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Predictors and outcomes of unplanned readmission to a different hospital

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Abstract

Objectives: To examine patient, hospital and market factors and outcomes associated with readmission to a different hospital compared with the same hospital.
Design: A population-based, secondary analysis using multilevel causal modeling.
Setting: Acute care hospitals in California in the USA.
Participants: In total, 509 775 patients aged 50 or older who were discharged alive from acute care hospitals (index hospitalizations), and 59 566 who had a rehospitalization within 30 days following their index discharge.
Intervention: No intervention.
Main Outcome Measures(s): Thirty-day unplanned readmissions to a different hospital compared with the same hospital and also the costs and health outcomes of the readmissions.
Results: Twenty-one percent of patients with a rehospitalization had a different-hospital readmission. Compared with the same-hospital readmission group, the different-hospital readmission group was more likely to be younger, male and have a lower income. The index hospitals of the different-hospital readmission group were more likely to be smaller, for-profit hospitals, which were also more likely to be located in counties with higher competition. The different-hospital readmission group had higher odds for in-hospital death (8.1 vs. 6.7%; $P < 0.0001$) and greater readmission hospital costs ($15 671.8 vs. $14 286.4; $P < 0.001$) than the same-hospital readmission group.
Conclusions: Patient, hospital and market characteristics predicted different-hospital readmissions compared with same-hospital readmissions. Mortality and cost outcomes were worse among patients with different-hospital readmissions. Strategies for better care coordination targeting people at risk for different-hospital readmissions are necessary.

Key words: readmissions, hospital care, patient outcomes, health policy

Introduction

Hospital readmission is an emerging policy agenda in many developed countries concerned with quality and safety of health care. In the USA, rehospitalizations are a known, important quality issue; various efforts to improve quality and coordination of hospital care have been made, but rehospitalizations are still common and costly. Nearly one-fifth of US Medicare beneficiaries were rehospitalized within 30 days of the index discharge between 2003 and 2004, and almost 35% were rehospitalized within 90 days in a population-based study [1]. The cost of unplanned rehospitalizations of Medicare patients has been estimated to be up to $17.4 billion per year [1]. Some rehospitalizations might be prevented by better coordination of care and discharge planning. In October 2012, the Centers for Medicare and Medicaid Services (CMS) adopted rehospitalizations for certain conditions within 30 days as a quality indicator and implemented for Medicare beneficiaries a pay-for-performance scheme related to the indicator [2] to incentivize hospitals' attention to services and outcomes for patients even after hospital departure.

This policy change has increased the interest in and need for further evidence on the attributes of rehospitalizations. Numerous studies have been conducted on rehospitalizations, most of which have focused on patient-level risk factors with various clinical conditions [1, 3, 4]. Published studies of hospital readmission from an organizational perspective often ignore readmissions to a different hospital, and studies from a payer or societal perspective often lump same-hospital and different-hospital readmissions together. However, different-hospital readmissions represent a substantial fraction (~18.3–29.3%) of overall readmissions and are likely precipitated by different clinical and social circumstances [3, 5, 6]. These circumstances may present unique challenges for the provision of effective post-hospital care. The few published studies on different-hospital readmissions suggest that readmission to a different hospital may cause a lack of continuity of critical information regarding patients' health conditions and treatment decisions [3, 5, 6], which can result in delayed medical decisions, duplicated tests or treatments, and worse outcomes. Kind and colleagues [3] using 2005–06 Medicare data showed that patients at for-profit hospitals were more likely to be readmitted to a different hospital within 1 month and experienced higher mortality and higher costs within 1 month of the index discharge, compared with patients discharged from non-profit hospitals. However, prior studies are limited in that they only examined specific conditions [6], used a small number of hospitals [5] or were limited to only the Medicare population [3, 6]. They also did not specifically examine unplanned admissions or include hospital regional data [3].

