

Association Between Interhospital Care Fragmentation, Readmission Diagnosis, and Outcomes

Sara Turbow, MD, MPH; Nikkil Sudharsanan, PhD, MPH; Kimberly J. Rask, MD, PhD; and Mohammed K. Ali, MD, MBA, MSc

The United States lags behind other high-income countries in life expectancy and case-fatality rates despite spending far more on health care.¹ In 2017, health care costs were responsible for 17.9% of the gross domestic product of the United States,² yet life expectancy ranked 28th among 36 high-income countries.³ As such, health professionals and policy makers are interested in identifying the unnecessary care and preventable costs that contribute to up to \$935 billion in waste each year⁴ and may lead to suboptimal outcomes for patients. Hospital care, costing more than \$1 trillion per year,⁵ is a major contributor to health care spending, and the United States' 5 million hospital readmissions per year⁶ are a primary target for cost-reducing and quality-improving efforts.^{7,8}

Previous work has shown that care fragmentation in the outpatient setting can lead to increased spending and worse outcomes,⁹⁻¹³ but research into the benefits of continuity between hospitals in the acute care setting is much more limited. Fragmented readmissions, defined as readmissions to a hospital different from the one the patient was originally discharged from, make up 20% to 30% of all readmissions.^{14,15} Existing studies of fragmented readmissions have shown inconsistent relationships between these readmissions and patient outcomes, perhaps because fragmented readmissions are treated homogeneously in many studies.¹⁶⁻¹⁹ Studies that segmented patients with fragmented readmissions by diagnosis in any way, even if it was as broad as readmission for a medical vs surgical reason, were more consistent in their findings of increased short-term mortality and longer lengths of stay in fragmented readmissions.^{14,20-24}

The purpose of this study was to examine the associations between interhospital care fragmentation and in-hospital mortality, length of stay (LOS), and costs in adult patients with 30-day readmissions across key categories: readmission to the same hospital for the same reason as their index admission, readmission to a different hospital (fragmented readmission) for the same reason as the index admission, readmission to the same hospital for a different reason, and readmission to a different hospital for a different reason (fragmented readmission). These findings could lead to better management of patients with fragmented readmissions, improve

ABSTRACT

OBJECTIVES: To assess in-hospital mortality, length of stay, and costs associated with interhospital fragmentation in 30-day readmissions and to determine whether these associations were more or less pronounced for patients with specific high-prevalence conditions.

STUDY DESIGN: Cross-sectional analysis using the Agency for Healthcare Research and Quality's National Readmissions Database for 2013 and 2014.

METHODS: All patients 18 years and older with a 30-day readmission in 2014 were included. We assessed if readmission to a hospital different from that of the index admission was associated with in-hospital mortality, length of stay, and costs of readmission, separately by whether the readmission occurred for the same or different major diagnostic category. Patients with 1 of 3 common diagnoses (congestive heart failure [CHF], chronic obstructive pulmonary disease [COPD], or myocardial infarction) were studied for disease-specific trends. The same analyses were performed on 2013 data as a sensitivity analysis.

RESULTS: In 2014, among 792,596 patients with a 30-day readmission, 22.2% experienced fragmentation. Compared with patients whose readmission occurred at the index hospital, patients readmitted to a different hospital experienced 20% higher odds of dying in hospital ($P = .02$ for same diagnosis readmission; $P = .03$ for different diagnosis readmission), a half-a-day longer length of stay ($P < .001$ for both same and different diagnosis readmissions), and more than \$1000 higher costs ($P < .001$ for both same and different diagnosis readmissions). For patients with a CHF or COPD index admission, mortality was consistently higher for fragmented readmissions for a different condition.

CONCLUSIONS: Fragmented readmissions were associated with higher in-hospital mortality and cost. Clinical variation across conditions warrants further investigation to optimize pre- and postdischarge operations and policy.

Am J Manag Care. 2021;27(5):e164-e170. doi:10.37765/ajmc.2021.88639

our deployment of care coordination resources for patients at risk for poor outcomes following a fragmented readmission, and help health care professionals, health systems, and payers understand the role that fragmentation plays in patient outcomes and its policy implications.

METHODS

This was a cross-sectional analysis of the Agency for Healthcare Research and Quality (AHRQ) National Readmissions Database (NRD) for 2014, with a sensitivity analysis performed on the 2013 NRD.²⁵ The NRD is a national, all-payer data set containing all nonfederal hospital admissions and readmissions from 27 states.²⁶ Patients and hospitals can be tracked or compared only within a single year of the NRD, and all data are limited to the duration of the hospitalization.

Patients

We included all patients 18 years and older with a 30-day readmission in 2014 to capture admission-readmission dyads. We excluded patients who were transferred between hospitals during an admission or whose index admission occurred in January 2014, as these admissions could have represented 30-day readmissions from December 2013.

Variable Definitions

We defined a fragmented readmission as a 30-day readmission to a hospital different from the hospital of the first admission in the data set. Each hospital is assigned an NRD-specific identifier; if the hospital identifiers were different between the 2 hospitalizations, we classified the readmission as fragmented. We limited this analysis to the first admission-readmission dyad of the year for each patient to not give undue weight to patients with excessive numbers of hospital admissions.

We examined reasons for admission and readmission both broadly and narrowly by focusing on major diagnostic categories (MDCs) and select acute and chronic conditions, respectively. For the MDC analysis, we defined the indication(s) for the initial admission and readmission as the primary MDC associated with the admission or readmission. MDCs are the largest categorization of diagnostic codes—68,000 *International Classification of Diseases, Ninth Revision (ICD-9)* codes are grouped into 700 diagnosis-related groups, which are then collected into 25 MDCs. We then divided the patients into 4 groups: those whose readmission was to the same hospital for the same MDC as the index admission (same hospital/same diagnosis: SH/SD), those whose readmission was to a different hospital for the same reason as the index admission (different hospital/same diagnosis: DH/SD), those whose readmission was to the same hospital but for a different MDC from the index admission (same hospital/different diagnosis: SH/DD), and those whose readmission was to a

TAKEAWAY POINTS

- ▶ Previous work has shown that interhospital care fragmentation is associated with poor patient outcomes. However, most studies treated readmissions homogeneously and did not differentiate based on the reason for readmission. Those that segmented readmissions found differences in outcomes across reasons for readmission.
- ▶ This cross-sectional study of a nationally representative database showed that in-hospital mortality was 20% higher for patients who were readmitted to a different hospital compared with patients who were readmitted to the same hospital. For patients with a congestive heart failure or chronic obstructive pulmonary disease index admission, mortality was higher for patients with a fragmented readmission for a different condition compared with patients without a fragmented readmission.

different hospital for a different reason from the index admission (different hospital/different diagnosis: DH/DD).

Given the broad nature of MDCs, we selected 3 conditions from the top 2 MDCs for hospital admissions (circulatory and respiratory causes) to assess if and how interhospital fragmentation or continuity influences specific common conditions. We defined the indication for the initial admission and readmission using *ICD-9* codes defined by Medicare for each condition.²⁷ We selected 3 conditions of interest: myocardial infarction (MI), congestive heart failure (CHF), and chronic obstructive pulmonary disease (COPD). We chose these conditions because they are highly prevalent and represent both acute problems (MI) and chronic problems with exacerbations (CHF, COPD); these conditions are also foci of quality improvement programs like the Hospital Readmissions Reduction Program.²⁷ We then divided the patients into the same 4 groups as the MDC analysis. Readmissions due to complications of these conditions were considered different diagnoses than the index admission (ie, an admission for an arrhythmia following an MI would be considered a readmission for a different diagnosis).

We examined 3 outcomes: in-hospital mortality during the readmission, LOS of the readmission, and cost of the readmission. The NRD contains only information about in-hospital mortality, and no mortality data or linkage following discharge are available. We defined in-hospital mortality as a patient having been recorded as dying during their readmission. LOS was defined as the number of days between the date of admission and the date of discharge. Costs were calculated by converting cumulative hospital charges for the readmission (listed in the NRD) to costs using the Healthcare Cost and Utilization Project's Cost-to-Charge Ratio Files.²⁸

Statistical Analysis

We described the characteristics of the entire sample using weighted univariate statistics, including the distribution of the 4 exposure groups. We then assessed the frequencies of MDCs for the initial admission and the readmission across the 4 groups of patients to determine if fragmentation was more pronounced among certain MDCs. Next, we compared patient and hospitalization characteristics across the 4 groups using weighted χ^2 tests and analysis of variance to ascertain if other systematic differences across exposure groups

may have also affected outcomes. We repeated the initial descriptive analyses comparing all fragmented and all nonfragmented patients as well.

