

HUMAN FACTORS ENGINEERING AND THE SYSTEM'S APPROACH TO PATIENT SAFETY

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GREATER NEW YORK HOSPITAL ASSOCIATION & UNITED HOSPITAL FUND

CLINICAL QUALITY FELLOWSHIP PROGRAM

Disclosure of Conflict(s) of Interest



- Robert Panzer, MD reports no relevant financial interests/relationships.

Learning Objectives



- Define human factors
- Explain how human factors relate to high reliability organizations
- Discuss solutions for human factors problems
- Describe the special human factor issues related to Information Technology and Electronic Medical Records
- Understand the importance of understanding human factors to enable a Just Culture

WHAT IS HUMAN FACTORS

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 (IEA)

Reliability Culture



Defibrillator Case



- 32-year-old healthy man w/wife, young kids
- Presents to ED with rapid heartbeat
 - Non-life-threatening condition (SVT)
- Synchronized shock @50j → refractory
- Try again @ 100j → VF Arrest
- 45-minute resuscitation attempt → patient dies
- Investigation reveals that MD failed to put device in SYNC mode for second shock

Defibrillator Case (cont.)



- **What would you do immediately about the involved physician?**
 - Discipline the physician?
 - Suspend the physician pending retraining?
 - Fire the physician?
 - Defer judgment pending investigation?

Back to Defibrillator Case



□ Design issues

- Lack of user feedback
 - Device silently leaves sync mode
- Lack of forcing function
 - Allows unsynchronized shock for SVT
 - AED's for lay use detect rhythm type

□ Standardization issues

- Hospital had several different makes

□ Liability issues, culture of blame

- Prior cases known, others not



Defibrillator Usability Study



- Fourteen expert participants
- Four tasks: 2 routine, 2 emergent
- Two defibrillator models
- SimMan™ patient simulator
- 50% of participants inadvertently delivered an unsynchronized countershock for SVT
 - 71% of participants making error never aware



➤ Fairbanks RJ, Caplan SH, et al. Usability Study of Two Common Defibrillators Reveals Hazards. *Annals of Emergency Medicine* Oct 2007; 50(4): 424-432.

➤ [See also associated editorial: Karsh and Scanlon, Oct 2007; 50(4): 433-435]

