HealthGrades Quality Study

Patient Safety in American Hospitals

July 2004

HEALTHGRADES®
THE HEALTHCARE QUALITY EXPERTS®

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Study Released by HealthGrades

July 2004

Introduction

Policymakers, providers, and consumers have made the safety of patients in United States hospitals a top priority. The need to monitor, track, assess, and improve the safety of inpatient care is at the top of many stakeholders' agendas.

Despite the shocking and widely publicized statistics on preventable deaths due to medical errors in America's hospitals, there is little evidence that patient safety has improved in the last five years. During his keynote speech at the recent Annual Session of the American College of Physicians, leading patient safety expert and co-author of the five-year old Institute of Medicine (IOM) report "To Err Is Human," Dr. Lucian Leape said that he has not seen a "big improvement" in patient safety since the publication of the IOM report.

This is highly unfortunate given that the IOM report found an estimated 98,000 preventable deaths *each year* due to medical errors.[1] With no significant improvement over the last five years, we may have lost an additional 490,000 Americans due to our failure to improve patient safety.

The United States loses more American lives to patient safety incidents every six months than it did in the entire Vietnam War. This also equates to three fully loaded jumbo jets crashing every other day for the last five years.[2] Although not recognized as a cause of death by the Centers for Disease Control & Prevention (CDC) in its annual National Vital Statistics Report,[3] if they were, medical errors would be ranked as the sixth leading cause of death in the United States and outrank deaths due to diabetes, influenza and pneumonia, Alzheimer's disease, and renal disease.

"You can't manage what you can't measure" is a widely held belief regularly professed by many quality gurus. Without accurate measurement we can't significantly improve the quality of care. There has been limited data and research on the magnitude of medical injuries and patient safety subsequent to the unprecedented "To Err Is Human" IOM report in 1999. One reason for this is that significant issues around defining, reporting, and using these measurements continue to be debated. In response to the increased need for patient safety measurements, the Agency for Healthcare Research and Quality (AHRQ) recently developed and released a set of Patient Safety Indicators (PSI), which are specifically designed for screening hospital administrative data for incidents of concern related to patient safety.[4] See Appendix A for a complete list of the AHRQ Patient Safety Indicators.

Using this measurement tool, a recent study published in JAMA[5] was the first to identify the rates of, and excess length of stay and mortality associated with, these specific patient safety indicators. Extrapolating from their sample data, representing approximately 20% of all U.S. hospitals (2000 Healthcare Cost and Utilization Project Nationwide Inpatient Sample[*]), Zhan and Miller estimated that the 18 patient safety indicators evaluated contributed to **$9.3 billion excess charges and 32,591 deaths** in the United States annually.[5] The March 2004 MedPAC Report to the Congress-Medicare Payment Policy- found that not only are hundreds of thousands of Medicare beneficiaries experiencing adverse events every year, but they are doing so at increasing rates. MedPAC determined that the majority of patient safety adverse events in Medicare beneficiaries increased from 1995 to 2002.[6] Although the estimates of patient safety adverse events documented in these two studies vary, the sheer magnitude and impact of every estimate clearly support the IOM's contention that medical injuries are a serious epidemic confronting the American health care system.

Given this serious epidemic and further economic burden on our already strained health care system, consumers and purchasers must be armed with information that allows them to make quality-oriented health care choices when choosing a hospital. To identify the patient safety incident rates for every hospital in the country, HealthGrades applied AHRQ's Patient Safety Indicator software[4] to three years of Medicare data (2000-2002) to identify incidences of patient safety events by PSI. We then to applied the methodology referenced in the JAMA study[5] to evaluate the mortality and cost associated with these patient safety incidents. To our knowledge, this is the first study to identify the impact of patient safety incidents on potentially avoidable deaths and excess costs associated with AHRQ's patient safety indicators in the Medicare population across all U.S. hospitals.

Summary of Findings

AHRQ's development of the Patient Safety Indicators was based on the Institute of Medicine's definition of *patient safety,* which is ***"freedom from accidental injury due to medical care, or medical errors."***[1] *Medical error* is defined as "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim…[including] problems in practice, products, procedures, and systems."[7]

In 2002, AHRQ, in collaboration with the University of California-Stanford Evidence-Based Practice Center, identified 20 indicators that could be readily identified in hospital discharge data and were deemed potentially preventable patient safety incidents. This tool set of 20 evidence-based PSIs was created and released to the public in 2003 to be used by various health care stakeholders to assess and improve patient safety in U.S. hospitals.[4]

Using AHRQ's *PSI Version 2.1, Revision 1, March 2004* software application[4] which was applied to approximately 37 million Medicare discharge, we identified the rates of 16 patient safety incidents relevant to the Medicare population (excluded the four obstetric-related PSIs) in every

[*] Additional information on the HCUP data is available at http://www.hcup-us.ahrq.gov/databases.jsp.

hospital across the U.S. We then applied previous peer-reviewed research by Zhan and Miller,[5] to assess the result of these safety incidents on mortality and cost in the same population. The 16 PSIs studied are listed in Appendix A.

