Diagnoses and Timing of 30-Day Readmissions After Hospitalization for Heart Failure, Acute Myocardial Infarction, or Pneumonia

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Importance To better guide strategies intended to reduce high rates of 30-day readmission after hospitalization for heart failure (HF), acute myocardial infarction (MI), or pneumonia, further information is needed about readmission diagnoses, readmission timing, and the relationship of both to patient age, sex, and race.

Objective To examine readmission diagnoses and timing among Medicare beneficiaries readmitted within 30 days after hospitalization for HF, acute MI, or pneumonia.

Design, Setting, and Patients We analyzed 2007-2009 Medicare fee-for-service claims data to identify patterns of 30-day readmission by patient demographic characteristics and time after hospitalization for HF, acute MI, or pneumonia. Readmission diagnoses were categorized using an aggregated version of the Centers for Medicare & Medicaid Services' Condition Categories. Readmission timing was determined by day after discharge.

Main Outcome Measures We examined the percentage of 30-day readmissions occurring on each day (0-30) after discharge; the most common readmission diagnoses occurring during cumulative periods (days 0-3, 0-7, 0-15, and 0-30) and consecutive periods (days 0-3, 4-7, 8-15, and 16-30) after hospitalization; median time to readmission for common readmission diagnoses; and the relationship between patient demographic characteristics and readmission diagnoses and timing.

Results From 2007 through 2009, we identified 329 308 30-day readmissions after 1 330 157 HF hospitalizations (24.8% readmitted), 108 992 30-day readmissions after 548 834 acute MI hospitalizations (19.9% readmitted), and 214 239 30-day readmissions after 1 168 624 pneumonia hospitalizations (18.3% readmitted). The proportion of patients readmitted for the same condition was 35.2% after the index HF hospitalization, 10.0% after the index acute MI hospitalization, and 22.4% after the index pneumonia hospitalization. Of all readmissions within 30 days of hospitalization, the majority occurred within 15 days of hospitalization: 61.0%, HF cohort; 67.6%, acute MI cohort; and 62.6%, pneumonia cohort. The diverse spectrum of readmission diagnoses was largely similar in both cumulative and consecutive periods after discharge. Median time to 30-day readmission was 12 days for patients initially hospitalized for HF, 10 days for patients initially hospitalized for acute MI, and 12 days for patients initially hospitalized for pneumonia and was comparable across common readmission diagnoses. Neither readmission diagnoses nor timing substantively varied by age, sex, or race.

Conclusion and Relevance Among Medicare fee-for-service beneficiaries hospitalized for HF, acute MI, or pneumonia, 30-day readmissions were frequent throughout the month after hospitalization and resulted from a similar spectrum of readmission diagnoses regardless of age, sex, race, or time after discharge.

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HOSPITAL READMISSIONS ARE common[1-4] and can be a marker of poor health care quality and efficiency.[5-9] To lower readmission rates, the Centers for Medicare & Medicaid Services (CMS) began publicly reporting 30-day risk-standardized readmission rates for heart failure (HF), acute myocardial infarction (MI), and pneumonia after these measures were endorsed by the National Quality Forum.[10-13] These measures are part of a federal strategy to provide incentives to improve quality of care by reducing preventable readmissions.[14]

See also p 394 and Patient Page.

CME available online at www.jamaarchivescme.com and questions on p 401.

Author Video Interview available at www.jama.com.

Critical to the development of effective programs to reduce readmission is an understanding of the diagnoses and

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timing associated with these events. Using 2003-2004 Medicare data, Jencks and colleagues[15] identified the most frequent diagnoses accounting for readmission within 30 days after hospitalization for 10 common conditions. Yet unanswered questions remain that may be pertinent when planning targeted interventions and benchmarking performance. For example, within the 30-day period after hospitalization, do certain periods have higher numbers of readmissions and therefore merit even greater attention to readmission risk? Do the diagnoses responsible for readmission change to a significant degree over the month following discharge, indicating a need to tailor interventions to the time after hospitalization? Do the diagnoses and timing of 30-day readmissions substantively vary by patient age, sex, or race, thereby suggesting that interventions be guided by patient demographic characteristics? Insights into the diversity and variation of readmission diagnoses can illustrate the potential benefits of general vs disease-specific interventions in reducing the overall number of readmissions.

We therefore studied Medicare beneficiaries who were readmitted within 30 days after hospitalization for HF, acute MI, or pneumonia from 2007 through 2009 to describe readmission diagnoses and timing for each condition. These 3 conditions are primarily responsible for almost 15% of hospitalizations in older persons[16] and are the focus of current public reporting efforts.[14]

METHODS

Study Sample

We used Medicare Standard Analytic and Denominator files to identify hospitalizations to acute care hospitals from 2007 through 2009 with a principal discharge diagnosis of HF, acute MI, or pneumonia. Cohorts were defined with *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes identical to those used in the CMS publicly reported readmission measures (eTable 1 available at http://www.jama.com).[11-13] We included hospitalizations among patients 65 years or older with a complete claims history for 1 year preceding admission. Reasons for exclusion included in-hospital death, less than 30 days' enrollment in Medicare fee-for-service after hospital discharge, transfer to another acute care facility, and discharge against medical advice.

