Human Factors Engineering In Medicine

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Goal

View patient safety through the lens of the Safety Science
Objectives

NOW:

System Safety Engineering
   – Human Factors Engineering
   – Systems Approach, Just Culture
A few Examples...
   – How does this all fit in to Patient Safety?

LATER:

Examples, examples, examples...
Chart Credit: Modified from L. Leape

- Dangerous (>1/1,000)
  - Healthcare (1 of 616)
  - Bungee Jumping
  - Chemical Manufacturing
  - Driving

- Ultra Safe (<1/100K)
  - Commercial Aviation
  - European Railroads
  - Nuclear Power

Total lives lost per year

Number of encounters for each fatality
The Problem

IOM Report in 2000

- Govt: 50% less error in 5 years
- Funding, Regs, High Focus

13 Years later....

ESSENTIALLY NO CHANGE

WHY? ➔ Focus still on **individual** performance
➔ Solutions inconsistent with safety science

Leape LL, Berwick DM. Five years after To Err Is Human: what have we learned? JAMA. May 18 2005;293(19)
Wachter RM. The end of the beginning: Patient Safety Five Years After 'To Err Is Human'. Health Aff. 2004(11)
Adverse Event Rates

1991
3.7%
New York
HMPS, Brennan, Leape, et al.

2000
2.9%
Utah and Colorado
Thomas, Studdert, et al.

2010
5.7%
North Carolina
Landrigan et al.

2010
13.1%
Medicare Beneficiaries
Levinson et al.

2011
33.2%
IHI Global Trigger Tool
Classen et al.

Wrong Direction!

Disclaimer: Studies have different methodology and sample size and cannot be directly compared
Why No Change?

1. Preoccupation with Human Error...
   ...Instead of **reducing** HARM

2. Ineffective solutions
“Systems Approach”

Is the goal: “Eliminate Human Error?”

→ NO

Human Error cannot be eliminated

– Futile goal; misdirects resources/focus
– Causes culture of blame and secrecy
  • “name, blame, shame, and train” mentality

It is about reducing HARM
809M airline passengers/yr...

...30,000 flights per day

Pilots & ATC:

Make 2 errors per hour
Human Factors Engineering

“We don’t redesign humans; We redesign the system within which humans work”
Cognitive Science (how we think)

Industrial and Organizational Psychology (how we collaborate)

Work Analysis (how we work now)

Systems Safety Engineering (how we manage risk)
Time From Arrest to Defibrillation

![Graph showing the decrease in survival from sudden cardiac arrest with increasing time from arrest to defibrillation. The graph indicates that the chance of success is reduced by 7-10% each minute.]
Defibrillator Case

- VF cardiac arrest
- nurse with patient
- charges unit...
- clears patient...
- presses “on” button
- Machine powers down
  – 2-3 minute delay in shock
Huh?
Defibrillator Case

- Trend found in EMS Reporting system
- Simulation study (Denmark)
  - 72 physicians
  - 5 of 192 defib attempts – Turned it off
    ▪ Measurable delay in shock
  - Devices turn off even if charged and ready

<table>
<thead>
<tr>
<th>Knowledge-Based</th>
<th>Rule-Based</th>
<th>Skill-Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvisation in unfamiliar environments</td>
<td>Protocolized behavior</td>
<td>Automated Routines</td>
</tr>
<tr>
<td>No routines or rules available to help handle</td>
<td>Process, Procedure</td>
<td>Require little conscious attention</td>
</tr>
</tbody>
</table>

Figure adapted from: Embrey D. Understanding Human Behaviour and Error, Human Reliability Associates
Based on Rasmussen’s SRK Model of cognitive control, adapted to explain error by Reason (1990, 2008)
Defibrillator Case #2

- 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
- 45m resuscitation attempt → patient dies
- Investigation reveals that MD failed to put device in SYNC mode for second shock
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 never aware


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

“Physician should have taken time to ask ED staff for an operator’s manual for the defibrillator and read it after he arrived in the ED to perform a cardioversion”

“the preventative or corrective action is provided in the device labeling”

