Potential impact of automated dispensing systems on medication errors

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Satellite Symposium Pyxis/Cardinal Health

EAHP, Sevilla, March 18th, 2004
To err is human

- 2.9-3.7% of hospital admissions experienced an adverse event
- > 50% of adverse events attributable to errors
- Extrapolation: 44’000 to 98’000 deaths in USA each year (medication errors: 7’000)!
- 8th leading cause of death (motor vehicle accident 43’500, breast cancer 42’000, AIDS 16’500)

One BOEING 747 crash every 2 days ...

IOM, 1999
Errors step by step

- Prescription: 49%
- Transcription: 11%
- Dispensing: 14%
- Administration: 26%

Bates D, JAMA 1995;274:29-34
Dispensing errors

- Dose calculation, unit conversion
- Lecture error
- Selection error
- Repartition error (wrong time, wrong patient)
- Aseptic error
Global strategy

- Simplify
- Standardise
- Diminish memory-based steps
- Suppress retranscriptions
- Suppress manual steps
- Reduce the similarity
- Reinforce barriers
- Improve the communication

- Redesign information and drug flows
The « ideal » process ?
Impact of information technologies

◆ CPOE

– Important decrease of serious medication error rate (- 55 to - 81%)
– Reduction of ordering errors, but also…
  ▼ Transcription - 84%
  ▼ Dispensing - 68%
  ▼ Administration - 59%

Impact to be evaluated for each development
◆ Ergonomy ?
◆ Clinical decision support systems (CDSSs) ?

Bates D, JAMA 1998;280:1311-6
Impact of information technologies

- **Barcode scanning**
  - No objective demonstration of benefits
  - Necessity to identify the caregiver, the drug and the patient
  - Poor actual identification of drug unit-doses
  - Theoretical interests: ensuring the « 5 rights »
    - Improve the reliability of final checks
    - Improve the process traceability: medication administration record (MAR)

- **Real impact to be evaluated**
  - Right patient
  - Right drug
  - Right dose
  - Right route
  - Right time
Impact of information technologies

✦ Automated dispensing systems
  – Several studies versus traditional unit dose system (cart/cassette manually filled)
  – Studies on
    ▼ Activity modification
    ▼ Acceptability
    ▼ Error rates: 7 identified
      – 5 Pyxis
      – 1 Baxter ATC-212
      – 1 Mc Laughlin dispensing system
      – 0 other systems (e.g. Omnicell)
# Automated dispensing systems

## Literature

### Impact on error rate

<table>
<thead>
<tr>
<th>Author</th>
<th>Publ. Year</th>
<th>Technology after</th>
<th>Outcome</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barker</td>
<td>1984</td>
<td>Mc Laughlin Dispensing System</td>
<td>Medication errors observed during administration</td>
<td>Error rate diminished from 15.9 to 10.6% (incl. time errors). Most errors were wrong time (9.2 to 5.4%). Omission errors reduced (4.1 to 2.6%).</td>
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<td>Klein</td>
<td>1994</td>
<td>Baxter ATC-212</td>
<td>Dispensing errors (double-check)</td>
<td>0.84% errors among doses filled manually by technicians versus 0.66% for automatic filling.</td>
</tr>
<tr>
<td>Borel</td>
<td>1995</td>
<td>Medstation Pyxis</td>
<td>Medication errors observed during administration</td>
<td>Error rate diminished from 16.9 to 10.4% (incl. time errors). Most errors were wrong time (10.2 to 8.4%). Omission errors reduced (4.1 to 1.1%).</td>
</tr>
<tr>
<td>Ray</td>
<td>1995</td>
<td>Medstation Pyxis</td>
<td>Dispensing errors (double-check)</td>
<td>Dispensing errors decreased from 0.89 to 0.61%.</td>
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# Automated dispensing systems

