Article

Toward a More Complete Picture of Readmission-Reducing Initiatives

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Abstract: Readmissions are common and costly. This study examines the effectiveness of two initiatives known to help reduce readmissions. Using data from the American Hospital Association, the Census Bureau, and the Center for Medicare and Medicaid Services' Hospital Compare database, we found that a higher quality of hospital care does not reduce, but in fact increases readmission rates. Although health information sharing decreases readmission rates, the effect is statistically significant only among the lowest-quality hospitals, not among mid- and high-quality hospitals. The results of our study have important policy implications for providers and hospital administrators with respect to efforts to reduce readmission rates.

Keywords: readmissions; quality of hospital care; health information sharing

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1. Introduction

Readmission, usually defined as an unplanned admission to the same or another acute care hospital within a specified time frame [1], is known to be costly for both patients and healthcare systems. For most principal diseases, including health attack, heart failure, pneumonia, chronic obstructive pulmonary disease (COPD), and hip and knee arthroplasty, patients face higher costs for readmission than for initial admission [2]. In the United States, nearly 20% of patients are readmitted within 30 days of their first discharge, costing the healthcare system more than \$15 billion annually [3]. In 2012, policymakers established the Hospital Readmissions Reduction Program (HRRP), designed to reduce avoidable readmissions by imposing penalties in the form of reduced Medicare payments to hospitals with excessive readmissions [1]. The government has also encouraged hospitals and clinicians to provide appropriate discharge guidelines and transitional care via effective communication.

Nevertheless, 83% of 3080 hospitals evaluated by the Center for Medicare and Medicaid Services (CMS) incurred a penalty in the 2021 fiscal year [4]. With so many hospitals facing the risk of readmission penalties, in this study we undertook to examine the effectiveness of two key initiatives designed to reduce readmission rates, namely, quality improvements and the use of health information technology. Prior studies have suggested that better inpatient care [5,6] along with interventions such as reviewing patients' medication histories (i.e., medication reconciliation), educating patients regarding post-discharge care, and arranging outpatient appointments [7], are associated with lower readmission rates. Health information technology (IT), the adoption of which has increased dramatically since the enactment of the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009 [8], is also expected to reduce hospital readmissions by improving the coordination of care [9].

The fact that recent studies have produced inconsistent results regarding the effects of the quality of hospital care and the use of health IT on readmission rates [9–11] raises the question of whether these efforts are misdirected. Regarding the quality of hospital care, a number of researchers have pointed out that much of the difference in readmission risks seems to be explained by patients' demographic, social, and clinical characteristics [11,12],

resulting in a low association between readmission rates and other outcome measures (e.g., mortality rates or adherence to recommended hospital care processes) [11,13]. Another possibility, holding other things constant, is that a higher quality of care might attract more patients; studies have shown that patients and their families feel relieved rather than frustrated when readmitted [14]. The inconclusive relationship between health information technology and readmission rates can be explained by the focus on the adoption rather than the actual use of health IT (i.e., health information sharing). An exclusive focus on adoption can be misleading, as many hospitals that have adopted health IT have failed to actively share information within hospitals and with other providers. The finding of the Office of the National Coordinator for Health IT that despite a high rate of adoption (96% as of 2017) [15], one third of patients who visited a health care provider reported having to repeat a test, provide their medical history again, or wait longer than usual for results is evidence of a gap between health IT adoption and use [16].

We investigated how the quality of hospital care and health information sharing affect readmission rates. Our study departs from others in two ways, (1) by emphasizing the positive effect of the quality of hospital care on readmission, and (2) by examining health information sharing as opposed to the adoption of health IT, such as electronic medical records (EMRs).

Using the data from the American Hospital Association's (AHA's) annual and IT surveys, the Center for Medicare and Medicaid Services' (CMS's) Hospital Compare database, and the Census Bureau's County Population by Characteristics database, among other resources, we found, unlike many previous studies, that a higher quality of hospital care increases readmissions, whereas health information sharing decreases readmissions. We further found that information sharing decreases hospital-wide readmission rates only among the lowest-quality hospitals, not among mid- and high-quality hospitals. Our finding of a positive relation between the quality of hospital care and readmission rates suggests that penalties imposed by the current policy may be misapplied, and may in fact impede improvements in the quality of care. The results of our study further suggest that despite investing billions of dollars in increasing the use of health information technology, the government has not consistently realized the goal of lowering readmission rates. The government should revisit policies related to readmission and information sharing in order to arrive at a more complete picture of hospital care that might yield insights into how to more effectively pursue the goals of improving hospital outcomes and reducing the cost of care.

The paper is organized as follows. In Section 2, we describe our data and model, and in Section 3 present our results. We discuss our results and conclusions in Section 4.

