Advancing pharmacy practice utilizing a human factors approach: Responding to a call from the IOM

Ben-Tzion (Bentzi) Karsh, PhD
Industrial and Systems Engineering
University of Wisconsin-Madison

Michelle A. Chui, PharmD, PhD
School of Pharmacy
University of Wisconsin-Madison

Why do we need human factors to improve pharmacy practice?

- Initiatives to expand the scope of pharmacy practice in the community setting
  - Implementing MTM and other cognitive services
  - Collaboration with other health care professionals
  - Improving patient safety and decreasing med errors
- Critical need for practice-based research that focuses on community pharmacies

Difficulty in changing the paradigm

- Community pharmacies face many internal barriers
  - Pharmacist training and self-efficacy
  - Organizational, corporate, and financial pressures
  - High workload in fast pace, chaotic environment
  - Pharmacy layout and workflow patterns
- Previous studies exploring cognitive service expansion in community pharmacies have focused on pharmacist training and measuring clinical and economic outcomes of MTM services
  - Ashville Project, Ten City Challenge

How did they do it?

- Literature highlighting exemplars is encouraging
- Pharmacists want to emulate these pharmacists but may not know how
- What is not published is the process by which these pharmacists overcame work design, personnel management, and other barriers in order to successfully implement time-consuming interventions
- Quality emerges from the design of your work system

A Call from the Institute of Medicine

- In 2000, the IOM released its report, To Err is Human: Building a Safer Health System
- Highlighted serious errors that occur daily in hospitals
- Lead to many HFE efforts designed to reduce error rate in hospital, and reduce the consequences of errors
- Limited attempt made to utilize HFE outside hospital settings

Take Away Messages…

- We know that quality and safety *emerge* from the *interaction* between people and the system in which they work. Human factors engineering helps you understand that interaction so that you can better design systems to improve quality and safety.…LEARN ABOUT IT!
- We have a set of tools, standards, guidelines and principles for improving human performance, safety and productivity…USE & APPLY THEM!
- We know that human factors engineering does improve performance and safety …WHEN USED AND IMPLEMENTED APPROPRIATELY.

Main Take Away Message

THE ROAD TO HIGH QUALITY & SAFE PATIENT CARE RUNS THROUGH THE PERFORMANCE OF YOU AND YOUR STAFF

So if your technology is bad, your workflows don't work, or the physical space doesn't work for you, your performance will be bad. If your performance is bad, your patients suffer.

So what do we do? The prevailing patient safety paradigm:

From Matt Scanlon, MD

Common healthcare thinking

- Errors are personal failings / when something bad happens someone must be at fault
- Policies create safety
- And recently…technology will save us!

An alternative approach

Human factors engineering / Ergonomics

(at least that's one proposition from the Institute of Medicine

What is human factors engineering?

- SCIENCE: **Discovers** and applies information about human behavior, abilities, limitations and other characteristics to the **design** of tools, machines, systems, tasks, jobs, and environments for productive, safe, comfortable and effective human use
- PRACTICE: Designing the fit between people and products, equipment, facilities, procedures and environments

What is human factors engineering?

- SCIENCE. Considered by many as the basic science of human performance, thus the basic science of safety, efficiency, quality

- PRACTICE. Evidence-based design for supporting people's physical and cognitive work

A few HFE topics of study

- Usability
- Mental workload
- Situation awareness
- Human-automation interaction
- Alerts
- Lifting
- Training
- Teamwork and team training
- Information processing
- Naturalistic decision making
- Handoffs
- Interruptions / distractions
- Violations
- Human error
- Safety

Who *requires* human factors engineering in their designs?

- US Federal Aviation Administration
- Department of Defense
- Department of Transportation
- Nuclear Regulatory Commission
- Department of Energy
- National Aviation and Space Administration
- FDA?

What are the objectives?

