Enhancing Patient Safety Through Integrated Supply Chain Management

Wu Tuck Seng
Deputy Director, NUH Pharmacy Department & Chairman of National Medication Safety Committee
Scope

• Explore innovative workflows, processes and use of IT to enhance patient safety:
  ➢ Integrating drug distribution in the medication use process
  ➢ Drug procurement - safety aspects
  ➢ Innovative drug delivery systems, use of bar coding, closed loop medication and inventory management systems to improve safety and enhance work efficiency
Drug Distribution in Medication Use Process

- Medication use process - prescribing, preparation & dispensing, drug administration

- Prescribing - availability, P & T Committee oversight, generic substitution, therapeutic substitution, opportunities for prescribing errors - LASA drugs, different strengths, different formulations

- Preparation & dispensing - ready to use, compounded products, storage & supply

- Drug administration - drug retrieval/receipt, labels, safety, convenience, information
Drug Procurement – Safety Aspects

- **Products** – High Alert Medications (HAMs), Look Alike – Sound Alike (LASA) Medications, Use aspects, Precautions, QA, QC
- **Services** – ensuring acceptable turnaround times, efficiency, and reliability, reducing wastages (defects)
Ready to Use Medication

- **Unit doses for oral tablet / capsule**
- Commercial ready to use
  - KCL infusion bag, NaCl syringes, NaCl minibag plus
- **Lab prepared pre-mix solutions**
Safety of HAM (IPSG 3)

• Commercial pre-diluted preparations
  – KCL
• Pharmacy lab prepared pre-diluted solutions
  – MgSO$_4$, KH$_2$PO$_4$
• Mini-bag plus
  – CaCl$_2$
Safety of HAM (IPSG 3)

% Prediluted Magnesium Sulphate Consumption
(Jan 12 – Feb 13)

Target: 80% premix
Driver: Pharmacy Department
Rationale: Reduce risk of accidental administration of concentrated electrolyte by using pre-diluted preparation
Formulæ: No. of bags of prediluted / Total No. (pre-diluted + concentrated) x 100
Action:
- Introduce pre-diluted Magnesium sulphate to all areas in hospital.
- Restrict concentrated preparation as ward stocks to selected areas only
- FMEA on Prediluted Electrolytes

<table>
<thead>
<tr>
<th>Month</th>
<th>Pre-diluted</th>
<th>Concentrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 12</td>
<td>0</td>
<td>1313</td>
</tr>
<tr>
<td>Feb 12</td>
<td>0</td>
<td>1411</td>
</tr>
<tr>
<td>Mar 12</td>
<td>0</td>
<td>1419</td>
</tr>
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<td>Apr 12</td>
<td>0</td>
<td>1329</td>
</tr>
<tr>
<td>May 12</td>
<td>0</td>
<td>1410</td>
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<td>Jun 12</td>
<td>263</td>
<td>904</td>
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<td>Jul 12</td>
<td>732</td>
<td>551</td>
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<td>Aug 12</td>
<td>659</td>
<td>594</td>
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<td>Sep 12</td>
<td>682</td>
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<td>Oct 12</td>
<td>925</td>
<td>508</td>
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<td>Nov 12</td>
<td>856</td>
<td>447</td>
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<td>Dec 12</td>
<td>989</td>
<td>468</td>
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<tr>
<td>Jan 13</td>
<td>925</td>
<td>371</td>
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<tr>
<td>Feb 13</td>
<td>1020</td>
<td>140</td>
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</table>
Safety of HAM (IPSG 3)

% Prediluted Magnesium Sulphate Consumption (Mar 13 – May 14)

Target: 80% premix
Driver: Pharmacy Department
Rationale: Reduce risk of accidental administration of concentrated electrolyte by using pre-diluted preparation
Formulae: No. of bags of prediluted / Total No. (pre-diluted + concentrated) x 100
Action:
-Monitoring to ensure that the target consumption / usage is sustained for the pre-diluted preparation
Safety of HAM (IPSG 3)

• Handling of Look Alike Sound Alike (LASA) Medication | NUH-HAP-PHA-017

– Selection, Procurement, Storage, Ordering & transcribing, Preparing & dispensing, Administration

– LASA drug list online

– Risk mitigation for LASA drugs: bar code verification, tall man lettering, bin code, automated dispensing cabinets
Drug Storage

• Security of drugs in wards is ensured by using patient profiled Automated Dispensing Cabinets (ADCs)
• Also deployed in OT and EMD department
• Includes storage & inventory tracking of controlled drugs
FEEDBACK FORM ON LOOK ALIKE SOUND ALIKE (LASA) DRUGS IN THE HOSPITAL FORMULARY

Dear all

We are soliciting feedback on sound alike look alike drugs that we have in the hospital. Please go through the existing compiled list at the following website: http://nuhweb/css/pharma/files/drugLists/Look-alike%20Drugs.pdf.

