Human Factors Engineering in Health Care

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Outline

1. What’s human factors engineering (HFE)
2. Why is human factors engineering important in health care
3. Patient safety
4. IT in HC
5. Navigating Health Systems
What’s HFE?

Human + Factors + Engineering
What’s HFE?

• Using knowledge about human capabilities, abilities, and limitations
  • 5 senses
  • communication styles
  • ranges in physical size and strength

• Designing things or processes to fit human abilities and limitations

• Using specific ways to uncover hidden needs, assumptions and unexpected interactions, e.g.
  • Mental work load techniques
  • Task analysis
  • Usability testing
What’s Human Factors?

“Human Factors (or ergonomics) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance”.

International Ergonomics Association, 2000
Scope of Human Factors Engineering
Human Factors

- Psychology
- Industrial Engineering
- Industrial Design
- Physiology
- Biomechanics
- Computer Science
People involved in Health Care

• Are Diverse:
  – Healthcare providers and workers
  – Patients
  – Families

• All have varied:
  – Needs
  – Abilities
  – Limitations

that change over time
Healthcare systems

Healthcare

PEOPLE
• education, training, orientation,

MATERIALS
• medications, supplies, ...

TOOLS
• Medical equipment, information technology, forms, communication materials

METHODS
• procedures, diagnostic and treatment processes, management practices, policies, communications practices, coordination of effort, ...
Healthcare System

• An overloaded system
• Workflows and roles have not changed in the past couple of centuries
• Emphasis is placed on sickness control, not on health promotion
• The same challenges are faced everywhere, but are tackling them independently
• We cannot keep up with complex diagnostic and therapeutic technologies
Domains of HFE

• Physical Ergonomics: Focuses on the physical characteristic of the person
  – Design of hospital facilities
  – Design of physical environment
  – Patient handling

• Macroergonomics: Focuses on the psychosocial characteristic of the person
  – Job stress and burnout
  – Teamwork
  – Work schedules

• Cognitive Ergonomics: Focuses on the cognitive characteristics of the person
  – Human Error
Why Human Factors Engineering in HC

• [http://www.youtube.com/watch?v=BFd54Yzg-vo&list=PLE9858C8933D0411F](http://www.youtube.com/watch?v=BFd54Yzg-vo&list=PLE9858C8933D0411F)
Cost Impacts

• Centers for Medicare and Medicaid Services (CMS), more than one million patient safety incidents occurred to hospitalized Medicare patients in the US over the years 2002 to 2004, causing more than 250,000 deaths and costing $9.3 billion
Adverse Event Rates in Healthcare

- Cardiac Surgery Patient ASA 3-5
- Himalaya mountaineering
- Microlight flights helicopters
- Fatal iatrogenic adverse events
- Medical risk (total)
- Chartered Flight
- Civil Aviation
- Railways (France)
- Chemical Industry (total)
- Nuclear Industry
- Blood transfusion
- Anesthesiology ASA1

Risk levels:
- $10^{-2}$: Very unsafe
- $10^{-3}$
- $10^{-4}$
- $10^{-5}$
- $10^{-6}$: Ultra safe

References:
Why do we fail?

• Current systems in healthcare are highly dependent on level 1 measures:
  – intent
  – vigilance
  – hard work

• We focus on outcomes, so only measure the process where there is catastrophic failure

• We miss process defects where the patient does well despite the system

• We don’t really analyse failures and learn from them systematically
“To Err is Human”

• Doing tasks engages the cognitive characteristics of the person
• It involves perception, information processing, execution knowledge, and skills
How do we make decisions…

- Automatic cognition
- Active problem solving
  - Problem-solving is slow, conscious, sequential

Level of cognition required

Skill-based
Rule-based
Knowledge-based
Performance
Are these lines straight?

Optillusions.com
Cognition is Affected by...

