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Impact of Including Readmissions for Qualifying Events in the Patient Safety Indicators

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Abstract

The Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSI) do not capture complications arising after discharge. We sought to quantify the bias due to omission of readmissions for PSI-qualifying conditions. Using 2000–2009 California Office of Statewide Health Planning and Development Patient Discharge Data we examined the change in PSI rates when including readmissions in the numerator, hospitals performing in the extreme deciles and longitudinal performance. Including 7-day readmissions resulted in a 0.3% – 8.9% increase in average hospital PSI rates. Hospital PSI rates with and without PSI-qualifying 30-day readmissions were highly correlated for point estimates and within-hospital longitudinal change. Most hospitals remained in the same relative performance decile. Longer length of stay, public payer, and discharge to skilled nursing facilities were associated with a higher risk of readmission for a PSI-qualifying event. Failure to include readmissions in calculating the PSIs is unlikely to lead to erroneous conclusions.

Introduction

As quality of care has become increasingly important, the ability to measure quality efficiently and accurately has also become important. The Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSI) are one tool to measure quality of care. These indicators have been widely adopted, appearing in national and statewide public reports,^{1,2} used as quality improvement tools in hospitals and select indicators have been adopted by the Centers for Medicare and Medicaid Services (CMS) Hospital Compare.³

The indicators have the advantage of being easily applied to readily available administrative data, making them a frequent choice for researchers and quality improvement personnel. However, as with many indicators based on administrative data, there are lingering concerns about the accuracy of the tools. The positive predictive value of the indicators has been

widely studied,^{4–10} and the indicator algorithms have been improved in response to these studies. In addition, studies have examined the sensitivity of the indicators for identifying in-hospital complications^{8,11,12}, but another source of potentially missed cases are complications that develop after discharge. The most serious of such complications will likely result in readmission. One study found that up to 20% of patients hospitalized in a general medical service experienced an important adverse event post-discharge,¹³ while another study found that 29% of colorectal surgical patients experienced a significant complication following discharge.¹⁴

Studies have linked inpatient PSI events with a higher likelihood of readmissions,^{15,16} but only a few have examined the risk of readmission for a PSI event and the impact of those readmissions on PSI rates. Three studies examined the impact of readmissions on the PSIs, finding substantial rate increases after including readmissions for a PSI event in the numerator of two indicators (Postoperative Deep Vein Thrombosis and Pulmonary Embolism (DVT/PE), 22% rate increase;¹⁷ Selected Infection Due to Medical Care, 25% increase),¹⁸ and a small increase for Postoperative Hemorrhage (9% increase).¹⁹ Higher observed rates when expanding the numerator definition are not surprising and a simple increase of numerator events does not in itself lead to bias when readmissions are omitted; no systematic bias in PSI performance would occur if post-discharge complications are randomly distributed. However, if the distribution of readmissions for PSIs varies systematically—for example, if practice patterns such as length of stay influence the chances of developing a complication in the hospital vs. after discharge—then performance as measured by the PSIs would likewise be systematically biased.

This study examines the potential bias in relative hospital performance resulting from omitting readmissions for PSI-qualifying conditions from the current PSI definitions. Second, this study examines the factors associated with readmission location for a PSI-qualifying event.

Methods

Data

We used 2000–2009 California Office of Statewide Health Planning and Development Patient Discharge Data, which includes information about diagnoses, treatments, length of stay and patient characteristics for approximately 29 million unique discharges from acute care hospitals in California. We identified readmissions by using the combination of an encrypted patient identifier, date of birth and gender to link index and subsequent admissions. We included only adults age 18 and older.

Patient Safety Indicators

All analyses were completed using PSI Version 4.0. For readmission-augmented PSIs, we first applied the denominator statement to the index admission. The readmission-augmented numerator statement was the sum of the PSI numerator statement applied to the index admission and a modified numerator statement applied to readmissions, as follows. Modified numerator statements applied to readmissions included PSI-qualifying principal

and secondary diagnoses with a present on admission (POA) flag. All numerator procedure statements must have occurred within the first 3 days of the stay, with the exception of the Respiratory Failure indicator, where we required that the procedure code date be the same day as the admission. PSI 3, Pressure Ulcer, was modified to reflect changes implemented in later versions (i.e. numerator statement includes only 707.23, 707.24, 707.25 after October 1, 2004. Removed exclusion of 707.20–22.)