For the main analyses, we used unadjusted and adjusted logistic and linear regression models to compare the 3 outcomes across our exposure groups of interest. Adjusted models included several potential confounders of the fragmentation-outcome relationship available in the NRD, including both demographic (age, sex, payer, zip income quartile [median incomes in a patient's zip code divided into quartiles]) and clinical (MDC of the readmission, Elixhauser mortality risk score, alcohol use, drug use, and if the patient left against medical advice) variables. As a sensitivity analysis, we included LOS and cost of the index admission in the above models examining LOS and cost of the readmission. All analyses were done using patient-level data. We performed these regression analyses using the nonfragmented groups as the reference. The same analyses were repeated for the MI, CHF, and COPD groups; the only difference was that the MDCs were not included in the regression models.

We completed all analyses in SAS 9.4 (SAS Institute) using weighted survey procedures according to the scheme provided by the AHRQ.²⁹ As a sensitivity analysis to examine whether these findings were stable across years, we used the same analytical approach using data from the NRD from 2013.

This study was deemed exempt from review by the Emory University Institutional Review Board.

RESULTS

The 2014 NRD contains 14,894,613 unweighted admissions. After removing individuals younger than 18 years (8.5% of original sample; 1,264,040 admissions), interhospital transfers (2.9% of original sample; 401,141 admissions), and admissions occurring in January 2014 (7.7% of original sample; 1,151,054 admissions), 12,078,378 total admissions remained. We then transposed the data set to make patients the unit of observation, rather than admissions, leaving a sample of 3,181,258 patients. The first 2 admissions from each patient in the sample were analyzed to determine if the readmission occurred more than 30 days after the initial admission or less than 30 days. In the final sample there were 792,596 patients with readmissions occurring 30 days or less from their index admission (eAppendix Figure 1 [eAppendix available at ajmc.com]).

Table 1 includes characteristics for the entire sample. Briefly, 53.8% of those experiencing 30-day readmissions in 2014 were female, and the mean age was 61.6 years. Most patients had Medicare insurance (56.5%). Only 3.6% of admissions were paid for out of pocket.

Table 1 also includes the distribution of the 4 groups of patients for the MDC analysis: SH/SD, 36.1% (n = 285,185); DH/SD, 8.9% (n = 71,708); SH/DD, 41.8% (n = 328,889); and DH/DD, 13.3% (n = 106,814). An estimated 178,522 patients (22.2%) had a fragmented readmission. Patients experiencing care fragmentation tended to be younger than patients whose readmission was not fragmented (Table 1).

Additionally, patients in the fragmented groups had lower Elixhauser mortality risk scores than patients in the nonfragmented groups; the LOS and costs for the index admission were similar across all groups. Similar results were seen when comparing all fragmented patients with all nonfragmented patients (eAppendix Tables 1 and 2).

Overall, 3.9% of patients died during their readmission. In unadjusted analyses, in-hospital mortality was 2.6%, 2.8%, 4.9%, and 5.1%, in the SH/SD, DH/SD, SH/DD, and DH/DD groups, respectively (SH/SD vs DH/SD: $P = .019$; SH/DD vs DH/DD: $P = .031$) (Table 2). Both fragmented groups had a mean readmission LOS of 5.9 days ($P < .001$) and higher mean costs of the readmission (by \$1000 on average) ($P < .001$) than did their respective nonfragmented groups.

eAppendix Figure 2 displays the distribution of MDCs for the readmission within each fragmentation category. The 3 MDCs with the highest overall prevalence among 30-day readmissions—circulatory, respiratory, and digestive diseases—had similar distributions of the fragmentation categories. Other MDCs had notably different frequencies across fragmentation categories. For example, alcohol/drug use or induced mental disorders and pregnancy/childbirth and puerperium had a much higher proportion of DH/SD and a much lower proportion of SH/DD than did the more common MDCs.

DH/SD patients had 18% higher odds of mortality in adjusted models (adjusted odds ratio [AOR], 1.18; 95% CI, 1.12-1.25) than did SH/SD patients (Table 3). The results were similar for DH/DD patients compared with SH/DD patients (AOR, 1.21; 95% CI, 1.17-1.26). DH/SD patients had a LOS approximately half a day longer than SH/SD patients (0.54 days; 95% CI, 0.45-0.64 days), and DH/DD patients had a longer LOS by 0.28 days (95% CI, 0.20-0.35 days) vs SH/DD patients. Costs were also higher among fragmented readmissions: \$1375 (95% CI, \$1010-\$1739) more for DH/SD patients vs SH/SD patients and \$1269 (95% CI, \$985-\$1552) more for DH/DD vs SH/DD patients. Similar results were seen for the readmission LOS and readmission cost when index admission LOS and cost were included in the models (eAppendix Table 3).

For the analyses focused on MI, CHF, and COPD, all 3 diagnoses had a similar prevalence of care fragmentation (COPD, 18.7%; CHF, 20.7%; MI, 21.5%) (eAppendix Tables 4-6). For MI, there was no association between fragmentation status and mortality (Table 4); in fact, mortality for patients readmitted to a different hospital for a repeat MI was lower than for those readmitted to the same hospital. For COPD and CHF, there was no difference in mortality for patients with a fragmented readmission for the same reason, but odds of mortality were 40% higher in DH/DD vs SH/DD patients (COPD: AOR, 1.41; 95% CI, 1.17-1.71; CHF: AOR, 1.43; 95% CI, 1.25-1.62).

With regard to LOS and cost, for COPD, no statistically significant differences were seen in LOS or cost for DH/SD vs SH/SD patients. DH/DD patients had a half-a-day longer LOS (0.57 days; 95% CI, 0.24-0.91 days) and more than \$2000 (95% CI, \$1529-\$3025) greater expenditures compared with SH/DD patients. For CHF, DH/SD vs SH/SD patients had a half-day longer LOS (0.50 days; 95% CI, 0.15-0.84

TABLE 1. Comparison of Fragmentation/MDC Groups at Baseline Among Adult Patients With 30-Day Readmissions*

	Overall	Readmitted for same MDC		P	Readmitted for different MDC		P
		Nonfragmented (SH/SD) n = 285,185 (36.1%)	Fragmented (DH/SD) n = 71,708 (8.9%)		Nonfragmented (SH/DD) n = 328,889 (41.8%)	Fragmented (DH/DD) n = 106,814 (13.3%)	
Female	53.8% (0.17)	56.2% (0.26)	51.2% (0.31)	<.001	53.1% (0.17)	51.0% (0.22)	<.001
Age in years	61.6 (0.17)	56.8 (0.21)	55.7 (0.19)	<.001	66.3 (0.19)	63.7 (0.14)	<.001
Zip income quartile ^b							
\$1-\$39,999	30.0% (0.78)	29.7% (0.82)	33.1% (0.76)	<.001	29.0% (0.82)	31.6% (0.73)	<.001
\$40,000-\$50,999	27.3% (0.50)	27.3% (0.51)	26.9% (0.46)		27.3% (0.56)	27.6% (0.47)	
\$51,000-\$65,999	22.7% (0.46)	22.9% (0.49)	21.1% (0.43)		23.1% (0.50)	21.8% (0.41)	
> \$66,000	20.0% (0.73)	20.1% (0.76)	18.8% (0.66)		20.6% (0.81)	19.0% (0.65)	
Insurance payer							
Medicare	56.5% (0.39)	47.5% (0.43)	46.8% (0.40)	<.001	64.8% (0.45)	61.3% (0.33)	<.001
Medicaid	16.0% (0.32)	19.7% (0.41)	23.6% (0.46)		11.5% (0.28)	15.2% (0.29)	
Private	20.7% (0.34)	25.3% (0.43)	20.8% (0.32)		18.0% (0.37)	16.6% (0.26)	
Self-pay	3.6% (0.13)	3.9% (0.15)	5.3% (0.18)		2.9% (0.13)	3.8% (0.13)	
No charge	0.6% (0.09)	0.7% (0.10)	0.7% (0.10)		0.5% (0.08)	0.6% (0.09)	
Other	2.6% (0.13)	2.9% (0.15)	2.7% (0.16)		2.4% (0.12)	2.5% (0.12)	
Left AMA (Y)	2.2% (0.05)	2.3% (0.07)	5.2% (0.16)	<.001	1.3% (0.04)	3.2% (0.09)	<.001
Drug use (Y)	5.5% (0.13)	5.6% (0.16)	9.7% (0.28)	<.001	3.8% (0.11)	7.2% (0.18)	<.001
Alcohol use (Y)	5.7% (0.09)	5.2% (0.11)	7.1% (0.16)	<.001	5.3% (0.10)	7.5% (0.14)	<.001
Elixhauser mortality risk score	6.0 (0.05)	4.3 (0.05)	3.7 (0.07)	<.001	7.8 (0.06)	6.5 (0.07)	<.001
Length of stay in days (first admission)	5.7 (0.04)	5.2 (0.06)	5.1 (0.05)	<.001	6.2 (0.04)	6.1 (0.05)	<.001
Cost in \$ (first admission)	14,129 (187.5)	12,238 (178.7)	10,808 (141.1)	<.001	16,189 (232.4)	14,984 (201.6)	<.001

