

Medical University of South Carolina

MEDICA

MUSC Theses and Dissertations

2016

Improving the Accuracy of Publicly Reported PSI Rates through Enhanced Internal Documentation Review

Daniel E. Furlong

Medical University of South Carolina

Follow this and additional works at: <https://medica-musc.researchcommons.org/theses>

Recommended Citation

Furlong, Daniel E., "Improving the Accuracy of Publicly Reported PSI Rates through Enhanced Internal Documentation Review" (2016). *MUSC Theses and Dissertations*. 395.

<https://medica-musc.researchcommons.org/theses/395>

This Dissertation is brought to you for free and open access by MEDICA. It has been accepted for inclusion in MUSC Theses and Dissertations by an authorized administrator of MEDICA. For more information, please contact medica@musc.edu.

IMPROVING THE ACCURACY OF PUBLICLY
REPORTED PSI RATES THROUGH ENHANCED
INTERNAL DOCUMENTATION REVIEW

BY

Daniel E. Furlong

A doctoral project submitted to the faculty of the Medical University of
South Carolina in partial fulfillment of the requirements for the degree
Doctorate of Health Administration
in the College of Health Professions


© Daniel E. Furlong 2016 All rights reserved

IMPROVING THE ACCURACY OF PUBLICLY REPORTED PSI RATES
THROUGH ENHANCED INTERNAL DOCUMENTATION REVIEW

by


Daniel E. Furlong

Approved by:


Chair, Project Committee James Zoller, PhD Date 5/11/16


Member, Project Committee Karen Wager, DBA Date 5/11/16


Member, Project Committee Danielle Scheurer, MD Date 5/19/16


Dean, College of Health Professions Lisa K. Saladin, PT, PhD Date 5/16/16

Abstract

Abstract of Doctoral Project Presented to the
Executive Doctoral Program in Health Administration and Leadership
Medical University of South Carolina
In partial fulfillment of the Requirements for the
Degree of Doctor of Health Administration

IMPROVING THE ACCURACY OF PUBLICLY REPORTED PSI RATES THROUGH ENHANCED INTERNAL DOCUMENTATION REVIEW

BY

Daniel E. Furlong

Chairperson: James Zoller, PhD
Committee: Danielle Scheurer, MD
Karen Wager, DBA

Patient Safety Indicators, or PSIs, are used by several healthcare related federal agencies and third-party payers to determine the quality of care being delivered by a healthcare provider. A composite PSI, PSI-90, includes a group of PSIs that are publicly reported as quality indicators for a provider, and that are used as part of the Value Based Purchasing calculation. Poor PSI-90 rates directly influence healthcare services reimbursement rates by CMS and may be considered an indication of a quality of care problem by potential patients and third party payers. This research is a case study on the effectiveness of a program implemented by the Medical University of South Carolina (MUHA) to improve the accuracy of their reported PSI-90 composite score.

Table of Contents

Abstract.....	iii
Introduction	1
PSI-03	11
PSI-06	12
PSI-07	12
PSI-08	13
PSI-09	13
PSI-10	13
PSI-11	14
PSI-12	14
PSI-13	15
PSI-14	15
PSI-15	16
PSI-90	16
Statement of the Problem	17
Research Question	18
Literature Review.....	20
Clinical Best Practice	22
Using Clinical Data.....	29
Cost of EBM.....	34
How They Fit Together.....	37
The Cost of Non-Performance	38
Methods.....	42
Operational Definitions.....	47
Participants	55
Data Analysis.....	56
Post-Intervention Review	59
Limitations.....	61
Results.....	63
PSI-03	67
PSI-06	69
PSI-07	71
PSI-08	74
PSI-09	74
PSI-10	76
PSI-11	77
PSI-12	80
PSI-13	82
PSI-14	84
PSI-15	86
Discussion.....	90
Study Overview	91
Discussion.....	92
Recommendations	107
Areas for Future Studies	107
References	109

FIGURES

Figure 1 - NQF Weights for the Patient Safety for Selected Indicators Composite	17
Figure 2 - AHRQ Model of Knowledge Transfer (Titler, 2008)	26
Figure 3 - Changes in Quality Measure Compliance (AHRQ, 2012).....	29
Figure 4 - Weighing Cost to Benefits (Marshall, Demers, O'Brien & Guyatt, 2005)	35
Figure 5 - Adult PSI Chart Correction Process.....	47
Figure 6 - Pediatric PSI Chart Correction Process.....	47
Figure 7 - PSI-03 Incidence Rates (per 1000 discharges).....	69
Figure 8 - PSI-06 Incidence Rates (per 1000 discharges).....	71
Figure 9 - PSI-07 Incidence Rates (per 1000 discharges).....	73
Figure 10 - PSI-09 Incidence Rates (per 1000 discharges).....	76
Figure 11 - PSI-10 Incidence Rates (per 1000 discharges).....	77
Figure 12 - PSI-11 Incidence Rates (per 1000 discharges).....	79
Figure 13 - PSI-12 Incidence Rates (per 1000 discharges).....	82
Figure 14 - PSI-13 Incidence Rates (per 1000 discharges).....	84
Figure 15 - PSI-14 Incidence Rates (per 1000 discharges).....	86
Figure 16 - PSI-15 Incidence Rates (per 1000 discharges).....	88
Figure 17 - Weighing Cost to Benefits (Marshall, Demers, O'Brien & Guyatt, 2005).....	102

TABLES

Table 1- PSI-90 Composite Elements.....	11
Table 2- PSI-90 Elements (AHRQ, 2010).....	65
Table 3 - PSI-03 Flagged and Corrected Incidents.....	68
Table 4 - PSI-06 Flagged and Corrected Incidents.....	70
Table 5 - PSI-07 Flagged and Corrected Incidents.....	72
Table 6 - PSI-09 Flagged and Corrected Incidents.....	75
Table 7 - PSI-11 Flagged and Corrected Incidents.....	78
Table 8 - PSI-12 Flagged and Corrected Incidents.....	81
Table 9 - PSI-13 Flagged and Corrected Incidents.....	83
Table 10 - PSI-14 Flagged and Corrected Incidents.....	85
Table 11 - PSI-15 Flagged and Corrected Incidents.....	87

Introduction

Since 2007 the federal government has been increasing pressure on healthcare providers to improve their quality of care. One way the government has done this is by requiring providers to absorb the expense of treating many patient conditions that they introduced to the patient through exposure to the healthcare system itself. These conditions, referred to as hospital-acquired conditions (HAC) in an inpatient setting, vary from actual mistakes made during surgery, to improper care in a medical inpatient nursing unit, to happenstance. Essentially, if a patient is not documented as having the condition upon admission (present on admission, or POA), and is later diagnosed with it during their admission, it is considered to have been introduced by the care provided. Although not all HACs are totally preventable, the US Health and Human Services (HHS) has determined through research and provider input that there are target levels, varying based on the condition, that should be considered acceptable.

The Centers for Medicare and Medicaid Systems (CMS) analyzes Medicare patient data to determine if a HAC exists on a patient, and if so, they eliminate that comorbidity from the patient's diagnosis-related group (DRG). This frequently reduces the patient's severity level, resulting in reduced payments to the provider. For these patients, CMS believes the provider should be responsible for the treatment of any condition not present upon admission, and that includes HACs. CMS also publicly reports the incidence of these conditions on such sites as [medicare.gov/hospitalcompare](https://www.medicare.gov/hospitalcompare) for Medicare patients.

In 2003 Agency for Healthcare and Research Quality (AHRQ) created a limited list of HACs and identified these conditions as patient safety indicators (PSI). Since 2003 the list has evolved, resulting today in provider-level and area-level PSIs along with a composite score that creates a weighted score based on the individual PSIs. These PSIs

have become the standard method to compare patient safety as delivered by providers and is how CMS reports this information. In addition, University HealthSystem Consortium (UHC) also collects this data from their members, although they collect it for all inpatients and not just Medicare patients. This provides their membership with a broader data set to review and to compare to other providers, and more easily allows them to compare to other providers of similar type. Lastly, third-party payers, through the normal billing process, also receive diagnosis information from providers that allows the payers to reduce payments based on providers introducing comorbidities through their care of the patient.

Due to the public reporting of the data, the reduced payment to providers based on the medical record information, and the goal of improving safety for all patients, providers should consider any process that can reduce HACs. The Medical University of SC Hospital Authority (MUHA), has introduced such an internal process that this researcher believes will improve the clinical documentation, the medical coding, and the publicly reported PSI rates for their inpatient population.

For the purposes of this project, the researcher will use following terminology, which is in alignment with the definitions put forth by the Office of the National Coordinator for Health Information Technology (ONC) for the United States.

Electronic medical records (EMRs) are a digital version of the paper charts in the clinician's office. An EMR contains the medical and treatment history of the patients in one practice. EMRs have advantages over paper records (Garret, Seidman, 2011).

Electronic health records (EHRs) include those things found in an EMR — and more. EHRs focus on the total health of the patient – going beyond standard clinical data collected in the provider’s office and inclusive of a broader view of a patient’s care. EHRs are designed to reach out beyond the health organization that originally collects and compiles the information. They are built to share information with other healthcare providers, such as laboratories and specialties, so they contain information from all the clinicians involved in the patient’s care records (Garret, Seidman, 2011).

Patient Safety Indicators (PSI) are a set of healthcare quality indicators that identify potential in-hospital adverse events, complications, or undesirable outcomes following surgeries, procedures, and childbirth. The set of PSIs used in this study were developed by the Agency for Healthcare Research and Quality (AHRQ), “after a comprehensive literature review, analysis of ICD-9-CM codes, review by a clinician panel, implementation of risk adjustment, and empirical analyses” (AHRQ, 2014a). PSIs are considered preventable with proper patient care and are therefore considered indicators of a hospital acquired condition (HAC).

Hospitals, especially academic medical centers which provide care for underserved or tertiary patient populations, collect hundreds of data elements per day for hospitalized patients. If a patient is in an intensive care unit, or goes into surgery, then the number of data points collected rise to thousands per day and sometimes thousands per hour.

Medication and ancillary services orders, medications administered, lab results, radiology results, nutrition and liquid intake and output, nursing observations, pathology results, and vital signs are just a few of the many data points collected during a typical inpatient stay.

If the hospital also includes a physician practice plan, or is integrated with an outside practice plan, then their data also includes ambulatory visit information. Although ambulatory visits typically comprise 97% of an organization's visits, they are only responsible for 20% of the data collected, based on an analysis of the MUHA Enterprise Data Warehouse (EDW). This is due to the volume of data required to manage an inpatient visit compared to an outpatient visit, but that volume of inpatient data makes it more challenging to accurately code the patient's medical record for billing purposes.

With the growth of electronic medical records (EMRs) maintaining the patient's medical record electronically, there is also a growth in software that analyses the thousands of data points attributed to a patient's stay, looking for patterns that may indicate a particular diagnosis or condition as having occurred during the admission. Having the data electronically also allows an organization to more readily determine how well they are adhering to clinical best practices across large numbers of patients very quickly, assuming they have defined algorithms to detect best practices in the data.

Previously these types of analyses would require manual chart abstraction, but with only partial success due to the delays inherent in reviewing a patient's paper chart after discharge, the validity of sampling methods, and the labor required to pull, review, and abstract patient data from the chart. When using electronic data from an organization, a researcher may study the entire population instead of picking sample and they may review the complete patient medical record immediately upon discharge. Unlike paper charts, with electronic data the labor requirements to review patient charts is minimal, as staff can develop complex algorithms to analyze patient data to detect patterns, conditions, or adherence to best practices.

Having patient data available electronically can also improve a healthcare organization's ability to understand where they should focus their quality efforts. When relying on paper charts and abstractions, clinical practices that result in quality shortcomings would grow until such time they were clearly influencing outcomes – only then would the work begin to determine the underlying cause. With the appropriate use of electronic patient data, however, clinical practices that affect patient outcomes may be detected early, sometimes while the patient is still under the provider's care.

Even with electronic patient data this type of analysis can take too much time and resources to run against typical EMR systems, as they are designed primarily for online transactional processing (OLTP). In an OLTP system, everything from the database, to the database drivers, to the database tables, to the database fields (columns) are designed for inserting, updating, or retrieving data based on a limited-in-scope transaction. A transaction in the clinical environment may include a single order, a nursing note, or a lab result. It may also include small groups of these types of elements, each still processed as a single transaction even though it may affect a group of records. Because of this, OLTP databases must utilize complex locking and synchronization systems to ensure the integrity of the database.

Contrast this with an online analytical processing (OLAP) structure, which is designed for slicing and dicing large datasets very quickly. In these types of structures, data is stored in more of a cube format, where indices may run between rows (records) as well as between columns (fields) of data. There is generally little to no record locking, as most transactions are simply reading the data, which further speeds processing of data. In some OLAP databases, such as Sybase IQ, the traditional OLTP data structure is turned on its

side and each record becomes a single column, allowing each column in the structure to use indices that are more efficient. All EMR systems are based on OLTP data structures, while all true data warehouses are based on OLAP structures since they are built for deep, broad, and speedy data analysis.

Data warehouses are repositories of data that are often collected from a myriad of data sources, integrated or linked together into a data structure optimized for reporting and analysis not possible when pulling data from a transaction based system. Along with using a different data structure, database administrators build warehouses using database engines designed specifically for manipulating large amounts of data, such as Sybase IQ.

Differences in resource requirements between extracting data from an OLTP and an OLAP system are staggering. In one recent test at the Medical University of South Carolina Hospital Authority (MUHA), a data extraction from the OLTP database took twenty-four minutes to pull the required data set. The analyst then extracted the same data from the OLAP database in less than seven seconds. Other tests at MUHA demonstrated differences between over 24 hours with OLTP compared to less than one minute using OLAP databases when pulling data based on more complex algorithms (L. Gale, personal communications, June 2012).

If there are decisions that can be made utilizing complex algorithms against large datasets, then caregivers can use the algorithms' results to change the way they treat patients while they are still under their care in an inpatient setting. At the very least, they can extract the needed data shortly after discharge, instead of having to wait for chart abstractions or month end reporting to take place. This allows for improvements in

patient care to take place more quickly as problems can be uncovered more quickly.

However, these algorithms are too slow to run against a standard OLTP system, where users interact on a transaction level. Instead, they must be run against data sets that have been archived to an OLAP format. The process of moving them from an OLTP format to an OLAP format requires time and overhead, and as a result the data in an OLAP database is typically between eight and twenty-four hours old. In many cases the currency of the data is not critical – twenty-four-hour old data is often suitable for quality of care studies, patient discharge analyses, and trending.

These OLAP databases, or data warehouses, have been in use within the financial industry for decades, but are still somewhat new to healthcare. Their recent growth is due in large part to the HITECH Act, which incentivizes providers to install EMRs.

Secondary to the EMR incentives, the concept of a clinical data warehouse gained in popularity as providers strived to figure out how to use this newly acquired, and vast, clinical data in an electronic format to improve overall financial as well as patient population outcomes.

The primary advantage of a clinical data warehouse is that it makes use of data that is already collected, and frequently, scrubbed by existing systems. There is no need to purchase or develop new systems to collect the data, as the warehouse can collect data from a myriad of diverse systems and, through careful analysis, logical links between the systems may be created. Links may include common identifiers such as patient ID (one for each unique patient) or visit ID (one for each visit or admission), or more complex ones such as those based on lab results, radiology results, medications administered,

timeliness of care (including medication administration and tests), compliance with best practices, or caregiver assignment (attending physician, admitting physician, nurse, etc.).

Much of the cost of healthcare is due to the effort we put into improving outcomes (Newhouse, 2010), so if we can reduce the cost of quality while still improving quality, we can differentiate an organization from its local, regional, and national competitors by providing a higher quality of care at a lower cost. Sometimes this differentiation does not require an actual improvement in care, but just a reported improvement in care. To the public, and to payers, reported quality scores represent the quality of the provider. If the numbers are reported incorrectly, that error becomes fact once published. This makes it critically important to report actual, accurate quality information.

The cost of actually improving quality within a healthcare setting, however, is often very high due to the cost of monitoring compliance through manual means. Even more simple efforts to improve the accuracy of reporting become complex when relying on staff members reviewing the patient medical records manually.

The data warehouse can change that because it may contain all clinical care elements, easing the analysis of patient outcomes both prior to and post intervention. Furthermore, by reusing data already collected and owned by an organization through the use of a warehouse, we can optimize the use of assets already owned, and, find new ways to reduce costs by applying best practices to areas where we can prove it makes a difference in patient outcomes.

The objective of this study is to demonstrate that by using a data warehouse to identify patients with possible hospital acquired conditions (HACs), identified as patient safety

indicators (PSI), a hospital can improve the clinical documentation of patient care and reduce the number of reported PSIs of discharged patients by improving the accuracy of the patient's medical record.

PSIs are indicators of HACs, or adverse events, complications, or undesirable outcomes that are considered within control of the caregivers. For example, if a patient is admitted without a pressure ulcer, but is then diagnosed or treated for one during his or her admission in a hospital, then the Agency for Healthcare Research and Quality (AHRQ, the research arm of the US Department of Health and Human Services) considers the pressure ulcer to have been acquired during admission. Since clinical best practices include methods to reduce or eliminate pressure ulcers, a new occurrence is considered to have been caused by a failure to follow clinical best practices.

The Centers for Medicare and Medicaid Systems (CMS), and the AHRQ, have defined PSI-90 as a composite score that represents the PSIs that are of most interest to CMS. PSI-90 also serves as a representative score that is used as an indicator of the overall quality of the provider. Since not all PSIs are included in the composite PSI-90 score, this study will review only those individual PSIs that are included in the composite PSI-90 score, and that MUHA has determined have enough incidents to where they may impact them with the new program. Those with "Did Not Include" checkmarks were excluded from this study:

PSI	PSI Description	Did Not Include
03	Pressure Ulcer-Prior 20074 Decubitus Ulcer	
06	Iatrogenic Pneumothorax	
07	Central Venous Catheter-Related Blood Stream Infection	
08	Postoperative Hip Fracture	✓
09	Postoperative Hemorrhage or Hematoma	
10	Postoperative Physiologic and Metabolic Derangement	✓
11	Postoperative Respiratory Failure	
12	Perioperative Pulmonary Embolism or Deep Vein Thrombosis	
13	Postoperative Sepsis	
14	Postoperative Wound Dehiscence	
15	Accidental Puncture or Laceration	

Table 1- PSI-90 Composite Elements

Following are more detailed definitions of each of the above PSIs included in this study.

PSI-03

PSI-03 represents pressure ulcers. Pressure ulcers tend to form when a patient is sedentary for extended periods of time, thus patient stays of less than five days are excluded. Also excluded are admissions due to a variety of skin diseases (due to the difficulty in defining the cause of the sore) and diagnoses related to a variety of physical disabilities such as paraplegia and quadriplegia due to the inherent difficulties in patient mobility. Pressure ulcers are considered one of the easier PSIs to manage as it usually just requires attentive caregivers to reposition the patient in their bed regularly and to perform scheduled skin assessments.

Nationally, PSI-03 occurs 0.40 times out of 1000 patient discharges (AHRQ, 2013).

PSI-06

PSI-06 represents Iatrogenic Pneumothorax. Pneumothorax is a type of lung injury that allows air to leak into the area between the chest wall and the lung itself. This condition can cause mild to severe chest pain and shortness of breath, but it is typically not fatal. Iatrogenic Pneumothorax is this same type of injury that was caused by medical error, such as an injection that missed its mark. Although Iatrogenic Pneumothorax typically is not fatal, Pneumothorax events do result in patient discomfort, extended stays, and additional costs.

Nationally, PSI-06 occurs 0.38 times out of 1000 patient discharges (AHRQ, 2013).

PSI-07

PSI-07 represents Central Venous Catheter-Related Blood Stream Infections. These are often referred to as central line associated bloodstream infections (CLABSI) and they can lead to serious patient injury or death. A central line is a very thin line that is inserted into a large vein in the neck, chest, or groin that allows a catheter to be inserted so that it may be threaded until it reaches a vein closer to the heart. Medications, fluids, and nutrition may be sent through the line. Unlike an intravenous catheter (IV) which is inserted in veins near the skin and utilized for short periods of time, a central line is generally used when the patient must be medicated over a long period of time, and therefore the lines may stay inserted for weeks at a time.

The CDC attributes thousands of deaths per year to this preventable condition.

Nationally, PSI-07 is not common, with just 0.43 patients out of 1000 qualifying discharges identified with PSI-07.

PSI-08

PSI-08 represents Postoperative Hip Fractures. Although part of the composite PSI-90 score, MUHA decided not to include this PSI in its process due to them having no flagged PSI-08 discharges since 2010.

PSI-09

PSI-09 represents Perioperative Hemorrhage or Hematoma. These events are due to a patient hemorrhaging after surgery, or, developing a hematoma after surgery. Only surgical cases are included and only for those patients who are 18 or older (see the appendices for the full criteria).

Nationally, PSI-09 is common, occurring 5.86 times out of 1000 patient discharges (AHRQ, 2013), and are the third most common PSI of the ones this study is covering.

PSI-10

PSI-10 represents Postoperative Physiologic and Metabolic Derangement. PSI-10 is most closely associated with mortality, where 41% of patients in one study who died while admitted had a secondary diagnosis of this condition (Duane, 2014).

Nationally, PSI-10 occurs 0.50 times out of 1000 patient discharges (AHRQ, 2013).

MUHA collected the data for PSI-10 but decided to not include it as part of this process and therefore it is excluded from this study.

PSI-11

PSI-11 represents Postoperative Respiratory Failure.

These PSIs are very common, occurring 8.61 times out of 1000 patient discharges (AHRQ, 2013), placing it in second place for the most commonly occurring PSIs.

PSI-11 only includes patients over the age of 18 who have had elective surgery in their denominator. To also be included in the numerator, they must have a secondary diagnosis of Postoperative Respiratory Failure or meet one or more of the following conditions:

- Mechanical Ventilation for 96 consecutive hours or more - zero or more days after the first major operating room procedure code
- Mechanical Ventilation for less than 96 consecutive hours or undetermined - two or more days after the first major operating room procedure code
- Reintubation - one or more days after the first major operating room procedure code (AHRQ, 2014b)

PSI-12

PSI-12 represents Perioperative Pulmonary Embolism (PE) or Deep Vein Thrombosis (DVT). Mortality associated with these conditions varies from 6% to 27% since 2000, depending upon the study cited. PE and DVT are both fairly common, with 0.3% to 1.6% of the surgical population experiencing this condition. Some surgeries experience as high as 24% PE incidence, or 240 per 1000 surgeries, with up to 12.9% mortality rate (Desciak, Martin, 2011).

Nationally, PSI-12 occurs 4.51 per 1000 discharges. This ranks this PSI in the top three PSIs rates for the PSIs included in this study. This high rate of PE and DVT, along with

its associated high mortality rate, make PSI-12 a condition that attracts the attention of both healthcare providers and researchers.

PSI-13

PSI-13 represents Postoperative Sepsis, the PSI with the highest rate of all PSIs included in this study. Postoperative Sepsis remains a leading cause of death in the United States and surgery patients account for one-third of all sepsis cases (Anderson, Smith, 2002).