Analyses

We quantified the impact of including readmissions for PSIs in three ways. First, we calculated the percent increase observed after including readmissions for PSIs. Second, we calculated the change in relative hospital performance when using the two metrics. We examined the percent of hospitals within the top and bottom deciles using the all-hospital readmission metric that remained in those extreme deciles after applying the alternative metric. We also examined the percent that moved two or more deciles. We examined correlations to assess the impact of restricting analyses to same-hospital readmissions on longitudinal trends within the same hospital. We calculated the change in readmission rates from combined years 2000 – 2002 to combined years 2007–2009. We then calculated the Pearson correlation coefficient for change in performance using PSI and readmission-augmented PSI rates.

To examine the factors associated with readmission location, we performed a mixed model logistic regression, clustered by hospital to account for hospital effects. The dependent variable was 30-day readmission to the same hospital for a PSI-qualifying event and independent variables included patient age (18–44, 45–64, 65–74, 75–84 and 85+), gender (male and female), discharge location (home, skilled nursing facility or residential care, other), length of stay (LOS) (0–1 days, 2–3 days, 4–6 days, 7–10 days, 11–20 days, 21–50 days, 51+ days), primary payer (Medicare, MediCal, Self-pay, other), hospital ownership (Not-for-profit, state, University of California [UC] hospital, private), bedsize (3 terciles) and teaching status (teaching, non-teaching). To control for case mix, we included All Patient Refined-Diagnosis Related Group (APR-DRG) and AHRQ Comorbidity Index. The model was refined to identify the most parsimonious model.

Results

Mean hospital rates and standard deviations are found in Table 1. Including readmissions for each PSI resulted in between 0.3% and 8.9% increase in average hospital 7-day PSI rates and a 0.6% to 19.5% increase for average hospital 30-day readmission rates (Table 1). Hospital PSI rates with and without 30-day readmissions for PSIs were highly related for both point estimates and estimates of within-hospital longitudinal change (Table 2). Kappa scores between indicators for identifying high and low outliers were also very high (Table 2). Finally, most hospitals remained in the same relative performance decile after including readmissions for PSIs, and of those that moved, very few moved more than two deciles.

In our initial regression model, hospital factors (hospital ownership, bedsize and teaching status) were not significantly associated with the risk of readmission for a PSI-qualifying event within 30 days of discharge. We dropped these factors and repeated the regression

analysis. Table 3 shows the results of a regression model including only patient factors, controlling for APR-DRG and comorbidity. Longer length of stay, public payer (Medicare or MediCal), and discharge location were associated with a higher risk of readmission for a PSI-qualifying event.

Discussion

This study found little impact of including readmissions in PSI numerator statements, especially when focusing on common uses of the PSIs, namely comparisons between hospitals and longitudinal comparisons within a hospital.

Three previous studies have examined the impact of including readmissions in specific PSIs. One study of the “Postoperative Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)” PSI found a 22% increase in this indicator rate when readmissions for that PSI were included.¹⁷ A related study found an 9.3% increase for “Postoperative Hemorrhage and Hematoma.”¹⁹ Our study found a much lower impact of readmissions on the PE/DVT indicator (3.2%) a more substantial increase for postoperative hemorrhage and hematoma (19.5%). However, the PSI version used in Shufelt et al. was more restrictive than the version used in this study. A third study found a 25% increase in the indicator Central Line Associate Blood Stream Infection (formerly Selected Infection due to Medical Care).¹⁸ The definition of this indicator has also changed significantly since the analysis by Gallagher et al. and as such comparisons between their findings and ours are difficult. However, the authors did argue that an increase of 22% warranted the consideration of including readmissions in the numerator.

The risk factors for readmissions for PSI events we identified are similar to those reported in the literature for all-cause readmissions, with longer LOS,²⁰ Medicare or MediCal as a primary payer, and discharge to a SNF having a higher risk of readmission for a PSI event.^{21,22} While these risk factors likely reflect more fragile patients with more complex disease, these findings can guide efforts to identify patients at higher risk of readmissions for PSI events for intervention, follow-up, or studies of the sensitivity of the PSIs.

This study is limited in several ways. Analyses included only one state, which may not be representative of the nation. In addition, we did not examine post-discharge complications that did not result in readmission or that resulted in death. It is possible that these types of complications may vary more systematically and could be a source of bias in performance as assessed by the PSIs. Finally, these results are focused on an all-payer population and only examine a subset of common complications.

These results suggest that the cases missing when complications from PSI conditions become apparent after discharge (resulting in readmission rather than being coded during the index hospitalization) are not systematically distributed and do not result in bias. Failure to include readmissions in calculating the PSIs is unlikely to lead to erroneous conclusions. Future research could examine additional quality indicators.

