The Making of a Closed-Loop Medication System for Both Safety & Efficiency

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Hong Kong Hospital Authority
Clinical practice is far from perfect...
Costs to Society

**QAHCS**
- 8% of hospital bed days
- $4.7 billion/year

**UK**
- 8.5 days/adverse event
- Costs to NHS 1 billion pounds/year

**US**
- Costs of ADEs in hospitals $2 billion/year
- All drug-related problems $177.4 billion/year
# Top Reasons for Medication Incidents

<table>
<thead>
<tr>
<th>Prescribing</th>
<th>Wrong Strength</th>
<th>20%</th>
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<tbody>
<tr>
<td></td>
<td>Wrong Patient</td>
<td>19%</td>
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<tr>
<td></td>
<td>Wrong Drug</td>
<td>14%</td>
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<table>
<thead>
<tr>
<th>Dispensing</th>
<th>Wrong Drug</th>
<th>39%</th>
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<tbody>
<tr>
<td></td>
<td>Wrong Strength</td>
<td>16%</td>
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<tr>
<td></td>
<td>Wrong Dosage</td>
<td>11%</td>
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<thead>
<tr>
<th>Administering</th>
<th>Dose Omission</th>
<th>24%</th>
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<tr>
<td></td>
<td>Extra Dose</td>
<td>14%</td>
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<tr>
<td></td>
<td>Wrong Drug</td>
<td>11%</td>
</tr>
</tbody>
</table>

Source: Medication Incidents Reporting Programme Bulletin
Development in the HA
The Journey Continues

1990  “Green fields”
1991  Patient administration + Departmental systems
1995  **Clinical Management System (CMS)**
      • Direct clinician documentation and order entry
2000  CMS Phase II
      • Electronic Patient Record (ePR)
2003  eSARS
2004  ePR Image Distribution
2006  PPI ePR sharing
2008  **CMS Phase III**
2009  Filmless HA
      Hong Kong wide eHR
2010  Inpatient MOE
The HA ePR

*9.6M* patients  
*273M* episodes of care  
*1.2B* lab results  
*66M* radiology results

*339M* drugs prescribed  
*2.1M* operating records  
*51M* diagnostic codes
CMS is a key enabler for many systematic improvement initiatives
Medication Ordering Entry (MOE)

Drugs prescribed: 51.6 million each year (outpatient / inpatient discharge) since 1994
<table>
<thead>
<tr>
<th><strong>Drug Allergy Checking</strong></th>
<th></th>
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<tbody>
<tr>
<td><strong>Drug Allergy Alerts Raised</strong></td>
<td>68,790</td>
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<tr>
<td>Alert Accepted</td>
<td>32,102 (47%)</td>
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<tr>
<td>Alert Overridden</td>
<td>36,688 (53%)</td>
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<thead>
<tr>
<th><strong>Drug Drug Interaction</strong></th>
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<tbody>
<tr>
<td><strong>DDI Alerts Raised</strong></td>
<td>10,975</td>
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<tr>
<td>Alert Accepted</td>
<td>3881 (35%)</td>
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<tr>
<td>Alert Overridden</td>
<td>7094 (65%)</td>
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</table>
Error prone manual process with physical MAR
Laborious and Risky Drug Administering Practice
Challenges of IPMOE

1. Complexity
   - Inherent complexity of inpatient medications and need for frequent changes
   - Clinical workflows and variants

2. Technical challenges
   - Bedside access to computers
   - System down time

3. Reduce clinical risk
   - Patient identification
   - Decision support systems (dosing, checking, etc)
   - New errors induced by new system (iatrogenesis)
Principles of IPMOE Development

1. Closed loop system
   • Ordering, dispensing, administering

2. Focus on safety and efficiency
   • Usability-focused design
   • Integrate into clinical workflow

3. Strong clinician/user engagement
   • In vivo development
First, do no harm
Closed Loop System
We aim for BOTH Balanced Safety AND Efficiency

We aim for BOTH
Formula ordering

Calculated Dose

Amikacin Sulphate injection

Dose by Weight: 7.5 mg/kg
Recommended 7.5 mg/kg

Body Weight: 3 kg

Calculated Dosage: 22.5 mg

Final Dosage: 22.5 mg
Discontinue with reason
Strike through the discontinued drug