A summary of our findings follows:

1. Approximately 1.14 million total patient safety incidents occurred among the 37 million hospitalizations in the Medicare population from 2000 through 2002.
2. The PSIs with the highest incident rates per 1,000 hospitalizations at risk were Failure to Rescue, Decubitus Ulcer, and Post-operative Sepsis. These three patient safety incidents accounted for almost 60% of all patient safety incidents among Medicare patients hospitalized from 2000 through 2002.
3. Of the total of 323,993 deaths among patients who experienced one or more PSIs from 2000 through 2002, 263,864, or 81%, of these deaths were potentially attributable to the patient safety incident(s).
4. Failure to Rescue (i.e., failure to diagnose and treat in time) and Death in Low Mortality Diagnostic Related Groups (i.e., unexpected death in a low risk hospitalization) accounted for almost 75% of all mortality attributable to patient safety incidents.
5. Of the remaining 65,972 deaths attributable to the other 14 patient safety indicators (excluding Failure to Rescue and Death in Low Mortality DRGs), almost 75% were in patients with Decubitus Ulcer (34,320), Post-operative Pulmonary Embolism or Deep Vein Thrombosis (8,445) or Post-operative Respiratory Failure (6,320).
6. There were small variations in PSI incident rates across hospitals and regions.
7. Overall, the Central and Western regions of the U.S. performed better than the Northeast and Sunbelt.
8. Teaching hospitals and larger hospitals (>200 beds) had slightly higher patient safety incident rates per 1,000 as compared to non-teaching hospitals across most PSIs.
9. Patient safety incidents were more prevalent among medical admissions compared to surgical admissions.
10. Overall, the best performing hospitals (hospitals that had the lowest overall PSI incident rates of all hospitals studied, defined as the top 7.5% of all hospitals studied) had five fewer deaths per 1,000 hospitalizations compared to the bottom 10^{th} percentile of hospitals. This significant mortality difference is attributable to fewer patient safety incidents at the best performing hospitals. Fewer patient safety incidents in the best performing hospitals resulted in a lower cost of $740,337 per 1,000 hospitalizations as compared to the bottom 10^{th} percentile of hospitals.
11. The 16 PSIs studied accounted for $8.54 billion in excess inpatient cost to the Medicare system over 3 years, or roughly $2.85 billion annually. Decubitus Ulcer ($2.57 billion), Post-operative Pulmonary Embolism or Deep Vein Thrombosis ($1.40 billion), and Selected Infections due to Medical Care ($1.71 billion) were the most costly and accounted for 66% of all excess attributable costs from 2000 through 2002.

Methodology

In order to evaluate *overall* hospital performance and to identify the best performing hospitals across the U.S., we used AHRQ's *Patient Safety Indicator Version 2.1, Revision 1, March 2004* software application[4] to evaluate every hospital in the country on each PSI and then developed a ranking methodology to evaluate patient safety performance for each hospital overall. To minimize potential impact of variation in hospital coding of specific E codes when assessing overall hospital performance, we followed the recommendation of AHRQ[8] to exclude three PSIs (Accidental Puncture or Laceration, Complications of Anesthesia, Transfusion Reaction) that included these specific E codes in their definition from the overall hospital analysis. See Appendix B, Overall Hospital Patient Safety Performance Methodology, for full details.

After identifying the incident rates for each PSI (as mentioned above), we calculated the excess charge and mortality attributable to the patient safety incidents using attributable charge and mortality data from previous peer-reviewed research by Zhan and Miller.[5] In addition, we used an assumption that cost was 50% of the total charge.[9]

Findings

Using the *Patient Safety Indicator Version 2.1, Revision 1, March 2004* software application developed by AHRQ[4], HealthGrades identified a total of 1.14 million patient safety incidents that occurred in approximately 37 million hospitalizations in the Medicare population from 2000 through 2002. Per 1,000 at risk hospital admissions, national patient safety incident rates varied by PSI from 0.01 (Transfusion Reaction) to 155 (Failure to Rescue). The most commonly occurring PSIs are noted in Table 1 below. These three PSIs accounted for almost 60% of all patient safety incidents from 2000 through 2002.

Table 1: Most Commonly Occurring Patient Safety Incidents per 1,000 At Risk Hospitalizations

Patient Safety Indicator	Incident Rate per 1,000 At Risk Hospitalizations
Failure to Rescue	155
Decubitus Ulcer	30
Post-operative Sepsis	13

The rates of patient safety incidents that we identified are very consistent with previous studies.[5,6,10,11,12] Also consistent with previous findings, Medicare patients have higher patient safety incident rates per 1,000 at risk hospital admissions compared to other patient groups across most PSIs.[6,11,12] This is especially true for Post-operative Respiratory Failure and Death in Low Mortality DRG where the relative incident rate differences were 85% and 55% higher, respectively, in the Medicare population as compared to all patients. For the incident rates of all 16 PSIs, see Appendix C. For a comparison of the incident rates found in this study to previous research, see Appendix D.

Similar to a recent study published in Health Affairs,[10] we found that, overall, patient safety incidents were more prevalent among medical admissions as compared to surgical admissions. When patients with patient safety incidents were analyzed, heart failure and pneumonia were the top reasons for admission. For a list of the most common diagnoses associated with patient safety incidents, see Appendix E.