TO EXIT
PRESS HERE

PRESS
TO OPERATE
DOOR

TO EXIT
PRESS HERE

PRESS
TO OPERATE
DOOR
Please stock latex free gloves only.
## Knowledge-Based
- Improvisation in unfamiliar environments
- No routines or rules available

## Rule-Based
- Protocolized behavior
- Process, Procedure

## Skill-Based
- Automated Routines
- Require little conscious attention

---

**Conscious**

**TRIAL & ERROR**

1. MISAPPLY GOOD RULE
2. NOT APPLY GOOD RULE
3. APPLY BAD RULE

**SLIPS & LAPSES**

**Automatic**

Figure adapted from: Embrey D. Understanding Human Behaviour and Error, Human Reliability Associates
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Slips and Lapses: Common

Policies, Inservices, Discipline, Training, Vigilance

TO ERR IS HUMAN
BUILDING A SAFER HEALTH SYSTEM
Culture in Healthcare

Safety

Accountability

Try harder!

Do better!
Both important, yet separate

Accountability

Safety

Administrative function
Indiana: 5 nurses
Safety Attitudes

“The single greatest impediment to error prevention in the medical industry is that we punish people for making mistakes.”

--Lucian Leape, Testimony to congress
Too soft, you say?
# Just Culture: The Three Behaviors

<table>
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<tr>
<th>Normal Error</th>
<th>Reckless Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Inadvertent action: slip, lapse, mistake</em></td>
<td><em>Conscious disregard of unreasonable risk</em></td>
</tr>
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</table>

Manage through:
- Processes
- Procedures
- Recurrent training
- Design
- Environment

Manage through:
- Remedial action
- Punitive action

## Support


See also, *Just Culture: Balancing Safety and Accountability*, Sidney Dekker (2008)
Why is a culture of safety so important?

- 1 serious or major injury
- 10 minor injuries
- 30 property damage injuries
- 600 incidents with no visible damage or injury

1,753,498 accidents from 297 companies, 21 different industries

*Slide acknowledgment: Robert Panzer, MD*
Accident Causation Pyramid
“Tip of the iceberg”

- 1 serious or major injury
- 10 minor injuries
- 30 property damage injuries
- 600 incidents with no visible damage or injury

1,753,498 accidents from 297 companies, 21 different industries

Slide acknowledgment: Robert Panzer, MD
Example...

Multiple inpatient PEs occur over 2 years

Audit: 50%
Compliance with Hospital VTE guideline...

WHY are those doctors so non-compliant?
# CPOE Pathway: Screen #1

DVT-PE Prophylaxis Pathway

<table>
<thead>
<tr>
<th>Mr#: 00000000819</th>
<th>Pt#: 3169</th>
<th>Isol: U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allergies: NKA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Age > 60 DVT-PE Prophylaxis Selection Screen**

**Non-Surgical**
- [ ] No operative procedure planned during admission

**Surgical Procedure (other than those listed below)**
- [ ] <45 minute operative duration
- [ ] >45 minute operative duration

**Procedure Specific**
- [ ] Intracranial surgery
- [ ] Acute spinal cord injury
- [ ] Cesarean section
- [ ] Multiple trauma
- [ ] Hip fracture
- [ ] Total hip replacement
- [ ] Total knee replacement

**OR**
- [ ] Prophylaxis not indicated

---

- [ ] F1 Pt List
- [ ] F2 Option Menu
- [ ] F4 Display Risk Factors
- [ ] F5 Emergency Bypass
CPOE Pathway: Screen #2

DVT-PE Prophylaxis Pathway

DVTTEST, LTFORTY  M  24Y
Mr#: 000000000817  Pt#: 3167  Isol: U
Allergies: NKA

☐ 1 or more major risk factors
☐ 1 or more minor risk factors
   Major:
   - prior DVT or PE
   - malignancy
   - hypercoaguable state
   - prolonged immobility (>72hr)
   - paralysis
   - immobilizing cast
   - central venous access
   - myocardial infarction
   - heart failure, decompensated
   - sepsis or severe infection
   - stroke (non-hemorrhagic)