We then used definitions consistent with the CMS measures to identify all readmissions due to any cause occurring within 30 days of hospitalization.[11-13] As with the CMS measures, only the first rehospitalization within 30 days of discharge was considered a 30-day readmission. Additional rehospitalizations within this 30-day period were not counted as 30-day readmissions or index hospitalizations for the same condition. Subsequent hospitalizations occurring after 30 days from discharge were counted as index admissions if they met inclusion criteria. All study analyses were performed on the whole population of readmitted patients.

Sample Classification

We categorized readmission diagnoses using a modified version of the CMS Condition Categories (CCs).[17] Each of the 189 CC groups is structured around a reasonably well-specified disease or medical condition.[17] However, because nearly 90% of the 189 CC groups each accounted for less than 1% of all readmissions, we consolidated related diagnoses into a shorter list of 30 modified CCs to make data presentation more clinically meaningful. Based on our opinion, these 30 modified CCs were designed to be clinically internally consistent and capture the most common readmission diagnoses after discharge from HF, acute MI, and pneumonia hospitalizations. The specific diagnoses comprising each modified CC are presented in eTable 2. Cardiopulmonary diagnoses were described with relatively greater granularity given their expected importance following index hospitalization for HF, acute MI, or pneumonia.

Outcomes

Readmission Diagnoses. We identified the percentage of observed 30-day readmissions due to the 30 most common reasons for readmission by modified CC for the HF, acute MI, and pneumonia cohorts. We noted the percentage of observed 30-day readmissions due to cardiovascular diagnoses after hospitalizations for HF and acute MI, and pulmonary diagnoses following hospitalizations for pneumonia (modified CC groups comprising cardiovascular and pulmonary diseases are listed in eTables 3 and 4).

Readmission Timing. We identified the percentage of 30-day readmissions occurring on each day (0-30) after discharge.

Readmission Diagnoses by Time After Discharge. We identified the 10 most common readmission diagnoses by modified CC during cumulative periods after discharge (days 0-3, 0-7, 0-15, and 0-30) that may occur before outpatient follow-up and therefore be of particular importance to discharging hospitals. We also examined the 10 most common readmission diagnoses by modified CC in consecutive periods after discharge (days 0-3, 4-7, 8-15, and 16-30) that could coincide with outpatient visits and therefore be of particular value to ambulatory care providers. We intentionally constructed shorter intervals during days 0-15 compared with days 16-30 after discharge to provide greater granularity of information for hospitals and clinicians engaging in early outpatient follow-up. Lastly, we investigated whether the median time to readmission differed for the 5 most common readmission diagnoses.

Patient Demographic Characteristics and Readmission. We examined whether patient age, sex, and race were associated with readmission timing and the pattern of readmission diagnoses.

Statistical Analyses

Readmission Diagnoses and Timing. We calculated summary statistics for readmission diagnoses by modified CC, readmission timing by day (0-30) af-

ter discharge, and readmission diagnoses by days 0-3, 0-7, 0-15, 0-30, 4-7, 8-15, and 16-30 after discharge. We then estimated Kaplan-Meier survival curves for the 10 most common readmission diagnoses as categorized by modified CC for each condition. The outcome was readmission. Survival time was the number of days from discharge to readmission. Data were censored at the time of death or at 30 days, whichever occurred first. We also calculated the median time to readmission for all patients in the HF, acute MI, and pneumonia cohorts as well as for those readmitted with the 5 most common readmission diagnoses for each condition.

Patient Demographic Characteristics and Readmission Diagnoses. To examine the association of patient demographic characteristics with readmission diagnoses and timing among 30-day readmissions, we first fit extended logistic regression models for the top 5 readmission diagnoses for each condition. We used a generalized estimating equation approach because of the clustering of hospitalizations within hospitals. Patient characteristics included age (65-74, 75-84, and ≥85 years), sex, and race (white, black, other). Further subdivision of race categories using CMS data are unreliable.[18] We adjusted for the comorbidities used by CMS in its calculations of hospital risk-standardized readmission rates for HF, acute MI, and pneumonia.[11-13]

We then illustrated the association of patient demographic characteristics with the marginal number of rehospitalizations due to common readmission diagnoses through use of a least squares means method.[19] We first calculated the predicted population probability of readmission due to these common diagnoses by applying the estimates (β coefficients) from the logistic models to hypothetical readmission cohorts with balanced patient characteristics. For ease of data presentation, we assumed cohort sizes of 100 readmissions. To isolate the association of each patient demographic characteristic with the marginal number of rehospitalizations due to common readmission diagnoses, we assumed that the marginal prevalence of the remaining demographic characteristics in each cohort was equal to the marginal prevalence of these patient characteristics in the overall HF, acute MI, and pneumonia readmission populations. We then calculated the predicted number of patients readmitted for common diagnoses by multiplying the predicted population probability by 100, the total number of readmissions in each hypothetical cohort. For example, to identify the association of sex with the number of readmissions for recurrent HF, we compared the predicted number of readmissions due to recurrent HF among 100 readmitted women compared with 100 readmitted men. These 2 groups had a marginal prevalence of age, race, and comorbidities that was identical to that of the overall HF readmission population.