- Reduce errors, fatigue, stress and injuries at work, while at the same time…
- Improving productivity, ease of use, safety, comfort, acceptance, job satisfaction, and quality of life
- Or simply – improve safety, quality, efficiency, and productivity **all at the same time** ☺

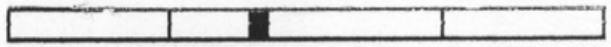
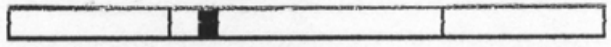
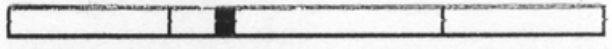
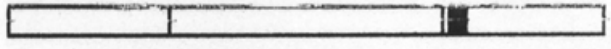
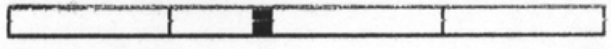
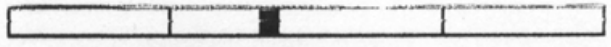
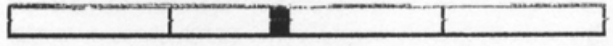
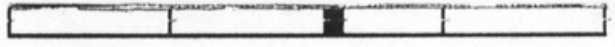
Too good to be true?

Close your eyes when you know HOW MANY results are out of range!!!
Ready….

Species : Adult Canine
Patient : SYDNEY
Client : SUE BOSLEY

Test		Results		Reference Range		
ALKP	=	85	U/L	23	-	212
ALT	=	23	U/L	10	-	100
BUN	=	16.6	mg/dl	7.0	-	27.0
CREA	=	0.77	mg/dl	0.50	-	1.80
GLU	=	130.6	mg/dl	77.0	-	125.0
TP	=	6.21	g/dl	5.20	-	8.20
Na	=	149.9	mmol/l	144.0	-	160.0
K	=	4.44	mmol/l	3.50	-	5.80
Cl	=	116.9	mmol/l	109.0	-	122.0

Close your eyes when you know how many results are out of range. Do not proceed to the next slide.

Test	Results	Reference Range	Indicator
			LOW NORMAL HIGH
ALKP	= 85 U/L	23 - 212	
ALT	= 23 U/L	10 - 100	
BUN	= 16.6 mg/dl	7.0 - 27.0	
CREA	= 0.77 mg/dl	0.50 - 1.80	
GLU	= 130.6 mg/dl	77.0 - 125.0	
TP	= 6.21 g/dl	5.20 - 8.20	
Na	= 149.9 mmol/l	144.0 - 160.0	
K	= 4.44 mmol/l	3.50 - 5.80	
Cl	= 116.9 mmol/l	109.0 - 122.0	

What was the difference?

- The first data presentation was cognitively challenging because you needed to mentally find the lab value, and then interpret whether or not the value was in range. Each comparison was an opportunity for error.
- The second provided what we call a *direct perception* display to answer the cognitive challenge I posed to you.
- Both are typical of types of displays you might encounter every day. Both affected accuracy (quality/safety) and response time (productivity). Only one was good.

Can HFE really do all that?

- Yes, because we focus on designing systems to support human performance
- It's about human performance *in context* or *in the system.*

What does HFE focus on to meet the objectives?

- Designing systems to support and extend human performance
  - Cognitive performance (e.g. problem identification, problem diagnosis, problem solving, communication, decision making, awareness, checking medications, entering medications…..)
  - Physical performance (e.g. safe patient transfer, programming an IV pump, reaching the top shelf for medications….)

How are the goals achieved?

- Person approach
  - Focus on individuals
  - Blaming individuals for forgetfulness, inattention, or carelessness, poor production
  - Methods: poster campaigns, writing another procedure, disciplinary measures, threat of litigation, retraining, blaming and shaming
  - Target: Individuals
- System approach
  - Focus on the conditions under which individuals work
  - Building defenses to avert errors/poor productivity or mitigate their effects
  - Methods: creating better systems
  - Targets: System (team, tasks, workplace, organization)

HFE is NOT

- Just applying checklists and guidelines
- Using oneself as a model for design (designer fallacy)
- Designing solutions based on what users say they need (surprise ☺!)
- Common sense

We don’t design based on what users say they need?

