Introduction to Human Factors and Workshop Overview

Raj Ratwani, PhD
Center Director and Scientific Director
National Center for Human Factors in Healthcare
MedStar Institute for Innovation, MedStar Health
Assistant Professor of Emergency Medicine, Georgetown University

@RajRatwani
#HFsafty
#IHICongress
National Center for Human Factors in Healthcare

• We focus on **studying human capabilities and designing technology, systems, and processes to meet these capabilities** for **safety, efficiency, & quality**

30 team members
- Human Factors (4 PhD, 2 MS)
- Health Equities (1PhD)
- Computer Science (1MS)
- Aerospace Engineering (1MS)
- Clinicians (4 MD, 2 RN)
The Center’s Work

Applied Research
• Grants and contracts from government, foundations, and industry
• Publications, presentations, interventions, policy recommendations

Usability Services
• Medical devices
• Digital health

Safety Integration
• Safety consults
• Serious safety event reviews

Education and Outreach
• Georgetown University Medical School Course
• Workshops, talks, and trainings
<table>
<thead>
<tr>
<th>Federal Agencies</th>
<th>Foundations</th>
<th>Universities</th>
<th>Societies, Associations, Institutes</th>
<th>Corporations &amp; Businesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIH, National Institutes of Health</td>
<td>PEW Charitable Trusts</td>
<td>George Mason University</td>
<td>ASHRM, American Society for Health Care Risk Management</td>
<td>RAND Corporation</td>
</tr>
<tr>
<td>CMS.gov, Centers for Medicare &amp; Medicaid Services</td>
<td>Emergency Medicine Foundation, EMF</td>
<td>University at Buffalo</td>
<td>AMA, American Medical Association</td>
<td>RTI International</td>
</tr>
<tr>
<td>NIST, National Institute of Standards and Technology</td>
<td>Robert Wood Johnson Foundation</td>
<td></td>
<td>ISMP, Institute for Safe Medication Practices</td>
<td>Intel</td>
</tr>
<tr>
<td>FDA</td>
<td>EMPRF, Emergency Medicine Patient Safety Foundation</td>
<td></td>
<td>ECRI Institute</td>
<td>APTIMA Human-Centered Engineering</td>
</tr>
<tr>
<td>DHA, Defense Health Agency</td>
<td></td>
<td></td>
<td></td>
<td>EmOpti, Inc.</td>
</tr>
</tbody>
</table>
Our History - Patient Safety

“Progress has been slow.”
Journal of the American Medical Association

2009
“180,000 Medicare patients die annually from medical errors.”
Office of the Inspector General

2010
“33% hospitalized patients are harmed; 7% result in permanent injury or death.”
Health Affairs

2013
“Medical errors the third leading cause of death in America.”
ProPublica

2014
“How Many Die from Medical Mistakes in U.S. Hospitals?”

2005
“Annual death toll from medical errors is closer to 200,000.”
Dead by Mistake
Heart Newspapers Special Report

2010
“No significant change in rate of preventable errors.”
New England Journal of Medicine

2011
“200,000-400,000 deaths per year due to preventable harm in hospitals.”
Journal of Patient Safety

MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You

From the Karen Martin Group
The Central Tenant of Human Factors

“We don’t redesign humans; We redesign the system within which humans work”
Human Factors

The scientific discipline focused on
(1) understanding human capabilities and
(2) designing tools and machines, systems, and processes for safe, efficient, and effective use.
Humans are Error Prone

• Humans naturally make errors despite extensive training and experience
  – Error rates are exacerbated by our normal work conditions:
    • Fatigue
    • Interruptions/multi-tasking
    • Stress

• We can reduce safety events by redesigning components of the system
  – Reduce harm
## Routine Errors