Patient Demographic Characteristics and Readmission Timing. We fit extended Cox proportional hazards models to determine the association of patient characteristics with readmission timing by estimating comorbidity–adjusted hazard ratios for each patient characteristic. We used a generalized estimating equation approach. We confirmed the proportional hazards assumption by log-log plotting and based survival time on the number of days from discharge to readmission. Data were censored at the time of death or at 30 days, whichever occurred first.

All significance levels for logistic and Cox proportional hazards models were 2-sided with a P value $<.05$. Analyses were primarily conducted by A.F.H. and Z.L. using SAS 9.2 (SAS Institute Inc). We obtained institutional review board approval, including waiver of the requirement for participant informed consent, through the Yale University Human Investigation Committee.

RESULTS

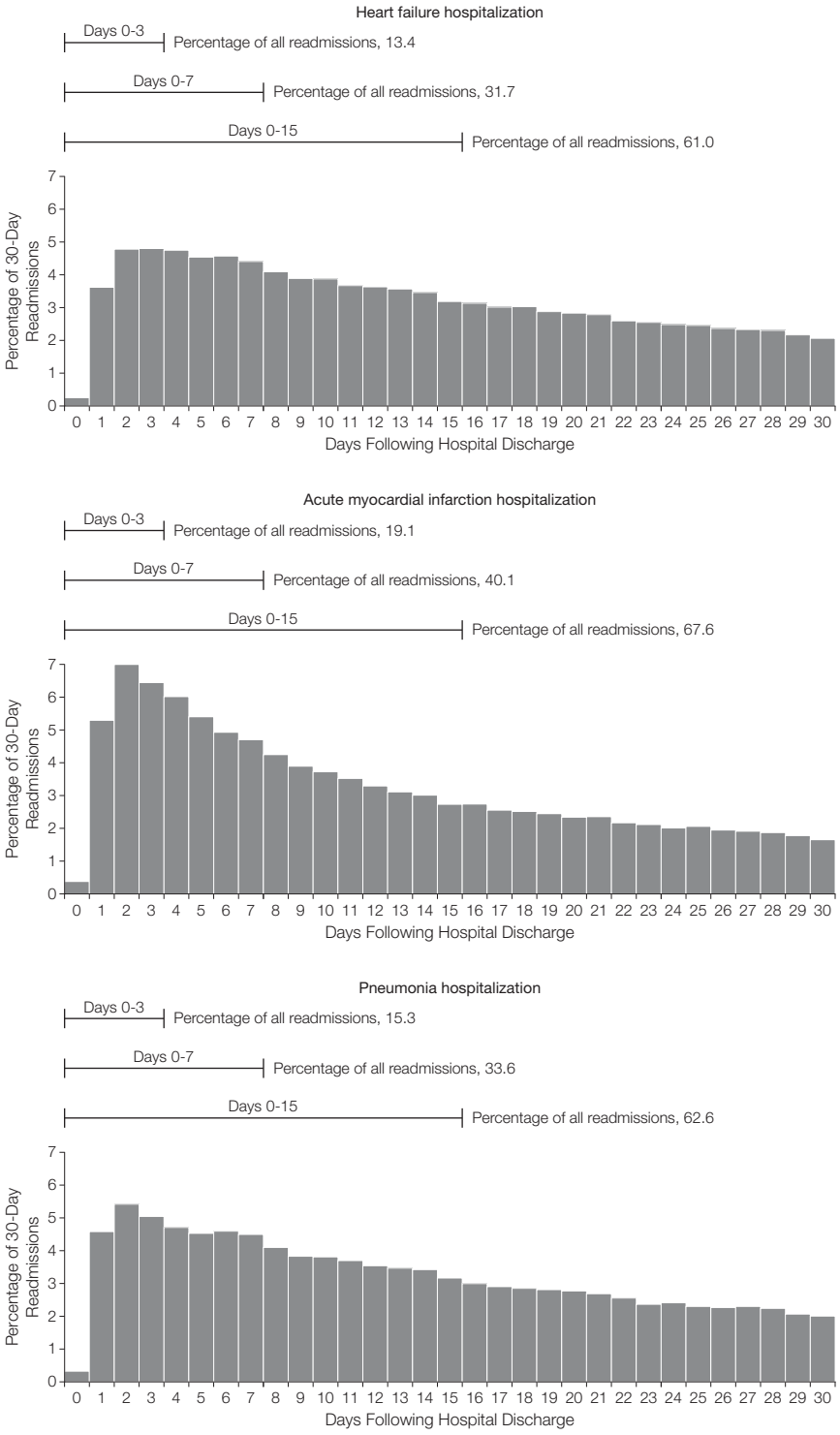
We identified 329 308 30-day readmissions after 1 330 157 hospitalizations for HF (24.8% readmitted), 108 992 30-day readmissions after 548 834 hospitalizations for acute MI (19.9% readmitted), and 214 239 30-day readmissions after 1 168 624 hospitalizations for pneumonia (18.3% readmitted). The index cohorts for HF comprised 971 736 unique patients; for acute MI, 513 671; and for pneumonia, 1 013 953. The HF readmission cohort comprised 282 222 unique patients, of whom 246 999 (87.5%) were readmitted once, 27 342 (9.7%) were readmitted twice, and 7881 (2.8%) were readmitted 3 or more times. The acute MI readmission cohort comprised 106 034 unique patients, of whom 103 302 (97.4%) were readmitted once, 2546 (2.4%) were readmitted twice, and 186 (0.2%) were readmitted 3 or more times. The pneumonia readmission cohort comprised 202 838 unique patients, of whom 192 911 (95.1%) were readmitted once, 8749 (4.3%) were readmitted twice, and 1178 (0.6%) were readmitted 3 or more times.