The objective of this study was to examine the frequency, factors and consequences of all-cause, 30-day unplanned readmissions to a different hospital, compared with the same hospital. Using the California state inpatient dataset, including all ages and all insurance types, allowing for linkage between hospitalizations and also to hospital financial report data, we examined the patient, hospital and market characteristics associated with 30-day unplanned readmissions to a different hospital, compared with the same hospital (from which the patient was initially discharged). We also compared the outcomes and in-hospital costs of same- and different-hospital readmissions using a causal inference approach.

We hypothesized that patients rehospitalized to a different hospital would have worse outcomes and would use more healthcare resources than those with a same-hospital readmission. In addition, we hypothesized that different-hospital readmissions would be associated with characteristics of the patient, the index hospital and the market where the index hospital was located [7].

Methods

Databases and study population

Patient data were obtained from the 2006 California state inpatient dataset (SID) [8] including patient discharge summary data. Developed and distributed by the AHRQ's Health Care Utilization Profile (HCUP) project, the California SID includes clinical (diagnoses, procedures, discharge status, etc.) and non-clinical information (patient age, ethnicity, dates of admission and discharge, etc.) for each hospitalization event. The SID is a de-identified dataset, but it includes a scrambled patient identifier with which all admission records of a patient within a year can be linked. The identifier is not valid across years. Hospital data were obtained from 2006–07 California hospital financial reports, which all California hospitals must submit annually to the Office of Statewide Planning Health and Development. These provided information on hospital ownership, bed size, teaching status, location and operational margin [9]. Finally, county data regarding market competition, primary care provider rates, college degrees rates and preventable hospitalization rates from 2005 to 2007 were obtained from the County Health Rankings and Roadmaps program (http://www.countyhealthrankings.org/), which collects a wide range of county-level measures of vital health factors from various national data sources and compiles them to produce rankings of the overall health of communities.

The study population included adults aged 50 or older who were admitted and discharged alive from acute care hospitals in California at least once between April and September 2006. We chose to examine adults >50 years old to focus our study on patients with multiple chronic conditions and with Medicare insurance who are at highest risk of readmission and the target of national policymaking. We then identified those with an unplanned readmission within 30 days of the index discharge and divided them into two groups: patients who had an unplanned readmission at the same (index) hospital from which they were discharged (hereafter the same-hospital readmission group) and those rehospitalized at a different hospital from the index hospital (hereafter the different-hospital readmission group). Whether a readmission was planned was ascertained from the California SID using the variable indicating whether a (re)admission was scheduled or not. Similar to existing studies [1, 3], patients who were admitted to a different hospital on the same day they were discharged from the index hospital were considered inter-hospital transfers (not readmissions), but patients readmitted at the index hospital on the same day they were discharged from that hospital were considered readmissions. The final analytic sample included 509 775 patients discharged alive from 357 acute hospitals in the 55 counties in California. The study was approved by the institutional review board for human subject research at the institution with which the first author is affiliated.

Variables

For all readmissions, our main outcomes were in-hospital death, adverse events and resource utilization. In-hospital death during rehospitalization was obtained from the California SID. Adverse events during rehospitalization included pressure ulcer, infection due to medical care, postoperative respiratory failure and postoperative pulmonary embolism or deep vein thrombosis, defined according to AHRQ's patient safety indicator algorithm [8], relatively common adverse events for older adults [10]. We counted only adverse events that occurred during hospitalization, using the presence-on-admission (POA) indicator [11]. Service use during rehospitalization was measured by length of stay (LOS) and total inpatient cost, calculated by

multiplying the hospital charge and cost-to-charge ratio [8]. Finally, second readmission—whether or not a rehospitalized patient experienced another admission within 30 days of discharge from the readmission—was ascertained from the California SID.

Characteristics of index hospitals ascertained included size, ownership, teaching status, location and operational margin. Operational margin is a ratio defined by the difference between operating revenue and operating expenses divided by operating revenue [12]. Four characteristics of the county where the index hospitals were located were selected based on a literature review: (i) the Herfindahl Index, a measure of competition in the market, calculated by the sum of squared market shares of the facilities in each county [13]; (ii) primary care provider density, as measured by the number of primary care physicians divided by the population in 2006; (iii) neighborhood college degrees, as measured by the percentage of the population aged 25+ with at least a 4-year college degree between 2005 and 2007, as a proxy of socioeconomic status and (iv) preventable hospitalization stays, as measured by the hospitalization rate for ambulatory care sensitive conditions per 1000 Medicare enrollees in 2005 and 2006. The patients' sociodemographic (age, sex, race, insurance, income) and clinical characteristics (comorbidity, LOS during the index hospitalization, admission history) were obtained from the California SID.