AMA, against medical advice; DD, different diagnosis; DH, different hospital, fragmented readmission; MDC, major diagnosis category; SD, same diagnosis; SE, standard error; SH, same hospital, nonfragmented readmission; Y, yes.

*All values are shown as mean (SE of mean) or percent (SE of column percent).

^bZip income quartile: a quartile classification of the estimated median household incomes of individuals in the patient’s zip code. These quartiles vary by year of data.

days) and \$2433 higher costs (95% CI, \$1118-\$3749); DH/DD vs SH/DD patients similarly had approximately a half-day longer LOS (0.61 days; 95% CI, 0.36-0.86 days) and \$3682 higher costs (95% CI, \$2833-\$4532). The differences among patients readmitted for MI to a different hospital were most striking—up to a whole day longer LOS (1.02 days; 95% CI, 0.53-1.51 days) and more than \$6000 more in costs (\$6579; 95% CI, \$4169-\$8988). There was no difference between patients readmitted for a reason other than MI to a different hospital compared with patients readmitted to the same hospital in adjusted models for LOS, but costs were consistently higher in fragmented readmissions (adjusted regression coefficient, \$1814; 95% CI, \$791-\$2836).

We also performed the above analyses on the 2013 NRD (eAppendix Tables 10-12). The results were similar to those seen in the 2014 NRD.

DISCUSSION

In this analysis of readmissions in the United States in 2014, we found that patients experiencing fragmented interhospital care, whether readmissions were for the same or different diagnoses

as the index admission, had 20% higher mortality than their nonfragmented counterparts, longer LOS, and higher costs, even after adjusting for a wide range of patient demographic and clinical factors. Results were similar when we examined care for those with index admissions for MI, CHF, or COPD, but mortality was higher only for patients readmitted for a different condition. These findings have numerous implications for policy and practice going forward.

Previous literature has shown inconsistent patterns between fragmentation and mortality.^{14-17,19-24,30-37} Notably, many of these studies have focused on very narrow populations. We found consistent associations between fragmentation and higher in-hospital mortality in our more generalizable patient sample; however, the results differed when we examined individual diagnoses. It may be that fragmentation affects different conditions differently—for example, a patient with CHF may have a specific diuretic regimen that is known to be effective for them and is written in their previous discharge summary—information that may only be available if the patient returns to their previous place of admission. Management of MI, on the other hand, follows a much more structured, standardized treatment protocol, so as long as the standard of care is followed,

CLINICAL

TABLE 2. Unadjusted Outcomes During Readmission Across Fragmentation/MDC Groups

Outcome	Overall	Readmitted for the same MDC			Readmitted for a different MDC		
		Nonfragmented (SD/SH)	Fragmented (SD/DH)	P	Nonfragmented (DD/SH)	Fragmented (DD/DH)	P
In-hospital mortality (percentage [SE])	3.9% (0.04)	2.6% (0.05)	2.8% (0.08)	.019	4.9% (0.07)	5.1% (0.08)	.031
Readmission length of stay in days (SE)	5.6 (0.02)	5.4 (0.03)	5.9 (0.04)	<.001	5.7 (0.02)	5.9 (0.03)	<.001
Readmission cost in \$ (SE)	12,394 (108.0)	12,055 (156.9)	13,215 (123.14)	<.001	12,260 (157.0)	13,189 (94.3)	<.001

DD, different diagnosis; DH, different hospital, fragmented readmission; MDC, major diagnostic category; SD, same diagnosis; SE, standard error; SH, same hospital, nonfragmented readmission.

TABLE 3. Association Between Fragmented Care and Readmission In-Hospital Mortality, LOS, and Costs Separately for Patients Readmitted for the Same MDC and Different MDC*

Outcome	Readmitted for the same MDC			Readmitted for a different MDC		
	Unadjusted	Model 1 ^b	Model 2 ^c	Unadjusted	Model 1 ^b	Model 2 ^c
In-hospital mortality ^d	1.10 (1.02-1.14)	1.16 (1.10-1.23)	1.18 (1.12-1.25)	1.04 (1.01-1.08)	1.18 (1.14-1.23)	1.21 (1.17-1.26)
Readmission LOS ^e in days	0.55 (0.46-0.64)	0.56 (0.46-0.65)	0.54 (0.45-0.64)	0.23 (0.15-0.30)	0.29 (0.22-0.36)	0.28 (0.20-0.35)
Readmission cost ^e in \$	1190 (822-1559)	1344 (977-1710)	1375 (1010-1739)	929 (644-1215)	1238 (955-1521)	1269 (985-1552)

LOS, length of stay; MDC, major diagnostic category.

*All estimates correspond to an indicator for fragmented readmission relative to nonfragmented readmission.

^bModel 1 adjusts for mortality score, alcohol use, drug use, left against medical advice, age, sex, payer, and zip income quartile.

^cModel 2 adjusts for model 1 covariates plus indicator variables for MDC of readmission.

^dEstimates for mortality correspond to odds ratio (95% CI).

^eEstimates for LOS and cost correspond to mean difference (95% CI).

TABLE 4. Association Between Fragmented Care and Readmission In-Hospital Mortality, LOS, and Costs Separately for Patients Readmitted for the Same MDC and Different MDC, Stratified by Initial Admission for COPD, MI, and CHF*

Outcome	Readmitted for the same reason		Readmitted for a different reason	
	Unadjusted	Model 1 ^b	Unadjusted	Model 1 ^b
Initial admission for COPD				
In-hospital mortality ^c	1.18 (0.64-2.16)	1.29 (0.70-2.38)	1.27 (1.06-1.53)	1.41 (1.17-1.71)
Readmission LOS ^d in days	-0.08 (-0.39 to 0.24)	-0.02 (-0.34 to 0.30)	0.54 (0.20-0.88)	0.57 (0.24-0.91)
Readmission cost ^d in \$	266 (-443 to 975)	295 (-413 to 1004)	2198 (1454-2940)	2277 (1529-3025)
Initial admission for MI				
In-hospital mortality ^c	0.50 (0.33-0.74)	0.58 (0.39-0.87)	1.07 (0.88-1.31)	1.08 (0.88-1.32)
Readmission LOS ^d in days	0.91 (0.43-1.39)	1.02 (0.53-1.51)	0.25 (0.02-0.48)	0.23 (-0.01 to 0.47)
Readmission cost ^d in \$	6930 (4558-9302)	6579 (4169-8988)	1848 (840-2856)	1814 (791-2836)
Initial admission for CHF				
In-hospital mortality ^c	0.81 (0.62-1.05)	0.95 (0.73-1.23)	1.32 (1.17-1.50)	1.43 (1.25-1.62)
Readmission LOS ^d in days	0.50 (0.17-0.84)	0.50 (0.15-0.84)	0.60 (0.36-0.85)	0.61 (0.36-0.86)
Readmission cost ^d in \$	2839 (1553-4125)	2433 (1118-3749)	3867 (3028-4706)	3682 (2833-4532)

CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; LOS, length of stay; MDC, major diagnostic category; MI, myocardial infarction.

*All estimates correspond to an indicator for fragmented readmission relative to nonfragmented readmission.

^bModel 1 adjusts for mortality score, alcohol use, drug use, left against medical advice, age, sex, payer, and zip income quartile.

^cEstimates for mortality correspond to odds ratio (95% CI).

