CE

Medical Errors: Excess Hospital Costs and Lengths of Stay

Leslie D. Nordgren, MPH; Trista Johnson, PhD; Mark Kirschbaum, PhD; Michelle L. Peterson, MPH

To focus on effective patient safety strategies in an environment of intense competition for resources, a method of quantifying the effect of potential sources of medical errors was developed. This study assessed excess length of stay (LOS) and hospitalization costs associated with patients who experienced errors. The distribution of the errors occurring within the mean LOS experienced by others with the same diagnosis and severity was also examined. Patients with errors had longer stays and greater costs when compared to controls.

Key Words
cost containment and management
data analysis
patient safety
statistical analysis

In 1999, the Institute of Medicine released a landmark report entitled *To err is human: Building a safer health system* (Committee on Quality of Health Care in America, 2000). This report estimated that as a result of adverse events between 44,000 and 98,000 individuals die and millions more are injured each year in the United States. Medical errors are generally regarded in the literature as omissions or deviations from planned and intended patient care. In addition to the harm that errors may cause to patients in hospitals, there are other consequences, such as longer hospital stays and increased healthcare costs (Bates et al., 1997; Classen, Pestotnik, Evans, Lloyd, & Buerke, 1997; Evans et al., 1993; Schneider, Gift, Rothermich, & Sill, 1995; Senst et al., 2001).

Only a few studies have quantified the financial burden of adverse drug events, with excess costs ranging from $95 to $4,685 per event (Bates et al., 1997; Classen et al., 1997; Evans et al., 1993; Schneider et al., 1995; Senst et al., 2001). These studies have also shown significantly longer lengths of stay (LOS) are associated with adverse drug events.

There are, however, several limitations inherent in the previous research conducted on costs of medical errors. Almost all estimates focused on adverse drug event costs and were limited to events that involve significant patient harm. Previous studies have not included an assessment of all types of errors, such as falls, surgical mishaps, and test or treatment adverse events. Furthermore, significant costs may be also associated with medical errors that do not specifically cause harm to the patient.

Improving and maintaining the health and safety of patients are basic elements in providing quality healthcare. To continue to focus on these elements in an environment of acute competition for resources, methods need to be developed to assist in the planning and development of effective patient safety strategies involving all potential sources of errors. It is important to be able to quantify the number of patients affected by medical errors within a hospital and to establish what these errors represent, in terms of cost to the hospital and increased LOS for patients. The ability to quantify potential monetary savings is an important first step in prioritizing and planning improvements and will help justify the costs involved in error reduction strategies.

The hypothesis of the study was that, in comparing all types of medical errors, the LOS and total variable hospital costs for the patients with error reports would be significantly greater than those for patients with no reported errors. All types of errors refer to reported falls, medication events, accidental traumas, care concerns, device/equipment failures, infection control issues, surgical events, laboratory and test issues, treatment and procedure events, and others. For this study, a "medical error" is defined as follows: A reported unplanned deviation in patient care that may or may not have resulted in harm to the patient. The adverse event must have reached the patient, as categorized under C (an error occurred that reached the patient but did not cause patient harm) through I (an error occurred that may have contributed to or resulted in the patient's death). The C–I categories were defined by the National

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Coordinating Council for Medication Error Reporting and Prevention (NCCMERP, 2001). See **Table 1**.

To date, the question of whether a longer LOS leads to a higher risk of the occurrence of a medical error or whether the error leads to the LOS remains unresolved. Also examined was the time from admission to the first error for each case. It was hypothesized that the greatest percentage of the errors would occur within the mean LOS for patients with no errors and with similar diagnoses and levels of severity.

Methods

Study Design

The excess cost and LOS study utilized a matched case-control design. Cases were defined as patients with a reported error; controls were defined as patients with no reported error. Cases and controls were matched based on the following variables: age, gender, race, All Patient Refined Diagnosis Related Group (APR DRG), and APR DRG severity code at time of discharge (Averill et al., 2003). The hospital system Institutional Review Board for Human Subjects approved this study.