<table>
<thead>
<tr>
<th>Domain</th>
<th>% Accidents/Incidents due to routine errors</th>
<th>Dataset &amp; Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation (Commercial)</td>
<td>60.5%</td>
<td>199 accidents in the United States from 1990-1996; data from NTSB and FAA</td>
</tr>
<tr>
<td>Aviation (Maintenance)</td>
<td>48%</td>
<td>Survey of 550 aircraft maintenance personnel in Australia (Hobbs et al., 2007)</td>
</tr>
<tr>
<td>Mining</td>
<td>~58.9%</td>
<td>508 cases from Australia (2004-2008) (Patterson &amp; Shappell, 2010)</td>
</tr>
<tr>
<td>ICU</td>
<td>~53%</td>
<td>120 adverse events in 79 patients; 54 preventable adverse events. In total examined 391 patients with 420 unit admissions in 1490 patient days (Rothschild, 2005)</td>
</tr>
<tr>
<td>Railways</td>
<td>63%</td>
<td>19 rail accidents in Australia (Baysari et al., 2009)</td>
</tr>
</tbody>
</table>
What You Will Learn Today

• Basics of the human factors and systems safety approach

• How to apply this approach to your organization to reduce safety hazards

• How to foster a culture of safety
Life as a Safety AVP: Before and After Learning Human Factors and Systems Safety Concepts

Seth Krevat MD, FACP, Assistant Vice President, Safety, MedStar Health
Human Factors 101 - Understanding Human Error and the Strengths and Limitations of Human Performance

Kristen Miller, DrPH, CPPS, Director of Education and Academic Affairs & Senior Research Scientist, National Center for Human Factors in Healthcare, MedStar Health

Nat Benda, MS, Senior Research Fellow, National Center for Human Factors in Healthcare, MedStar Health
Applying a Systems Approach to Create a Culture of Safety

Kathryn (Kate) Kellogg, MD, MPH, Associate Medical Director & Director of Human Factors Safety Integration, National Center for Human Factors in Healthcare, MedStar Health
Usability: Why it Matters for Patient Safety

Natalie Abts, MS, Usability Services Senior Program Manager, National Center for Human Factors in Healthcare, MedStar Institute for Innovation, MedStar Health
Thinking Differently About Safety – Resilience in Systems and Health IT

Terry Fairbanks, MD, MS, FACEP, AVP, Ambulatory Quality & Safety, Founding Director, National Center for Human Factors in Healthcare, MedStar Institute for Innovation, MedStar Health
Case Studies of Human Factors in Patient Safety and Guided Event Review

Terry Fairbanks, MD, MS, FACEP, AVP, Ambulatory Quality & Safety, Founding Director, National Center for Human Factors in Healthcare, MedStar Institute for Innovation, MedStar Health
Consequences:

- 11 dead
- 17 injured
- $61B cost

Mineral Management Service
- No safety reports
- Absence of catastrophic events
Thank you

Raj Ratwani, PhD
@RajRatwani / #HFsafty
Raj.M.Ratwani@MedStar.net
Life as a Safety VP: Before and After Learning Human Factors and Systems Safety Concepts

Seth A. Krevat, MD, FACP
Assistant Vice President, Safety, MedStar Health
Attending Physician Palliative Care, MedStar Georgetown University Hospital
Assistant Professor of Clinical Medicine, Georgetown University School of Medicine

@SAKrevat
#HFsafty
Safety Moment – embarrassed
Safety Moment - Events

89 y/o man falls at home and fractures his hip, goes to hospital, has DNR order

After surgery, goes to regular floor bed without monitoring

AM, medicine MD saw patient and noted hypoxia

Later arrested was resuscitated, intubated and transferred to ICU

Pt./family request extubation and desire for comfort measures

Pt. extubated and allowed to pass away.
Safety Moment – Family
Safety Moment - My Response
We want to hear from you…

• We realize you may have challenges within your own system
• Be thinking about your challenge
• At the end of this lecture, we will ask you to discuss amongst your table and pick one to share
• If you prefer, you can tweet at us using #HFsafe
MedStar Patient Safety – a framework

Reducing Risk of Harm
- High Reliability (HRO)
- Human Factors Engineering
- Occurrence Reporting
- Good Catch Program
- Simulation
- Patient and Family Advisory Council Quality and Safety

Unanticipated Outcomes – mitigating the effects
- Go Team
  - Patient Communication Consult Service
  - Event Review/Root Cause Analysis
  - Care for Caregiver

