



World Health
Organization

Patient Safety

A World Alliance for Safer Health Care

Introduction to Patient Safety Research

Presentation 8 - Understanding Causes: Cohort Study



2: Introduction: Study Details

■ Full Reference


Cullen DJ, Sweitzer BJ, Bates DW, Burdick E, Edmondson A, Leape LL. Preventable adverse drug events in hospitalized patients: a comparative study of intensive care and general care units. Crit Care Med, 1997, 25;1289-1297

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 **Preventable adverse drug events in hospitalized patients: a comparative study of intensive care and general care units.**

[Cullen DJ, Sweitzer BJ, Bates DW, Burdick E, Edmondson A, Leape LL.](#)

Department of Anesthesia, Massachusetts General Hospital and Harvard Medical School, Boston, USA.

OBJECTIVES: To compare the frequency and preventability of adverse drug events and potential adverse drug events in intensive care units (ICUs) and non-ICUs. To evaluate systems factors involving the individual caregivers, care unit teams, and patients involved in each adverse drug event by comparing ICUs with non-ICUs and medical ICUs with surgical ICUs. **DESIGN:** Prospective cohort study. Participants included all 4,031 adult admissions to a stratified, random sample of 11 medical and surgical units in two tertiary care hospitals over a 6-month period. Units included two medical and three surgical ICUs and four medical and two surgical general care units. **SETTING:** Two tertiary care hospitals: Eleven medical and surgical units, including two medical and three surgical ICUs. **PATIENTS:** Adult admissions (n = 4,031). **INTERVENTIONS:** None. **MEASUREMENTS AND MAIN RESULTS:** Rate of preventable adverse drug events and potential adverse drug events, length of stay, charges, costs, and measures of the unit's environment. Incidents were detected by stimulated self-report by nurses and pharmacists and by daily review of all charts by nurse investigators. Incidents were subsequently classified by two independent reviewers as to whether they represented adverse drug events or potential adverse drug events and as to severity and preventability. Those individuals involved in the preventable adverse drug event and potential adverse drug event underwent detailed interviews by peer case-investigators. The rate of preventable adverse drug events and potential adverse drug events in ICUs was 1.9 events per 1000 patient days, nearly twice that rate of non-ICUs ($p < .01$). The medical ICU rate (2.5 events per 1000 patient days) was significantly ($p < .05$) higher than the surgical ICU rate (1.4 events per 1000 patient days). When adjusted for the number of drugs used in the previous 24 hrs or ordered since admission, there were no differences in rates between ICUs and non-ICUs. ICU acuity, length of stay, and severity of the adverse drug event were greater in ICUs than non-ICUs, but there were no differences between medical ICU and surgical ICU patients. Structured interviews indicated almost no differences between ICUs and non-ICUs for many characteristics of the patient, patient care team, systems, and individual caregivers. **CONCLUSIONS:** The rate of preventable and potential adverse drug events was twice as high in ICUs compared with non-ICUs. However, when adjusted for the number of drugs ordered, there was no greater likelihood for preventable adverse drug events and potential adverse drug events to occur in ICUs than in non-ICUs. Preventable adverse drug events and potential adverse drug events occurred in units that functioned normally and involved caregivers who were working under reasonably normal circumstances, not at the extremes of workload, stress, or a difficult environment.

3: Introduction: Research Team

- **Head researcher - David J. Cullen, MD, MS**
Former Chairman of Department of Anaesthesiology and Pain Medicine (1996 - 2005)
St. Elizabeth's Medical Center and Tufts University Medical School in Boston, Massachusetts, USA
Areas of expertise: anaesthesiology and critical care medicine
- **Other team members:**
Bobbie Jean Sweitzer, MD
David W. Bates, MD
Elisabeth Burdick, MS
Amy Edmondson, PhD
Lucian Leape, MD

4: Background: Opening Points

- **Medical treatment is estimated to accidentally injure 1.3 million people each year in the US**
 - Harvard Medical Practice Study found that medications are the most common cause of adverse events
- **Patients in intensive care units (ICUs) are at especially high risk of an adverse drug event related to human error because:**
 - Workload is intense
 - Many interactions between patients and caregivers
 - Critical illness reduces both the patients' natural resilience and ability to defend themselves from consequences of human error
 - Patients in the ICU receive twice as many drugs as patients in general care units