Data Sources

Data for this analysis came from two sources: a freestanding database containing error reports (patient safety database) and a patient activity administrative data warehouse. The voluntary patient safety-reporting system was designed to collect information on errors or concerns involving patients or visitors. The data warehouse captures information describing all patient encounters, standard administrative billing data, as well as detail charge data, including diagnostic and procedural classifications, diagnosis severity group, LOS, cost of care, and so on.

Study Sample

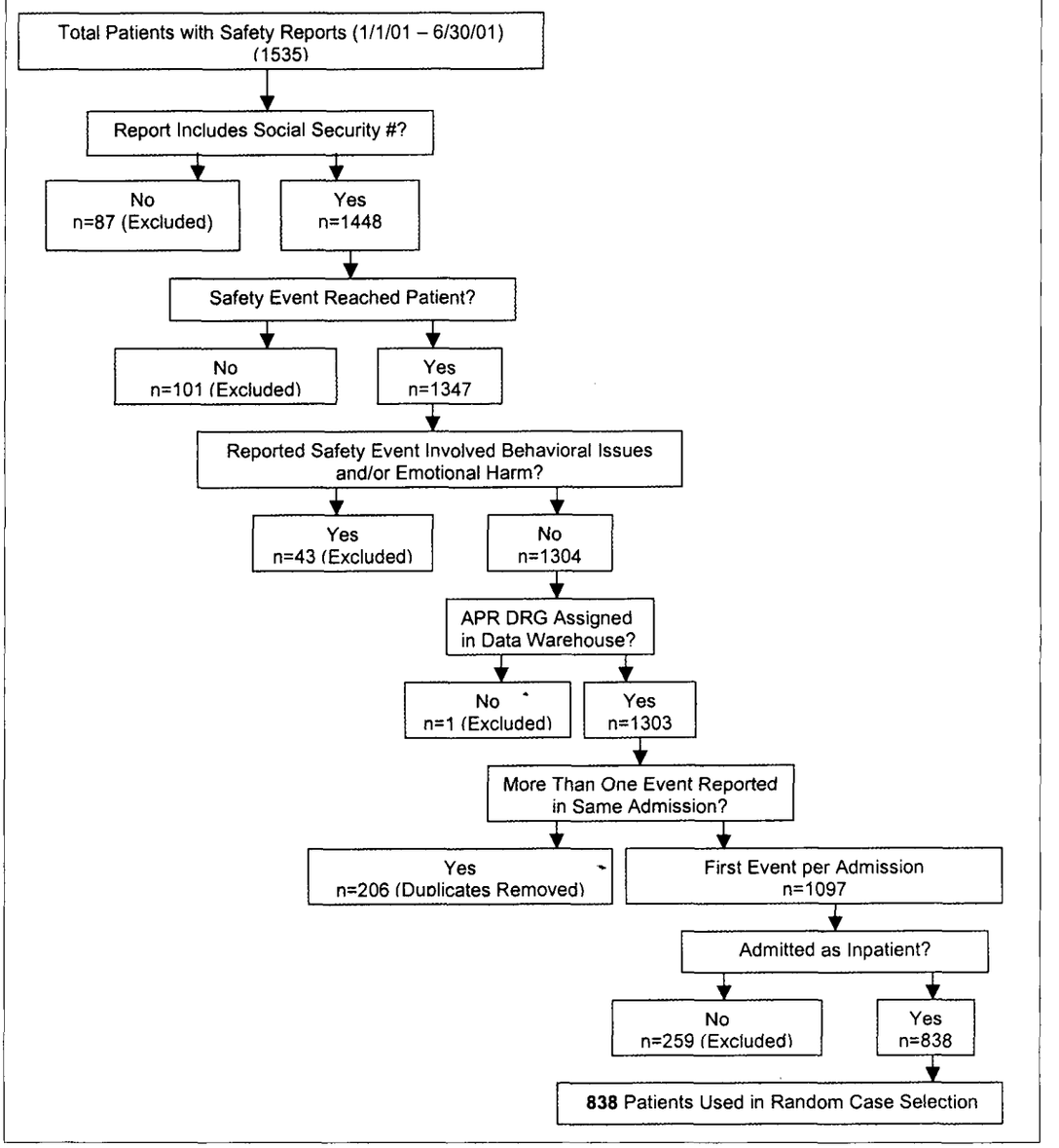
The study was conducted at a community-based, tertiary care, not-for-profit hospital in a large metropolitan area in the Midwest. There were more than 500 staffed beds at the study hospital and more than 15,000 inpatient admissions during the study period of January 1, 2001 through June 30, 2001.