^dEstimates for LOS and cost correspond to mean difference (95% CI).

fragmentation may not have as much impact on the patient's outcome, but it may result in duplication of laboratory testing, imaging, and treatments, leading to associations with longer LOS and increased costs.

Although we did not perform additional analyses on less common MDCs, it is worth noting that fragmented readmissions, specifically for the same reason (DH/SD), were disproportionately common in certain MDCs, namely alcohol/drug use or induced mental disorders and pregnancy, childbirth, and puerperium. The former may be reflective of patient instability or frustration with care, leading them to seek care at a different hospital. Reasons for care fragmentation around pregnancy and childbirth are less clear—perhaps these fragmented readmissions are reflective of emergency complications of pregnancy, childbirth, and the postpartum period.³⁸

The differences between fragmented and nonfragmented groups may be due to some reverse causality based on severity of illness and indication for admission, where fragmented patients may have been at higher risk for conditions requiring care at specialty hospitals. As such, these patients may have been taken to centers of excellence for these conditions, which could result in fragmented, but appropriate, care. This may warrant further investigation.

Fragmentation was generally associated with greater LOS, but the difference was not large. We suspect that this is because LOS is driven by medical diagnoses and social comorbidities,³⁹ rather than continuity challenges associated with care fragmentation. Both DH/SD and DH/DD patients had higher costs compared with their nonfragmented counterparts (with the exception of patients with COPD readmitted for another COPD diagnosis). We hypothesize that these increased costs may have been more directly related to fragmented care—the care team at the readmitting hospital may have had no choice but to order duplicative laboratory and imaging tests to fully evaluate the patient. Although many previous studies have looked at mortality as a major outcome in fragmentation, our findings suggest that cost may be the outcome that could be most affected by improving informational and interhospital continuity of care across various diagnoses, and our findings may have implications for reducing waste.⁴ Future studies could examine what cost components contribute to these higher numbers and assess what laboratory tests or imaging studies are being repeated across fragmented readmissions. These findings also suggest that interoperability of electronic health records may be an important policy and practice focus to minimize waste in inpatient care.

Limitations

The primary limitation of this study is that our associations may be biased estimates of the true causal effect of fragmentation on outcomes due to unmeasured differences between patients who did and did not receive fragmented care. Given that there are likely several unobserved factors that could influence both whether a readmission was fragmented and patient outcomes, our estimates are best interpreted as suggestive associations. Still, we adjusted for a wide range of variables, including a comprehensive mortality

risk score, giving us some confidence that our results are not purely driven by omitted variable bias. Unfortunately, we were not able to identify the exact reasons why the patients in the study sought care at different hospitals; this also prevents us from further differentiating “appropriate” from “inappropriate” fragmentation. Because of the limits on data linkage placed by the data vendor, we were not able to measure factors such as urban/rural status, travel distance to the hospital, and whether the patient was transported via ambulance. Additionally, we did not know whether the hospital treated as the “index” hospital was truly the patient's usual source of care. These factors might affect a patient's probability of a fragmented readmission; for example, patients often go to the nearest hospital, even if they had previously received care elsewhere,⁴⁰ which also could affect outcomes. Finally, the NRD does not contain any information about hospital participation in health information exchanges or shared electronic health records. As of 2014, 80% of hospitals had some ability to query other organizations for health information,⁴¹ which may have mitigated some of the negative effects of care fragmentation identified in this analysis compared with previous work, although the utility of health information exchanges in improving information continuity between settings of care is still unclear.⁴²

Another limitation is our approach to determining whether the readmission was for the same or a different reason. We chose to start with MDCs, the largest “bucket” of diagnosis groups, for several reasons. First, because this was a secondary data analysis, we cannot account for discrepancies in coding among health professionals. We did not want subtle differences in coding to place a patient in the “readmission for a different reason” category when in reality the readmission was for the same reason. If a patient's primary diagnosis across 2 hospitalizations fell in 2 different MDCs, we felt confident that it was substantially different. By first examining MDCs, then conducting a focused analysis on MI, CHF, and COPD, we have taken both a broad and a more focused approach to examine outcomes following a fragmented readmission. As future studies continue to examine fragmentation in specific diagnoses and patient groups, or in prospective studies in which diagnoses can be recorded along the way, researchers will be able to get more refined information regarding the role of diagnosis in the impact of interhospital fragmentation of care on patient outcomes.

CONCLUSIONS

This study contributes to our increasing understanding of which patients are at risk for interhospital care fragmentation and provides a more nuanced view of the association between fragmented care and patient and hospital-use outcomes. As we move to further understand, and eventually intervene on, interhospital care fragmentation, we must develop a deeper understanding of which patients are at risk for fragmentation, which patients are at risk for poor outcomes following fragmentation, and which factors we can reasonably target for intervention. ■

Acknowledgments

The authors thank Jordan Kempker for facilitating use of the National Readmissions Database for this study.

Author Affiliations: Department of Medicine (ST) and Department of Family and Preventive Medicine (ST, MKA), Emory University School of Medicine, Atlanta, GA; Heidelberg Institute for Global Health (NS), Heidelberg, Germany; Department of Health Policy and Management (KJR) and Departments of Global Health and Epidemiology (MKA), Emory University Rollins School of Public Health, Atlanta, GA.

Source of Funding: None.

Author Disclosures: The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (ST, KJR, MKA); acquisition of data (ST); analysis and interpretation of data (ST, NS, KJR, MKA); drafting of the manuscript (ST, NS, KJR, MKA); critical revision of the manuscript for important intellectual content (ST, NS, KJR, MKA); statistical analysis (ST, NS); and administrative, technical, or logistic support (MKA).

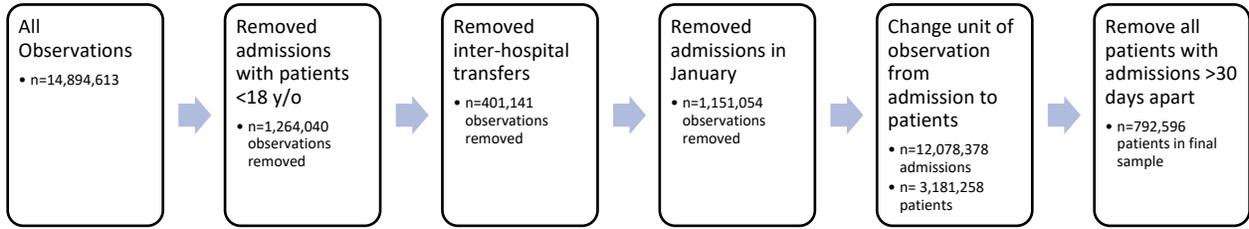
Address Correspondence to: Sara Turbow, MD, MPH, Department of Medicine, Department of Family and Preventive Medicine, Emory University School of Medicine, 49 Jesse Hill Jr Dr SE, Atlanta, GA 30303. Email: sara.turbow@emory.edu.