The mean (SD) patient age of each readmission cohort was 80.3 years (7.9 years) for HF, 79.8 years (8.0 years) for acute MI, and 80.0 years (8.0 years) for pneumonia. Common comorbidities among readmissions are listed in eTable 5 (available at http://www.jama.com).

Readmission Diagnoses

Ranked reasons for readmission for all 30 modified CCs are presented in eTable 6. Following hospitalization for HF and acute MI, readmission was most often due to HF (35.2% and 19.3% of readmissions, respectively). Following hospitalization for pneumonia, readmission was most likely for recurrent pneumonia (22.4%). The percentage of readmissions due to cardiovascular disease was 52.8% for the HF and 53.4% for the acute MI cohorts. The percentage of readmissions due to respiratory disease was 38.5% for the pneumonia cohort. Of all 30-day readmissions, the 5 most common readmission diagnoses comprised 55.9% of the HF, 44.3% of the acute MI, and 49.6% of the pneumonia readmission cohorts.

Figure 1. Thirty-Day Readmissions by Day (0-30) Following Hospitalization for Heart Failure, Acute Myocardial Infarction, or Pneumonia



The denominators used to calculate the percentage of 30-day readmissions on each day after hospitalization were 329 308 30-day readmissions following heart failure hospitalization, 108 992 30-day readmissions following acute myocardial infarction hospitalization, and 214 239 30-day readmissions following pneumonia hospitalization.

Readmission Timing

Of all 30-day readmissions, we found that 61.0% of the HF, 67.6% of the acute MI, and 62.6% of the pneumonia cohorts occurred during days 0 through 15 following discharge (FIGURE 1). More than 30% of 30-day readmissions occurred during days 16 through 30 for all 3 cohorts.

Readmission Diagnoses by Time After Discharge

The overall pattern of readmission diagnoses was largely similar in both cumulative and consecutive periods after discharge (FIGURE 2 and FIGURE 3). However, we did note that the percentage of readmissions due to recurrent HF and recurrent pneumonia changed slightly with time. For example, the percentage of readmissions due to recurrent HF was 31% during days 0 through 3; 33% during days 0 through 7; 34% during days 0 through 15; and 35% during days 0 through 30 after discharge. The percentage of readmissions due to recurrent pneumonia was 27% during days 0 through 3; 23% during days 4 through 7; 21% during days 8 through 15; and 21% during days 16 through 30 following hospitalization.

Median times to readmission were 12 days for patients initially hospitalized with HF, 10 days for patients initially hospitalized with acute MI, and 12 days for patients initially hospitalized with pneumonia (eTable 7). Median times to readmission for the 5 most common readmission diagnoses ranged from 11 to 13 days for the HF, 9 to 11 days for the acute MI, and 11 to 14 days for the pneumonia cohorts.

