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Original Investigation

Outcomes of Infection-Related Hospitalization in Medicare Beneficiaries Receiving In-Center Hemodialysis

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Background: Infection is a common cause of hospitalization in adults receiving hemodialysis. Limited data are available about downstream events resulting from or following these hospitalizations.

Study Design: Retrospective cohort study using the US Renal Data System.

Setting & Participants: Medicare beneficiaries initiating in-center hemodialysis therapy in 2005 to 2008.

Factors: Demographics, dual Medicare/Medicaid eligibility, body mass index, comorbid conditions, initial vascular access type, nephrology care prior to dialysis therapy initiation, residence in a care facility, tobacco use, biochemical measures, and type of infection.

Outcomes: 30-day hospital readmission or death following first infection-related hospitalization.

Results: 60,270 Medicare beneficiaries had at least one hospitalization for infection. Of those who survived the initial hospitalization, 15,113 (27%) were readmitted and survived the 30 days following hospital discharge, 1,624 (3%) were readmitted to the hospital and then died within 30 days of discharge, and 2,425 (4%) died without hospital readmission. Complications related to dialysis access, sepsis, and heart failure accounted for 12%, 9%, and 7% of hospital readmissions, respectively. Factors associated with higher odds of 30-day readmission or death without readmission included non-Hispanic ethnicity, lower serum albumin level, inability to ambulate or transfer, limited nephrology care prior to dialysis therapy, and specific types of infection. In comparison, older age, select comorbid conditions, and institutionalization had stronger associations with death without readmission than with readmission.

Limitations: Findings limited to Medicare beneficiaries receiving in-center hemodialysis.

Conclusions: Hospitalizations for infection among patients receiving in-center hemodialysis are associated with exceptionally high rates of 30-day hospital readmission and death without readmission.

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INDEX WORDS: Infection; infection-related hospitalization; hospital readmission; transitions of care; survival; mortality; hemodialysis; end-stage renal disease (ESRD); Medicare beneficiaries; discharge diagnosis; dialysis access; sepsis.

Infection accounts for nearly one-fourth of hospitalizations in patients receiving hemodialysis.[1] Despite the recognition that infection is a common complication of end-stage renal disease (ESRD),[1-4] few studies have examined consequences of these hospitalizations. Among HEMO (Hemodialysis) Study participants, 58% of infection-related hospitalizations were complicated by hospitalization for 7 or more days, intensive care unit (ICU) care, or death.[5] Furthermore, among patients on hemodialysis therapy in the United States hospitalized for an infection in 2011, approximately one-third were readmitted within 30 days,[1] highlighting the high risk of readmission following hospitalization for an infection in this population.

Factors that portend poor outcomes among adults on hemodialysis therapy hospitalized for infection and the leading causes of readmission or death are not well described. Examining risk factors for and outcomes following infection-related hospitalization could aid in the identification of effective interventions to reduce associated risks. In the current study, we examine outcomes following hospitalization for infection among Medicare beneficiaries receiving in-center hemodialysis, with a focus on factors associated with 30-day readmission and death without readmission.

METHODS

Study Cohort and Data Collection

We assembled data from the US Renal Data System (USRDS) on Medicare Part A and B beneficiaries who initiated dialysis therapy from January 1, 2005, through June 30, 2008; survived the first 90 days of dialysis; and were receiving in-center hemodialysis

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at a free-standing dialysis facility with known profit status on day 91.[6] We retrieved baseline data for age; sex; race; ethnicity; comorbid conditions, including diabetes, heart failure, hypertension, chronic obstructive pulmonary disease, coronary artery disease, peripheral vascular disease, cerebrovascular disease (cerebrovascular accident or transient ischemic attack), cancer, and amputation; tobacco use; vascular access type; Quételet (body mass) index (BMI) at dialysis therapy initiation; nephrology care and biochemical studies (serum creatinine, albumin, and hemoglobin) prior to dialysis therapy initiation; and residence in a care facility (nursing home, assisted living, or other) at dialysis therapy initiation (Centers for Medicare & Medicaid Services [CMS] Form 2728). We ascertained dual Medicare/Medicaid eligibility from the USRDS. We classified region as Northeast, South, Midwest, or West based on ESRD Network.

Infection-Related Hospitalization

We focused on the first infection-related hospitalization after day 90 of dialysis therapy. Medicare beneficiaries were observed for an infection-related hospitalization until the time of transplantation, recovery of kidney function, change in dialysis modality, loss to follow-up, death, or study end. We limited our study to infection-related hospitalizations with discharge dates at least 30 days prior to December 31, 2009, to allow for complete assessment of 30-day outcomes. We included hospitalizations for which the date of admission was the same as the date of discharge and combined hospitalizations with overlapping dates of admission and discharge into a single hospitalization, with discharge diagnoses selected from the hospital record with the earliest start date or longest length of stay (LOS; 8% of all hospitalizations in our cohort). This approach minimizes the likelihood of counting admissions/transfers directly to inpatient rehabilitation facilities or other acute inpatient facilities as hospital readmissions because the latter hospitalizations would have been combined into a single hospitalization record.