REFERENCES

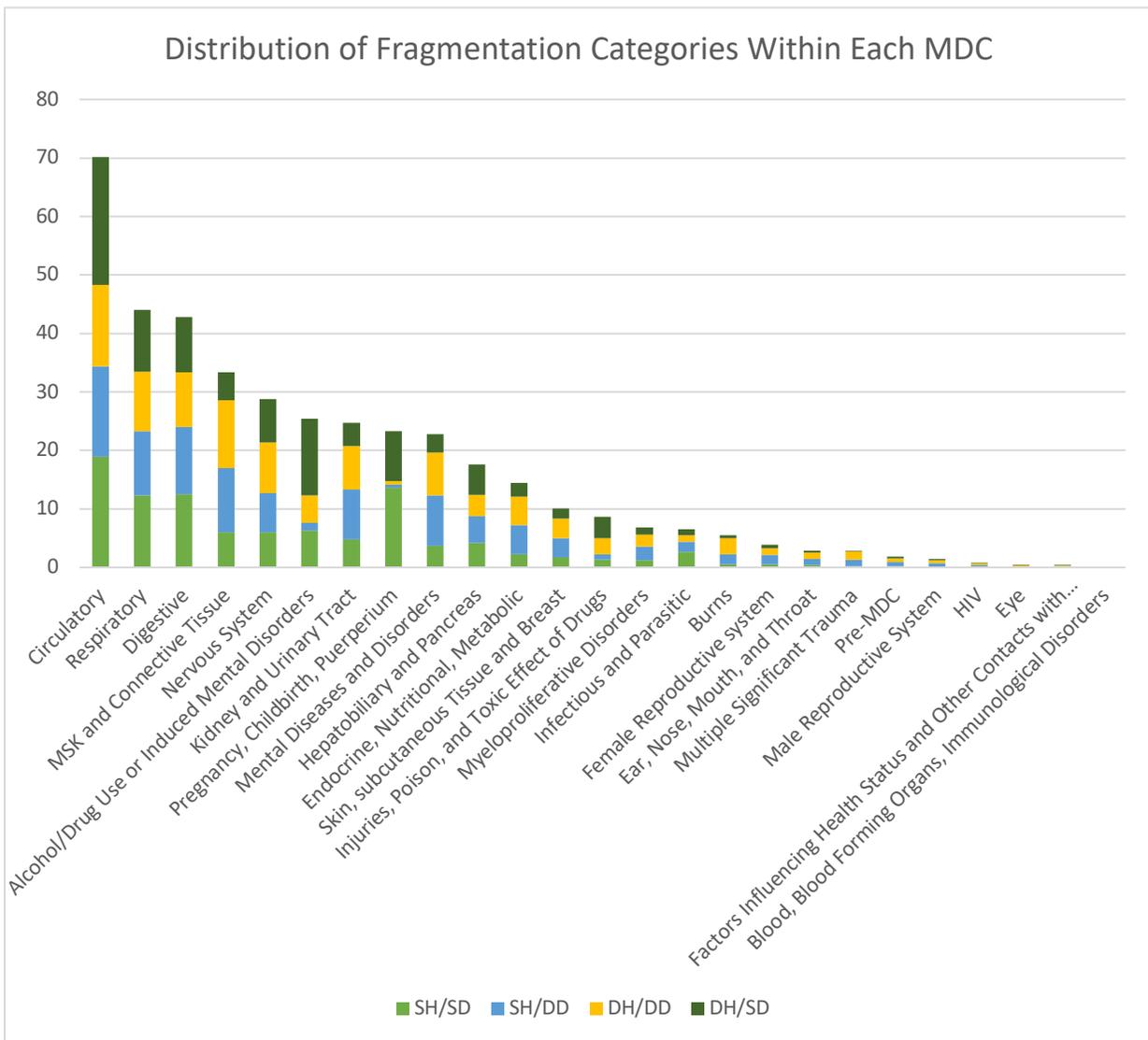
- Kamal R, Ramirez G, Cox C. How does health spending in the U.S. compare to other countries? Peterson-KFF Health System Tracker. December 23, 2020. Accessed January 5, 2021. <https://www.healthsystemtracker.org/chart-collection/health-spending-u-s-compare-countries/>
- Sisko AM, Keehan SP, Poisal JA, et al. National health expenditure projections, 2018-27: economic and demographic trends drive spending and enrollment growth. *Health Aff (Millwood)*. 2019;38(3):491-501. doi:10.1377/hlthaff.2018.05499
- Annual report: 2018. America's Health Rankings. Accessed August 1, 2020. <https://www.americashealthrankings.org/explore/annual/measure/Overall/state/ALL?edition-year=2018>
- Shrank WH, Rogstad TL, Parekh N. Waste in the US health care system: estimated costs and potential for savings. *JAMA*. 2019;322(15):1501-1509. doi:10.1001/jama.2019.13978
- CMS Office of the Actuary releases 2017 national health expenditures. News release. CMS; December 6, 2018. Accessed May 22, 2019. <https://www.cms.gov/newsroom/press-releases/cms-office-actuary-releases-2017-national-health-expenditures>
- Bailey MK, Weiss AJ, Barrett ML, Jiang HJ. Characteristics of 30-day readmissions, 2010-2016. *Healthcare Cost and Utilization Project statistical brief No. 248*. February 2019. Accessed May 22, 2019. <https://www.hcup-us.ahrq.gov/reports/statbriefs/sb248-Hospital-Readmissions-2010-2016.pdf>
- Hospital Readmissions Reduction Program (HRRP). CMS. Updated August 24, 2020. Accessed September 1, 2020. <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program>
- James J. Medicare Hospital Readmissions Reduction Program. *Health Affairs*. November 12, 2013. doi:10.1377/hpb20131112.646839
- Kern LM, Seirup JK, Rajan M, Jawahar R, Stuard SS. Fragmented ambulatory care and subsequent health-care utilization among Medicare beneficiaries. *Am J Manag Care*. 2018;24(9):e278-e284.
- Bayliss EA, Ellis JL, Shoup JA, Zeng C, McQuillan DB, Steiner JF. Effect of continuity of care on hospital utilization for seniors with multiple medical conditions in an integrated health care system. *Ann Fam Med*. 2015;13(2):123-129. doi:10.1370/afm.1739
- Bentler SE, Morgan RO, Virnig BA, Wolinsky FD. The association of longitudinal and interpersonal continuity of care with emergency department use, hospitalization, and mortality among Medicare beneficiaries. *PLoS One*. 2014;9(12):e115088. doi:10.1371/journal.pone.0115088
- Nyweide DJ, Anthony DL, Bynum JPW, et al. Continuity of care and the risk of preventable hospitalization in older adults. *JAMA Intern Med*. 2013;173(20):1879-1885. doi:10.1001/jamainternmed.2013.10059
- Johnston KJ, Hockenberry JM. Are two heads better than one or do too many cooks spoil the broth? the trade-off between physician division of labor and patient continuity of care for older adults with complex chronic conditions. *Health Serv Res*. 2016;51(6):2176-2205. doi:10.1111/1475-6773.12600
- Burke RE, Jones CD, Hosokawa P, Glorioso TJ, Coleman EA, Ginde AA. Influence of nonindex hospital readmission on length of stay and mortality. *Med Care*. 2018;56(1):85-90. doi:10.1097/MLR.0000000000000829
- Hua M, Ng Gong M, Miltiades A, Wunsch H. Outcomes after rehospitalization at the same hospital or a different hospital following critical illness. *Am J Respir Crit Care Med*. 2017;195(11):1486-1493. doi:10.1164/rccm.201605-09120C
- Jia H, Zheng Y, Reker DM, et al. Multiple system utilization and mortality for veterans with stroke. *Stroke*. 2007;38(2):355-360. doi:10.1161/01.STR.0000254457.38901.f8
- Justiniano CF, Xu Z, Becerra AZ, et al. Long-term deleterious impact of surgeon care fragmentation after colorectal surgery on survival. *Dis Colon Rectum*. 2017;60(11):1147-1154. doi:10.1097/DCR.0000000000000919
- Galanter WL, Applebaum A, Boddipati V, et al. Migration of patients between five urban teaching hospitals in Chicago. *J Med Syst*. 2013;37(2):9930. doi:10.1007/s10916-013-9930-y
- Luu NP, Hussain T, Chang HY, Pfoh E, Pollack CE. Readmissions after colon cancer surgery: does it matter where patients are readmitted? *J Oncol Pract*. 2016;12(5):e502-e512. doi:10.1200/JOP.2015.007757
- Saunders RS, Fernandes-Taylor S, Kind AJH, et al. Rehospitalization to primary versus different facilities following abdominal aortic aneurysm repair. *J Vasc Surg*. 2014;59(6):1502-1510. doi:10.1016/j.jvs.2013.12.015
- Pak JS, Lascano D, Kabat DH, et al. Patterns of care for readmission after radical cystectomy in New York State and the effect of care fragmentation. *Urol Oncol*. 2015;33(10):426.e13-426.e19. doi:10.1016/j.urolonc.2015.06.001
- Kothari AN, Loy VM, Brownless SA, et al. Adverse effect of post-discharge care fragmentation on outcomes after readmissions after liver transplantation. *J Am Coll Surg*. 2017;225(1):62-67. doi:10.1016/j.jamcollsurg.2017.03.017
- Stitzenberg KB, Chang Y, Smith AB, Meyers MO, Nielsen ME. Impact of location of readmission on outcomes after major cancer surgery. *Ann Surg Oncol*. 2017;24(2):319-329. doi:10.1245/s10434-016-5528-1
- Zheng C, Habermann EB, Shara NM, et al. Fragmentation of care after surgical discharge: non-index readmission after major cancer surgery. *J Am Coll Surg*. 2016;222(5):780-789.e2. doi:10.1016/j.jamcollsurg.2016.01.052
- NRD database documentation. Agency for Healthcare Research and Quality. Accessed August 1, 2018. <https://www.hcup-us.ahrq.gov/db/nation/nrd/nrddbdocumentation.jsp>
- Overview of the Nationwide Readmissions Database (NRD). Agency for Healthcare Research and Quality. Accessed August 1, 2018. <https://www.hcup-us.ahrq.gov/nrdoverview.jsp>
- Hospital Readmissions Reduction Program (HRRP). CMS. Updated August 24, 2020. Accessed September 1, 2020. <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html>
- Cost-to-Charge Ratio Files. Agency for Healthcare Research and Quality. September 2018. Accessed May 22, 2019. <https://www.hcup-us.ahrq.gov/db/state/costtocharge.jsp>
- Producing national HCUP estimates – accessible version. Agency for Healthcare Research and Quality. Accessed May 22, 2019. https://www.hcup-us.ahrq.gov/tech_assist/nationalestimates/508_course/508course_2018.jsp
- Wolinsky FD, Miller TR, An H, Brezinski PR, Vaughn TE, Rosenthal GE. Dual use of Medicare and the Veterans Health Administration: are there adverse health outcomes? *BMC Health Serv Res*. 2006;6:131. doi:10.1186/1472-6963-6-131
- Staples JA, Thiruchelvan D, Redelmeier DA. Site of hospital readmission and mortality: a population-based retrospective cohort study. *CMAJ Open*. 2014;2(2):E77-E85. doi:10.9778/cmajo.20130053
- Glebova NO, Hicks CW, Taylor R, et al. Readmissions after complex aneurysm repair are frequent, costly, and primarily at nonindex hospitals. *J Vasc Med Biol*. 2014;60(6):1429-1437. doi:10.1016/j.jvs.2014.08.092
- Tsai TC, Orav EJ, Jha AK. Care fragmentation in the postdischarge period. *JAMA Surg*. 2015;150(1):59-64. doi:10.1001/jamasurg.2014.2071
- Brooke BS, Goodney PP, Kraiss LW, Gottlieb DJ, Samore MH, Finlayson SRG. Readmission destination and risk of mortality after major surgery: an observational cohort study. *Lancet*. 2015;386(9996):884-895. doi:10.1016/S0140-6736(15)00087-3
- Mays JA, Jackson KL, Derby TA, et al. An evaluation of recurrent diabetic ketoacidosis, fragmentation of care, and mortality across Chicago, Illinois. *Diabetes Care*. 2016;39(10):1671-1676. doi:10.2337/dc16-0668
- McAlister FA, Youngson E, Kaul P. Patients with heart failure readmitted to the original hospital have better outcomes than those readmitted elsewhere. *J Am Heart Assoc*. 2017;6(5):e004892. doi:10.1161/JAHA.116.004892
- Graboyes EM, Kallagjeri D, Saeed MJ, Olsen MA, Nussenbaum B. Postoperative care fragmentation and thirty-day unplanned readmissions after head and neck cancer surgery. *Laryngoscope*. 2016;127(4):868-874. doi:10.1002/lary.26301
- Stulberg DB, Dahlquist I, Jarosch C, Lindau ST. Fragmentation of care in ectopic pregnancy. *Matern Child Health J*. 2016;20(5):955-961. doi:10.1007/s10995-016-1979-z
- Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Millbank Q*. 2005;83(4). doi:10.1111/j.1468-0009.2005.00428.x
- Rising KL, Karp DN, Powell RE, Victor TW, Carr BG. Geography, not health system affiliations, determines patients' revisits to the emergency department. *Health Serv Res*. 2017;53(2):1092-1109. doi:10.1111/1475-6773.12658
- Connecting health and care for the nation: a shared nationwide interoperability roadmap. Office of the National Coordinator for Health Information Technology. 2015. Accessed May 22, 2019. <https://www.healthit.gov/sites/default/files/hie-interoperability/nationwide-interoperability-roadmap-final-version-1.0.pdf>
- O'Malley AS, Grossman JM, Cohen GR, Kemper NM, Pham HH. Are electronic medical records helpful for care coordination? experiences of physician practices. *J Gen Intern Med*. 2010;25(3):177-185. doi:10.1007/s11606-009-1195-2

