within 30 days.

INDEX WORDS: Disaster preparedness; emergency response; natural disaster; vulnerable population; early dialysis; hemodialysis; end-stage renal disease (ESRD); emergency department (ED) visit; hospitalization; mortality; missed dialysis session; adverse outcome; Hurricane Sandy.

Devastating natural disasters disproportionately affect vulnerable populations, including children, those who are poor, and those who are medically fragile.[1-4] Patients with end-stage renal disease (ESRD) are particularly at risk during disasters.[1-6] Studies following Hurricane Katrina identified a number of adverse outcomes for dialysis patients, including increased hospitalizations.[7,8]

Since that time, considerable progress has been made in emergency preparedness for dialysis-dependent patients. Many states require dialysis facilities to have back-up power plans and/or generators so they can remain open in the face of power outages.[9] Dialysis facilities commonly have practices in place to facilitate access to urgent dialysis care in times of crisis, including directing patients to facilities that remain open, use of shorter dialysis treatments to accommodate more patients, remain open for a third shift, and in some cases will operate 24 hours a day using staff from other facilities to ensure that additional patients affected by the emergency can receive timely dialysis.[9-11] The Kidney Community Emergency Response (KCER) Coalition, formed in response to Hurricane Katrina, routinely activates during potential disasters to assist ESRD Networks in identifying and connecting patients to facilities at which they can receive dialysis if their usual source of dialysis is not available.[12,13] Additionally, some dialysis providers seek to provide dialysis ahead of a scheduled visit, also known as "early dialysis," so patients will not have to

From the [1]Office of the Assistant Secretary for Preparedness and Response and [2]Centers for Medicare & Medicaid Services, US Department of Health and Human Services, Washington, DC; and [3]Acumen LLC, Burlingame, CA.

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Address correspondence to Nicole Lurie, MD, MSPH, Assistant Secretary for Preparedness and Response, US Department of Health and Human Services, Office of the Secretary, 200 Independence Ave SW, Rm 638G, Washington, DC 20201. E-mail: nicole.lurie@hhs.gov

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miss a dialysis session if a major storm or hurricane disrupts electricity or transportation in a given area.[14] Because surge dialysis care in advance of a storm is not precluded by federal law or regulation, state health officials commonly encourage dialysis facilities to implement this protective practice in advance of an anticipated emergency or disaster. For example, in advance of Hurricane Sandy, nearly 70% of ESRD facilities in the affected areas provided Sunday dialysis for patients who typically received dialysis on a Monday-Wednesday-Friday (MWF) schedule.[15] In advance of a rare snowstorm in New Orleans in 2013, nearly all dialysis patients were contacted and advised to receive early dialysis.

Fortunately, <5% of patients with ESRD had an emergency department (ED) visit or were hospitalized following Hurricane Sandy, but it is not clear whether those rates would have been higher without the widespread receipt of early dialysis.[15] If early dialysis is to be promoted as a best practice and protective measure in renal care, evidence for its effectiveness in avoiding subsequent adverse outcomes, such as ED visits, hospitalizations, and 30-day mortality, is needed.

Building on prior work, we used claims data from the Centers for Medicare & Medicaid Services (CMS) Datalink Project to examine the relationship between the receipt of early dialysis and adverse outcomes of patients with ESRD who received hemodialysis in New York City and the state of New Jersey, the areas most affected by Hurricane Sandy.

METHODS

Data Source and Study Population

We used Parts A and B Medicare fee-for-service claims, processed as of October 10, 2014, and covering the period from September 29, 2012, to November 30, 2012, to identify patients with ESRD who received facility-based hemodialysis (dialysis) in New York City and the state of New Jersey, the areas most affected by Hurricane Sandy.

