The Canadian Adverse Events Study: The Incidence Of Adverse Events Among Hospital Patients In Canada

Research funded by CIHI and CIHR

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May 11, 2006
Outline

• Our national study
• Other studies, briefly
• Our methods
• Results
• Limitations
• Implications
First and only national study of incidence of adverse events in Canadian healthcare
British Columbia
Alberta
Ontario
Québec
Study Reviewers

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*Québec:* Dr. Edouard Bastien; Dr. Richard Clermont, Evelyne Jean, Cécile Lavoie, Dr. André Rioux. Julie Robindaine, and Daphney St-Germain

*Ontario:* Dr. Ed Etchells, Virginia Flintoft, Wilhelmine Jones, Dr. Peter Kopplin, Dr. David MacPherson, and Elaine Thiel

*Alberta:* Fatima Chatur, Dr. Leslie Cunning, Dr. Peter Hamilton, Dr. Narmin Kassam and Carolyn Nilsson

*British Columbia:* Karen Cardiff, Dr. Robert Crossland, Dr. Iain Mackie, Cheryl Marr, Dr. Jacob Meyerhoff, Eva Somogyi and Dr. Robert Wakefield
Study Goals

1. To identify the incidence of adverse events in a representative sample of Canadian hospitals
2. To compare the incidence between medical and surgical patients and between different types of hospitals
3. To compare the incidence to similar studies in England, Australia, New Zealand and elsewhere
Example

- 77 year-old male with a long history of renal stones was seen in ER with hematuria
- CT revealed renal stones AND a large renal mass with nodules in lungs
- CT done 1 year previously revealed a smaller renal mass and *no* nodules
- His urologist had seen that CT report but missed the conclusion as did several others
Example

• An adverse event and (likely) preventable (ie., potentially curable last year, now not)
• Caused by an omission….
  – If only, the radiologist had called
  – If only, the resident had seen the XRay
  – If only, the staffman had read the report
  – If only, other urologists had read the report
  – If only the patient had complained…
Not at all unique
Harvard Medical Practice Study

NEJM Feb 1991

• Review of 30,121 randomly selected medical records from 51 NY acute care hospitals for patients in 1984
• Purpose: incidence of medical negligence
• Adverse events occurred in 4% of hospitalizations; 28% of these were due to negligence (=1% hospitalizations)
• 71% of AE’s gave rise to disabilities < 6 months
• 14% resulted in patient’s death: 1/200 admissions!
Quality In Australian Health Care Study *Med J Australia* Nov 1995

- 14,000 admissions to 28 hospitals in New South Wales and South Australia
- Used HMPS methods, but redefined AE
- 17% of admissions had an adverse event
- 50% preventable.
- 77% lasted < 12 months;
- 5% of the patients died
- *Deaths ‘due to’ AE’s: 1/250 admissions*
Was Canada any better?
Canadian study methods

1. Hospital Selection
2. Patient Chart Selection
3. Two stage Chart Review
   a) Initial screening by nurses
   b) Detailed review by physicians
4. Data Analysis
1. Hospital Selection

- Sampled: acute care hospitals in the 5 participating provinces, with at least 1,500 separations in 2002
- 20 hospitals randomly selected – 1 teaching, 1 large and two small in each of 5 provinces
2. Chart Selection

• Random sample of patient hospitalizations (230 for large and teaching and 142 for small plus 10% oversample) for the fiscal year 2000

• Included all hospitalizations for patients over 18 years with a > 24 hours stay (or died within 24 hours of admission)

• Hospitalizations with a most responsible diagnosis related to obstetrics or psychiatry were excluded
3. Chart Review

- Two-stage retrospective chart review, involving trained nurse & physician reviewers

- **Stage 1:** using explicit criteria, nurse reviewers flagged patient records that MAY have had an adverse event

- **Stage 2:** using explicit criteria, physician reviewers determined if an adverse event occurred – and using judgment assessed the degree of preventability
a) First Stage Chart Review

