IMPACT OF TECHNOLOGY ON MEDICATION SAFETY

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Learning Objectives

• Understand historical impact of medication technology
• Analyze processes prone to medication errors
• Be familiar with CPOE, eMAR, BCMA and smart pumps
• Define the roles of health care professionals and stakeholders in the implementation and proper utilization of medication technology
To err is human\textsuperscript{1,2} “

- The “To Err is Human” published by the Institute of Medicine (IOM) in 1999 highlighted the lack of safer medical practices medical errors had in the US health system and created an urgency for a change in paradigm.
- Healthcare providers were urged to assess and redesign faulty systems in efforts to reduce medication errors in diagnosis, treatment and preventative services.
- Report attributed 44,000 to 98,000 yearly deaths in hospitals to errors due to poor safety checks and balances.
- A study by Stelfox et al. from 1994 to 2004 highlighted the impetus created by report with a significant increase in patient safety publications and federally funded research.
Incentive to change\textsuperscript{2,3}

- The American Recovery and Reinvestment Act of 2009 established incentives for Doctors and Health Care systems to create sustainable Electronic Health Record (EHR) initiatives

- Act was aimed at the increased utilization of health information technology to provide safer medical practices and create safeguards for health care professionals

- 2005 study by Hillestad et al. on potential benefits of electronic medical records estimated saving of $142-$371 Billion through better safety and improved efficiency
Table 1  Adoption and duration of use of eMAR and CPOE technologies in medium-to-large acute-care hospitals in 2008 (N=2603)

<table>
<thead>
<tr>
<th>eMAR and CPOE use by adoption status</th>
<th>n  (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMAR in operational use</td>
<td>1790 (68.8)</td>
</tr>
<tr>
<td>CPOE in operational use</td>
<td>919 (35.3)</td>
</tr>
<tr>
<td>Neither technology in operational use</td>
<td>698 (26.8)</td>
</tr>
<tr>
<td>eMAR only in operational use</td>
<td>986 (37.9)</td>
</tr>
<tr>
<td>CPOE only in operational use</td>
<td>115 (4.4)</td>
</tr>
<tr>
<td>Both eMAR and CPOE in operational use</td>
<td>804 (30.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration of use</th>
<th>eMAR (n = 1790)</th>
<th>CPOE (n = 919)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—2 years (2007—08)</td>
<td>160 (8.9)</td>
<td>79 (8.6)</td>
</tr>
<tr>
<td>3—4 years (2005—06)</td>
<td>303 (16.9)</td>
<td>156 (17)</td>
</tr>
<tr>
<td>5—6 years (2003—04)</td>
<td>478 (26.7)</td>
<td>241 (26.2)</td>
</tr>
<tr>
<td>7—8 years (2001—02)</td>
<td>136 (7.6)</td>
<td>94 (10.2)</td>
</tr>
<tr>
<td>&gt;8 years (before 2001)</td>
<td>115 (6.4)</td>
<td>98 (10.7)</td>
</tr>
<tr>
<td>Adoption year missing</td>
<td>598 (33.4)</td>
<td>251 (27.3)</td>
</tr>
</tbody>
</table>

CPOE, computerized physician order entry; eMAR, electronic medication administration record.

Appari A, J Am Med Inform Assoc 2012;19:360-367
Errors in Medication Process

Bates DW, JAMA 1995;274:29-34
Root Causes of errors

Current health information technology initiatives are geared towards standardizing and minimizing of errors due to:

- **Communication**: Lack of consistent delivery of patient health information between providers within the same institution and with other healthcare facilities
- **Inadequate information flow**: efficient delivery of lab results, transitions of care medication orders & inconsistent reporting of errors
- **Human element**: dosing calculation errors, failure to adhere with protocols, ordering, transcription, filling and administration errors
- **Patient related issues**: identification miscues, inadequate education and incomplete assessments
Creating Solutions

• New Advances in technology geared towards minimizing error at each step of the medication process include:
  - Computerized Provider Order Entry (CPOE)
  - Electronic Medication Administration (eMAR)
  - Barcode Medication Administration (BCMA)
  - Smart pumps
Computerized Provider Order Entry (CPOE)⁴

- Computer based system of automating and standardizing medication orders, mitigating issues with illegible writing and incomplete orders at the start point in data transmission.

- Incorporation of clinical decision support systems into the CPOE process increases efficiency of physicians by streamlining patient health record (allergies, drug interactions, lab values, etc.) to foster better outcomes.

- Implementation of CPOE has been a gradual process gaining buy-in from stakeholders. A 2009 study by Appari A et al. of 2603 hospitals showed a 30.9% implementation rate of CPOE in conjunction with eMAR.
Potential Impact of CPOE\textsuperscript{3,7}

• The Leapfrog Group’s recommendations on safety practices estimate an error reduction of 3 million serious medication errors with the implementation of CPOE in all urban hospitals.

