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One to 10-Day Versus 11–30-Day All-Cause Readmission and Mortality in Older Patients with Heart Failure

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Abstract

Heart failure (HF) is the leading cause for 30-day all-cause readmission in older Medicare beneficiaries and 30-day all-cause readmission is associated with a higher risk of mortality. In the

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current analysis we examined if that association varied by timing of 30-day all-cause readmission. Of the 8049 Medicare beneficiaries hospitalized for HF, 1688 had 30-day all-cause readmissions, of whom 1519 were alive at 30 days. Of these, 626 (41%) had early (first 10 days) 30-day readmission. Propensity scores for early 30-day readmission, estimated for all 1519 patients, were used to assemble a matched cohort of 596 pairs of patients with early versus late (after the first 10 days) all-cause readmission, balanced on 34 baseline characteristics. Two-year all-cause mortality occurred in 51% and 57% of matched patients with early vs. late 30-day all-cause readmissions, respectively (hazard ratio {HR} associated with early 30-day readmission, 1.21; 95% CI, 1.04–1.42; p=0.014). This association was not observed in the subset of 436 patients whose 30-day all-cause readmission was due to HF (HR, 1.01; 95% CI, 0.79–1.28; p=0.963), but was observed in the subset of 756 patients whose 30-day all-cause readmission was not due to HF (HR, 1.37; 95% CI, 1.12–1.67; p=0.002; p for interaction, 0.057). In conclusion, in a high-risk subset of older hospitalized HF patients readmitted within 30 days, readmission within 11 to 30 (vs. 1–10) days was associated with a higher risk of death and this association appeared to be more pronounced among those readmitted for non-HF related reasons.

Keywords

1-10-Day All-Cause Readmission; 11-30-Day All-Cause Readmission; Heart Failure; All-Cause Mortality

Heart failure (HF) is the leading cause of 30-day all-cause readmission, which has been identified in the Affordable Care Act as a target for reduction of Medicare cost.[1,2] Although the clinical relevance of the cost-driven metric of short-term readmission at 30 days has been questioned,[3] it has been shown to be associated with a significantly higher risk of subsequent mortality.[4] However, it remains unclear whether timing of 30-day readmission is associated with mortality. It has been suggested that early 30-day readmissions are potentially more preventable and thus markers of poor quality of care.[5] For hospitalized HF patients, it is also not clear if the association between an early 30-day readmissions and mortality would vary by the cause of 30-day readmission. The objective of our study was to examine the association between early vs. late 30-day readmission, and if this association was modified by cause of 30-day readmission.

Methods

We used data from the Alabama Heart Failure Project, the details of which have been previously described.[6] Briefly, the cohort included 8555 Medicare beneficiaries hospitalized for acute HF in 106 Alabama hospitals during 1998–2001, of whom 8049 were discharged alive. Of these, 1688 (21%) patients had a 30-day all-cause readmission, of whom 1519 were alive at 30 days. Of these, 626 (41%) were readmitted within 10 days. We matched 596 these patients with 596 patients who were readmitted during 11 to 30 days, but had similar propensity scores for 10-day readmission, thus assembling a matched cohort of 1192 patients (Figure 1).[7–12] Post-match balance on measured baseline characteristics was checked by estimating absolute standardized difference.[13–16] Data on death and time to death were obtained from Medicare administrative data.

Descriptive analyses comparing baseline characteristics between the two groups were performed using Pearson's Chi-square and Wilcoxon rank-sum tests as appropriate. Cox regression models were used to estimate hazard ratios (HR) and 95% confidence intervals (CI) associated with 10-day readmission (versus 11–30-day readmission) among matched patients. Kaplan-Meier survival analyses were used to generate plots for all-cause mortality during about 2 years of follow-up, by time and cause of 30-day all-cause readmission. To assess nonlinearity in the relationship between days to readmission as a continuous variable and all-cause 2-year mortality, we fitted restricted cubic spline models with 4 knots at 5, 10 (reference), 20 and 25 days, in the matched data as well as in the pre-match data adjusting for propensity scores. Overall, 548 (36%) patients were readmitted for HF. We conducted a subgroup analysis to examine if the association between early 30-day readmission and mortality varied between patients readmitted for HF vs. for other reasons. All statistical tests were two-tailed with a p-value <0.05 considered significant. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp. and SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) were used for data analyses.