Visit ajmc.com/link/88639 to download PDF and eAppendix

eAppendix Figure 1. Data Cleaning Flowchart



eAppendix Figure 2. Distribution of Fragmentation Categories Within Each MDC



eAppendix Tables 1 and 2. Analysis of All Fragmented v. All Non-Fragmented Patients

eAppendix Table 1. Comparison of Non-Fragmented and Fragmented Groups at Baseline Among Adult Patients with 30-Day Readmissions†

	Not Fragmented 77.8% (n=614,074)	Fragmented 22.1% (n=178,522)	P
Female	54.5% (0.18)	51.0% (0.21)	<0.001
Age	61.9 (0.19)	60.2 (0.15)	<0.001
Zip income quartile			
<i>1 – 39,999</i>	29.5% (0.81)	32.1% (0.73)	
<i>40,000 – 50,999</i>	27.3% (0.53)	27.4% (0.45)	<0.001
<i>51,000 – 65,999</i>	23.0% (0.45)	21.5% (0.40)	
<i>66,000+</i>	20.4% (0.78)	18.9% (0.64)	
Insurance payer			
<i>Medicare</i>	56.8% (0.44)	55.5% (0.34)	
<i>Medicaid</i>	15.3% (0.33)	18.6% (0.34)	
<i>Private</i>	21.4% (0.38)	18.3% (0.24)	<0.001
<i>Self-pay</i>	3.3% (0.14)	4.4% (0.14)	
<i>No charge</i>	0.6% (0.09)	0.7% (0.09)	
<i>Other</i>	2.6% (0.13)	2.6% (0.13)	
Left AMA (Y)	1.7% (0.05)	4.0% (0.11)	<0.001
Drug use (Y)	4.7% (0.12)	8.2% (0.20)	<0.001
Alcohol use (Y)	5.3% (0.10)	7.3% (0.13)	<0.001

Elixhauser mortality risk score	6.2 (0.05)	5.3 (0.62)	<0.001
Length of stay (1 st admission)	5.8 (0.04)	5.7 (0.04)	<0.001
Cost (1 st admission)	14,360 (202.2)	13,317 (169.4)	<0.001

†All values are shown as mean (SE of mean) or percent (SE of column percent)

eAppendix Table 2. Outcomes during Readmission across Non-fragmented v. Fragmented Groups

	Non-Fragmented	Fragmented	p
In-hospital mortality	3.9% (0.05)	4.2% (0.6)	<0.001
Readmission Length-of-stay	5.5 (0.03)	5.9 (0.03)	<0.001
Readmission Cost	12,165 (133.3)	13,200 (89.8)	<0.001

eAppendix Table 3. Association between fragmented care and readmission in-hospital mortality, length-of-stay (LOS), and costs separately for patients readmitted for the same major diagnostic category (MDC) and different MDC^a

Outcome	Readmitted for the same MDC			Readmitted for a different MDC		
	Unadjusted	Model 1 ^c	Model 2 ^d	Unadjusted	Model 1 ^c	Model 2 ^d
Readmission	0.55	0.54	0.53	0.23	0.28	0.27
LOS^b (Days)	(0.46-0.64)	(0.45-0.63)	(0.44-0.62)	(0.15-0.30)	(0.21-0.35)	(0.20-0.34)
Readmission Cost^b (\$)	1,190 (822-1559)	1,487 (1138-1835)	1,507 (1160-1854)	929 (644-1215)	1,330 (1061-1600)	1,351 (985-1552)

a. All estimates correspond to an indicator for fragmented readmission relative to non-fragmented readmission.