Hospital inpatient error reports between January 1, 2001 and June 30, 2001 were analyzed. Errors were categorized by levels of impact or harm (NCCMERP, 2001). Patients with error reports were excluded if an error did not reach or affect the patient. Of the 1,535 total error reports submitted during the study time period, 838 were eligible for the study, according to the inclusion criteria (**Figure 1**). Error reports that involved behavioral issues and/or emotional harm were excluded, because there is a greater possibility that these events may have been self-inflicted. A random sample of 300 reports was selected for this study (referred to as "cases" for the remainder of this report). This sample size was determined adequate to produce at least an 80% level of power to detect differences between group means for LOS and costs ($\alpha = 0.05$). The resulting event report data were then linked electronically with related hospital data, stored in its warehouse. These data included LOS, age, gender, race, APR DRG, and the APR DRG severity code data. Each diagnostic code could then be associated with one of four severity classes, permitting each APR DRG and associated four severity classes (ranging

Table 1. Categories of Errors Used in Analysis (National Coordinating Council for Medication Error Reporting, 2001)

Category	Description
C	An error occurred that reached the patient but did not cause patient harm.
D	An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm.
E	An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention.
F	An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization.
G	An error occurred that may have contributed to or resulted in permanent patient harm.
H	An error occurred that required intervention necessary to sustain life.
I	An error occurred that may have contributed to or resulted in the patient's death.

Figure 1. Algorithm for Inclusion and Exclusion of Error Reports from Analysis



from 1 = *mild* to 4 = *extreme*) to be considered a unique group for the analysis. APR DRG severity of illness class is assigned via an algorithm (Averill, 2003). This algorithm accounts for complexity and comorbidity as a function of secondary diagnoses, patient age (for some principal diagnoses), and presence of some non-operating-room procedures.

To obtain comparison groups, the data warehouse was queried for patients admitted during the same period of time at this hospital and within the same diagnostic and severity class groups as the cases. Patients with reported errors were excluded from this group. The 12,264 patients returned from this query are referred to as "non-cases" in this report. One control was randomly selected from the non-cases to match each case from the same diagnostic/severity class group. This match was also based on age (case age ± 5 years), gender, and race (Caucasian/other). The final sample comprised 300 cases and 300 matched controls.

Statistical Analysis

Crude analysis was conducted to compare the cases and controls to the total population.

Differences in the mean LOS and age were tested using a Student's t test and confirmed using the Mann-Whitney U test. Differences in gender and race were tested with a Pearson's chi-square test (a p value of less than .05 was considered statistically significant, and all tests were two-tailed). Confidence intervals at 95% were also calculated. All statistical analyses were performed on a personal computer with the statistical package SPSS for Windows (Version 9.0).

Time-to-Error Analysis

A method was devised to explore whether errors led to longer LOSs or, alternatively, whether unrelated longer LOSs simply increased the chance of errors. The time-to-error analysis utilized all 838 eligible cases. The average LOS for each diagnostic/severity class group in the study was calculated for all patients at this hospital who did not have an error report (12,264 non-cases) during the first 6 months of 2001. Of the 358 original diagnostic/severity class groups, 31 had only one patient, so these groups were dropped, because they prohibited calculation of average LOS in their respective groups. This left 12,233 non-cases in the remaining 327 groups. This also left 801 of the original 838 patients with error reports (cases) for comparison. Time from admission to the first error for each of the 801 cases was compared with the mean LOS for non-cases in the same diagnostic/severity class group. The percentage of cases that had an error within the average LOS for non-cases in the same diagnostic/severity class group was calculated.