In addition, we found slightly higher patient safety incident rates among teaching hospitals as compared to non-teaching hospitals. This finding has been well documented in other studies. As such, AHRQ recommended[8] dividing the hospitals by teaching status (teaching and non-teaching) when analyzing the data to assess comparative hospital performance within a peer group. We found a 73% higher rate of Selected Infections due to Medical Care in teaching versus non-teaching hospitals (3.61 per 1,000 vs. 2.08 per 1,000). Also driving the disparity between teaching and non-teaching hospitals were Post-operative Physiologic and Metabolic Derangement (1.62 per 1,000 vs. 0.96 per 1,000) and Accidental Puncture or Laceration (3.83 per 1,000 vs. 2.35 per 1,000). Similar to teaching hospitals, larger hospitals (>200 beds) had increased rates of patient safety incidents compared to small hospitals (<200 beds). For rates of each PSI by hospital size and type, see Appendix C.

We determined that the 16 PSIs we studied may have contributed to 263,864 deaths in the Medicare population from 2000 through 2002. Eighty-one percent of these *preventable* deaths were potentially attributable to the patient safety incident. This translates to an approximate 25% overall mortality rate in Medicare patients with one or more patient safety incidents. More simply stated, one in every four Medicare patients who were hospitalized from 2000 through 2002, and experienced a patient safety incident, died - compared to only 0.15 of every four Medicare patients (3.7%) who did not experience a patient safety incident. The patient safety incidents associated with the highest number of mortalities were Failure to Rescue (187,289), Decubitus Ulcer (34,320), and Post-operative Pulmonary Embolism or Deep Vein Thrombosis (8,445).

Although we found only small variations in patient safety incident rates across most hospitals and regions, the Central and Western regions of the U.S. had lower overall patient safety incident rates than the national median performance and the Northeast and Sunbelt regions, both of which had higher patient safety incident rates than the national median.

This study identified the best performing hospitals to establish a best practice benchmark against which other hospitals could be evaluated. Best performing hospitals were identified as the top 7.5% of hospitals based on overall hospital performance (see Appendix B). Best hospitals had both significantly lower patient safety incident rates and cost as compared to the average and hospitals in the bottom 10^{th} percentile. See Table 2 below.

Table 2: Quality and Cost Comparisons by Performance Profile

Overall Patient Safety Hospital Performance	Potentially Avoidable Deaths[5] Associated with Patient Safety Incidents as Compared to Best Performing Hospitals	Potentially Avoidable Cost[5,9] Associated with Patient Safety Incidents as Compared to Best Performing Hospitals
Average	2 per 1,000 hospitalizations	$311,835 per 1,000 hospitalizations
Bottom 10th percentile	5 per 1,000 hospitalizations	$740,337 per 1,000 hospitalizations

Potentially avoidable deaths and cost comparisons were calculated using previous research by Zhan and Miller[5] and Friedman et al.[9]

The comparatively lower attributable excess mortality and cost among the best performing hospitals is directly related to their lower overall patient safety incident rates. If all the Medicare patients who were admitted to the bottom 10th percentile of hospitals from 2000 through 2002 (781,948) had been admitted to the best performing hospitals, almost 4,000 deaths would have been prevented and approximately 580 million dollars would have been saved. Alternatively, if all hospitals performed as the "best" do now, these savings would also be achieved**.**

The economic consequence of patient safety incidents is staggering and makes the strongest business case for quality to date. These 16 patient safety incidents accounted for $8.54 billion in excess inpatient costs to the Medicare system over the three years studied, or roughly $2.85 billion annually. This annually recurring and preventable expense represented almost three percent of the entire $102 billion allocated for Medicare hospital inpatient care for 2002.[13] Costs attributable to just three of the four most commonly occurring patient safety incidents-Decubitus Ulcer ($2.57 billion), Selected Infections Due to Medical Care ($1.71 billion), and Post-operative Pulmonary Embolism or Deep Vein Thrombosis ($1.40 billion) - accounted for 66% of all excess attributable costs from 2000 through 2002. See Appendix F for attributable excess mortality and cost by PSI and in total.

To extrapolate to the nation as a whole, we calculated that Medicare hospital discharges represented 45% of all short-term acute care hospital discharges from 2000 through 2002. Using this finding and excluding obstetric patients, we calculated that an extra $19 billion was spent, and over 575,000 preventable deaths occurred, as a direct result of the 2.5 million patient safety incidents that occurred in U.S. hospitals from 2000 through 2002.

Interpretation of Results

This is the first study to look at the potentially avoidable mortality and cost impact of patient safety incidents using AHRQ's PSIs[4] across all U.S. hospitals among the most concentrated at risk patient population, Medicare patients. This study identified a substantial number of patient safety incidents that resulted from failures in the processes of care in hospitals. The patient safety events addressed in this study may represent only the tip of the iceberg. They are lower than those reported from other sources, most likely due to the fact that we analyzed selected types of medical injuries that were discovered during hospitalizations of Medicare patients. As such, we believe that our findings underestimate the true rates and associated costs of patient safety incidents in American hospitals.

