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Adverse Effects of the Medicare PSI-90 Hospital Penalty System on Revenue-Neutral Hospital-Acquired Conditions

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Objective: Health systems are grappling with improving the quality and safety of health care. By setting clear expectations, there is an opportunity to configure care models to decrease the risk of adverse events and promote the quality of care. The US Centers for Medicare and Medicaid Services have used Patient Safety Indicator 90 (PSI90), a composite rate of hospital-acquired conditions (HACs), to adjust payments and score hospitals on quality since 2015. However, PSI90 may be associated with adverse prioritization for preventing some conditions over others.

Our objective was to evaluate the time-dependent rates of HACs between 2013 and 2016 to assess the association of funding models on adverse events, particularly pressure injury.

Methods: We analyzed a retrospective observational cohort of patients hospitalized in US Academic Medical Centers observed by the Vizient CDB/RM pre-post PSI90 implementation. Changes in HAC component rates of PSI90 between 2013 and 2016 were measured longitudinally using mixed-effects negative binomial regression modeling.

Results: Regardless of whether the composite measure of patient outcomes was PSI90 or all HACs, in general, there was significant decrease after PSI90 was implemented, reflecting an association between PSI90 and CMS reimbursement policy. However, pressure injury rates increased by 29.4% (SE = 0.08; $P < 0.05$) during this time frame, the only HAC observed to increase related to PSI90.

Conclusions: Patient safety in hospitals will only thoroughly improve when hospitals are fully incentivized to practice prevention of all HACs rather than work around the harms that result from failed prevention efforts.

Key Words: medicare, quality of care, payments, pressure injury, patient safety

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Health systems are grappling with challenges in quality and safety.[1,2] New efforts are underway to measure quality and incentivize performance.[3] Patient safety indicators (PSIs) are used to measure hospital-acquired condition (HAC) outcomes and considered synonymous with the quality.[4,5] For instance, the American Nurses Credentialing Center considers prevention of certain PSIs, including falls, pressure injuries, catheter-associated urinary tract infections (CAUTI) and central line–associated bloodstream infections (CLABSI) as important indicators critical in hospitals' pathway to receive Magnet recognition.[6] For more than 20 years, the Agency for Healthcare Research and Quality has defined PSI criteria to give health systems clear expectations of high-quality care.[7] Health systems now have a better understanding of which PSIs are considered most straightforward to prevent.[8] The Centers for Medicare and Medicaid Services (CMS) also uses these PSI measures to scale health system payments.[9] Higher rates are targeted for reduced payments. The ultimate goal of these payment measures is to reduce wasteful spending on high-cost HACs such as pressure injuries and infections and more importantly reduce rates to prevent harm.[10,11]

Centers for Medicare and Medicaid Services reduced reimbursements through the Inpatient Prospective Payment System in 2008 when it would no longer pay for several HACs.[12] Having had a noticeable effect on the reduction of HAC rates such as pressure injuries, CMS took payment reductions a step further by announcing it would penalize health systems 1% of total reimbursements which fell into the lowest-quartile with respect to composite rates of select HACs defined by the PSI system.[13,14] The composite rate, known as "PSI90" went into effect in 2015 and consists of 10 PSIs: (PSI03) pressure injury, (PSI06) iatrogenic pneumothorax, (PSI08) inhospital fall with hip fracture, (PSI09) perioperative hemorrhage or hematoma, (PSI10) postoperative acute kidney injury, (PSI11) postoperative respiratory failure, (PSI12) perioperative pulmonary embolism or deep vein thrombosis (VTE), (PSI13) postoperative sepsis, (PSI14) postoperative wound dehiscence, and (PSI15) unrecognized abdominopelvic accidental puncture/laceration.

Although PSI90 is a composite rate reflecting the prevention of multiple conditions, not all conditions are equal with respect to prevention guidelines. Sepsis prevention may include use of prophylactic antibiotics. Fall prevention requires assessment of fall risk and appropriately applied remediation methods. Pressure injury prevention consists of a time-consuming, complex series of unrelated tasks for nurses, consisting of daily skin checks and risk assessments, repositioning every 3 to 4 hours, and managing moisture and incontinence among other tasks.[15] Furthermore, several other PSIs, such as falls, pressure injuries, CAUTI, and VTE, are interrelated because of common pathophysiological processes, multimorbidity, and care patterns. Recovering patients may attempt to get out of bed and move around, but this could result in a fall. Clinicians who respond to fall risk by keeping a patient bed-ridden are placing the patient at-risk for pressure injury development as well as other complications.[16] Likewise, clinicians respond to incontinence by catheterizing the patient, which in turn exposes the patient to risk of CAUTI. Finally, a patient who is immobilized for extended time is also at-risk for VTE. Considering the Donabedian model, it may be possible to address all of these unintended consequences at once by structuring a prevention protocol around the most complex conditions threatening the patient to improve all quality outcomes (Fig. 1).[17]