<table>
<thead>
<tr>
<th>Start Date</th>
<th>End Date</th>
<th>Drug</th>
<th>Hospital</th>
<th>Specialty</th>
<th>Type</th>
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<tbody>
<tr>
<td>20 Oct 09</td>
<td>01 Jan 10</td>
<td><strong>WARFARIN SODIUM</strong> tablet oral: 5mg daily for 12 weeks</td>
<td>QMH</td>
<td>MED</td>
<td>OP</td>
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<tr>
<td>23 Oct 09</td>
<td>01 Jan 10</td>
<td><strong>ASPIRIN</strong> tablet oral: 100mg daily for 12 weeks</td>
<td>QMH</td>
<td>MED</td>
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<td>01 Jan 10</td>
<td><strong>ADALAT RETARD</strong> tablet oral: 20mg daily for 12 weeks</td>
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<td>MED</td>
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<tr>
<td>29 Oct 09</td>
<td>15 Jan 10</td>
<td><strong>BETALOC TARTRATE</strong> tablet oral: 100mg bd for 16 weeks</td>
<td>PYN</td>
<td>MED</td>
<td>OP</td>
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<td>27 Oct 09</td>
<td>22 Jan 10</td>
<td><strong>BETALOC TARTRATE</strong> tablet oral: 100mg bd for 16 weeks</td>
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<td>20 Oct 09</td>
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<td><strong>DIAMICRON</strong> tablet oral: 80mg daily for 12 weeks</td>
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<td>20 Oct 09</td>
<td>02 Dec 09</td>
<td><strong>METFORMIN HCL</strong> tablet oral: 500mg bd for 6 weeks</td>
<td>PYN</td>
<td>MED</td>
<td>OP</td>
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**Alert**

**WARFARIN SODIUM** tablet oral: 5mg daily has been discontinued on 20 Oct 09
Reason: Warfarin Overdose

**CONFIRM:**
WARFARIN SODIUM tablet oral: 5mg daily
Proceed ordering?

[Yes] [No]
Facilitate renal adjustment

Renal adjustment for Gentamicin - injection

Please select the conventional dose for dosage adjustment

- 60mg in 50mL NS over 30 mins Q8H
- 80mg in 50mL NS over 30 mins Q8H

Gentamicin 60mg in 50mL NS over 30mins Q8H

- Cr > 60mL per min 60mg in 50mL NS over 30 mins Q8H
- Cr 40 - 60mL per min 60mg in 50mL NS over 30 mins Q12H
- Cr 20 - 40mL per min 60mg in 50mL NS over 30 mins Q24H

Adjusted Dose:
60 mg in 50 mL NS Q24H

Gentamicin 60 mg in 50 mL NS over 30mins Q24H
Supporting Chemotherapy

Facilitate round up / down of chemo drugs
Eliminate transcription in pharmacy
Improve administration safety by barcoding
eMAR & Barcoding

- Right patient
- Right drug
- Right route
- Right time
- Right dose
Better labeling of IV Drug / Fluid

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<tr>
<th>DRUG</th>
<th>Amount</th>
<th>mixed in 100mL</th>
<th>NS, over 30min</th>
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DATE AND TIME   28/9/2010 15:30  
GIVEN/CHECKED BY  

CHAN, TI MAN, A123456(7)  
HN12345678

Gentamicin Sulphate - injection  
DOSE 20mg IN  
100mL NS - over 30 minutes  

Prepared at 28/9/2010 15:30
Usability (and Safety) by Design

User Interface Guidelines for Medication
For safe on-screen display of medication information
The guideline aims to advocate the best and evidence-based electronic medication system user interface design.
More safe and user-friendly system with design philosophies and evidence
Clinician / User Engagement
In vivo Development
### IPMOE Development

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<tr>
<th>Quarter</th>
<th>4Q/09</th>
<th>1Q/10</th>
<th>2Q/10</th>
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### Wireless (network)

- Digital Signature design & development
  - Tender
  - Implementation

### MOE Revamp

- Project evaluation and System review
<table>
<thead>
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<th>2Q13</th>
<th>3Q13</th>
<th>4Q13</th>
<th>1Q14</th>
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Rollout plan subject to 1st cluster experience
The IPMOE journey has just begun...