Our estimates clearly support the IOM[1] and MedPAC[6] reports and the findings of Zhan and Miller[5] which contend that medical errors and injuries are epidemics in the U.S. We agree with leading patient safety expert, Dr. Lucian Leape, that there have not been "big improvements" in patient safety since the publication of the IOM report.

We now have a very compelling business case for quality improvement. So, how do we actually improve quality? When the IOM issued its landmark report on medical errors in 1999, many health care organizations reacted by creating reporting systems to track adverse events. For many of those organizations, however, that's where their efforts to prevent errors began and ended. According to Dr. Lucian Leape, "To understand an adverse event and *prevent* future problems requires analysis. You have to examine, investigate, and talk to people."[14]

Despite recognition of medical errors and injuries as a cause of death and patient safety as an area in need of significant attention and improvement, the overall approach to patient safety and definitional issues continue to be debated. Despite these issues, some health professionals have pushed through and made strides in improving patient safety. For example, anesthesia-related mortality has dramatically improved in the last 40 years.[15] Hospital-acquired infections have also been substantially reduced over several decades.[16]

Unfortunately, the best practices associated with these past and ongoing successes have not been readily diffused and adopted by other areas of medicine. Why? We believe that the reasons for this are multi-factorial: 1) Medical errors seem to be the elephant in the room that no one wants to acknowledge or talk about. The lack of recognition and acknowledgement of the seriousness and urgency of the problem fosters a culture of denial and complacency. Also, our culture has typically viewed medical errors as a failure of people rather than systems, which prevents reporting and consequent analysis and solutions to prevent it from recurring. 2) Many industry experts believe we need large and expensive reporting systems to adequately track and decrease adverse events. Inadequate information systems and infrastructure are clearly one important aspect of the patient safety problem. Nonetheless, the commonly talked-about "solutions" to health care's broken system, computerized physician order entry system (CPOE) and electronic medical records, for example, will not be able to prevent the majority of patient safety incidents

we identified as significant contributors to preventable deaths and excess costs each year. 3) Hospitals have resource constraints. Big problems usually require a lot of resources. The aviation industry, well known for its safe practices and low incident rates of adverse events, spends about $3 million each year just analyzing near-misses. So, how can the provider community fix such an enormous problem without substantially more financing and resources?

According to the expert, Dr. Leape, "if a hospital has a real commitment to safety, it is going to get so much information that you don't need an [expensive] reporting system. I can talk to any three nurses in a unit for an hour about what bothers them, and come out with a safety agenda that will keep me busy for a year."[14] In recent years, AHRQ and other Federal agencies have sponsored extensive research on patient safety. In partnership with other Federal agencies, AHRQ has developed and funded a portfolio of research projects that 1) identify risks and hazards that lead to medical errors and the causes of patient injury associated with the delivery of medical care; 2) identify and design practices that eliminate medical errors and test them to determine their effectiveness; 3) disseminate information on and educate health professionals, students, and practitioners about proven patient safety practices that reduce or prevent patient injury associated with the delivery of medical care; and 4) monitor and evaluate threats to patient safety. AHRQ has sought to improve patient safety by promoting best practices, training new researchers, linking safety professionals and communication through Web-based tools, and promoting international collaboration. AHRQ has also compiled and released various safety tips for patient and health care professionals based on available evidence.[11]

In addition to AHRQ's directed efforts, other agencies, such as the Centers for Medicare and Medicaid Services, Department of Veterans Affairs, Food and Drug Administration, Joint Commission on Accreditation of Healthcare Organizations, and the Institute of Medicine, have all developed programs aimed at improving safety. The high visibility and priority of patient safety in America's hospitals has produced important and needed research that will identify best practices and optimal implementation to improve this national epidemic.

Until these best practices are developed, disseminated, and adopted to prevent medical errors and injuries, focused improvement efforts on four key areas - Failure to Rescue, Decubitus Ulcer, Postoperative Sepsis, and Postoperative Pulmonary Embolism or Deep Vein Thrombosis - will significantly improve patient safety in our hospitals and reduce costs. If we focused our efforts among Medicare beneficiaries on these four areas only and were able to reduce excess attributable mortality and costs by just 20%, we would prevent almost 18,000 avoidable deaths and save Medicare and society $380 million in excess inpatient costs annually. The enormity of just 20% of this situation is analogous to turning a deaf ear and blind eye to 35 jumbo jets filled with Medicare beneficiaries crashing each year. This should result in an outcry from every American demanding the right to patient safety in our hospitals.

In conclusion, our results illustrate and validate previous studies that medical injuries in hospitals continue to be a real threat to Americans and are associated with significant negative economic consequences. Most disturbingly, similar to previous study conclusions[1,5,6,10] these figures likely represent an underestimation of the true mortality and costs attributable to patient safety

incidents within our U.S. health care system. As such, we recommend that more research be done to assess patient outcomes beyond death and costs, to understand circumstances and risk factors associated with medical injuries, and to develop strategies to prevent medical injuries.