Nationally, PSI-13 occurs 12.0 times per 1000 discharges (AHRQ, 2013), which unfortunately matches a study conducted three years early, as it demonstrates little improvement over the years 2010 and 2013 (Vogel, Dombrovskiy, Carson, Graham, & Lowry, 2010). At a rate of 12.0 times per 1000 discharges, PSI-13 occurs three times (300%) more than the average of all PSIs in this study, which occur 4.06 times per 1000 discharges, on average (AHRQ, 2013).

PSI-14

PSI-14 represents Postoperative Wound Dehiscence (PWD), a complication after surgery whereby the suture ruptures either partially or completely. Like some other post-surgery complications, the patient's physical condition may impact the occurrence rates. Obesity and diabetes, for example, may increase the risk of postoperative wound dehiscence. The AHRQ rates do not, however, take into account any of the risk factors since they should apply to all patients in the denominator across the country.

Nationally, PSI-14 occurs at a rate of 1.85 per 1000 discharges (AHRQ, 2013).

PSI-15

PSI-15 represents an Accidental Puncture or Laceration. It includes “a physician’s rate of inadvertent cuts, punctures, perforations, and lacerations during a surgical procedure” (AHRQ, 2014c). As with all PSIs in this study, patients must be 18 years or older and it excludes patients who presented with a primary or secondary diagnosis of an accidental puncture or laceration. It also excludes obstetric patients and spinal surgery patients.

Nationally, PSI-15 occurs 2.45 times per 1000 discharges (AHRQ, 2013).

PSI-90

PSI-90 is a composite score that consists of a calculation that includes all of the above individual PSIs. The PSIs are weighted differently based on whether or not a condition is present on admission (POA) or not. When POA=0, the condition was considered not present on admission. Below is the table from AHRQ indicating the weights of each component of PSI-90. Based on this table, PSI-03 counts nearly 53% of the total PSI-90 score if the condition was not present on admission.

Indicator	Label	Weight USEPOA = 0 ¹	Weight USEPOA = 1 ¹
PSI 03	Pressure Ulcer Rate	0.5295	0.1357
PSI 06	Iatrogenic Pneumothorax Rate	0.0318	0.0614
PSI 07	Central Venous Catheter-Related Blood Stream Infection Rate	0.0478	0.0831
PSI 08	Postoperative Hip Fracture Rate	0.0022	0.0005
PSI 09	Postoperative Hemorrhage or Hematoma Rate	0.0	0.0
PSI 10	Postoperative Physiologic and Metabolic Derangement Rate	0.0	0.0
PSI 11	Postoperative Respiratory Failure Rate	0.0	0.0
PSI 12	Postoperative Pulmonary Embolism or Deep Vein Thrombosis Rate	0.1527	0.2209
PSI 13	Postoperative Sepsis Rate	0.0309	0.0536
PSI 14	Postoperative Wound Dehiscence Rate	0.0064	0.0159
PSI 15	Accidental Puncture or Laceration Rate	0.1988	0.4289
SUM		1.0001	1.0000

¹ The use of POA results in different weights for the composite. Without POA, USEPOA = 0; With POA, USEPOA = 1.
Source: 2008 State Inpatient Databases, Healthcare Cost and Utilization Program, Agency for Healthcare Research and Quality.
Note: in Version 3.2, PSI #3 is labeled "Decubitus Ulcer" and PSI #7 is labeled "Selection Infection due to Medical Care."

Figure 1 - NQF Weights for the Patient Safety for Selected Indicators Composite

STATEMENT OF THE PROBLEM

For a typical inpatient stay of three days, healthcare providers can collect hundreds of data points within the patient's medical record. For patients who spend just one day in intensive care, thousands of data points may be collected. This overabundance of data provides detailed medical history for the patient, but it also creates an overwhelming amount of clinical information for providers and medical coders to review for purposes of clinical documentation, medical coding and subsequent billing.

Medical coding drives quality-of-care data published by CMS for each provider, making it imperative that the coding be accurate. CMS and most large third-party payers also tie the payment of services to the medical coding, reducing payments for any patient condition reported that is considered preventable or not present on admission. To improve the accuracy of publicly reported data and ensure that appropriate payments are

made to providers, the large amounts of clinical data must be translated or aggregated into information that can be used to improve patient care while also ensuring accurate clinical documentation and medical coding.

RESEARCH QUESTION

This study will review an intervention initiated by MUHA in October 2013 whereby MUHA pulls all patient discharge data from the data warehouse and processes it through an AHRQ-provided data engine, designed specifically to detect possible PSIs. The AHRQ engine creates a list of patients that, based on the data in the patient's medical record, have one or more PSIs. Four different groups within MUHA then review the patients on this list to ensure that both the clinical documentation and the medical coding are correct. The goal of the intervention is to reduce the number of false-positives submitted to CMS, UHC, AHRQ, and third-party payers in order to more accurately reflect MUHA's quality of care.

This study will determine if an organization can successfully improve their reported PSI rates if they implement internal processes to review the rates for accuracy prior to submission to CMS, UHC, AHRQ, and third-party payers.

This study will be conducted at MUHA. In 2013 MUHA was nationally ranked in six specialties (three adult, three pediatric) and high performing in ten. Only 3% of all hospitals in the United States are ranked in even one specialty (US News & World Report, 2013). In 2015 MUHA was still ranked in two specialties, and was named the top hospital in South Carolina (US News & World Reports, 2015). The scoring criteria varies from year to year, but in 2015 hospital acquired conditions, typified by PSIs, made up

10% of the overall score (US News World Reports, 2015a). Therefore if the program implemented at MUSC is successful the rankings may see an improvement next year, if the scoring criteria maintains the same or increases the PSI weighting as the data analyzed was from 2011, 2012, and 2013 (US News & World Reports, 2015b).

Per AHRQ guidelines, the study population will be all patients who have had surgeries, delivered a baby, or had a procedure performed while an inpatient at MUHA. The study will review all patients who meet these guidelines between October 1, 2012 and August 31, 2015.

Literature Review

This review will consider published literature that addresses hospital acquired conditions and patient safety indicators, but also literature that speak to the overall effectiveness of clinical best practices. In clinical situations, best practices are most often implemented to improve patient outcomes through improved quality of care, and so research into how data is obtained, organized, and accessed for effective analysis will also be introduced. Because this study is based on the reporting of federally defined measures, it would be impossible to review literature without also including the policies, guidelines, and standards that defined the measures themselves. While not peer-reviewed in the academic sense, these measure artifacts are typically introduced well in advance of them becoming a requirement, followed by a public feedback period, and also reviewed by various medical panels and medical associations before implementation by agencies such as the Centers for Medicare and Medicaid Systems (CMS).

This review will begin by presenting past research on clinical best practices. Since best practices are generally based on evidence, today from data in the EMR primarily, it will then move to discussing the sources of clinical data. Although we begin with the assumption that clinical best practices and evidenced based medicine are worthwhile endeavors, there is a cost to these and so past research that considers the cost of EBM will be presented. The value of how best practices, data sources, and cost considerations must be considered and balanced, will then be reviewed. While up to this point the benefits and methods to achieve conformance with best practices is our focus, this section will close with a discussion on the cost of non-performance.

PSI related literature will go back to 2003, the date when patient safety indicators were first introduced. Evidenced based medicine publications reviewed will go back to 1996 to

demonstrate the journey, and challenges, experienced around EBM over the past two decades.

CLINICAL BEST PRACTICE

Since this study will review patient outcomes that are considered controllable when adhering to clinical best practices, the researcher will accept that compliance with best practices, and their associated measures, will improve patient outcomes as represented by the absence of PSIs. Although some studies have found no direct correlation between clinical best practices and patient outcomes (Worrall, Chaulk & Freake, 1997), other studies have suggested that the failure to determine a connection is based more on lack of adherence to a complete set of best practices rather than lack of a correlation to certain best practices and improved care (Glasziou & Haynes, 2005).

What is a best practice? From BusinessDirectory.com, in general terms a best practice is, “a method or technique that has consistently shown results superior to those achieved with other means, and that is used a benchmark” (BusinessDictionary.com, 2013).

For general business, such as manufacturing, service industries, and retail, this definition may be considered complete. However, healthcare is more complex since there are not many standard health situations – every patient is different – and frequently patients present with multiple symptoms and multiple comorbidities. There are also multiple best practices that may have be applied to a single patient during a visit, as there is more to patient care than providing healthiness – caregivers must also be cognizant of social, ethical, and religious values of the patient while they are trying to treat the patient in a

most effective, yet also cost efficient, manner. This provides a more complex definition of best practice within healthcare:

We define best practice in healthcare as the 'best way' to identify, collect, evaluate, disseminate, and implement information about as well as to monitor the outcomes of healthcare interventions for patients / population groups and defined indications or conditions. Information is required on the best available evidence on safety, efficacy, effectiveness, cost-effectiveness, appropriateness, social and ethical values and quality of the healthcare interventions (Perleth, Jakubowski, & Busse, 2001, p.235).

According to Perleth et al., best practices include aspects other than simply evidenced based medicine (EBM). EBM, in fact, may not result in best clinical practices being performed because it allows patient care to be modified based on patient input, including their own personal preferences. For instance, best clinical practice may call for a procedure that the patient has religious or moral conflicts about and therefore it is not performed by the caregiver. There is an ongoing challenge with clinicians who are caught between delivering what they feel is the best plan of care, clinically, and listening to the patient for their preferences, as they often do not align (Montori, Brito, Murad, 2013). Best practices also include the use of health technology and clinical practice guidelines (CPG).

CPGs are recommendations to caregivers regarding patients who present with a specific set of conditions (Fletcher, 2008). PSI indicators are not best practices, but instead represent patient outcomes that are more frequently experienced in the absence of best clinical practices. Even the AHRQ indicates that their defined PSIs “may be amenable to prevention at the system or provider or level” (AHRQ, 2015). The AHRQ also notes, in the same publication, that PSIs are “potentially preventable complications” (AHRQ, 2015). Although there is controversy surrounding whether or not PSI are preventable,

their incidence is reported to and published by the AHRQ and therefore hospitals devote considerable resources to reducing the reported rates.

One of the concerns with attempting to reduce PSIs by applying best clinical practices is that patient care is commonly modified by the caregiver due to both the heterogeneity of patients and the complexity of healthcare itself. There is no guideline that can cover every conceivable patient or health scenario, so caregiver judgment must also dictate care (Sackett, Gray, Rosenberg, 1996), as the human is too complex an organism to account for every possible state of being. Therefore, some institutions, such as the organization in this study, are trying to determine if they can reduce their reported PSI rates by simply improving the accuracy of their clinical documentation, thus also improving the accuracy of the medical coding.

Best clinical practices are often difficult to identify and adopt by caregivers for a variety of reasons. Three practical reasons include:

1. There are at least two million medical works published annually;
2. There is an overwhelming amount of new information, and often the information is ambiguous, or even contradictory, in its application for use;
3. Healthcare organizations and systems are faced with cost and regulatory pressures that create an environment unaccepting of change (Nieva, et. al., 2005).

In order for a process or procedure to be considered a best practice, it generally follows a path such as that defined by Titler in Figure 2, whereby the practice is first demonstrated as effective using research in a very controlled setting, followed by communication and education about the findings, followed by the development of specific interventions, and

then followed by adoption by caregivers who may modify the practice based on organizational differences (Titler, 2008). In this model, shown in Figure 2, new knowledge is created through research studies and then distilled through quality forums, Institutes of Medicine, and other healthcare organizations charged with this work.

Once the research data is distilled and it is determined that new knowledge exists, this knowledge is either disseminated to chosen partners or mass communicated to the healthcare community. Depending on the knowledge being communicated, it may require targeting of markets to gain acceptance, while some knowledge simply requires marketing through common media outlets.

Once disseminated, caregivers must adopt the new practices, which may require training, new technology, user groups, and new policies or guidelines being developed within an organization. Once adopted, the organization confirms whether or not the new intervention is successful and if not may modify their adoption within the organization. In order to gain general acceptance of the new best practices, it sometimes requires that third parties, such as payers, standards organizations (such as The Joint Commission), or regulators (such as Centers for Medicare and Medicaid Services) require that the best practices be adopted in order to improve the population's health.

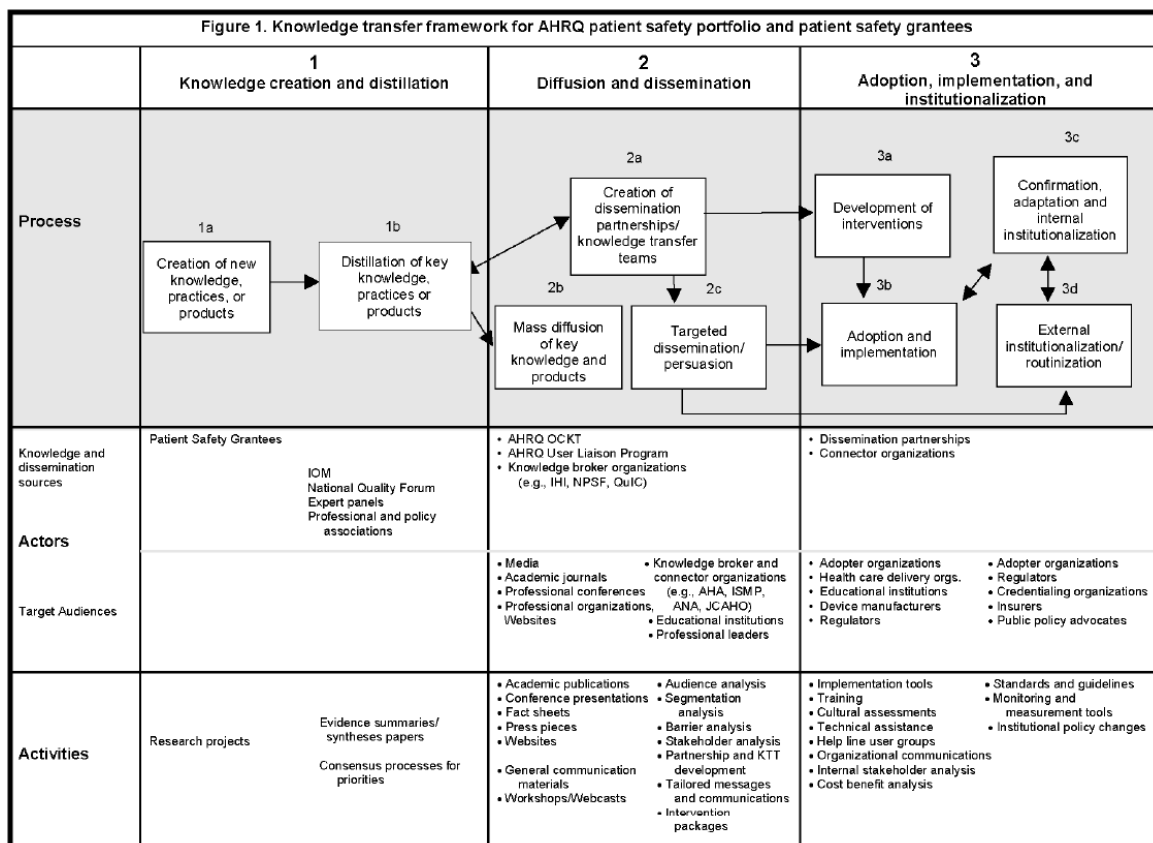


Figure 2 - AHRQ Model of Knowledge Transfer (Titler, 2008)

What is missing from Titler's model (Figure 2) is the feedback loop that would be considered typical in any commonly recognized change management cycle, such as Plan-Do-Check-Act (ASQ, 2013), whereby the original improvement plan is monitored and adjusted to ensure it is working to its fullest extent. Although this may be conducted for best clinical practices within a specific organization, it is only done wide-scale in the healthcare industry through the introduction of new research that is performed by those, or on those, who have already implemented the best practices defined thus far. This research is most commonly performed in academic medical centers. Of those academic medical centers, only a chosen few are considered academic health science centers

(AHSC), where the top medical research is performed starting with basic sciences, shifting that new knowledge to use in the clinical sciences, and ending with the transformation of clinical knowledge and practices through commercialization of the new knowledge (Tremblay, 2012). Academic medical centers, in comparison, may train medical professionals in both an academic and clinical environment, but they lack the basic research components or the translational research components where knowledge moves from bench (lab) to bedside (clinical practice). The United States only has twenty-seven health science centers, with the rest of the world accounting for two dozen more centers.

Since academic medical centers include only 141 organizations in the United States (AAMC, 2013) out of over 5700 hospitals (AHA, 2013) and over 296,500 physician practices (SKA, 2015), only a small percentage of all caregivers work in the places where any significant research is centered. Given that the majority of research takes place in these academic facilities and yet they only represent a very small portion of all healthcare providers, a large majority of caregivers and patients are not being represented in studies (Howell, 2013). This offers another explanation into why healthcare best practices take so long to adopt. Caregivers know that the practice will be adjusted but that it will take years to do so, and so caregivers may wait until they find enough supporting evidence to suggest that the practice should now be adopted. If they do adopt a new best practice that was based on research, unless they make the effort to do their own research or contact the original researcher with updates, the results of their best practice implementation will go unnoticed and undocumented.

There are formal programs, by groups such as the American Hospital Association (AHA), which were created to promote the adoption of best practices. Their *Hospitals in Pursuit of Excellence* (HPOE) program provides a platform used to accelerate performance improvement, provide education, develop evidence-based tools, and provide fellowships and networks to engage hospitals in national improvement projects (HPOE, 2013). The challenge is, or as Umbdenstock (2012, p.1) states it, “the opportunity now in front of us is to identify and implement the most effective ways to spread improvement so that we can continuously adopt best practices.” He adds that this cannot be accomplished without some sort of plan, a plan that includes measures, resources, tools, and assistance to orchestrate it all. This would have to include, as noted previously, a feedback mechanism that is more efficient, effective, and encompassing than the current method (Umbdenstock, 2012).

Nonetheless, organizations frequently are more amenable to adopting new best practices when they are struggling to improve patient outcomes in an area the best practice portends to address (Titler, 2008). Because they are focused on research to improve outcomes, frequently the AHSCs are the first to adopt new practices, so it should be no surprise that many of the top hospitals in the United States are in this group, including the Medical University of South Carolina Hospital Authority (MUHA), where this study will be conducted.

Unfortunately, there are many best practices that are not followed despite there being strong evidence of their positive impact on patient care and their general acceptance by health professionals (Newhouse & White, 2011). For example, in 2010 many proven preventive services were only given two-thirds of the time to the very patients they are

meant to serve. Pneumococcal vaccinations were only received by 20% of high risk adults aged 18 to 64 years of age. Despite seeing improvements in 80% of the twenty-one acute care measures, acute care services were only delivered appropriately 75% of the time (AHRQ, 2010a). This indicates that healthcare still has a long way to go in the way of improving patient outcomes through the application of best practices, even when they understand and agree upon them.

As shown in Figure 3, in 2012 the AHRQ reported that 56% of quality measures are improving in compliance across all patient demographics. That, however, still leaves 44% of the measures as either static or decreasing in compliance, and indeed 58% of measures are dropping in compliance for the middle class patient (AHRQ, 2012).

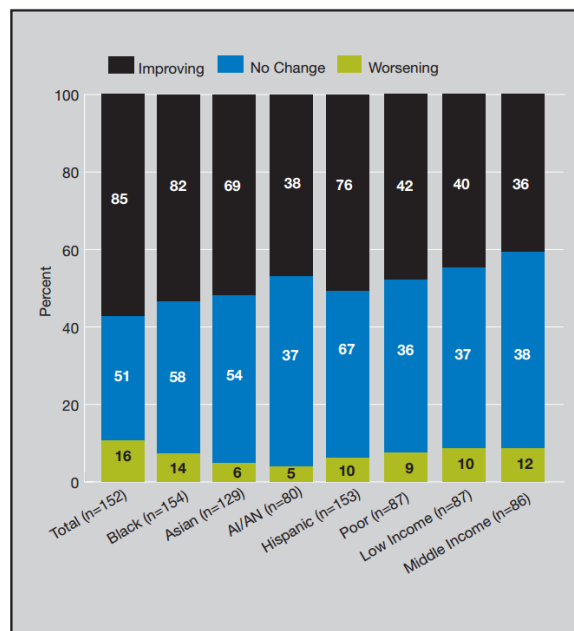


Figure 3 - Changes in Quality Measure Compliance (AHRQ, 2012)

USING CLINICAL DATA

A review of available literature suggests that clinical decisions are best made when based on real time data from an EMR. Although this may be true for direct patient care, it is often not the case when comparing patient outcomes across populations, to adherence to best practices in care as an institution or a provider, or to federal regulations and global standards. In these cases, data is most often extracted from the EMR and stored within a data warehouse, where it can be analyzed in a variety of ways without affecting the performance of the EMR.

The majority of published research to date has been focused on using data from the organization's EMR to change clinical care through the use of alerts, reminders, and *simple* clinical decision support algorithms. Unfortunately, the depth of analysis available for studying the typical EMR is limited, as EMRs are designed for fast single transaction, interactive response times, and not designed for longitudinal or cross population analysis. The few examples of using clinical data warehouses were focused on research usage (Wachman et al., 2011), while others were used to demonstrate that the data coming from an EMR may not be completely accurate (Botsis, Hartvigsen, Chen & Weng, 2010). There were no studies found that demonstrated the use of a data warehouse to directly improve the accuracy of patient documentation, or being used to improve actual patient outcomes. This is perhaps because data warehousing is still a relatively new science within the healthcare provider industry compared to other industries such as finance, retail sales, and manufacturing.

Botsis et al. (year) noted that although clinical decisions were being made with the data while in the EMR, not all of the information used to base the decision on is stored in the EMR (or, therefore, in the warehouse). This makes using data, regardless of source, as the sole driver for clinical decisions (or warnings and alerts) unpredictable, and in some cases inaccurate. Because of this shortcoming, whatever system or process which is developed must be viewed as *additional* clinical advice, and not the sole clinical advice, and as such it must be considered along with all other information available to the clinician. This also makes medical coding more difficult, as many bits of information about the patient are either entered as non-discrete data (free text) or are buried down several screens within the EMR system that make coding more time consuming.

Likewise, this non-discrete data is frequently not imported to a data warehouse due to its unstructured context. The frequent lack of discrete data within the patient's medical record can make the resulting medical coding inaccurate, leading to false indications of a PSI.

Other studies found that data warehouses can, in some cases, provide more complete information than other systems, even if those systems were designed for a specific purpose (Weng, Bigger, Busacca, Wilcox & Getaneh, 2010). This is because the data warehouse can house a large amount of diverse information, supplied from a variety of systems. In these cases the diverse information may be analyzed for patterns between the systems, even if the patient's record is not complete. In one case a clinical data warehouse generated a higher positive predictive accuracy (31% versus 6.6%) for diabetes studies than the organization's own diabetes registry. Further, it resulted in double the study participation rate of the existing diabetes registry (Weng, et al, 2010).

This increase in accuracy can be due to the larger number of parameters that can be analyzed in a data warehouse, compared to a specialized registry that is manually fed patient information based on a specific diagnosis. In the above case, the manual data entry is relying on correct ICD9 coding (250.* codes) for diabetes that triggers the patient being manually entered into the registry. During this rekeying process data entry errors may occur, and then any later corrections to the diagnosis has to be manually corrected in the registry – a task that can be overlooked as the registries are typically managed by non-clinical groups (P. Wagstaff, personal communication, January 2013).