This example illustrates that simple clinical decision points can expose patients to many risks reflected in PSI90. However, the PSI90 weighting system may influence risk. Hospital-acquired conditions are weighted in PSI90 based on volume and harm

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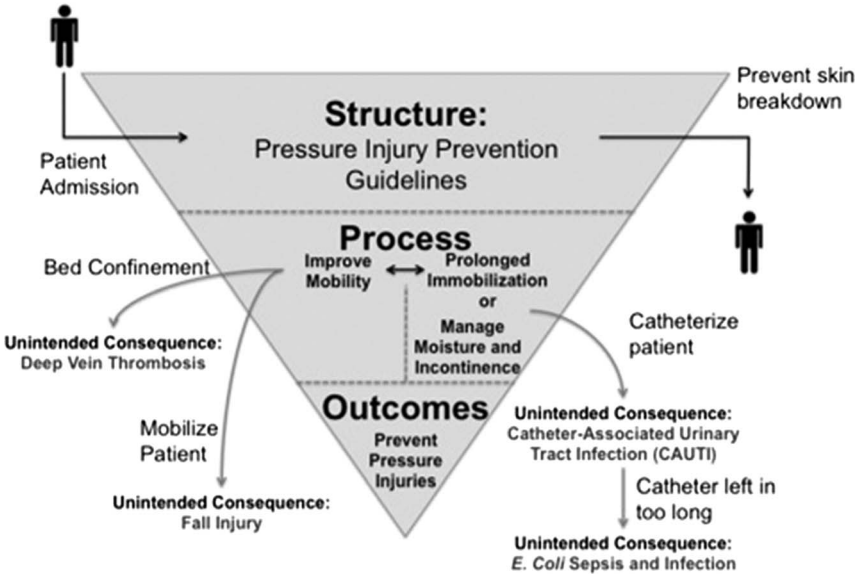

FIGURE 1. Relating poor compliance with a pressure injury prevention process to the unintended consequences of other harmful hospital-acquire condition outcomes using the Donabedian model, Structure-Process-Outcomes.

according to a severity index. As a result, the weight given to pressure injury is 0.06, compared with respiratory failure which is 0.30. Variable weighting could scale some conditions under PSI90 as "low-hanging fruit" for hospitals to prevent based on the simplicity of their prevention guidelines and disproportionate weight to PSI90, whereas others are complex, if not impossible to avoid all cases. We hypothesize that because of current incentives created by PSI90, some complex HACs are not undergoing the same rate reductions relative to HACs with simpler prevention guidelines. This study uses an observational cohort of US academic medical centers to evaluate associations between HAC rates and implementation of payments resulting from PSI90.

METHODS

Study Design

We used a retrospective observational cohort of US academic medical centers to evaluate the time-dependent rates of HACs included in PSI90 between 2013 and 2016. These academic medical centers were participating members of the Vizient Clinical Data Base and Resource Manager ("CDB/RM", www.vizient.com, ©2017), which reports quarterly, facility-level administrative data on deidentified hospitalized patients that are available for download through CDB/RM queries through member institutions. The CDB/RM consists of more than 300 hospitals currently, of which, most were participating members during the period of observation, received CMS payments and responded to CMS reimbursement updates naturally.

After the Johns Hopkins IRB exempted this study as nonhuman subject research, hospital data on PSI90 outcomes and inpatient characteristics were acquired from CDB/RM. These data were managed longitudinally by hospital-quarter using a symmetric timeline pre- and post-PSI90 implementation. Counts of all PSI90 conditions were stored separately in a central database, in addition to other HACs not present-on-admission which were omitted from the PSI90 list but considered important nursing-sensitive indicators including CAUTI, CLABSI (i.e., PSI07), *Clostridium difficile*, ventilator-acquired pneumonia, and methicillin-resistant *Staphylococcus aureus* (MRSA).

Characteristics that were gathered from the CDB/RM provided facility-level aggregate data by each quarter, including: counts of cases by each PSI in PSI90; counts of cases by each HAC; counts of total inpatient admissions; and case-mix index. All data collected from the CDB/RM were only for adult patients age 18 or older. Patient-level information was not available.

