

A Business Case:

Identifying Excess Cost & Length of
Stay of Adverse Patient Safety Events

Introduction

The notion that adverse patient safety events result in excess costs is not a new concept. However, more research is needed on the actual costs of different types of adverse events at an organizational level. Therefore, American Data Network sought to conduct research on the financial costs and increased length of stay of the most frequently occurring adverse events in hopes the findings would help hospitals target patient safety efforts at areas that can have the most significant effect.

Data Analysis Project Summary

Background

According to the Agency for Healthcare Research and Quality (AHRQ), “the Patient Safety Indicators (PSIs) are a set of quality measures that provide information on potential in-hospital complications and adverse events following surgeries, procedures, and childbirth. The PSIs were developed after a comprehensive literature review, analysis of ICD-9-CM codes, review by a clinician panel, implementation of risk adjustment, and empirical analyses.”

PSIs are designed to rely on administrative discharge data that is collected by nearly all US hospitals. While using administrative data has inherent imperfections, PSIs are widely accepted as the most useful tool for identifying complications or adverse events.

Pertinent Literature Review

Several studies have evaluated the cost of adverse events, including the OIG’s “Adverse Events in Hospitals: National Incidence Among Medicare Beneficiaries” [\[weblink\]](#) from November 2010, as well as Chapter 45 (AHRQ Quality Indicators) of AHRQ’s April 2008 publication, “Patient Safety and Quality: An Evidence-Based Handbook for Nurses.” [\[weblink\]](#) In 2011, AHRQ’s Patient Safety Network (PSNet) published an article, “Measuring the Cost of Hospital Adverse Patient Safety Events” [\[weblink\]](#) estimating the excess cost of hospital inpatient care due to adverse safety events in the US Department of Veterans Affairs (VA) hospitals during fiscal year 2007. Specifically, it measured adverse events according to PSI algorithms. Results suggested that the excess cost of nine different PSIs for VA patients are much higher than previously [estimated](#) by other researchers. The results also indicated potential for savings across different adverse safety events, which can be used to help prioritize efforts to improve quality of care in hospitals. Furthermore, these estimates can assist in determining when financial incentives are well aligned or misaligned with improvement efforts.

Project Scope

Adverse events can lead to increased resource utilization and greater intensity of services, resulting in additional cost and days of hospitalization. Because there is a growing need for a business case for safety, American Data Network (ADN) utilized HCUP All Payer data (4+ million records representing 484 facilities) and CMS MEDPAR data (13+ million records representing 3,378 facilities) to evaluate the prevalence and estimate excess costs and Length of Stay (LOS) associated with patients meeting the [AHRQ v4.5](#) definitions for selected PSIs. ADN hypothesized that patients experiencing an adverse event, as defined by AHRQ’s PSIs, would have a higher cost and LOS than those patients not experiencing an adverse event.

Measures

Of the 24 available PSIs in AHRQ's v4.5, ADN selected PSIs for inclusion based upon appropriateness for a cost/LOS impact study, and then vetted these selections through literature review (i.e., most prevalent, most reliable). We further excluded PSIs that had low occurrence rates (postoperative hip fracture, retained surgical items, and transfusion reaction) or were not applicable to both HCUP and MEDPAR data sets (obstetrics). The remaining 10 PSI measures of interest are listed below in Table 1.

Table 1: AHRQ PSI Measures Utilized in Cost/LOS Impact Study

PSI ID	PSI Description
PSI-03	Pressure Ulcer Rate
PSI-06	Iatrogenic Pneumothorax Rate
PSI-07	Central Venous Catheter-Related Bloodstream Infection Rate
PSI-09	Perioperative Hemorrhage or Hematoma Rate
PSI-10	Postoperative Physiologic and Metabolic Derangement Rate
PSI-11	Postoperative Respiratory Failure Rate
PSI-12	Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate
PSI-13	Postoperative Sepsis Rate
PSI-14	Postoperative Wound Dehiscence Rate
PSI-15	Accidental Puncture or Laceration Rate

Methodology

Data was captured in two groups for each PSI measure to facilitate cost/LOS comparisons:

- Patients meeting the [AHRQ v4.5](#) PSI numerator definition (i.e., patients with a PSI)
- Patients meeting the [AHRQ v4.5](#) PSI denominator definition, excluding numerator population (i.e., patients without a PSI)

Data sets used for this study include:

- **All Payer** = HCUP All Payer data (CY2011) excluding various parameters (i.e., specialty hospitals, long-term acute care facilities, rehab hospitals and hospice facilities), as well as any facility which could not be matched back to a CMS cost report via a CMS ID, and including client All Payer data submitted directly to ADN (Oct2011-Sep2012).
- **MEDPAR** = CMS MEDPAR data (Oct2011-Sep2012), excluding various parameters (i.e., specialty hospitals, long-term acute care facilities, rehab hospitals and hospice facilities), as well as ADN client data included for this timeframe, which was replaced/supplemented with Medicare data submitted directly to ADN (Oct2011-Sep2012).
- All Payer and MEDPAR data were adjusted for inflation using the Price Producers Index (PPI).