Some of the uses of data warehouses have been around identifying patient sets for research. Wachman, et al. (2011) describes the use of a data warehouse where research subjects were identified through using a complex set of requirements that would be very difficult to identify using an EMR. These requirements included a specific combination of diagnoses codes, lab orders, and medication orders. The data warehouse identified a set of potential subjects that when manually cross checked against the medical records, was 100% accurate (Wachman et al., 2011).

Although Wachman's work was considered research, his application of the data warehouse demonstrates the power and flexibility of the data warehouse compared to any other data source within a healthcare organization. Wachman et al. did not go to their EMR for the data, nor did they go to a variety of systems to piecemeal the data elements together. The former is the only choice for organizations that lack a data warehouse, and the latter is often the only choice for organizations that lack a centralized and consolidated EMR. For those organizations that have constructed a warehouse, it is ground zero for seeding research concepts, or in the case of MUHA, the foundation of its PSI accuracy improvement program reviewed in this study.

Other studies have used the data warehouse to pull lab values, vitals, and medications administered in order to determine if certain medications impact outcomes, but then use other data sources to determine comorbidities or other data elements that may impact the patient (Woodard, Urech, Landrum, Wang & Petersen, 2011). Since the data warehouse is typically the only database in an organization that combines, and relates, data from multiple sources, it is the best source when attempting to correlate care with outcomes.

Although powerful, the data warehouse concept is not just about providing data. It must be about allowing clinicians and researchers to increase their knowledge in order to improve patient care and advancing medicine. Nancy Staggars, PhD, RN, FAAN (professor, University of Maryland School of Nursing) notes that, “To achieve good knowledge management, it is necessary to go beyond a data warehouse and provide for the use of the knowledge in these data in patient care” (CIN, 2011, p. 609). This means that organizations must begin to take advantage of their terabytes of data about patient and organizational history and turn it into knowledge in order to improve patient outcomes. Dr. Brennan agrees by adding that an EMR does not just replace the patient chart with “bright lights.” Instead, it must allow us to share outcomes and therefore create new nursing knowledge. Dr. Brennan concludes by noting, “It [the EMR] must, however, arise from and return to clinical practice” (CIN, 2011). This conclusion suggests that we do not create EMRs or data warehouses for the sake of the technology, but rather based on the needs of the clinicians and to assist the clinicians with improving patient outcomes.

Pam Cipriano, nurse scholar-in residence, Institute of Medicine and Editor-in-Chief, *American Nurse Today*, suggests that we need to move systems from financial-based systems to clinical-based systems. The EMR should be a means to quality (CIN, 2011), although as much as the EMR is a means to quality, its contributions are based on managing patients one by one and typically over a limited period of time. However, much of the advances in medicine are based on the analysis of longitudinal patient data over many years, or a cross-population of patient data over a given geographic region or demographic group. This is how a data warehouse can demonstrate its power, as it can

take the thousands of data elements from an EMR for millions of patient encounters and quickly analyze the data points – resulting in faster diagnoses, improved patient treatment plans, and increased compliance with best clinical practices. Likewise, it can be used to quickly analyze patients’ medical records for potential PSIs so that they can be reviewed, and the medical records corrected if necessary, before the EMR data is published to CMS or other outside parties.

Data integrity has also been a concern when data are used to influence clinical practice. With PSIs, the data in the patient’s medical record may be accurate, and the medical coding staff may have accurately coded a PSI, but the PSI may still not be present. PSI-9, for example, represents postoperative hemorrhage or hematoma. However, the algorithm used by the AHRQ engine does not specifically exclude intraoperative hemorrhaging. In one study conducted by Utter et al., 2013, 28% of all PSI-9 incidents manually abstracted from patient charts using the AHRQ criteria were not post-operative, but instead intraoperative. Since bleeding is an inherent risk of surgery, the fact that these were included in the rates, and not as controllable as true PSI-9, it leads some to question their control over managing PSIs overall (Utter, Baron, Tancredit, et. al., 2013).

COST OF EBM

In the *Journal of Nursing*, Newhouse (2010) questions whether the high cost of healthcare can be attributable, at least in part, to our focus on improving healthcare. Although she does not discount the importance of ongoing quality improvement, she does question "at what cost" are we willing to improve? One of the aspects of the MUHA

program was that they wanted to minimize costs within the program, to see if they could improve their publicly reported rates without a huge investment of time or money.

Newhouse considers that when a quality measure is not being met an organization will throw money and resources at the problem even if the payback is minimal. She describes

using a matrix (Figure 4, adopted from

Marshall, Demers, O'Brien & Guyatt,

2005) that should drive quality

initiatives, where each is measured

against cost minimization, cost

effectiveness, cost utility, or cost benefit.

High-cost / low-effectiveness is an

automatic rejection, while low-cost / high-effective initiatives are automatically accepted.

Others within the matrix must be defended if in the top right corner or further supported

if in the bottom left corner. Those left in the middle must be further analyzed unless

others more promising options are available.

Newhouse provides four methods of analyzing the return on quality initiatives: Cost Minimization, Cost Effectiveness, Cost Utility, and Cost Benefit.

The first method, cost minimization, compares two or more alternatives and if they have similar outcomes, then the least expensive alternative should be chosen (Newhouse, 2010).

The second method, cost effectiveness, compares the cost of the intervention to the patient's health benefit (Newhouse, 2010). This is useful when comparing the cost of a

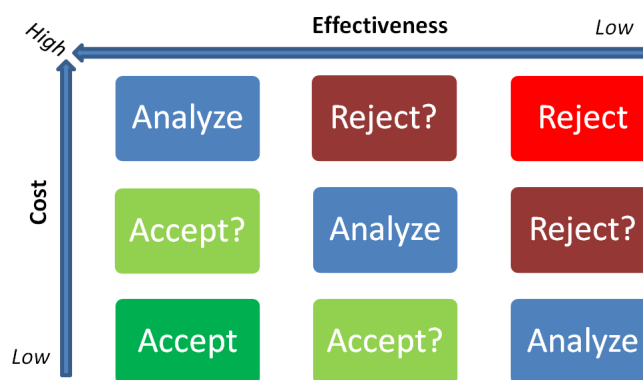


Figure 4 - Weighing Cost to Benefits (Marshall, Demers, O'Brien & Guyatt, 2005)

preventative step taken in comparison to the potential expense (probability x expected expense) if the step were skipped. Cost effectiveness takes into account health benefits to the patient while also taking into account costs to the facility.

The third method, cost utility, compares the cost of the intervention to a utility-type measure, such as "quality adjusted life-year" (Newhouse, 2010). For example, if the expense is \$10,000 and the patient will expect one more year of quality life, then the expense may be considered a bargain compared to a cost of \$350,000 while only adding two more years of quality life.

The last method, cost benefit, compares the cost of the intervention, process, or procedure is compared to the monetary benefit gained by having it in place (Newhouse, 2010).

Newhouse suggests these four methods as ways to objectively determine whether or not a procedure, process, or intervention should be provided to patients, but none of these processes take into account the emotional, or humanitarian, aspects of healthcare.

Patients, and their families, frequently are not concerned with the cost of healthcare as they do not pay the costs directly out of pocket. However, with the recent rises in deductibles for healthcare plans there is an expectation that customers, the patients, will become much more interested in the cost of procedures and interventions – leading to healthcare providers having to be more transparent in the cost of services provided. This will allow patients to better choose healthcare services based on the perceived value to them compared to the actual cost expected (Beck, 2014). This, in turn, may lead to patients having to make healthcare decisions based on one of the four methods above.

HOW THEY FIT TOGETHER

There are clearly many challenges to making full use of the data that organizations collect. The data in EMRs is typically considered accurate and up-to-the-minute, but its ability to link to other systems is often limited (Westra et al., 2010). Even when using clinical alert systems such as those developed by Persell et al. within the EMR, the system is limited in its analysis because the EMR is expected to be near-instant response, and so processing must be taken offline to full take advantage of longitudinal and cross-population data (2010).

Wu, Roy, and Stewart described prediction modeling based on EMR data, but like the other EMR models the research was on a very limited set of predictors (2010). To more fully implement a predictive process would require that data be taken out of the online transactional processing system (OLTP) and moved into an online analytical processing system (OLAP) such as a data warehouse.

While the cost of the system must be considered (Newhouse, 2010), if it does not improve decision making ability without interrupting workflow (Persell, 2011) then it will be ignored by caregivers. This is why the process implemented by MUHA was desired over so many other potential programs that could have been used to improve reported PSI rates – patient care was not altered as part of the program, clinical workflow was not redirected, and the patient-physician relationship was not interrupted.

Newhouse recognizes that implementing a program or system may take upfront costs or work, with the long term goal of lower costs. With limited upfront costs and minimal ongoing costs, MUHA is using their data to analyze patient discharges through the

AHRQ engine. The MUHA data warehouse is essentially being used to improve the accuracy of the patient's chart within the EMR, and improving the accuracy of the data reported to CMS, UHC, AHRQ, and third-party payers for the PSIs that compose PSI-90.

THE COST OF NON-PERFORMANCE

There is a direct cost to poor patient outcome performance, whether real (through poor care delivery) or perceived (through poor reporting of the care delivery). As of federal fiscal year 2015, providers are now carrying any costs associated with hospital acquired conditions (HAC) for Medicaid and Medicare patients (Rajaram, Chung, Kinnier, et al, 2015). There is no reason why all third-party payers will not eventually do the same, as they traditionally follow any CMS cost-saving measure that holds providers accountable for treatment and outcomes.

The impact of HACs, represented in part through PSIs, is greater for teaching hospitals such as the organization used in this study, MUHA. According to Rajaram, Chung, Kinnier, et al., providers accredited by Joint Commission had significantly higher rates of penalized hospitals (24% vs. 14.4% no accredited). Major teaching hospitals were also penalized more, representing 62.2% of those penalized, compared to just 17% of nonteaching hospitals being penalized. They also discovered that the more complex patient populations resulted in higher penalty odds, with those in the highest complexity quartile representing 32.8% being penalized vs only 12.1% of those in the lowest complexity quartile. Related to complex patient cases, Level 1 trauma centers were also almost twice as likely to be penalized as those that were not.

MUHA is accredited by the Joint Commission, is a major teaching hospital, is a Level 1 trauma center, and is a tertiary care facility which cares for the most complex cases in the region. The result is a very high probability that MUHA will have cases that result in more HACs than their local competitors, be penalized for HACs, and as such they must focus resources on reducing PSI incidents and PSI reported figures.

Other studies have suggested that the rate of PSIs and therefore HACs, can be directly related to the patient's payer method. Medicaid and Medicare patients, for example, were demonstrated to have significantly higher incident rates for seven and twelve PSIs, respectively. Interestingly, on two PSIs they had lower rates than private payers (Spencer, Roberts, Gaskin, 2015).

Since CMS is leading the way to reduce payments to hospitals who have higher than average incident rates for PSIs, and since academic medical centers like MUHA have a higher than average mix of Medicaid and Medicare patients, it increases the likelihood that there will be a financial impact on MUHA if they cannot improve their processes to prevent PSIs or at least ensure that they are only reporting true PSI incidents. Even without the financial implications, the public is more aware today of these publicly reported figures and patients use them to compare providers before making healthcare decisions (Spencer, et al., 2015). This further increases the need for accurate reporting to ensure patients are making decisions based on true patient outcomes.

What Spencer, et al. did not address was whether or not the lower payment rates for hospitals by CMS, which is about 30% less than private payers (Spencer, et al., 2015), resulted in a less than ideal patient care experience or whether the patient's previous

health conditions, family support structure, or other factors impacted outcomes. However, they did note that the CMS patients had the highest level of recorded comorbidities. They did not assess whether these comorbidities contributed to higher PSI rates, or whether they were simply recorded at a higher rate in order to maximize reimbursements. In either case, providing caregivers with payer information may be useful to providers as it may give them additional data points that they must take into consideration when treating the patient.

As noted by Spencer, et al., identifying relationships between outcomes is not a perfect science because of the complexity of healthcare. Studies have shown that even if an EMR and a data warehouse both used to identify potential adverse events, the results are inconclusive due to the complexity of the data and of the patient. Northwestern Memorial Hospital implemented a data warehouse based engine to attempt to detect 51 different potential non-drug adverse event conditions. Their goal was to improve upon their EMR's alert engine which had similar conditions already being monitored.

Their research determined that the data warehouse found 71% of the adverse events, the EMR 63% of the events, but that they both only agreed on 34% of the events. This means that about half of those detected by each engine were not detected by the other engine (O'Leary, Devisetty, Patel, Malkenson, Sama, et al., 2013), and that if only one engine were being used, they would miss half of the potential adverse events. This suggests that due to the complexity of healthcare and patient health, providers must use a variety of tools to detect the absence of best practices or the potential presence of adverse events such as PSIs.

Perhaps the most telling research compared the financial impact of flagged PSIs compared to actual PSIs based on manual chart abstraction. The automated flagging of PSI incidents was based on the AHRQ engine (version 4.2), the same software used by MUHA to flag PSIs and the same software used by AHRQ to flag and report PSI results. The researchers compared the results of the AHRQ engine to the results of manually reviewing patient charts to determine if a PSI indeed was present. False positives could have been detected by the engine due to faulty algorithms, missing electronic data, inaccurate electronic data, or data buried within text that the AHRQ engine cannot take into account in its algorithms.

The study by Rosen, Chen, Borzecki, Shin, Itani, and Shwartz in 2014 found that the AHRQ engine flagged a higher percentage of PSIs than the manual chart abstractions that could take into account text and other non-discrete documentation. Based on the reimbursement value of the PSIs, they suggest that 33% of hospitals who rely on the AHRQ engine to detect PSIs may lose up to 10% annually in reimbursements from CMS for Medicaid and Medicare patients. Further, since Hospital Compare now includes the PSI-90 composite score, an organization will have inaccurate data presented publicly if they rely solely on the AHRQ engine to report their PSI rates.

Methods

This project will use observational techniques to assess the effectiveness of a program implemented at MUHA to reduce the reported patient safety indicator (PSI) incidents. The research will utilize quantitative methods to evaluate the effectiveness of the intervention by comparing the reported PSI rates both before and after initiating the program for all patients who meet the inclusion criteria, as defined by AHRQ, at MUHA during the study period.

The intervention being studied was implemented by MUHA in October 2013. It includes a process whereby all patient discharges are analyzed to determine if the clinical documentation indicates one or more PSIs for each discharged patient. If the analysis determines that a PSI is indicated for a patient, then the patient's chart with the indicated PSI is carefully reviewed through a multi-step, multi-disciplinary process to ensure that the clinical documentation is accurate. By reviewing and potentially correcting false PSI findings, the PSI data reported to AHRQ and UHC is more accurate and MUHA may then focus its efforts on reducing the reasons behind the actual, remaining PSIs.

The process involves four primary groups at MUHA:

Medical coders: The medical coders review the patient's medical record upon discharge and determine which diagnosis codes should be assigned to the patient's visit. Payments, PSIs, and many other metrics are based on diagnosis codes and so it is imperative that they be accurate. However, since they are based on an interpretation of what has been charted by the caregivers, there are sometimes errors in the coding. This team spends between two and eight hours per month, collectively, on this process.

Clinical documentation integrity (CDI): The clinical documentation integrity group was created in 2005 for the purpose of reviewing patient charts for coding errors, with the primary purpose being to increase revenue by correctly coding patient discharges. However, beginning in August of 2013 they added to their focus the ability to improve patient care, as a properly documented patient medical record will result in improving patient care for future visits as the patient's medical history will be accurate. The focus on accurate medical records can also improve medical care for currently admitted patients, as their medical records should more accurately represent the patient's condition. This benefit is possible because caregivers are becoming more careful in their original clinical documentation in order to not have to do it again after being reviewed by the CDI. This team spends between four and eight hours per month, collectively, on this process.

Chief Quality Officer (CQO): The CQO is responsible for all clinical quality at MUHA. She is a practicing MD, serving as a hospitalist, and personally reviews every PSI that was not due to a coding error. The CDI group reports to the CQO.

Attending physicians and surgeons: The attending physicians and surgeons are the caregivers who provide most of the clinical documentation that is used to determine which diagnosis codes should be assigned to this patient's visit.

The process of reviewing the data includes multiple steps, and varies slightly between adult and pediatric patients, although both are run weekly based on patient discharges for the prior week. The adult process begins with the medical coders pulling a list of patients with potential PSIs from the PSI dashboard for any patient indicated with PSI-11. The

CDI group also pulls a report weekly, but they limit their report to include adult patients with all PSI indicators except for PSI-11.

These two groups then review the patient charts for those patients on their lists to ensure that the chart was coded correctly. If the medical coders find or suspect a problem with the coding, then they pass the chart along to the CDI group for confirmation of the needed change. Only after the CDI and CQO review the suggested correction, and approve it, is the correction made to the patient chart by the medical coders. If the coding is correct, then the medical coders simply indicate that no change was made within the PSI dashboard and the case is closed.

The CDI group, in all cases, passes the outcomes of their review on to the CQO. In cases where the CDI confirmed the PSI as real, and the CQO agrees, then the CQO forwards the patient to the service line for review by the attending or surgeon for review. If the surgeon agrees that the PSI is real, then they email the medical coders to confirm their agreement. If they disagree, then the attending or surgeon corrects their clinical documentation and then emails the medical coders to indicate the patient's medical record has been updated. The medical coders, in this case, then update the diagnosis codes based on the changes to the patient's medical record.

If the CQO determines that the medical coding is incorrect, then the CQO will update the PSI dashboard with information on the needed corrections and then the medical coders make the required corrections in order to remove the PSI flag.

In all cases where the CDI sends their results to the CQO, it is the CQO who makes the final determination on whether or not the coding needs correction or the patient's medical

record needs to be reviewed and/or updated by the attending or surgeon. The next step taken is based on whether the CQO believes it is a coding problem.

The goal of the intervention is to improve the accuracy of the clinical documentation, reduce the number of reported unsubstantiated? PSIs, and reduce the number of PSIs so that the quality department can focus on the clinical events contributing to the remaining actual PSI incidents. The latter may only be accomplished if the number of PSIs are reduced due to errors in the patient's medical record, which is the expectation.

To track the number of corrections made each week, MUHA created a PSI tracking system that is used as their "dashboard." This dashboard pulls data from the data warehouse for patient discharges that were flagged by the AHRQ engine as having one or more possible PSIs. After review by the medical coders, CDI, and CQO, if the PSI indication is not determined to be accurate, then the warehouse record is flagged within the PSI dashboard. This allows the quality department at MUHA to track the number of corrections made as a result of this process.

Below is a flowchart of how the adult PSI review process works. The pediatric process, which follows the adult process, is similar except the CDI group manages the review of all PSIs.

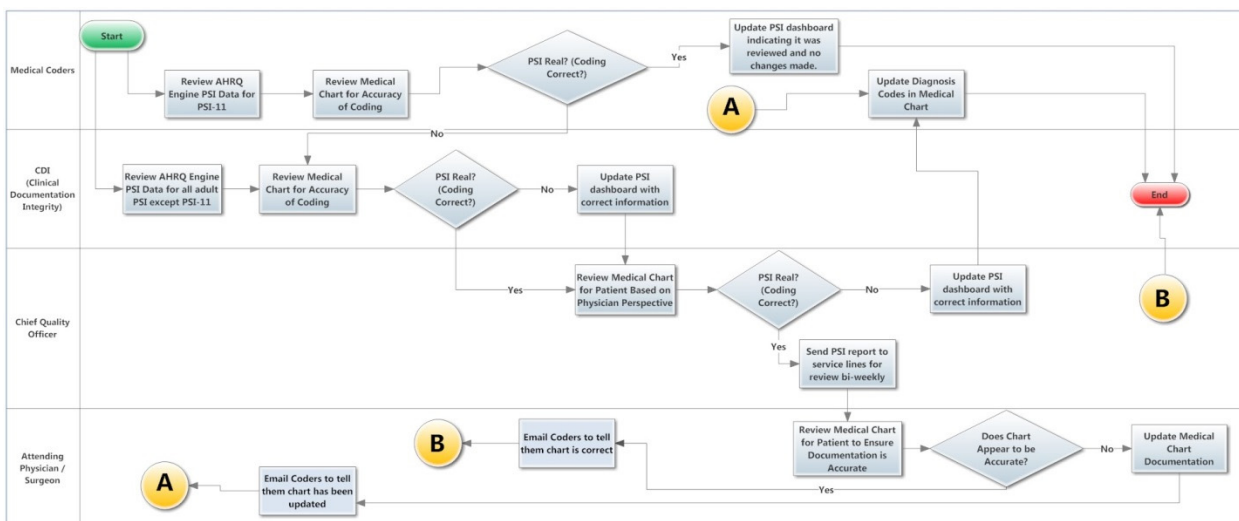


Figure 5 - Adult PSI Chart Correction Process

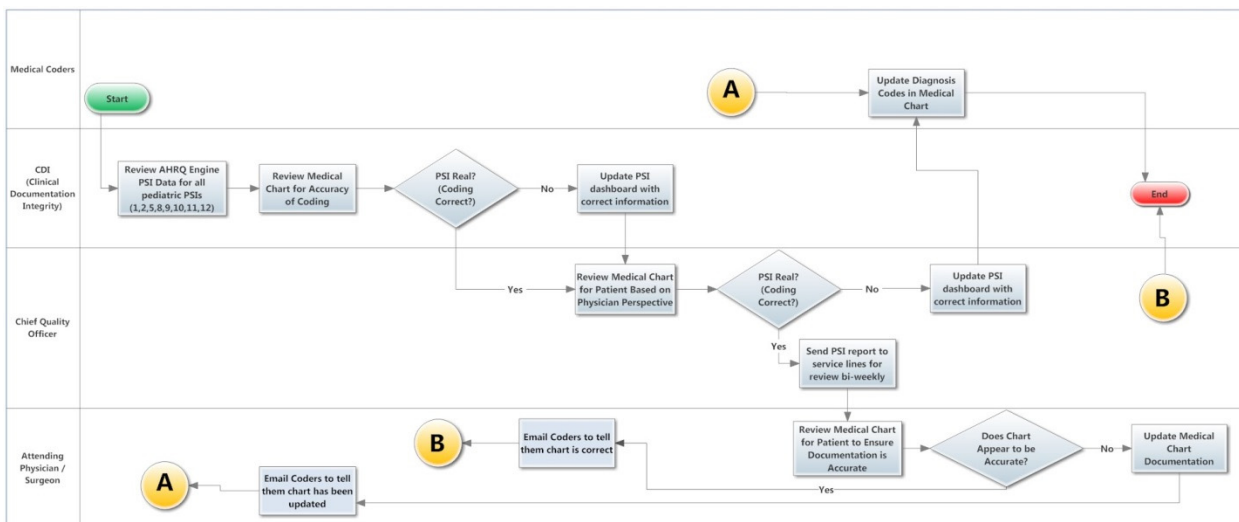


Figure 6 - Pediatric PSI Chart Correction Process

OPERATIONAL DEFINITIONS

AHRQ Engine: The AHRQ collects discharge data from healthcare providers and processes this data through an algorithm to determine how many of a provider’s patient

medical records indicated the presence of a PSI (see below). The AHRQ also provides a software package that identifies patients with PSIs that may be run by a provider before submitting their data to AHRQ. This package is downloaded by the provider and run on the provider's equipment anytime the provider wishes, designed primarily to allow the provider to review the PSI data before submission to the AHRQ. This software application is run weekly against the MUHA data warehouse and then stores its results back into the MUHA data warehouse, and is the basis for the MUHA PSI dashboard.

