Medication safety and technology
- A view from the UK -

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Imperial College Healthcare NHS Trust
• 3 main hospitals + 2 smaller hospitals
• 1,200 beds
• 70 pharmacists
• 70 pharmacy technicians
• 70 assistants / other staff
• Medicine information
• Parenteral nutrition
• Preparation chemotherapy
• Prescribing is paper-based
• Original pack dispensing (not unit dose)
Key terms

- Adverse drug reactions
- Iatrogenic harm
- Medication errors

Shaded area denotes adverse drug events.
Key terms

Adverse drug reactions

Iatrogenic harm

Medication errors

Shaded area denotes adverse drug events

“any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of health professional, patient or consumer.”
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Medication errors in UK hospitals

Prescribe medication → Dispense or supply medication → Administer medication → Monitor effects
Prescription errors in UK hospitals

- **Prescribing error**
  - Error in 1.5–15% medication orders

- **Dispensing error**
  - Error in dispensing or supply medication

- **Administration error**
  - Error in administering medication

- **Monitoring error**
  - Error in monitoring effects

**Prescription error**:
- Error in 1.5–15% medication orders

**Dispensing error**:
- Error at final check in 0.6-2.7% items; outside pharmacy in 0.02%

**Administration error**:
- Error in 3.0-8.0% non-IV doses
- 30-90% IV doses

**Monitoring error**:
- ??
What about primary care?
Garfield et al 2009 BMC Medicine
Error rate 7.46% items (Shah et al 2001):

- No directions 25%
- Prescribing something not needed 18%
  - Directions incomplete 11%
    - Over supply 11%
  - Strength missing 9%
  - Quantity missing 8%
  - No Signature 5%
- Other 13%
Error rate 2.9% prescriptions
(Jones & Britten 1998)
Error Rate 5.2% items
(Beardon et al 1993)
Error rate 3.3% items (Franklin et al 2007):

- 1.6% labelling
- 1.7% content

Clinical Severity:
- 67%: minor
- 32% moderate
- 1% severe
Intention → Prescribing → Presentation → Dispensing → Adherence → Effect

Error Rate 30-50% patients (Cochrane 2008, Nice 2009)
Medication ineffective = 50%-90% (NNT medication 2-10)
Drug related admissions = 6.5%-7.5% admissions
•69% of these are preventable

Intention
Prescribing
Presentation
Dispensing
Adherence
Effect
With thanks to Nick Barber
Why do errors occur?
Reason’s Accident Causation Model

- Latent conditions
- Error producing conditions
- Active Failures
  - Slips\&lapses
  - Mistakes
  - Violations

Defences
The Swiss Cheese model

Defences

Latent failures
Prescribing in hospitals

• In the UK, most prescribing is done by the most junior doctors
• Specialist prescribers often have to prescribe drugs outside of their specialty
• Results in a prescribing error in 1-15% prescriptions
How to prevent these?

(i) Prevent prescribers from making errors?

(ii) Identify errors and rectify them?
(i) Reducing prescribing errors

- Educational interventions?
  - Some evidence for benefits, but not dramatic
- Feedback on errors?
  - Some evidence for benefits
- Electronic prescribing?
(ii) Identifying and rectifying errors
Identifying and rectifying errors

- Appropriate use of checks and alerts (where using electronic systems)
- Clinical pharmacy services
- Nursing staff
- The patient?
Technology

Is technology the answer?
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<tr>
<th>Medicine (approved name)</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>Start</th>
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<td>PO</td>
<td>q.d.</td>
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Why are you still studying medication errors? There won’t be any soon, once we have electronic prescribing…
The technologies available

- Electronic prescribing (+/- electronic medication administration records in hospital and care home)
  - with various levels of decision support
- Automated dispensing
  - Pharmacy based (“robots”)
  - Ward based (“vending machines”)
  - Aseptic compounding robots
  - Automated CD storage
- Barcode verification of medication and/or patients
- “Smart” IV pumps
Electronic prescribing

• EP is commonplace in UK primary care
  – Vast majority of prescribing is electronic
• Most prescribing for hospital inpatients is paper-based, although electronic prescribing becoming more widespread
  – Small number hospitals used electronic prescribing for more than 10 years
Hospital electronic prescribing (EP)