Results

Demographics of the Study Sample

The sample of all cases and controls together (n = 600) was compared with the total hospital inpatient population admitted during the same time period. The study sample was significantly older (sample mean 61 years versus hospital population mean 51 years, $p < .05$). The sample had a significantly longer average LOS (sample mean 8.8 days versus hospital population mean 4.4 days, $p < 0.05$). The sample had greater average total variable costs (sample mean $7,482 versus hospital population mean $3,869, $p < .05$). The sample also had a higher percentage of Caucasians (sample 69% versus hospital population 59%, $p < .05$). The sample and the hospital population had the same distribution of patients by gender (59% female in both groups). The average age of the 300 cases and the 300 controls was 60.76 years and 60.74 years, respectively (p = .99). The sample of 300 cases selected was not significantly different from all potential 838 cases by age, gender, or race, as an expected result of a sample selected randomly.

Medication error (36%) and falls (29%) accounted for the largest percentages of the reported errors (see **Table 2**). The distribution of the types of errors in the sample of cases was similar to that for all eligible cases.

LOS Comparison

The mean LOS for the 300 cases was 10.8 days, and the mean LOS for the 300 matched controls was 6.8 days. The mean difference was 4.0 days ($p<0.001$). The cases had, on average, 59% longer stays than the controls.

Cost Comparison

The mean total variable cost for the 300 cases was $8,687, and the mean total variable cost for the 300 matched controls was $6,276. The mean difference was $2,411 ($p$ = .016). The cases had, on average, 38% greater costs than the controls.

Time from Admission to Adverse Event

When compared to non-cases in the same diagnostic/severity class groups, 82% (654/801) of the adverse events occurred at or before the mean LOS for non-cases (see **Figure 2**).

Table 2. Reported Errors by Type

Error Type	Percentage of Reports: Among Cases (n = 300)	Percentage of Reports: Among All Eligible Cases (n = 838)
Medication Errors	36	38
Patient Falls	29	28
Test Errors	8	7
Care Concerns	7	8
Surgical Errors	6	5
Treatment Errors	4	5
Behavioral Errors	4	3
Accidental Trauma	3	3
Device/Equipment Failure	3	3

Discussion

This study was undertaken as part of an overall organizational desire to establish a strong business case for investing in patient safety interventions. The results of this study show a significant increase in LOS and total variable costs for patient cases with medical errors when compared to controls matched on diagnosis, severity, age, gender, and ethnicity. If these differences in LOS (4 excess days) and costs ($2,411 excess) were extrapolated to the estimated annual total number of event reports at this hospital where an error reached the patient (2,868), the total impact would be 11,472 excess days and $6,914,748 in excess costs. Previous studies for adverse medication and drug event differences ranged from slightly less than 2 to nearly 5 excess days per event (Bates et al., 1997; Classen et al., 1997; Evans et al., 1993; Schneider et al., 1995; Senst et al., 2001). The differences in costs from these studies ranged from $95 to $4,685 per event, which compares favorably with the findings from this study.

Before this analysis was conducted, it was presumed that medical errors would most likely have an undesirable effect on direct patient care costs. Results from this analysis quantified the effect and illuminated the significance of everyday unnecessary losses that seem small when viewed as individual events. These calculated costs associated with errors surpassed costs of litigation and risk management activities, which had previously been the only organizational focus because they were readily quantifiable.

