Early hospital readmission among hemodialysis patients in the United States is associated with subsequent mortality

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Dialysis providers in the United States may soon be held accountable for their patients' 30-day hospital readmissions. However, few studies have evaluated the timing of readmissions, which determines the window in which dialysis providers could act to prevent readmission. We therefore examined the timing of readmissions of hemodialysis patients in the United States and its association with mortality among 285,795 prevalent adult Medicare-primary hemodialysis patients from a national registry. Patients had at least one hospitalization in 2010-2013 (first index) and survived for 30 days or more. Readmission timing was defined as 0-7, 8-14, or 15-30 days after the index discharge. Multivariable Cox proportional hazards models were used to estimate the association between readmission timing (referent no readmission) and mortality, censored at one year. Overall, 23.1% of patients had readmissions within 30 days of the index discharge, of which over one-third (35.9%) were within the first week. Regardless of timing, patients with readmissions had a higher risk of death within one year, compared to those with no readmissions, with hazard ratios of 2.04 (95% confidence interval 2.00-2.09) for being readmitted within 15-30 days; 1.98 (1.93-2.04) for being readmitted within 8-14 days; and 1.76 (1.71-1.80) for being readmitted within 0-7 days. Thus, opportunities for dialysis providers to intervene and prevent early readmission may be limited. Regardless of the timing, readmission appears independently associated with a substantially increased risk of mortality in this population.

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End-stage renal disease (ESRD) patients in the United States average 2 hospital admissions per year, the costs of which account for >40% of all US Medicare expenditures for ESRD.[1] Additionally, with the exception of readmission history, ESRD is the strongest risk factor for 30-day readmissions among Medicare patients.[2] With the goals of improving patient-centered outcomes and reducing costs, the Centers for Medicare & Medicaid Services (CMS) established the Hospital Readmissions Reduction Program under the Affordable Care Act[3] and implemented the standardized readmissions ratio (SRR) as a quality measure for hospitals[4] and, more recently, dialysis facilities.[5] Despite this, few US studies have explored readmissions of dialysis patients,[6–10] and the SRR remains a controversial measure for dialysis facilities.[11,12]

One of the primary criticisms of the use of the SRR to measure the quality of dialysis patient care is that many 30-day readmissions may occur soon after discharge from the previous hospital admission, providing limited opportunities for dialysis providers to intervene on any medical or psychosocial issue that might lead to a readmission. We sought to examine the prevalence and correlates of 30-day hospital readmissions that occurred earlier (within 0–7 and 8–14 days) and later (within 15–30 days) among a prevalent US cohort of hemodialysis patients. Secondarily, to examine whether the timing of readmission is differentially associated with poor outcomes, we also examined the association of earlier and later readmission compared with no readmission with subsequent 1-year mortality.

RESULTS
Index admission and patient characteristics
Patients who were readmitted had index admissions that were more likely to involve intensive care use compared with patients with no readmission, although index admission

characteristics generally did not differ by the timing of the readmission (Table 1). There was 43.5% agreement overall between categories of causes of index admissions and readmissions; for same-day readmissions, it was 88.5%. In general, patient characteristics also did not differ substantially by readmission timing (Table 1). Overall, the mean age of hemodialysis patients at index admission was 63.4 years; 46.4% were female, 36.6% were black, and 43.5% were dual-eligible for Medicaid at index admission. Most patients (70.4%) had been on dialysis for at least 1 year (median ESRD vintage, 2.5 years). Approximately half (52.4%) of the patients had diabetes, and most (95.3%) had hypertension at the index admission (Table 1).