Study Limitations

Several limitations should be recognized in interpreting the results of this study. The data set used, MedPAR, is administrative data and thus, the reliability and validity of the AHRQ PSIs depend on the accuracy and completeness of the ICD-9-CM coding. There may be various coding errors or omissions of important diagnoses and complications. Also, lack of clinical details limits the potential of administrative data in risk adjustment, which could result in biases among certain patient populations. The AHRQ PSIs incorporated the latest understanding of the potential and limitations of administrative data and drew on broad consultations with clinical coding experts to ensure their clinical validity and reliability.[10,17] We believe that today's urgent social need to understand patient safety makes it sensible to use existing administrative data sources to assess and start to address the problem.[18]

Expert Consultation

We would like to thank Thomas Boardman, Ph.D., who assisted HealthGrades in developing the overall hospital patient safety performance methodology (Appendix B). Dr. Boardman is a Professor of Statistics and the Co-director of the Center for Quality and Productivity Improvement at Colorado State University. He is also a partner in Boardman Associates, a consulting firm offering services in the areas of continuous improvement and statistical thinking. We would also like to thank Dr. Denise Remus, Senior Research Scientist, Quality Indicators, Agency for Healthcare Research and Quality (AHRQ), for her guidance in the application of the PSI software and report review.

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Appendix A

List of Patient Safety Indicators Used in the HealthGrades Study

- Accidental puncture or laceration
- Complications of anesthesia
- Death in low mortality Diagnostic Related Grouping (DRGs)
- Decubitus ulcer
- Failure to rescue
- Foreign body left during procedure
- Iatrogenic pneumothorax
- Selected infections due to medical care
- Post-operative hemorrhage or hematoma
- Post-operative hip fracture
- Post-operative physiologic and metabolic derangement
- Post-operative pulmonary embolism or deep vein thrombosis
- Post-operative respiratory failure
- Post-operative sepsis
- Post-operative wound dehiscence
- Transfusion reaction

List of AHRQ Patient Safety Indicators Not Used in the HealthGrades Study

- Birth Trauma – injury to neonate
- Obstetric trauma- cesarean delivery
- Obstetric trauma – vaginal delivery with instrument
- Obstetric trama – vaginal delivery without instrument

Appendix B

Health Grades, Inc.
Overall Hospital Patient Safety Performance
Methodology White Paper
2004 Analysis (2000 - 2002 MedPAR Data)

Introduction

To help consumers evaluate and compare patient safety performance, HealthGrades analyzed patient outcome data for virtually every hospital in the country. HealthGrades used data from the Centers for Medicare and Medicaid (CMS). The Medicare data (MedPAR file) from CMS contained the inpatient records for Medicare patients.

The steps listed below are those taken to determine the overall performance of hospitals with respect to patient safety by creating an overall patient safety indicator score by hospital. Given the challenges of "rare events," we believe that this is the best methodology for identifying performance across Patient Safety Indicators.

This methodology includes the following Patient Safety Indicators:

- Death in low mortality Diagnostic Related Groups (DRGs)
- Decubitus ulcer
- Failure to rescue
- Foreign body left during procedure
- Iatrogenic pneumothorax
- Selected infections due to medical care
- Post-operative hip fracture
- Post-operative hemorrhage or hematoma
- Post-operative physiologic and metabolic derangements
- Post-operative respiratory failure
- Post-operative pulmonary embolism or deep vein thrombosis
- Post-operative sepsis
- Post-operative wound dehiscence

Data Acquisition

We used the CMS MedPAR data for several reasons. First, it included virtually every hospital in the country, with the exception of military and Veterans Administration hospitals. Second, hospitals were required by law to submit complete and accurate information with substantial penalties for those that report inaccurate or incomplete data. Third, HealthGrades calculated that

the Medicare population represented approximately 45% of the adult patient admissions during the time period studied.

Data Exclusions

HealthGrades used the *Patient Safety Indicators, Version 2.1, Revision 1, March 2004* software from the Agency for Healthcare Research and Quality (AHRQ), downloaded from: www.qualityindicators.ahrq.gov/data/hcup/psi.htm

Following all AHRQ guidelines for use of the PSI software, we applied it to all short-term acute care hospitals in the MedPAR file for three years (2000-2002).

Given that this data set applies mostly to patients over the age of 65, we excluded the following PSIs from the analysis:

- Birth trauma – injury to neonate
- Obstetric trauma – cesarean delivery
- Obstetric trauma – vaginal delivery with instrument
- Obstetric trauma – vaginal delivery without instrument

Based on AHRQ's recommendation,[8] we excluded three additional indicators:

- Accidental puncture or laceration
- Complications of anesthesia
- Transfusion reaction

We also removed hospitals in the U.S. territories and Puerto Rico from the data set.

Overall Patient Safety Score

To determine the overall patient safety score by hospital, HealthGrades performed the following steps:

1. We calculated the AHRQ risk-adjusted rate and the smoothed rate for each hospital and PSI.

2. We determined whether to use the AHRQ risk-adjusted or smoothed rate.
   - When the risk-adjusted rate was similar* to the smoothed rate, we used the risk-adjusted rate.
   - Otherwise we used the smoothed rate.

   * As recommended by AHRQ, "similar" was defined as a smoothed rate greater than 0.8 times the risk-adjusted rate where both rates were measured relative to the national average (meaning a reliability in excess of 0.8).