Results

The 1192 matched patients had a mean age of 75 years, 56% were women and 23% were African American. Except for rural hospital, before matching patients were balanced on all key measured baseline characteristics. All 34 measured baseline characteristics were balanced in the matched cohort (Table 1). Two-year all-cause mortality occurred in 51% and 57% of matched patients with early vs. late 30-day all-cause readmissions, respectively (hazard ratio {HR} associated with early 30-day readmission, 1.22; 95% CI, 1.04–1.40; p=0.014; Table 2 and Figure 2). Our restricted cubic spline analysis showed no evidence of a nonlinear relationship between days to readmission and all-cause mortality for either the pre-match data or the matched data (p > 0.20 for test for non-linearity, for both; Figure 3).

Among the subset of 436 patients whose 30-day all-cause readmission was due to HF, two-year all-cause mortality occurred in 60% and 59% of patients with early vs. late 30-day all-cause readmissions, respectively (HR associated with early readmission, 1.01; 95% CI, 0.79–1.32; p=0.963). Among the subset of 756 patients whose 30-day all-cause readmission was not due to HF, two-year all-cause mortality occurred in 45% and 56% of patients with early vs. late 30-day all-cause readmissions, respectively (HR associated with early readmission, 1.37; 95% CI, 1.11–1.67; p=0.002). This differential association between 11–30-day readmission and 2-year mortality between patients with HF and non-HF readmission was of borderline significance (p=0.057).

Discussion

Findings from the current study demonstrate that among older patients hospitalized for HF who had a readmission within 30 days after discharge from the index hospitalization, readmission during days 11–30 was independently associated with a significantly higher risk of all-cause mortality at 2 years. We also observe that this association between early readmission and 2-year mortality appeared to be more pronounced among the subset of patients whose 30-day readmission were due to reasons other than HF. To the best of our

knowledge this is the first study to examine the differential association of timing of 30-day all-cause readmission on mortality in hospitalized older patients with HF. These findings suggest that timing of readmissions may be used as a marker to further risk-stratify HF patients who are readmitted within 30 days of discharge.

It is tempting to speculate that HF patients who are readmitted within the first 10 days after hospital discharge had suboptimal inpatient HF care and early decompensation. It is possible that more immediate readmissions are due to reasons that are more readily preventable and manageable, such as discharge without achieving euvolemia and/or with inadequate dose of diuretics.[5] However, an early 30-day readmission may also be a marker of a higher socioeconomic status and/or health literacy as these patients may recognize early warning symptoms. They are also more likely to better comprehend and adhere to discharge instructions about diet and medications and have timely outpatient follow-up. Interestingly, among patients whose 30-day readmission was due to HF, timing of 30-day readmission had no association with outcomes. It is not clear why among patients whose 30-day readmission was not due to HF, those readmitted during days 11–30 (vs. the first 10 days) would have worse outcomes.

Hospitalized older adults with HF who are readmitted within 30 days of discharge constitute a high-risk subset with poor prognosis which include a higher rate of all-cause mortality, subsequent readmission, and greater long-term cost.[4] Findings from our current study suggest that timing and cause of 30-day all-cause readmission may identify those even at a higher risk among this already high-risk subset. If these findings can be replicated, these metrics could be used to further risk stratify patients with HF who have a 30-day all-cause readmission. Future studies need to develop and test interventions that may improve outcomes in these patients.

There are several limitations of our study. As in any observational study, findings of our study are subject to bias and despite our use of propensity score matching, residual bias or bias due to an unmeasured confounder is possible. Importantly, we had no markers on frailty including body mass index. Our analysis was restricted to fee-for-service Medicare beneficiaries from a single state from an earlier era of heart failure management and may not be generalizable. In conclusion, among hospitalized patients with HF who had a 30-day all-cause readmission, a late readmission after the first 10 days, is associated with a higher risk of all-cause mortality, especially among patients whose 30-day readmissions are not due to HF.