PSI: Patient Safety Indicators, as defined by the AHRQ, are data-driven indications that the patient suffered from a healthcare condition acquired after admission. The AHRQ considers PSIs preventable with clinical best practices.

PSI Rates: Published PSI incidence rates represent the number of patients who have acquired a specific condition after admission per 1000 discharges that are subject to the criteria for inclusion in the denominator for that PSI. As an example, if PSI-03 has a rate of 0.15, it would indicate that 0.15 patients per 1000 patient discharges, including only those patients who met the inclusion criteria for this PSI, acquired pressure ulcers after admission.

PSIs are a set of indicators that identify potential in-hospital adverse events, complications, or undesirable outcomes following surgeries, procedures, and childbirth. AHRQ developed the set of PSIs used in this study “after a comprehensive literature review, analysis of ICD-9-CM codes, review by a clinician panel, implementation of risk adjustment, and empirical analyses” (AHRQ, 2014a).

The PSIs that will be included in this intervention include:

PSI	PSI Description
03	Pressure Ulcer-Prior 20074 Decubitus Ulcer
06	Iatrogenic Pneumothorax
09	Postop Hemorrhage or Hematoma
10	Postop Physiological Metabolic Derangement
11	Postop Respiratory Failure
12	Postoperative PE or DVT
13	Postoperative Sepsis
14	Postoperative Wound Dehiscence
15	Accidental Puncture or Laceration

This study will use the MUHA enterprise data warehouse to extract patient information on a weekly basis; the data is then loaded into an analysis engine provided by AHRQ. The AHRQ engine provides output that is stored into another data warehouse table, which the MUHA quality department reviews on a PSI dashboard.

The quality department then provides the medical coding department with the list of patients that were determined by the AHRQ engine to have possibly experienced a PSI while admitted at MUHA. Each PSI has a set of criteria that must be met before a patient may be considered for inclusion in its group, and each PSI has a further set of exclusions that will remove an otherwise valid patient from a given group.

The set of AHRQ inclusion criteria determines the denominator for the given PSI rate, and the criteria may include a complex set of demographic and patient diagnostic information. For some PSIs, the criteria includes DRGs (diagnostic related groups), while others include the more specific ICD-9 codes. In both cases, the AHRQ engine is attempting to determine if MUHA treated a patient for a condition that they did not present with upon admission – the assumption being that if they did not present with the condition, then they developed the condition while under MUHA’s care. The AHRQ engine does this by searching through all patients in the data warehouse for diagnoses

that indicate a hospital acquired condition, a task that would be unwieldy or impossible to do manually for every admission.

The PSI denominator inclusionary criteria can be complex, sometimes comparing thousands of criteria to the patient's documented chart. Exclusionary criteria can be equally complex, and the engine might exclude patients who meet these criteria from the denominator, even though they might otherwise qualify. For example, the below exclusionary criteria for PSI-03 (pressure ulcer) must compare hundreds of different data points:

Exclude patients from the denominator, even if they meet the inclusion conditions, who meet any of these criteria:

- with length of stay of less than 5 days
- with a principal ICD-9-CM diagnosis code for pressure ulcer
- with any secondary ICD-9-CM diagnosis codes for pressure ulcer present on admission and any secondary ICD-9-CM diagnosis codes for pressure ulcer stage III or IV (or unstageable) present on admission
- with any-listed ICD-9-CM diagnosis codes for hemiplegia, paraplegia, or quadriplegia
- with any-listed ICD-9-CM diagnosis codes for spina bifida or anoxic brain damage
- with any-listed ICD-9-CM procedure codes for debridement or pedicle graft before or on the same day as the major operating room procedure (surgical cases only)
- with any-listed ICD-9-CM procedure codes for debridement or pedicle graft as the only major operating room procedure (surgical cases only)
- transfer from a hospital (different facility)
- transfer from a Skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF)
- transfer from another healthcare facility
- MDC 9 (skin, subcutaneous tissue, and breast)
- MDC 14 (pregnancy, childbirth, and puerperium)
- with missing gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing), or principal diagnosis (DX1=missing)

(AHRQ,
2014a)

The specific ICD9 codes for the above exclusionary conditions include any of the below codes:

ICD-9-CM Hemiplegia, paraplegia, or quadriplegia diagnosis codes:

33371 ATHETOID CEREBRAL PALSY
3341 HERED SPASTIC PARAPLEGIA
3420
34200
FLACCID HEMIPLEGIA
FLCCD HMIPLGA UNSPF SIDE
34201 FLCCD HMIPLGA DOMNT SIDE
34202 FLCCD HMIPLG NONDMNT SDE
3421
34210
SPASTIC HEMIPLEGIA
SPSTC HMIPLGA UNSPF SIDE
34211 SPSTC HMIPLGA DOMNT SIDE
34212 SPSTC HMIPLG NONDMNT SDE
34280 OT SP HMIPLGA UNSPF SIDE
34281 OT SP HMIPLGA DOMNT SIDE
34282 OT SP HMIPLG NONDMNT SDE
3429
34290
HEMIPLEGIA, UNSPECIFIED
UNSP HEMIPLGA UNSPF SIDE
34291 UNSP HEMIPLGA DOMNT SIDE
34292 UNSP HMIPLGA NONDMNT SDE
3430 CONGENITAL DIPLEGIA
3431 CONGENITAL HEMIPLEGIA
3432
3433
CONGENITAL QUADRIPLGIA
CONGENITAL MONOPLGIA
3434 INFANTILE HEMIPLEGIA
3438
3439
3440
34400
34401
34402
34403
34404
34409
3441
CEREBRAL PALSY, NEC
CEREBRAL PALSY, NOS
QUADRIPLGIA AND QUADRIPAREISIS
QUADRIPLGIA, UNSPECIFD
QUADRPLG C1-C4, COMPLETE
QUADRPLG C1-C4, INCOMPLT
QUADRPLG C5-C7, COMPLETE
QUADRPLG C5-C7, INCOMPLT

OTHER QUADRIPLEGIA
 PARAPLEGIA NOS
 3442 DIPLEGIA OF UPPER LIMBS
 3443 MONOPLGIA OF LOWER LIMB (end
 34430 MONPLGA LWR LMB UNSP SDE
 34431 MONPLGA LWR LMB DMNT SDE
 34432 MNPLG LWR LMB NONDMNT SD
 3444 MONOPLGIA OF UPPER LIMB
 34440 MONPLGA UPR LMB UNSP SDE
 34441 MONPLGA UPR LMB DMNT SDE
 34442 MNPLG UPR LMB NONDMNT SD
 3445 MONOPLGIA NOS
 34460 CAUDA EQUINA SYND NOS
 34461 NEUROGENIC BLADDER
 3448 OTHER SPECIFIED PARALYTIC
 SYNDROMES
 34481 LOCKED-IN STATE
 34489 OTH SPCF PARALYTIC SYND
 3449 PARALYSIS NOS
 43820 LATE EF-HEMPLGA SIDE NOS
 43821 LATE EF-HEMPLGA DOM SIDE
 43822 LATE EF-HEMIPLGA NON-DOM
 43830 LATE EF-MPLGA UP LMB NOS
 43831 LATE EF-MPLGA UP LMB DOM
 43832 LT EF-MPLGA UPLMB NONDOM
 43840 LTE EF-MPLGA LOW LMB NOS
 43841 LTE EF-MPLGA LOW LMB DOM
 43842 LT EF-MPLGA LOWLMB NONDM
 43850 LT EF OTH PARAL SIDE NOS
 43851 LT EF OTH PARAL DOM SIDE
 43852 LT EF OTH PARALS NON-DOM
 43853 LT EF OTH PARALS-BILAT
 7687 HYPOXIC-ISCHEMIC ENCEPH
 76870 HYPOXC-ISCHEM ENCEPH NOS
 76872 MOD HYPOS-ISCHEM ENCEPH
 76873 SEV HYPOX-ISCHEM ENCEPH

ICD-9-CM Spina bifida or anoxic brain damage diagnosis codes:

3481 ANOXIC BRAIN DAMAGE
 74100 SPIN BIF W HYDROCEPH NOS
 74101 SPIN BIF W HYDRCEPH-CERV
 74102 SPIN BIF W HYDRCEPH-DORS
 74103 SPIN BIF W HYDRCEPH-LUMB
 74190 SPINA BIFIDA
 74191 SPINA BIFIDA-CERV
 74192 SPINA VIFIDA-DORSAL
 74193 SPINA BIFIDA-LUMBAR
 7685 SEVERE BIRTH ASPHYXIA

ICD-9-CM Debridement or pedicle graft procedure codes:

8345 OTHER MYECTOMY
 8622 EXC WOUND DEBRIDEMENT
 8628 NONEXCIS DEBRIDEMENT WND
 8670 PEDICLE GRAFT/FLAP NOS
 8671 CUT & PREP PEDICLE GRAFT
 8672 PEDICLE GRAFT ADVANCEMEN
 8674 ATTACH PEDICLE GRAFT NEC
 8675 REVISION OF PEDICLE GRFT

(AHRQ,
 2014a)

Once the engine identifies a patient discharge as meeting the standard criteria for inclusion in the denominator, and the visit is not excluded (as described above for PSI-03), the patient's chart is then reviewed by the engine to determine if the patient was diagnosed with a secondary condition that meets PSI criteria during their admission at MUHA. This determines if the patient is included in the numerator when determining the percentage of patients who potentially acquired this condition after admission. This percentage is then multiplied by 1000 to determine the rate, always shown as the number of instances per 1000 discharges.

$$\text{rate} = \frac{\text{patients}_{\text{withSecondaryDx}}}{\text{patients}_{\text{whoMetInclusionCriteria}}} \times 1000$$

The engine uses the secondary diagnoses in this determination because the primary diagnosis is the reason for admission, and therefore the patient would not have developed that condition after admission.

Below is an example of the numerator criteria for PSI-03, Pressure Ulcer Rate (see the appendices for the criteria for all PSIs):

Include patients in the numerator, for...

Discharges, among cases meeting the inclusion and exclusion rules for the denominator, with any secondary ICD-9-CM diagnosis codes for pressure ulcer and any secondary ICD-9-CM diagnosis codes for pressure ulcer stage III or IV (or unstageable).

ICD-9-CM Pressure ulcer diagnosis codes:

70700 PRESSURE ULCER, SITE NOS
70701 PRESSURE ULCER, ELBOW
70702 PRESSURE ULCER, UPR BACK
70703 PRESSURE ULCER, LOW BACK
70704 PRESSURE ULCER, HIP
70705 PRESSURE ULCER, BUTTOCK
70706 PRESSURE ULCER, ANKLE
70707 PRESSURE ULCER, HEEL
70709 PRESSURE ULCER, SITE NEC 1

ICD-9-CM Pressure ulcer stage diagnosis codes:

70723 PRESSURE ULCER, STAGE III
70724 PRESSURE ULCER, STAGE IV
70725 PRESSURE ULCER, UNSTAGEBL

(AHRQ, 2014a)

The data warehouse is the most efficient way to analyze the above criteria, as it is the only dataset that includes data from all care settings and is designed to analyze large data sets without affecting the users on the production EMR. Since the production EMR is for direct patient care, it requires fast response times for the caregivers. Running a process such as the AHRQ engine against the EMR data would slow performance for the real-time users (caregivers) and potentially lock patient records while the process was examining them.

This researcher's null hypothesis suggests that the patient documentation is accurate, and therefore reviewing the charts would not improve the reported PSI rates. The alternative hypotheses, however, suggests that MUHA does not have as many actual PSIs as the initial patient documentation would indicate upon discharge. Instead, MUHA's rate of

PSIs is skewed by inaccurate documentation by caregivers or coders, which then must be corrected after discharge to portray an accurate representation of the patient's quality of care.

If any of the alternative hypotheses were favored, then the researcher will expect to observe a decreased rate for one or more of the included PSIs post-intervention. Further, if the quality department can then focus their attention on this new, lower rate of PSIs, then the actual rate of PSIs may also show a decrease. If the null hypothesis is correct, then reviewing preliminary PSI rates will not influence the final, published rates as the draft rates would be accurate.

PARTICIPANTS

This study will include all patients discharged from MUHA's hospitals throughout the period October 1, 2012 to August 31, 2015. MUHA initiated the AHRQ engine in October, 2013, therefore the intervention period will be October 1, 2013 to August 31, 2015. The pre-intervention period, which will be used as the baseline, is the twelve-month period from October 1, 2012 to September 30, 2013.

PSI rates for discharges October 1, 2012 to September 30, 2013 will be determined after the fact, and not during the period in which they occurred. Because the AHRQ system was not available at MUHA until October 2013, this pre-intervention data will be calculated as part of this study by running patient information from the data warehouse for these periods through the AHRQ engine.

Although each PSI has its own patient population of interest (the denominator), all patient discharges are passed through the engine to determine eligibility. The resulting set of patients that comprise the denominator for each PSI is then considered to be the sample size for that particular PSI. Because the researcher has no control over the sample size, a priori power analysis will not be used to determine sample size. Instead, a post-hoc power analysis will be conducted as part of the results analysis to determine its power.

MUHA was chosen for this study due to its size, patient mix, and willingness to participate in the study. MUHA represents:

- 703 patient beds,
- 1,200 physicians (attending, residents, house staff)
- 1,925 nursing staff,
- \$1.2 billion in 2013 annual revenue
- 39,500 patient admissions annually

DATA ANALYSIS

Like many healthcare organizations, MUHA had a best-of-breed approach to their electronic health record (EHR). This approach means that multiple systems must be tied together in order to determine compliance with best practices or to identify hospital acquired conditions (HACs), such as PSIs. Even with the implementation of Epic Enterprise on July 1, 2014, there are still many other systems required to provide patient care that do not feed their data into Epic.

In addition, historical patient data was not converted or loaded into Epic, and the only demographic information loaded into Epic was for patients who had upcoming visits

scheduled. This means that any type of analysis that requires a review of the patient’s entire medical history, or any analysis that requires the entire patient population, must be conducted within the data warehouse – the only system that includes either of these data sets and that had the processing capacity to perform such an analysis without directly affecting patient care.

Since this study is reviewing all patient discharges for MUHA from October 1, 2012 to August 31, 2015, a period of nearly three years, neither the current nor the old EMR was an option as each system only contained half of the required data. Therefore, the data warehouse was determined to be the only source of data for the AHRQ engine and for this study. Of the set of AHRQ-defined PSIs, the following PSIs will be included as part of this study as these are the PSIs identified by MUHA as part of their quality improvement program:

PSI	PSI Description
03	Pressure Ulcer-Prior 20074 Decubitus Ulcer
06	Iatrogenic Pneumothorax
09	Postoperative Hemorrhage or Hematoma
10	Postoperative Physiologic and Metabolic Derangement
11	Postoperative Respiratory Failure
12	Perioperative Pulmonary Embolism or Deep Vein Thrombosis
13	Postoperative Sepsis
14	Postoperative Wound Dehiscence
15	Accidental Puncture or Laceration

Although each PSI has its own criteria for defining its patient population of interest (the denominator), and another set of criteria that defines the patient population who are suspected of having the particular PSI (the numerator), all nine of the PSIs above result in a calculated rate. This rate is indicated as “number of PSI events per 1000 discharges” by AHRQ. The rates are specific to each PSI, with the number of suspected PSI events

calculated using the numerator criteria and the qualifying discharges being calculated using the denominator criteria.

Because the AHRQ rates are published “per 1000 discharges,” and not as a percentage, they are listed to two decimal places. Therefore all rates in this study will also be represented to two decimal places (e.g., 5.42, 89.33, and 3.17) in order to detect all differences publishable by AHRQ. The percentage of patient discharges that result in the specific PSI will also be shown, even though it can be calculated by the reader by dividing the rate (# of events/1000 discharges) by 1000. For example, if a PSI has an incidence rate of 15 PSI events per 1000 qualifying discharges, then the percentage of patient discharges suspected of meeting the PSI criteria is calculated as $\frac{15}{1000} = 1.50\%$.

An example of the results is shown below, shown here with only nine months and only for three PSIs. The actual results will be represented in a table showing all twenty-four months included in the study and for all PSIs included as part of the study.

The numbers shown are the rates for each PSI (incidents per 1000 discharges).

PSI	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013	May 2013	Jun 2013
03	7.00	5.01	2.90	4.43	5.12	7.23	2.99	4.48	6.15
06	0.40	0.35	0.50	0.24	0.22	0.39	0.50	0.42	0.44
09	1.40	4.90	4.88	2.44	5.21	0.00	11.20	7.79	3.98

Although the examples provided above are contrived, actual PSI rates can vary greatly from month to month due to a variety of factors (patient mix, staffing levels, normal variability, etc.). Therefore, in addition to comparing actual rates pre- and post-intervention, this study will also identify trends in the rates (per 1000 discharges) for each

PSI in the study. Trends for each PSI rate will be shown for the three periods shown below, with each graph representing a single PSI:

1. Pre-intervention period only
2. Post-intervention period only
3. Pre- and post-intervention period

The pre-intervention period trend will be used to determine, for each PSI, the direction the rate was trending prior to the intervention. The post-intervention period trend will be used to determine, for each PSI, the direction the rate is trending after the intervention. The pre- and post-intervention trend will then provide a continuous picture of the overall direction the rate is trending for each PSI.

By using the three separate trends, any change in the trend in the incident rate (per 1000 discharges) can be compared to determine if the intervention had an impact on the direction or degree of change for any given PSI. Trends will be determined in a linear fashion.

The nine PSIs included in this study are defined in more detail in the introduction chapter.

POST-INTERVENTION REVIEW

The above PSIs have three possible states pre- versus post-intervention:

1. The PSI rate may improve
2. The PSI rate may remain stable
3. The PSI rate may get worse

To determine any changes in the rates, each PSI will be compared pre- and post-intervention, along with their trends, to determine if the PSI improved, remained stable, or became worse.

This study will be using the actual PSI rates reported to AHRQ monthly to determine if the program intervention was effective, and not depending on interviews, surveys, or other qualitative instruments to collect data. Because MUHA is a medium sized academic medical center, sees a good mix of patients, and has been using this quality program for over one year, it is believed that the program and its results could be duplicated at other hospitals. However, a power analysis will be conducted to determine the probability that the results may be duplicated across larger patient populations.

One major constraint for other providers will be the availability of a data warehouse or other data repository that can be used to feed the AHRQ engine offline from the EMR. Given that other organizations have the required infrastructure and data sets available, the sampling data from MUHA will be used to determine, with an 80% or higher confidence, that the same intervention process could be used for other patient populations at other organizations.

The program intervention includes the entire patient population at MUHA for the period of time included in the study. This population of patients will be considered a sample as the entire population will include all possible patients admitted to MUHA in the future as well as other hospitals who implement the same intervention.

By reviewing all PSI rates, including those that do not improve, the researcher also believes that new research questions will be developed that will lead to other potential studies to determine the root causes for these deviant PSI rates.

LIMITATIONS

It is possible that not all PSIs studied by this researcher will show a decreased rate pre-versus post-intervention.

As an example, in cases where the numerator or denominator are dependent upon data automatically collected, such as from lab or radiology results, documentation errors are less common. If the PSI's numerator and denominator are not dependent upon such data feeds, then other potential causes for the lack of improvement will be reviewed based on a more complete review of the criteria, the PSI intervention process, and other potential quality factors at MUHA affecting the PSI rate.

It is possible that a limited number of nursing units are the source of any increase, or lack of decrease, for a given PSI. To test this, if any nursing unit has a disproportionate share of the numerator a second analysis will be performed. A disproportionate share will be determined if a nursing unit's rate is not within two standard deviations of the mean rate for all nursing units.

The above analysis, if required, will be included in the results and discussion chapters of this study.

Since all PSIs are charged against the discharging nursing unit, any patient transfers within MUHA will not be taken into consideration. Therefore, the engine attributes all

PSIs to the discharging unit, even if the patient is only on that unit for a small percentage of their admission duration.

Other than the above listed analysis, this study will not attempt to determine the root cause of why any nursing unit did not improve their scores for a given PSI. This is because the increase may be due to a reduction in nursing staff levels or experience, a reduction in physician staffing levels or experience, a change in nursing unit leadership, a shift in patient mix, or a variety of other root causes that may suggest a need for further research.

Results

This study reviewed an intervention initiated by MUHA in October 2013 whereby MUHA pulls all patient discharge data from the data warehouse and processes it through an AHRQ-provided data engine, designed specifically to detect probable PSIs. The AHRQ engine creates a list of patients that have indications of one or more PSIs based on an automated analysis of data in the electronic medical record system. Up to four different clinical quality groups then review the patients on this list to ensure that both the clinical documentation and the medical coding are correct. The goal of the intervention is to reduce the number of false-positives submitted to CMS, UHC, and third-party payers in order to more accurately reflect MUHA's quality of care.

For the PSIs included in this study, all patient discharges at MUHA were reviewed since program inception in October 2013. Further comparisons are made for October 2012 to September 2013 in order to provide a basis for comparison pre- and post-implementation of the processes at MUHA. MUHA discharges approximately 36,000 patients per year.

This study determined if an internal process implemented by MUHA could improve MUHA's reported PSI rates. The study only included those PSIs included in the composite PSI-90 score as listed in Table 2. PSI-90, the composite PSI score that is suggested to represent a view of a hospital's overall quality, and an organization's PSI-90 composite score may be used to reduce CMS reimbursements as it is used as a metric in two of its pay-for-performance programs.

Table 2 lists the components of PSI-90 along with their weights (as a percentage of 1.00) of the total PSI-90 score. Two PSIs that are included in the PSI-90 composite score, PSI-08 and PSI-10, were excluded by MUHA due to their low incidence rates at MUHA and

low weights within the composite. Two other PSIs, PSI-09 and PSI-11, were included in the study since they are included in other publicly reported rankings, even they do not currently contribute any weight to the PSI-90 composite score.

PSI	PSI Description	Percentage of PSI-90 Composite Score	MUHA Excluded from Program
03	Pressure Ulcer-Prior 20074 Decubitus Ulcer	24.03%	
06	Iatrogenic Pneumothorax	4.57%	
07	Central Venous Catheter-Related Blood Stream Infection	12.80%	
08	Postoperative Hip Fracture	0.11%	✓
09	Postoperative Hemorrhage or Hematoma	0.0%	
10	Postoperative Physiologic and Metabolic Derangement	0.0%	✓
11	Postoperative Respiratory Failure	0.0%	
12	Perioperative Pulmonary Embolism or Deep Vein Thrombosis	23.60%	
13	Postoperative Sepsis	3.83%	
14	Postoperative Wound Dehiscence	1.24%	
15	Accidental Puncture or Laceration	29.83%	

Table 2- PSI-90 Elements (AHRQ, 2010)

The results listed in the following tables begin in the first month of the new process, October 2013, and include data through August 2015. The results listed in the graphs begin twelve months prior to the program’s commencement to use as a comparison of pre- vs post-implementation rates. The researcher extracted the data in September 2015, allowing the quality teams involved in the process to make the required corrections for all months up to August 2015. The results presented are broken down by each individual PSI included in PSI-90. There is one table and one chart listed for each PSI included in the study.