Data output for each PSI measure included:

- AHRQ Measure ID and Description
- Volume of patients meeting the PSI numerator definition (those patients who had the PSI)
- Volume of patients meeting the PSI denominator definition (those patients who did not have the PSI)
- Average Total Cost Per Case
 - Costs are calculated using each facility's ratio of costs to charges (RCC), as indicated in the most recently published Medicare Cost Report. The facility ratio is then applied to the total charges for each patient to estimate the cost associated with the encounter.
- Average Length of Stay (ALOS)
 - ALOS is a mean calculated by dividing the sum of inpatient days by the number of patient admissions within the same PSI classification.

Explanation of Data Fields

- **# of Pts w/PSI** = Number of patients meeting the [AHRQ v4.5](#) numerator definition of the PSI indicator
- **Avg Total Cost w/PSI** = Average Total Cost Per Case for patients meeting the [AHRQ v4.5](#) numerator definition of the PSI indicator
- **Avg LOS w/PSI** = Average LOS for patients meeting the [AHRQ v4.5](#) numerator definition of the PSI indicator
- **# of Pts w/o PSI** = Number of patients meeting the [AHRQ v4.5](#) denominator definition of the PSI indicator
- **Avg Total Cost w/o PSI** = Average Total Cost Per Case for patients which meet the [AHRQ v4.5](#) denominator definition of the PSI indicator
- **Avg LOS w/o PSI** = Average LOS for patients which meet the [AHRQ v4.5](#) denominator definition of the PSI indicator
- **Excess Cost of Pt w/PSI** = Difference in 'Avg Total Cost w/PSI' (Column 4) and 'Avg Total Cost w/o PSI' (Column 7). *To be interpreted as avoidable costs.*
- **% Excess Cost** = 'Excess Cost of Pts w/ PSI' (Column 9) divided by 'Avg Total Cost w/PSI' (Column 4) multiplied by 100. *To be read as "Patients with this PSI are estimated to cost X% more than patients without this PSI." Facilities are encouraged to use "% Excess Cost" when applying study findings. See section below.*
- **Excess LOS of Pt w/PSI** = Difference in 'Avg LOS w/PSI' (Column 5) and 'Avg LOS w/o PSI' (Column 8). *To be interpreted as avoidable days.*
- **% Excess LOS** = 'Excess LOS of Pts w/PSI' (Column 11) divided by 'Avg LOS w/PSI' (Column 5) multiplied by 100. *To be read as "Patients with this PSI are estimated to stay X% longer than patients without this PSI." Facilities are encouraged to use "% Excess LOS" when applying study findings. See section below.*

Data Findings

Based on the **HCUP All Payer** data, the PSIs in **order of highest percentages of excess cost** are as shown:

(The first row of the table provides column numbers referenced in the explanation of data fields on page 6.)