- **Internal Factors**
  - Psychological states (anger, fear, boredom, anxiety)
  - Physiological states (fatigue, illness)
    - After one night of missed sleep - performance can decrease by 25%
    - 17 hours awake is equivalent to a blood alcohol content of 0.05
## The Stroop Test

Please state the *COLOR of the text*

<table>
<thead>
<tr>
<th>Blue</th>
<th>Red</th>
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Medication Labels

- DO----MINE - dopamine or dobutamine
- HY----ZINE - hydralazine or hydroxyzine
Cognition is Affected by…

- **External Factors**
  - Environmental factors (noise, heat, light)
  - long work schedules
  - inadequate training
  - interruptions and distractions
Reason’s “Swiss Cheese Model” (SCM)

- **Latent Conditions**
- **Unsafe Supervision**
- **Preconditions for Unsafe Acts**
- **Active Conditions**
- **Unsafe Acts**
- **Organizational Influences**

Failed or absent defenses lead to an *Accident*. **Note:** This diagram illustrates the Swiss Cheese Model, which identifies four layers of defenses: latent conditions, unsafe supervision, preconditions for unsafe acts, and active conditions. Each layer represents a potential barrier to an accident, and the failure of any one can lead to an accident if other layers are in place.
The “System View” of human error

• Human error is not the cause of events, it is a symptom of deeper troubles in the system

• Human error is not the conclusion of an investigation, it is the beginning

• Events are the result of multiple causes
Medication AEs

- Medication errors are the #1 cause of preventable AEs
- What do you notice in this picture?

Enalaprilat is for **high blood pressure**
Pancuronium is a **muscle paralysis**
How to design processes to reduce error?

1. Reduce reliance on memory
   - Checklists
   - Protocols
   - Standardization
   - Color matching
   - Pre-packaging
   - Automated reminders

2. Reduce reliance on vigilance
   - Bar-coding
   - Constraints
   - Forced functions
   - Color coding

3. Simplify tasks and processes
4. Reduce handoffs
5. Reduce the need for calculation
6. Provide adequate training
7. Manage fatigue
8. Provide adequate informational resources
...AND THAT IS WHY WE LIFT ON THREE...

COMMUNICATION
Shift changes in hospitals

• Shift changes (handoffs, sign-outs) represent transitions that can impact the quality of patient care and patient safety
  – Verbal handoffs
    • Interruptions lead to diversion of attention, forgetfulness, and error
  – Written handoffs
    • Inconsistent
    • Missing code status, allergies, age, sex
Communication examples

• Vague--”Patient got into a little trouble”; “Mostly stable”
• Ambiguous-”Patient went south”
• Confusing-“He was all over the place but you don’t have to worry about that”
• Lack specificity-”I gave him a little propofol”
• Imprecise Analogies-”He was like a roller-coaster”
• Objectification and depersonification-”The Gall Bladder in room 34 is doing fine”
Hand-off as a Form of Communication

Communication Effectiveness

Cold

Richness of Communication Channel

Hot

Face-to-face at whiteboard

Face-to-face conversation

Video conversation

Phone conversation

Modeling Options

Videotape

Email conversation

Audiotape

Documentation Options

Paper

Original Diagram Copyright 2002 Alistair Cockburn, Modified Version Scott Ambler 2002
IPASS-SAFETY Nursing Handoffs

Completed Before Entering the Patient’s Room

- Illness Severity
  - Review Patient Status

- Patient Summary
  - Medical history up to admission

- Action Items
  - Tasks to finish during RN’s shift

- Situational Awareness
  - Questions by the oncoming RN

Completed at the Patient’s Bedside

- Stand at the Bedside
  - Introduce the oncoming RN

- Assess Your Patient
  - Check pain, IV, meds, skin, O2

- Falls Risk?
  - Notify your patient

- Explain Plan of Care
  - Review the schedule with patient

- Try to Involve Your Patient
  - Answer any of the patient’s questions

- Why?
  - Ask any remaining questions to your patient
Information Technology

I thought you were supposed to be user-friendly!
Why we need medical records?

To:

• recall observations
• inform others
• gain knowledge
• monitor performance
• justify interventions
• instruct students
Information Technology

• Massive influx of computing technology into health care
• Electronic Health Records are a sea change in medicine
• Changes the way providers interact with
  – patients
  – each other
  – their organizations
Building an Interconnected, Patient-Centric Care System
EHR Benefits

Meaningful Use of EHRs

- Improved individual and population health outcomes
- Improved ability to study and improve care delivery
- Increased transparency and efficiency
EHR Benefits

For Providers:
• Quick access to patient records from inpatient and remote locations for more coordinated, efficient care
• Enhanced decision support, clinical alerts, reminders, and medical information
• Performance-improving tools, real-time quality reporting
• Legible, complete documentation that facilitates accurate coding and billing
• Interfaces with labs, registries, other EHRs and HIEs