Analysis

We categorized the patients in the analytic sample into three groups according to readmission type: no readmission, same-hospital readmission and different-hospital readmission. We examined the factors associated with any hospital readmission (including both same- and different-hospital readmissions), with no-readmission as the reference group, and then the factors related to different-hospital readmission, with same-hospital readmission as the reference group. We estimated multilevel, multivariate logistic regression models using the SAS Glimmix procedure [14].

Next, we compared the outcomes of the same-hospital readmission group with those of the different-hospital readmission group. We developed generalized linear mixed-effects models (GLMMs) [15]. For binary outcome variables, we used logistic models; for cost, we used a gamma model with a log link function; and for LOS, we used a negative binomial model with a log link function. Three-level (patient, hospital and county levels) regression models were fitted for all the outcomes. Clinical condition groups classified by the AHRQ's Clinical Classifications Software (CCS) algorithm [16, 17] included all inferential models to adjust for admission type. To conduct a causal inference of the effect of readmission to a different hospital, we used a modified inverse probability weighting (IPW) method with a doubly robust (DR) estimation of the causal effect [18–21]. More details of the causal inference approach are in Supplementary Appendix 1.

Results

The sample included a total of 509 775 patients aged 50+ (mean: 70.8), the majority of whom were female, white and had Medicare insurance coverage (Table 1). Of these, 59 556 (11.7%) had a readmission within 30 days of discharge from the index hospital; 79.0% ($n = 47\,053$) had a readmission to the same hospital; and 21.0% ($n = 12\,513$) had a readmission to a different hospital. The majority of the index hospitals were medium size, non-profit, non-teaching hospitals located in urban areas. The average primary care provider rate among the counties where the index hospitals were located was 109.4, and the average preventable hospitalization rate was 59.3 per 1000 Medicare enrollees.

We found that several patient characteristics increased the odds of readmissions (Table 2), including being 80+, being black, having higher comorbidities, having Medi-Cal as the primary insurance and having an admission history. Having private insurance and having no insurance both significantly decreased the odds. Compared with the index hospitals for the no-readmission group, the hospitals for the any unscheduled readmission group were more likely to be public or teaching hospitals. The index hospitals for the any-readmission group were also more likely to be located in a county with higher competition and a higher potentially preventable hospitalization rate. The variables that were significant but had relatively small ORs may not be clinically significant.

Compared with the same-hospital readmission group, the different-hospital readmission group was more likely to be younger, male, people whose primary payers were something other than Medicare/Medi-Cal or private insurance (e.g. self-pay), and those with lower income. Race and having private insurance did not predict a different-hospital readmission. The index hospitals' characteristics had large effects on the odds of a different-hospital readmission: people discharged from small and for-profit index hospitals were significantly more likely to be readmitted to an alternative hospital. Last, different-hospital readmissions were more likely to occur when the index hospital was located in a county with higher competition.

Table 3 summarizes the causal effects of the outcomes of readmission, assuming that the same individual had a different-hospital readmission vs. a same-hospital readmission, with the principal clinical condition causing the readmission, as well as all the covariates listed in Table 2. Readmission to a different hospital accounted for 1.5% of the difference in in-hospital death rates (8.1 vs. 6.7%; $P < 0.001$), which is significantly different from zero. In addition, the estimated average total inpatient cost was ~10% more ($15 671.8 vs. $14 286.4; $P < 0.001$) than the cost that might have been incurred if readmitted to the same hospital; this difference in costs was significantly different from zero. The difference in adverse events was not statistically significant.

