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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 Patient Safety Indicators (PSIs) do not capture complications arising after discharge. This study sought to quantify the bias related to omission of readmissions for PSI-qualifying conditions. Using 2000-2009 California Office of Statewide Health Planning and Development Patient Discharge Data, the study team 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% to 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 PSIs is unlikely to lead to erroneous conclusions.

Keywords

Patient Safety Indicators, readmissions, hospital quality, quality metrics

As quality of care has become increasingly important, the ability to measure quality efficiently and accurately also has become important. The Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSIs) 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 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 likely will 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 PSIs, finding substantial rate increases after including readmissions for a PSI event in the numerator of 2 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;

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no systematic bias in PSI performance would occur if postdischarge complications are randomly distributed. However, if the distribution of readmissions for PSIs varies systematically—for example, if practice patterns such as length of stay (LOS) influence the chances of developing a complication in the hospital versus after discharge—then performance as measured by PSIs likewise would 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

The study team used 2000-2009 California Office of Statewide Health Planning & Development Patient Discharge Data, which includes information about diagnoses, treatments, LOS, and patient characteristics for approximately 29 million unique discharges from acute care hospitals in California. Readmissions were identified by using the combination of an encrypted patient identifier, date of birth, and sex to link index and subsequent admissions. Only adults ages 18 and older were included.

Patient Safety Indicators

All analyses were completed using PSI version 4.0. For readmission-augmented PSIs, the study team 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 flag. All numerator procedure statements must have occurred within the first 3 days of the stay, with the exception of the respiratory failure indicator, in which case the study team 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 (ie, numerator statement includes only 707.23, 707.24, 707.25 after October 1, 2004. Removed exclusion of 707.20-22).

Analyses

The impact of including readmissions for PSIs was quantified in 3 ways. First, the percent increase observed after including readmissions for PSIs was calculated. Second, the change in relative hospital performance when using the 2 metrics was calculated. The percentage of hospitals within the top and bottom deciles was examined using the all-hospital readmission metric that remained in those extreme deciles after applying the alternative metric. The percent that moved 2 or more deciles also was examined. Correlations were examined to assess the impact of restricting analyses to same-hospital readmissions on longitudinal trends within the same hospital. The change in readmission rates was calculated from combined years 2000-2002 to combined years 2007-2009. The Pearson correlation coefficient was then calculated for change in performance using PSI and readmission-augmented PSI rates.

To examine the factors associated with readmission location, the study team 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, 85+), sex (male, female), discharge location (home, skilled nursing facility or residential care, other), LOS (0-1 days, 2-3 days, 4-6 days, 7-10 days, 11-20 days, 21-50 days, 51+ days), primary payer (Medicare, Medi-Cal, self-pay, other), hospital ownership (not-for-profit, state, University of California hospital, private), bed size (3 terciles), and teaching status (teaching, nonteaching). All Patient Refined-Diagnosis Related Group (APR-DRG) and AHRQ Comorbidity Index were included to control for case mix. The model was refined to identify the most parsimonious model.

Results

Mean hospital rates and standard deviations are displayed in Table 1. Including readmissions for each PSI resulted in between a 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 also were very high (Table 2). Finally, most hospitals remained in the same relative performance decile after including readmissions for PSIs; of those that moved, very few moved more than 2 deciles.

In the initial regression model, hospital factors (hospital ownership, bed size, and teaching status) were not significantly associated with the risk of readmission for a PSI-qualifying event within 30 days of discharge. These factors were dropped and the regression analysis was repeated. Table 3 shows the results of a regression model

Table 1. Percent Increase in Average Hospital PSI Rates When Including Readmissions.

	Number of Hospitals	Numerator	Mean Hospital Rate per 1000 (SD)	Percent Increase[a]	
				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	1983	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%

Abbreviations: BSI, bloodstream infection; DVT, deep vein thrombosis; PE, pulmonary embolism; PSI, Patient Safety Indicator; SD, standard deviation.
[a]All increases significant at the $P < .0001$ level.

Table 2. Relationship Between PSI and Readmission-Augmented PSI Metrics.

	Pearson Correlation[a]		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 and laceration (PSI 15)	0.99	0.98	78.7%	2.0%	0.91	0.91

Abbreviations: BSI, bloodstream infection; DVT, deep vein thrombosis; PE, pulmonary embolism; PSI, Patient Safety Indicator.
[a]All correlations are statistically significant at the $P < .0001$ level.

including only patient factors, controlling for APR-DRG and comorbidity. Longer LOS, public payer (Medicare or Medi-Cal), and discharge location were associated with a higher risk of readmission for a PSI-qualifying event.