- Table “PSI-XX Flagged and Corrected Incidents”: The number of incidents for a given PSI automatically flagged and the number manually corrected for a given

month, listed since program inception. Note this table lists patient records flagged, and not the incidence rate. The last row is the percentage reduced through documentation correction. The three columns of data presented are:

- Year / Month – the year and month of the patient’s discharge, sorted descending by year and then month.
 - Flagged Count – the count of patients flagged by the AHRQ engine as having a potential preventable condition indicated by this PSI.
 - Corrected Count – the count of patients flagged by the AHRQ engine as having a potential preventable condition indicated by this PSI, but then being removed from the list for this PSI because the clinical documentation was corrected.
- Chart “PSI-XX Incidence Rate (per 1000 Discharges)”: The incidence rate, per 1000 qualifying discharges patients, identified as having PSI-XX. This is the standard method that AHRQ, CMS, and other reporting groups use to measure PSI incidence. Grouped by year and month and showing two linear trend lines beginning twelve months prior to program inception. A dashed *vertical* line indicates when the program was initiated at MUHA. A diamond (◇) on the Y axis indicates the national average for this PSI as reported by AHRQ in 2013 (AHRQ, 2013). Two data points are represented on this graph – when only one data point is shown, then the two data points match for a given period. Trends are also represented on the graph for each of the two data points. The *dashed* trend line indicates the linear trend of the automatically flagged / detected PSIs, while the

dash-dot-dot trend line indicates the linear trend after corrections are made to the documentation. Beta coefficients of both trend lines are also provided.

There are two PSIs that MUHA decided to exclude from their program, even though they are part of the PSI-90 composite score, due to the low percentage value that each contribute to the PSI-90 score (PSI-08 and PSI-10). PSI-09 and PSI-11, although also having a low contribution to PSI-90, were included due to MUHA's desire to lower the overall incidence rate of these indicators and because they are included in some publicly reported ranking systems.

PSI-03

PSI-03, pressure ulcers, showed little improvement in incidents between those flagged and those determined real based on a manual review of documentation and subsequent clinical review. PSI-03 Flagged and Corrected Incidents, Table 3, lists the count of PSI-03 incidents detected and the count of incidents removed after documentation review and correction. There was only a single correction since the program commenced.

Year / Month	Flagged Count	Corrected Count
2013/10	0	0
2013/11	3	0
2013/12	0	0
2014/1	1	0
2014/2	1	0
2014/3	4	0
2014/4	1	0
2014/5	0	0
2014/6	1	0
2014/7	1	0
2014/8	0	0

2014/9	0	0
2014/10	1	0
2014/11	1	0
2014/12	1	0
2015/1	0	0
2015/2	0	0
2015/3	1	0
2015/4	0	0
2015/5	0	0
2015/6	4	1
2015/7	1	0
2015/8	1	0
Totals	22	1
Percent Corrected	4.5%	

Table 3 - PSI-03 Flagged and Corrected Incidents

This single correction listed above resulted in a 4.5% reduction between automatically flagged and reported incident counts due directly to this program.

The incidence rate for PSI-03, calculated as the number of incidents detected per 1000 qualifying patient discharges in Figure 5, has trended upward since October 2012 and continued that trend even after program inception. The average incident rate was 1.94 per 1000 qualifying discharges from October 2012 to September 2013, but has dropped 3% to 1.87 per 1000 qualifying discharges since program commencement in October 2013. After corrections the post implementation rate is 1.79, a drop of 8% over pre-implementation. Although also trending upward as represented in Figure 5, the beta coefficient of the corrected trend line is only 33.7% of the beta coefficient of the detected trend line.

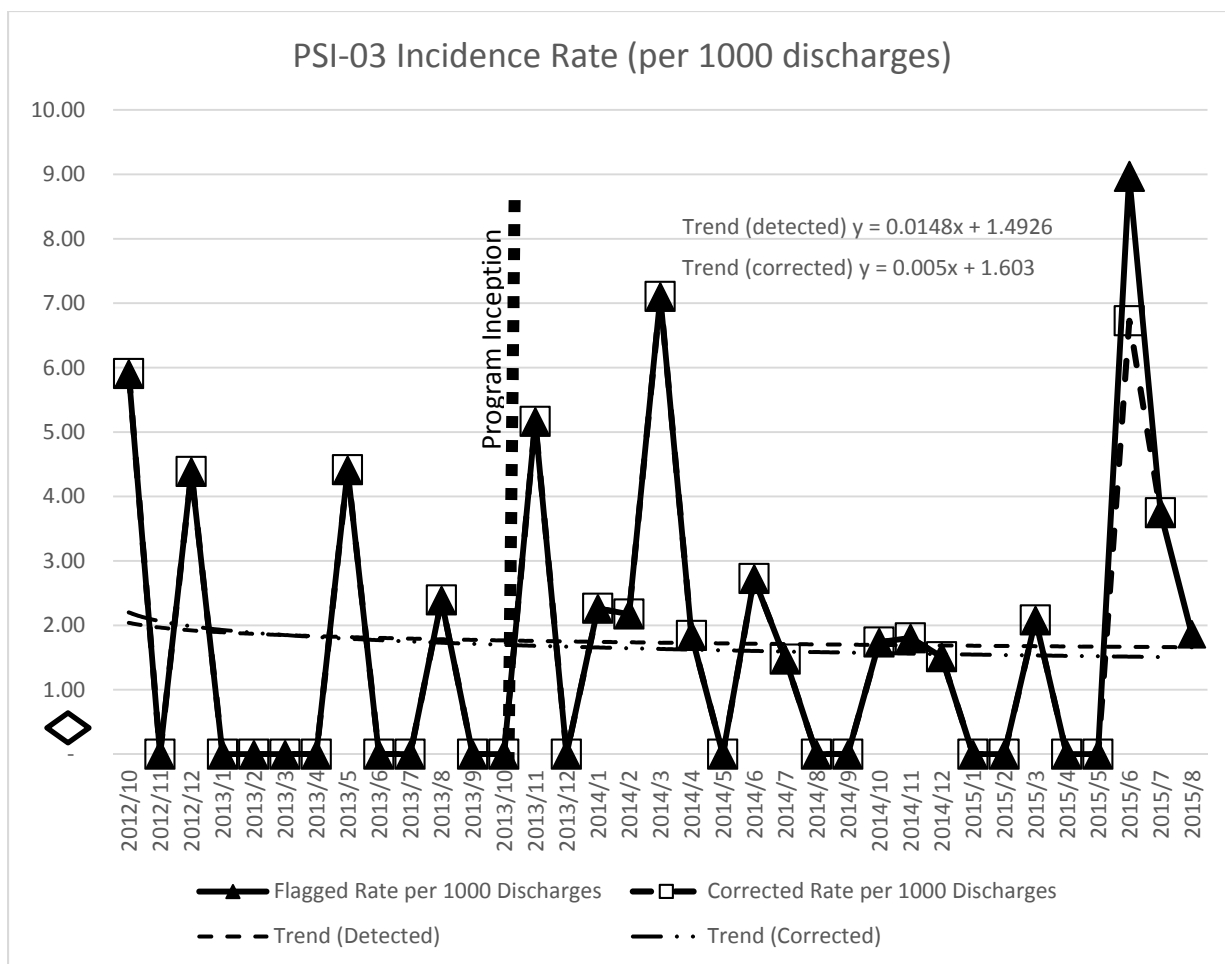


Figure 7 - PSI-03 Incidence Rates (per 1000 discharges)

PSI-06

PSI-06, Iatrogenic Pneumothorax, showed little improvement in incidents between those flagged and those determined real based on a manual review of documentation and subsequent clinical review. PSI-06 Flagged and Corrected Incidents, Table 4, lists the count of PSI-06 incidents detected and the count of incidents removed after documentation review and correction. There was only a single correction since the program commenced.

Year / Month	Flagged Count	Corrected Count
2013/10	0	0
2013/11	0	0
2013/12	1	0
2014/1	1	0
2014/2	0	0
2014/3	2	0
2014/4	1	0
2014/5	0	0
2014/6	0	0
2014/7	1	0
2014/8	1	0
2014/9	0	0
2014/10	0	0
2014/11	0	0
2014/12	1	0
2015/1	4	0
2015/2	0	0
2015/3	1	0
2015/4	2	0
2015/5	1	0
2015/6	0	0
2015/7	1	1
2015/8	1	0
Totals	18	1
Percent Corrected		5.6%

Table 4 - PSI-06 Flagged and Corrected Incidents

The single correction listed above resulted in a 5.6% reduction between automatically flagged and reported incident counts due directly to this program.

The incidence rate for PSI-06, calculated as the number of incidents detected per 1000 qualifying patient discharges in Figure 6, has trended upward since October 2012 and has continued that trend even after program inception. The average incident rate was 0.46 per 1000 qualifying discharges from October 2012 to September 2013, and remained at that

rate after program commencement in October 2013. After corrections the post implementation rate is 0.43, a drop of 6%. Although also trending upward as represented in Figure 6, the beta coefficient of the corrected trend line is only 39% of the beta coefficient of the detected trend line.

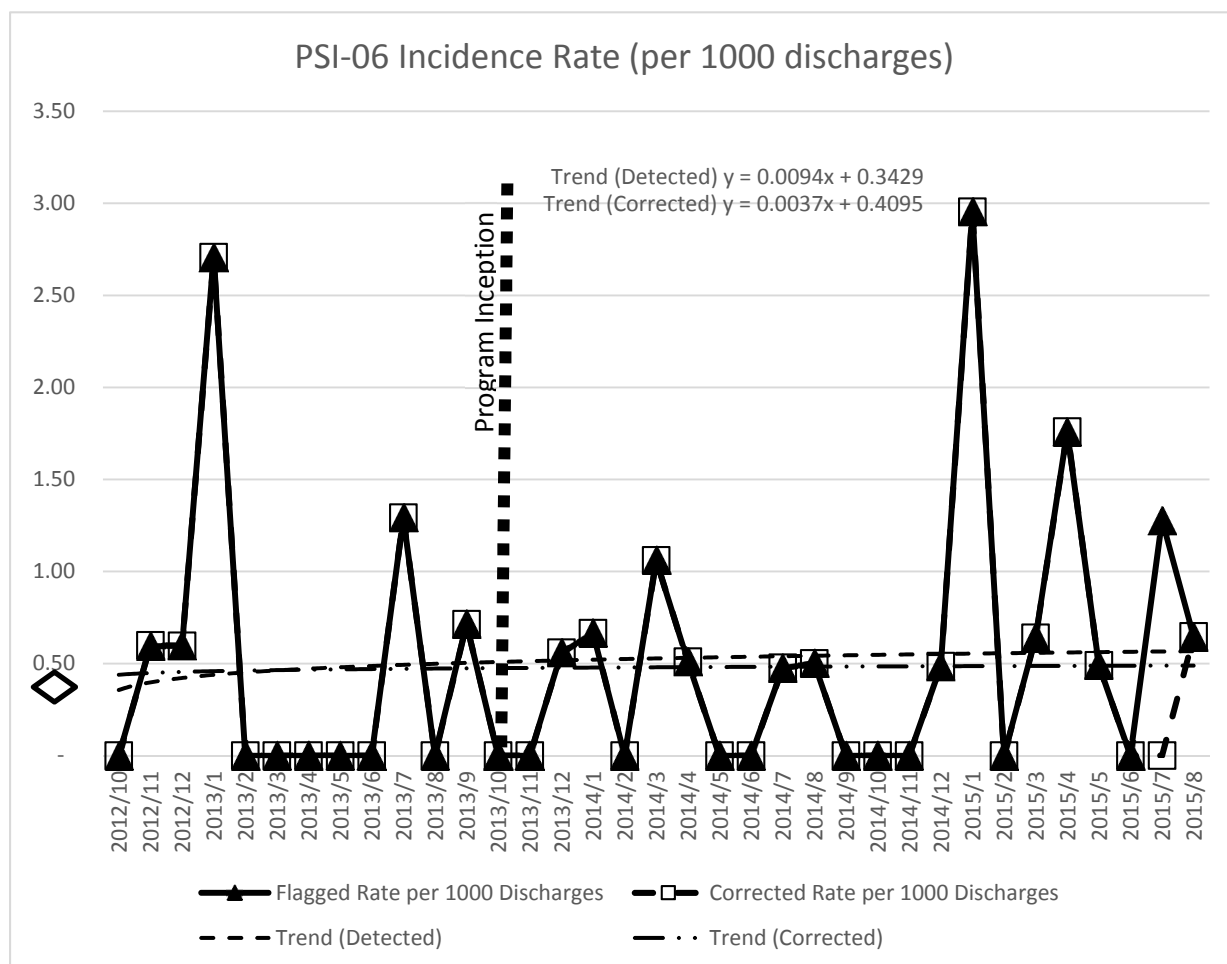


Figure 8 - PSI-06 Incidence Rates (per 1000 discharges)

PSI-07

PSI-07, Central Venous Catheter-Related Blood Stream Infection, showed an 18.2% decrease in reported incidents compared to the flagged incidents. There is a slight

downward trend in flagged incidents but a larger decrease in the trend for actual incidents due to the high number of corrected documentation in recent months. PSI-07 Flagged and Corrected Incidents, Table 5, lists the count of PSI-07 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	0	0
2013/11	0	0
2013/12	0	0
2014/1	0	0
2014/2	1	1
2014/3	0	0
2014/4	1	1
2014/5	1	0
2014/6	0	0
2014/7	0	0
2014/8	0	0
2014/9	0	0
2014/10	0	0
2014/11	2	0
2014/12	0	0
2015/1	0	0
2015/2	1	0
2015/3	0	0
2015/4	0	0
2015/5	0	0
2015/6	0	0
2015/7	0	0
2015/8	0	0
Totals	6	2
Percent Corrected	33.3%	

Table 5 - PSI-07 Flagged and Corrected Incidents

The two corrections listed above resulted in a 33.3% reduction between automatically flagged and reported incident counts due directly to this program.

The automatically flagged incident rate dropped from 0.30 per 1000 to 0.22 per 1000, followed by a 33.3% chart correction rate. This resulted in a post-correction rate of 0.15, a 50% drop in the actual incident rate as compared to pre-implementation. As demonstrated in Figure 7, the beta coefficient of the corrected trend line is 5% higher than the beta coefficient of the detected trend line.

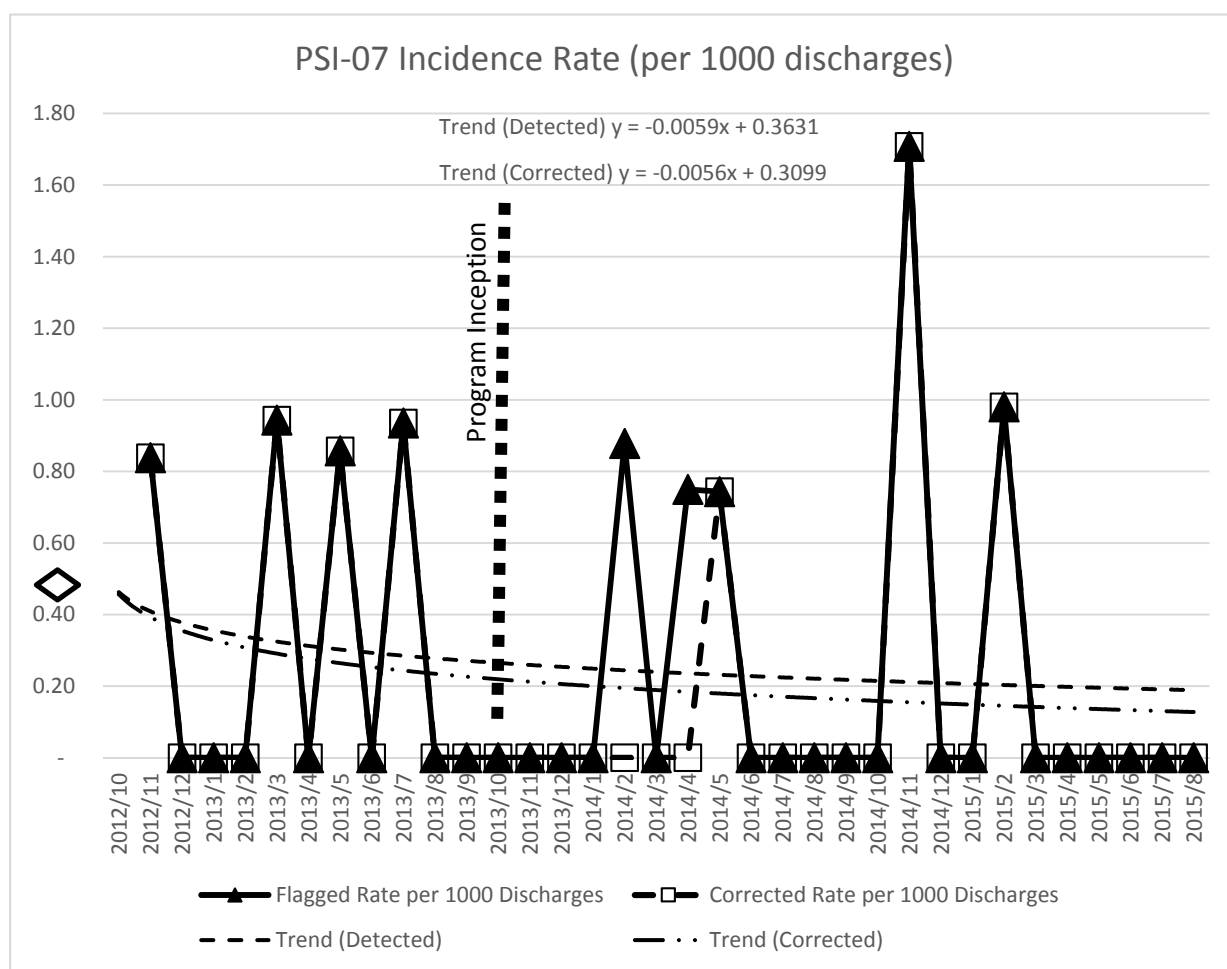


Figure 9 - PSI-07 Incidence Rates (per 1000 discharges)

PSI-08

Although part of the composite PSI-90 score, MUHA decided not to include this PSI in its process due to them having no flagged PSI-08 discharges since 2010.

PSI-09

PSI-09, Postoperative Hemorrhage or Hematoma, demonstrated a 15.1% decrease in reported incidents compared to the flagged incidents. PSI-09 Flagged and Corrected Incidents, Table 6, lists the count of PSI-09 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	8	0
2013/11	1	0
2013/12	3	0
2014/1	10	1
2014/2	8	1
2014/3	9	2
2014/4	2	0
2014/5	9	0
2014/6	6	2
2014/7	9	0
2014/8	6	2
2014/9	9	0
2014/10	5	1
2014/11	7	2
2014/12	5	1
2015/1	6	3
2015/2	6	2
2015/3	6	1
2015/4	6	1
2015/5	9	0
2015/6	4	0
2015/7	1	1
2015/8	4	1
Totals	139	21
Percent Corrected	15.1%	

Table 6 - PSI-09 Flagged and Corrected Incidents

The incidence rate for PSI-09, demonstrated as the number of incidents detected per 1000 qualifying patient discharges, Figure 8, has trended slightly upward since October 2013 for flagged records, but downward sharply for corrected records. The average reported incident rate was 9.30 per 1000 qualifying discharges from October 2012 to September 2013, but decreased by 18% to 7.65 per 1000 qualifying discharges since program commencement in October 2013. For uncorrected records, the trend has been slightly downward, with a pre-commencement average of 9.30 and a post-commencement average of 9.02, a drop of 3%. The corrected incidents represent a 15.1% improvement over the uncorrected incidents since program commencement. Although both trend lines are decreasing as demonstrated in Figure 8, the beta coefficient of the corrected trend line is 27 times better than the beta coefficient of the detected trend line.

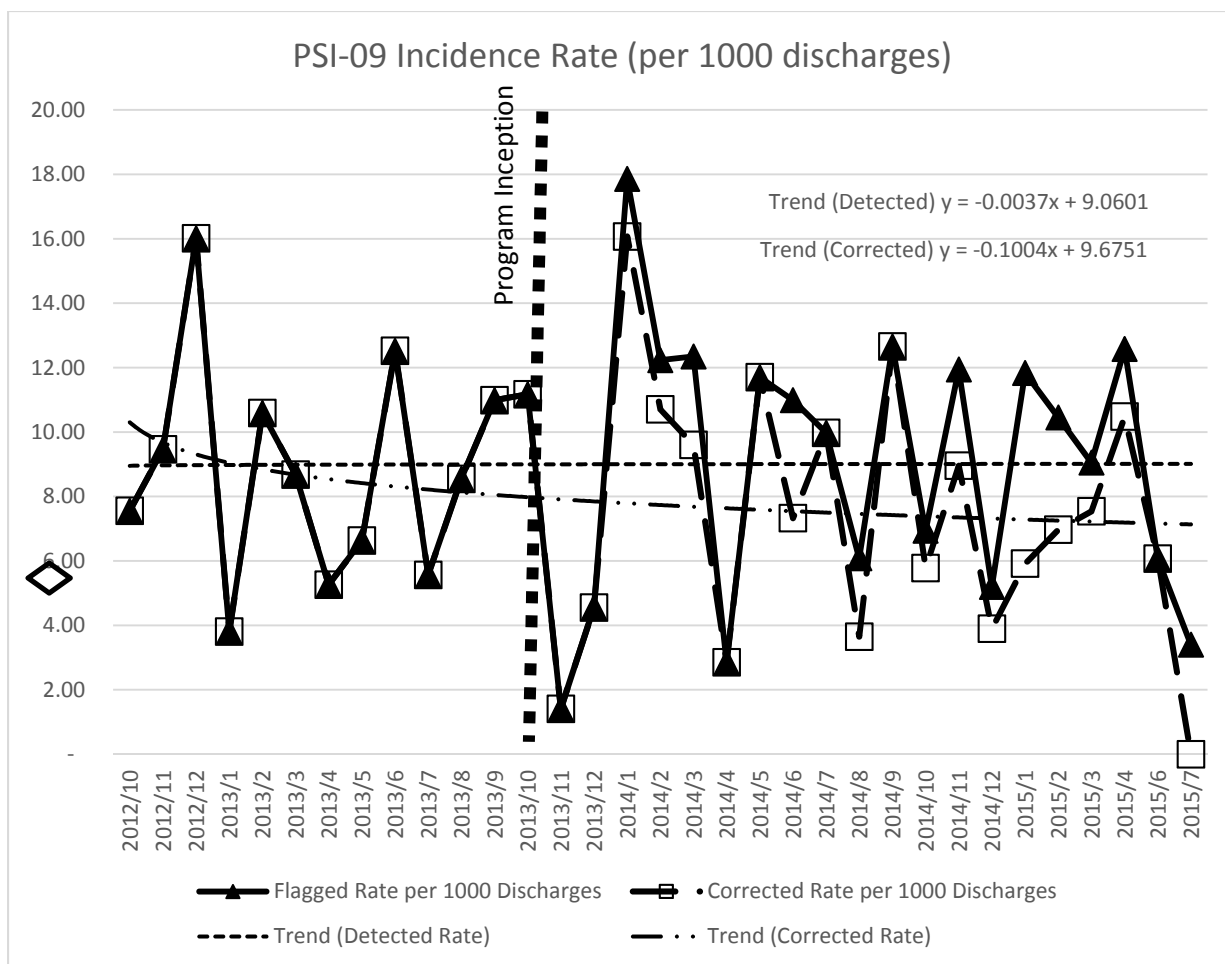


Figure 10 - PSI-09 Incidence Rates (per 1000 discharges)

PSI-10

PSI-10, Postoperative Physiologic and Metabolic Derangement, is a part of PSI-90 but MUHA decided not to include this PSI in its process. Unlike PSI-08, the data for PSI-10 is collected but not reviewed. The data shown in PSI-10 Incidence Rates (per 1000 discharges), Table 9, are for automatically flagged data only.