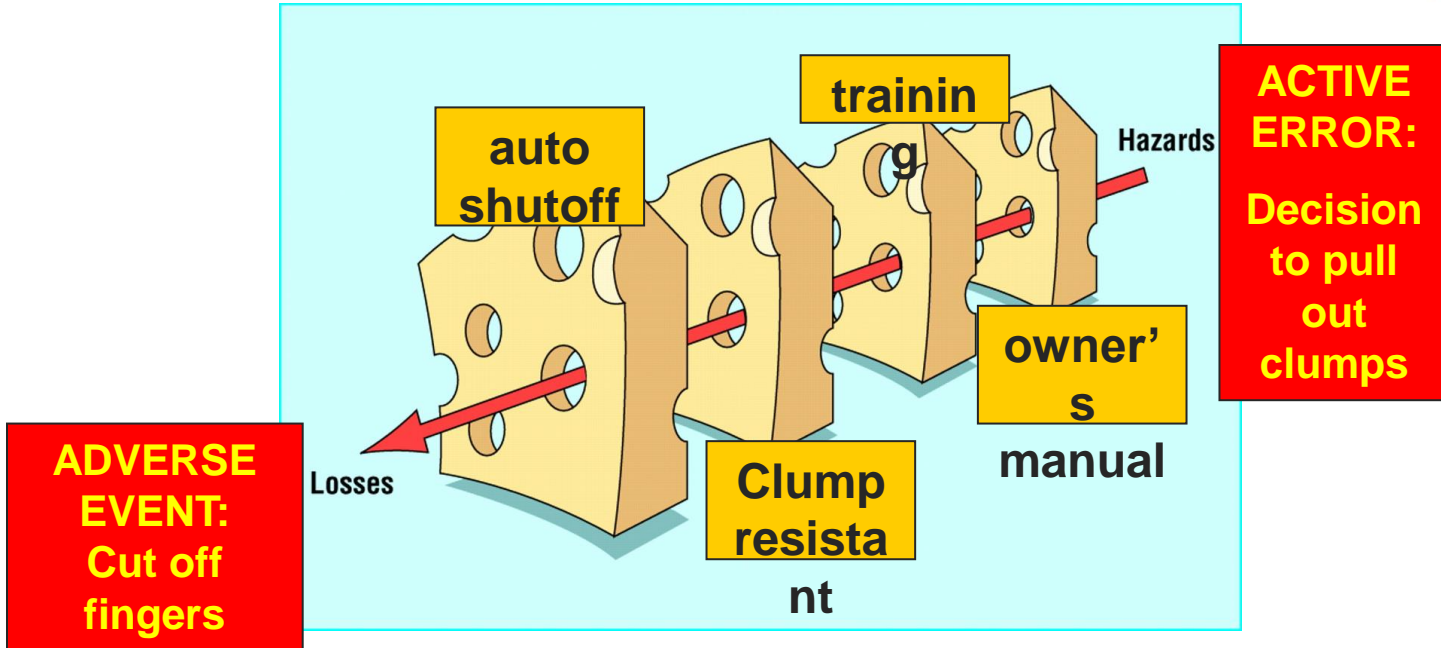
Mitigating Human Error



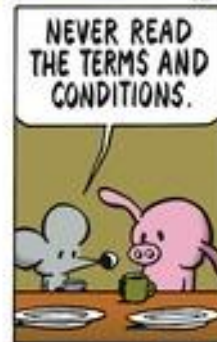
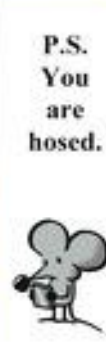
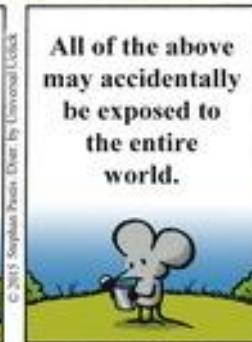
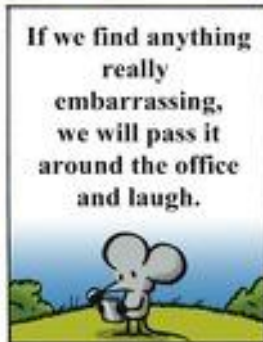
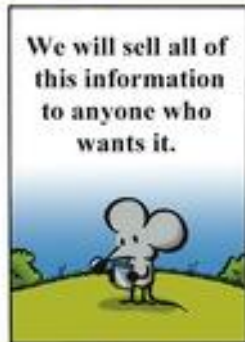
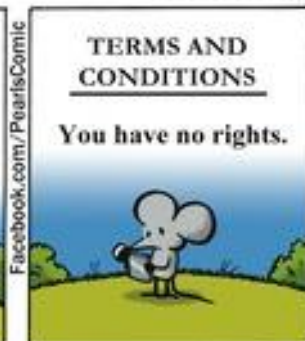
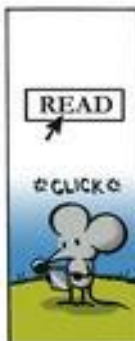
- **If error is inevitable... How to improve safety?**
 - Reduce the occurrence of human error
 - With better design, support, allocation of function
 - NOT training and policy
 - Mitigate the effects of inevitable error
 - With better design
 - Better feedback
 - Forcing functions

Lawnmower Swiss Cheese

What slices are most effective?



