**Bar Code Medication Administration (BCMA): Finding the Return on Investment**

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**Outline**

- BCMA Overview  
  - Cost  
  - Benefits
- Complexity of measuring “prevented” errors from “near miss” logs.  
  - “Near misses” estimates  
  - Noise in the logs
- Strategy for measuring value of averted errors  
  - Determining internal cost for adverse event  
  - Sources/variables available to measure costs.  
  - Strategies for collecting cases  
  - Matching cases  
  - Scales for assessing severity
- Summary and recommendations

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**Growth in BCMA**

<table>
<thead>
<tr>
<th>Survey Year</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>527</td>
<td>25.1</td>
</tr>
<tr>
<td>2007</td>
<td>531</td>
<td>19.6</td>
</tr>
<tr>
<td>2006</td>
<td>460</td>
<td>13.2</td>
</tr>
<tr>
<td>2005</td>
<td>510</td>
<td>9.4</td>
</tr>
<tr>
<td>2004</td>
<td>493</td>
<td>4.4</td>
</tr>
<tr>
<td>2003</td>
<td>550</td>
<td>3.2</td>
</tr>
<tr>
<td>2002</td>
<td>505</td>
<td>1.5</td>
</tr>
</tbody>
</table>

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**Ballpark of Cost for Average Hospital (191 beds)**

- Initial costs  
  $377,000
- Annual costs  
  $320,000

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**Benefits to Bar Coding Drug Products**

- Average likely liability award per preventable ADE  
  $532
- Societal $181,600
- Drug charges 63 percent to 97

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**Impacts Processes**

- Franklin et al 2007 -- Time Spent  
  - Pharmacy service 68 min to 98 min weekdays (p = 0.001; t test)  
  - Drug administration round 50 min to 40 min (p = 0.006; t test)  
  - Nursing medication tasks other than drug rounds 21.1% to 28.7% (p = 0.006; x² test)
- Poon et al., 2006 – Time Spent  
  - Statistically unchanged for time on medication administration  
  - Before 26.5% -- after 24.5%

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Near Misses—How Do You Know?

Estimated Error Rate by Administrative Error Type per 1000 Opportunities

<table>
<thead>
<tr>
<th>Error type</th>
<th>Baseline</th>
<th>Lower bound</th>
<th>Upper bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong drug</td>
<td>43</td>
<td>8.6</td>
<td>60</td>
</tr>
<tr>
<td>Wrong dose</td>
<td>129</td>
<td>43</td>
<td>456</td>
</tr>
<tr>
<td>Missed dose</td>
<td>43</td>
<td>9.5</td>
<td>49</td>
</tr>
<tr>
<td>Wrong frequency</td>
<td>34</td>
<td>18.9</td>
<td>34.4</td>
</tr>
</tbody>
</table>

(Karnon et al., 2007)

Probability of “No Harm” — Two Prediction Models from Karnon, 2002

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Original values</th>
<th>Revised values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescription wrong drug &amp; route</td>
<td>80–99%</td>
<td>50–70%</td>
</tr>
<tr>
<td>Prescription wrong dose &amp; frequency</td>
<td>80–99%</td>
<td>70–90%</td>
</tr>
<tr>
<td>Dispensing</td>
<td>80–99%</td>
<td>96–99%</td>
</tr>
<tr>
<td>Administration wrong drug &amp; dose</td>
<td>80–99%</td>
<td>98–99.9%</td>
</tr>
<tr>
<td>Administration missed dose &amp; rate</td>
<td>80–99%</td>
<td>99.5–99.9%</td>
</tr>
</tbody>
</table>

ADEs with Potential for Harm

<table>
<thead>
<tr>
<th>Type</th>
<th>Baseline</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>No harm</td>
<td>95%</td>
<td>80%</td>
<td>99%</td>
</tr>
<tr>
<td>Significant harm</td>
<td>2%</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>Serious harm</td>
<td>2%</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>Severe/life threatening/fatal harm</td>
<td>1%</td>
<td>0%</td>
<td>4%</td>
</tr>
</tbody>
</table>

(Karnon et al., 2007)

BCMA Errors – The Numbers from Sakowski, 2005

![Graph showing the number of BCMA errors for 4 Thursdays in 2004, indicating attempts and possible errors.](image-url)
Predicting the effect of “Cry Wolf”

- Alarm reliability known in advance or learned over time
- Demanding task primary task
- 10% all or none
  - Choose an optimal strategy
- Most responded in parallel to alarm reliability
- Consistent response requires reliable alarms

Findings on Near Misses

- Moriss et al., 2008
  - Pre BCMA: 15.1/1,000
  - Post BCMA: 4.4/1,000
- Franklin et al., 2007
  - Wrong dose: 51/1,778
  - Omission: 111/1,778
- Mahoney et al., 2007
  - Wrong patient: 12.2/100,000
  - Wrong time: 25/100,000
  - Wrong dose/drug/route: 2.6/100,000

BCMA Near Miss Rate (cont.)