Discussion

Hospital readmission is an adverse health service outcome and a serious economic burden to society. In this study using statewide, person-level hospital readmission data, we found that the overall 30-day unplanned readmission rate was 11.7%, with a sizable proportion (21%) of unplanned hospital readmissions to a different hospital. We also identified several predictors for readmission to a different hospital, which included patient characteristics—younger, male, and lower income—and characteristics of the hospital where the index admission and discharge occurred—smaller, for-profit and located in counties with a higher competition market. Last but not least, we found that patients who were readmitted to a different hospital incurred higher costs and were more likely to die during the hospital readmission.

The overall 30-day readmission rate is lower than reported in previous studies, primarily because we only included unplanned readmissions rather than all readmissions, and we also included adults of a broad range of ages and insurance types, with multiple chronic conditions. The proportion of readmissions to a different hospital (21%) is consistent with prior published results, which ranged approximately from 18 to 29% [3, 5, 6], suggesting that this rather sizable proportion needs to be accounted for in the measurement of hospital readmission rate for quality or other purposes. According to our findings, these patients are a particularly high-risk group, since they have fewer resources (lower income) and worse outcomes (mortality). Thus, those

Table 1 Sample characteristics

Variables	All	Same-hospital unplanned readmission	Different-hospital unplanned readmission
Patient characteristics	509 775 (100.0) *n* (column %)	47 053 (100.0) *n* (column %)	12 513 (100.0) *n* (column %)
Age			
50–59	118 786 (23.3)	8711 (18.5)	2665 (21.3)
60–69	116 397 (22.8)	9423 (20.0)	2796 (22.3)
70–79	130 853 (25.7)	12 546 (26.7)	3298 (26.4)
80+	143 739 (28.2)	16 373 (34.8)	3754 (30.0)
Sex			
Male	227 712 (44.7)	21 763 (46.3)	6152 (49.2)
Female	282 063 (55.3)	25 290 (53.7)	6361 (50.8)
Race			
White	349 186 (68.5)	31 492 (66.9)	7858 (62.8)
Black	35 764 (7.0)	3810 (8.1)	1225 (9.8)
Hispanic	79 223 (15.5)	7421 (15.8)	2223 (17.8)
Other	45 602 (9.0)	4330 (9.2)	1207 (9.6)
Insurance			
Medicare	324 385 (63.6)	33 499 (71.2)	8411 (67.2)
Medi-Cal	38 295 (7.5)	4256 (9.0)	1424 (11.4)
Private	122 984 (24.1)	7863 (16.7)	2150 (17.2)
Other[a]	24 111 (4.7)	1435 (3.1)	528 (4.2)
Income level			
Low	124 688 (24.5)	11 944 (25.4)	3762 (30.1)
Medium	258 302 (50.7)	24 204 (51.4)	6187 (49.4)
High	126 785 (24.9)	10 905 (23.2)	2564 (20.5)
Admission history			
Yes	76 174 (14.9)	11 771 (25.0)	3228 (25.8)
No	433 601 (85.1)	35 282 (75.0)	9285 (74.2)
Number of chronic conditions[b] (Mean/SD)	3.22 (1.6)	3.7 (1.6)	3.6 (1.6)
Length of stay, index hospitalization (Mean/SD)	4.64 (6.3)	6.3 (8.0)	6.9 (10.8)
Index hospital characteristics	357 (100.0) *n* (column %)	333 (100.0) *n* (column %)	346 (100.0) *n* (column %)
Staffed beds (size)			
Small	110 (30.8)	91 (27.3)	100 (28.9)
Medium	184 (51.5)	179 (53.8)	183 (52.9)
Large	63 (17.7)	63 (18.9)	63 (18.2)
Ownership			
Profit	95 (26.6)	76 (22.8)	91 (26.3)
Public	66 (18.5)	65 (19.5)	60 (17.3)
Non-profit	196 (54.9)	192 (57.7)	195 (56.4)
Teaching hospital			
Yes	24 (6.7)	24 (7.2)	24 (6.9)
No	333 (93.3)	309 (92.8)	322 (93.1)
Location			
Urban	294 (82.4)	272 (81.7)	291 (84.1)
Rural	63 (17.7)	61 (18.3)	55 (15.9)
Operational margin[c] (mean/SD) * 100	−3.20 (14.1)	−3.7 (13.6)	−3.1 (13.6)
County[d] characteristics	*n* = 55 Mean (SD)	*n* = 55 Mean (SD)	*n* = 55 Mean (SD)
Herfindahl Index	0.5 (0.3)	0.5 (0.3)	0.5 (0.3)
Primary care provider (PCP) rate	109.4 (44.3)	109.4 (44.3)	109.4 (44.3)
% College degrees	24.0 (10.7)	24.0 (10.7)	24.0 (10.7)
Preventable hospitalization rate	59.3 (12.3)	59.3 (12.3)	59.3 (12.3)
Readmission outcomes	*n* = 59 566 Mean (SD)	*n* = 47 053 Mean (SD)	*n* = 12 513 Mean (SD)
In-hospital death (Yes = 1)	0.069 (0.25)	0.067 (0.25)	0.080 (0.27)
Adverse events (Yes = 1)	0.007 (0.08)	0.006 (0.08)	0.007 (0.09)
Cost ($)	14 313.8 (20 054.0)	14 028.4 (19 531.1)	15 337.9 (21 798.1)
Length of stay (days)	6.1 (7.2)	6.1 (7.2)	6.1 (7.5)
Second rehospitalization (Yes = 1)	0.2 (0.41)	0.2 (0.41)	0.2 (0.41)