1	2	3	4	5	6	7	8	9	10	11	12
	Measure	# of Pts w/PSI	Avg Total Cost w/ PSI	Avg LOS w/ PSI	# of Pts w/o PSI	Avg Total Cost w/o PSI	Avg LOS w/o PSI	Excess Cost of Pts w/ PSI	% Excess Cost	Excess LOS of Pts w/ PSI	% Excess LOS
1	PSI-07: Central Venous Catheter-Related Bloodstream Infection Rate	545	\$ 38,681	13.43	2,681,901	\$ 10,345	4.68	\$ 28,336	73%	8.75	65%
2	PSI-11: Postoperative Respiratory Failure Rate	2,821	\$ 37,081	11.40	272,956	\$ 12,422	3.60	\$ 24,659	67%	7.80	68%
3	PSI-14: Postoperative Wound Dehiscence Rate	279	\$ 48,423	14.46	161,287	\$ 16,460	5.84	\$ 31,963	66%	8.62	60%
4	PSI-13: Postoperative Sepsis Rate	800	\$ 48,769	14.33	58,559	\$ 19,262	5.69	\$ 29,507	61%	8.64	60%
5	PSI-10: Postoperative Physiologic and Metabolic Derangement Rate	229	\$ 34,234	10.99	324,915	\$ 13,705	3.85	\$ 20,529	60%	7.14	65%
6	PSI-15: Accidental Puncture or Laceration Rate	7,537	\$ 25,990	7.63	3,480,340	\$ 10,656	4.64	\$ 15,334	59%	2.99	39%
7	PSI-12: Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate	6,273	\$ 40,277	11.73	835,354	\$ 17,389	4.66	\$ 22,888	57%	7.07	60%
8	PSI-09: Perioperative Hemorrhage or Hematoma Rate	1,679	\$ 32,535	8.70	839,246	\$ 17,562	4.70	\$ 14,973	46%	4.00	46%
9	PSI-06: Iatrogenic Pneumothorax Rate	2,987	\$ 15,692	7.00	3,382,935	\$ 10,353	4.51	\$ 5,339	34%	2.49	36%
10	PSI-03: Pressure Ulcer Rate	26,817	\$ 19,632	9.32	947,350	\$ 16,140	7.37	\$ 3,492	18%	1.95	21%

Data Findings

Based on the **HCUP All Payer** data, the PSIs in **order of highest percentages of excess LOS** are as shown:

(The first row of the table provides column numbers referenced in the explanation of data fields on page 6.)

1	2	3	4	5	6	7	8	9	10	11	12
	Measure	# of Pts w/PSI	Avg Total Cost w/ PSI	Avg LOS w/ PSI	# of Pts w/o PSI	Avg Total Cost w/o PSI	Avg LOS w/o PSI	Excess Cost of Pts w/ PSI	% Excess Cost	Excess LOS of Pts w/ PSI	% Excess LOS
1	PSI-11: Postoperative Respiratory Failure Rate	2,821	\$ 37,081	11.40	272,956	\$ 12,422	3.60	\$ 24,659	67%	7.80	68%
2	PSI-07: Central Venous Catheter-Related Bloodstream Infection Rate	545	\$ 38,681	13.43	2,681,901	\$ 10,345	4.68	\$ 28,336	73%	8.75	65%
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8	PSI-15: Accidental Puncture or Laceration Rate	7,537	\$ 25,990	7.63	3,480,340	\$ 10,656	4.64	\$ 15,334	59%	2.99	39%
9	PSI-06: Iatrogenic Pneumothorax Rate	2,987	\$ 15,692	7.00	3,382,935	\$ 10,353	4.51	\$ 5,339	34%	2.49	36%
10	PSI-03: Pressure Ulcer Rate	26,817	\$ 19,632	9.32	947,350	\$ 16,140	7.37	\$ 3,492	18%	1.95	21%

Data Findings

Based on the **CMS MEDPAR** data, the PSIs in **order of highest percentages of excess cost** are as shown:

(The first row of the table provides column numbers referenced in the explanation of data fields on page 6.)

1	2	3	4	5	6	7	8	9	10	11	12
	Measure	# of Pts w/PSI	Avg Total Cost w/ PSI	Avg LOS w/ PSI	# of Pts w/o PSI	Avg Total Cost w/o PSI	Avg LOS w/o PSI	Excess Cost of Pts w/ PSI	% Excess Cost	Excess LOS of Pts w/ PSI	% Excess LOS
1	PSI-11: Postoperative Respiratory Failure Rate	26,256	\$ 52,101	13.76	1,519,617	\$ 15,936	3.52	\$ 36,165	69%	10.24	74%
2	PSI-15: Accidental Puncture or Laceration Rate	28,176	\$ 35,985	10.74	13,415,460	\$ 11,627	5.13	\$ 24,358	68%	5.61	52%
3	PSI-10: Postoperative Physiologic and Metabolic Derangement Rate	2,480	\$ 55,417	14.99	1,965,826	\$ 18,555	3.97	\$ 36,862	67%	11.02	73%
4	PSI-13: Postoperative Sepsis Rate	6,480	\$ 72,237	18.86	407,708	\$ 26,635	6.59	\$ 45,602	63%	12.27	65%
5	PSI-06: Iatrogenic Pneumothorax Rate	5,005	\$ 29,439	9.11	12,886,900	\$ 10,960	4.89	\$ 18,479	63%	4.22	46%
6	PSI-14: Postoperative Wound Dehiscence Rate	1,297	\$ 57,416	20.90	445,577	\$ 23,641	8.61	\$ 33,775	59%	12.29	59%
7	PSI-12: Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate	34,373	\$ 47,525	14.92	3,564,163	\$ 20,667	5.51	\$ 26,858	57%	9.41	63%
8	PSI-09: Perioperative Hemorrhage or Hematoma Rate	8,709	\$ 44,222	11.92	3,580,808	\$ 20,919	5.59	\$ 23,303	53%	6.33	53%
9	PSI-07: Central Venous Catheter-Related Bloodstream Infection Rate	34	\$ 24,203	11.59	8,363,866	\$ 12,078	5.56	\$ 12,125	50%	6.03	52%
10	PSI-03: Pressure Ulcer Rate	120,678	\$ 20,919	10.93	4,121,925	\$ 18,394	9.01	\$ 2,525	12%	1.92	18%