• Adverse drug events in an inpatient setting can create an estimated $1 billion if installed in all hospitals. Majority of these saving could be attributed to reduction of adverse events especially in geriatric patients.

• Use of CPOE in an ambulatory setting poses great benefit in reducing office visits and hospitalizations that amount to $1000-$2000 per adverse event.
Electronic Medication Administration Record (eMAR)\textsuperscript{6}

- An eMAR serves as the communication interphase that makes provision for timely tracking of patient medication therapy. Incorporation of barcode technology facilitates ease of real-time use while improving quality safeguards.

- Effective implementation of eMARs greatly impacts transitions and continuation of care across multitudes of healthcare professionals.

- A 2011 ASHP natural survey of pharmacy practice showed 67.3\% of hospital with eMAR infrastructure in place. When used with CPOE and Barcoding technology, eMARs have shown to increase quality and safety outcomes.
Impact of eMARs

- The increase impact on overall patient safety has led to a drastic decrease in usage of handwritten administration records in the past decade from 46.1% to 8.4% in 2011.

- The effective translation of medication orders from CPOEs to eMARs provide tremendous value in increasing efficiency and safety by totally eliminating the transcription step in the medication process.

- Electronic nature of information alleviates physical storage issues, minimizes HIPPA violations and creates easy point of care access to patient medication records.
Barcode Medication Administration (BCMA)\textsuperscript{9}

- BCMA plays a vital role in confirming patient identification during medication administration and serves as a downstream safety checkpoint to prevent human errors.

- With the proper use of BCMA, prevention of potentially harmful medication errors are streamlined from pharmacy dispensing of drugs to bedside administration.

5 Right’s Principle

- Right Patient
- Right Drug
- Right Route
- Right Dose
- Right Time
BCMA Impact on errors\textsuperscript{9,10}

- A direct observational study by Poon EG et al. in 2010 measured error rates in medication administration in wards without BCMA (n=6723) and hospital wards equipped with BCMA (n=7318).

- A 41% reduction in administration errors and 51% reduction of potentially harmful errors were seen in wards with BCMA systems.
BCMA Impact on workflow\textsuperscript{9,10}

- A 2005 observational study by Poon EG et al. done at Brigham women’s Hospital in Boston, MA explored the impact of BCMA on nurses’ workflow and patient interaction time.

- A total of 232 two hour sessions split between wards with and without BCMA technology showed no statistically difference in time consumption during administration (26.5% vs. 24.5%) before and after implementation of BCMA.
Smart Pumps\textsuperscript{11,12}

- Computerized IV Safety Systems ("smart pumps") used in the delivery of medication provide additional safety measures in averting potentially harmful medication errors that otherwise cannot be mitigated by CPOE and BCMA technologies.

- Incorporation of drug libraries and clinical decision support technology (dose-error reductions, dose calculations) in smart pumps provide extra error surveillance and alerts bedside.
Smart Pumps Impact on errors

- With a reported 51% of errors that cause harm occurring during administration of medication, smart pumps play vital roles in preventing errors in critical situations where slightest error can lead to grave consequences. (i.e. chemotherapy, PCA therapy, Neonatal therapy etc.)

- Study by Larsen GY et al. in 2005 evaluating implementation of smart pumps showed a decrease (per 1000 doses) in medication error from 3.1 to 0.8 and 10-fold errors from 0.41 to 0.08.
Smart Pumps impact on workflow\textsuperscript{11,12,13}

- Implementation of smart pumps has not been influenced by hospital size compared to other technologies and showed a 40% adoption rate in 2005.

- Limitations to patient safety and error detection exist due to soft limits that allow easy overrides by nurses during administration. A 2009 study by Trbovich PL et al. showed lower nurse response and remedy of wrong dose soft limits (63%) compared to wrong dose hard limits (75%).
Assembling the Puzzle

Role Of Health care providers

- Creating a culture where utilization of technology (CPOE, eMAR, BCMA & smart pumps) to deliver safe and quality care is paramount
- Providing adequate training and guidance to staff to maximize technological capacity in mitigating human error.
- Consistent reporting of medication errors to devise strategies to improve processes within practice models
- Establishing performance standards, expectations and improvement strategies through the utilization of metrics to track error prevention rates
- Integrating extensive patient education for safer at home medication practices
- Utilizing resources and exploring new innovations through biomedical research and engineering
Patient-centered care

- Successful implementation of healthcare technology and a patient-centered approach to quality and safety can only be possible through the education and vested interest from key stakeholders.

- Patient
- Physicians
- Nurses
- Information Technology
- Pharmacist
- Biomedical Engineering & Research
- Other Health care Professionals with point of care access
References

7. Lesar TS, Briceland LL, Delcoure K et al.. Medication prescribing errors in a teaching hospital. JAMA 1990;263:2329-2334
13. ISMP. Effective approaches to standardization and implementation of smart pump technology. 1st ed. Huntingdon Valley, PA; 2006