Patient Demographic Characteristics and Readmission Diagnoses

Even when patient age, sex, or race was associated with the comorbidity-adjusted odds of readmission for a particular diagnosis, neither the predicted number of readmissions due to this diagnosis nor the overall spectrum of readmission diagnoses differed to a clinically significant degree. For example, among readmissions following the index hospitalization for HF,

increasing patient age was associated with higher adjusted odds of readmission for pneumonia (adjusted odds ratios, 1.21 and 1.59 with increasing age group) (eTable 8). However, increasing age was associated with only 2.1 more predicted pneumonia readmissions among 100 rehospitalizations in patients aged 85 years or older compared with those aged 65 through 74 years (from 3.6 to 5.7 readmissions) (TABLE 1). The greatest change in predicted readmission number due to variation in any demographic characteristic was 5.6 additional predicted readmissions for HF among 100 rehospitalizations following the index acute MI hospitalization for patients aged 65 through 74 years compared with those aged 85 years and older (from 16.3 readmissions to 21.9 readmissions). The association of patient age, sex, and race with the overall spectrum of readmission diagnoses was always small, even when corresponding odds ratios appeared prominent, because the great majority of readmission diagnoses constituted only a small proportion of all 30-day readmissions.

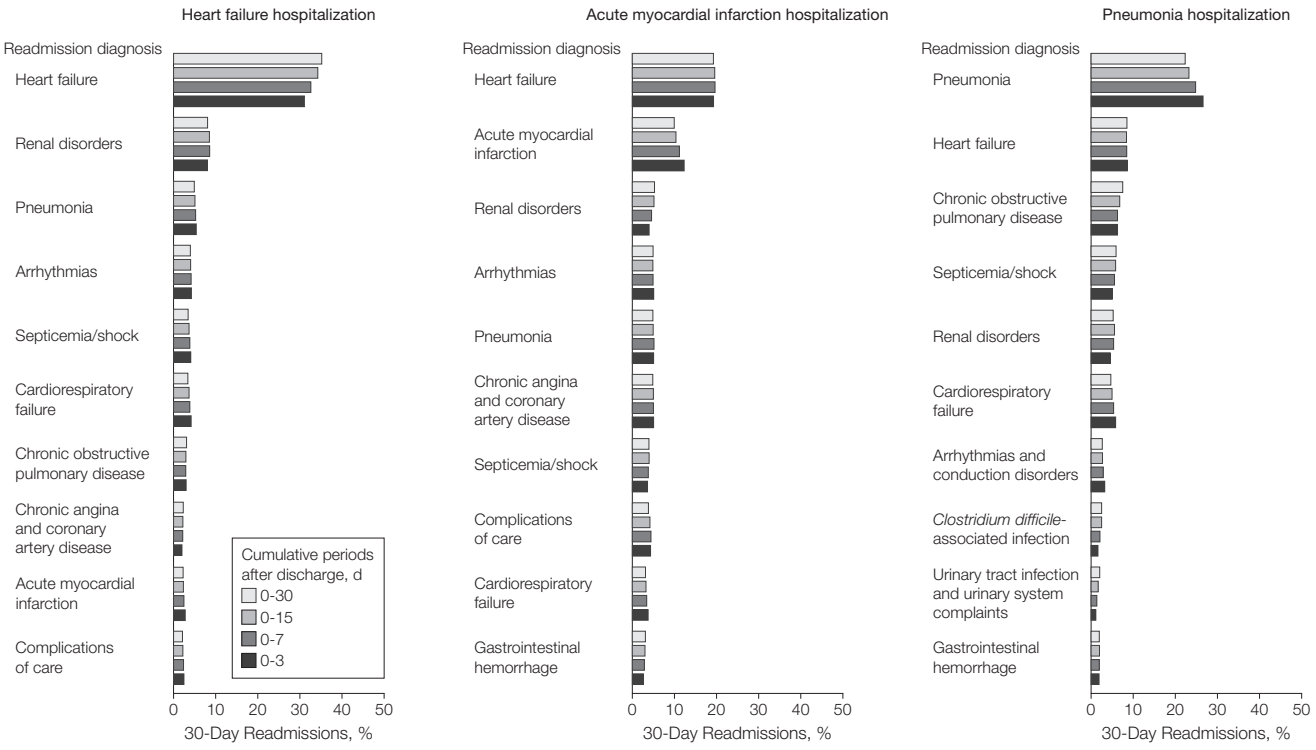
Patient Demographic Characteristics and Readmission Timing

Comorbidity-adjusted hazard ratios did not appear to differs by patient age, sex, or race to a clinically significant degree (TABLE 2).

COMMENT

Medicare fee-for-service beneficiaries are readmitted within 30 days after hospitalization for HF, acute MI, or pneumonia with a diverse spectrum of diagnoses that usually differs from the cause of the index hospitalization. We have extended prior literature by revealing that the overall pattern of diagnoses responsible for readmission did not substantively differ by patient demographic characteristics or time after discharge. We have also shown that although a disproportionately high number of readmissions occurred soon after hospitalization, readmissions remained frequent throughout the month. These findings imply that the entire 30-day period after discharge is one of heightened vulnerability to readmission from a wide variety of illnesses. Programs to reduce 30-day readmissions should therefore be correspondingly broad in scope in the diagnoses they target and effective for at least the full month following hospitalization. Interventions targeted at specific diseases or time periods responsible for only a fraction of all 30-day readmis-

