Human Factors and Ergonomics in Health Care and Patient Safety

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What’s the problem?

- US – health care expenditures = 13% GNP

- Institute of Medicine – 1999 – Report on medical errors and patient safety:
  - 44,000 to 98,000 Americans die in hospitals each year as a result of medical errors.

- Canada:
  - About 185,000 of the 2.5 million annual hospital admissions associated with an adverse event
Patients Pledge to Fight Medical Error

Patient safety advocates from throughout the Americas concluded a hemispheric workshop in May pledging to raise awareness about the deadly toll of medical errors and to work to improve patient safety in their home countries.

Evangelina Vásquez, of Mexico, told how her son, Uriel, suffered neonatal jaundice shortly after birth, and how her pleas for medical attention were dismissed by health care providers. The untreated jaundice produced a type of irreversible brain damage known as kernicterus. Vásquez took her case to Mexico's National Commission on Human Rights and won a favorable decision.

Alicia Herrera, another participant from Mexico, told how she had suffered extreme pain and permanent disfigurement and disability as a result of faulty administration of anesthesia prior to a tooth extraction. Herrera wrote a book about her ordeal, \textit{The Face of Medical Negligence: Do You Want to See My Face?}
Second Global Patient Safety Challenge

Safe Surgery Saves Lives


http://www.who.int/patientsafety/en/
"Health care has safety and quality problems because it relies on outmoded systems of work. If we want safer, higher-quality care, we will need to have redesigned systems of care, including the use of information technology to support clinical and administrative processes."

(p. 4)
Progress toward understanding patient safety

- IOM’2000 Report – *To Err is Human*
- IOM’2001 Report – *Crossing the Quality Chasm*
- IOM’2003 Report – *Patient Safety – Achieving a New Standard for Care*
- IOM’2003 Report – *Keeping Patients Safe*
- IOM’2006 Report – *Preventing Medication Errors*
  - Human error / System approaches
  - Design of information technology
  - Importance of human factors
HFE expertise in healthcare organizations

Employee health: occupational safety & health, ergonomics

Purchasing of equipment: usability

Quality improvement: process analysis

Risk management: incident reporting, event analysis

OR and critical care: teamwork, communication
51 chapters:
• Human error
• Sociotechnical systems and macroergonomics
• Technology, medical devices
• Physical ergonomics
• Methods and tools
• Various care settings
• …
Take-home messages

1. A human factors perspective can provide useful, important information on *systemic factors* that contribute *to patient safety*.

2. Need to *integrate* human factors in the *design* of healthcare technologies, systems and processes.
Based on research on human factors in...

... health care and patient safety

Funding from the Agency for Healthcare Research and Quality

http://www2.fpm.wisc.edu/seips/
Medication Errors
Leape et al. (1995) “Systems analysis of adverse drug events” JAMA

| Errors by Type of Adverse Drug Event (ADE) and Stage of Drug Ordering and Delivery* |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                                 | Physician Ordering, No. (%) | Transcription and Verification, No. (%) | Pharmacy Dispensing, No. (%) | Nurse Administration, No. (%) | All, No. (%) |
| Preventable ADEs               | 41 (32)                         | 2 (5)                               | 4 (11)                         | 40 (32)                         | 87 (26) |
| Potential ADEs, nonintercepted | 26 (20)                         | 25 (63)                             | 21 (55)                        | 84 (67)                         | 156 (47) |
| Potential ADEs, intercepted     | 63 (48)                         | 13 (33)                             | 13 (34)                        | 2 (2)                           | 91 (27) |
| Totals                         | 130 (100)                        | 40 (100)                             | 38 (100)                       | 126 (100)                       | 334 (100) |
| % by stage                     | 39                               | 12                                  | 11                              | 38                              | 100      |

*Percentages may not add to 100% due to rounding.

