Inpatient Medication Entry (IPMOE) for enhancing Safety and Efficacy of Medication Management

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Medication errors: a major patient safety issue

- 82% of American adults take at least one medication and 29% take five or more.
- The USA-based Institute of Medicine (IOM) estimates that one medication error occurs per hospitalized patient per day.
- 700,000 emergency department visits and 120,000 hospitalizations are due to ADEs annually.
- About 15% of the prescribing errors reach patients; the others are caught in time by pharmacists and other health-care workers.
- $3.5 billion is spent on extra medical costs of ADEs annually.
Computerized Provider Order Entry (CPOE)

- Use of computer assistance to directly enter orders from a computer or mobile device. The order is also documented or captured in a digital, structured, and computable format.

- At the minimum, ensures standardized, legible and complete orders, thereby reducing errors at ordering and transcribing.

- The Institute of Medicine identified Medication Order Entry (MOE) as an answer to improving medication safety for a long time (2000).

- The Health Information Technology for Economic and Clinical Health Act (HITECH) 2009 set Meaningful Use of and incentivized EHR adoption for Medicare and Medicaid. CPOE is the first of the core requirements of Meaningful Use.
CPOE

- Commercially available through vendors vs. in-house developed

- Variable designs:
  - Standalone vs. integrated into a wider clinical information or electronic patient record system
  - Confined to ordering (prescription) vs. downstream electronic processing of orders, i.e. open vs. closed loop
  - Whether combined with a clinical decision support (CDS) system of variable complexity
## Reduction in medication errors in hospitals due to adoption of computerized provider order entry systems

<table>
<thead>
<tr>
<th></th>
<th>Point estimate (%)</th>
<th>Estimate bound (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean % reduction in medication errors on using CPOE</td>
<td>-48 %</td>
<td>-55 to -41 %</td>
</tr>
<tr>
<td>Proportion of Medication orders made using CPOE</td>
<td>26.1 %</td>
<td>16 to 53.6 %</td>
</tr>
<tr>
<td>&amp; reduction in medication error frequency resulting from using CPOE</td>
<td>-12.5</td>
<td>-14.4 to -10.6 %</td>
</tr>
<tr>
<td>Absolute reduction in medication errors frequency resulting from using CPOE</td>
<td>17.4 m</td>
<td>0.08 to 27.1 m</td>
</tr>
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</table>

Figure 1  Estimated medication errors averted due to observed and increased use of computerized provider order entry in inpatient acute-care hospitals in a 1-year period.
**Figure 2.** Relationship between adverse drug events (ADEs), potential ADEs, medication errors and prescribing errors (modified from Morimoto\textsuperscript{63} p. 307).
Leapfrog CPOE Standard

* Leapfrog Group: a voluntary programme where large employers and public agencies raise awareness of and reward high-quality providers for accomplishing improvements (big leaps) in patient safety

* CPOE recommended as one of 3 big leaps in 2000

* The Leapfrog Group CPOE Standard:
  * Physicians enter at least 75% of medication orders via a computer system that includes prescriber-error prevention software.
  * Demonstrate that their inpatient CPOE System can alert physicians of at least 50% of the common, serious prescribing errors using a testing protocol now under development by First Consulting Group
Leapfrog CPOE Evaluation Tool

- A protocol for testing whether a CPOE system with CDS can intercept a variety of potentially dangerous medication orders in various simulated clinical scenarios.

- A test bank of over 130 adult test orders developed by an expert panel.
For every 5% increase in Leapfrog scores:

- Primary outcome of preventable ADE
  - Relative reduction 43% (CI 12-63%)
  - Absolute reduction 4.2% (CI 1.1-7.4)
  - 4 fewer per 100 admissions
Adherence to guideline or to computerized recommendation increased.

Prescribing errors decreased although there are some negative (observational) studies recently. There is no evidence on the effect on ADEs.

Studies on cost and effectiveness showed mixed results. In addition, some important costs may not be accounted for.

Quantitative studies show high adherence to alerts. However qualitative studies show many overridden alerts. Acceptance rate increase with the clinical importance of the alerts.

Direct order entry time increase. When indirect time is measured the overall time did not change, or even decreased.

Bottom Line

- Standardized, structured and legible orders
- Potential mainly realized when integrated with
  - other clinical systems/applications
  - clinical decision support
  - judicious use of alert to avoid fatigue
CPOE in the Hospital Authority

- In the HA CMS, the Generic Clinical Request System (GCRS) has been developed for ordering laboratory & radiology tests and simple clinical procedures.
- Medication Order Entry (MOE) has been implemented in the outpatient setting for many years.
- Inpatient Medication Order Entry (IPMOE)
  - Development started 2009
  - Pilot at Princess Margaret Hospital 2013
  - Fully implemented at Tseung Kwan O Hospital and Prince of Wales Hospital
  - To be implemented at all acute HA hospitals in the next 4 years
IPMOE in HA

- Developed in-house and in-vivo as a module in HA’s Clinical Management System
- Loop of prescription, dispensing and administration closed
  - Prescription: doctors’ digital signatures incorporating government recognized Hong Kong Post E-Cert scheme
  - Dispensing: integration with pharmacy dispensing system
  - Administration: use of mobile devices with WiFi and Bluetooth connection
- Integration with and into typical workflow on wards
- Extensive clinical decision support features
- System generated print medication administration forms in case of contingency
Before IPMOE

- Doctors prescribe on MAR
- Pharmacists enter prescriptions into electronic system
- Pharmacists check the order and dispense drugs to ward
- MAR sent to Pharmacy by porter or fax
- Nurses check MAR to schedule administration
- Nurses perform 3-checks-5-rights
- Nurses sign on MAR

Pharmacists check the order and dispense drugs to ward.