5: Background: Study Rationale

- **Many adverse drug events (ADEs) are preventable**
- **Understanding how errors in drug use occur is essential for reducing injuries and developing prevention strategies**
 - *"Our intent was to study human errors leading to ADEs, looking for systemic problems and designing system wide solutions and then testing their efficacy."*

6: Background: Setting Up a Research Team

- Part of a larger study of adverse drug events
- **Selecting collaborators:**
 - *"Those whom I chose were based on interest, motivation and ambition."*
- **Obtaining funding:**
 - Federal Grant from US Agency for Health Care Policy and Research
 - Smaller grants obtained from Harvard malpractice insurer

7: Methods: Study Design

- **Design: prospective cohort study**
- **Objectives:**
 - To compare the frequency and preventability of adverse drug events and potential adverse drug events in ICUs and non-ICUs
 - To evaluate systems factors involving the individual caregivers, care unit teams, and patients involved in each adverse drug event by comparing:
 - ICUs with non-ICUs
 - Medical ICUs with surgical ICUs

8: Study Design: Population and Setting

- **Population: 4,031 adult patients admitted to 11 ICU and general care units in two tertiary care hospitals in the US between Feb. and July 1993**
 - Two medical ICUs
 - Three surgical ICUs
 - Four medical general care units
 - Two surgical general care units
- **Sampling: Stratified, random sample of patients admitted to medical and surgical units**
 - Patients eligible to be in study more than once
 - When patients had more than one adverse drug event, only the first episode in that admission was evaluated

9: Methods: Data Collection

- Incidents were identified in three ways:
 - Unit personnel asked to report incidents to nurse investigators
 - Nurse investigator visited each unit and solicited information from nurses, pharmacists, and clerical personnel concerning all actual or potential drug-related incidents
 - Nurse investigator reviewed all charts daily on weekdays and once on weekends
- All incidents evaluated independently by two physician reviewers and classified according to:
 - Whether they represented actual or potential ADEs
 - Severity and preventability of the event

10: Methods: Data Collection (2)

- Each preventable or potential ADE investigated to determine if there was an error and if so, the circumstances, apparent causes, and profiles of the persons involved
 - Individuals involved in the preventable actual or potential ADE underwent detailed interviews
 - Interviews conducted by peer case-investigators (physician to physician, nurse to nurse, and pharmacist to pharmacist)

11: Methods: Interviews

- **Case-investigators used structured forms to seek details about the circumstances surrounding the incident**
 - E.g. experience with the drug, treatment plan, stress factors, external distractions, sleep deprivation, etc.
- **Interviewees were asked to self-assess:**
 - Competency and skill
 - Decision-making style
 - Openness to change
 - Duration on the service or job
 - Amount and quality of supervision
 - Relationship of the incident to the timing of their shift
- **Respondents asked to discuss their perception of why the event occurred, graded on a 1 to 5 Likert scale**

12: Methods: Data Analysis and Interpretation

- **Results of each preventable ADE analyzed by a multidisciplinary team of physicians, pharmacists, nurses and systems analysts**
- **Analyses performed:**
 - **Comparison of difference between units in rates of adverse drug events (Chi-square, analysis of variance, and unpaired t-tests)**
 - **Univariate comparison of resource utilization (Wilcoxon rank-sum test)**
 - **Multivariate comparisons of post-event length of stay and resource utilization for ICU vs. non-ICU patients and medical vs. surgical patients (multiple linear regression)**

13: Results: Key Findings

- Study identified 247 adverse drug events in 206 admissions
- 236 persons involved in the preventable and potential ADEs interviewed by a peer case-investigator
- Rate of preventable ADEs and potential ADEs in ICUs was 19 events per 1000 patient days: nearly twice the rate for non-ICUs (10)
- However, when adjusted for the number of drugs used, no statistically significant differences in rates between ICUs and non-ICUs

14: Results: Key Findings (2)

- **Medical ICU rate (25 events per 1000 patient days) was significantly higher than the surgical ICU rate (14 events per 1000 patient days)**
- **Length of stay and severity of the adverse drug event were greater in ICUs than non-ICUs, but there were no differences between medical ICU and surgical ICU patients**
- **Structured interviews indicated almost no differences between ICUs and non-ICUs for many characteristics of the patient, patient care team, systems, and individual caregivers.**