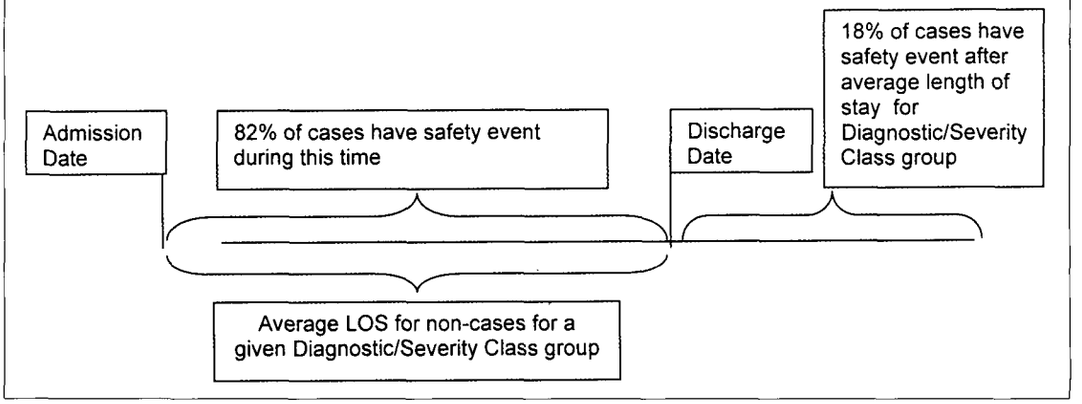
This study differs from previous studies in two important aspects. First, errors for this study were identified by actual error reports by hospital healthcare professionals. There was little question about whether these were truly errors, as may be the case in trying to establish whether an error occurred through retrospective review of patient charts. Also, interrater reliability can be difficult to achieve when data are collected from chart reviews. Using data from electronic patient-safety-reporting systems, a greater number of cases can be analyzed as compared to manual chart reviews, which can be very labor intensive and costly to conduct.

Second, this study included all types of medical errors (falls, medication events, accidental trauma, care concerns, device/equipment failures, infection control issues, surgical events, laboratory and test issues, treatments/procedures, and others). Previous studies have mainly focused on medication errors and adverse drug events.

The demographic differences between the sample and the inpatient population illustrated the importance of selecting a comparison group of controls that is as similar as possible to the cases when costs and LOS are being compared. Necessarily, greater importance was placed on similarity between the cases and controls to achieve a more valid comparison.

To determine whether errors prolong hospitalization or, conversely, whether longer stays expose patients to a greater likelihood of errors, the length of time from admission to the first error report was analyzed. This analysis showed that the great majority (82%) of errors occurred at or before the average LOS for the controls in the same diagnostic/severity class group. This finding may suggest that

Figure 2. Example of the Time to Error Analysis for a Given Diagnostic/Severity Class Group



errors prolong hospitalization by necessitating additional monitoring or treatment, rather than that longer stays expose patients to a greater likelihood of an error. Most of the errors occur early in the hospital stay and few occur in the later part of the stay, indicating that the chance of an error is not evenly distributed over the time of the hospitalization. As more error reports are submitted over time, a larger sample would be available to determine whether any diagnostic/severity class groups tend to fall outside the mean for their group more frequently than others.

Limitations

While the study results may not be generalizable to other hospitals, the methodology for LOS and cost analysis may be helpful to others who aim to detect the magnitude of the effect of medical errors in an organization. In addition, because this study excluded cases in which the reported error was caught before it had an effect on the patient, as well as reports that involved emotional harm, these results do not reflect the effect of these particular events on excess LOS and costs. Because these data were collected from a voluntary reporting system, more errors may have occurred than were reported, and this may result in the presence of unreported errors in the control group. In this hospital system, costs are allocated if charges are assigned. Therefore, all costs may not be reflected in the total variable costs for some patients where a corrective action was taken but not charged. As a result, the estimated differences may be conservative. Another point for consideration is that the severity classes are assigned at hospital discharge. This could mean that a patient may have been admitted with a relatively minor diagnosis, and the severity class assignment may have increased as a result of an error. This may also lead to an underestimate of the difference between cases and controls.

Future Research Directions

Demographic differences observed between the total study sample of matched cases and controls and the hospital population warrants more extensive research to understand factors that contribute to observed differences. Further research might also assess the incremental costs associated with multiple errors and excess costs attributable to specific errors (e.g., inpatient falls, lapses in infection control, and the like). Data from the current cost and LOS analysis may be useful as a basis for calculating returns on investments in patient safety improvements. By tracking LOS and cost markers, the real effect of safety enhancements may be evaluated from an economic standpoint. Over time, as more error data are collected, the data may be analyzed by type of error and location within the hospital. This analysis would help in targeting and analyzing error reduction initiatives. The purpose of this study did not include the analysis of any specific safety initiatives, but was more generally directed at the use of existing data in determining areas of opportunity for improvement. This approach may be useful in testing approaches to medical error reduction in a manner that is most cost effective.