Causes of medication errors:
- lack of knowledge of drug
- faulty dose checking
- setting up of infusion pump
Medication administration technologies

IV Pump Technology

Bar Code Medication Administration (BCMA) Technology
Safe Medication Administration through Technologies and Human Factors – SMArTHF

Aims of the project:

1. To determine the effect of Smart IV Pump technology implementation and integration with BCMA technology on medication errors.
2. To determine the impact of Smart IV pumps and the integration with BCMA technology on end users.
3. To describe a human factors prospective error analysis and to qualitatively evaluate its effectiveness on the implementation success of technology in an acute care hospital setting.

http://cqpi2.engr.wisc.edu/smarthf/index.html
Multidisciplinary research team

- Pascale Carayon (PI)
- Tosha Wetterneck (co-PI)
- Roger Brown
- Joshua De Silvey
- Myra Enloe
- Ann Schoofs Hundt
- Qian Li
- Mark Linzer
- Tracy Love
- Brad Ludwig
- Susan Kleppin
- Mustafa Ozkaynak
- Prashant Ram
- Steve Rough
- Tanita Roberts
- Mark Schroeder
- Sade Sobande
Task sequences observed – BCMA medication administration

BCMA = Bar Coding Medication Administration

02/04/2006
Work system factors observed in BCMA medication administration

- **Tasks:**
  - Potentially unsafe med. admin.

- **Person:**
  - Patient in isolation

- **Environment:**
  - Messy, insufficient light

- **Technology:**
  - Automation surprises, malfunctions

- **Organization:**
  - Interruptions
Leape et al. (1995) “Systems analysis of adverse drug events” JAMA

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Technological solution?
CPOE = Computerized Provider Order Entry
CPOE Implementation in ICUs
Intensive Care Unit
Intensive Care Unit (ICU)
How does a medication order look like?
CPOE Implementation in ICUs

Aims of the project:
1. To determine the effect of CPOE on safety and quality of care in ICUs.
2. To determine the impact of CPOE on end users (physicians, pharmacists, nurses, respiratory therapists) in ICUs.
3. To determine the financial value of CPOE implementation.
4. To examine the impact of prospective human factors error analysis in CPOE implementation.

http://cqpi2.engr.wisc.edu/cpoe/index.htm
In conclusion...
178 medication incidents in 7 months

<table>
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<th>TYPE OF INCIDENT</th>
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<td>1. The <em>wrong patient</em> received or almost received a medication</td>
<td>36</td>
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<td>2. A patient received or almost received a <em>wrong dose</em> of medication</td>
<td>36</td>
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<tr>
<td>3. A patient received or almost received an <em>extra (unordered) dose</em> of medication</td>
<td>36</td>
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<tr>
<td>4. A patient’s medicine was <em>omitted</em> or almost omitted</td>
<td>31</td>
</tr>
<tr>
<td>5. A patient received or almost received the <em>wrong drug</em></td>
<td>23</td>
</tr>
<tr>
<td>6. A patient received or almost received medication at the <em>wrong time</em></td>
<td>14</td>
</tr>
<tr>
<td>7. A patient received or almost received the medicine through an <em>improper route</em></td>
<td>2</td>
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Probably the first (modern) study on medication errors...

... was conducted by Alphonse Chapanis (1960).

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In Part I of a two-part article, the authors report their study of 178 medication errors and near errors occurring in an 1100-bed hospital during a seven-month period. They discuss the critical incident technique as a method of studying the problem, previous research and its shortcomings and the major causes of errors unearthed by the study.

In Part II, which will appear in the next issue of this Journal, the authors will outline their recommendations, based on the study findings, to reduce medication errors and near errors in hospitals.
What can we do today so that 40 years from now human factors concepts and methods will have made a difference in the safety of patient care?
Understanding the characteristics of health care:
- Complexity
- ‘People’ industry
- Technology
- Criticality
- Variety of care settings: hospital, outpatient, home,…

Partnership with health care

Systemic effects or ‘unintended consequences’

Impact
Need for HFE (intervention) research…

…that will **contribute to care** that is:
- safe
- effective
- patient-centered
- timely
- efficient
- equitable
HFE in Healthcare Delivery

**Research needs**

- Major issues facing health care and patient safety:
  - Workload of healthcare providers
  - Medical errors and adverse events: identification, management, review, recovery
  - Reliability of systems, processes and technologies
  - Patient safety in a variety of settings
  - Transitions of care
  - Medical devices and healthcare information technology
Take-home messages

1. A human factors perspective can provide useful, important information on systemic factors that contribute to patient safety.

2. Need to integrate human factors in the design of healthcare technologies, systems and processes.
“Given the complexity of health care and the formidable obstacles it presents to change, to overcome those barriers and create a safe culture does indeed seem to be the ultimate challenge for those who specialize in human factors.”
Muchas Gracias...

Merci...

Thank you...