• Nurse reviews based on 18 “triggers”
• Triggers included (partial list):
  – Unplanned admission before index admission
  – Unplanned readmission after discharge from index admission
  – Hospital incurred patient injury
  – Adverse drug reaction
  – Unplanned transfer from general care to intensive care
  – Unplanned return to OR
  – Development of neurological deficit not present on admission
  – Unexpected death
b) Second Stage Chart Review

- Records positive on initial trigger(s) reviewed in depth by physicians for adverse events
- 3 part definition of adverse event
  - Was there an unintended injury or complication?
  - If so, did it result in disability, death or prolonged hospital stay?
  - If so, was it caused by health care management?
Triggers for Potential Adverse Events (01/10)

Unplanned Admission (Including Readmission) as a Result of any Health Care Management Within the 12 Months Prior to the Index Admission:

- No
- Yes

Evidence In:
- Admission History & Physical
- Diagnostic Radiology
- Dr. Orders
- Laboratory Reports
- Procedure Reports
- Nurses Notes
- Outpatient Notes
- Consultant's Notes
- Discharge Summary
- Emerg Admission Progress Note
- Medication
- Progress Notes
- Other Hospital

Date of Onset of Readmission Symptoms: [ ]
Date of Previous Admission: [ ]

Previous Admission Discharge Diagnosis:

Previous Admission Treatment/Procedure:

Reason for Readmission:

Other Clinical Details:
Results
The review process

- 4164 medical records sampled
- 3776 initial screening
  - 1527 positive for screening criteria
    - 1512 MDs Reviews
      - 388 not eligible for inclusion (note 1.)
      - 31 inadequate documentation
    - 2218 negative for screening criteria
      - 3745 eligible for full screening
        - 1 inadequate documentation
        - 1512 MDs Reviews
        - 14 MD unable to access chart

Note 1: 388 not eligible for inclusion: Less than 24 hour stay (n=261); Obstetrics (n=56); Transfer in from other hospital (n=48); Cardiac arrest on arrival with subsequent death (n=3); Rehab or Respite care (n=2); Psychiatric (n=2); Unable to determine (n=16).
Defining the AEs

- 1133 injuries or complications in 858 hospitalizations
- 401 (47%) resulted in death, disability at the time of discharge or prolonged hospitalization
- 255 hospitalizations had one or more of these that rated 4 or higher on the 6-point causation scale
- The total number of AEs was 289 and twenty-seven (10.6%) of the hospitalizations with AEs had more than one AE
- After weighting for the sample frame, the overall AE rate was 7.5% [CI 5.7 -9.3]
## Adverse Events and Preventability By Hospital Type

<table>
<thead>
<tr>
<th>Hospital Type</th>
<th>Small</th>
<th>Large</th>
<th>Teach</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts sampled</td>
<td>1431</td>
<td>1160</td>
<td>1154</td>
<td>3745</td>
</tr>
<tr>
<td>Number charts with AE</td>
<td>73</td>
<td>68</td>
<td>114</td>
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</table>

© May 11, 2006
## Two Stage Weighting

<table>
<thead>
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<td>Weighted AE rate</td>
<td>5.60%</td>
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</table>
Weights applied to the 95% confidence intervals

<table>
<thead>
<tr>
<th>Data Category</th>
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<tr>
<td>Weighted 95% CI</td>
<td>(2.9 - 8.2)</td>
<td>(5.1 - 7.7)</td>
<td>(7.0 - 14.8)</td>
<td>(5.7 - 9.3)</td>
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## Adjustment for co-morbidities plus age and sex

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<td>6.00%</td>
<td>10.30%</td>
<td>n.a.</td>
</tr>
<tr>
<td>Adjusted 95% CI</td>
<td>(4.0 - 6.6)</td>
<td>(4.6 - 7.7)</td>
<td>(8.3 - 12.9)</td>
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### Preventability By Hospital Type

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<td>(8.3 - 12.9)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Number Preventable AE</strong></td>
<td>42</td>
<td>28</td>
<td>36</td>
<td>106</td>
</tr>
<tr>
<td><strong>Weighted Preventable AE rate</strong></td>
<td>3.30%</td>
<td>2.50%</td>
<td>3.30%</td>
<td>2.80%</td>
</tr>
<tr>
<td><strong>Weighted 95% CI</strong></td>
<td>(1.5 - 5.1)</td>
<td>(1.7 - 3.3)</td>
<td>(1.8 - 4.8)</td>
<td>(2.0 - 3.6)</td>
</tr>
</tbody>
</table>
Virtually certain evidence of preventability (examples)