- 101 (61%) of 165 hospital trusts responded in survey of English hospitals
  - 70 (70%) had at least one EP system in place
  - 56% of sites with EP had more than one system in place. Four sites had more than 4 systems.
  - 63 different systems
- Electronic discharge prescriptions now common - but often mainly a word processor, no decision support
- Inpatient EP will become more common once electronic health records become established

Ahmed, Franklin and Barber, 2012
Automation of dispensing in hospitals

- Automated dispensing systems
  - Pharmacy based ("robots")
  - Aseptic compounding robots
  - Ward based ("vending machines")
    - 6 of 91 respondents
  - Automated CD storage
    - 2 of 91 respondents

McLeod, Barber and Franklin, 2012
Dispensing robot

Recognises products on loading, using barcode and dimensions of pack
Ward-based automated storage

Verifies product on loading, using barcode
Aseptic compounding robot

Verifies bags using barcode
Verifies vials using photo recognition
Automated CD storage
Smart pumps

- Drug “libraries” to permit checking of doses and infusion rates
- Require standardisation of infusion concentrations etc
- Potentially safer infusion of intravenous medication.
- However, bypassing of the safety software is common
What is technology good at?

- Repetitive tasks, same every time
- Follows the rules
- Forcing functions
  - Can’t proceed until you’ve completed all the fields
- More legible than handwriting
- Reminders
- Supporting formularies, protocols, standardisation of treatment
- Audit trail
But...

- Can be inflexible
- New error types
  - Selection errors from menus
  - Menus often present very long lists of options which prescribers not familiar with
  - Assumptions - “the computer must be right”
- New work processes may be required, which can themselves increase or decrease errors
  - Checking of patient identity can be enforced
  - Development of workarounds
Selection errors

- Selection of penicillamine, instead of penicillin
- Menu arranged alphabetically in hospital system
  - Paracetamol soluble tablets
  - Paracetamol suspension
  - Paracetamol tablets
- Many patients prescribed paracetamol soluble tablets
  - At risk of hypernatraemia
Selection errors

- Selection of penicillamine, instead of penicillin
- Menu arranged alphabetically in hospital system
  - Paracetamol suspension
  - Paracetamol tablets
  - Paracetamol tablets soluble
Assumptions

• Human-computer interaction causes most deaths of all IT induced fatalities
  – Eg a UK hospital: ~1000 cancer patients under-dosed with radiotherapy over 9 years. Decision support software incorporated in machine, staff did not know and applied a second, manual dose reduction calculation
    – McKenzie ‘Knowing machines’ 1996
  – Common assumption that EP systems include allergy checking, when it sometimes doesn’t...
Workarounds
Workarounds

- Increased patient identification from 17% of doses with manual system, to 81% with barcode system
- Why only 81%?
- Staff sometimes found the wristband hard to scan, and so stuck the barcode to the patient’s table…

Franklin et al, 2008
Violations
The result?

Some types of error reduced
The result?

Some new types of error introduced
Local evaluation therefore essential
What to measure?

Some measures that are easy to do:

• Omitted doses for hospital inpatients
  – Find the number and the causes...

• Prescribing errors
  – Pharmacists recording errors identified...

• Adherence to prescribing protocols eg prophylaxis of thromboembolism

• Do not assume that benefits in other health systems / other countries will extrapolate to your own context
When do we measure the effectiveness of the system?

With thanks to Nick Barber
UK evaluations

- Electronic prescribing
  - Most (but not all) evaluations show a modest reduction in prescribing error

- Closed loop ward based automated dispensing system with barcode verification
  - More dramatic reduction in administration errors

- Dispensing robots
  - Reduction in “wrong content errors”
How to maximise the benefits?

- Professionals need to engage early with change
- Good relationship with suppliers
- Software adaptable locally
- Individuals need to see the benefits for themselves
- Local evaluation essential
Conclusions

• Not easy – otherwise would have been solved by now
  – Not just “plug and play”
  – Unintended consequences
  – Do not assume that solutions from elsewhere will translate into local practice. Evaluation essential

• A useful tool, when used with care
IT – approach with care