3. We divided the hospitals in to two peer groups: teaching and non-teaching.

   To identify the teaching peer group, we used the Medicare Cost Report (Form CMS-2552-96). A facility was considered a teaching hospital if they answered "yes" to the question, "Is this a teaching hospital or affiliated with a teaching hospital?"

4. We calculated national median incident percentage and standard deviation by PSI and peer group. For each PSI and peer group, we calculated the minimum volume (statistical power) needed to detect that PSI's national median value with 95% confidence.

5. As many of the PSIs are very rare events, we took steps to eliminate small hospitals with inadequate volume (statistical power) over three years to be able to detect the event. (See Exhibit 1 for the minimum volume required for each PSI.) We eliminated all hospitals from that PSI if they did not meet these volume thresholds.

6. In each peer group, we determined how many hospitals had an incident percent in each of the 13 PSIs. (See Exhibit 2.) Based on this distribution, we chose to create a patient safety score only for hospitals included in at least 11 of the 13 PSIs for both teaching and non-teaching hospitals. In other words, we eliminated all hospitals with an incident percent in only 10 or fewer of the 13 PSIs from the analysis.

7. The remaining hospitals were included in the analysis:
   - 884 teaching hospitals
   - 868 non-teaching hospitals

8. Many of the PSIs are very rare events, and in some cases there are a significant number of zero values. Statistically speaking, however, over time a zero defect rate is impossible. As such, we substituted a very small, randomly generated value for each zero. The same randomly generated number was used for all hospitals. In no case was this randomly generated number greater than the lowest actual incident rate.

9. Because each PSI has a different denominator of patients (e.g., inclusion and exclusion criteria), one cannot simply add up the rates of each PSI to determine an aggregate or average rate. To address this challenge, HealthGrades applied several statistical techniques to arrive at an aggregated Patient Safety score.
   - We assessed distributions of each PSI by peer group for symmetry (e.g., normally distributed).
   - Because the distributions were not symmetrical using the incident percentages of each PSI, we transformed these values to their corresponding $\log_{10}$ values, which produced symmetrical distributions for all PSIs.
   - The national median incident percentage and its associated standard deviation for each PSI for each peer group calculated in step 4 was also transformed to its $\log_{10}$ value.

- Zero substitution was performed for those hospitals where the incident percent was 0% (cannot transform 0 to $\log_{10}$).
- We calculated the z-score, or distance from the national median ([hospital $\log_{10}$ value - national median $\log_{10}$ value]/national median standard deviation $\log_{10}$ value), for each hospital by PSI and peer group.
- We summed the z-scores across all PSIs for each hospital by peer group. We rank ordered the aggregate z-scores by hospital by peer group from lowest z-score (most negative and "best" performers) to highest (most positive z-score and worst performers).
- Qnorms were plotted for each peer group and the top 7.5 percentile was determined to be the outlier performers from the rest of the normally distributed aggregate z-scores.

10. We identified both teaching and non-teaching hospitals in the top 7.5% as "best performing" and passing the initial qualifications to win the Distinguished Hospital Award for Patient Safety.

Additional Criteria

In addition to being in the top 7.5%, hospitals had to meet the following criteria to win the Distinguished Hospital Award for Patient Safety:

- Have an overall HealthGrades star rating of at least 2.5
- Have a HealthGrades star rating in a minimum number of procedures/diagnoses:
  - 21 out of 26 procedures/diagnoses for teaching hospitals
  - 20 out of 26 procedures/diagnoses for non-teaching hospitals

Number of Hospitals in each best performing category:

Hospital Type	Number of Best Performing Providers
Teaching hospitals	48
Non-teaching hospitals	40

Exhibit 1

Minimum Volume* Necessary to Be Rated in Each PSI

Patient Safety Indicator	Minimum Volume	
	Teaching Hospitals	Non-Teaching Hospitals
Death in low mortality DRGs	249	328
Decubitus ulcer	18	22
Failure to rescue	6	6
Foreign body left during procedure	7614	8970
Iatrogenic pneumothorax	698	878
Selected infections due to medical care	193	316
Post-operative hip fracture	657	591
Post-operative hemorrhage or hematoma	295	398
Post-operative physiologic and metabolic derangements	305	184
Post-operative respiratory failure	88	123
Post-operative pulmonary embolism or deep vein thrombosis	48	68
Post-operative sepsis	48	60
Post-operative wound dehiscence	301	357

*****The minimum volume is defined as the minimum number of discharges that were eligible to be counted for the measure as defined in the Patient Safety Indicator Version 2.1 (Revision 1) software used in this analysis that would statistically significantly detect one event with 95% confidence.