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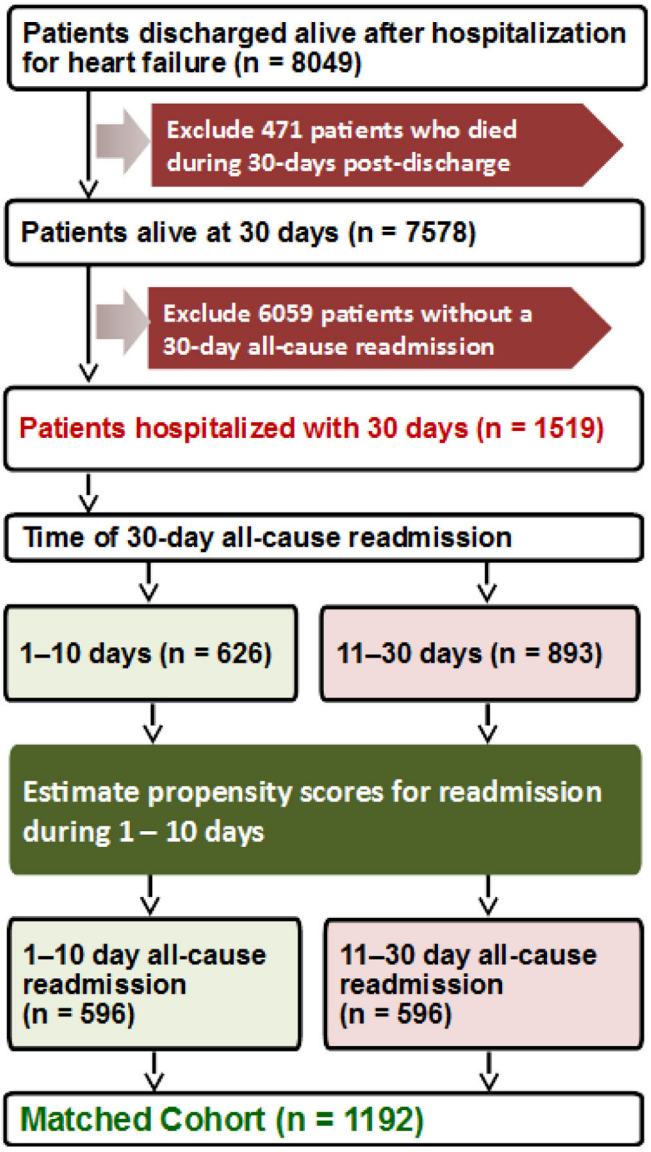
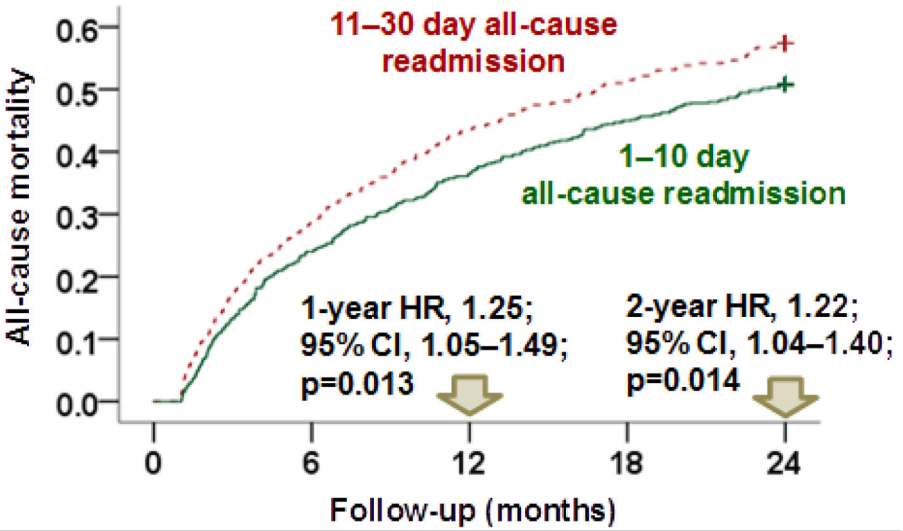


Figure 1.