[a]Other includes self-pay, no-charge, county indigent programs, charity care, etc.

[b]The number of chronic conditions in 18 body systems were counted by using the US AHRQ's Chronic Care Indicator (CCI) [22].

[c]Operation margin ratio was defined as the difference between operating revenue and operating expenses divided by operating revenue, and it was multiplied by 100 for the scaling purpose.

[d]A county is the one where the index hospital was located at.

Table 2 Factors associated with unplanned hospital readmission

Variables	Any readmission (Ref: no readmission)[a]			Readmission to a different hospital (Ref: readmission to the same hospital)[a]		
	Prevalence (%)	OR (95% CI)	*P*	Prevalence (%)	OR (95% CI)	*P*
Patient characteristics						
Age			<0.001			<0.001
50–59	9.6	1		23.4	1	
60–69	10.5	1.007 (0.978–1.036)		22.9	0.996 (0.933–1.063)	
70–79	12.1	1.085 (1.051–1.12)		20.8	0.922 (0.859–0.989)	
80+	14.0	1.247 (1.208–1.286)		18.7	0.819 (0.763–0.879)	
Sex			<0.001			<0.001
Female	11.2	0.889 (0.874–0.905)		22.0	0.914 (0.877–0.952)	
Male	12.3	1		20.1	1	
Race			<0.001			0.336
White	11.3	1		20.0	1	
Black	14.1	1.142 (1.102–1.183)		24.3	0.945 (0.871–1.026)	
Hispanic	12.2	1.02 (0.994–1.047)		23.1	0.956 (0.899–1.017)	
Other	12.1	1.031 (0.998–1.064)		21.8	0.963 (0.892–1.04)	
Insurance			<0.001			0.138
Medicare	12.9	1		20.1	1	
Medi-Cal	14.8	1.169 (1.129–1.211)		25.1	1.001 (0.928–1.081)	
Private	8.1	0.783 (0.761–0.806)		21.5	1.021 (0.956–1.089)	
Other[b]	8.1	0.783 (0.743–0.825)		26.9	1.145 (1.02–1.286)	
Income level			<0.001			0.002
Low	12.6	1.011 (0.988–1.035)		24.0	1.089 (1.03–1.151)	
Medium	11.8	1		20.4	1	
High	10.6	0.937 (0.914–0.96)		19.0	0.963 (0.906–1.023)	
Admission history			<0.001			0.755
Yes	19.7	1.768 (1.731–1.806)		21.5	0.992 (0.946–1.041)	
No	10.3	1		20.8	1	
Number of chronic conditions		1.149 (1.143–1.156)	<0.001		0.993 (0.979–1.006)	0.296
Length of stay, index hospitalization		1.025 (1.024–1.026)	<0.001		1.005 (1.003–1.007)	<0.001
Index hospital characteristics						
Staffed beds (size)			<0.001			<0.001
Small	11.7	1.03 (0.989–1.072)		28.0	1.67 (1.387–2.01)	
Medium	11.8	1		20.3	1	
Large	11.5	0.975 (0.946–1.005)		20.3	0.842 (0.697–1.017)	
Ownership			<0.001			<0.001
Profit	12.1	1.008 (0.976–1.042)		29.4	1.845 (1.556–2.187)	
Public	12.2	1.091 (1.045–1.139)		21.0	1.217 (0.973–1.522)	
Non-profit	11.5	1		19.1	1	
Teaching hospital			0.009			0.067
Yes	11.9	1.063 (1.016–1.112)		23.8	1.299 (0.982–1.717)	
No	11.7	1		20.6	1	
Location			0.457			0.924
Urban	11.7	1		21.0	1	
Rural	11.3	1.023 (0.964–1.085)		21.5	0.987 (0.756–1.289)	
Operational margin		1.001 (1.000–1.002)	0.186		0.999 (0.993–1.005)	0.742
County[c] characteristics						
Herfindahl Index		0.868 (0.784–0.96)	0.006		0.534 (0.318–0.896)	0.018
PCP rate/10		0.992 (0.985–0.999)	0.024		0.999 (0.958–1.041)	0.961
% College degrees		1.004 (1–1.007)	0.037		1.009 (0.989–1.029)	0.386
Preventable hospitalization rate/10		1.043 (1.022–1.063)	<0.001		1.117 (0.993–1.256)	0.064