For Patients:
• Reduced need to fill out the same forms at each office visit
• Reliable point-of-care information and reminders notifying providers of important health interventions
• Convenience of e-prescriptions electronically sent to the pharmacy
• Patient portals for online interaction with providers
• Electronic referrals allow for easier access to follow-up care with specialists
BUT ...
New Safety Concerns

• Emerging evidence suggest that EHR causes new safety concerns due to:
  – Usability issues
  – Disruptions of clinical processes
  – Unsafe work-arounds to by-pass technology-related constraints

• EHR related safety concerns are multifaceted:
  – Unsafe technological features of EHR
  – EHR user behaviors
  – Organizational Characteristics
  – Rules and regulations that guide EHR related activities
<table>
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<tr>
<th>Category of concern</th>
<th>Definition</th>
<th>Examples</th>
</tr>
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| Unmet display needs (n=36)                 | Mismatch between information needs and content display                                                                                                                                                    | ▶ User required to review multiple screens to determine status of orders or review active medications  
▶ EHR allows simultaneous order entry on two different patients with subsequent medication order for wrong patient  
▶ User interface wording and function inconsistent throughout EHR  
▶ Order entry dialog allows conflicting information to be entered  
▶ Software designed at remote facility conflicts with local software use  
▶ Despite testing, a new feature allows unauthorized users to sign orders  
▶ Corrupted files or databases prevent entry of diagnoses and orders  
▶ Corrupted files or databases prevent retrieval of complete patient information |
| Software modifications (n=24)              | Concerns due to upgrades, modifications, or configuration                                                                                                                                                | ▶ Failure of patient context manager  
▶ Remote internal server failure prevents patient data from being retrieved  
▶ Radiology studies canceled in EHR remain active in Picture Archiving and Communication System (PACS) workflow  
▶ Interface flaw causing duplicate patient record creation from external source |
| System–system interface (n=17)             | Concerns due to failure of interface between EHR systems or components                                                                                                                                    | ▶ Transition of patients between wards or units not reflected in EHR, resulting in missed medications or orders  
▶ Bulk ordering of blood products results in prolonged delay due to matching algorithm  
▶ Template completion depends on remote data, and user is unaware that network delays have caused incomplete data retrieval  
▶ User assigns surrogate signer for patient alerts, but alerts not forwarded because of logic error not known by user |
| Hidden dependencies in distributed system (n=17) | One component of the EHR is unexpectedly or unknowingly affected by the state or condition of another component                                                                                       | ▶ Transition of patients between wards or units not reflected in EHR, resulting in missed medications or orders  
▶ Bulk ordering of blood products results in prolonged delay due to matching algorithm  
▶ Template completion depends on remote data, and user is unaware that network delays have caused incomplete data retrieval  
▶ User assigns surrogate signer for patient alerts, but alerts not forwarded because of logic error not known by user |
Currently...

- Functionality is quite fragile
- Design and functionality are not optimized
- Partially addresses the needs of healthcare providers
A potential vision of the future

• Fully integrated, multi-functional, multi-disciplinary EHR capable of:
  – capturing data at very frequent intervals (e.g. q minute)
  – incorporating n-way real time dialog functions,
  – multi-disciplinary decision support,
  – full-scale acuity adjusted workload and care management capture with full data archiving and retrieval capacity
Navigating Health Systems
Signs

• Clear signage is extremely important in hospitals

• Why?
  – Time spent in the hall can be life-threatening for patients who need immediate treatment
  – Navigating a hospital can be confusing at best and infuriating at worst for families trying to locate the room of a loved one
How much time can be lost because of poor hospital signage?

- 30% of first-time visitors and
- 15% of repeat visitors reported navigation issues
- Staff reported spending an average of 2 – 4 mins per interaction providing directions to visitors
- 25% of staff members admitted to not being able to find their own destination
- Maps are not always easy to follow
- Participants found difficulty with the inconsistent placement of signs and embedded signs with multiple levels of information
HFE Approach

1. Identify the best areas for signage.
2. The signs must be clear and easy to read.
3. Signage must also be universal.
   - use a consistent system
     - Terms
     - Colors
     - Place of signs
Human Factors Engineering in HC

• Contributes to the safe design of healthcare systems by considering:
  – The various needs
  – Abilities
  – And limitations of people involved in the system

• The quality and safety of care provided by healthcare systems are dependent on:
  – the patient’s risk factors
  – the technical skills and knowledge of the healthcare staff,
  – influenced by various characteristic of the system redesigned, changed and improved

by applying HFE principles and methods
THANK YOU