We welcome your feedback should you encounter any such drug that is not in the existing list. This will help us to tackle the problem and work towards preventing any potential medication error from this aspect.

Your submissions (The look/sound alike combinations in one table):

<table>
<thead>
<tr>
<th>Description (Generic Name and Brand Name)</th>
<th>Strength</th>
<th>Dosage Form</th>
<th>Manufacturer</th>
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Submitted by (name)
Contact number and/or e-mail

Please fill in all columns. Thank you.

You could submit this form to Pharmacy Purchasing via:
Fax     fax number 67795358
E-mail  sook_weilim@nuhs.edu.sg
Despatch to Basement Pharmacy, Purchasing Section
Examples
Examples
Examples

Heparin sodium
5,000 I.U./mL
For I.V. or S.C. use

Calcium Chloride
10% Injection 1g in 10mL
For intravenous injection. Each vial contains 6.8mmol calcium ions, 13.6mmol chloride ions.
Working with Vendors

• **Liaising** with pharmaceutical vendors to differentiate these drugs via additional labeling or colour changes

• **Sourcing** for alternative brands of drugs that have been identified to be physically similar in appearance
Accurate & Timely Dispensing - Inpatient Closed Loop Medication Management System

- **Start**
  - Electronic prescription (eIMR)

- **Medication order Check (eIMR)**
  - Manual bar-coded supply by pharmacy (20%)

- **Package & bar-code tablets/capsules**
  - Unit dose bar-coded medication*

- **Despatch to Wards**
  - Secured medication storage at ward (80%) 24hr supply

- **Preparation of med trolleys**

- **Bedside verification (eMARS / eIMR)**

- **INPATIENT PHARMACY**

- **Patient**
  - *Patient-specific packs delivered to med trolleys.*
  - *Non-patient specific topped up in OmniRx units*
eMAS: Electronic Medication Administration System

Scans Name Tags And Medication Rings

Drug allergies and alerts On CMIS

Drug Interaction Flag

Pharmacy Intervention But can serve

(By end 2014 - replace PDA with IPAD Mini)
Figure 1. Process flow between ordering, dispensing and administration of medication for a patient.

- Physician uses electronic Inpatient Medication Record (eIMR) to order medications.
- Pharmacist uses eIMR to review medication orders.
- Nurse uses electronic Medication Administration Record System (eMARS) to verify and administer medication.

- Non-Ward Stock Supplies: Supplies by Satellite Pharmacy.
- Ward Stock Supplies:
  - Automated Tablet Dispensing and Packaging System
  - Manual Repackaging by Vendor
  - Barcoded Unit Dose

- Preparation of Med. Trolley
- Ward Stock
- Automated Dispensing Cabinet
### eHOR Incidents, 2008 – 2013 (per 1000 patient days)

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<tbody>
<tr>
<td>Q1</td>
<td>0.89</td>
<td>0.72</td>
<td>0.66</td>
<td>0.4</td>
<td>0.46</td>
<td>0.60</td>
</tr>
<tr>
<td>Q2</td>
<td>0.9</td>
<td>0.72</td>
<td>0.66</td>
<td>0.4</td>
<td>0.46</td>
<td>0.60</td>
</tr>
<tr>
<td>Q3</td>
<td>0.9</td>
<td>0.72</td>
<td>0.66</td>
<td>0.4</td>
<td>0.46</td>
<td>0.60</td>
</tr>
<tr>
<td>Q4</td>
<td>0.9</td>
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<td>0.66</td>
<td>0.4</td>
<td>0.46</td>
<td>0.60</td>
</tr>
</tbody>
</table>

- **Apr 08**: Start of eIMR deployment
- **Jan 09**: End of eIMR deployment
- **Feb 09**: Start of IPAS deployment
- **Oct 09**: End of IAS deployment

**Scanned med and Pat**
- **Scanned med**:
  - FY2008: 22.36%
  - FY2009: 49.54%
  - FY2010: 73.6%
- **Scanned Pat**:
  - FY2008: 30.33%
  - FY2009: 63.78%
  - FY2010: 85.7%