15: Conclusion: Main Points

- **Unadjusted rate of preventable and potential adverse drug events was twice as high in ICUs compared with non-ICUs**
- **However, when adjusted for the number of drugs ordered, there was no greater likelihood for preventable ADEs and potential ADEs to occur in ICUs than in non-ICUs**
- **Preventable adverse drug events and potential adverse drug events occurred in units that functioned normally**
 - **Involved caregivers who were working under normal circumstances, not at the extremes of workload, stress, or a difficult environment**

16: Conclusion: Discussion

- **Reducing the number of drugs used in the ICU may decrease the incidence of adverse drug events**
 - Even if only a small fraction of errors result in injury, this rate can be substantial in the ICU because of the intensity of treatment
- **Systems failures may be far more important contributing factors to ADEs than the obvious causes of fatigue and stress**
 - Study did not confirm conventional wisdom that serious errors are made primarily by overworked and exhausted individuals working with complex patients in an environment filled with distractions
 - Common systems failures include poor communication, lack of standardization and insufficient labelling

17: Conclusion: Discussion (2)

- **Study limitations**
 - Study included only two tertiary care hospitals that managed relatively similar patients
 - Methods for detecting ADEs undoubtedly missed some of these events - may result in underestimation of incidence of ADEs
 - Interviewers could not be blinded to the purposes of the studies - may have introduced interview bias
 - Interviewees self-assessment of sleep status may have underestimated degree of fatigue

18: Conclusion: Study Impact

- **Academic impact**
 - More than 20 major articles published in leading general medical, critical care and anaesthesiology journals
 - Extensive citations, lay and professional press media interviews
- **Practice impact**
 - Promoted the development of a patient safety culture based on scientific studies, not subjective opinion
 - Highlighted the important role that clinical pharmacists may play in reducing ADEs

19: Conclusion: Study Impact (2)

- **Policy impact**
 - Increased awareness of medical errors and the need to fix problems, not fire people
 - Highlighted potential for cost savings through reducing errors
 - Led to the formation of the National Patient Safety Foundation
- **Patient impact**
 - Led to studies of ADEs in the outpatient settings and of comparable human errors in medicine (e.g. blood banks)

20: Conclusion: Practical Considerations

- **Study duration**
 - 60 months from conception to write-up
- **Cost**
 - Over \$1 million USD for the whole study effort (not just this paper)
- **Competencies needed**
 - High level statistician support
 - Extensive data management
 - Expertise from multiple disciplines: psychology, pharmacy, etc.
- **Ethical approval**
 - Took several months to obtain, and some difficulties were encountered at one of the two hospitals

21: Author Reflections: Overcoming Barriers

- **Need for informed consent?**
 - *"The Human Studies Committee wanted informed consent from each patient, even through we never interacted with any patient. However, we eventually convinced them to back off."*
- **Reassuring participants about confidentiality:**
 - *"Also, those who made the errors were scared to talk privately about it with our interviewers. We had to reassure them about the confidentiality issues and it worked most of the time."*

22: Author Reflections: Lessons and Advice

- **If you could do one thing differently in this study what would it be?**
 - *"If we had the resources, study many more hospitals of different types, cultures and locations to show generalizability."*
- **Would this research be feasible and applicable in developing countries?**
 - *"No, far too many resources needed."*

23: Author Reflections: Ideas for Future Research

- **What message do you have for future researchers from developing countries?**
 - *"Focus on a clear question and don't try to do too much in any one study."*
- **What would be an important research project you recommend that they do?**
 - *"Test a suggested solution to one human error problem and see if it reduces the specific error."*

24: Additional References and Resources

- **Institutions**
 - [National Patient Safety Foundation](#)
 - [Lucian Leape Foundation](#)
- **References**
 - Kohn LT, Corrigan JM, Donalson MS, eds. **To Err Is Human**. Institute of Medicine, Washington, DC: National Academy Press; 1999.
 - Cullen DJ, Bates DW, Leape LL, and the Adverse Drug Event Prevention Study Group. **Prevention of adverse drug events: a decade of progress in patient safety**. *J Clin Anesth*. 2000;12:600-614.