- Nope – at least not entirely
- Your ideas about what you need might be
  - Wrong
  - Incomplete
  - Based on level of expertise
- Users stated needs can be helpful, but they are not sufficient for good design. They should be treated as hypotheses.

Human Factors is Common Sense?

- What is common sense, really?
  - What may be common sense to the vendor, may not be common sense to you
  - What may be common sense to you may not be common sense to your colleague
  - What may be common sense to a staff pharmacist, is not common sense to a resident or pharmacy student

HFE contrasts to common healthcare thinking about quality and safety

- Errors are personal failings / when something bad happens someone must be at fault
- Policies create safety
- And recently…technology will save us!

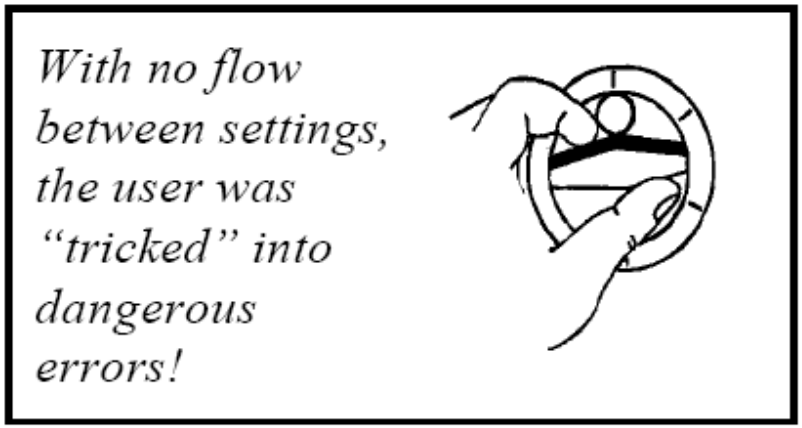
Response to “errors as personal failings” and “someone is at fault”

HFE Proposition #1- stop blaming everything on “human error.” The problem is system design

Designed-induced or human error?

- A physician treating a patient with oxygen set the flow control knob, as show in Figure 1, between 1 and 2 liters per minute, not realizing that the scale numbers represented discrete, rather than continuous, settings. *There was no oxygen flow between the settings, yet the knob rotated smoothly, suggesting that intermediate settings were possible.* The patient, an infant, became hypoxic before the error was discovered. One solution would have been a rotary control that snaps into a discrete setting. Some indication of flow also should have been provided.

Figure 1 - Controls



From Sawyer, D. (1996). Do it by design: an introduction to human factors in medical devices. US Food and Drug Administration.

So is a HFE or systems approach “blame free”?

NO

But, we need situational or systems "charity"

"FROM JERUSALEM TO JERICHO": A STUDY OF SITUATIONAL AND DISPOSITIONAL VARIABLES IN HELPING BEHAVIOR [1]

JOHN M. DARLEY [2] AND C. DANIEL BATSON

Princeton University

The influence of several situational and personality variables on helping behavior was examined in an emergency situation suggested by the parable of the Good Samaritan. People going between two buildings encountered a shabbily dressed person slumped by the side of the road. Subjects in a hurry to reach their destination were more likely to pass by without stopping. Some subjects were going to give a short talk on the parable of the Good Samaritan, others on a nonhelping relevant topic; this made no significant difference in the likelihood of their giving the victim help. Religious personality variables did not predict whether an individual would help the victim or not. However, if a subject did stop to offer help, the character of the helping response was related to his type of religiosity.

Darley and Batson Journal of Personality and Social Psychology, 1973, 27, 100-108

Who were the subjects?

Subjects

The subjects for the questionnaire administration were 67 students at Princeton Theological Seminary.