Discussion

This study found little impact from including readmissions in PSI numerator statements, especially when focusing on common uses of 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 DVT/PE PSI found a 22% increase in this indicator rate when readmissions for that PSI were included.[17] A related study found a 9.3% increase for postoperative hemorrhage and hematoma.[19] The present study found a much lower impact of readmissions on the DVT/PE indicator (3.2%) and a more substantial increase for postoperative hemorrhage and hematoma (19.5%). However, the PSI version used in Shufelt et al[19] was more restrictive than the version used in the present study. A third study found a 25% increase in the central line–associated bloodstream

Table 3. Factors Associated With Readmission to Same Hospital for a PSI-Qualifying Event.[a,b]

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)
Medi-Cal	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)

Abbreviations: APR-DRG, All Patient Refined-Diagnostic Related Group; CI, confidence interval; PSI, Patient Safety Indicator; SNF, skilled nursing facility.
[a]Dependent variable: 30-day readmission to same hospital as index admission for any PSI-qualifying event.
[b]APR-DRG and AHRQ Comorbidity Index were included as covariates.

infection indicator (formerly selected infection due to medical care indicator).[18] The definition of this indicator also has changed significantly since the analysis by Gallagher et al, and as such comparisons between their findings and the findings of the present study 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 identified in this study are similar to those reported in the literature for all-cause readmissions, with longer LOS,[20] Medicare or Medi-Cal as a primary payer, and discharge to a skilled nursing facility having a higher risk of readmission for a PSI event.[21,22] Although 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, the study team did not examine postdischarge 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 PSIs is unlikely to lead to erroneous conclusions. Future research could examine additional quality indicators.

Authors' Note

The authors take sole responsibility for the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, and approval of the article.

Declaration of Conflicting Interests

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References

1. Aguilera N, Marrufo GM. Can better infrastructure and quality reduce hospital infant mortality rates in Mexico? *Health Policy*. 2007;80:239-252.
2. Agency for Healthcare Research and Quality. AHRQ Quality Indicators Software. http://qualityindicators.ahrq.gov/Software/default.aspx. Accessed December 5, 2013.
3. US Department of Health and Human Services. Hospital Compare: Measures displayed on Hospital Compare. http://www.medicare.gov/hospitalcompare/Data/Measures-Displayed.html. Accessed December 5, 2013.
4. Cevasco M, Borzecki AM, O'Brien WJ, et al. Validity of the AHRQ patient safety indicator "central venous catheter-related bloodstream infections." *J Am Coll Surg*. 2011;212:984-990.

5. Chen Q, Rosen AK, Cevasco M, Shin M, Itani KM, Borzecki AM. Detecting patient safety indicators: how valid is "foreign body left during procedure" in the Veterans Health Administration? *J Am Coll Surg*. 2011;212:977-983.
6. Henderson KE, Recktenwald A, Reichley RM, et al. Clinical validation of the AHRQ postoperative venous thromboembolism patient safety indicator. *Jt Comm J Qual Patient Saf*. 2009;35:370-376.
7. Kaafarani HM, Borzecki AM, Itani KM, et al. Validity of selected patient safety indicators: opportunities and concerns. *J Am Coll Surg*. 2011;212:924-934.
8. Romano PS, Mull HJ, Rivard PE, et al. Validity of selected AHRQ patient safety indicators based on VA National Surgical Quality Improvement Program data. *Health Serv Res*. 2009;44:182-204.
9. Rosen AK, Itani KM, Cevasco M, et al. Validating the patient safety indicators in the Veterans Health Administration: do they accurately identify true safety events? *Med Care*. 2012;50:74-85.
10. Utter GH, Borzecki AM, Rosen AK, et al. Designing an abstraction instrument: lessons from efforts to validate the AHRQ patient safety indicators. *Jt Comm J Qual Patient Saf*. 2011;37:20-28.
11. Murff HJ, FitzHenry F, Matheny ME, et al. Automated identification of postoperative complications within an electronic medical record using natural language processing. *JAMA*. 2011;306:848-855.
12. Cima RR, Lackore KA, Nehring SA, et al. How best to measure surgical quality? Comparison of the Agency for Healthcare Research and Quality Patient Safety Indicators (AHRQ-PSI) and the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) postoperative adverse events at a single institution. *Surgery*. 2011;150:943-949.
13. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med*. 2003;138:161-167.
14. Regenbogen SE, Bordeianou L, Hutter MM, Gawande AA. The intraoperative surgical apgar score predicts post-discharge complications after colon and rectal resection. *Surgery*. 2010;148:559-566.
15. Encinosa WE, Hellinger FJ. The impact of medical errors on ninety-day costs and outcomes: an examination of surgical patients. *Health Serv Res*. 2008;43:2067-2085.
16. Friedman B, Encinosa W, Jiang HJ, Mutter R. Do patient safety events increase readmissions? *Med Care*. 2009;47:583-590.
17. Weller WE, Gallagher BK, Cen L, Hannan EL. Readmissions for venous thromboembolism: expanding the definition of patient safety indicators. *Jt Comm J Qual Saf*. 2004;30:497-504.
18. Gallagher B, Cen L, Hannan EL. Readmissions for selected infections due to medical care: expanding the definition of a patient safety indicator. In: Henriksen K, Battles JB, Marks ES, Lewin DI, eds. *Advances in Patient Safety: From Research to Implementation. Volume 2: Concepts and Methodology*. Rockville, MD: Agency for Healthcare Research and Quality; 2005.
19. Shufelt JL, Hannan EL, Gallagher BK. The postoperative hemorrhage and hematoma patient safety indicator and its risk factors. *Am J Med Qual*. 2005;20:210-218.
20. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009;360:1418-1428.
21. van Walraven C, Dhalla IA, Bell C, et al. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. *CMAJ*. 2010;182:551-557.
22. Silverstein MD, Qin H, Mercer SQ, Fong J, Haydar Z. Risk factors for 30-day hospital readmission in patients ≥65 years of age. *Proc (Bayl Univ Med Cent)*. 2008;21:363-372.