**32.6% decrease**
eHOR Data: Preventable CLMMS Incidents

- 2008: 86
- 2010: 30
- 2012: 25

Post Implementation of Closed Loop Medication

71% decrease
## Key Performance Indicators (KPIs)

<table>
<thead>
<tr>
<th>KPIs</th>
<th>Fulfillment</th>
<th>Current Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 80% of Med Orders stocked in Cabinets</td>
<td>Fulfilled</td>
<td>80% of medication orders are stocked in cabinets</td>
</tr>
<tr>
<td>Safe Picking of Medications</td>
<td>Fulfilled</td>
<td>Prevented 3 errors per 100 Patient Days</td>
</tr>
<tr>
<td>Correct Medications Admin</td>
<td>Fulfilled</td>
<td>Prevented 7.1 errors per 100 Patient Days</td>
</tr>
<tr>
<td>Secure Medication Storage</td>
<td>Fulfilled</td>
<td>System mandates user login</td>
</tr>
<tr>
<td>Improved work efficiency, redeployment to patient centric activities</td>
<td>Fulfilled</td>
<td>Nursing saves 22 FTEs, but Pharmacy incurs 4 PA FTEs and saves 0.5 pharmacist FTE</td>
</tr>
<tr>
<td>Restocking process is streamlined with real time inventory</td>
<td>Fulfilled</td>
<td>Single trips are made to wards to restock medications, compared with double trips previously</td>
</tr>
<tr>
<td>Reduction of wastage</td>
<td>Fulfilled</td>
<td>Wastage reduction of $3 406 per year (18% saving)</td>
</tr>
<tr>
<td>Automated billing ensures efficient, timely and accurate billing</td>
<td>Fulfilled</td>
<td>0.6 PA FTE saved with interim implementation of MCE, 1.5 PA FTE projected savings with full implementation</td>
</tr>
<tr>
<td>85% of medications to be barcoded</td>
<td>Exceeded</td>
<td>91% of medications administered are barcoded (Prior to outsource: 40%)</td>
</tr>
</tbody>
</table>
Case Study – NUH Pharmacy

• NUH Pharmacy Store is the central pharmacy location for drugs/Over-the-Counter (OTC) items. It adopts hub-and-spoke model of drug distribution

• Consist of 8 staff (6 store-keepers, 1 Healthcare Assistant, 1 Senior Assistant Manager) – Lean manpower

• Outsourced all wards’ infusion topping up services to Baxter Company.

• Stock Turn 13 – 14 times per year

• Monitors “no-stock” drugs weekly

• Monitors consumption trend and reviews par level monthly

• Inventory system used is SAP – German software

• Weekly ordering using Material Replenishment Planning system (MRP) in SAP
Store Functions

• Perform receiving of stocks from suppliers for all drugs and over-the-counter items

• Process weekly stock request from 10 Pharmacy sections. Also process Emergency request for drugs when requested

• Top-up weekly regular stocks/ward supplies to 56 wards, 15 outpatient clinics

• Process drug request of 36 departments

• Top-up Omnicells daily in EMD and Major Operating Theatre, Day Surgery Operating Theatre and Day Surgery Centre

• Number of drug transactions per month is about 6000 to 7000 line items per month
Process Flow of Drug Receipt and Distribution

Current Drug Distribution System in NUH

- MRP (MQL: Reached par)
- Porter/Pharmacy store staff delivers stocks to pharmacies
- Top up of stocks to store
- Approval of PO
- Suppliers deliver goods along with invoice
- Goods receiving in store
- Purchasing department generate PO
- Requisitions
- Emergency orders
- Strictly monitored drugs
- Miscellaneous
Use of IT – AIDC, Bar Coding

• Reducing Goods Receiving and Document Posting time in Pharmacy Store using AIDC (Automated Inventory Data Collection) technology

• **Problem Analysis:**
  a) Time consumed in filing the 300 to 500 PO generated per week
  b) Delayed matching of PO against invoice manually
  c) Printed copies of PO and extensive use of A4 size papers
  d) Human error in all manual activities resulting in wrong product receipt. Difficult to track error as there is lack of accountability unless manually tracked
Objectives

1) To simplify the process of manually filling and matching of PO against invoice

2) To eliminate the data entry process of document posting in SAP

3) To enable scanning of products that has product bar codes to expedite receiving time and reduce product error upon receiving