Just Culture

Knowledge and Compassion Focused on You
“A-ha” Moments in Learning the Systems Approach

- Lesson 1 - Mistake Proofing ≠ Risk Reduction
- Lesson 2 - Just culture is complex and nuanced
- Lesson 3 - There are variations and limitations to human performance
- Lesson 4 - Standardization is not always better
- Lesson 5 - Leadership and messaging is key
Lesson 1. Mistake Proofing v. Risk Reduction - 2011

- Value Added Activities
- Motion
- Over-production
- Over-processing
- Waiting
- Transportation
- Inventory
- Defects
Lesson 1. Mistake Proofing v. Risk Reduction - 2011

- Over-production
- Over-processing
- Waiting
- Transportation
- Inventory

Handwritten notes:
1. Professor
2. Long HT x 1 stat
3. Abstract MD, KID
4. No flow to BP
5. Need 940 manual chart

Knowledge and Compassion Focused on You
Lesson 1. Mistake Proofing v. Risk Reduction - 2011

"You've gotta help me! I can't read my own writing!"
Mistake Proofing
Mistake Proofing
## Risk Reduction

### JOB BREAKDOWN INSTRUCTION SHEET: Physician Model for Service Excellence

<table>
<thead>
<tr>
<th>Job Breakdown Sheet for Daily Hospital Visit</th>
<th>KEY POINTS</th>
<th>REASONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step #1 The Welcome</strong></td>
<td>Sit Down</td>
<td>You are not rushed and have time for the patient</td>
</tr>
<tr>
<td></td>
<td>My name is</td>
<td>Knows who you are</td>
</tr>
<tr>
<td></td>
<td>My role is</td>
<td>Knows why you are there</td>
</tr>
<tr>
<td></td>
<td>My connection with your referring Doc is</td>
<td>Knows that there will be continuity</td>
</tr>
<tr>
<td></td>
<td>I have reviewed your information and know how to care for you</td>
<td>Knows that you have the knowledge to make the right and safe decisions. The patient needs to feel safe and have hope</td>
</tr>
<tr>
<td><strong>Step #2 The Care</strong></td>
<td>Here is what I am going to do and why</td>
<td>I’m informed</td>
</tr>
<tr>
<td></td>
<td>Here are the next steps</td>
<td>I know what to expect, no surprises</td>
</tr>
<tr>
<td></td>
<td>Ask for understanding of the Plan</td>
<td>I’m clear on the plan</td>
</tr>
<tr>
<td></td>
<td>Ask for permission to proceed with plan</td>
<td>I have input and control, I feel safe</td>
</tr>
<tr>
<td></td>
<td>Ask for patient’s needs</td>
<td>My needs are being met</td>
</tr>
<tr>
<td><strong>Step #3 The Goodbye</strong></td>
<td>Continues Care: I’ll be back at… At Discharge: I’ll inform your PCP</td>
<td>They will know when to expect to see you again. Their PCP will have the knowledge needed to safely assume my care</td>
</tr>
<tr>
<td></td>
<td>Your test results will be available at</td>
<td>They will have information about their condition by:</td>
</tr>
<tr>
<td></td>
<td>What I need you to do</td>
<td>I have a role in my healing, I have control</td>
</tr>
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<td></td>
<td>Your nurse will start these treatments</td>
<td>I know my care plan for the day</td>
</tr>
<tr>
<td></td>
<td>Explain availability, give business card</td>
<td>I will not be left alone</td>
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SAFE Toolbox to improve the safety of care we deliver

<table>
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<tr>
<th>Tools</th>
<th>How To Use It</th>
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</thead>
<tbody>
<tr>
<td>Speak Up for Safety</td>
<td>• If you <strong>see something, say something</strong>&lt;br&gt;• <strong>Report</strong> unsafe conditions</td>
</tr>
<tr>
<td>Asking Questions</td>
<td>• Ask questions, request change, express concerns, elevate if necessary (ARCC)&lt;br&gt;• Resolve uncertainty with validate and verify</td>
</tr>
<tr>
<td>Focusing on Tasks</td>
<td>• <strong>STOP</strong>, Think, Act and Review (STAR)</td>
</tr>
<tr>
<td>Effective Communication</td>
<td>• <strong>SBAR</strong>&lt;br&gt;• Repeat/Read-Backs&lt;br&gt;• Use communication clarifiers (Phonetic: A=Alpha; numeric: 13 = “one, three”)</td>
</tr>
</tbody>
</table>
Lesson 2. Just Culture is complex and nuanced.