3. Admission because of severe anemia. The anemia had been documented in previous admission but not investigated fully, which resulted in delayed diagnosis of colorectal carcinoma

5. *Clostridium difficile* colitis following antibiotic therapy. Patient did not receive sufficient volume expansion, which led to acute renal failure and death
Virtually no evidence of preventability

150. Abdominal pain and fever following elective surgical procedure. Patient readmitted for antibiotic treatment

151. Acute complications following angioplasty with stent resulted in repeat angiography (x2), repeat angioplasty (x1) and prolonged hospital stay
Disabilities and Death

- 65% of AEs: either no disability or minimal and moderate impairment with recovery within 6 months
- 40 patients who had a total of 46 AEs died
- 1.6% [CI =0.9 to 2.2%]: died = 1 / 165 admissions
Length of stay

- Patients experiencing AEs have longer stays in hospitals
  - Teaching hospitals: 11 days versus 5 days (medians)
  - Large: 8 days vs 5
  - Small: 6 vs 4 for those with none
- Physician reviewers using professional judgement estimated that the 255 patients with AEs required an additional 1521 days in hospital directly related to their adverse event
Timing of AE

Fig. 2: Timing and occurrence of AEs relative to index hospital admission. Two of the 289 AEs were excluded because of incomplete timing data. O = occurrence, D = detection of AE.
Other Key Findings

• Omissions in medicine AEs (the failure to carry out necessary diagnosis or treatment) were more common (57.1%), than adverse events resulting from errors of commission (42.9%)
• Adverse events from both types of errors are roughly equal in surgery
• Average age of patients experiencing an adverse event was 64.9 years (SD=16.7) compared to 62.0 (SD=18.4) for those who did not
• No difference between female and male patients
Extrapolation

- In fiscal year 2000 between 141,250 and 232,250 acute care hospitalizations could have been associated with an AE out of 2,500,000 similar hospitalizations in Canada
- The number of preventable deaths could have ranged from 9,250 to 23,750
Extrapolation

Deaths associated with AE:

- USA: 1 death per 200 admissions
- Australia: 1 / 250
- Canada: 1 / 165
- Spain: ?
Limitations

- Retrospective chart review: hindsight bias
- Budget constraints: only 20 hospitals in five provinces
- Very small or remote hospitals were not studied
- Only adult patients in acute care general hospital
- Excluded those with a most responsible diagnosis in obstetrics or psychiatry
- Our reliability measurement: only moderate agreement among physicians in assessing injury, preventability and the contribution of healthcare management to AE
- The additional length of stay attributed to the AE was based on the physician’s professional opinion and interpretation of the patient chart
Was Canada any better?

Nope – we are all in the same boat!
### Incidence Estimates from Other Chart Review Studies

<table>
<thead>
<tr>
<th>Country</th>
<th>N</th>
<th>Year</th>
<th>Incidence of AE</th>
<th>Preventable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA (Utah &amp; Colorado)</td>
<td>15,000</td>
<td>2000</td>
<td>2.9%</td>
<td>-</td>
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<tr>
<td>England</td>
<td>1,014</td>
<td>2001</td>
<td>11.7%</td>
<td>50%</td>
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<td>New Zealand</td>
<td>6,579</td>
<td>2004</td>
<td>12.9%</td>
<td>37%</td>
</tr>
<tr>
<td>Denmark</td>
<td>1,097</td>
<td>2001</td>
<td>9.0%</td>
<td>40.4%</td>
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<tr>
<td>Canada</td>
<td>3,745</td>
<td>2002</td>
<td>7.5%</td>
<td>39%</td>
</tr>
</tbody>
</table>
Why did we do a Canadian study?