Flow chart displaying assembly of matched cohort of patients with heart failure (HF) who had a 30-day all-cause readmission



Number at risk					
11–30 day readmission	596	424	337	290	254
1–10-day readmission	596	453	378	328	293

Figure 2.

Kaplan Meier plot for all-cause mortality in a propensity-matched cohort of 1192 older patients with heart failure with a 30-day all-cause readmission, by timing of readmission (HR=hazard ratio; CI=confidence interval)

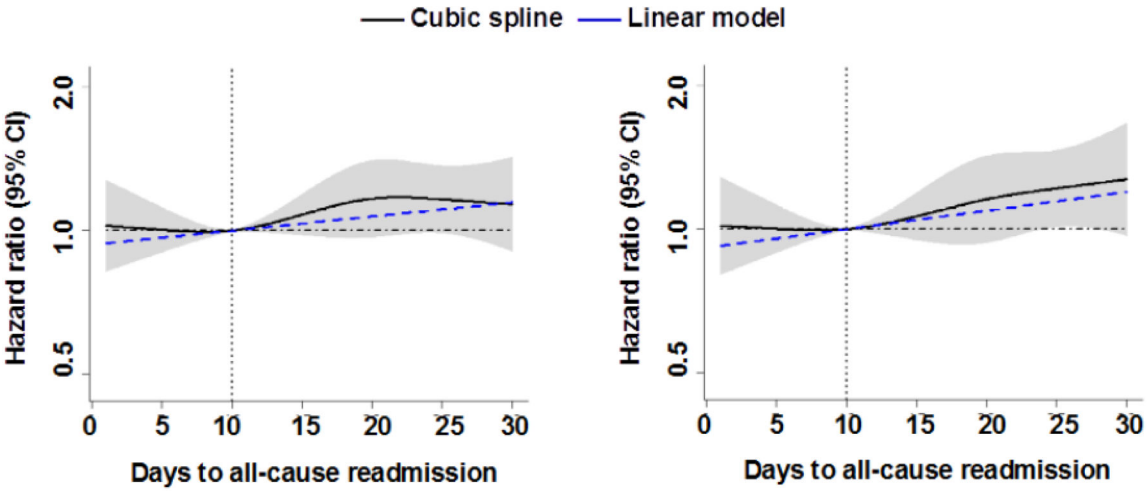


Figure 3.

Hazard ratios (HR) and 95% confidence intervals (CI) for 2-year all-cause mortality by days to 30-day all-cause readmission according to restricted cubic spline regression models using four knots at 5, 10 (reference), 20 and 25 days. Solid black lines represent HRs and shaded areas represent 95% CIs. Plots on the left panel (A) are based on 1519 pre-match patients, adjusting for propensity scores, and those on the right panel (B) are based on 1192 propensity score-matched patients balanced on 34 baseline characteristics

Table 1

Baseline characteristics of patients with heart failure who had a 30-day all-cause readmission, by timing of readmission