Doctors prescribe on MAR:
- Nurses check MAR to schedule administration
- Nurses perform 3-checks-5-rights
- Nurses sign on MAR

Pharmacists enter prescriptions into electronic system:
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- Nurses perform 3-checks-5-rights
- Nurses sign on MAR
### Top Reasons for Medication Incidents

<table>
<thead>
<tr>
<th>Prescribing</th>
<th>Wrong Strength/dosage</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wrong Patient</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Known Drug Allergy</td>
<td>9%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dispensing</th>
<th>Wrong Drug</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wrong Strength/dosage</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Wrong Patient</td>
<td>10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Administering</th>
<th>Dose Omission</th>
<th>21%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extra Dose</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Wrong Drug</td>
<td>9%</td>
</tr>
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Hospital Authority Risk Alert Jul 2014
Workflow of close-loop IPMOE

1. **Doctors** prescribe drug via IPMOE

2. **Nurses** login system as administered nurse & view MAR via IPMOE (allow > 1 nurse)

3. **Nurses** scan bar code on drug bag to verify right drug at right time

4. **Nurses** scan patient barcode bracelet to verify right patient at bed side

Patient identity & drugs data transmitted to scanner via Bluetooth

Pharmacists vet the order & dispense drugs to ward

Administrative record can be seen in Pharmacy to facilitate drug refill

System helps to sort out drugs due for giving

Clear drug administration details are documented in the system

Administratio
Core Features: Prescription

1. Drug search:
   - By Drug Name
   - By BNF
   - Repeat from Patient’s history
   - Choose from Drug Set

2. Common dosage, condition and route suggestions

3. Medication decision support checking
   - Drug allergy and adverse reaction
   - Drug-Drug interaction
   - Pregnancy contraindication
   - HLAB1502
   - G6PD deficiency
   - Therapeutic duplication
## Core Features: Dispensing

| 1. Dispensing management | - Timely intervention on problem prescription  
|                          | - Reduce prescription turn-around time |
| 2. Label management      | - 2D code label on all individual patient dispensing items  
|                          | - 2D code label for ward stock items which are high risk medications or pre-packed items |
Core Features: Administration

- System generated schedule of administration
- Barcode scanning for
  - patient and drug identification,
  - right time and right route
- Reminding of outstanding /follow up tasks via clinical dashboard
- Dispensing request: urgent/ replenishment
Benefits

- Reduce Medication Error
- Improve efficiency
- Streamline workflow
- Improve communication among caregivers
- Improve medication documentation
Impact of IPMoe

Prescribing error pre and post-implementation

Significant decrease
Impact of IPMOE

Prescribing error pre and post-implementation

- Problems remained
  - Could not be detected by IPMOE
  - Required pharmacists’ clinical judgment

Dosage checking
- e.g. renal dosage adjustment

Therapeutic duplication
- e.g. IV/PO, drugs in same class

Wrong route selected

Glyceryl Trinitrate – sublingual tablet
500 micrograms
1 tablet
stat pem [oral]

Glyceryl Trinitrate Subl Tab 500mcg
GLY04 (reg#l0d)
10:43 24-Sep 04

Legend:
- Pre (wrong)
- Pre(missing/incomplete)
- Post (wrong)
- Post (missing/incomplete)
Impact of IPMOE

Transcribing error pre and post-implementation

Number of near misses

Admin Time  Allergy  Concurrent Use  Dosage Form  Dosage unit/abbrev  Dose  Drug Name  Dilution Method  Frequency  Infusion Rate  Interaction  Route  Strength

Pre  Post
Residual/emerging risks

- Dependency on system for operation
- Contingency plans for scheduled and unscheduled down time
- Bugs in the system
- Risks arising from new workflow and unfamiliarity with system features
  - Omission of insulin injection when prescribed prn instead of regular with conditional omission
- System only as good as it is designed
  - E.g. will not catch wrong dose
- Remote prescription
IT is a game changer in healthcare as in all realms of life

Effectiveness difficult, if not totally impossible, to prove with traditional evidence based medicine methodologies

CDSS with appropriate alerts

System design and features key to effectiveness and efficacy

Engagement, reengineering of workflow & processes and implementation have great impact on successful adoption

Continual update based on user experience and in line with hardware & software development will lead to continual improvement