Exhibit 2

Volume of Hospitals by Number of PSIs Rated

Teaching Hospitals		
Number of PSIs	**Number of Providers**	**Cumulative Percentage**
13	807	65.72%
12	78	72.07%
11	66	77.44%
10	69	83.06%
9	52	87.30%
8	39	90.47%
7	34	93.24%
6	27	95.44%
5	25	97.48%
4	15	98.70%
3	6	99.19%
2	6	99.67%
1	4	100.00%

Non-Teaching Hospitals		
Number of PSIs	**Number of Providers**	**Cumulative Percentage**
13	542	14.99%
12	160	19.41%
11	330	28.54%
10	355	38.36%
9	203	43.97%
8	131	47.59%
7	163	52.10%
6	208	57.85%
5	516	72.12%
4	367	82.27%
3	307	90.76%
2	169	95.44%
1	165	100.00%

Appendix C-National Patient Safety Incident Rates per 1000 At Risk Hospitalizations by Hospital Size & Type (MedPAR 2000-2002)

		Teaching Status		Hospital Mission		Hospital Size			Range	
Patient Safety Indicator	**National Average**	**Teaching**	**Non-Teaching**	**For Profit**	**Not-for-profit**	**<200 beds**	**200-500 beds**	**>500 Beds**	**Minimum**	**Maximum**
Failure to Rescue	155.03	157.99	151.05	150.23	155.44	139.71	159.98	158.95	139.71	159.98
Decubitus Ulcer	29.86	31.18	28.38	36.90	29.25	28.85	30.47	29.78	28.38	36.90
Post-op Sepsis	13.20	13.17	13.25	16.48	12.94	11.54	13.50	13.74	11.54	16.48
Post-op Pulmonary Embolism or Deep Vein Thrombosis	13.14	14.44	11.27	12.49	13.19	10.15	13.13	15.00	10.15	15.00
Post-op Respiratory Failure	8.01	8.68	7.12	9.19	7.92	5.85	8.35	9.13	5.85	9.19
Post-op Wound Dehiscence	3.76	3.70	3.83	3.82	3.75	3.89	3.82	3.57	3.57	3.89
Accidental Puncture or Laceration	3.09	3.83	2.35	2.67	3.13	1.92	3.15	4.35	1.92	4.35
Selected Infections due to Medical Care	2.84	3.61	2.08	2.77	2.85	1.49	3.00	4.21	1.49	4.21
Death in Low Mortality DRGs	2.81	2.96	2.67	2.57	2.83	2.58	2.86	3.01	2.57	3.01
Post-op Hemorrhage or Hematoma	2.46	2.59	2.27	2.13	2.49	2.09	2.39	2.79	2.09	2.79
Post-op Hip Fracture	1.84	1.60	2.20	1.99	1.83	2.55	1.86	1.43	1.43	2.55
Post-op Physiologic and Metabolic Derangement	1.35	1.62	0.96	1.28	1.36	0.66	1.28	1.89	0.66	1.89
Iatrogenic Pneumothorax	1.01	1.17	0.86	0.90	1.02	0.75	1.04	1.28	0.75	1.28
Complications of Anesthesia	0.24	0.21	0.28	0.56	0.21	0.33	0.22	0.21	0.21	0.56
Foreign Body Left During Procedure	0.07	0.08	0.06	0.07	0.07	0.05	0.08	0.09	0.05	0.09
Transfusion Reaction	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01

Appendix D- Comparison of HealthGrades Patient Safety Incident Rates to Previous Research Using AHRQ PSI Methodology (Incidents per 1000 at risk hospitalizations)

Patient Safety Indicator	HealthGrades[1] (MedPAR 2000-2002)	MedPAC Analysis[2] (MedPAR 2002	Zhan and Miller[3]	Romano, Geppert and Davies[4]	Relative Difference Between HealthGrades and MedPAC	Relative Difference Between Zhan et al. and HealthGrades	Relative Difference Between Romano et al. and HealthGrades
Failure to Rescue	155.03	151.1	Not Analyzed	174.24	2.53%	NA	-12.39%
Decubitus Ulcer	29.86	31.9	21.51	21.3	-6.83%	27.96%	28.67%
Post-op Sepsis	13.20	13.5	11.25	10.91	-2.29%	14.76%	17.33%
Post-op Pulmonary Embolism or Deep Vein Thrombosis	13.14	12.3	9.34	9.19	6.40%	28.93%	30.07%
Post-op Respiratory Failure	8.01	8.7	3.58	3.59	-8.62%	55.31%	55.18%
Post-op Wound Dehiscence	3.76	3.8	2.05	1.93	-1.13%	45.44%	48.64%
Accidental Puncture or Laceration	3.09	3.6	3.32	3.24	-16.33%	-7.28%	-4.70%
Selected Infections due to Medical Care	2.84	3.0	1.99	1.93	-5.66%	29.92%	32.03%
Death in Low Mortality DRGs	2.81	3	Not Analyzed	0.43	-6.90%	NA	84.68%
Post-op Hemorrhage or Hematoma	2.46	2.4	2.06	2.06	2.39%	16.22%	16.22%
Post-op Hip Fracture	1.84	1.3	0.77	0.8	29.28%	58.11%	56.48%
Post-op Physiologic and Metabolic Derangement	1.35	1.4	1.00	0.89	-3.41%	26.13%	34.26%
Iatrogenic Pneumothorax	1.01	1.1	0.67	0.67	-8.48%	33.93%	33.93%
Complications of Anesthesia	0.24	Not Analyzed	0.71	0.56	NA	-195.29%	-132.90%
Foreign Body Left During Procedure	0.07	Not Analyzed	0.09	0.08	NA	-26.54%	-12.48%
Transfusion Reaction	0.01	Not Analyzed	0.004	0.0004	NA	22.23%	92.22%

Appendix D continued- Comparison of HealthGrades Patient Safety Incident Rates to Previous Research Using AHRQ PSI Methodology (Incidents per 1000 at risk hospitalizations) Footnote Explanations

[1] HealthGrades' data source was MedPAR hospital discharge data from 2000 to 2002 (approximately 40 million Medicare hospital discharge claims from every nonfederal short-term hospital in every state)

[2] MedPAC analysis of 100% of MedPAR data using Agency for Healthcare Research and Quality indicators and methods. MedPAC. Quality of care for Medicare beneficiaries. Report to the Congress: Medicare Payment Policy. March 2004.