4) To reduce the use of A4 size papers and printing cost with paperless good receipts

5) To increase efficiency in goods receiving process by posting real time upon receipt of goods
Implementation Plan

- Use Automated Inventory Data Collection System (AIDC). This system entails the use of PDA (handheld) device
- The paperless process for goods receipts eliminates manual process of filing, matching and data entry for document posting
The Results

Average Time taken to match each Invoice with Purchase Order

- Manual: 27 sec
- AIDC: 15 sec

• No of Sec in reduction: **12 sec**
• % in reduction: **44.4%**

Time Taken to complete the posting process of Goods Receipts of Store items

- Manual: 240 mins
- AIDC: 5 mins

• No. of Mins in reduction: **235 mins**
• % in reduction: **97.9%**
Benefits (Financial)

- Cost savings per week in the following areas:
  a) Reduction in the use of A4 size papers to generate PO = $30 - $50
  b) Elimination of filing time taken in terms of hourly rate of staff salary = $21 - $42
  c) Elimination of time taken for matching of invoice against PO in terms of staff salary = $84
  d) Elimination of data entry of document posting in SAP = $166
- Total savings = $301 - $342 (per week). Therefore $15,652 - $17,784 per year.
- Productivity is indeed increased with multitasking of both receiving and posting of invoices done using handheld device at the point of receiving.
- Reduction in goods receiving process time and posting of documents in SAP. With the implementation of new technology, posting of items can be done concurrently (faster).
Benefits (Non-Financial)

1) Higher value added work for mature workers
2) Opportunity for training as the technology requires knowledge in the use of handheld device and uploading and downloading steps
3) Less physical and mental stress
4) High level of staff motivation with more time available for checking of inventory and follow-up of drug request and process
5) Better use of storage space as printed PO filing is no longer required
Results

• The use of technology has served the purpose of reducing the process of good receipts and posting of documents by 44.4% and 97.9% respectively

• Compared to the manual method, there is greater accountability as the access to handheld device use is based on individual password which can be tracked

• Tracking of goods received is more systematic. The reduction of time and less use of paper can save the Department an estimated $15,652 to $17,784 a year

• It also means that the process has made the department more environmentally friendly with reduced use of paper
Recommendations

• To further improve the overall time taken for batch process uploading and downloading of data from handheld device to SAP system
• Setting up suitable WIFI infrastructure to enable real time posting (done)
The National University Hospital of Singapore has been managing its closed-loop drug inventory system using the Personal Digital Assistant (PDA) device since 2009. The PDA however, has many limitations and thus is replaced by the tablet device. The aim of this project is to study the effectiveness of the closed-loop drug inventory system using the tablet device. Data comparing both the PDA and tablet device were collected for analysis to assess on the staff satisfaction, efficiency and productivity of the workflow processes after the tablet implementation.
Introduction - Use of PDA Device

- **2 MAIN PROCESSES**
  - Drugs arrived from suppliers
  - Receiving form is given (contains details of drugs supplied)
  - Purchase order number is keyed into the PDA
  - Once receiving is done, purchase details will be uploaded into SAP System at once
  - Details of supplied drugs checked against the list
  - List of drugs ordered will appear on PDA

(Uploading Process)

PDA

SAP SYSTEM
Introduction - Use of PDA Device

• Downloading Process

Drugs used by different department → No real time update → PDA is not updated → SAP SYSTEM

PDA
Limitations of PDA

Small Screen
- Truncates drug names and description
- Higher chances of human error

Time-Consuming
- Manual checking required
- Supplied drugs vs Order list

No-real time update
- To upload latest drug stock into SAP system when drugs arrived from supplier
- Results in many phone calls to enquire availability of drugs
Project Objectives

• Determining whether **efficiency has improved** by measuring **time taken for both the uploading and downloading process**

• Assessing **level of productivity** of store personnel. This is measured by the **number of phone calls** from the different departments. The fewer the calls, the less intervention thus higher productivity level of store personnel

• Evaluate **staff satisfaction** on the tablet device by implementing a survey comparing PDA and the tablet device.
Methods (Data Collection for PDA)

- ~Two week: 18th June to 2nd July 2013
- Log sheets: Number of stock enquiring phone calls
- Time-Study forms: Time of Picking, Packing and Checking processes

- One week: 18th to 24th June 2013
- Time-Study forms: Time of uploading and downloading processes
Methods (Tablet Implementation)