PEARLS BEFORE SWINE



Facebook.com/PearlsComic

© 2015 Stephan Pastis. Drawn by Universal Uclick

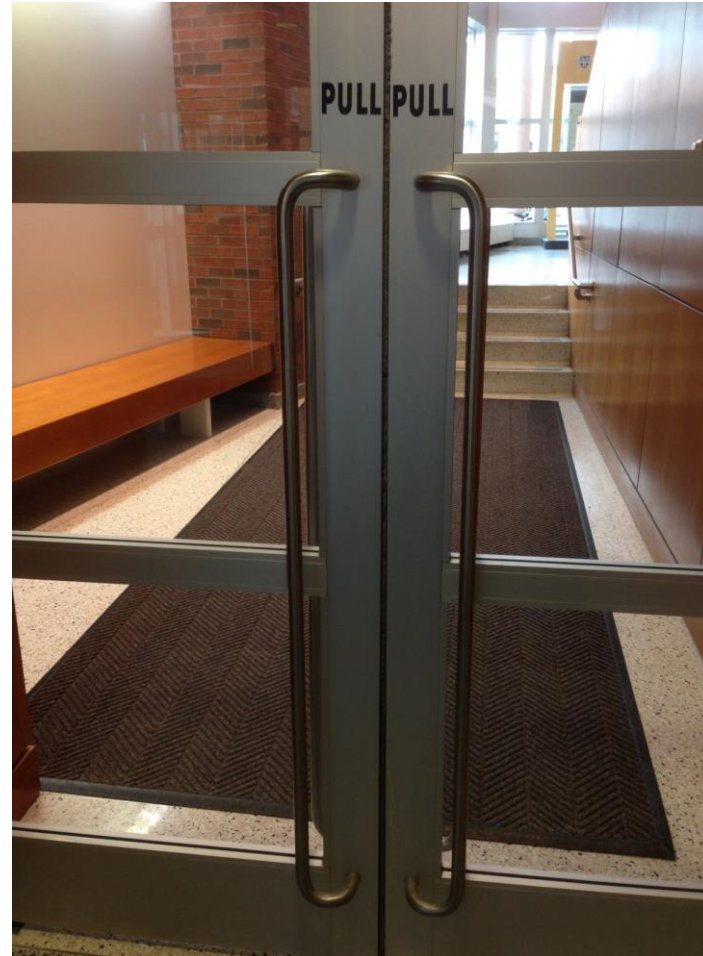
Human Factors Engineering



- Optimizes the relationship between technology and the human user
- Designs the system to match abilities
- Know human capabilities
- “Designing for human use”
- How humans err is not the focus
- Prominent in aviation, nuclear, military
- Know where to expect error (hazards)
- Design to protect from Hazards
 - Redesign, Redundancy, Forcing functions
 - Evaluation before purchase







How about this door?

16







Design of Medication Packaging

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Baxter International



Dennis Quaid's Medical Nightmare





Human Factors and IT/EMR's

Discussion questions



- From your experience what benefits do you see from IT and EMR's?
- From your experience, what problems do you see from IT and EMR's?

Safety Benefits of EMRs



- Core EMR
- ePrescribing
- CPOE
- Closed-Loop Medication Administration Validation
- Decision Support (e.g. Best Practice Advisories)

Safety Benefits of EMRs (cont.)



- Improve communication
- Make knowledge more readily accessible
- Assist with calculations
- Perform checks in real time
- Assist with monitoring
- Require key pieces of information (dose, weight, etc)

Observations



- EMR errors *and paper* system errors share many things in common:
 - Multiple steps within a complex system
 - **System failures** rather than person failures predominate
- New technology adds an additional layer of complexity for the end user
 - Clinicians redesign the **use** of newer technology in ways that were never intended.
 - Clinicians seduced by the hope of “error free computers”
 - Verbal, face-to-face **communication** is often **believed** not to be a part of the new technologies

EHR Ordering and Challenges/Concerns for Drug Safty



- ❑ **Alert Fatigue/Overload**
- ❑ **Limited Hard Stops**
 - Alerts require actions and responses
 - Final decision rests with the provider
- ❑ **Order Expiration/Renewal**
- ❑ **Order Release Issues:**
 - Phases of care
 - Combined flows – Outpatient-to-Inpatient
- ❑ **“Check your brain at the door” phenomenon**



