



World Health
Organization

Patient Safety

A World Alliance for Safer Health Care

Introduction to Patient Safety Research

Presentation 15 - Evaluating Impact: Cost Analysis



2: Introduction: Study Details

■ Full Reference

- **Bates DW, Spell N, Cullen DJ, et al. The costs of adverse events in hospitalized patients. JAMA 1997;277:307-11**

[Link to Abstract \(HTML\)](#)

[Link to Full Text \(PDF\)](#)

Not currently available online

The costs of adverse drug events in hospitalized patients. Adverse Drug Events Prevention Study Group

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OBJECTIVE: To assess the additional resource utilization associated with an adverse drug event (ADE). DESIGN: Nested case-control study within a prospective cohort study. PARTICIPANTS: The cohort included 4108 admissions to a stratified random sample of 11 medical and surgical units in 2 teaching hospitals over a 6-month period. Cases were patients with an ADE, and the control for each case was the patient with the most similar pre-event length of stay. MAIN OUTCOME MEASURES: Postevent length of stay and charges. METHODS: Incidents were detected by self-report stimulated by nurses and pharmacists and by daily chart review. Incidents were classified as to whether they represented ADEs. Information on length of stay and charges was obtained from hospital records. Costs were estimated by multiplying components of charges times hospital-specific ratios of costs. During the study period, there were 247 ADEs among 207 admissions. After outliers and multiple episodes were excluded, there were 190 ADEs, of which 60 were preventable. In paired regression analyses adjusting for multiple comparisons, severity, comorbidity, and case mix, the additional length of stay associated with an ADE was 2.2 days (P=.04). For preventable ADEs, the increase in length of stay (P=.03) and \$5857 in total cost (P=.07). After adjusting for our sampling strategy, the estimated additional length of stay attributable to an ADE was 2.2 days (P=.04) and \$5857 (P=.07) for preventable ADEs. Based on these estimates and the incidence of ADEs, we estimate that the annual costs attributable to all ADEs and preventable ADEs for the hospital are \$5.6 million and \$2.8 million, respectively. CONCLUSIONS: The substantial costs of ADEs justify investment in efforts to prevent these events. Moreover, these estimates are conservative because they do not include costs of injuries to patients or malpractice costs.

3: Introduction: Patient Safety Research Team

- **Lead researcher - Professor David W. Bates, MD, MSc**
 - Brigham and Women's Hospital in Boston, USA
 - Field of expertise: medication safety, patient safety, medical informatics
- **Other team members:**
 - Nathan Spell, MD
 - David J. Cullen, MD, MSc
 - Elisabeth Burdick, MS
 - Nan Laird, PhD
 - Laura A. Petersen, MD, MSc
 - Stephen D. Small, MD
 - Bobbie J. Sweitzer, MD
 - Lucian L. Leape, MD



4: Background: Opening Points

- **Adverse drug events (ADE) during hospitalization are common**
 - **Drugs are the leading cause of adverse events, occurring in 0.7% of hospitalized patients**
- **In a previous model, the annual national cost of drug-related morbidity and mortality was estimated at \$76.6 billion**

5: Background: Study Rationale

- **Due to the ongoing economic crisis in US hospitals, only cost-effective quality improvement efforts are likely to be pursued**
 - **To reduce the cost of adverse drug events, the cost of these events must first be defined**
- **Research team wanted to be able to justify investing in interventions to reduce ADE frequency**
 - **Lots of scepticism, especially on the part of Chief Financial Officers**

6: Background: Setting up a Research Team

- Part of a follow-up to an ADE Prevention Study published in the **Journal of the American Medical Association in 1995**
 - Research team already been assembled from the previous ADE Prevention Study
- Study was a low-cost follow up
 - Essentially done without additional funding

7: Methods: Study Objective

- **Objective:**
 - To assess the additional resource utilization associated with an adverse drug event
- **Research questions:**
 - What percentage of ADEs are preventable?
 - What is the post-event length of stay caused by an ADE?
 - What is the total cost of resource utilization during the additional length of stay?
 - Are potential quality improvement efforts toward reducing the incidence of ADEs cost-effective?