- On 1st September 2013
- Only Uploading process
- An adaptation period: 2 to 3 weeks
## Methods (Data collection for tablet)

- **~Two week: 30th September to 14th October 2013**
- **Log sheets: Number of stock enquiring phone calls**

- **One week: 23rd to 27th September 2013**
- **Time-Study forms: Time of uploading and downloading processes**
Methods (Staff Satisfaction Survey)

- Assess staff level of acceptance for Tablet device vs PDA
- Difficulty in Tablet manipulation
- Identify tablet limitations, if any
Methods (Data Analysis)

- Data comparison of PDA and Tablet device
- Determining whether work efficiency and productivity are improved
Results and Discussion

(Graph1) Mean time spent: 2.2min/day (PDA), 0.42min/day (Tablet). Standard deviation is 0.20 (PDA), 0.12 (Tablet).

Uploading Process: Tablet device with real-time monitoring function has lower mean uploading time and a lower standard deviation → Faster and more consistent.

Reason: Drug stock data is immediately transferred from the tablet device to the SAP system → No accumulation of data → All hospital departments has the latest updated information on availability of requested medication → Increase overall efficiency of entire workflow.
Results and Discussion

(Graph 2) Decrease in number of stock enquires phone calls due to implementation of tablet device’s real time uploading function improves staff’s productivity.

Less distractions and interruptions enable staff to focus and carry out their current duties accurately, thus enhancing efficiency of workflow.
Results and Discussion

(Graph 3) The results show that 50% of the staff rated the tablet device at a difficulty level of 2 compared to 4 for the PDA device.

This shows that the tablet device was easier to use and handy thus enabling staff productivity to increase, enhancing overall workflow efficiency.

Furthermore, based on the staff satisfaction survey, 7 out of 8 of the store staff felt lesser time is taken to complete each process using tablet device. Overall, 100% of the store staff prefer the tablet device over PDA.
Graph 4: Pick, Pack & Check Process

<table>
<thead>
<tr>
<th>Location</th>
<th>Picking</th>
<th>Packing</th>
<th>Checking</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>20.03</td>
<td>10.03</td>
<td>4.1</td>
</tr>
<tr>
<td>RH</td>
<td>2.18</td>
<td>1.83</td>
<td>14.47</td>
</tr>
<tr>
<td>Location</td>
<td>17.93</td>
<td>7.34</td>
<td>14.47</td>
</tr>
<tr>
<td>R2</td>
<td>60.92</td>
<td>14.47</td>
<td>14.47</td>
</tr>
<tr>
<td>SP5A</td>
<td>36.73</td>
<td>14.47</td>
<td>14.47</td>
</tr>
</tbody>
</table>

Time Taken (min)
Improvement

- Time taken varies according to the amount of drugs requested by each section
- Locations like R1 and R2 -> a larger amount of drugs -> longer time
- Each medication is assigned with a barcode number -> electronically scanning -> checking process is eliminated -> reduced turn around time of supplying medications to patients
Conclusions

**Uploading Process**
- Mean Time: 2.2min/day - 0.42min/day
- Standard Deviation: 0.20 - 0.12
- Faster and more consistent

**Number of phone calls**
- Overall decrease from 18 phone calls to 10 phone calls
- Less distraction for staff
- Higher productivity

**Staff Satisfaction Survey**
- 50% of the staff rated the tablet device at difficulty level 2 compared to 50% who rated PDA at difficulty level 4
- 87.5% felt tablet takes lesser time
- 100% prefer the tablet device
Moving Forward (Future)

• Increase outsourcing as relevant - should be better, cheaper, faster, safer where possible
• Vendor managed inventory, Just-In-Time stock supply
• Online real time management of drug inventory linked to formulary decisions & drug dictionary – drug knowledge management database
• Online real time management of drug inventory linked to automated dispensing cabinets to improve safety
• Online real time charging of drugs supplied
• Picture recognition, bar coding of drugs and product information on line
• Extend role of pharmacy technicians in medication management - medication reconciliation, supply of controlled drugs
In Summary

Enhancing patient safety through integrated supply chain management is achievable via integrating drug distribution to support the medication use process, being cognisant of safety aspects of drug procurement - e.g. HAMs, LASA drugs etc; and using closed loop medication management, closed loop inventory management systems, employing the use of bar coding and bin codes. The implementation of these innovations also enhances work efficiency overall. We should continue to work on this as Kaizen to up the level of safety and efficiency.
Thank You

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