2. Materials and Methods

2.1. Hypotheses Development

The assumption underlying the penalizing of excessive readmission rates is that re-admission is a consequence of something hospitals or health professionals did or did not do during a patient's stay [5]. Using this logic, previous studies have found that readmission rates increase in the presence of substandard care [5] and the absence of interventions such as greater attention to patient readiness for discharge and enhanced disease monitoring [7].

Improving the quality of hospital care, however, can attract more patients not only for first visits, but also for readmission. We thus expected patients, when the quality of inpatient care is higher and given a choice, to prefer inpatient over other ambulatory or urgent care services. The fact that initiatives aimed at improving the quality of hospital care can, paradoxically, increase readmissions [17] suggests the following hypothesis.

Hypothesis 1 (H1). *The quality of hospital care is positively related to hospital readmission.*

Health information technology can help healthcare professionals within and outside of hospitals to more readily access patient information (e.g., discharge summaries, medication

history, laboratory results, etc.). Such access was predicted to reduce errors and facilitate follow-up, improving quality of care after patients are discharged and ultimately resulting in fewer avoidable readmissions [18]. These projected benefits notwithstanding, studies of the effect of health IT on readmission rates have yielded mixed results [9,19]. Although health IT use was in its infancy when the earliest studies were conducted [19], it has been more than 10 years since the HITECH legislation was enacted and we now have data on the actual use as opposed to the adoption of health IT. The expectation that sharing electronic information such as clinical summaries and radiology reports would augment the transition of care and lower overall readmissions suggests the following hypothesis.

Hypothesis 2 (H2). *Health information sharing is negatively related to hospital readmission.*

2.2. Data

We tested our hypotheses using data from the annual and IT surveys of the American Hospital Association (AHA) (<https://www.ahadata.com/>, accessed on 15 February 2021) and ‘small-area income and poverty estimates’ and ‘Annual County and Resident Population Estimates by Selected Age Groups and Sex’ from the publicly available Census Bureau (<https://www.census.gov/>, accessed on 15 February 2021) data for 2014–2016. To have a one-year lag between the explanatory and outcome variables, we also obtained, from the publicly available Center for Medicare and Medicaid Services’ Hospital Compare database (<https://data.cms.gov/provider-data>, accessed on 15 February 2021) data on hospital-wide all-cause unplanned readmissions for 2015–2017. The AHA’s annual surveys provide data on hospital characteristics, including bed size, ownership type, teaching status, system affiliation, and total facility admissions. The AHA’s IT surveys describe the extent to which each hospital shares patient data with other stakeholders. County-level information, including the poverty ratio, male population, and percentage of the population over 65, was obtained from the Census Bureau’s datasets. Note that as these data sets do not involve “human subjects,” the current research did not need to be reviewed and approved by the Institutional Review Board (IRB).

2.3. Model

We used the following specification (Equation (1)) to estimate unplanned readmissions against quality of hospital care and information sharing. Our main dependent variable, 30-day unplanned readmissions, was obtained from CMS Hospital Compare. CMS annually reports this measure by calculating the number of patients readmitted to any hospital within 30 days of the date of discharge divided by the total number of Medicare beneficiaries aged 65 years and older who are discharged from a focal hospital [20].

$$\begin{aligned}
 \text{Unplanned Readmission Rate}_{it+1} &= \alpha + \beta_1 \text{Quality of Hospital Care}_{it} \\
 &+ \beta_2 \text{Information Sharing}_{it} + \beta_3 \text{HHI}_{it} \\
 &+ \beta_4 \text{Male Population}_{it} \\
 &+ \beta_5 \text{65 Years and Older Population}_{it} \\
 &+ \beta_6 \text{Poverty Ratio}_{it} + \epsilon_{it}
 \end{aligned} \tag{1}$$

Quality of Hospital Care, or degree of excellence, one of our main independent variables, is one of the key factors that determines the unplanned readmission rate. As academics have yet to reach a consensus on an empirical measure of quality, the previous literature does not concur on the empirical construction of this variable. The present paper does not intend to enter the battlefield on the construction of quality measures, but rather to employ a safe measure that can consistently provide statistical information on the quality of hospital services. As developing ‘the best’ quality measure is outside the scope of this paper, our non-ambitious, conservative, statistical objectives can be easily achieved using principal component analysis (PCA).

We used PCA to measure the quality of hospital care based on four variables—bed size, system affiliation, teaching status, and nonprofit status, all obtained from the AHA annual survey. Bed size, a key quality indicator because of economies of scale, is measured using 8 pre-defined codes from the AHA annual survey: (1) 6–24 beds; (2) 25–49 beds; (3) 50–99 beds; (4) 100–199 beds; (5) 200–299 beds; (6) 300–399 beds; (7) 400–499 beds; and (8) 500 or more beds. System affiliation can work with bed size as a quality indicator, and system hospitals, having access to cheaper resources and being more likely to invest in the latest technology, systems, and equipment, are found to outperform independent hospitals [21].