<table>
<thead>
<tr>
<th>Error</th>
<th>Not Given</th>
<th>Given</th>
<th>Doses</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>No order</td>
<td>50</td>
<td>98</td>
<td>17025</td>
<td>0.0087</td>
</tr>
<tr>
<td>No order patient</td>
<td>7</td>
<td>0</td>
<td>17025</td>
<td>0.0004</td>
</tr>
<tr>
<td>Order discontinued</td>
<td>24</td>
<td>23</td>
<td>17025</td>
<td>0.0028</td>
</tr>
<tr>
<td>Wrong route</td>
<td>4</td>
<td>5</td>
<td>17025</td>
<td>0.0005</td>
</tr>
<tr>
<td>Too early</td>
<td>88</td>
<td>167</td>
<td>17025</td>
<td>0.0150</td>
</tr>
</tbody>
</table>

Strategy for Identifying ROI BCMA

- Determine costs per ADE
  - Identify ADEs with harm
  - Identify matching case controls
  - Statistical analysis
- Count near misses with potential for harm
- Apply percentage would have caught anyway
- Near misses x costs = $

Costs of ADEs with Harm from the Literature—Matched Case Controls

- (Kaushal et al., 2007) – adverse events and drug events
  - $3,961 medical intensive care
  - $3,857 cardiac intensive care
- (Bates et al., 1997) – $4,685 for preventable ADEs
- (Sen et al., 2001) – $2,162
- (Gardner, 2003) – $800
- (Food and Drug Administration 2003) – $2,257
- (Backster et al., 2007) – Pre-op antibiotic timing $2,500
Criteria for Selecting Matching Case Controls
- Age
- Gender
- Race
- Payer
- Time Period
- Nursing Unit
- Length of Stay
- Pre-event Costs
- Diagnosis
- Diagnosis Case Weight
- Severity
- Discharge Destination (especially alive or dead)

Criteria so far...
- Nursing unit on day of stay of event case
- Admission date within 14 days of event case
- Length of stay >= event day
- Optimal score matching (Greevy, 2004)
- Four matches maximum

NCC MERP Index for Categorizing Medication Errors Algorithm
- **Harm**
  - Impairment of the physical, emotional, or psychological function or structure of the body and/or pain resulting there from.
- **Monitoring**
  - To observe or record relevant physiological or psychological signs.
- **Intervention**
  - May include change in therapy or active medical/surgical treatment.
- **Intervention Necessary to Sustain Life**
  - Includes cardiovascular and respiratory support (e.g., CPR, defibrillation, intubations, etc.)
*An error of omission does reach the patient.*

Another Severity Scale
- Does not require patient abstraction/knowledge of patient outcome
- Eleven score scale
  - Incident with no potential effect = 0
  - Incident would result in death = 10

Discrepancies with Potential for Harm
- **Amount**
  - 24 Hour dose and critical dose levels used in decision support
  - Single dose tenfold (Kozer et al.)
- **Route**
  - IV more serious (J. P. Santell & Cousins, 2005)
  - Wrong route/wrong technique disproportionately error rate (J. P. C. Santell, D. D.; Hicks, R., 2005)
- **Setting**
  - ICU vs. Obstetrics (Bates et al., 1997; Classen, et al., 1997)
- **Timing**
  - Pre-op antibiotics (Backster et al., 2007; Bratzler et al., 2005)
Discrepancies with Potential for Harm - Wrong Drug

- Drug in drug classes included for costs by Poon (Poon et al., 2006)
- BCMA study sample – 23 involved drugs with high potential for serious ADE (Gokavoski et al., 2006)
  - Opioids (morphine); n=11
  - Anticoagulants (heparin or warfarin); n=2
  - Potassium; n=1
  - Sodium chloride; n=1
- High Alert Drugs (Cullen, 2007)
- Drug products reported in MEDMARX (J. P. Santell, et al., 2003)
- Drug categories reported by Winterstein (Winterstein et al., 2002)
- Drugs causal in errors reported by Classen (Classen et al., 1997)
- Drugs causal in 5 or more ADEs reported by Kane (Kane et al., 2006)
- Pediatric causal drug categories reported by Kaushal (Kaushal et al., 2001)
- MEDMARX top 10 causal drug reporting 2002-2003 (Santell et al., 2003)
- MEDMARX Neuro-Muscular Blocking Agents (Santell, 2006)
- Most harmful outcomes MEDMARX 2002 (Santell et al., 2003)

Wrong Dose Criteria

<table>
<thead>
<tr>
<th>marijuana dosage(Tsing)</th>
<th>percent critical marijuana dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of the drug category's dose and formulations</td>
<td>Total of the drug category's dose and formulations</td>
</tr>
<tr>
<td>Total of the drug category's dose and formulations</td>
<td>Total of the drug category's dose and formulations</td>
</tr>
</tbody>
</table>

What is the size of the over or under dose based on the clinician's intent vs usual daily dose?

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Freq</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.03</td>
<td>1.00</td>
<td>0.00</td>
<td>3.00</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>0.03</td>
<td>0.00</td>
<td>3.00</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.00</td>
<td>5</td>
</tr>
</tbody>
</table>

**Reasons for discrepancies:**
- Fear of underdosing
- Fear of overdosing
- A treatment...

Recommendations

- BCMA application
  - Talk to other users/conferences
  - Read the literature
  - Dig into the detail for sample
    - Full day/week/unit for short period
    - Limited drug(s) for long period
- Pick a unit/drug with higher probability
  - High alert drug
  - Intensive care

Final Thoughts

- Great potential for improving patient safety
- Pick your focus (e.g. de-emphasize timeliness?)
- Watch for new types of challenges
- Informed integration of the process changes
- Decision support
  - Integrate laboratory alerts
  - Allergy checks
  - Reasonable dose checks
References