8: Methods: Study Design

- **Design: cost analysis using a nested control study within a prospective cohort study**
 - Incidents detected by self-report by nurses and pharmacists and chart review and classified if reporting an ADE
 - Data on length of stay and charges obtained from billing data and estimated costs targeted for analysis

9: Methods: Study Population and Setting

- **Setting:**
 - Brigham and Women's Hospital (726 beds) and Massachusetts General Hospital (846 beds), both in Boston, Massachusetts
- **Population:**
 - 4,108 admissions to a stratified random sample of 11 medical and surgical units over a six-month period
 - Within this population, there were 247 adverse drug events
 - Of these, 190 examined to calculate the cost of adverse drug events

10: Methods: Data Collection

- **Three methods of data collection:**
 - **Passive data collection:** nurses and pharmacists reported incidents
 - **Active data collection:** nurse investigators solicited information from personnel regarding ADEs twice daily
 - **Chart review:** nurse investigators reviewed charts daily
- **Types of data collected:**
 - **Patient data:** demographics, primary insurer and impact of adverse drug event during hospitalization
 - **Outcome variables:** length of stay and total charges

11: Methods: Data Analysis and Interpretation

- **Classification of incidents**
 - Two physician reviewers classified ADEs according to presence and preventability
- **Data analysis**
 - Multiple linear regressions were used to compare post-event resource utilization and length of stay
- **Cost estimation**
 - Extrapolations used to estimate ADE cost in each hospital and nationally

12: Results: Key Findings

- **Incidence of ADEs was 6.0% (247 out of 4108 patients)**
 - 70 (28%) preventable
 - 140 (57%) judged significant
 - 74 (30%) judged serious
 - 30 (12%) judged life-threatening
 - 3 (1%) fatal

13: Results: Key Findings (2)

- **Length of stay** increased by 2.2 days for all ADEs and 4.6 days for preventable ADEs
- **Total costs** increased by \$3244 for all ADEs and \$5857 for preventable ADEs

Table 4.—Adjusted Paired Analysis, Excluding Outliers and Multiple Adverse Drug Events (ADEs)*

	Cases	Controls	Difference	R ²	P
Total ADEs					
No. of events	190	190
Length of stay after ADE, d	12.6 (0.83)	10.4 (0.83)	2.2	0.69	.04
Total hospital charges after ADE, \$	30 932 (2464)	24 591 (2464)	6341	0.74	.04
Total costs after ADE,† \$	16 580 (1258)	13 336 (1258)	3244	0.74	.04
Preventable ADEs					
No. of events	60	60
Length of stay after ADE, d	15.8 (1.7)	11.2 (1.7)	4.6	0.71	.03
Total hospital charges after ADE, \$	42 686 (4891)	31 162 (4891)	11 524	0.77	.06
Total costs after ADE,† \$	22 792 (2632)	16 935 (2632)	5857	0.77	.07

*Values are mean (SE) and are adjusted for age, sex, race, primary insurer, diagnosis related group weight, Therapeutic Intervention Scoring System score, and Charlson Index score. The SEs are constrained to be the same for cases and controls in the paired regression analyses. All P values are 1-sided.

†Derived by multiplying components of charges times hospital-specific ratios of costs to charges, and summing.

14: Results: Projected Costs of ADEs

Table 5.—Projected Hospital Costs of Adverse Drug Events (ADEs) for 1 Year*

Unit Type	All Patient-Days in the Hospital, %	Patient-Days in This Unit Type Included in the Sample, %	Estimated No. of Events per Hospital per Year†	Estimated Costs per Event,‡ \$	Estimated Total Costs per Year, \$\$
Medical ICU	3.2	11.4	133	3369	449 209
Surgical ICU	9.1	14.6	204	5097	1 038 256
General medical	40.4	53.7	919	2738	2 515 185
General surgical	47.3	20.3	904	1772	1 601 153
Total	100.0	100.0	2159‡	2595	5 603 803

15: Conclusion: Main Points

- **Substantial costs of adverse drug events to hospitals should provide incentives to invest in efforts to prevent these events**
 - Estimates found in this study are conservative since they do not include the cost of injuries to patients or malpractice costs
- **Hospitals can justify devoting additional resources to develop systems that reduce the number of preventable ADEs**
 - Not only improves patient care but also to reduces ADE-related expenses

16: Conclusion: Study Impact

- **Major academic impact**
 - Cited 593 times as of 2008
 - Came out at same time as another study by Classen et al which reached very similar result
- **Policy impact**
 - Used as key basis for numerous other studies intended to estimate potential benefits of ADE prevention
- **Practice impact**
 - Used by large numbers of organizations when considering the return on investment for interventions that may improve medication safety

17: Author Reflections: Lessons and Advice

- **Advice for researchers**
 - Consider adding an economic evaluation to primary safety epidemiological studies - expensive part is finding adverse events
 - Serious lack of data on these sorts of costs in different countries and settings - more data is desperately needed
- **This kind of work is especially needed for developing countries in which resources tend to be scarce**
 - Research feasible any time a group is collecting primary data about adverse events AND has access to cost or resource utilization data
 - Not an easy combination to identify!

18: Author Reflections: Overcoming Barriers

- **Challenge: obtaining cost data from hospitals**
 - Hospitals not used to providing such data - nervous that the results might leak out and tarnish their reputation
 - Research team also had initial worries about whether sample size would be big enough

19: Additional References