Darley and Batson Journal of Personality and Social Psychology, 1973, 27, 100-108

Response to “focus on individual” and “policies create safety”

HFE Proposition #2: Workarounds and violations are *outcomes,* not just causes

They are typically symptoms of an underlying system design problem – treat the disease, not the symptom

HFE violations research

Workarounds to Barcode Medication Administration Systems: Their Occurrences, Causes, and Threats to Patient Safety

ROSS KOPPEL, PHD, TOSHA WETTERNECK, MD, MS, JOEL LEON TELLES, PHD, BEN-TZION KARSH, PHD

Abstract The authors develop a typology of clinicians' workarounds when using barcoded medication administration (BCMA) systems. Authors then identify the causes and possible consequences of each workaround. The BCMAs usually consist of handheld devices for scanning machine-readable barcodes on patients and medications. They also interface with electronic medication administration records. Ideally, BCMAs help confirm the five "rights" of medication administration: right patient, drug, dose, route, and time. While BCMAs are reported to reduce medication administration errors—least likely medication error to be intercepted— these claims have not been clearly demonstrated. The authors studied BCMA use at five hospitals by: (1) observing and shadowing nurses using BCMAs at two hospitals, (2) interviewing staff and hospital leaders at five hospitals, (3) participating in BCMA staff meetings, (4) participating in one hospital's failure-mode-and-effects analyses, (5) analyzing BCMA override log data. The authors identified 15 types of workarounds, including, for example, affixing patient identification barcodes to computer carts, scanners, doorjambs, or nurses' belt rings; carrying several patients' prescanned medications on carts. The authors identified 31 types of causes of workarounds, such as unreadable medication barcodes (crinkled, smudged, torn, missing, covered by another label); malfunctioning scanners; unreadable or missing patient identification wristbands (chewed, soaked, missing); nonbarcoded medications; failing batteries; uncertain wireless connectivity; emergencies. The authors found nurses overrode BCMA alerts for 4.2% of patients charted and for 10.3% of medications charted. Possible consequences of the workarounds include wrong administration of medications, wrong doses, wrong times, and wrong formulations. Shortcomings in BCMAs' design, implementation, and workflow integration encourage workarounds. Integrating BCMAs within real-world clinical workflows requires attention to *in situ* use to ensure safety features' correct use.

■ **J Am Med Inform Assoc.** 2008;15:408–423. DOI 10.1197/jamia.M2616.

Evaluation of Nurse Interaction With Bar Code Medication Administration Technology in the Work Environment

Pascale Carayon, PhD,† Tosha B. Wetterneck, MD,‡§ Ann Schoofs Hundt, PhD,† Mustafa Ozkaynak, MS,* Joshua DeSilvey, MS, RPh,|| Brad Ludwig, MS, RPh,§ Prashant Ram, MS,¶ and Steven S. Rough, MS, RPh§*

Objectives: This study explores nurses' use of bar code medication administration (BCMA) technology from a human factors viewpoint. The BCMA technology consists of a medication network server and handheld devices that connect to medication administration record data through wireless radiofrequency link.

Methods: A total of 62 observations of medication administration were conducted in 1 academic hospital. Observations were performed by a team of 2 people (a human factors engineer and a pharmacist) in a variety of critical care and medical/surgical units. Data were recorded on the medication administration task, the BCMA technology, organizational factors (in particular interruptions), the physical environment, and various individual factors related to the nurses and patients.

Results: Eighteen different sequences were identified and represented very large variability in the order in which steps of the medication administration process are performed; some of the sequences can be considered as potentially unsafe acts. We identified various working conditions that can hinder the medication administration process. For example, 20 instances of interruptions were observed. Some patient factors (e.g., isolation patients) were also identified that made the BCMA-based medication administration process challenging.

Conclusions: When introducing a new technology into the health care environment, it is important to assess changes in workflow and tasks that may result from the use of the technology. Our study shows the use of direct observation in helping to identify the work system factors that facilitate or hinder the medication administration tasks. This information can help health care organizations identify opportunities to redesign the process and/or the technology to maximize worker efficiency, interaction with the technology, and patient safety.

Key Words: bar code medication administration, human factors engineering, observation, nurse, patient safety

(*J Patient Saf* 2007;3:34–42)

Conceptual Definition

"Violations can be defined as deliberate – but not necessarily reprehensible – deviations from those practices deemed necessary (by designers, managers, and regulatory agencies) to maintain the safe operation of a potentially hazardous system"

~ Reason, 1990

Heroes or Dummies?