Infection-related hospitalization was ascertained by identifying hospitalizations with a principal discharge diagnosis of selected *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes (Table S1, available as online supplementary material).[7-9] We limited our examination to the infection-related diagnoses outlined in the supplemental material. We generally excluded the following types of infection: those commonly found in only infants or children, hepatitis B and C virus, HIV (human immunodeficiency virus), cholecystitis associated with cholelithiasis/choledocholithiasis, infections specified as chronic (eg, chronic osteomyelitis or amputation infection [chronic]), sexually transmitted diseases (eg, chlamydia, gonorrhea, syphilis, and pelvic inflammatory disease), pregnancy-related infections, or those that could not be classified into an organ system or an organ system of interest. Furthermore, we excluded rare parasitic or protozoal diseases and limited our ascertainment of tuberculosis-related diagnoses to select pulmonary infections (eg, pulmonary, lung, and bronchus). The types of selected infections were classified broadly into mutually exclusive categories: (1) bloodstream infections or sepsis (ie, bacteremia, candidemia, viremia, or sepsis); (2) pulmonary; (3) genitourinary; (4) gastrointestinal, peritonitis, or hepatobiliary; (5) skin and soft tissue; (6) bone and joint; (7) cardiovascular; (8) central nervous system; (9) dialysis access (including peritoneal dialysis access) or central venous catheters; or (10) device, procedure, or surgery related (not related to dialysis access). Due to the small number of cardiovascular and central nervous system infections, these subsequently were combined into one category.

For the first infection-related hospitalization, we also collected data for hospital LOS, whether ICU or coronary care unit (CCU) care was required (identified using USRDS hospitalization data), and the use of invasive mechanical ventilation (identified using procedure codes 96.70, 96.71, and 96.72). To ascertain whether an adult received care in an ICU or CCU or required mechanical ventilation, all hospital records were examined prior to combining the overlapping hospital records.

Outcomes of Infection-Related Hospitalization

We examined 30-day outcomes after the first infection-related hospitalization among patients who survived the index hospitalization. If patients underwent transplantation (n = 35) or were lost to follow-up (n = 1) within 30 days following the index hospitalization, they were not included in the examination of outcomes. The primary outcomes of interest were readmission or death without readmission within 30 days of hospital discharge. For descriptive purposes, we also examined death following hospital readmission and within 30 days of discharge (death either during the hospital readmission or following discharge from the readmission hospitalization). Similar to examination of the index hospitalization, we included hospitalizations in which the date of admission was the same as the date of discharge and hospitalizations with overlapping dates of admissions and dates of discharge were combined into a single hospitalization. Principal causes of readmission were examined and grouped based on 3-digit *ICD-9-CM* codes. Causes of death were classified based on the ESRD Death Notification Form (Form CMS-2746-U3).

Statistical Analyses

We examined and summarized baseline characteristics of the cohort using Kruskal-Wallis test for continuous variables and χ^2 test for categorical variables. To examine factors associated with 30-day hospital readmission or death, we used multinomial logistic regression with the following outcomes: readmission, death without readmission, or neither within 30 days of discharge (referent outcome category). To focus on the first clinical event after discharge, we classified patients who were readmitted and then died as readmission in the multinomial logistic regression model. We elected a priori to examine sequential multinomial models, the first limited to patient characteristics, the second additionally accounting for type of infection, and the third further accounting for processes of care during the first hospitalization. In our first model, we included baseline demographics, dual Medicare/Medicaid eligibility, region, BMI, comorbid conditions, initial vascular access type, nephrology care prior to dialysis therapy initiation, residence in a care facility at dialysis therapy initiation, tobacco use, estimated glomerular filtration rate (based on the 4-variable Modification of Diet in Renal Disease Study equation),[10] and serum albumin level. In our second model, we further included type of infection, combining select types into larger categories to account for small numbers. In our third model, we additionally included LOS (as quartiles), ICU/CCU care, or mechanical ventilation during the index hospitalization. Of those with at least one infection-related hospitalization, the percent with missing data for select data elements was as follows: 24%, albumin; 0.3%, estimated glomerular filtration rate; 0.3%, initial vascular access type; and 1.3%, BMI. Inference under missing data was based on multiple imputation,[11] with 10 imputed data sets; individual point and variance estimates were obtained from fitting multinomial logistic regression to each of the 10 imputed data sets and results were combined to provide valid inferences that properly account for the uncertainty due to the missing data elements.

All data were analyzed using SAS, version 9.2 (SAS Institute Inc). Our study did not involve human subjects as defined by the University of California Davis Institutional Review Board.

RESULTS

Our initial cohort included 140,665 Medicare beneficiaries on in-center hemodialysis therapy. Of these, 60,270 developed at least one infection-related hospitalization during follow-up. Patients observed to have at least one infection were followed up for a median of