[a]Along with the number of chronic conditions [23, 24], 17 dummies for 18 clinical condition groups [16, 17] are included in the model to adjust case-mix, but they were omitted from the table because of space limitations.

[b]Other includes self-pay, no-charge, county indigent programs, charity care, etc.

[c]A county is the one where the index hospital was located at.

who experience (or who are at risk for) readmission to a different hospital may require more intensive quality improvement approaches.

As for the outcomes of unplanned readmission to a different hospital, we found that the different-hospital readmission group had worse outcomes—higher risk for in-hospital death and higher total inpatient spending—than the same-hospital readmission group. This finding is consistent with Kind *et al.* [3], which included planned and unplanned readmissions among the Medicare population. Using these

Table 3 Outcomes of unplanned hospital readmissions to a different hospital: findings of causal inferences[a]

Different-hospital readmission (Yes = 1)[b]					
	$\hat{u}_1$	$\hat{u}_0$	DR estimate	CI	*P*-value
In-hospital deaths	0.081	0.067	0.015	0.0089 to 0.021	<0.001
Adverse events	0.0056	0.0063	−0.0007	−0.0076 to 0.0062	0.84
Second readmission	0.206	0.213	−0.0063	−0.015 to 0.0024	0.16
Cost ($)	15 671.8	14 286.4	1385.4	988.1 to 1782.6	<0.001
Length of stay	6.495	6.436	0.058	−0.112 to 0.229	0.50

[a]The reference group includes patients rehospitalized to the index hospital; all the patient, hospital and county characteristics in Table 1 and 17 dummies for 18 clinical condition groups [17] were included in the propensity model; and the details of the analytic approach for the causal inference are in Supplementary Appendix 1.

[b]$\hat{u}_1$ ($\hat{u}_0$) is the estimated mean assuming all were readmitted to a different (the same) hospital. The DR estimate is $\hat{u}_1 - \hat{u}_0$.

data, we quantified the excess risk of mortality to be 1.5% after accounting for all the patient-, hospital- and market-level covariates [3].

Factors that predicted overall (any) hospital readmission included being older, being African American, receiving Medi-Cal, having more chronic comorbidities and having a longer index hospitalization, consistent with prior studies [4, 6, 25, 26]. In contrast to predictors of hospital readmission to any hospital, a different-hospital readmission was more likely to occur among people who were younger, male and poor, and those without Medicare/Medi-Cal or private insurance. Race and admission history did not predict a different-hospital readmission. These findings may suggest that younger, low-income adults may be admitted to a different hospital when they have unmet or reoccurring inpatient care needs after their discharge from the index hospital. They may have fewer incentives to get readmitted at the same hospital and/or they are more likely to experience fragmented care rather than coordinated care; further studies are needed.