**Just Culture: The Three Behaviors**

<table>
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<tr>
<th>Normal Error</th>
<th>At-Risk Behavior</th>
<th>Reckless Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Inadvertent action: slip, lapse, mistake</em></td>
<td><em>A choice: risk not recognized or believed justified</em></td>
<td><em>Conscious disregard of unreasonable risk</em></td>
</tr>
<tr>
<td>Manage through changes in: Processes, Procedures, Recurrent training, Design, Environment</td>
<td>Manage through: Removing incentives for At-Risk Behaviors, Creating incentives for healthy behaviors, Increasing situational awareness, Re-examining environment</td>
<td>Manage through: Remedial action, Punitive action</td>
</tr>
</tbody>
</table>

Support

Coach

Sanction


See also, *Just Culture: Balancing Safety and Accountability*, Sidney Dekker (2008)
Algorithms?

Just Culture Process

- Start
  - Was the job understood? Yes, No
    - Yes: Was the action as intended? Yes, No
      - Yes: Were the results as intended? Yes, No
        - Yes: Sabotage or Malevolent Act
        - No: Knowingly violated procedures? Yes, No
          - Yes: Are the procedures clear? Yes, No
            - Yes: Reckless Violation
            - No: Defective training or selection experience? Yes, No
              - Yes: Negligent Error
              - No: Pass substitution test? Yes, No
                - Yes: History of violating procedures? Yes, No
                  - Yes: Repeated incident with similar root cause
                  - No: No blame error
                - No: History of violating procedures? Yes, No
                  - Yes: Repeated incident with similar root cause
                  - No: No blame error

Increasing Individual Culpability / Diminishing Individual Culpability

- Severe Sanctions
  - Final warning and negative performance appraisal
  - First written warning; coaching / increased supervision until behavior is corrected
  - Documented for the purpose of accident prevention awareness and training will suffice

* Indicates a 'System' induced error. Manager/supervisor must evaluate what part of the system failed and what corrective and preventative action is required. Corrective and preventative action shall be documented for management review.
What is a Just Culture?

• Complex and nuanced.

• A Just Culture supports learning from unsafe acts in order to improve the level of safety awareness through the improved recognition of safety situations and helps to develop conscious articulation and sharing of safety information.

– Global Aviation Information Network
Lesson 3. Limits in Human Performance
Great Clinicians Move to Leaders

Why would anyone do that?
Lesson 4. Standardization is not always better

- Healthcare is complex.
- If people don’t follow rules there is almost always a good reason.
- Our job is to understand why they don’t follow the rules.
- Work as imagined v. work as performed
- Punishing people rarely fixes the problem and my lead to less understanding of what the hazards are in the system – decreased reporting of errors.
NEW Fall Prevention Strategies

1. New Bathroom Signs
   - Signs will be placed near every patient bathroom alerting them that for their safety a staff member may stay with them while they are in the bathroom.
NEW Fall Prevention Strategies

1. New Bathroom Signs
   - Signs will be placed near every patient

2. Patient Education
   - There will be a small double sided laminated sign in each patient room
     - Side 1 – information for the patient regarding fall prevention methods
     - Side 2 – the Morse Fall Scale
   - On admission, the nurse will sit down with the patient and review
NEW Fall Prevention Strategies

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     - Side 1 – information for the patient
     - Side 2 – the Morse Fall Scale
   - On admission, the nurse will sit down with the patient and review NEW Fall Prevention Strategies

3. Fall Sitel
   - NEW fall Sitel for all nurses and techs has been rolled out and will be due by September
An Interpreter Should ALWAYS Be Used
STOP CLABSI
Lesson 5. Leadership and messaging is key.