Data Findings

Based on the **CMS MEDPAR** data, the PSIs in **order of highest percentages of excess LOS** are as shown:

(The first row of the table provides column numbers referenced in the explanation of data fields on page 6.)

1	2	3	4	5	6	7	8	9	10	11	12
	Measure	# of Pts w/PSI	Avg Total Cost w/ PSI	Avg LOS w/ PSI	# of Pts w/o PSI	Avg Total Cost w/o PSI	Avg LOS w/o PSI	Excess Cost of Pts w/ PSI	% Excess Cost	Excess LOS of Pts w/ PSI	% Excess LOS
1	PSI-11: Postoperative Resp Failure Rate	26,256	\$ 52,101	13.76	1,519,617	\$ 15,936	3.52	\$ 36,165	69%	10.24	74%
2	PSI-10: Postoperative Postoperative Physiologic/ Metabolic Derangement Rate	2,480	\$ 55,417	14.99	1,965,826	\$ 18,555	3.97	\$ 36,862	67%	11.02	73%
3	PSI-13: Postoperative Sepsis Rate	6,480	\$ 72,237	18.86	407,708	\$ 26,635	6.59	\$ 45,602	63%	12.27	65%
4	PSI-12: Perioperative PE or DVT Rate	34,373	\$ 47,525	14.92	3,564,163	\$ 20,667	5.51	\$ 26,858	57%	9.41	63%
5	PSI-14: Postoperative Wound Dehiscence Rate	1,297	\$ 57,416	20.90	445,577	\$ 23,641	8.61	\$ 33,775	59%	12.29	59%
6	PSI-09: Perioperative Hemorrhage or Hematoma Rate	8,709	\$ 44,222	11.92	3,580,808	\$ 20,919	5.59	\$ 23,303	53%	6.33	53%
7	PSI-15: Accidental Puncture or Laceration Rate	28,176	\$ 35,985	10.74	13,415,460	\$ 11,627	5.13	\$ 24,358	68%	5.61	52%
8	PSI-07: Central Venous Catheter Related Bloodstream Infection Rate	34	\$ 24,203	11.59	8,363,866	\$ 12,078	5.56	\$ 12,125	50%	6.03	52%
9	PSI-06: Iatrogenic Pneumothorax Rate	5,005	\$ 29,439	9.11	12,886,900	\$ 10,960	4.89	\$ 18,479	63%	4.22	46%
10	PSI-03: Pressure Ulcer Rate	120,678	\$ 20,919	10.93	4,121,925	\$ 18,394	9.01	\$ 2,525	12%	1.92	18%

Analysis and Study Findings

Excess Cost

During the timeframe studied, the PSI with the highest percentage of excess cost when reviewing the HCUP All Payer population (4+ million records) was PSI-07 Central Venous Catheter Related Bloodstream Infection Rate with 73% excess cost. In other words, patients with Central Venous Catheter Related BSI are estimated to cost 73% more than those without. This is followed by PSI-11 Postoperative Respiratory Failure Rate and PSI-14 Postoperative Wound Dehiscence Rate, with excess costs estimated at 67% and 66%, respectively. When applying the excess cost percentages to the patients affected by the top 3 PSIs within the HCUP All Payer data set, the total avoidable costs are estimated at \$94 Million. When applied for all 10 PSIs included in the study, the total avoidable costs are estimated at \$516 Million.