Electronic Record Order Errors

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? Resize Close X
Verify Orders - Order Details

✔ Verify
✖ Reject
🗑️ Reject & R/O
🔗 Interactions
📄 New i-Vent
🕒 Order Hx
📄 Show Charge
✔ Reverify Order

Order ID: 48238229

← Back to Order List 9 of 9

dalteparin (FRAGMIN) injection 756,875 Units

New Ordered by: Dahan, Isaac, MD Today 1442

[Edit Clinical Information](#)

Order dose:	12,500 Units/kg/day	Route:	Subcutaneous	Frequency:	EVERY 12 HOURS
Admin dose:	756,875 Units (30.28 mL)	Volume:	30.28 mL	For:	60 Days
Weight:	Actual (121.1 kg)	Calc volume:	Yes	# of doses:	120
Ordered dose of 12,500 Units/kg/day EVERY 12 HOURS exceeds recommended single dose limit of 18,000 Units				1st dose:	Today 1500
12,500 Units/kg/day × 121.1 kg (Weight as of Thu Apr 26, 2012 1846)				Last dose:	6/26/2012 0300
= 1,513,750 Units/day over 2 administrations per day				Scheduled times:	
= 756,875 Units × 1 mL/25,000 Units				4/27/2012	1500
= 30.28 mL × 25,000 Units/mL (rounded to the nearest 0.01 mL from 30.273 mL)				4/28/2012	0300, 1500
= 757,000 Units					

[Edit Dispense Information](#)

Dispense from: SMH MAIN PHARMACY

First doses: SMH MAIN PHARMACY

Dispense code: Syringe

Admin instructions: [Edit](#)

(none)

Dispensable: **dalteparin (porcine) (FRAGMIN) injection 25,000 units/mL**

Products to dispense	Order dose	Admin dose	Dispense	Package
🔗 DALTEPARIN SODIUM 25000 UNIT/ML SC SOLN*SH*	12,500 Units/kg/day	756,875 Units	30.28 mL	3.8 mL Vial

Reference links:
[Lexi-Comp](#) [Lexi-Comp Peds](#)

Interactions:
Dose

Overridden by: Dahan, Isaac, MD (no reason given)

A true story from one of our Medical Center Insurance Company partners

(Paraphrased)

Prosecuting attorney – “Doctor, why did you order the overdose that killed my client’s loved one?”

Resident on the stand – “I wasn’t that familiar with the medication, but I figured it must have been OK since the computer took it”

But what can I do???



- **“I can’t change design, so how does this help?”**
 - Procurement: Ask the questions
 - Recognize and report device and HIT hazards
 - Develop the culture by recognizing system contributions
 - Then you’ll learn more about hazards in your system
 - RCAs- recognize the system contributions
 - RCA **RED RULES**: RCA will never result in:
 - “Failure to follow policy” (or procedure) as only root cause
 - “Develop policy” or “train staff” as only action
 - “Human Error” as a cause without identifying contributing factors

Human Factors Strategies

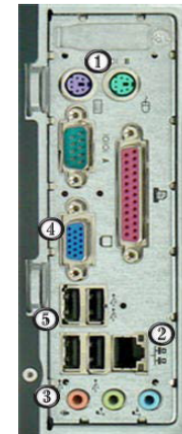


Adaptive Strategies



Human Factors Strategies to Increase Reliability

1. Standardize common processes, procedures, equipment
2. Simplify task structure, reduce complexity
3. Promote conditions for decision-making
4. Meaningfully integrate technology
5. Avoid reliance on memory and vigilance



Human Factors Strategies (cont.)