Teaching status, with teaching hospitals being known to treat rare diseases and complex patients by conducting research and using advanced technology, is also perceived to affect quality. Prior researchers have found differences in the quality of care between teaching and nonteaching hospitals, especially for elderly patients [22]. Previous studies have also suggested that providing high-quality service is crucial to nonprofits, especially in the presence of high information asymmetry, which renders service difficult to evaluate [23–25]. Using PCA based on these four antecedents, we generated a quality-of-care variable with which all four variables showed the expected high correlation. Following H1, the ex ante expectation of the effect of the quality of hospital care on readmissions is positive.

Information Sharing, our second independent variable, was measured in terms of the extent of information shared. The AHA IT surveys included the question, “Which of the following patient data does your hospital electronically exchange/share with one or more of the provider types listed below? (Check all that apply) (1) for hospitals within a system, (2) for hospitals outside a system, (3) for ambulatory providers within a system, and (4) for ambulatory providers outside a system.” We added the values of the answers to this question to generate the variable of information sharing. For example, when a hospital exchanges patient data only with other hospitals within its system, not with hospitals outside its system and other ambulatory providers both within and outside its system, the value of information sharing is 1. This implies that the minimum value of information sharing is 0 and the maximum value is 4. Basically, the lower the value of breadth, the less information is shared among stakeholders. Following H2, the ex ante expectation of health information sharing on readmission is negative.

Our study included several county-level control variables, as patients’ demographic, social, and clinical characteristics seem to explain much of the variance in readmission rates [11,12]. We included the Herfindahl–Hirschman index (HHI) calculated on the basis of total facility admissions. The higher the Herfindahl index, the more concentrated the market. The ex ante expectation of the effect of the Herfindahl index is negative, as even patients who do not believe they receive enough care from the index hospital, but have none but the first choice, are likely to decide not to be readmitted, all other things being held constant. Following a previous study [26], we also included the male population and population 65 years and older out of total population among our controls. The ex ante expectation of male population is negative, as the risk of re-hospitalization is higher for women than for men [26]. The ex-ante expectation of the population 65 years and older is positive, as elderly people face an increased risk of readmission. We also controlled for the poverty ratio, calculated as the number of people at the poverty level divided by the total population. The ex ante expectation of the poverty ratio is positive, as patients at the poverty level find it difficult to access appropriate ambulatory or post-discharge care services [27].

3. Results

The summarized statistics for 8096 observations, presented in Table 1, show the average unplanned readmission rate to be 15.394. The minimum value of the quality of hospital care variable, generated using the key indicators of bed size, system affiliation, teaching status, and nonprofit status, was -2.083 and the maximum value was 3.877 . For

health information sharing, another explanatory variable used in our study, the minimum value was zero and the maximum value was four.

Table 1. Summary of statistics.

Variable	Mean	SD	Min	Max
Unplanned Readmission Rate	15.394	0.820	10.400	20.200
Bed Size	3.916	2.008	1	8
System Affiliation	0.641	0.480	0	1
Teaching Status	0.071	0.256	0	1
Nonprofit Status	0.643	0.479	0	1
Health Information Sharing	3.084	1.226	0	4
Quality of Hospital Care	0.000	1.275	−2.083	3.877
HHI	0.659	0.344	0.027	1
Male Population	0.495	0.015	0.438	0.637
Population 65 Years and Older	0.163	0.042	0.061	0.389
Poverty Ratio	15.202	5.375	3.400	46.800

Table 2 shows the main result of our OLS regression analysis regarding the effect of the quality of hospital care, health information sharing, and the control variables. In column (1), in which we include only control variables—the coefficients of HHI, the male population, the population 65 years and older, and the poverty ratio—are consistent with our stated ex ante expectations, and are thus not discussed further. In column (2), the coefficient of quality of hospital care is positive and statistically significant, supporting H1. The coefficient of health information sharing in column (3) is negative and statistically significant, supporting H2. In column (4), in which we include both explanatory variables, the sign and significance remain the same, further supporting our two hypotheses.

Table 2. Impact of the quality of hospital care and health information sharing on readmissions.