Among hospital characteristics, patients discharged from for-profit hospitals were more likely to have a different-hospital readmission, a finding consistent with Kind and colleagues [3]. When we examined the index- and readmission-hospital characteristics of the different-hospital readmission group, people discharged from a non-profit hospital tended to be readmitted to another non-profit hospital; but those discharged from a for-profit or public hospital tended to be readmitted to a non-profit hospital (not shown). As for county characteristics, patients discharged from an index hospital in a higher competition market were more likely to experience a different-hospital readmission. In terms of reasons for readmission, there was substantial overlap between the two groups in the top 15 principal clinical conditions, although the rankings were somewhat different (Supplementary Appendix 2) [17]. These findings imply that, rather than clinical conditions, non-clinical factors and the process of care may have differed between the groups. In particular, there may be ways that hospitals, especially for-profit hospitals in a highly competitive market, induce individuals with no insurance to go elsewhere.

This study used a population-based HCUP dataset linked to hospital financial reports and county data to describe predictive factors and outcomes of different-hospital unplanned rehospitalizations among adults with a wide range of ages and insurance types. We also report the impact of non-clinical factors on readmission, including hospital operational margin and market competition, which has been rarely observed in the existing readmission literature. We decided to use the California SID, because it has greater precision of measures of key variables for the current study and because of our prior access and experience with it. The dataset provides POA indicators for adverse events and an indicator for whether a (re)admission is planned or not; moreover, it can be linked to California hospital financial data, permitting calculation of hospital operational margin.

This study has several limitations. This is a secondary data analysis, so reporting and/or coding errors of data may exist, which could have influenced our estimations. Not available were details of patients' clinical conditions, DRG-based severity of illness, quality of outpatient or follow-up care after the index discharge, or ZIP codes of the hospital or patient. We targeted middle-aged and older adults hospitalized in California only. We also examined data from 2006, before a series of nation-wide policy interventions to improve quality of hospital care. Further study with a more recent dataset can ascertain the impacts of recent policy changes on readmission patterns and practice.

In summary, this study shows that different-hospital readmission is influenced by not only clinical but also non-clinical factors, and that the different-hospital readmission group, who might have experienced more fragmented care, had worse outcomes than the same-hospital readmission group. Further investigations are necessary into the reasons for and processes of different-hospital readmission, potentially providing evidence to develop policies and programs to improve continuity of care among populations at risk for hospital readmission. By using a causal model to show that patients readmitted to a different hospital have higher mortality and costs than those readmitted to the same hospital, this study (i) reaffirms a health benefit from care continuity; (ii) suggests that if hospital readmission is needed, referral back to the index hospital by post-acute care providers could save lives and (iii) shows that when readmission to a different hospital is necessary, coordination and communication between sites of care needs to be a high priority. The Affordable Care Act's policies could result in a lower number of different-hospital readmissions and ameliorate their associated adverse outcomes and costs, meriting further evaluation. Lastly, studies on the predictors and outcomes of unplanned hospital readmissions in different health systems from that of USA also would be valuable.

Supplementary material

Supplementary material is available at *INTQHC* online.

Authors' contributions

H.K.: concept and design, acquisition of data, analysis and interpretation of data, statistical analysis, drafting of the manuscript and critical revision of the manuscript. W.H.: analysis and interpretation of data, drafting of the manuscript and critical revision. M.C.P.: analysis and interpretation of data, drafting of the manuscript and critical

revision. J.S.R.: analysis and interpretation of data, drafting of the manuscript and critical revision. Z.Z.: acquisition of data, drafting of the manuscript and statistical analysis. J.K.: analysis and interpretation of data, drafting of the manuscript and statistical analysis. K.B.: concept and design, analysis and interpretation of data, drafting of the manuscript and critical revision.

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