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Table 1

Percent Increase in Average Hospital PSI Rates When Including Readmissions

	Number of hospitals	Numerator	Mean hospital rate per 1000 (SD)	Percent Increase ^J	
				7-day Readmission	30-day Readmission
Pressure Ulcer (PSI 03)	484	223,692	13.5 (21.6)	2.8%	9.9%
Iatrogenic Pneumothorax (PSI 06)	484	16,673	0.6 (0.4)	4.4%	9.9%
Central Line Associated BSI (PSI 07)	484	91,899	3.7 (4.9)	3.9%	12.2%
Postoperative Hemorrhage or Hematoma (PSI 09)	433	10,534	1.4 (1.0)	8.6%	19.5%
Postoperative Physiologic or Metabolic Derangement (PSI 10)	433	1,983	1.2 (3.7)	0.3%	1.3%
Postoperative Respiratory Failure (PSI 11)	423	38,284	20.6 (63.0)	0.2%	0.6%
Postoperative PE or DVT (PSI 12)	433	50,703	7.9 (13.8)	1.0%	3.2%
Postoperative Sepsis (PSI 13)	423	10,836	13.2 (51.3)	0.4%	1.9%
Postoperative Wound Dehiscence (PSI 14)	418	731	0.4 (0.7)	8.9%	14.9%
Accidental Puncture and Laceration (PSI 15)	484	20,654	0.8 (0.7)	3.8%	8.5%

BSI – blood stream infection; DVT – deep vein thrombosis; PE – pulmonary embolism; PSI – Patient Safety Indicator; SD – standard deviation.

^J All increases significant at p<.0001 level.

Table 2

Relationship Between PSI and Readmission-Augmented PSI Metrics

	Pearson correlation [/]		Change in relative performance			Kappa Score Outliers	
	Point estimate	Longitudinal change	% Remaining in decile	% Moving 2 or more deciles		Low	High
Pressure Ulcer (PSI 03)	0.99	0.99	88.1%	0.03%		0.97	0.66
Iatrogenic Pneumothorax (PSI 06)	0.99	0.98	76.3%	2.0%		0.90	0.88
Central Line Associated BSI (PSI 07)	0.99	0.99	78.1%	<0.01%		0.94	0.94
Postoperative Hemorrhage or Hematoma (PSI 09)	0.95	0.97	69.5%	3.0%		0.86	0.84
Postoperative Physiologic or Metabolic Derangement (PSI 10)	0.99	0.99	99.5%	0.0%		0.99	0.99
Postoperative Respiratory Failure (PSI 11)	0.99	0.99	96.9%	<0.0%		0.99	0.99
Postoperative PE or DVT (PSI 12)	0.99	0.99	87.5%	0.7%		0.95	0.95
Postoperative Sepsis (PSI 13)	0.99	0.99	97.0%	0.2%		0.98	0.99
Postoperative Wound Dehiscence (PSI 14)	0.96	0.96	97.7%	0.0%		0.98	0.96
Accidental Puncture & Laceration (PSI 15)	0.99	0.98	78.7%	2.0%		0.91	0.91

[/] All correlations are statistically significant at the p<.0001 level.

BSI – blood stream infection; DVT – deep vein thrombosis; PE – pulmonary embolism; PSI – Patient Safety Indicator.

Table 3

Factors Associated with Readmission to Same Hospital for a PSI-qualifying Event

Factor	Odds Ratio (95% CI)
Age	
18 – 44 years	1.00
45 – 64 years	0.99 (0.96–1.02)
75 – 84 years	0.97 (0.94 – 1.01)
85 + years	1.03 (0.99 – 1.07)
Sex	
Male	1.00
Female	0.93 (0.85 – 0.89)
Length of stay	
0 – 1 days	0.96 (0.93–0.99)
2 – 3 days	1.00
4 – 6 days	1.26 (1.23 – 1.30)
7 – 10 days	1.62 (1.57 – 1.67)
11 – 20 days	1.89 (1.80 – 1.99)
21 – 50 days	1.86 (1.71 – 2.01)
51+ days	1.81 (1.62 – 2.02)
Payer	
Private	1.00
Medicare	1.46 (1.40 – 1.53)
MediCal	1.67 (1.40 – 1.54)
Other	0.68 (0.62 – 0.73)
Discharge Location	
Home	1.00
SNF	2.29 (2.20 – 2.39)
Residential Care	1.56 (1.32 – 1.84)
Other	1.55 (1.39 – 1.72)

Dependent variable: 30-day readmission to same hospital as index admission for any PSI-qualifying event.

APR-DRG and AHRQ Comorbidity Index were included as covariates.

APR-DRG – All Patient Refined-Diagnostic Related Group; CI – confidence interval; PSI – Patient Safety Indicator; SNF – skilled nursing facility