We included patients in our study if they were ESRD Medicare beneficiaries alive as of October 28 and enrolled in Medicare Parts A and B in September, October, and November 2012, as determined by the Enrollment Database, and had a claim for at least one maintenance dialysis treatment for October 1 to October 28, as identified through Medicare Part B Outpatient fee-for-service claims with type of bill 72x. We excluded patients receiving at-home hemodialysis or peritoneal dialysis. We also excluded patients who spent the entire week of the storm in the hospital, defined as being admitted on or prior to October 28 and not discharged until after November 3 (Fig S1, available as online supplementary material).

We classified patients according to whether they received early dialysis. To determine whether patients received early dialysis, we compared study patient treatment patterns from the week prior to the storm (October 21, 2012, to October 27, 2012) to the week of the storm (October 28, 2012, to November 3, 2012). Patients were categorized as receiving dialysis on a MWF or Tuesday-Thursday-Saturday (TThS) schedule based on their prior week's treatment pattern. We excluded patients who did not have a detectable MWF or TThS dialysis schedule the week prior to the storm (n = 1,663/15,499), resulting in a final sample size of 13,836 patients with a MWF or TThS schedule (Fig S1). We considered patients to have received early dialysis if they were in the MWF group and received dialysis on Saturday, October 27, or Sunday, October 28, 2012, or were in the TThS group and received dialysis on Sunday, October 28, or Monday, October 29, 2012.

We used Medicare's Dialysis Facility Compare (DFC) and Certification and Survey Provider Enhanced Reporting (CASPER) data sets to identify ESRD treatment facilities in the study areas. We considered facilities open on a specific date if they submitted at least one claim with a treatment date of service for that date.

Patient Characteristics and Adverse-Outcome Measures

Demographic and health status characteristics of patients who did and did not receive early dialysis included age (<65, 65-84, or ≥85 years), sex, race (white or nonwhite), dual eligibility status (ie, eligible for Medicare and Medicaid; yes/no), and onset of dialysis care (dialysis vintage ≤1 or >1 year). To identify potential differences in health status, we also identified ED visits and hospitalizations in the 30 days before the storm, as well as evidence of underlying cardiovascular comorbid conditions because another study found elevated rates in New Jersey following Hurricane Sandy.[16] Cardiovascular comorbid conditions were defined as a having an *International Classification of Diseases, Ninth Revision* diagnosis code of myocardial infarction (410), congestive heart failure (428), stroke (430-434), and arrhythmia (426-427) on an inpatient or outpatient Medicare fee-for-service claim 30 days (September 29, 2012, to October 28, 2012) prior to the storm.

Outcome measures included ED visits and hospitalizations during the week of the storm (October 29, 2012, to November 3, 2012) and mortality 30 days after the storm (October 29, 2012, to November 27, 2012) for patients who did and did not receive early dialysis. Hospitalizations were determined by admission dates during the week of the storm and were counted once regardless of length of stay. ED visits were determined by service dates during the week of the storm, and a patient was only counted once regardless of frequency of visits. We identified patients who died within 30 days of the storm.

Analysis

We compared patient-level variables of patients who did and did not receive early dialysis to identify potential demographic and health status differences between the 2 groups using χ^2 test. We then used an unadjusted logistic regression model to evaluate whether early dialysis was associated with ED visits or hospitalizations in the week of the storm and in 30-day mortality. Finally, we used multivariable-adjusted logistic regression, including age, sex, race, dual-eligibility status, onset of dialysis care, and health status characteristics (ED visits, hospitalizations, and evidence of underlying cardiovascular comorbid conditions) in the 30 days before the storm to calculate the adjusted odds of adverse outcomes and identify patient characteristics that were independently associated with the outcomes of interest. We considered $P < 0.05$ to be statistically significant. Analyses were conducted using SAS, version 9.2 (SAS Institute Inc), and STATA, version 12 (StataCorp LP).

Participant Protections

The analysis was exempt from institutional review board review because it was performed as a public health quality review and deidentification methods were implemented in accordance with CMS policy and Health Insurance Portability and Accountability Act (HIPAA) requirements.