The incidence rate for PSI-10, demonstrated as the number of incidents detected per 1000 qualifying patient discharges in the following chart, has trended upward since October 2012 for automatically flagged records. The average incident rate was 0.54 per 1000

qualifying discharges from October 2012 to September 2013, but increased by 101% to 1.09 per 1000 qualifying discharges since program commencement in October 2013. Since PSI-10 was not included as part of this program, no records were corrected so all figures are for automatically flagged records and are those that are publicly reported.

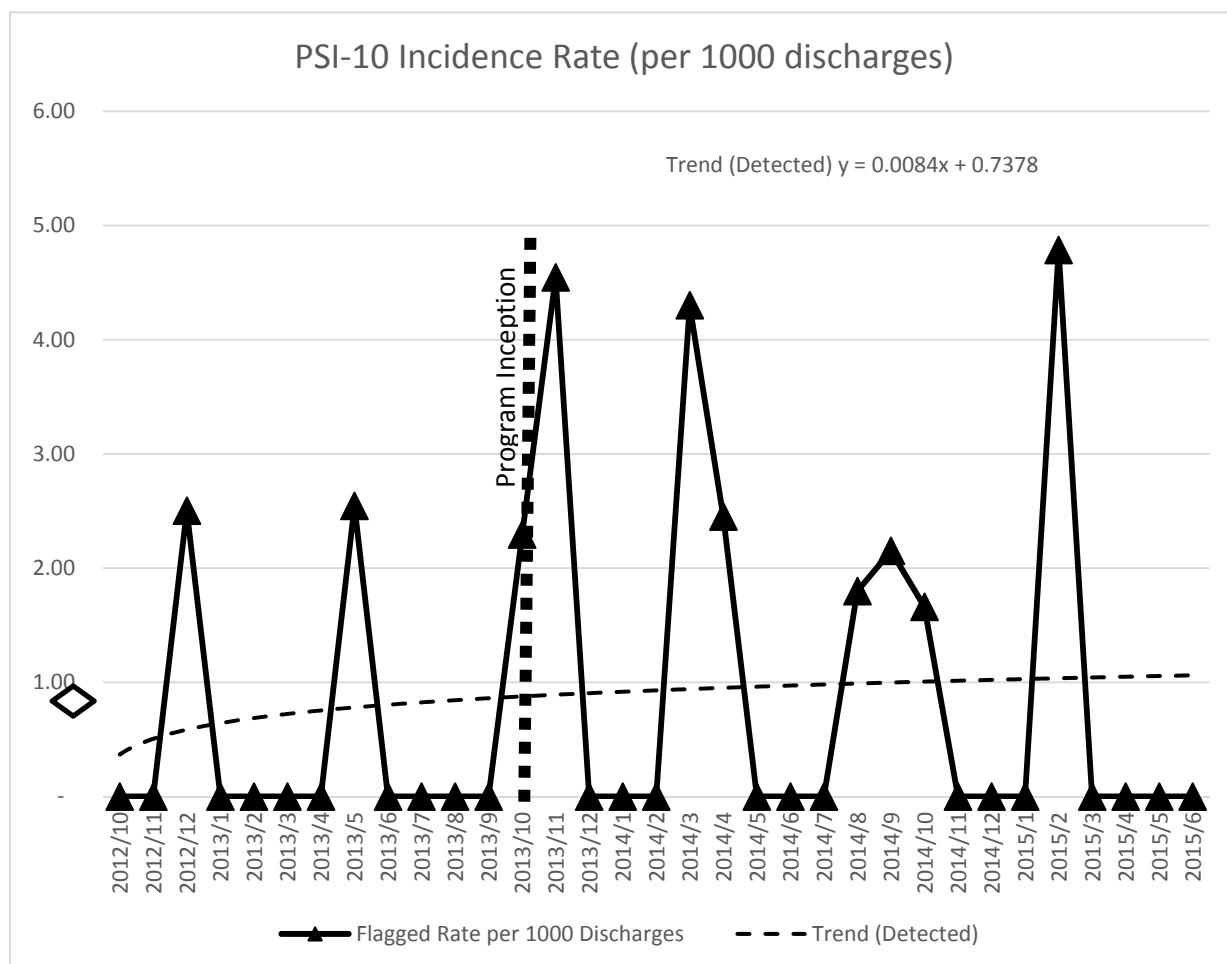


Figure 11 - PSI-10 Incidence Rates (per 1000 discharges)

PSI-11

PSI-11, Postoperative Respiratory Failure, demonstrated a 25.5% reduction in reported incidents when compared to the automatic flagging of PSI-11 incidents. PSI-11 Flagged

and Corrected Incidents, Table 7, lists the count of PSI-11 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	8	3
2013/11	8	2
2013/12	7	4
2014/1	4	2
2014/2	3	0
2014/3	10	4
2014/4	7	3
2014/5	9	0
2014/6	9	2
2014/7	8	4
2014/8	6	3
2014/9	4	0
2014/10	7	0
2014/11	12	2
2014/12	5	1
2015/1	5	1
2015/2	4	1
2015/3	5	1
2015/4	8	4
2015/5	10	1
2015/6	7	2
2015/7	2	0
2015/8	9	0
Totals	157	40
Percent Corrected		25.5%

Table 7 - PSI-11 Flagged and Corrected Incidents

The incidence rate for PSI-11, demonstrated as the number of incidents detected per 1000 qualifying patient discharges in the following chart, has trended downward since October 2012 for all records. The average incident rate was 26.25 per 1000 qualifying discharges

from October 2012 to September 2013, but decreased by 45% to 14.48 per 1000 qualifying discharges for corrected records since program commencement in October 2013. For uncorrected records, the trend has been downward as well, with a pre-commencement average of 26.25 and a post-commencement average of 19.43, a 26% improvement. The corrected records represented a 25% improvement over the uncorrected records since program commencement. The combination of the uncorrected rate dropping and a high percentage of corrected records resulted in the 45% drop in reported rates. The beta coefficient of the corrected rate trend line is 160% better than that of the flagged rate trend line.

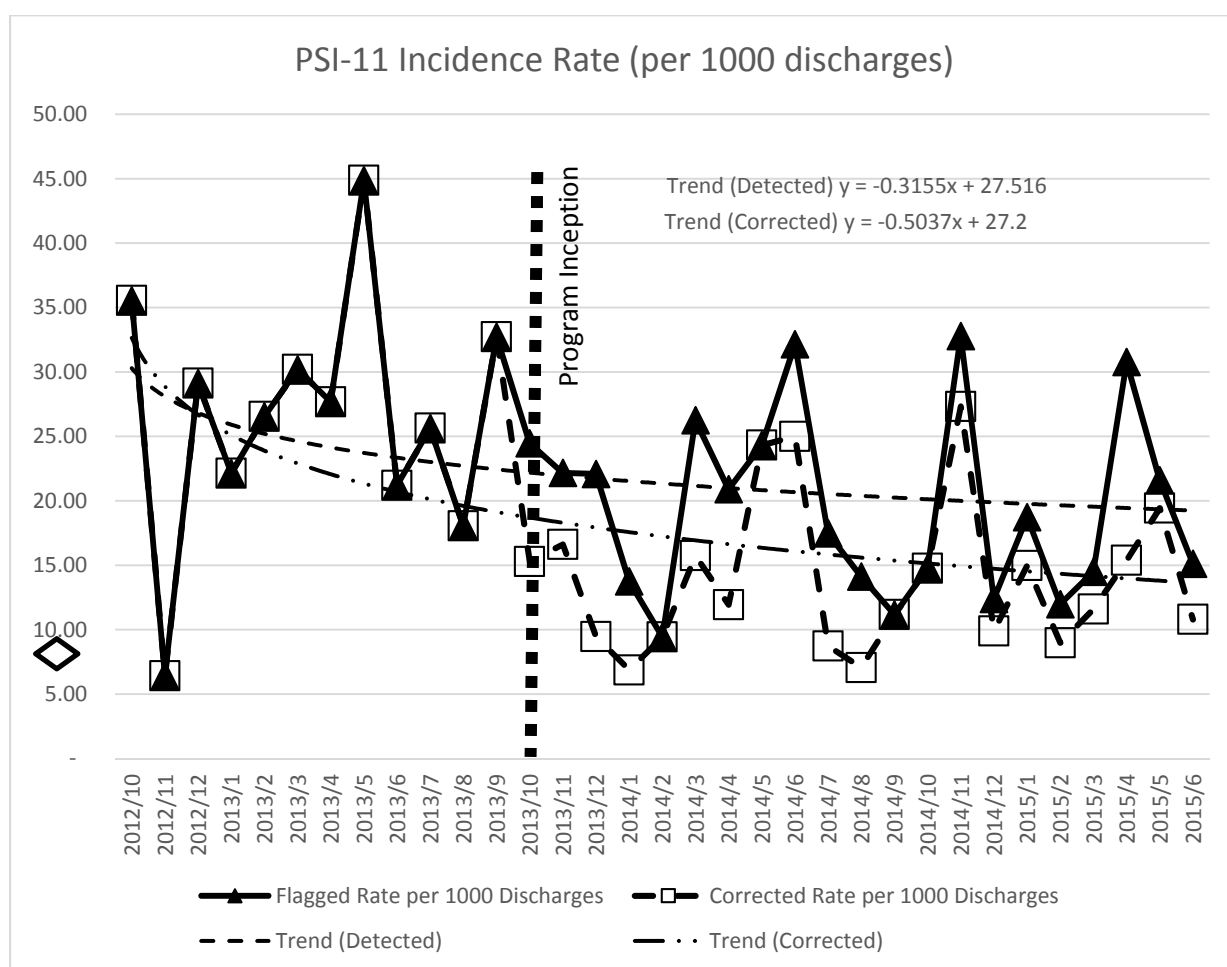


Figure 12 - PSI-11 Incidence Rates (per 1000 discharges)

PSI-12

PSI-12, Perioperative Pulmonary Embolism or Deep Vein Thrombosis, demonstrated a 25% reduction in reported rates compared to flagged rates since process inception. Most of that improvement was based on a reduction in automatically flagged incidents, as only 4.3% of the records were corrected as a result of this process. PSI-12 Flagged and Corrected Incidents, Table 8, lists the count of PSI-12 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	5	0
2013/11	9	0
2013/12	6	0
2014/1	12	0
2014/2	6	0
2014/3	13	0
2014/4	5	0
2014/5	8	0
2014/6	5	0
2014/7	4	0
2014/8	9	0
2014/9	9	1
2014/10	2	0
2014/11	5	0
2014/12	9	0
2015/1	2	0
2015/2	6	2
2015/3	3	0
2015/4	2	0
2015/5	6	0
2015/6	7	1
2015/7	3	1
2015/8	5	1

Totals	141	6
Percent Corrected	4.3%	

Table 8 - PSI-12 Flagged and Corrected Incidents

The incidence rate for PSI-12, demonstrated as the number of incidents detected per 1000 qualifying patient discharges in the following chart, has trended downward since October 2012 for all records. The average reported incident rate was 10.98 per 1000 qualifying discharges from October 2012 to September 2013, but decreased by 25% to 8.24 per 1000 qualifying discharges for corrected records since program commencement in October 2013. For uncorrected records, the trend has been downward as well, with a pre-commencement average of 10.98 and a post-commencement average of 8.60, a 22% improvement. The corrected records represent a 4.3% improvement over the uncorrected records since program commencement.

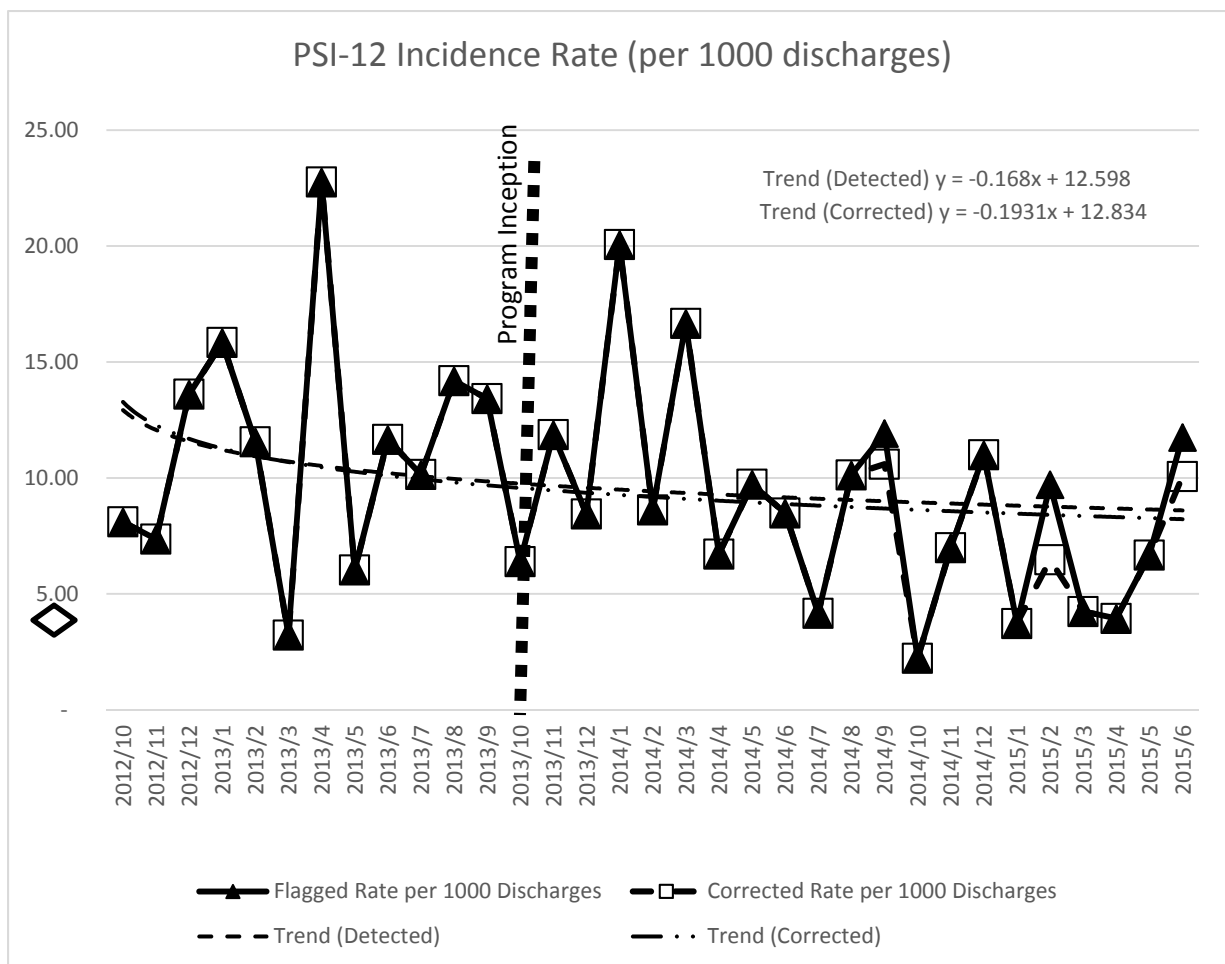


Figure 13 - PSI-12 Incidence Rates (per 1000 discharges)

PSI-13

PSI-13, Postoperative Sepsis, has demonstrated a 36% decrease in reported incidents compared to automatically flagged incidents. PSI-13 Flagged and Corrected Incidents, Table 9, lists the count of PSI-13 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	2	1
2013/11	3	1
2013/12	0	0
2014/1	1	1
2014/2	0	0
2014/3	0	0
2014/4	2	2
2014/5	2	0
2014/6	0	0
2014/7	0	0
2014/8	1	0
2014/9	2	0
2014/10	1	0
2014/11	3	1
2014/12	2	2
2015/1	0	0
2015/2	2	1
2015/3	1	0
2015/4	0	0
2015/5	0	0
2015/6	1	0
2015/7	1	0
2015/8	1	0
Totals	25	9
Percent Corrected		36%

Table 9 - PSI-13 Flagged and Corrected Incidents

The incidence rate for PSI-13, demonstrated as the number of incidents detected per 1000 qualifying patient discharges in the following chart, Figure 12, has trended downward since October 2012 for all records. The average reported incident rate was 14.39 per 1000 qualifying discharges from October 2012 to September 2013, but decreased by 38% to 8.9 per 1000 qualifying discharges for corrected records since program commencement in October 2013. For uncorrected records, the trend has been downward as well, with a pre-commencement average of 14.39 and a post-commencement average of 13.9, a 3% improvement. The corrected records represented a 36% improvement over the

uncorrected rate since program commencement. The vast majority of the improvement is the result of corrected records. The beta coefficient of the corrected rate is 1.8 times better than the beta coefficient of the automatically flagged rate.

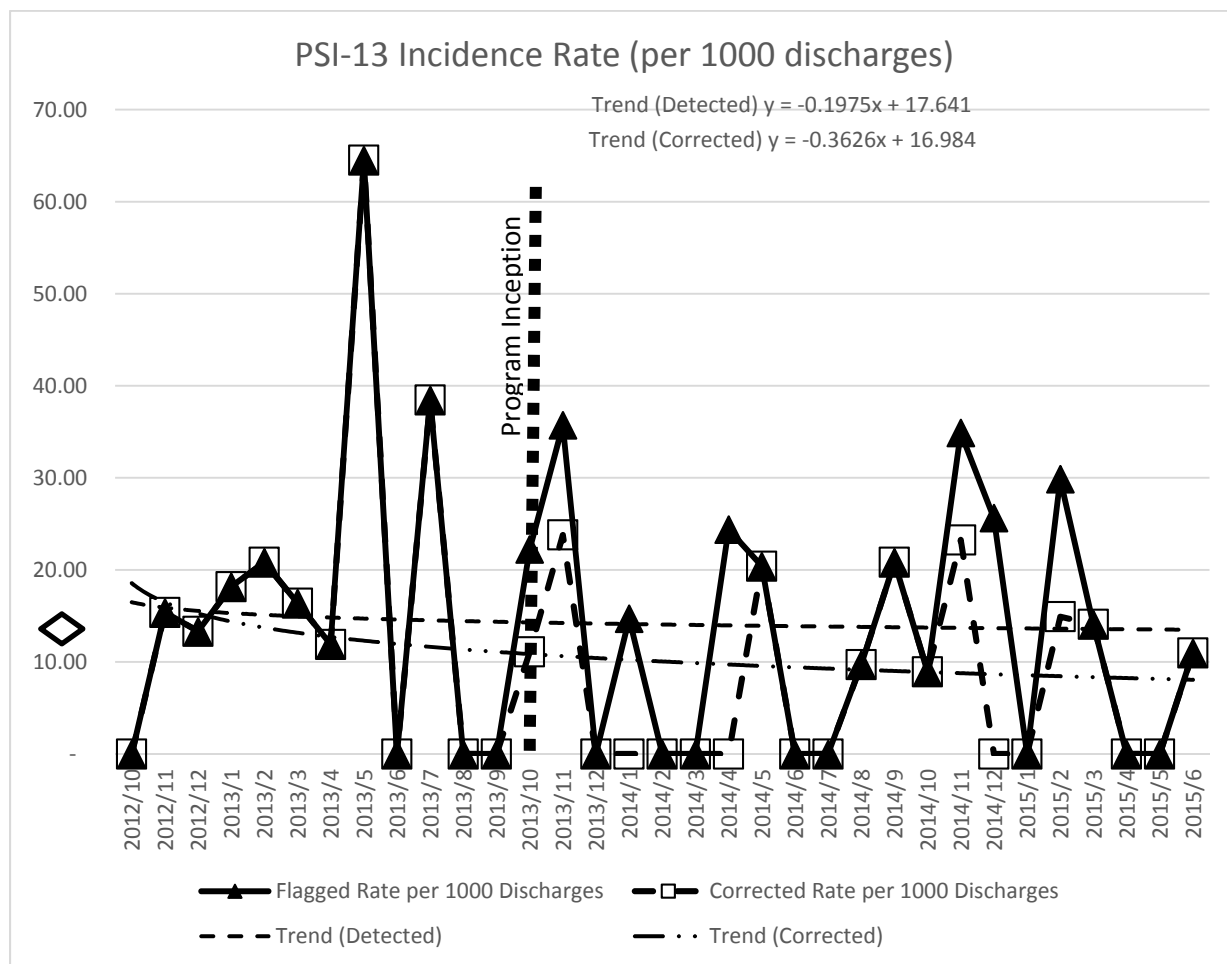


Figure 14 - PSI-13 Incidence Rates (per 1000 discharges)

PSI-14

PSI-14, Postoperative Wound Dehiscence, had just one discharge detected and no records corrected since program inception. PSI-14 Flagged and Corrected Incidents, Table 10,

lists the count of PSI-14 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	0	0
2013/11	0	0
2013/12	0	0
2014/1	0	0
2014/2	0	0
2014/3	0	0
2014/4	0	0
2014/5	0	0
2014/6	0	0
2014/7	0	0
2014/8	0	0
2014/9	0	0
2014/10	0	0
2014/11	0	0
2014/12	0	0
2015/1	0	0
2015/2	0	0
2015/3	0	0
2015/4	0	0
2015/5	1	0
2015/6	0	0
2015/7	0	0
2015/8	0	0
Totals	1	0
Percent Corrected		0.0%

Table 10 - PSI-14 Flagged and Corrected Incidents

The incidence rate for PSI-14, demonstrated as the number of incidents detected per 1000 qualifying patient discharges in the following chart, has trended sharply downward since October 2012 for all records, due primarily to only one PSI-14 detected since program commencement. The average incident rate was 2.71 per 1000 qualifying discharges from

October 2012 to September 2013, but decreased by 88% to 0.33 per 1000 qualifying discharges for all records since program commencement in October 2013. The corrected records represented no improvement over the uncorrected records since program commencement.