[3] Zhan C. and Miller MR. Excess Length of Stay, Charges, and Mortality Attributable to Medical Injuries During Hospitalization. JAMA 2003;290(14): 1868-74. Zahn and Miller's data source was the Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) hosptial discharge

[4] Romano et al. A National Profile of Patient Safety In U.S. Hospitals. Health Affairs 2003;22(2):154-66. Romano et al.'s data source was Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) from 1995 to 2000 (all payer discharge claims form 28 states representing approximately 20% of all US nonfederal short-term hospitals).

Appendix E-Top 5 Most Common Principal Diagnoses Associated with Hospitalized Patients Who Experienced a Patient Safety Incident Across the U.S. from 2000-2002

Most Common Principal Diagnoses Associated with Medical Admissions	
Diagnosis	Number of Cases
Pneumonia	37,193
Congestive Heart Failure	31,856
Aspiration Pneumonia	31,251
Septicemia	28,377
Urinary Tract Infection	24,025

Appendix F-Patient Safety Incidents and Their Attributable Mortality and Excess Charge Among Medicare Beneficiaries by PSI from 2000-2002

Patient Safety Indicator	Actual Number of National Incidents	Percentage of Total Number of Incidents	All-cause National Medicare Mortality Rate	Attributable Mortality Rates**	Total Number of National Deaths (all-cause) in At Risk Patients by PSI	Number of Deaths Attributable to a PSI (Attributable Mortality**)	Attributable Charge **	Excess Charge Attributable to a PSI** In Millions	Excess Cost Attributable to a PSI^^ In Millions
Decubitus Ulcer	474,692	41.59%	13.13%	7.23%	62,327	34,320	$10,845	$5,148.03	$2,574.02
Failure to Rescue*	187,289	16.41%	100.00%	100.00%	187,289	187,289	NA*	NA*	NA*
Post-op Pulmonary Embolism or Deep Vein Thrombosis	128,738	11.28%	12.21%	6.56%	15,719	8,445	$21,709	$2,794.77	$1,397.39
Accidental Puncture or Laceration	111,989	9.81%	7.65%	2.16%	8,567	2,419	$8,271	$926.26	$463.13
Selected Infections due to Medical Care	88,286	7.73%	13.16%	4.31%	11,618	3,805	$38,656	$3,412.78	$1,706.39
Iatrogenic Pneumothorax	33,571	2.94%	18.57%	6.99%	6,234	2,347	$17,312	$581.18	$290.59
Post-op Respiratory Failure	28,940	2.54%	30.97%	21.84%	8,963	6,320	$53,502	$1,548.35	$774.17
Post-Op Hemorrhage or Hematoma	24,108	2.11%	10.45%	3.01%	2,519	726	$21,431	$516.66	$258.33
Post-op Hip Fracture	12,042	1.05%	6.35%	4.52%	765	544	$13,441	$161.86	$80.93
Post-op Sepsis	22,992	2.01%	29.01%	21.92%	6,670	5,040	$57,727	$1,327.26	$663.63
Death in Low Mortality DRG*	10,603	0.93%	100.00%	100.00%	10,603	10,603	NA*	NA*	NA*
Post-op Physiologic and Metabolic Derangements	6,700	0.59%	23.12%	19.81%	1,549	1,327	$54,818	$367.28	$183.64
Post-op Wound Dehiscence	6,384	0.56%	14.99%	9.63%	957	615	$40,323	$257.42	$128.71
Foreign Body left in during Procedure	2,591	0.23%	6.25%	2.14%	162	55	$13,315	$34.50	$17.25
Complications of Anesthesia	2,357	0.21%	1.44%	0.00%	34	0	$1,598	$3.77	$1.88
Transfusion Reaction	190	0.02%	8.95%	4.31%	17	8	$38,656	$7.34	$3.67
Totals	**1,141,472**	-	-	-	**323,993**	**263,864**	-	**$17,087.47**	**$ 8,543.73**

* By definition, all patients with the event died and were excluded from Zahn and Miller's analysis on attributable mortality and cost associated with PSI incidents.

**Based on previous research done by Zhan C and Miller MR. Excess Length of Stay, Charges, and Mortality Attributable to Medical Injuries During Hospitalization. JAMA. 2003; 290(14):1868-1874.

^^ Assuming an average cost to charge ratio of 0.5 (Friedman B. La Mare J, Andrews R, McKenzie D. Practical options for estimating cost of hospital inpatient stays. J Health Care Finance. 2002; 29(1): 1-13