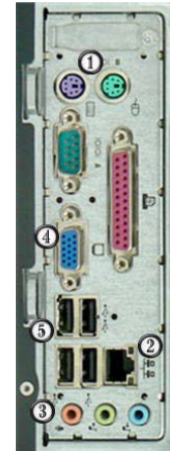


Adaptive Strategies



Human Factors Strategies to Increase Reliability

6. Design for error
7. Make things visible and provide feedback
8. Promote collaboration/teamwork
9. Equip staff with Human Factors knowledge to proactively recognize hazards
10. Promote a safety culture



Questions?



Annie's Story (if time permits)

(Human Factors & Just Culture video)



Vanderbilt Nurse Conviction Medication and other errors (if time permits)



□ David Marx analysis:

- https://www.outcome-eng.com/wp-content/uploads/2019/03/Vanderbilt-Homicide-A-Just-Culture-Analysis_David-Marx.pdf



□ Human Factors issues

- Pyxis medication search lists separate for Brand and generic names
- Nurse couldn't find Versed in Pyxis profile for the patient even though it was listed as generic midazolam
- Nurse was able to find medications in Pyxis with just 2 letters, allowing her to pull up "vecuronium" when searching for Versed
- No Bar Code Medication Administration (BCMA) safety check in PET scan area

Implementing Actions - Stronger



Adaptive Strategies



Implementing Actions

	Action Category	Example
Stronger Actions (these tasks require less reliance on humans to remember to perform the task correctly)	Architectural/physical plant changes	Replace revolving doors at the main patient entrance into the building with powered sliding or swinging doors to reduce patient falls.
	New devices with usability testing	Perform heuristic tests of outpatient blood glucose meters and test strips and select the most appropriate for the patient population being served.
	Engineering control (forcing function)	Eliminate the use of universal adaptors and peripheral devices for medical equipment and use tubing/fittings that can only be connected the correct way (e.g., IV tubing and connectors that cannot physically be connected to sequential compression devices or SCDs).
	Simplify process	Remove unnecessary steps in a process.
	Standardize on equipment or process	Standardize on the make and model of medication pumps used throughout the institution. Use bar coding for medication administration.
	Tangible involvement by leadership	Participate in unit patient safety evaluations and interact with staff; support the RCA ² process; purchase needed equipment; ensure staffing and workload are balanced.

Implementing Actions - Intermediate



Adaptive Strategies



Implementing Actions

Intermediate Actions	Redundancy	Use two RNs to independently calculate high-risk medication dosages.
	Increase in staffing/decrease in workload	Make float staff available to assist when workloads peak during the day.
	Software enhancements, modifications	Use computer alerts for drug-drug interactions.
	Eliminate/reduce distractions	Provide quiet rooms for programming PCA pumps; remove distractions for nurses when programming medication pumps.
	Education using simulation-based training, with periodic refresher sessions and observations	Conduct patient handoffs in a simulation lab/environment, with after action critiques and debriefing.
	Checklist/cognitive aids	Use pre-induction and pre-incision checklists in operating rooms. Use a checklist when reprocessing flexible fiber optic endoscopes.
	Eliminate look- and sound-alikes	Do not store look-alikes next to one another in the unit medication room.
	Standardized communication tools	Use read-back for all critical lab values. Use read-back or repeat-back for all verbal medication orders. Use a standardized patient handoff format.
	Enhanced documentation, communication	Highlight medication name and dose on IV bags.

Implementing Actions - Weaker



Adaptive Strategies



Implementing Actions

Weaker Actions (these tasks require more reliance on humans to remember to perform the task correctly)	Double checks	One person calculates dosage, another person reviews their calculation.
	Warnings	Add audible alarms or caution labels.
	New procedure/ memorandum/policy	Remember to check IV sites every 2 hours.
	Training	Demonstrate correct usage of hard-to-use medical equipment.

Action Hierarchy levels and categories are based on *Root Cause Analysis Tools*, VA National Center for Patient Safety, http://www.patientsafety.va.gov/docs/joe/rca_tools_2_15.pdf. Examples are provided here.