Figure 2. Percentage of Patients Readmitted With Common Readmission Diagnoses During Cumulative Periods Following Hospitalization for Heart Failure, Acute Myocardial Infarction, or Pneumonia



The denominators used to calculate the percentage of 30-day readmissions due to common readmission diagnoses during each cumulative period after hospitalization for heart failure were 44 257 readmissions for days 0 through 3, 104 362 for days 0 through 7, 201 005 for days 0 through 15, and 329 308 for days 0 through 30. Analogously, following acute myocardial infarction hospitalization, the denominators used were 20 801 readmissions for days 0 through 3, 43 687 for days 0 through 7, 73 641 for days 0 through 15, and 108 992 for days 0 through 30. Following pneumonia hospitalization, the denominators used were 32 829 readmissions for days 0 through 3, 71 995 for days 0 through 7, 134 033 for days 0 through 15, and 214 239 for days 0 through 30.

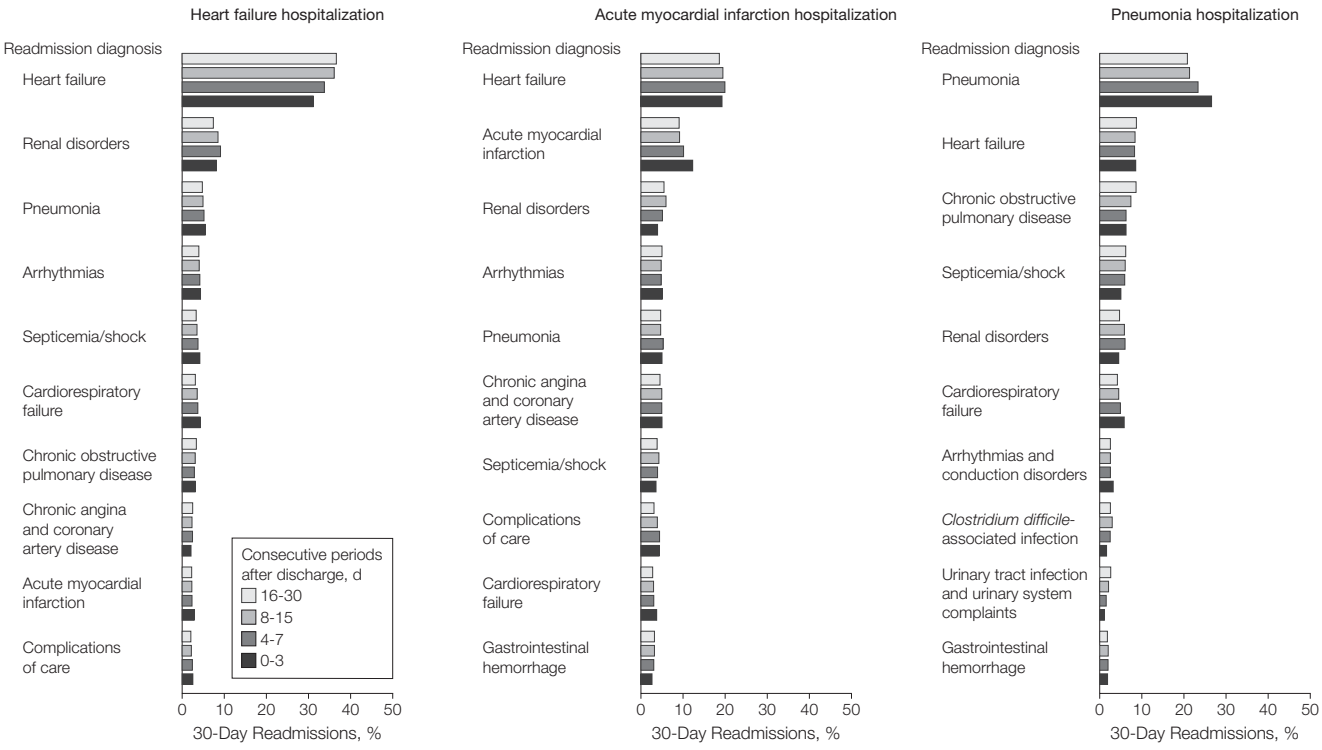
sions may be less efficacious unless they provide broader collateral benefits.

Similar to previous work, we demonstrated in a recent cohort that readmission diagnoses usually differed from the specific diagnosis responsible for the index hospitalization and often involve different physiologic systems.[15,20-22] For example, only 22% of readmissions after hospitalization for pneumonia were due to recurrent pneumonia and less than 40% were due to pulmonary disease. Moreover, only a minority of readmissions were attributable to the 5 most common readmission diagnoses among patients initially hospitalized for acute MI or pneumonia. No diagnosis was responsible for more than 5% of the remaining readmissions.