Analysis

We used mixed-effects negative binomial regression models to longitudinally analyze proportional changes in rates of HACs over time within hospitals after changes in CMS policy and compared these results to a fixed effects model. The negative binomial structure of the regression model was meant to analyze HAC counts. We organized these data as a series of quarterly, hospital-level measurements of each HAC in the PSI90 definition, as well as composite rates of PSI90 cases and total HACs. The regression models controlled for annual changes in HACs across 2013–2014, 2014–2015, and 2015–2016, hypothesizing that greater rate reductions would occur after the CMS payment penalty for high PSI90 rates in the first quarter of 2015. In addition to time, these models controlled for case-mix index and tested for the presence of between-hospital effects based on varying rates of HACs as well as different volumes of patient admissions.

RESULTS

Incidence of at least one PSI90 case was reported in 306 hospitals between 2013 and 2016 (Table 1). During this period of observation, there were about 6.94 million total hospital encounters at-risk for an HAC, and 1.12 PSI90 cases per 100 hospital encounters were observed overall (78,224 cases in total). Most HACs in the study happened before 2014, reflecting a general decreasing trend in the total number of HACs after CMS introduced PSI90 payment reductions.

The decrease in total PSI90 and HAC cases after 2014 was significant between all hospitals (Table 2). Several HAC categories in particular had observed significant reductions—iatrogenic pneumothorax, CLABSI, and postoperative respiratory failure had significant, continual decreasing trends across all years between 2013 and 2016. Postoperative hemorrhage or hematoma

TABLE 1. Descriptive Statistics of Key Parameters in Academic Medical Centers of the Vizient CDB/RM Between 2013 and 2016

Descriptor	n	Rate (per 100 Hospital Encounters)
Hospitals	306	
Hospital-quarters	3443	
Total admissions	6,940,639	
Total PSI90s	78,224	1.12
Total HACs	162,887	2.35
Total PSI03	2759	3.9

and postoperative wound dehiscence observed significant decreases after 2014. Postoperative acute kidney injury and postoperative sepsis did not exhibit any significant shifts in rates of occurrence during the study. Finally, VTE and accidental puncture/laceration did not occur frequently enough to achieve statistical power.

Only one condition, hospital-acquired pressure injury was observed to increase significantly after the introduction of CMS policy on PSI90. According to the analysis, there were no significant shifts in pressure injury rates before 2015. However, between 2015 and 2016, there was a 29.4% increase in the rate of pressure injuries nationally in academic medical centers in the CDB/RM, specifically stages 3 and 4 and unstageable pressure injuries not present-on-admission in adult hospitalized patients. From another perspective, there were 2759 pressure injury cases across all 4 years. The mean rate of pressure injuries between 2013 and 2015 was 3.6 cases per 10,000 hospital encounters (range: 3.48-3.77 per 10,000 hospital encounters). However, by 2016, the pressure injury rate rose to 4.8 cases per 10,000 hospital encounters.

DISCUSSION

These results highlight important associations between recent CMS payments connecting reimbursement penalties with composite HAC rates. Overall, hospitals seem to be improving HAC prevention efforts, given the associations in overall reductions since 2014. However, the hypothesis of this study is strengthened by the associations found in the timeline of PSI90 establishment and increased pressure injury rates. Pressure injuries, which could be considered one of the more complex conditions to prevent in the long list of PSI90 cases, are associated with significant rate increases overlapping with the PSI90 penalties. As a result, these incidences could also be exposing patients to concurrent harms across a spectrum of HACs.

It may not be an accident that the rates of pressure injuries are exclusively increasing since 2015. The PSI90 composite score could create incentivizes for nursing to overlook pressure injury prevention in favor of focusing prevention on low hanging fruit, that is, procedures and treatments that are directly remunerated. Because the total weight of pressure injury contributed to the adjusted value of PSI90 is only 6%, the investment in pressure injury prevention is imbalanced with the cost for implementing its complex prevention protocol and harm to patients.[18] Nonetheless, if hospitals can drive down the rates of other PSIs, and pressure injuries still increase slightly, the improvements in other areas could offset pressure injury rates enough to give a hospital the appearance of being a good performer. This weighting may be problematic for patients and health systems susceptible to pressure injuries.