Timing of readmission
Overall, 23.1% of patients had a readmission within 30 days; of these, 40.2%, 23.9%, and 35.9% had readmissions within 15 to 30, 8 to 14, and 0 to 7 days (Table 2). Of the 3863 same-day readmissions, 3113 (80.6%) were to the same facility. When same-day readmissions were excluded (Table 2), 22.1% of patients had a readmission within 30 days, and early readmissions (within 7 days) comprised 32.0% of all readmissions. In comparison, 31.0% had emergency department (ED) visits in the 30 days after the index discharge (Table 2). When ED visits, observation stays, and readmissions in the 30 days after the index discharge were combined, 37.6% of patients had at least 1 of these events in the 30 days after the index discharge; of these postadmission events, approximately half (42.3%) occurred in the first 7 days after discharge.

Same-day readmissions were the most common type of readmission (Figure 1) in the 30 days following discharge from the index admission; same-day readmissions comprised 16.1% of early (0–7 days) readmissions and 5.8% of all readmissions. The distributions were similar to that in the primary analysis when the combined events including readmissions, observation stays, and ED visits were examined (Supplementary Figure S1).

Overall, readmissions were more common after index admissions with lengths of stay of ≥4 days, were attributed to cardiovascular causes, or involved intensive care use, relative to other index admissions (Supplementary Table S1). Although early readmissions were slightly more common among patients with longer index admissions, the timing of the readmissions did not differ substantially by other admission characteristics, although index admissions due to infections and vascular access complications rather than cardiovascular causes were less likely to result in an early readmission (Supplementary Table S1). In general, the timing of readmission was also similar across patient characteristics, including age, sex, race/ethnicity, and Medicaid eligibility; readmissions were slightly more common among patients with shorter dialysis vintage (with patients on dialysis for the shortest period being 34% more likely to be readmitted and 13% more likely to be readmitted within a week than patients on dialysis for the longest period) and functional disability (Supplementary Table S1).

Association of readmission timing with 1-year mortality
There were 66,184 deaths over the year after the index discharges (mean follow-up, 315 days). Cumulative mortality among those with readmissions in the 30 days post-index admission discharge was twice as high as that among those without a readmission, regardless of the timing (Figure 2). With full adjustment, those with readmissions within 15 to 30 and 8 to 14 days remained at approximately twice the risk of mortality in the year after the index discharge compared with patients without readmissions (Table 3). For those readmitted within 0 to 7 days, the relative risk was lower, with these patients being at ∼76% higher risk of 1-year mortality than patients without readmissions. When same-day readmissions were considered separately, results were similar for all groups except that patients with same-day readmissions were at a 1.2-fold higher risk of mortality compared with patients with no readmissions (Table 3). Results were similar with the combined events of readmission, ED visit, or observation stay (Table 3).

DISCUSSION
We found that 23% of index admissions among prevalent US hemodialysis patients resulted in a readmission within 30 days of discharge; furthermore, 38% resulted in a readmission, ED visit, or observation stay within 30 days. More than one-third of these events were within the first week after the index admission discharge, and ∼6% of all readmissions occurred on the same day as the index discharge. Although index admissions that involved intensive care were more likely to result in early readmissions, readmission timing generally did not vary substantially by other measured index admission or patient characteristics, suggesting that targeting patients at risk of readmission may be difficult and that events that occur during hospitalizations may be the best predictors of readmission. Finally, in the year after the index discharge, patients with readmissions were about twice as likely to die as those without readmissions, with patients having the earliest readmissions having a slightly lower (∼1.8-fold) relative risk of mortality than patients having later readmission.

The finding that many readmissions are within the first week after discharge has potential implications for processes of care and policy regarding readmissions in dialysis patients. Some tasks that might help reduce readmission, such as reassessment of dry weight,[7,13,14] may depend on the attending nephrologist. In fact, it has been suggested that the readmission policy should apply to nephrologists rather than, or in addition to, dialysis facilities.[12] Provider visits in the month after hospital discharge have been shown to be associated with a lower probability of readmissions[7]; however, nephrologist visits to the dialysis facility are unlikely to coincide with these early postdischarge periods for all admissions among patients at the facility. This may be particularly true at smaller, more remote facilities and among patients who are hospitalized frequently.[15] It is also unlikely that complete discharge information, which may be more important than admission information for preventing