We additionally found that the overall pattern of diagnoses responsible for readmission did not substantively differ by patient demographic characteristics or time after discharge. This observation suggests that hospitals should account for a fairly standard spectrum of readmission diagnoses when designing and implementing interventions to prevent rehospitalization regardless of patient age, sex, race, or anticipated follow-up date in the month after hospitalization. Similarly, ambulatory clinicians seeing patients at different periods after discharge should be aware that the diverse spectrum of readmission diagnoses is largely stable over time, and they should perform their surveillance and preventive measures accordingly. Although we found that readmissions for recurrent HF were more likely to occur later in the month and that readmissions for recurrent pneumonia were more likely to occur soon after discharge, these differences involved less than 6% of all readmissions. It may be that recurrent volume overload is a progressive process that takes some time to manifest,[23] whereas recurrent pneumonia is greatest in recently hospitalized patients who are often colonized with drug-resistant pathogens.[24]

The broad range of acute conditions responsible for readmission may reflect a posthospitalization syndrome—a generalized vulnerability to illness among recently discharged patients, many of whom have developed new impairments both during and after hospitalization.[25] Inpatients frequently experience loss of strength and mobility[26] and develop new disabilities and difficulties in performing activities of daily living.[27-29] Hospitalized patients may have nutritional deficits due to

Figure 3. Percentage of Patients Readmitted With Common Readmission Diagnoses During Consecutive Periods Following Hospitalization for Heart Failure, Acute Myocardial Infarction, or Pneumonia



The denominators used to calculate the percentage of 30-day readmissions due to common readmission diagnoses during each consecutive period after hospitalization for heart failure were 44 257 readmissions for days 0 through 3, 60 105 for days 4 through 7, 96 643 for days 8 through 15, and 128 303 for days 16 through 30. Analogously, following acute myocardial infarction hospitalization, the denominators used were 20 801 readmissions for days 0 through 3, 22 886 for days 4 through 7, 29 954 for days 8 through 15, and 35 531 for days 16 through 30. Following pneumonia hospitalization, the denominators used were 32 829 readmissions for days 0 through 3, 39 166 for days 4 through 7, 62 038 for days 8 through 15, and 80 206 for days 16 through 30.

reduced appetite and imposed caloric restriction.[30] Sleep deprivation may occur.[31] Delirium often continues even after hospitalization.[32] Adverse effects of commonly used pharmacotherapies started in the hospital and continued at discharge may exacerbate all of these conditions.[33-35]

This heightened vulnerability to a diversity of illnesses may explain why interventions that are broadly applicable to many conditions with multiple components or are delivered by a multidisciplinary team are more likely to reduce readmissions.[36,37] Rich et al[38] demonstrated that the combination of general HF education by a registered nurse, dietary education by a registered dietician, consultation with a social worker, medication management by a geriatric cardiologist, and home visits reduced the number of all-cause readmissions. Similarly, Jack et al[39] demonstrated that patient education, care

Table 1. Association of Patient Age, Sex, and Race With the Predicted Number of Common Readmission Diagnoses Among 100 Readmissions Following Hospitalization for Heart Failure, Acute Myocardial Infarction, or Pneumonia[a]

	No. of Readmissions							
	Patient Age, y			Patient Sex		Patient Race		
Readmission Diagnosis by Modified Condition Category	65-74	75-84	≥85	Men	Women	White	Black	Other
Heart failure cohort								
Heart failure	34.0	33.8	35.6	34.8	34.0	33.8	38.4	35.3
Renal disorders	7.5	7.8	7.9	7.7	7.8	7.7	8.0	7.8
Pneumonia	3.6	4.4	5.7	5.0	4.1	4.7	3.6	4.3
Arrhythmias and conduction disorders	4.0	3.7	3.1	3.4	3.8	3.7	2.9	3.0
Septicemia/shock	2.9	3.3	3.6	3.4	3.1	3.2	3.2	3.9
Acute myocardial infarction cohort								
Heart failure	16.3	18.7	21.9	18.3	19.4	18.9	18.8	19.6
Acute myocardial infarction	8.3	8.6	12.1	10.0	9.1	9.5	9.7	9.8
Renal disorders	4.7	5.3	5.4	5.3	5.0	5.0	6.8	5.5
Arrhythmias and conduction disorders	5.0	4.8	4.2	5.0	4.5	4.9	2.9	4.2
Pneumonia	3.6	4.3	5.5	5.3	3.7	4.4	4.0	4.3
Pneumonia cohort								
Pneumonia	20.6	21.4	23.1	24.1	19.7	22.0	18.5	21.8
Heart failure	5.7	6.5	8.0	6.1	7.3	6.7	7.4	6.2
Chronic obstructive pulmonary disease/asthma	5.6	4.7	3.4	4.4	4.5	4.5	4.4	4.3
Septicemia/shock	5.0	5.3	5.5	5.7	4.9	5.1	6.3	6.3
Renal disorders	4.4	4.9	5.4	4.8	5.0	4.8	5.9	5.0

[a]When illustrating the association of age with the predicted number of patients readmitted with common diagnoses, patient populations were made identical to the overall readmission cohorts in sex, race, and comorbidity. To isolate the association with age, our cohort consisted of 100 patients aged 65 through 74 years, 100 patients aged 75 through 84 years, and 100 patients aged 85 years or older. Analogously, populations were identical in age, race, and comorbidity when illustrating the association with sex and consisted of 100 men and 100 women. Populations were identical in age, sex, and comorbidity when illustrating the association with race and consisted of 100 white patients, 100 black patients, and 100 patients of other race.