Variable	Before propensity score matching			After propensity score matching		
	30-day readmission timing (n=1519)			30-day readmission timing (n=1192)		
	1–10 days (n=626)	11–30 days (n=893)	p-value	1–10 days (n=596)	11–30 days (n=596)	p-value
Age (years)	75 (±11)	74 (±11)	0.106	75 (±11)	75 (±11)	0.700
Women	350 (56%)	500 (56%)	0.975	334 (56%)	338 (57%)	0.815
Black	145 (23%)	211 (24%)	0.833	140 (23%)	133 (22%)	0.629
Admission from nursing home	45 (7%)	47 (5%)	0.122	32 (5%)	34 (6%)	0.800
Smoking history	72 (12%)	122 (14%)	0.214	70 (12%)	70 (12%)	1.000
Left ventricular ejection fraction						
<45%	236 (38%)	337 (38%)		225 (38%)	222 (37%)	
≥45%	182(29%)	272 (30%)	0.792	175 (29%)	172 (29%)	0.934
Unknown	208 (33%)	284 (32%)		196 (33%)	202 (34%)	
Heart failure	478 (76%)	677 (76%)	0.806	454 (76%)	452 (76%)	0.892
Hypertension	435 (70%)	644 (72%)	0.266	419(70%)	415 (70%)	0.800
Coronary artery disease	387 (62%)	530 (59%)	0.333	367 (62%)	364 (61%)	0.858
Atrial fibrillation	167 (27%)	257 (29%)	0.369	162 (27%)	153 (26%)	0.554
Left bundle branch block	80 (13%)	113 (13%)	0.942	76 (13%)	80 (13%)	0.731
Diabetes mellitus	290 (46%)	436 (49%)	0.337	281 (47%)	279 (47%)	0.908
Stroke	139 (22%)	191 (21%)	0.704	130 (22%)	125 (21%)	0.724
Chronic obstructive pulmonary disease	252 (40%)	329 (37%)	0.178	235 (39%)	231 (39%)	0.812
Dementia	50 (8%)	68 (8%)	0.790	46 (8%)	45 (8%)	0.913
Cancer	20 (3%)	25 (3%)	0.655	18 (3%)	16 (3%)	0.728
Pulse (beats per minute)	88 (±22)	89 (±22)	0.297	89 (±22)	88 (±22)	0.431
Systolic blood pressure (mmHg)	147 (±33)	149 (±33)	0.427	148 (±33)	150 (±32)	0.196
Pulmonary edema by chest x-ray	423 (68%)	617 (69%)	0.530	401 (67%)	404 (68%)	0.853
Serum creatinine (mEq/L)	1.7 (±1.2)	1.8 (±1.5)	0.193	1.7 (±1.3)	1.7 (±1.4)	0.957
In hospital events						
Pneumonia	173 (28%)	232 (26%)	0.473	160 (27%)	157 (26%)	0.844
Acute myocardial infarction	39 (6%)	47 (5%)	0.422	32 (5%)	38 (6%)	0.460
Pressure ulcer	47 (8%)	87 (10%)	0.131	47 (8%)	45 (8%)	0.828
Hospital and care characteristics						
Rural hospital	225 (36%)	272 (30%)	0.022	205 (34%)	202 (34%)	0.855
Cardiology care	327 (52%)	465 (52%)	0.950	313 (53%)	309 (52%)	0.817
Intensive care	31 (5%)	56 (6%)	0.276	31 (5%)	29 (5%)	0.791
In hospital length of stay	7.0 (±5.1%)	7.2 (±5.3)	0.448	7.1 (±5.2)	6.8 (±5.6)	0.245
Discharge medications						
ACE inhibitors or ARBs	333 (53%)	485 (54%)	0.667	323 (54%)	322 (54%)	0.954
Beta blockers	187 (30%)	268 (30%)	0.954	179 (30%)	178(30%)	0.950

Variable	Before propensity score matching			After propensity score matching		
	30-day readmission timing (n=1519)			30-day readmission timing (n=1192)		
	1–10 days (n=626)	11–30 days (n=893)	p-value	1–10 days (n=596)	11–30 days (n=596)	p-value
Loop diuretics	487 (78%)	713 (80%)	0.335	471 (79%)	471 (79%)	1.000
Digoxin	261 (42%)	362 (41%)	0.652	249 (42%)	252 (42%)	0.860
Potassium sparing diuretics	98 (16%)	131 (15%)	0.597	89 (15%)	94 (16%)	0.688
Potassium supplements	274 (44%)	374 (42%)	0.464	259 (43%)	247 (41%)	0.482
Opioids	53 (6%)	40 (6%)	0.716	37 (6%)	37 (6%)	1.000

Table 2

All-cause mortality in 1192 propensity score-matched patients with heart failure who had a 30-day all-cause readmission, by early (1–10 days) versus late (11–30 days) readmission

Mortality	Events (%)		Hazard ratio* (95% CI); p-value
	1–10 days (n=596)	11–30 days (n=596)	
1-year	218 (37%)	259 (44%)	1.25 (1.05–1.49); p=0.013
2-year	303 (51%)	342 (57%)	1.22 (1.04–1.40); p=0.014

*Hazard ratios when 1-to-10-day readmission was compared with 11-to-30-day readmission