• A critical element for accelerating safety work is that a country has its own data
• The number is an underestimate and so the method cannot be used as an outcome measure for safety
• Modeling can be carried out to delineate:
  – Possible areas for improvement
  – High hazard situations
  – Management opportunities
When safety nets fail....

- CT report non-verbal
- CT Report missed
- CT not read, no F/U
- CT report ignored
- Unaware CT done

Radiology    Residents      Staff          Consultants      Family Doctor
patients are harmed

Especially, if:

a. Patients remain uninformed
b. Too trusting ("They would call if something was seen on the XRay...")
Acceptable risk

Number of encounters for each fatality

Dangerous (≥1/1000)

Regulated

Ultra-safe (≤1/100K)

Total Lives Lost per year

100,000

10,000

1,000

100

10

1

10

100

1,000

10,000

100,000

1,000,000

10,000,000

“Acceptable public risk”
Risky activities (Canada)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total Lives Lost per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>10</td>
</tr>
<tr>
<td>Commercial Airlines</td>
<td>100</td>
</tr>
<tr>
<td>Bungee Jumping</td>
<td>1,000</td>
</tr>
<tr>
<td>Rock Climbing for 25 hrs</td>
<td>10,000</td>
</tr>
<tr>
<td>Suba diving</td>
<td>100,000</td>
</tr>
<tr>
<td>Coal Mining</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Offshore rig</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Timber</td>
<td>100,000,000</td>
</tr>
<tr>
<td>Truckers</td>
<td>100,000,000</td>
</tr>
<tr>
<td>Construction</td>
<td>1,000,000,000</td>
</tr>
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</table>

Number of encounters for each fatality:

- Dangerous: (>1/1000)
- Regulated: (<1/100K)
Unacceptable risk

15,000 deaths/yr

Dangerous
(>1/1000)

Regulated
(<1/100K)

Ultra-safe

1/165 risk of death

“Acceptable public risk”

Number of encounters for each fatality
Our task

Dangerous
(>1/1000)

Regulated
(<1/100K)

Ultra-safe

Number of encounters for each fatality

Hospitalisation

"Acceptable public risk"
Our task

Number of encounters for each fatality

“Acceptable public risk”

Hospitalisation

Total Lives Lost per year

100,000

100,000

10,000

1,000

100

10

1

Dangerous

Regulated

Ultra-safe

(>1/1000)

(<1/100K)

1

10

100

1,000

10,000

100,000

1,000,000

10,000,000

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Our task

- Dangerous (>1/1000)
- Regulated
- Ultra-safe (<1/100K)

Number of encounters for each fatality

Total Lives Lost per year: 10, 100, 1,000, 10,000, 100,000, 1,000,000, 10,000,000

Hospitalisation

“Acceptable public risk”
Study leads to change

• By examining the individual stories of the AEs we determined that the most common are:
  – failures in diagnosis
  – prescription of contraindicated drugs
  – incorrect management of organ failure
• Pan-Canadian initiative
• Modeled after US 100.000 lives Campaign
• 3 nodes; Western, Ontario, Eastern
• National Steering Committee
• Secretariat - Canadian Patient Safety Institute
• National Working Groups:
  – Measurement, Education, Communication
• Deployment of Rapid Response Teams
• Delivery of reliable, evidence based care for acute myocardial infarctions
• Prevention of ADEs through Medication Reconciliation
• Prevention of Central Line Infections
• Prevention of Surgical Site Infections
• Prevention of Ventilator - Associated Pneumonia
Western Node:
- BC Patient Safety Taskforce
- Canadian Patient Safety Institute
- Health Quality Council of Alberta
- Manitoba Patient Safety Institute

Lead Planning Group:
Dr. Ward Flemons
Dr. Ross Baker
Marlies van Dijk
Dr. Peter Norton
The Six Interventions: Western Node

Number of Teams per Strategy by Province

<table>
<thead>
<tr>
<th>PROVINCE</th>
<th>AMI</th>
<th>VAP</th>
<th>Med_Rev</th>
<th>Med_Rer</th>
<th>SST</th>
<th>CLI</th>
<th>Total Teams</th>
</tr>
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<tbody>
<tr>
<td>Alberta</td>
<td>5</td>
<td>6</td>
<td>32</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>59</td>
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<tr>
<td>British Columbia</td>
<td>35</td>
<td>5</td>
<td>41</td>
<td>28</td>
<td>9</td>
<td>15</td>
<td>154</td>
</tr>
<tr>
<td>Manitoba</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>24</td>
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<td>0</td>
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<td>0</td>
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</table>