b. Estimates for LOS and cost correspond to mean difference (95% confidence interval)

c. Model 1 adjusts for mortality score, alcohol use, drug use, left AMA, age, sex, payer, zip income quartile, LOS of the index admission, Cost of the index admission

d. Model 2 adjust for Model 1 covariates + indicator variables for MDC of readmission

eAppendix Tables 4-9. Analysis of Specific Conditions (2014 NRD)

eAppendix Table 4. Comparison of Fragmentation/COPD Groups at Baseline

Mean/Percent (SE)	Overall	Readmitted for COPD	Readmitted for different diagnosis	
	SH ^b	DH ^c n = 734	SH ^b	DH ^c n = 2,672

		n = 4,758 (26.2%)	(3.9%)	n = 9,950 (55.1%)	(14.8%)
Sex (F)	53.6% (0.43)	53.5% (0.80)	50.7% (2.00)	53.9% (0.56)	53.7% (1.10)
Age	70.0 (0.13)	68.8 ± 0.21	67.5 ± 0.45	71.0 ± 0.16	68.9 ± 0.26
Zip Income Quartile					
1-39,999	34.6% (0.97)	35.6% (1.35)	37.4% (2.00)	33.1% (1.01)	38.1% (1.32)
40,000-50,999	29.5% (0.74)	30.2% (1.07)	27.8% (1.95)	29.3% (0.80)	29.1% (1.20)
51,000-65,999	20.9% (0.63)	19.1% (0.84)	21.0% (1.78)	22.6% (0.76)	17.8% (0.91)
66,000+	15.0% (0.74)	15.1% (0.95)	14.1% (1.44)	15.0% (0.80)	15.1% (0.98)
Insurance					
Medicare	76.1% (0.46)	74.0% (0.77)	68.0% (1.95)	78.3% (0.55)	73.6% (0.98)
Medicaid	11.2% (0.37)	12.4% (0.58)	15.3% (1.51)	10.2% (0.43)	12.2% (0.72)
Private	8.3% (0.28)	8.1% (0.47)	11.0% (1.35)	7.8% (0.33)	10.1% (0.68)
Self-Pay	2.1% (0.13)	2.7% (0.26)	2.5% (0.58)	1.8% (0.17)	1.7% (0.29)
No Charge	0.3% (0.06)	0.6% (0.12)	NR	0.3% (0.05)	NR
Other	1.9% (0.17)	2.2% (0.28)	NR	1.7% (0.22)	2.2% (0.32)
Left AMA (Y)	2.4% (0.12)	2.2% (0.22)	5.2% (0.84)	1.9% (0.16)	3.5% (0.35)
Drug Use (Y)	3.8% (0.19)	4.1% (0.35)	6.4% (0.97)	3.2% (0.22)	5.0% (0.45)
Alcohol Use (Y)	5.1% (0.19)	5.3% (0.35)	6.8% (1.07)	4.7% (0.23)	5.5% (0.49)
Elixhauser Risk Score for Mortality range	5.7 (0.09)	4.0 (0.15)	3.7 (0.34)	6.6 (0.11)	6.0 (0.21)
Length-of-Stay (1 st Admission)	4.6 (0.04)	4.2 (0.05)	4.3 (0.17)	4.8 (0.06)	4.7 (0.11)
Cost of 1 st Admission	8,694 (108)	7,589 (123)	8,279 (316)	9,075 (143)	9,347 (270)

^aAll values are shown as mean (SE of mean) or percent (SE of column percent)

^bSH: Same hospital, non-fragmented readmission

^cDH: Different hospital, fragmented readmission

eAppendix Table 5. Comparison of Fragmentation/MI Groups at Baseline

	Overall	Readmitted for MI		Readmitted for different diagnosis	
		SH ^b n = 7.8% (1,459)	DH ^c n = 4.6% (904)	SH ^b n = 70.6% (13,102)	DH ^c n = 16.9% (3,265)
Sex (F)	42.1% (0.42)	40.7% (1.54)	35.9% (1.77)	42.4% (0.51)	42.7% (0.94)
Age	69.7 (0.14)	69.9 (0.42)	68.3 (0.46)	69.7 (0.16)	69.7 (0.28)
Zip Income Quartile					
1-39,999	30.1% (0.94)	35.2% (1.71)	26.9% (1.80)	29.7% (1.02)	30.1% (1.21)
40,000-50,999	28.8% (0.69)	27.1% (1.39)	27.6% (1.86)	28.8% (0.77)	30.1% (1.03)
51,000-65,999	22.4% (0.65)	21.6% (1.29)	23.9% (1.68)	22.6% (0.72)	21.6% (0.94)
66,000+	18.7% (0.79)	16.2% (1.28)	21.7% (1.76)	18.9% (0.87)	18.2% (1.00)
Insurance					
Medicare	67.5% (0.52)	67.7% (1.43)	64.0% (1.76)	67.5% (0.58)	68.4% (0.97)
Medicaid	8.3% (0.28)	8.6% (0.80)	9.1% (1.06)	8.2% (0.31)	8.4% (0.51)
Private	17.4% (0.42)	16.8% (1.21)	19.4% (1.42)	17.5% (0.47)	17.0% (0.73)
Self-Pay	3.7% (0.21)	3.7% (0.52)	4.3% (0.76)	3.7% (0.23)	3.9% (0.389)
No Charge	0.6% (0.10)	NR	NR	0.6% (0.12)	NR
Other	2.4% (0.18)	2.3% (0.40)	2.8% (0.68)	2.5% (0.22)	2.0% (0.27)
Left AMA (Y)	1.9% (0.11)	4.1% (0.62)	4.4% (0.72)	1.1% (0.09)	3.3% (0.35)
Drug Use (Y)	3.1% (0.15)	3.0% (0.47)	2.9% (0.55)	2.9% (0.18)	4.1% (0.39)
Alcohol Use (Y)	3.4% (0.15)	3.0% (0.48)	2.8% (0.52)	3.3% (0.19)	4.0% (0.37)
Elixhauser Risk Score for Mortality range	4.6 (0.08)	3.8 (0.23)	2.5 (0.25)	4.8 (0.10)	4.6 (0.17)
Length-of-Stay (1 st Admission)	5.5 (0.06)	4.0 (0.10)	2.4 (0.10)	5.8 (0.06)	5.7 (0.15)
Cost of 1 st Admission	22,223 (297)	16,536 (428)	10,224 (408)	23,671 (324)	21,934 (515)

^aAll values are shown as mean (SE of mean) or percent (SE of column percent)

^bSH: Same hospital, non-fragmented readmission

^cDH: Different hospital, fragmented readmission

eAppendix Table 6. Comparison of Fragmentation/CHF Groups at Baseline

	Overall	Readmitted for CHF		Readmitted for different diagnosis	
		SH ^b n = 10,571 (29.8%)	DH ^c n = 2,490 (6.9%)	SH ^b n = 17,261 (49.5%)	DH ^c N=4,936 (13.8%)
Female	48.0% (0.31)	46.4% (0.56)	41.7% (1.10)	50.2% (0.42)	46.5% (0.76)
Age	72.8 (0.2)	72.4 (0.26)	68.1 (0.39)	73.8 (0.19)	72.0 (0.26)
Zip income quartile					
<i>1 – 39,999</i>	32.5% (0.90)	33.3% (1.05)	37.5% (1.35)	31.2% (0.98)	33.3% (1.01)
<i>40,000 – 50,999</i>	27.2% (0.62)	27.1% (0.80)	26.3% (1.17)	27.3% (0.70)	27.5% (0.88)
<i>51,000 – 65,999</i>	21.5% (0.57)	21.3% (0.71)	20.1% (1.02)	21.8% (0.67)	21.4% (0.77)
<i>66,000+</i>	18.8% (0.76)	18.3% (0.85)	16.1% (1.00)	19.7% (0.88)	17.5% (0.92)
Insurance payer					
<i>Medicare</i>	77.9% (0.47)	76.1% (0.69)	68.3% (1.22)	80.6% (0.50)	76.9% (0.73)
<i>Medicaid</i>	9.1% (0.30)	10.4% (0.47)	14.5% (0.86)	7.4% (0.30)	9.6% (0.47)
<i>Private</i>	8.8% (0.27)	8.7% (0.38)	10.0% (0.69)	8.6% (0.33)	9.4% (0.489)
<i>Self-pay</i>	2.2% (0.14)	2.7% (0.21)	4.4% (0.47)	1.7% (0.14)	2.2% (0.23)
<i>No charge</i>	0.3% (0.05)	0.3% (0.07)	NR	0.3% (0.07)	NR
<i>Other</i>	1.7% (0.13)	1.8% (0.18)	2.1% (0.33)	1.5% (0.15)	1.7% (0.24)
Left AMA (Y)	1.7% (0.08)	1.8% (0.14)	4.8% (0.46)	1.0% (0.08)	2.6% (0.24)