Why Women Live Longer than Men

Heroes or dummies?

- Maybe workarounds/violations are the right choice when the policies, procedures, or technology is not appropriate for the situation?
- Maybe workarounds are responses to poorly designed technologies and are therefore symptoms of the actual problems?
- Just this month I saw a nurse using photocopied patient identification bar codes for use in bar coded medication administration
- Dummy?

Response to “technology will save us”

HFE Proposition #3: Implementing technology is dumb; implementing well-designed and well- integrated is smart

Well-designed?

(Fairbanks et al. 2007, Annals of Emergency Medicine)

- “Seven of 14 (50%) participants (experienced EMTs) performed at least 1 unsynchronized defibrillation when they intended to perform a synchronized cardioversion on the patient with SVT. Five of the 7 events occurred on the model that the participant prospectively stated they used most often in their practice.
- “After the participant pushed the “sync” button, the Lifepak10 displayed the word “SYNC” in steady state (eg, not flashing), which seemed to indicate that the machine was in synchronized mode. In fact, a constant display of the word “sync” indicates that the device is in synchronized mode but not ready to deliver a shock, whereas a flashing display indicates a state of readiness, ...”

HFE principles for well-designed technology

- Better feedback to the user
- Better cooperation with the user
- Better visibility and transparency of what the technology is doing
- Better matching of designs to mental models of the *USER*, not the designer and not the purchaser

How can this type of work help your pharmacy?

- Pharmacists are effective at determining when their work system is not performing optimally
  - They know chaos when they see it
- Pharmacists, by nature, are not early adopters
  - Pharmacists are taught to be reactive
  - Averse to change unless an innovation has been proven elsewhere or there is a clear need

How research can be done in your pharmacy

- A participatory process
  - Researcher and pharmacist have to agree
  - Research can provide valuable baseline information to the pharmacist prior to implementation of MTM services or technology
- Designs that can be used
  - Observation, interviews, focus groups
  - Many studies utilized both a researcher and a clinician to observe and interview as both come with different biases, experiences, and viewpoints

Automated Dispensing Systems

- Compared dispensing error rates before and after implementation of an automated dispensing system with bar code verification
- Two pharmacies (independent and chain)
- Direct unobtrusive observation
  - Licensed pharmacist
  - Errors confirmed in a low-key, nonthreatening manner
- Target error rate significantly decreased
  - Target errors after ADS were due to deliberate overriding of system controls

Flynn EA, Barker KN. Effect of an automated dispensing system on errors in two pharmacies. JAPhA 2006; 46(5): 613-5.

Utilizing HFE to improve pharmacy work systems

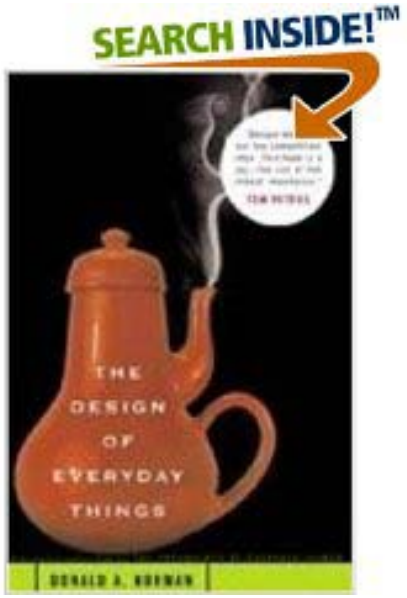
- How using HF can contribute to improving patient safety in community pharmacies
  - Studying workload
  - Studying teamwork/communication
  - Studying technology useability such as bar code scanning, e-prescribing, telepharmacy