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Authors' Biographies

Leslie Nordgren is a patient safety project manager in the Health Care Improvement Resources department at Allina Hospitals & Clinics, Roseville, MN. She completed her master's degree in epidemiology from the University of Minnesota in 2001 and has worked in her current position since that time. She is currently working toward a doctorate in injury epidemiology at the University of Minnesota.

Trista Johnson is the director of quality systems for Allina Hospitals & Clinics. She completed her doctorate in epidemiology in December 2002. She has worked in the field of patient safety for Allina since 2000. In her current role, she has been involved with multiple patient safety improvement initiatives and management of measurement systems for patient safety.

Mark Kirschbaum is director of care improvement for Abbott Northwestern Hospital, Minneapolis, MN, with responsibility for quality, risk, and patient safety. Mark received a bachelor of arts degree, summa cum laude, from College of St. Thomas, St. Paul, MN, a master of science degree from the University of Illinois, and a doctorate in nursing from the University of Minnesota.

Michelle L. Peterson completed her master's degree in epidemiology from the University of Minnesota in 2002. She is currently an epidemiologist in the HealthCare Improvement Resources department at Allina Hospitals and Clinics. At Allina, she acts as a statistical consultant for various research studies occurring across the sites.

For more information on this article, contact Leslie Nordgren by phone at 651/604-1080 or by e-mail at leslie.nordgren@allina.com.

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Core CPHQ Examination Content Area

II. Information Management

Objectives

By participating in this independent study offering, the reader will be able to do the following:

1. Describe the methodology used in this study and be able to identify differences in methodology in this study as compared to previous studies.
2. Describe how the methodology used in this study may be used in patient safety project planning.
3. Describe the findings of this study related to adverse medical events and their associated excess costs.

CE Questions, JHQ144

(Mark your answers on the answer sheet on page 60 or online at www.nahq.org/journal.)

1. **Identify three factors included in this study's analysis that may affect the length of stay and costs associated with a hospital admission.**
   a. age, previous hospitalization admissions, severity classification
   b. type of medical error, staffing ratio, size of hospital
   c. age, diagnosis, severity classification
   d. diagnosis, age, number of safety events.

2. **Previous studies have studied excess lengths of stay and costs on which type of error?**
   a. adverse drug events
   b. falls
   c. all types of medical errors combined
   d. surgical errors and device/equipment failures.

3. **Describe how this methodology may be used in patient safety project planning.**
   a. It may suggest specific patient safety improvement strategies.
   b. It may be used as a first step in prioritizing patient safety initiatives and justifying the associated costs.
   c. It may indicate which patients are at highest risk for an error.

d. It may be used to estimate the severity score of an error.

4. **How many error categories from the National Coordinating Council for Medication Error Reporting were used in the analysis?**
   a. 10
   b. 5
   c. 8
   d. 7

5. **When compared to non-cases with the same diagnostic/severity class groups, what percentage of errors occurred at or before the mean length of stay for non-cases?**
   a. 75%
   b. 82%
   c. 38%
   d. 25%

6. **What type of study design was used for the length of stay and cost comparison?**
   a. cohort study
   b. cross-sectional study
   c. matched case-control study
   d. a case series.

7. **Patients who were defined as cases included**
   a. patients admitted to the hospital who had a reported medical error that was not caught before reaching them.
   b. only outpatients.
   c. those with events involving behavioral issues.
   d. Patients with more than one reported error.

8. **For the cost and length of stay analysis, how was the final sample of cases selected?**
   a. by chart review
   b. by interviewing a random sample of patients
   c. by randomly sampling all patients from the hospital data warehouse
   d. by randomly sampling reports from the patient safety error-reporting system.

9. **Which type of errors accounted for the largest percentage of reports?**
   a. medical test errors
   b. medication errors
   c. patient falls
   d. surgical errors.

10. **The cases had, on average, what percentage of excess costs when compared to controls?**
    a. 54%
    b. 25%
    c. 38%
    d. 63%