Although CMS has historically had some success with the incentives its payments provide to improve hospital quality and safety, the outlook for pressure injuries is not promising based on these observational data.[11] The CMS policy achieved reductions in overall harm, but select patient cohorts could be at risk for pressure injuries and related consequences (e.g., falls, CAUTI, and VTE). As CMS considers its next phase of reimbursement policy, it should consider the threat that hospitals may game the IPPS to maximize profitability. This gaming concept is not meant to point the finger at hospitals for threatening patients either. Hospitals exist to heal sick patients, but few have the safety culture to adopt greater bandwidth for fully eliminating all HACs simultaneously. Without strong incentives from organizational leadership, it is difficult for hospitals to gravitate toward an improved safety culture. All else being equal, if hospitals have to choose where to begin to minimize patient harm, they can optimize their performance in the viewpoint of PSI90 by preventing some HACs that are simple to prevent and improve in other areas over time.

This study also adds to the growing body of literature as to what has happened with pressure injury rates since changes in CMS reimbursements for HACs, for which there are mixed results. First, Padula et al noted reductions in pressure injury in 200+ academic medical centers after the establishment of CMS reduced payments in 2008, until the end of observation in 2012.[13,19] Second, Waters and colleagues noted that there was not a significant reduction in pressure injury rates in the 2010s either using a nationally representative sample of 1381 hospitals in the National Database of Nursing Quality Indicators.[20] Third, based on a survey of pressure injury prevalence conducted by VanGilder and colleagues of 918,621 hospitalized patients in the United States, the facility-acquired pressure injury rate decreased from 6.2% to 3.4%.[21] Fourth, the CMS Office of Enterprise Data and Analytics reports a 58.4% increase in pressure injury as measured from baseline in October 2015 through September 2016 for more than 4000 US hospitals in the Hospital Improvement Innovation Network.[22,23] Weighting the rates of change between these 4 studies based on sample sizes, the pressure injury rate does not improve at all or slightly increases after CMS reimbursement changes in 2014. An additional study with Vizient CDB/RM data from overlapping facilities also highlighted a reduction in PSI03 rates, but this was in a select group of hospitals with focused quality improvement bundles for pressure injury prevention; thus, hospitals properly addressing the issue of pressure injuries to avoid unintended consequences of PSI90 seem to be insulated from a general trend across most hospitals in this study.[24]

The study has several limitations. First, the study does not imply causality between the establishment of PSI90 and HAC rates. The observational nature of this study is only meant to evaluate associations between payment penalties and outcomes. Second, the study was not powered to measure between-hospital rates for all PSIs for every quarter. Multilevel regression modeling requires greater numbers of observations to power quarterly rates clustered by hospital. Because some models were reported as fixed effects, whereas others random effects, and some coefficients were omitted for lack of significance, this study design could benefit from greater sample sizes to detect a minimal number needed to treat for each HAC in the PSI90 composite score. Third, this study uses administrative data, which are not as reliable for reporting on HACs as surveillance data because some HACs go underreported.[25,26] Thus, the counts of HACs in this study are likely underestimates, such that the rates of change may represent a lower-bound on the true results in hospitals. Fourth, the volume of hospitals represented in this study makes it fairly reflective of a wide selection of facilities in the United States, although the CDB/RM mostly consists of academic medical centers and is not a nationally representative sample. The generalizability of these findings could be improved by a greater selection of rural and community hospitals in addition to academic teaching hospitals that make up the majority of Vizient CDB/RM membership.

TABLE 2. Results of Mixed-Effects Negative Binomial Regression Models Illustrating Time-Dependent Trends in Rates of Patient Safety Indicators (PSI) And Hospital-Acquired Condition Totals For Academic Medical Centers in The Vizient CDB/RM*