Intervention Strategies:
- AMI - Acute Myocardial Infarction
- VAP - Ventilator-Associated Pneumonia
- Med_Rev - Medication Reconciliation
- SST - Surgical Site Infection
- CLI - Central Line-Acquired Bloodstream Infection
- RRT - Rapid Response Teams

Cartography: Chantal Hansen MGIS
Date: February 2006
Source: Statistics Canada Provincial Boundary Files
The Six Interventions: Western Node

Cities implementing one or more of the interventions in their healthcare settings

Teams/Western Node City

- AMI
- VAP
- MED_REC
- SSI
- CLI
- RRT

- Waiting for Data
- Other Nodes

Cartography: Chantal Hansen MGIS
Date: February 2006
Source: Statistics Canada Health Region Boundary Files
The Six Interventions:
Western Node

Med Rec - Prevent adverse drug events (ADEs) by implementing medication reconciliation

Total Number of Med Rec Teams/Health Region

- 8
- 7
- 4
- 3
- 2
- 1
- No Med Rec Teams
- Other Nodes
- Cities with Med Rec Teams
- Cities with other Teams

Cartography: Chantal Hansen MGIS
Date: February 2006
Source: Statistics Canada Health Region Boundary Files
Figure 1: 90-day post-discharge dispensing rates for beta-blockers, ACE inhibitors, and statins for acute myocardial infarction (AMI) patients age 20 and older in Saskatchewan, 1997-98 to 2001-02

Table 1: Provincial comparison of 90-day dispensing rates for beta-blockers, ACE inhibitors, and statins for new heart attack patients 65 and older, 1999-2000

<table>
<thead>
<tr>
<th></th>
<th>Saskatchewan</th>
<th>Nova Scotia</th>
<th>Quebec</th>
<th>Ontario</th>
<th>British Columbia</th>
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<tr>
<td>Beta-blockers</td>
<td>68%</td>
<td>83%</td>
<td>68%</td>
<td>68%</td>
<td>56%</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>65%</td>
<td>58%</td>
<td>57%</td>
<td>65%</td>
<td>53%</td>
</tr>
<tr>
<td>Statins</td>
<td>29%</td>
<td>36%</td>
<td>43%</td>
<td>40%</td>
<td>35%</td>
</tr>
</tbody>
</table>
How does Canada compare?

- 2004 Commonwealth Fund International Health Policy Survey in Australia, Canada, New Zealand, the United Kingdom, and the United States
- Adults
- 1400 per country and 3061 in the UK

When you need care or treatment, how often does the doctor tell you about treatment choices and ask for your ideas/opinions?

% saying sometimes/rarely or never

Australia: 35%
Canada: 35%
New Zealand: 35%
United Kingdom: 65%
United States: 50%
Last time you were sick or needed medical attention, how quickly can you get an appointment to see a doctor?

<table>
<thead>
<tr>
<th>Country</th>
<th>% saying 2 or more days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>20%</td>
</tr>
<tr>
<td>Canada</td>
<td>50%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>10%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>40%</td>
</tr>
<tr>
<td>United States</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Patient Safety</td>
<td>2.5</td>
</tr>
<tr>
<td>Patient-Centeredness</td>
<td>2</td>
</tr>
<tr>
<td>Timeliness</td>
<td>2</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>4.5</td>
</tr>
<tr>
<td>Equity</td>
<td>2</td>
</tr>
</tbody>
</table>
Conclusions: “win-win”

• The study provides a starting point for understanding the incidence of AEs and the resulting burden of injury.

• Additional work is needed to explore the types of AEs and their contributing factors.

• Efforts to improve medication safety and surgery are likely to play an important role in improving patient safety in Canadian hospitals.

• Additional research is needed on the incidence and types of AEs beyond the acute care hospital setting.
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