Table 2. Association of Patient Demographic Characteristics With Comorbidity-Adjusted Hazard Ratios for Readmissions Within 30 Days Following Hospitalization for Heart Failure, Acute Myocardial Infarction, or Pneumonia.

	Heart Failure (n = 329 308)		Acute Myocardial Infarction (n = 108 992)		Pneumonia (n = 214 239)	
Patient Demographic Characteristics	No. of Readmissions	Hazard Ratio (95% CI)	No. of Readmissions	Hazard Ratio (95% CI)	No. of Readmissions	Hazard Ratio (95% CI)
Age, y						
65-74	85 662	1 [Reference]	31 143	1 [Reference]	59 144	1 [Reference]
75-84	136 785	1.02 (1.01-1.03)	44 609	1.01 (0.99-1.02)	88 642	1.02 (1.01-1.03)
≥85	106 861	1.02 (1.01-1.03)	33 240	1.00 (0.98-1.01)	66 453	1.04 (1.03-1.05)
Sex						
Men	145 270	1 [Reference]	50 570	1 [Reference]	100 077	1 [Reference]
Women	184 038	0.98 (0.97-0.99)	58 422	0.99 (0.98-1.00)	114 162	1.00 (1.00-1.01)
Race						
White	272 045	1 [Reference]	94 275	1 [Reference]	187 288	1 [Reference]
Black	42 465	0.97 (0.96-0.99)	9764	0.98 (0.97-1.00)	17 412	0.99 (0.98-1.01)
Other	14 798	0.99 (0.97-1.00)	4953	0.98 (0.96-1.01)	9539	0.99 (0.97-1.01)

coordination, and confirmation of a specific medication plan by trained registered nurses plus medication education, reconciliation, and adherence assessment by a clinical pharmacist led to reductions in emergency department visits and readmissions. In contrast, single randomized interventions or strategies delivered by one expert have often failed.[36,37,40-43]

The timing of 30-day readmissions highlights the importance of both transitional care and longitudinal strategies that are effective for at least the full month following hospitalization. We found that a high proportion of 30-day readmissions occurred relatively soon after discharge, which may explain why hospitals least likely to provide outpatient follow-up within 7 days after hospitalization for HF had the highest rates of 30-day readmission.[44] The preponderance of early readmissions may also explain why exclusively outpatient interventions have often been ineffective in reducing 30-day readmissions that may have occurred before initial follow-up.[42,43] In contrast, strategies involving the combination of inpatient and early outpatient interventions with the use of tools that facilitate cross-site communication have lowered readmissions that occur soon after discharge.[45,46] However, because about one-third of 30-day readmissions occurred during days 16 through 30 after hospitalization, many patients require substantial attention well beyond the initial follow-up visit.

There are some additional factors to consider when interpreting this study. Data were limited to Medicare fee-for-service beneficiaries and conclusions drawn from this population may not apply to others. Nevertheless, this is the population that is the focus of recent federal policies. Also, we relied on claims data to assign diagnoses for both index hospitalizations and readmissions. However, administrative codes have been shown to be accurate for cardiovascular and pulmonary diagnoses.[47-49] Finally, CMS claims data contain relatively limited information on patient social factors potentially associated with readmission patterns,[50] and we did not develop proxy measures to test the relationship between these variables and readmission diagnoses and timing.

The diagnoses associated with 30-day readmission are diverse and are not associated with patient demographic characteristics or time after discharge for older patients initially hospitalized with HF, acute MI, or pneumonia. Although a high percentage of 30-day readmissions occurred relatively soon after hospitalization, readmissions remained frequent during days 16 through 30 after discharge regardless of patient age, sex, or race. This heightened vulnerability of recently hospitalized patients to a broad spectrum of conditions throughout the postdischarge period favors a generalized approach to preventing readmissions that is broadly applicable across potential readmission diagnoses and effective for at least the full month after hospitalization. Strategies that are specific to particular diseases or periods may only address a fraction of patients at risk for rehospitalization.

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Acquisition of data: Krumholz.
Analysis and interpretation of data: Dharmarajan, Hsieh, Lin, Bueno, Ross, Horwitz, Barreto-Filho, Kim, Bernheim, Suter, Drye, Krumholz.
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