☐ No risk factors
☐ Prophylaxis not indicated
   Minor:
   - obesity (BMI >30)
   - heart failure, compensated
   - trauma
   - pregnancy or < 1 mos postpartum
     (except in active labor)
   - Varicose veins
   - Inflammatory bowel disease
   - oral contraceptive
   - HRT, raloxifene or tamoxifen

☐ F1 Pt List  ☐ F4 Display Risk Factors
☐ F2 Option Menu
☐ F3 Previous Screen
CPOE Pathway: Screen #3

DVT-PE Prophylaxis Pathway

DVTTEST .LTFORTY M 24Y
Mr#: 000000000817 Pt#: 3167 Isol: U
Allergies: NKA

DVT-PE HIGH RISK OPERATIVE Prophylaxis Order Screen

Preferred Single Therapy: (Recommended)
☐ Heparin 5000 units SQ q 8 hrs/ begin preop

Sequential Therapy
☐ Intermittent Pneumatic Compression Stockings followed by
  heparin 5000 units SQ q 8 hrs

Alternative Therapies
☐ Intermittent Pneumatic Compression Stockings followed by LWMH
☐ Heparin 5000 units SQ q 8 hrs/ begin postop
☐ Enoxaparin 40 mg SC QD
☐ Dalteparin 5000 units SC QD
☐ Intermittent Pneumatic Compression Stockings

☐ Display Contraindications

☐ F1 Pt List ☐ F4 Display Risk Factors
☐ F2 Option Menu
☐ F3 Previous Screen
Result of CPOE Pathway

- Readily accepted by providers
- Increase in appropriate prophylaxis rates

50% → 66% → 93%

Develop **Sustainable** Solutions

Develop **Effective** Solutions

Consider Solutions in Context

Focus on HAZARDS
Prevention of Heart Disease

Primary Prevention

Secondary Prevention

Tertiary Prevention

Healthy Lifestyle
Smoking Cessation
Screening for Risk Factors
Control of Risk Factors
CAD: Management After Heart Attack
Optimizing Management of Heart Failure
Integrated Patient Safety Transformational Model (PST Model)

**Primary Prevention**

- Proactive Risk Assessment (PRA)
  - Design system and processes to avoid risks & hazards

**Secondary Prevention**

- Hazard Reporting
  - Identify & mitigate existing hazards before adverse events occur

**Tertiary Prevention**

- Adverse Event “Go Team”
  - Disclose, apologize, and ensure fair compensation
  - Reduce impact of harm & provide early system safety review
  - Provide second victim support, & conduct event discovery

**Patient and Family Satisfaction**

- Maximize interactions that lead to satisfied patients & families

**Transitions of Care**

- Maximize physician-patient & MD/RN communication in optimized shift handovers
What DOES NOT reduce risk

- Concluding after an adverse event/RCA:
  - “Failure to follow policy” (or procedure) as primary root cause
  - “Develop policy” or “train staff” or “counsel” as primary action
  - “Human Error” as a cause without contributing factors
  - Any flavor of the “name, blame, and train” approach
Reducing Risk: Where should we focus?

- Focus on hazards and unsafe conditions
- Focus on near misses
- Address contributing factors that can be changed
- Use a TRUE non-punitive safety system
- Employ EFFECTIVE and SUSTAINABLE solutions
“Fallibility is part of the human condition;
We cannot change the human condition;
But we can change the conditions under which people work”

--James Reason, PhD
Final Thoughts...

• 13 years later....
  Why No Change?
  – Focus on the INDIVIDUAL
  – Focus on EVENTS
  – Focus on OUTCOME
  – Culture of Blame
  – Lack of a true systems approach
Reference Books
& **Fun/Easy Reads


**Set Phasers on Stun**, Steve Casey (1998)

Handbook of Human Factors and Ergonomics in Health Care and Patient Safety, 2nd ED; P. Carayon (2012)


Human Error, James Reason (1990)

Normal Accidents, Charles Perrow (1984)
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Resilience Engineering Conference @ National Academies of Sciences
June 13 and 14, 2013, Washington DC
www.ResilienceEngineeringHealthcare.com

In the Breakout Session: examples, examples...