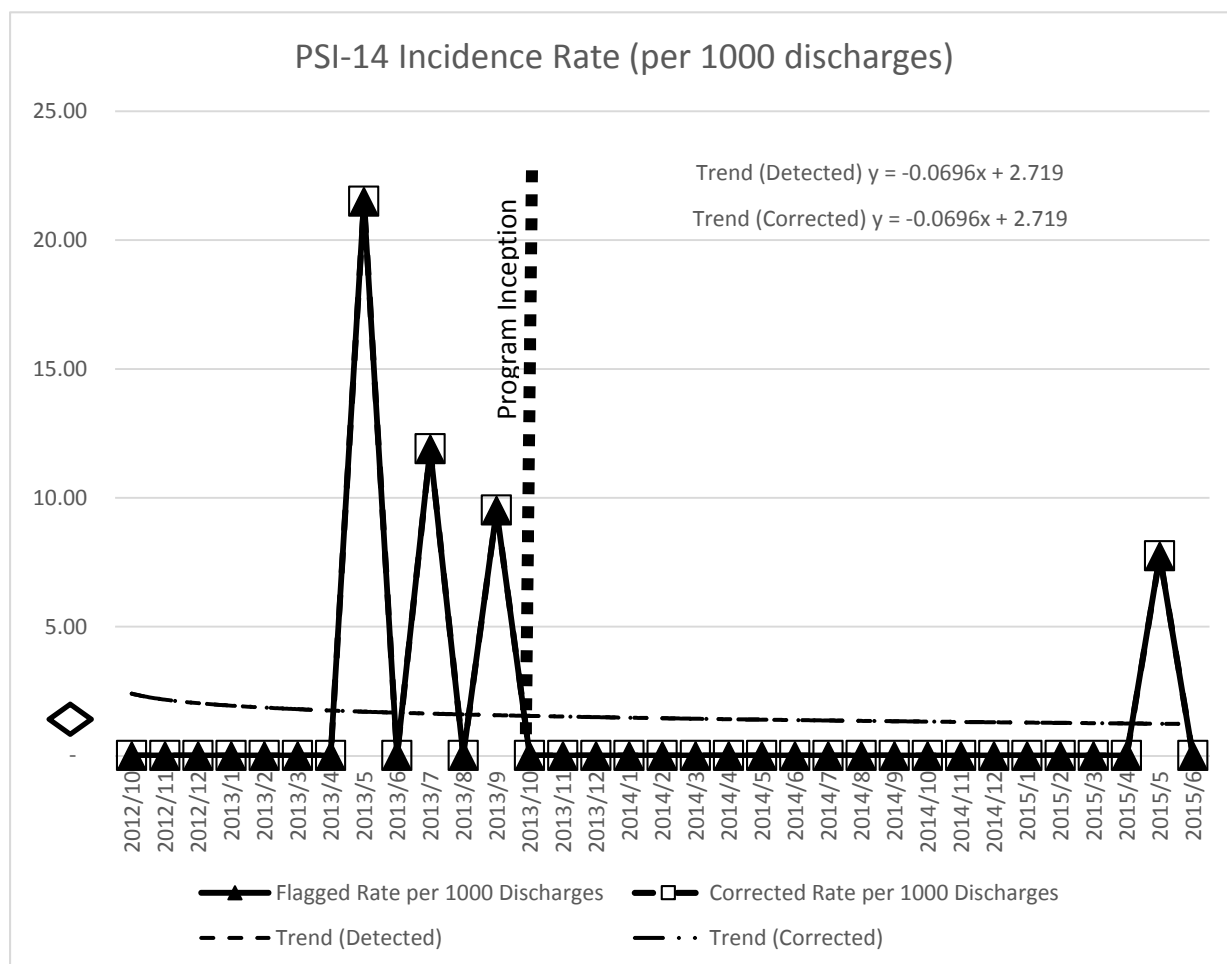


Figure 15 - PSI-14 Incidence Rates (per 1000 discharges)

PSI-15

PSI-15, Accidental Puncture or Laceration, demonstrated a 23.3% reduction in reported incidents compared to incidents automatically flagged. PSI-15 Flagged and Corrected

Incidents, Table 11, lists the count of PSI-15 incidents detected and the count of incidents removed after documentation review and correction.

Year / Month	Flagged Count	Corrected Count
2013/10	10	2
2013/11	7	0
2013/12	6	1
2014/1	5	1
2014/2	9	2
2014/3	7	3
2014/4	5	0
2014/5	13	0
2014/6	3	0
2014/7	4	1
2014/8	12	2
2014/9	11	2
2014/10	3	2
2014/11	8	2
2014/12	11	4
2015/1	1	0
2015/2	11	5
2015/3	3	2
2015/4	7	5
2015/5	5	0
2015/6	0	0
2015/7	0	0
2015/8	5	0
Totals	146	34
Percent Corrected	23.3%	

Table 11 - PSI-15 Flagged and Corrected Incidents

The incidence rate for PSI-15, demonstrated as the number of incidents detected per 1000 qualifying patient discharges in the following chart (Figure 24), has trended downward since October 2012 for all records. The average reported incident rate was 3.90 per 1000 qualifying discharges from October 2012 to September 2013, but decreased by 31% to

2.71 per 1000 qualifying discharges for corrected records since program commencement in October 2013. For uncorrected records, the trend has been downward as well, with a pre-commencement average of 3.90 and a post-commencement average of 3.53, a reduction of 9.6%. The corrected rate represents a 23.3% improvement over the uncorrected rates since program commencement. The beta coefficient of the corrected rate is 2.5 times better than the beta coefficient of the automatically flagged rate.

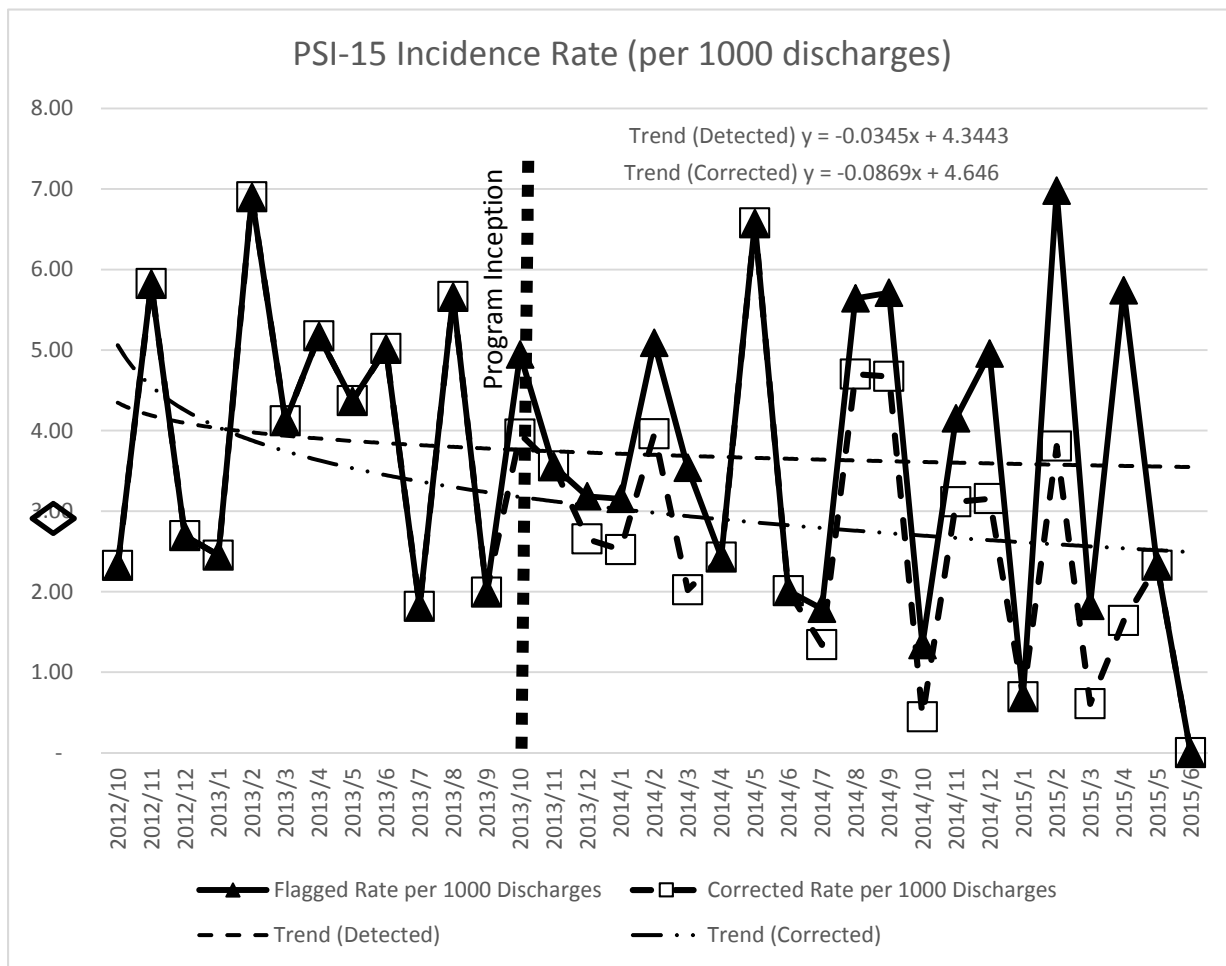


Figure 16 - PSI-15 Incidence Rates (per 1000 discharges)

Since program inception several of the PSIs in the study improved, while others showed no improvement and some became worse. This may indicate that some PSIs are more difficult to control than others, or that some may be more prone to erroneous documentation.

Discussion

STUDY OVERVIEW

This study examined whether an organization can successfully improve their reported PSI rates if they implement internal processes to review the accuracy of the patient's medical record after PSIs are flagged for a patient discharge. The process included correction of any inaccurate documentation within the patient's medical record prior to submission of the medical record data to CMS, UHC, and third-party payers who will then use that data to detect PSIs.

What is different about the program reviewed in this study is that it did not attempt to directly impact the delivery of care, but instead focused on the accuracy of the clinical documentation that is driving the identification of the PSIs. PSIs are considered hospital acquired conditions (HAC) as their existence is thought to be at least partially within the control of the provider if best practices are followed.

Although clinicians were engaged in the process, the program did not directly identify adherence to best practices, or lack of best practices, but rather whether or not they were correctly recording the clinical documentation within the patient's chart. The clinician was free to continue to care for their patients the way they always have. However, if a PSI was indicated for a particular discharge and the PSI was not attributable to an error in medical coding by the coding staff or coding software, then the clinician was engaged to determine if the PSI indication was accurate. If the PSI indication was not accurate, the clinician corrected the patient's medical record so that the medical coders could then recode the patient's medical record and remove the PSI indication. Any changes to way a physician provided clinical care to his or her patient, or to the ways in which he or she

documented the patient's medical care within the patient's medical record, were driven by the clinician and his or her desire to not have to review patient charts again due to inaccurate documentation.

DISCUSSION

Nine of the eleven Patient Safety Indicators that make up the composite PSI-90 score were included in this study, with improvements due to corrected records being observed in eight of the nine indicators. These improvements were attributed directly to the process implemented to correct erroneous charts and ranged from a 4.26% to a 36% improvement, with an average improvement of 16.40%. This improvement can be directly related to the new process because the patients were originally identified as PSIs as part of the process, but then corrected once reviewed as part of the new program. If the new process were not in place to catch these errors then these PSIs would have been erroneously reported to UHC, CMS, and other public reporting avenues.

Over the same period of time covered by the study, all PSIs within the study group also exhibited a decrease prior to chart corrections, ranging from 0.15% to an 87.65% decrease in flagged PSIs, with an average decrease of 17.82%. So although the program resulted in a 16.40% reduction in PSI events, they also were reduced slightly more at 17.82% prior to the corrections, for a total average reduction of 34.22%. The 16.40% reduction can be directly attributed to the program, but the 17.82% reduction in flagged rates may also be at least partially attributed to the new processes put into place.

The reduction of flagged rates may be attributed to an increased focus on PSIs due to this program. Since physicians and coding staff were being asked to review, and correct,

documentation for all flagged PSIs, the physicians and coding staff may have become more careful about how they document and code charts over time. The staff were learning from the review and correction process, resulting in a reduction in the number of documentation corrections required as their initial coding was becoming more accurate. This may explain why the flagged rates dropped post program commencement, even before the corrections took place. Likewise, since every PSI flagged was captured and then reviewed in the patient's medical record, the coding staff may have also become more careful in their coding efforts in order to reduce the number of coding errors attributable to them.

It is also likely that as the new process brought attention to PSIs, the caregivers may have adhered more closely with best practices that are published specifically to prevent the PSIs. Not all PSIs have changes in care that can greatly improve them, but others do. For example, it is difficult to reduce the number of accidental lacerations during surgery. However, other PSIs, such as PSI-12, Perioperative Pulmonary Embolism or Deep Vein Thrombosis, can be prevented through the following of best practices, such as through the use of both mechanical and pharmacological prophylactic intervention. This is, perhaps, why PSI-12 reduced their flagged rate by 22% over the study while only demonstrating another 4.3% of improvement due to corrections of the patient medical records.

Another possible reason for the reduction may be due to an overall increased focus on PSIs within the healthcare industry. With hospital acquired conditions (HAC) frequently being the topic of news, and with providers beginning to have to cover the costs of treating HACs, most caregivers are very aware of the causes and the impact a PSI can

have on their practice. This increased attention and awareness by caregivers may have had a positive impact on flagged PSIs, especially those that are more sensitive to adherence to best practices.

The most likely reason for the reduction in flagged PSIs may be a combination of the above reasons. These would include influences from an increased awareness of PSIs due to this program bringing attention to how the documentation impacts PSI reporting, the public and payer focus on HAC prevention, improved provider education on how PSIs impact cost reimbursement models, and improved adherence to best clinical practices when demonstrated how they can directly impact PSI rates. Between the reduction in flagged PSIs, and the reduction due to corrected charts, the average reported PSIs dropped by 34.22%.

The goal of the new process was to reduce the number of PSIs reported to UHC, CMS, AHRQ, and other agencies and organizations that publicly report this information or make reimbursement decisions and policies based on the data collected. In that regard this newly implemented process, which requires approximately eight man-hours per month to manage, was successful.

Since the research question was based on chart corrections, the results must be reviewed in context of improvements due to corrected patient medical records. However, aside from the reasons listed above as possible reasons for a reduction in flagged PSI rates, further discussion must also include suggestions as to why the pre-corrected rates dropped specifically for eight of the nine PSIs in the study. Disparities between

improvement rates between the various PSIs will also be reviewed and explained to the extent possible.

Some of the disparities between the various PSI improvement rates can be explained through the conditions that they represent, while others can be attributed to other programs that were implemented to improve patient care at MUHA. PSI-03, pressure ulcers, has been under intense scrutiny over the past several years at MUHA. There is a wound care team that is assigned to any patient that exhibits signs of having pressure ulcers, and all such events are documented, reviewed, and discussed with the nursing unit in an attempt to avoid future events. According to a nurse on the team assigned to correct PSIs, PSI-03 events were not part of the review process until approximately May, 2015.

These events were excluded from the review process due to the careful review that pressures ulcers were already receiving from the wound care nurses who personally review all pressure ulcer events. However, as other PSI events came under control as part of this program, the decision was made to include them in the review process anyway. Since they were included in the program, six pressure ulcers were flagged, with only one of them being corrected after review of the documentation. Although this represents a 16.67% correction rate since they started being reviewed, only 4.55% have been corrected since program inception due to their being excluded during the first nineteen months of the program.

A 16.67% correction rate over those four months where they were included was not expected, given the review process they already undergo on the nursing unit by the wound care nurses. However, since we are dealing with such a small sample size

(population = 6, correction = 1) more time is required before it can be determined if correction rates will continue to be this high.

PSI-06, iatrogenic pneumothorax, refers to the introduction of air into the pleural cavity, causing the lung to collapse, that was caused by an action of the caregiver. Iatrogenic pneumothorax is more common in tertiary care facilities such as MUHA as their patients are generally more complicated than those at non-tertiary care centers.

Iatrogenic pneumothorax is often due to the insertion of a central line, and its presence is generally easily recognized by a post-procedure chest x-ray. However, in some cases, a pneumothorax is an expected or anticipated part of a procedure (such as a lung biopsy) so these situations should not be coded as a PSI. As such, 5.56% of the automatically flagged charts were corrected, which was just one correction due to the low number of flagged incidents.

The rate of reported central venous catheter related blood stream infections, PSI-07, decreased by 33.33% due to corrected records, and another 17.18% due to an overall decrease in flagged rates for a total decrease of 50.51%. The high correction rate can be attributed to clinicians flagging a patient as having a potential blood stream infection prior to receiving blood work results, and then once the blood work is received the chart has additional notes indicating the negative presence of an infection. Or, the clinician may document that “blood infection was not present”.

However, when the automated coding software scans the patient chart, it often will identify key words in the clinical notes indicating a blood infection (e.g., “blood infection”) without detecting the accompanying “not present” modifier. So although the

rates have been dropping prior to the chart corrections, two-thirds of the reduction can be attributed directly to the process under study and are largely attributed to errors in the automated coding software.

When discussing this topic with nurses who work in the Clinical Documentation Integrity department, they suggested that reviewing just the patients automatically flagged is much more efficient than manually reviewing every patient chart for blood infections, and so although the automatic coding software has flaws, their new process catches and corrects the errors made by the software.

Perioperative hemorrhage or hematomas, PSI-09, are surgical sites that bleed around the site or bleed under the tissue causing a blood clot (or hematoma). Overall the rates were reduced by 17.71%, with 15.11% due to corrected charts. Unlike some of the other PSIs, PSI-09 is very subjective and that is reflected in 85% of the reduction being due to corrected records.

The challenge with bleeding and surgery is that bleeding is inherent in cutting human tissue, and so whether or not the bleeding is normal or a patient safety incident can be very subjective. Medical students and residents may document the patient as bleeding, which the automated software may detect, even though later the chart may have been corrected by an attending to reflect that the bleeding was within expected limits. Bleeding is more common with obese patients and those who have had past surgeries in the same area, or for those on blood thinners. Unless known and understood by the less experienced surgical staff, documentation about the expectedness of the hemorrhage or hematoma may be entered inaccurately.

Frequently, in order to get the record coded so that reimbursement claims can be processed, patient charts are coded prior to the attending physician updating the patient's medical record and signing off on the record. This can also result in errors in the documentation, especially if the initial documentation was performed by a medical student or resident or if the coder did not understand other conditions (obesity, past surgeries, etc.) that would have resulted in higher bleeding being expected and considered normal.

Postoperative respiratory failure (PORF), PSI-11, demonstrated a 25.48% decrease due to corrected records and another 19.36% due to other causes, for a total decrease of 44.84% since program inception. Reviewing the corrections, the rate of corrected records was twice as high in the first year of program inception than it was in the second year. This demonstrates that the accuracy of coding was improved over time, resulting in less corrections while still showing an overall decrease in the rates reported.

Part of the coding improvement was based on physicians more accurately documenting the presence or absence of PORF, the presence of which increases the reimbursement rate for the hospital. As with all providers, there has been a push to accurately document the patient's chart in order to receive the maximum payment based on the treatment provided. This reportedly led to some physicians indicating PORF any time they re-intubated the patient, even if was for non-preventable reasons.

The solution was to reeducate physicians so that they would better understand that intubating to prevent seizures or aspiration, or other non-respiratory reasons, is not considered to be PORF. The review of PSIs through the process in this study helped to

identify this situation so that it could be improved, reducing the flagged rate of PSI-11s significantly, even before further chart corrections were made.

Perioperative pulmonary embolism or deep vein thrombosis, PSI-12, has been a hospital acquired condition under targeted reduction efforts for several years at MUHA and other healthcare centers. This condition can be prevented through the use of both mechanical and pharmacological prophylactic interventions, with best practices calling for both in most post-surgical cases where a patient is sedentary.

In 2010 MUHA created a trauma report that identified all patients admitted with trauma along with the adherence by MUHA staff to best clinical practices, including PSI-12 preventive measures. This effort expanded to other clinical areas and is now part of standard protocols. Since program inception, PSI-12 has been reduced 25%, but with only 4.3% being attributed to chart corrections. PSI-12 is easy to detect and identify, so although the numbers have been decreasing, very little of it has been through chart corrections.

Postoperative sepsis, PSI-13, represented the largest percentage of corrected records through this program. PSI-13 rates dropped by 38.15% since program inception, with a full 36% due to chart corrections. That is 2.2 times the improvement shown by chart correction than the average improvement identified for all of the PSIs within the study.

This high rate of correction is attributed to the many ways that sepsis can be misidentified by a clinician, a coder, and by automated software. Symptoms of sepsis do not always indicate sepsis, and medications that are given for sepsis may be given for other conditions as well, or as a preventative measure while awaiting blood test results. Since

the definition for sepsis is very specific, sepsis-like symptoms may appear without meeting the strict criteria. When a patient is identified by the process as having a PSI-13, the clinical review team reviews blood test results to ensure the diagnosis was valid – if the blood tests do not confirm sepsis, then the coding is removed from the patient's medical record.

Postoperative wound dehiscence, PSI-14, is a condition when a surgical wound suture opens up post-surgery. Although MUHA demonstrated an 87.65% reduction in PSI-14, none of that reduction was due to chart corrections. This reduction is most likely due to a focus by MUHA on infection prevention, a leading cause of wound dehiscence. The lack of chart corrections can be attributed, as it has been for some other PSIs with low corrections, to the fact that wound dehiscence is clear cut. Either the wound is healing properly or it has opened.

Accidental puncture or laceration, PSI-15, demonstrated a 30.66% reduction since program inception, with 23.29% being due to chart corrections. Accidental punctures and lacerations can be very subjective, and unless the entire medical history is examined to determine if the patient has had previous surgeries at the same site or is in poor physical condition, it can easily be erroneously documented and coded. Like some other PSI events, obese patients are more susceptible to accidental punctures and lacerations due to the increased difficulty in moving around the internal parts of the body and finding the right organs and tissues, while avoiding arteries and the wrong tissues.

Automated coding software, and medical coders, will often code a puncture or laceration as accidental whenever they discover a note that indicates a cut somewhere that was not

part of the surgical plan. However, some surgeries have inherent risk of cutting other organs. For example, removing a tumor frequently requires that part of the connecting organ is also removed, and in cases where it is not removed, it is common (and expected) that the connected organ may be lacerated. In these cases it is considered a normal part of the surgery and not a PSI-15. So like PSI-13, the clinical review of the patient's medical record requires that there is clinical evidence that the accidental cut was not planned or expected before it is considered a PSI-15 event.

The PSI review process initiated by MUHA did reduce the reported PSIs by an average of 16.40%, with two PSIs reporting drops of over 30% and two others over 23%. That is a significant improvement in the publicly reported PSIs, and although it does not directly improve patient care since it is only the correction of patient medical records, it does allow MUHA to focus on the real problems as it removes the false positives. Also, as noted already, the flagged PSI rates dropped by an average of 17.82%, which could be considered a true reduction in PSI events.

Not all PSIs improved significantly. PSI-03, PSI-06, PSI-12, and PSI-14 all showed less than a 5% improvement due to this process being implemented. This is due in large part to the clarity of the symptoms and diagnosis for pressure ulcers, iatrogenic pneumothorax, deep vein thrombosis, and postoperative wound dehiscence represented by PSI-03, PSI-06, PSI-12, and PSI-14 respectively.