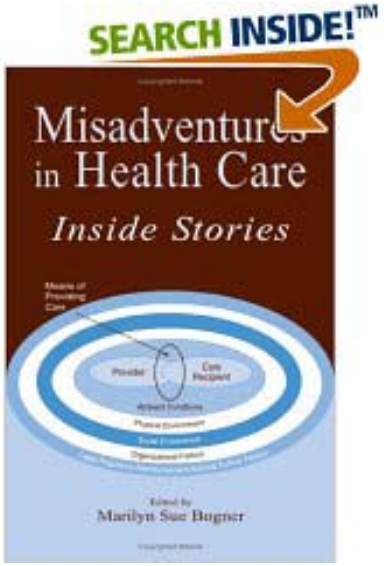
Contact Information

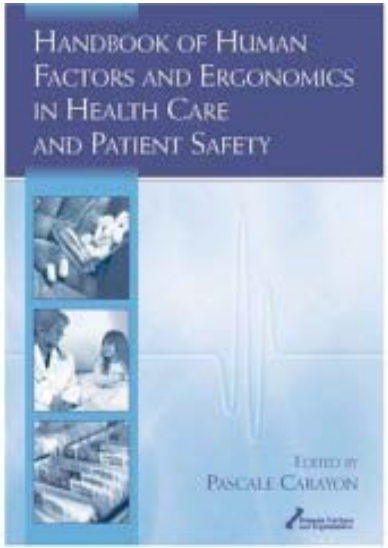
Ben-Tzion Karsh, Ph.D.
Associate Professor
Department of Industrial & Systems Engineering
UW-Madison
1513 University Avenue, Rm 3218
Madison, WI 53706
Tel: 608-262-3002
Fax: 608-262-8454
E-mail: bkarsh@engr.wisc.edu
www.engr.wisc.edu/mesh

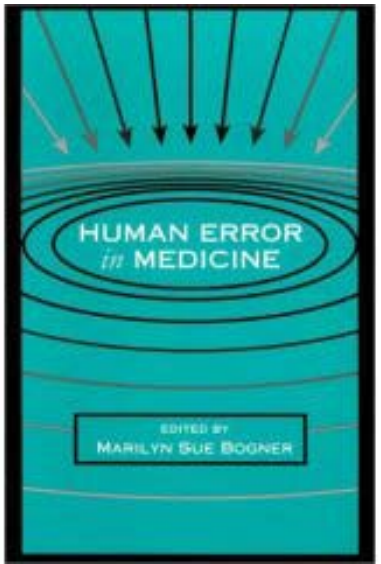
Michelle A. Chui, Pharm.D., Ph.D.
Assistant Professor
Social & Administrative Sciences
School of Pharmacy
UW-Madison
777 Highland Avenue
Rennebohm 2513
Madison, WI 53705
Tel: 608-262-0452
Fax: 608-262-5262
E-mail: mchui@pharmacy.wisc.edu

Good first reads









Good intro readings

- Karsh, B., Holden, R. J., Alper, S. J., and Or, K. L. (2006). A human factors engineering paradigm for patient safety – designing to support the performance of the health care professional. Quality and Safety in Healthcare, 15(Suppl I), i59-i65.
- Scanlon, M.C.**,** Karsh, B., Densmore, E., (2006). Human Factors and Pediatric Patient Safety. Pediatric Clinics of North America, 53, 1105-1119.
- Carayon P, Hundt AS, Karsh B, et al. Work system design for patient safety: the SEIPS model. *Quality and Safety in Healthcare.* 2006;15(Suppl I): i50-i58.
- Sawyer, D. (1996). Do it by design: an introduction to human factors in medical devices. US Food and Drug Administration. Pages 1-32.
- Johnson CM, Johnson TR, Zhang JJ. A user-centered framework for redesigning health care interfaces. *Journal of Biomedical Informatics.* 2005;38(1):75-87.
- Lin L, Isla R, Harkness H, Doniz D, Vicente KJ, Doyle DJ. Applying human factors to the design of medical equipment: Patient-controlled analgesia. *J Clin Monitoring and Computing.* 1998;14:253-263.
- Andre, A. D. and Wickens, C. D. When users want what's **NOT** best for them. *Ergonomics in Design*, 1995: 10-14.