DV: Unplanned Readmission Rates	(1)	(2)	(3)	(4)
Quality of Hospital Care		0.044 *** (0.013)		0.054 *** (0.013)
Health Information Sharing			−0.020 ** (0.008)	−0.034 *** (0.008)
HHI	−0.332 *** (0.042)	−0.283 *** (0.046)	−0.337 *** (0.042)	−0.278 *** (0.046)
Male Population	−3.610 *** (0.732)	−2.688 *** (0.749)	−3.748 *** (0.733)	−2.698 *** (0.744)
Population 65 Years and Older	0.744 ** (0.305)	0.970 *** (0.310)	0.703 ** (0.306)	0.955 *** (0.310)
Poverty Ratio	0.027 *** (0.002)	0.028 *** (0.002)	0.027 *** (0.002)	0.027 *** (0.002)
Constant	16.864 *** (0.368)	16.334 *** (0.381)	17.009 *** (0.372)	16.454 *** (0.380)
Observations	8096	8096	8096	8096
R-squared	0.056	0.059	0.056	0.061

Note: Standard errors (in brackets) are clustered at the hospital level. *** $p < 0.01$, ** $p < 0.05$.

Noting the opposite effects of the two key initiatives, we further investigated in Table 3 how the effect of health information sharing, which seems at least to achieve the goal of reducing readmissions, varies with different quality levels. Splitting the sample into four groups by quality—25th and below, 25–50th, 50–75th, and 75th and above—our results show the effect of health information sharing to be negative and statistically significant only among the lowest-quality hospitals. When hospital quality is medium and above, the coefficient of health information sharing becomes statistically insignificant.

One possible explanation is that the positive effect of high-quality hospitals attracting more patients outweighs any negative effect of health information sharing. The desired effect of enhancing the use of health information technology with the purpose of reducing readmissions does not seem to be realized consistently.

Table 3. Sub-sample analysis.

DV: Unplanned Readmission Rate	(1)	(2)	(3)	(4)
Health Information Sharing	−0.034 *** (0.011)	−0.018 (0.015)	−0.036 (0.022)	0.008 (0.025)
HHI	0.032 (0.099)	−0.266 *** (0.081)	−0.414 *** (0.083)	−0.393 *** (0.105)
Male Population	0.717 (0.741)	−1.176 (1.353)	−11.091 *** (2.438)	−18.060 *** (3.510)
Population 65 Years and Older	0.837 ** (0.359)	−0.582 (0.495)	1.282 * (0.688)	−0.112 (1.034)
Poverty Ratio	0.018 *** (0.003)	0.021 *** (0.004)	0.031 *** (0.005)	0.032 *** (0.007)
Constant	14.599 *** (0.413)	15.959 *** (0.696)	20.615 *** (1.229)	23.957 *** (1.799)
Observations	2006	2078	2049	1963
R-squared	0.039	0.042	0.096	0.083

Note: Standard errors (in brackets) are clustered at the hospital level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4. Discussion and Conclusions

The current study investigates the effectiveness of the two key initiatives known to reduce readmissions: quality of hospital care and health information sharing. The results of our study suggest that these initiatives are to some extent counter to policy aims, with efforts to improve the overall quality of hospital care paradoxically increasing readmission rates, and health information sharing consequently helping to decrease readmissions only among low-quality hospital groups.

Certain limitations of the present study afford opportunities for future research. The fact that we have hospital-level, not patient-level, data implies that we do not have information about precisely what accounts for individual patients' readmissions. Even if we had such information, it is likely that multiple factors affect the probability of patients being readmitted (e.g., high-quality hospitals and a lack of coordination between physicians and post-discharge facilities). A qualitative study would be more appropriate for answering the 'how' explanatory research question [28]. Furthermore, while our study broadly defines the quality of hospital care using the PAC method, future studies can categorize different levels of quality with the focus on inpatient care only, time-of-discharge care, and after-discharge care. Alternatively, the focus could be coordination among different providers, patient-centered education, the capabilities of post-discharge facilities, etc. Other studies might examine the quality of hospital care in greater detail with respect to how it works in association with health information sharing. Future studies could also examine how the effect of the quality of hospital care and health information sharing varies over different contexts, according to the availability of ambulatory services, insurance types (e.g., private vs. public), education level, etc.

To conclude, the present study enhances our understanding by investigating hospital readmission reduction efforts pursued through improving the quality of hospital care and actively using health IT. The positive association between the quality of hospital care and early readmission, and the negative association between health information sharing and readmission only among the lowest-quality hospital groups suggest a need to revisit the penalty schemes, as they might be punishing those who work hard to improve the quality

of hospital care. Our study can be used to tailor policy strategically to avoid unexpected and undesired outcomes of efforts to achieve the overarching goal of improving the quality of hospital care and reducing healthcare costs.

This study results in more questions than answers. This is due to our newly-suggested method of measuring hospital service quality. We believe that our study opens up a new avenue of classical readmission literature. Factors directly affecting readmission rates have been heavily investigated in the existing literature. It is time to consider a more complete picture of readmission-decreasing initiatives.

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