By investing three person-months initially to develop a software tool to pull and manage the PSI review process, and then spending an average of eight hours a month reviewing the PSIs, MUHA has reduced their publicly reported PSI data by an average of 16.4% – a

reduction typically not possible in hospital quality without significant investments in education, workflow analysis and redesign, and oversight. This is in addition to the 17.82% reduction due to the number of flagged PSIs being reduced.

Reviewing the model in Figure 19, as described by Newhouse (2011), this program may not have truly improved quality, but it did improve the quality metrics at a very low cost. This program would be described as high effectiveness and low cost – an easy ACCEPT.



Figure 17 - Weighing Cost to Benefits (Marshall, Demers, O'Brien & Guyatt, 2005)

The question of whether quality actually improved must be asked, since the 16.4% improvement is due to corrections of charts, and not an actual improvement in care being provided. Whether or not the program actually improved quality of care is not clear, as

one could attribute the drop in flagged rates, as noted previously, to an actual improvement in the delivery of the care and not as an indirect result of this program. However, by eliminating these 16.4% of corrected charts, more attention could be focused on the real PSI events, allowing the quality department to implement clinical practices to reduce these types of events. Lastly, as the publicly reported PSI rates improve, reimbursements to MUHA will increase, allowing further investments in the advancement of care.

How much financial impact this will have on MUHA is not clear at this time, as CMS will not be publishing their FY2017 report, which is based on discharges from July 1,

2013 through June 30, 2015, until the summer of 2016. At that time MUHA will be notified if they again fall in the bottom quartile for CMS, and be penalized, or if they will be elevated out of that quartile due to the overall 34.22% reduction in reported PSIs.

It should be noted that the period under review is for 24 months, as it was in previous years, and that the MUHA program was not implemented until October 1, 2013 – three months after the beginning of the review period for FY2017 penalties that take effect October 1, 2016. This will not allow MUHA to realize the full impact of their improved reported PSI scores for the upcoming federal fiscal year, and may require that MUHA wait until FY2018 reporting for their program to have a clear financial impact on MUHA reimbursements. Then, if they do move out of the lowest quartile in FY2018, it will only impact reimbursement rates for discharges after October 1, 2017 – four full years after implementation of the MUHA program.

This raises the question as to whether or not the 24-month review period discourages PSI improvement programs, as it takes nearly three years before a program's improvements are compared to other provider improvements. Until the reports are published by CMS a provider does not know if their improvement will or will not take them out of the lowest quartile.

Although MUHA did see a significant improvement in their reported PSIs, the CMS penal system force ranks healthcare providers, so if all healthcare providers improved their scores, then MUHA may still fall in the bottom quartile of providers. The PSI-90 component of the ranking method is based on a score of 1 to 10, with 10 being the worst and 1 being the best. MUHA scored a 10 for PSI-90 for FY2016 (based on the 24-month

review period from July 1, 2011 to June 30, 2013), and an 8.5 for the Total HAC Score (a composite score that includes PSIs and other HAC conditions). This ranked MUSC at #3097 out of 3359 providers, putting it in the bottom 7.8% of the included providers. Only those providers in the top 2519 providers were reimbursed the full 100% of payments by CMS.

Given that approximately 33% of MUHA's revenue is generated from Medicaid, and another 33% from Medicare, a 1% reduction in CMS Medicare reimbursements is significant. With \$1.2 billion in annual revenue, a 1% reduction in 33% of their revenue attributable to Medicare would result in a loss of up to \$3.96 million annually. If both Medicare and Medicaid were to participate in the penalty program, total at-risk revenue would equal nearly \$8 million per year.

Reimbursement losses from Medicare are not the only potential losses, as third-party payers are also quick to follow suite when CMS implements programs that link reimbursements to outcomes. If the large providers, such as Blue Cross, were to follow suite it could put the remaining 33% of MUHA revenue at risk for some type of penalty.

The process and accompanying software implemented by MUHA requires a minimal investment in time, making it available for hospitals of all sizes, financial means, and care levels. However, other institutions considering such a program need to understand that the PSIs that will show the greatest improvement will be those that are most subjective, and if these PSI rates are already low in their organization, the improvement realized may not be enough to justify implementation of a similar chart review program.

Future research should include adapting the MUHA tool to hospitals that do not use a closed staffing model, and with hospitals with less complex patients, to determine if the same model can provide the same benefits to providers and patients that are dissimilar to MUHA.

The closed staffing model in used at MUHA allows administrators to better align with physicians on documentation and quality improvement efforts. Because they work for the organization, as opposed to just having admission privileges, MUHA can require that physicians participate in programs such as this one. The physicians are also in house the majority of the time, either in the clinics or on the hospital floor, so it requires much less effort (and therefore less resources) for the quality team to work with physicians to review and correct the charts. With the typical open staff model, physicians are only in the hospital whenever they have patients admitted, and generally only during morning and evening rounds. This can impact the effectiveness of a program like this one in that type of environment.

For organizations with a less complex patient population, there would be a lower probability of PSIs that are related to long hospital stays, such as PSI-03 (pressure ulcers). Because they serve a less complex patient population, they may also have fewer surgeries, especially those that are associated with high levels of complications that are performed frequently in an academic medical center such as MUHA.

This program improved reported PSI rates beyond the improvements directly attributed to any other quality improvement programs that may have been instituted by MUHA or an individual department. This is indicated clearly without the need for subjective

interpretation because the process tracks the exact number of patient discharges that were flagged as having a PSI as well as the number of patient discharges that were corrected to remove the false PSI. This provides an accurate number of corrections, and as such an accurate percentage of corrected records due to this program.

Any other improvements may be attributed to an overall improvement in quality at MUHA, to more focus being on PSIs due to this program, to caregivers improving their clinical documentation in order to avoid having to go through this review process, and to a better educated caregiver group due to them going through a review process on corrected records. It is difficult to determine which reason provided the greatest improvement prior to the chart corrections, but the staff involved in the program believe that the review process also had a positive impact on PSIs even outside of the corrected clinical charts. Perhaps the reason why this program has had a significant impact on the flagged rates, as opposed to other programs that emphasized PSI improvements through just training, is that all PSIs that were not corrected by the coding or quality staff were eventually sent back to the physician for review and, if needed, corrected.

This meant that every flagged PSI that could not be attributed to an administrative error resulted in a physician having to take time to review the patient chart. The physician review of the chart takes time, which either reduces potential billable time or requires extra hours put in by the physician. Therefore, the physicians would want to avoid having to perform this extra review once they were required to go through this process one or more times, potentially resulting in their being more careful during initial documentation of future patients.

RECOMMENDATIONS

There should be more discussion about the ramifications of these reductions. Things such as estimates of improvements in reimbursement, reduced penalties, better rankings, etc. are important, but they, in themselves, do not directly improve patient care, and reducing the numbers alone should not be the ultimate goal. The program met its stated objectives, but it would be valuable to MUHA to determine if any other improvements were observed that could be attributed to this program. Further, it would be worthwhile to study the PSIs that had reductions in flagged PSI rates to determine the causes of those reductions. If the causes can be identified, then perhaps they can be duplicated in other areas at MUHA and at other institutions.

This study did not take into account the costs of physicians reviewing patient charts. Even though they are not hourly employees, chart reviews require them to shift time away from patients or put in extra hours, both of which have opportunity costs to the organization. This study also did not examine any improvements to reimbursements due to improved PSI rates, actual or anticipated, as any change in reimbursements will not be reflected until CMS' next fiscal year (October 1, 2016). Once this information is available the Chief Quality Office^{4r} should develop a cost-benefit analysis to determine their return on investment for this program.

AREAS FOR FUTURE STUDIES

Future studies should consider any opportunity costs compared to any increase in reimbursement rates due to a reduction in PSIs, in order to determine if there is a

quantitative financial impact on the organization through such a program. Lastly, if an organization has multiple hospitals with similar patient case mix indices, then it would be worthwhile to use one hospital as a control group and implement a similar improvement program in the other hospital to determine if the program positively influenced both the flagged and corrected PSI rates in just the hospital that implemented the program. This would help eliminate any other initiatives, either within the organization or due to outside influences, which may impact the flagged rates other than those associated with the implementation of the program.

References

- AAMC (Association of American Medical Colleges). (2013). About the AAMC. Retrieved from <https://www.aamc.org/about/> on November 24, 2013.
- AHA (American Hospital Association). (2013). Fast facts about US hospitals. Retrieved from <http://www.aha.org/research/rc/stat-studies/fast-facts.shtml> on November 22, 2013
- AHRQ (Agency for Healthcare Research and Quality). (2010). AHRQ Quality Indicators: Composite Measures User Guide for the Patient Safety Indicators (PSI) v.4.2. September 2010. Retrieved from http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V42/Composite_User_Technical_Specification_PSI.pdf
- AHRQ (Agency for Healthcare Research and Quality). (2010a). 2010 National Healthcare Disparities Report. Available at <http://www.ahrq.gov/research/findings/nhqrdr/nhdr10/pdf/nhdr10.pdf>. Accessed November 15, 2013.
- AHRQ (Agency for Healthcare Research and Quality). (2012). 2012 National Healthcare Disparities Report. Available at <http://www.ahrq.gov/research/findings/nhqrdr/nhdr12/2012nhdr.pdf> or <http://archive.ahrq.gov/research/findings/nhqrdr/nhdr12/index.html>. Accessed November 16, 2013.
- AHRQ (Agency for Healthcare Research and Quality). (2013). PATIENT SAFETY INDICATOR v4.5 BENCHMARK DATA tables. May 2013. Retrieved from http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V45/Version_45_Benchmark_Tables_PSI.pdf
- AHRQ (Agency for Healthcare Research and Quality). (2014a). AHRQ Quality Indicator, Version 4.5a, Patient Safety Indicators 03 (PSI 03), Technical Specifications. July 2014. Retrieved from http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V45a/TechSpecs/PSI_03_Pressure_Ulcer_Rate_V45a.pdf, September 2014.
- AHRQ (Agency for Healthcare Research and Quality). (2014b). AHRQ Quality Indicator, Version 4.5a, Patient Safety Indicators 11 (PSI 11), Technical Specifications. July 2014. Retrieved from http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V45a/TechSpecs/PSI_11_Postoperative_Respiratory_Failure_Rate_V45a.pdf. Accessed September 2015.

- AHRQ (Agency for Healthcare Research and Quality). (2014c). AHRQ Quality Indicator, Version 4.5a: PSI #15, Accidental puncture or laceration, Technical Specifications. July 2014. Retrieved from :
http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V45a/TechSpecs/PSI_15_Accidental_Puncture_or_Laceration_Rate_V45a.pdf. Accessed October 2, 2014.
- AHRQ (Agency for Healthcare Research and Quality). (2015). Fact Sheet on Patient Safety Indicators. Retrieved from
http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V45a/TechSpecs/PSI_11_Postoperative_Respiratory_Failure_Rate_V45a.pdf. Accessed February 17, 2016.
- Anderson R.N., Smith B.L. (2002). Deaths: leading causes for 2002. Natl Vital Stat Rep. Mar 7;53(17):1–89. anesthetic management. Journal of Clinical Anesthesia. Volume 23, pp. 153–165. Retrieved from
<http://www.cinj.org/sites/cinj/files/documents/PerioperativePulmonaryEmbolism.pdf>
- ASQ (American Society for Quality). (2013). Plan-Do-Check-Act (PDCA) Cycle. Retrieved from
<http://asq.org/learn-about-quality/project-planning-tools/overview/pdca-cycle.html>.
- Beck, M. (2014). How to bring the price of healthcare into the open (There’s a big push to tell patients what they’ll pay – before they decide on treatment). The Wall Street Journal. February 23, 2014. Retrieved from
<http://online.wsj.com/news/articles/SB10001424052702303650204579375242842086688>
- Botsis, T., Hartvigsen, G., Chen, F., Weng, C. (2010). Secondary Use of EHR: Data Quality Issues and Informatics Opportunities. AMIA Summits Translational Science Proceedings. 2010; 2010: 1–5. Retrieved on 3/18/2011 from
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3041534/?tool=pubmed>.
- BusinessDictionary.com. (2013). Available at <http://www.businessdictionary.com/definition/best-practice.html>
- CIN: Computers, Informatics, Nursing [Corporate Author]. (2011). 2011 Summer Institute in Nursing Informatics. Issue: Volume 29(10), October 2011, pp 608-612. DOI: 10.1097/NCN.0b013e3182387998. ISSN: 1538-2931. Accession: 00024665-201110000-00012
- Desciak, M.C., Martin, D.E. (2011). Perioperative pulmonary embolism: diagnosis and anesthetic management. Journal of Clinical Anesthesia (2011) volume 23, pp. 153–165.
 doi:10.1016/j.jclinane.2010.06.011
- Di Pietro, T.L., Doran, D.M., McArthur, G. (2010). Supportive Decision Making at the Point of Care: Refinement of a Case-Based Reasoning Application for Use in Nursing Practice. CIN: Computers, Informatics, Nursing. 28(4):235-240, July/August 2010.
- Duane, T. M. (2014). Agency for Healthcare Research and Quality Patient Safety Indicators and Mortality in Surgical Patients. August 22, 2014. Retrieved from

<http://insurancenewsnet.com/oarticle/2014/08/22/agency-for-healthcare-research-and-quality-patient-safety-indicators-and-mortality-a-546857.html#.VAtrQ2NBEVE>

Fletcher, R. H. (2008). Clinical practice guidelines. Uptodate.com. Accessed November 23, 2013 from <http://www.themgo.com/content/CIguidelines.PDF>.

Garret, P., Seidman, J. (2011). EMR vs EHR - What is the Difference? Health IT Buzz (ONC). January 4, 2011. Retrieved on 2/17/2016 from <https://www.healthit.gov/buzz-blog/electronic-health-and-medical-records/emr-vs-ehr-difference/>

Glasziou, P., Haynes, H. (2005). The paths from research to improved health outcomes. Evidenced Based Medicine (EBM) Volume 10 February 2005. Retrieved on 3/13/2010 from <http://andre.sasse.com/mbe/extensao/artigo002.pdf> (as downloaded from ebm.bmjournals.com).

Howell, W. L. J. (2013). Hospitals are proving grounds for patient safety measures. Association of American Medical Colleges (AAMC). Retrieved from https://www.aamc.org/newsroom/reporter/dec10/165672/teaching_hospitals_are_proving_grounds_for_patient_safety_measu.html on November 24, 2013.

HPOE. (2013). About HPOE. Available from http://www.hpoe.org/HPOE_General_Information/About_HPOE.shtml

Marshall D., Demers C., O'Brien B., Guyatt G. (2005). Economic evaluation. In: DiCenso A, Guyatt G, Cilisk D, eds. Evidence-Based Nursing: A Guide to Clinical Practice. St Louis, MO: Elsevier Mosby; 2005:298-317.

Montori, V.M., Brito, J.P., Murad, M.H. (2013). The Optimal Practice of Evidence-Based Medicine Incorporating Patient Preferences in Practice Guidelines. *JAMA*. 2013;310(23):2503-2504. doi:10.1001/jama.2013.281422. December 18, 2013.

Newhouse, R.P., White, K.M. (2011). Guiding Implementation: Frameworks and Resources for Evidence Translation. *Journal of Nursing Administration*. 41(12):513-516. December 2011. DOI: 10.1097/NNA.0b013e3182378bb0. ISSN: 0002-0443. Accession: 00005110-201112000-00006

Newhouse, Robin P. (2010). Do We Know How Much the Evidence-Based Intervention Cost? *Journal of Nursing Administration*. 40(7/8):296-299, July/August 2010.

Nieva, V.F., Murphy, R., Ridley, N., Donaldson, N., Combes, J., Mitchell, P., Kovner, C., Hoy, E., Carpenter, D. (2005). Agency for Healthcare Research and Quality (AHRQ). From Science to Service: A Framework for the Transfer of Patient Safety Research into Practice. Available at <http://www.ncbi.nlm.nih.gov/books/NBK20521/#A3532>

O'Leary, K.J., Devisetty, V.K., Patel, A.R., Malkenson, D., Sama, P., Thompson, W.K., Landler, M.P., Barnard, C., Williams, M.V. (2013). Comparison of traditional trigger tool to data warehouse based screening for identifying hospital adverse events. *BMJ Quality &*

Safety 2013;22:2 130-138 Published Online First: 4 October 2012doi:10.1136/bmjqs-2012-001102

- Perleth, M., Jakubowski, E., Busse, R. (2001). What is 'best practice' in healthcare? State of the art and perspectives in improving the effectiveness and efficiency of the European healthcare systems. *Health Policy*. June 2001. Volume 56: Issue 3. Available at <http://www.sciencedirect.com.ezproxy-v.MUHA.edu/science/article/pii/S016885100000138X>
- Persell, S.D., Kho, A.N., Thompson, J.A., Baker, D.W. (2011). Changes in Performance After Implementation of a Multifaceted Electronic-Health-Record-Based Quality Improvement System. *Medical Care*. 47(4):388-394, April 2009.
- Rajaram R., Chung J.W., Kinnier C.V., et al. Hospital Characteristics Associated With Penalties in the Centers for Medicare & Medicaid Services Hospital-Acquired Condition Reduction Program. *JAMA*.2015;314(4):375-383. doi:10.1001/jama.2015.8609. Retrieved from <http://jama.jamanetwork.com.ezproxy-v.MUHA.edu/article.aspx?articleid=2411284#Results>
- Rosen, A.k., Chen, Q., Borzecki, A.M., Shin, M., Itani, K.M.F., Shwartz, M. (2014). Using estimated True Safety Event Rates versus Flagged Safety Event Rates: Does It Change Hospital Profiling and Payment? *HSR: Health Services Research* 49:5 (October 2014). DOI: 10.1111/1475-6773.12180. Retrieved from <http://web.b.ebscohost.com.ezproxy-v.MUHA.edu/ehost/pdfviewer/pdfviewer?sid=34916367-923a-4e37-a049-6a8d8fbd9d0c%40sessionmgr198&vid=0&hid=101>.
- Sackett, D. L., Gray, Rosenberg, W. M., J. A. (1996). Evidenced based medicine: what it is and what it isn't. *BMJ* 1996; 312:71.
- Sensmeier, J. (2011). Clinical transformation: Blending people, process, and technology. *Nursing Management (Springhouse)*. Issue: Volume 42 IT Solutions, October 2011, p 2–4. DOI: 10.1097/01.NUMA.0000406581.95755.c7. ISSN: 0744-6314. Accession: 00006247-201110001-00001.
- SK&A (2015). Nationwide Physician Specialty Report. June 2015. Retrieved from http://www.skainfo.com/health_care_market_reports/Physician_Specialty_Count_by_State.pdf. Accessed September 8, 2015.
- Spencer, C.S., Roberts, E.T., Gaskin, D.J. (2015). Differences in the Rates of Patient Safety Events by Payer: Implications for Providers and Policymakers. *Medical Care*. Issue: Volume 53(6), June 2015, p 524–529. DOI: 10.1097/MLR.0000000000000363. ISSN: 0025-7079. Accession: 00005650-201506000-00008
- Titler MG. (2008). The Evidence for Evidence-Based Practice Implementation. In: Hughes RG, editor. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008 Apr. Chapter 7. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2659/>

- Tremblay, M. (2012). The entrepreneurial landscape of academic health science centres. Presented at 2012 EFMD Entrepreneurship Conference. March 5, 2012.
- Umbdenstock, R. (2012). Continuous Adoption of Best Practices: The New Normal. Institutes of Medicine (IOM), National Academies of Sciences. The Learning Health System Series. March 2012. Available at <http://www.iom.edu/~media/Files/Perspectives-Files/2012/Commentaries/VSRT-Continuous%20Adoption%20-%20Umbdenstock.pdf>
- US News & World Report. (2013). U.S. News Best Hospitals 2013-2014. Available at <http://health.usnews.com/best-hospitals/rankings>
- US News & World Report. (2015). U.S. News Best Hospitals 2015-2016. Medical University of South Carolina. Retrieved from <http://health.usnews.com/best-hospitals/area/sc/medical-university-of-south-carolina-6370085>
- US News & World Report. (2015a). U.S. News Best Hospitals 2015-2016. FAQ: How and why we rate and rank hospitals. July 21, 2015. Retrieved from <http://health.usnews.com/health-news/best-hospitals/articles/2015/05/20/faq-how-and-why-we-rate-and-rank-hospitals>
- US News & World Report. (2015b). U.S. News Best Hospitals 2015-2016. Methodology: U.S. News & World Report Best Hospitals 2015-16. July 15, 2015. Retrieved from <http://www.usnews.com/pubfiles/BH2015-16MethodologyReport.pdf>
- Utter, G.H., Zrelak, P.A., Baron, R., Tancredi, D.J., Sadeghi, B., Geppert, J.J., Romano, P.S. (2013). Detecting postoperative hemorrhage or hematoma from administrative data: The performance of the AHRQ Patient Safety Indicator. September 26, 2013. doi:10.1016/j.surg.2013.04.062
- Vogel, T.R., Dombrowskiy, V.Y., Carson, J.L., Graham, A.M., Lowry, S.F. (2010). Postoperative sepsis in the United States. *Ann Surgery*. December 2010. Volume 252(6). pp 1065-1071. doi [10.1097/SLA.0b013e3181dcf36e](https://doi.org/10.1097/SLA.0b013e3181dcf36e). Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2951484/>
- Wachman, E. M., Newby, P.K., Vreeland, J., Byun, J., Bonganzi, A., Bauchner, H., Philipp, B. L. (2011). The Relationship Between Maternal Opioid Agonists and Psychiatric Medications on Length of Hospitalization for Neonatal Abstinence Syndrome. *Journal of Addiction Medicine*. ISSN: 1932-0620. Accession: 01271255-201112000-00009. Issue: Volume 5(4), December 2011, p 293–299. DOI: 10.1097/ADM.0b013e3182266a3a.
- Weng, C., Bigger, J., Busacca, L., Wilcox, A., Getaneh, A. (2010). Comparing the effectiveness of a clinical registry and a clinical data warehouse for supporting clinical trial recruitment: a case study. *AMIA Annual Symposium Proceedings*. 2010 Nov 13;2010:867-71. Retrieved on 3/14/2011 from <http://www.ncbi.nlm.nih.gov/pubmed/21347102>.

- Westra, B. L., Subramanian, A., Hart, C. M., Matney, S.A., Wilson, P.S., Huff, S.M., Huber, D.L., Delaney, C.W. (2010). Achieving "Meaningful Use" of Electronic Health Records Through the Integration of the Nursing Management Minimum Data Set. *Journal of Nursing Administration*. 40(7/8):336-343, July/August 2010.
- Woodard, L. D., Urech, T., Landrum, C. R., Wang, D., Petersen, L. A. (2011). Impact of Comorbidity Type on Measures of Quality for Diabetes Care. *Medical Care*. Issue: Volume 49(6), June 2011, p 605–610. DOI: 10.1097/MLR.0b013e31820f0ed0. ISSN: 0025-7079. Accession: 00005650-201106000-00012.
- Worrall, G., Chaulk, P., Freake, D. (1997). The effects of clinical practice guidelines on patient outcomes in primary care: a systematic review. *Canadian Medical Association Journal* 1997;156:1705-12. Retrieved on 3/15/2011 from <http://canadianmedicaljournal.ca/cgi/reprint/156/12/1705.pdf>.