The PSI with the highest percentage of excess cost when reviewing the CMS MEDPAR population (13+ million records) was PSI-11 Postoperative Respiratory Failure with 69% excess cost. In other words, patients with Postoperative Respiratory Failure are estimated to cost 69% more than those without. This is closely followed by PSI-15 Accidental Puncture or Laceration Rate and PSI-10 Postoperative Physiologic/Metabolic Derangement Rate at 68% and 67%, respectively. When applying the excess cost percentages to the patients affected by the top 3 PSIs within the CMS MEDPAR data set, the total avoidable costs are estimated at \$1.7 Billion. When applied for all 10 PSIs included in the study, the total avoidable costs are estimated at \$3.6 Billion.

Excess LOS

During the timeframe studied, the PSI with the highest percentage of excess LOS when reviewing the HCUP All Payer population (4+ million records) was PSI- 11 Postoperative Respiratory Failure with 68% excess LOS. In other words, patients with Postoperative Respiratory Failure are estimated to stay 68% longer than those without. This is followed by PSI-07 Central Venous Catheter Related Bloodstream Infection Rate and PSI-10 Postoperative Physiologic/Metabolic Derangement Rate, with excess LOS days estimated for both measures at 65%. When applying the excess LOS percentages to the patients affected by the top 3 PSIs within the HCUP All Payer data set, the total avoidable LOS is estimated at 28,407 days. When applied for all 10 PSIs included in the study, the total avoidable LOS is estimated at 170,844 days.

The PSI with the highest percentage of excess LOS days when reviewing the CMS MEDPAR population (13+ million records) was PSI-11 Postoperative Respiratory Failure Rate with 74% excess LOS days. In other words, patients with Postoperative Respiratory Failure Rate are estimated to stay 74% longer than those without. This is followed by PSI-10 Postoperative Physiologic/Metabolic Derangement Rate and PSI-13 Postoperative Sepsis Rate at 73% and 65%, respectively. When applying the excess LOS percentages to the patients affected by the top 3 PSIs within the CMS MEDPAR data set, the total avoidable LOS is estimated at 375,611 days. When applied for all 10 PSIs included in the study, the total avoidable LOS is estimated at 1.18 Million days.

Attribution of Excess Cost/LOS

ADN attributed Excess Average Cost and LOS for each of the 10 PSIs studied by calculating the difference between two comparison groups, “Patients with a PSI” and “Patients without a PSI”. As discussed above, “Patients with a PSI” are defined as meeting the AHRQ PSI v4.5 numerator criteria. “Patients without a PSI” are defined as meeting the AHRQ PSI v4.5 denominator criteria, as well as excluding those who met the numerator criteria.

Since this attribution methodology was applied at the individual PSI level, our study did not account for patients who may have met the numerator criteria for any of the other PSIs studied. Thus, we queried the numerator data across all 16 PSIs originally reviewed to better understand how many patients were impacted by more than one PSI. We identified that only 2% of HCUP All Payer and 5.7% of CMS MEDPAR numerator patients were affected which we deem negligible. This finding substantiates that the Average Cost and LOS presented for “Patients with a PSI” can be reasonably attributed to the single PSI measured.

ADN also queried the denominator data to better understand how many patients experienced zero PSIs. We found that 98.6% of HCUP All Payer and 99.3% CMS MEDPAR denominator patients did not meet numerator criteria for any PSI studied, including those we ultimately excluded from this focused study (due to low occurrence rates or non-applicable to both HCUP All Payer and CMS MEDPAR data sets). This finding substantiates that the Average Cost and LOS reasonably represent the data displayed for “Patients without a PSI”.

With the findings for the two comparison groups affirmed, ADN feels assured that the estimates presented for Excess Average Cost and LOS can be safely used by facilities to approximate avoidable costs and avoidable days for each adverse event studied.

How to Apply Findings to Your Facility

Free Calculator Tool

To calculate the excess costs of adverse events at your facility, [click here to access our free calculator tool](#).

Facility Data

ADN clients can retrieve the numerator volume for each PSI indicator by logging into ADN's Quality Module via the Clinical Benchmarking System (CBS). Change the "Sort By" parameter to "Measure Source" and the "Category" parameter to "AHRQ"; next, select the PSI name in the "Measure" drop-down. To retrieve the Average Total Cost Per Case or Average LOS for the numerator population, drill into the "Incidence" volume to return a list of patients; then, run the "Summary Stats" using the Σ button. The Average Cost per Case and Average LOS is included in the "Basic Statistics" table.

Contact

For more information on tracking your facility's patient safety event data, contact Kristi Toblesky, Product/Services Specialist, at American Data Network for more information: ktoblesky@americandatanetwork.com.