## Literature

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<td>Schwarz</td>
<td>1995</td>
<td>Medstation Pyxis</td>
<td>Medication error rate spontaneously reported</td>
<td>Error rate decreased on the cardiovascular surgery unit (6.5 to 4.3 errors/month) but increased on the cardiovascular intensive care unit (1.0 to 1.7 errors/month)</td>
</tr>
<tr>
<td></td>
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<td>Missing doses reported</td>
<td>Missing doses diminished from 13.8 to 3.3/day (surgery unit) and from 3.3 to 1.2/day (ICU)</td>
</tr>
<tr>
<td>Shirley</td>
<td>1999</td>
<td>Medstation Pyxis</td>
<td>Administration time of first medication orally administer after patient admission</td>
<td>18% relative increase of first doses administered as scheduled (from 59 to 77%)</td>
</tr>
<tr>
<td>Klibanov</td>
<td>2003</td>
<td>Medstation Pyxis, incl. cubies</td>
<td>Discrepancies in inventory (number, wrong drawers)</td>
<td>19.5% drawers with wrong quantity (25% for matrix, 16% mini, 9% cubies) 2.3% drawers with wrong drug (91% cases with matrix, 9% mini, 0% cubies)</td>
</tr>
</tbody>
</table>
Automated dispensing systems

Literature

Summary

- Evidences of saving in time, ↑ availability for clinical activities and ↑ billing efficiency
- Only a slight reduction of medication errors, but...
  - Limited number of studies
  - Generally poor quality studies
  - Most recent technologies and connexion to CPOE not tested

Further studies are needed to evaluate the effectiveness of newer systems
Our experiment

- To determine error rate during drug dispensing in an experimental setting
- To determine the main mechanisms of errors
- To compare different types of stock organisations
Experimental conditions

- Phase 1
  Global ward stock system

- Phase 2
  Medstation Pyxis
Methods

- **Test population**
  - 30 nurses for each phase
  - medicine / surgery

- **Experiment**
  - 20 pill boxes
  - 4 different drugs
  - 4 administration schedules
  - 24 hours dispensing
Medstation Pyxis phase

- Electronic order entry
- Only CUBIE Smart Pockets (Computerized Unit-Based Inventory Exchange)
- Short nurses education (25 ‘)
- Evaluation form
Medstation Pyxis phase
Errors counting

- Comparison with reference pill-boxes

- Error classification

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<th>omission</th>
<th>commission</th>
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<td>selection</td>
<td>counting</td>
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</table>
Error rates

- Total: 3.1% without Pyxis, 2.9% with Pyxis
- Omission: 0.5% without Pyxis, 0.4% with Pyxis
- Selection: 2.6% without Pyxis, 2.2% with Pyxis
- Counting: 1.5% without Pyxis, 1.7% with Pyxis
- Repartition: 0.5% without Pyxis, 0.5% with Pyxis

*p < 0.05
n=2400
Medstation Pyxis query answers

**Interests**
- reduction of dispensing errors (16)
- better stock management (9)
- dispensing speed (7)
- ease of use (4)
- security against stealing (3)

**Limitations**
- poorer ergonomics (15)
- access time to drugs (6)
- mechanical dispensation, concentration problems (6)
- adaptation to ward pharmacies (5)
- breakdown management (2)
Potential interests for the security

- Major reduction of dispensing errors especially selection errors:
  - CPOE
  - CUBIE smart pockets
  - to be confirmed in real situations

- Improvement of drug traceability (e.g. narcotics, blood derivatives)

- Opportunity to redesign drug flow

- Should be connected to CPOE and a final check with barcodes
Possible system deviations

- Nurses waiting at busy administration times
- Removal of doses ahead of time to avoid waiting
- Overriding the device when a dose is needed quickly


A careful work-flow evaluation is necessary during the implementation
Thank’s!

- Catherine Du Pasquier
- Louise Riberdy
- Béatrice Pellet-Meier
- Pierre Chopard
- Philippe Garnerin
- Hospilog

This conference can be downloaded:

www.hcuge.ch/Pharmacie/ens/conferences.htm