Drug use (Y)	3.3% (0.14)	3.8% (0.26)	7.0% (0.57)	2.3% (0.14)	3.7% (0.30)
Alcohol use (Y)	3.2% (0.12)	3.3% (0.19)	4.4% (0.43)	3.0% (0.15)	3.4% (0.27)
Elixhauser mortality risk score	6.6 (0.07)	6.6 (0.10)	5.6 (0.19)	6.8 (0.09)	6.4 (0.14)
Length of stay (1 st admission)	5.7 (0.07)	5.4 (0.07)	5.0 (0.10)	6.1 (0.10)	5.6 (0.10)
Cost (1 st admission)	12,336 (273)	10,904 (201)	9,662 (219)	13,760 (453)	11,662 (247)

^aAll values are shown as mean (SE of mean) or percent (SE of column percent)

^bSH: Same hospital, non-fragmented readmission

^cDH: Different hospital, fragmented readmission

eAppendix Table 7. Outcomes During Readmission Across Fragmentation/COPD Groups

	Overall	Readmitted for COPD		Readmitted for a different diagnosis	
		SH ^a	DH ^b	SH ^a	DH ^b
In-hospital mortality	5.0% (0.19)	2.0% (0.23)	2.3% (0.66)	5.9% (0.27)	7.4% (0.54)
Readmission Length-of-stay	5.4 (0.05)	4.6 (0.06)	4.5 (0.13)	5.6 (0.06)	6.2 (0.16)
Readmission Cost	11,197 (129)	8,483 (168)	8,749 (330)	11,888 (179)	14,085 (331)

^aSH: Same hospital, non-fragmented readmission

^bDH: Different hospital, fragmented readmission

eAppendix Table 8. Outcomes During Readmission Across Fragmentation/MI Groups

	Overall	Readmitted for MI		Readmitted for a different diagnosis	
		SH ^a	DH ^b	SH ^a	DH ^b
In-hospital mortality	5.0% (0.18)	8.6% (0.85)	4.4% (0.73)	4.6% (0.20)	5.0% (0.43)
Readmission Length-of-stay	4.7 (0.04)	4.2 (0.11)	5.1 (0.23)	4.7 (0.05)	4.9 (0.10)
Readmission Cost	14,030 (190)	16,900 (461)	23,830 (1121)	12,939 (215)	14,787 (463)

^aSH: Same hospital, non-fragmented readmission

^bDH: Different hospital, fragmented readmission

eAppendix Table 9. Outcomes During Readmission Across Fragmentation/CHF Groups

	Overall	Readmitted for CHF		Readmitted for a different diagnosis	
		SH ^a	DH ^b	SH ^a	DH ^b
In-hospital mortality	6.4% (0.15)	4.7% (0.25)	3.8% (0.45)	7.1% (0.23)	9.1% (0.49)
Readmission	5.8 (0.05)	5.6 (0.09)	6.1 (0.12)	5.7 (0.08)	6.3 (0.09)
Length-of-stay					
Readmission Cost	13,685 (206)	11,814 (347)	14,653 (552)	13,618 (275)	17,485 (327)

^aSH: Same hospital, non-fragmented readmission

^bDH: Different hospital, fragmented readmission

eAppendix Tables 10-12. Analysis of 2013 NRD**eAppendix Table 10.** Comparison of Fragmentation/MDC Groups at Baseline Among Adult Patients with 30-Day Readmissions[†]

	Overall	Readmitted for same MDC		Readmitted for different MDC	
		SH [‡]	DH [§]	SH [‡]	DH [§]
		n =	n =	n =	n = 100,273
		280,384 (36.6%)	67,845 (8.7%)	318,726 (41.8%)	(11.7%)
Female	54.2% (0.17)	56.5% (0.28)	51.6% (0.31)	53.5% (0.16)	51.4% (0.21)
Age	61.6 (0.17)	56.7 (0.22)	55.8 (0.21)	66.3 (0.19)	63.9 (0.14)
Zip income quartile					
1 – 39,999	30.3% (0.78)	30.0% (0.82)	33.6% (0.78)	29.3% (0.83)	32.1% (0.71)
40,000 – 50,999	27.1% (0.50)	27.0% (0.52)	27.1% (0.47)	27.1% (0.55)	27.3% (0.44)
51,000 – 65,999	23.5% (0.44)	23.8% (0.46)	21.5% (0.43)	23.9% (0.46)	22.6% (0.40)
66,000+	19.2% (0.71)	19.2% (0.74)	17.8% (0.63)	19.7% (0.77)	18.0% (0.61)
Insurance payer					
Medicare	56.4% (0.41)	47.4% (0.46)	47.1% (0.41)	64.5% (0.48)	61.7% (0.33)

<i>Medicaid</i>	14.5% (0.30)	18.1% (0.40)	21.3% (0.45)	10.3% (0.25)	13.4% (0.27)
<i>Private</i>	20.8% (0.33)	25.2% (0.42)	20.8% (0.32)	18.1% (0.36)	16.8% (0.27)
<i>Self-pay</i>	4.5% (0.14)	4.9% (0.16)	6.5% (0.18)	3.6% (0.16)	4.6% (0.13)
<i>No charge</i>	0.7% (0.08)	0.8% (0.10)	0.8% (0.11)	0.6% (0.08)	0.6% (0.07)
<i>Other</i>	3.2% (0.13)	3.6% (0.15)	3.5% (0.14)	2.9% (0.13)	3.0% (0.12)
Left AMA (Y)	2.1% (0.05)	2.1% (0.06)	5.1% (0.16)	1.2% (0.04)	3.1% (0.10)
Drug use (Y)	4.8% (0.11)	5.1% (0.15)	8.4% (0.24)	3.4% (0.10)	6.2% (0.15)
Alcohol use (Y)	5.4% (0.09)	5.0% (0.10)	6.8% (0.16)	5.0% (0.10)	7.1% (0.14)
Elixhauser mortality risk score	5.8 (0.05)	4.1 (0.05)	3.6 (0.07)	7.5 (0.06)	6.3 (0.07)
Length of stay (1 st admission)	5.7 (0.04)	5.2 (0.07)	5.1 (0.04)	6.2 (0.04)	6.1 (0.05)
Cost (1 st admission)	13,877 (177.7)	11,960 (172.4)	10,843 (162.1)	15,895 (215.4)	14,821 (189.0)

†All values are shown as mean (SE of mean) or percent (SE of column percent)

‡SH: Same hospital, non-fragmented readmission

§DH: Different hospital, fragmented readmission

eAppendix Table 11. Outcomes during readmission across fragmentation/MDC groups

	Overall	Readmitted for the same MDC		Readmitted for a different MDC	
		SH†	DH‡	SH†	DH‡
In-hospital mortality	3.9% (0.04)	2.6% (0.04)	3.0% (0.07)	4.9% (0.07)	5.0% (0.09)
Readmission Length-of-stay	5.6 (0.02)	5.3 (0.04)	5.8 (0.04)	5.7 (0.03)	5.9 (0.03)
Readmission Cost	12,139 (102.79)	11,816 (146.2)	13,008 (128.2)	12,008 (120.8)	12,894 (88.7)

†SH: Same hospital, non-fragmented readmission

‡DH: Different hospital, fragmented readmission

eAppendix Table 12. Association between fragmented care and readmission in-hospital mortality, LOS, and costs separately for patients readmitted for the same MDC and different MDC†

<i>Outcome</i>	Readmitted for the same MDC			Readmitted for a different MDC		
	Unadjusted	Model 1¶	Model 2‡	Unadjusted	Model 1¶	Model 2‡
In-hospital mortality‡	1.17 (1.11-1.23)	1.25 (1.18-1.32)	1.27 (1.20-1.34)	1.04 (1.01-1.08)	1.18 (1.14-1.23)	1.21 (1.17-1.26)
Readmission LOS§	0.15 (0.06-0.25)	0.43 (0.33-0.53)	0.45 (0.35-0.55)	0.58 (0.49-0.67)	0.38 (0.29-0.47)	0.34 (0.25-0.43)
Readmission Cost§	1,000 (663-1336)	1,936 (1605-2267)	1,895 (1568-2223)	1078 (743-1412)	634 (308-961)	715 (387-1044)

†All estimates correspond to an indicator for fragmented readmission relative to non-fragmented readmission.

‡Estimates for mortality correspond to odds ratios (95% confidence intervals)

§Estimates for LOS and cost correspond to mean difference (95% confidence interval)

¶Model 1 adjusts for mortality score, alcohol use, drug use, left AMA, age, sex, payer, zip income quartile

‡Model 2 adjust for Model 1 covariates + indicator variables for MDC of readmission