	PSI03 Pressure Injury		PSI06 Iatrogenic Pneumothorax		PSI07 Central Venous Catheter-Related Bloodstream Infection		PSI08 Injurious Falls		PSI09 Perioperative Hemorrhage/ Hematoma		PSI10 Postoperative Acute Kidney Injury		PSI11 Postoperative Respiratory Failure		PSI13		PSI14		PSI90		Total HAC	
Variable	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**
Time																						
2014	−0.03	0.08	**−0.17**	0.06	**−0.16**	0.08	−0.01	0.19	−0.04	0.03	0.02	0.07	**−0.11**	0.03	−0.01	0.03	0.14	0.13	−0.11	0.08	−0.11	0.06
2015	0.05	0.08	**−0.23**	0.06	**−0.20**	0.08	−0.12	0.19	**−0.22**	0.03	0.02	0.07	**−0.31**	0.03	−0.03	0.03	−0.20	0.13	**−0.16**	0.08	**−0.16**	0.06
2016	***0.29***	0.08	**−0.54**	0.06	**−0.29**	0.08	−0.11	0.19	**−0.74**	0.03	0.21	0.07	**−0.68**	0.03	−0.08	0.03	**−0.89**	0.15	**−0.22**	0.08	**−0.24**	0.06
CMI																			**0.17**	0.06	**0.12**	0.05
Intercept	13.10	127.5	5.65	862.4	5.70	1020.4	4.30	1066.3	8.98	721.7	7.33	680.7	8.34	265.0	8.20	289.2	6.59	614.1	**−10.85**	0.51	**−9.74**	0.33
FE or RE	FE		FE		FE		FE		FE		FE		FE		FE		FE		RE		RE	
LLR	−11.55		−12.15		−11.36		−8.85		−14.48		−11.79		−14.30		−14.00		−9.69		−312.35		−620.98	

Values in bold indicates statistical significance at the 95% confidence level.

Values in italic indicates a statistically significant rate increase.

*Statistical models for PSI90 component scores PSI12 (perioperative pulmonary embolism or deep vein thrombosis) and PSI15 (unrecognized abdominopelvic accidental puncture/laceration) were omitted due to insufficient numbers of observations.

Coeff. indicates beta coefficient; CMI, case-mix index; FE, fixed-effects approach; HAC, hospital-acquired condition; ICC, intraclass correlation; LLR, log-likelihood ratio of fit; RE, random-effects approach; SE, standard error.

Fifth, we assume that the reporting rates of PSIs is consistent across all quarters, but there is uncertainty as to whether the detection of a condition such as pressure injury has improved between 2013 and 2015 that would account for observed increases of these conditions, independent of the physiological presentation of the condition. In general, we do not know how much of the improvement was due to improved data quality (i.e., accuracy in data coding and documentation) or was due to improved clinical quality, as Winters and colleagues have noted that PSIs have a lower positive predictive value.[27] Thus, some fluctuations in HAC rates are likely due to improvements in data accuracy. In addition, data accuracy may vary between PSI, which we were unable to test. Coding some PSIs could be more subjective than others, leading to variability in improvement between conditions. For example, documenting wound dehiscence and laceration may perhaps be more subjective than a pressure injury.

Given this notion that the PSI90 scoring system could alter incentives on the prevention of all HACs in favor of lower hanging fruit, greater diligence needs to be made to frequently update the rates of different PSIs reported to CMS on a quarterly basis. Trends in the rates of pressure injuries and other conditions need to be considered relative to the remainder of the PSIs in the Inpatient Prospective Payment System. If pressure injuries are not improving as a result of PSI90, then it may be better off removed and reviewed as its own condition for reimbursement reductions. A simple alternative would be to adjust the weight that pressure injury contributes to the adjusted PSI90 score to something greater than 0.06 so that it incentivizes hospitals to plan for pressure injury prevention equal to other conditions. Another alternative to that could be that PSI90 rates are dynamic between hospitals and based on which HAC rates are worst for each hospital.

The CMS initiative to create PSI90 was well intentioned to make hospitals responsible for driving down all HAC rates simultaneously rather than addressing one at a time. For the most part, this reimbursement strategy seems to have worked because the timeline of PSI90 establishment is associated with significant decreases in a number of HACs. However, PSI90 succumbs to the classic Gestalt Principle that the whole is greater than the sum of its parts. The overhanging penalties for PSI90 rates could be positioning hospitals to address those HACs with higher PSI90 weights but without addressing the needs for improvement in HACs where hospitals are not as effective at prevention.

Although this analysis is focused on the United States, other health-care systems have also focused on pay-for-performance. For instance, the UK's National Health Service (NHS) introduced a pay-for-performance scheme into primary care in 2004. Primary care physicians were paid up to 25% more if they met indicators. This system has been met with variable responses, and some regions from the UK have opted out. However, what is important to note is that incentive schemes, financial or otherwise, may have unintended consequences as focus can be diverted and manipulation of care and administrative systems undertaken.[28]

In conclusion, patient safety in hospitals will only thoroughly improve when hospitals are fully incentivized to practice prevention rather than work around the harms that result from failed prevention efforts. Therefore, CMS should aim its sight on payment to hospitals that invest in a quality improvement infrastructure to do the right thing and not simply penalize the hospitals that underperform.[29]

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