Consistency is INSPIRE.

Trust takes years to build, seconds to break and forever to repair.

Knowledge and Compassion Focused on You.
Accountability - Empowerment = Blame
Empowerment - Accountability = Low Performance
Accountability + Empowerment = High Performance

WHO IS ACCOUNTABLE?

Knowledge and Compassion Focused on You

MedStar Health
National Center for Human Factors in Healthcare
Accountability is not just for frontline staff.
Accountability – Empowerment = Blame

Empowerment – Accountability = Low Performance

Accountability + Empowerment = High Performance
Where we started
SUO = Serious Unanticipated Outcome
SSE = Serious Safety Event
MSH Serious Safety Event (SSE) Rate
12-Month Rolling Rate per 10,000 Adjusted Patient Days
Target 0.00; 12-Month Rolling Rate = 0.37
Malpractice liability expense improvement has been trending downward due to a number of factors including:

- Improved reporting – More accurate and timely information to facilitate early intervention
- System focus on Safety as an organizational priority has:
  - Contributed to a system-wide reduction in malpractice expense
  - Resulted in a reduction of SSE’s
- Several successive years of this experience led to a non-recurring reduction in actuarial confidence level used to record malpractice liabilities in FY 17

### Historical Malpractice Expense

**Budget vs. Actual ($ in millions)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Budget</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY17</td>
<td>$25.8M</td>
<td></td>
</tr>
<tr>
<td>FY16</td>
<td>$24.9M</td>
<td></td>
</tr>
<tr>
<td>FY15</td>
<td>$17.7M</td>
<td></td>
</tr>
<tr>
<td>FY14</td>
<td>$2.5M</td>
<td></td>
</tr>
<tr>
<td>FY13</td>
<td>$(7.1M)</td>
<td></td>
</tr>
<tr>
<td>FY12</td>
<td>$(5.0M)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Corporate Risk Management Department, Rachel Leyko, Risk & Insurance Manager
Conclusion – Moving forward

What we’ve covered:
• Lesson 1 - Mistake Proofing ≠ Risk Reduction
• Lesson 2 - Just Culture is complex and nuanced
• Lesson 3 - There are variations and limitations to human performance
• Lesson 4 - Standardization is not always better
• Lesson 5 - Leadership and messaging is key

Where we’re going next:
• Describing systems safety and human factors science underlying these lessons
Discussion and Questions

Thank you

Seth Krevat, MD, FACP
@SAKrevat
Seth.Krevat@MedStar.Net
Share your challenge

• Take 5 minutes to discuss among your table
• Decide on a challenge to share
• Write it on one of the post-it’s at your table
• We will also have those who are willing share
• We will discuss common themes later in the program
• You can also tweet at us using #HFsafety
Human Factors 101 - Understanding Human Error and the Strengths and Limitations of Human Performance

Kristen Miller, DrPH, CPPS,
Director of Education and Academic Affairs & Senior Research Scientist, National Center for Human Factors in Healthcare, MedStar Institute for Innovation, MedStar Health

Nat Benda, MS
Senior Research Fellow, National Center for Human Factors in Healthcare, MedStar Institute for Innovation, MedStar Health
WHY (DO WE NEED) HUMAN FACTORS?
WHY HUMAN FACTORS?

How many of you have...

• Ever purchased the wrong grocery item because the labels looked similar?
WHY HUMAN FACTORS?

How many of you have...

- Ever purchased the wrong grocery item because the labels looked similar?
WHY HUMAN FACTORS?

How many of you have...

- Washed your hair with conditioner instead of shampoo?
WHY HUMAN FACTORS?

How many of you have...

• Washed your hair with conditioner instead of shampoo?
WHY HUMAN FACTORS?

How many of you have...

- Walked into the wrong restroom?
WHY HUMAN FACTORS?
WHY HUMAN FACTORS?
WHY HUMAN FACTORS?
WHY HUMAN FACTORS?
What would happen if you confused the following products?

These errors significantly impact patient safety.
“So I got her IV, her antibiotic and her epidural bag. Both bags had ends that received IV tubing. I had her antibiotic in my hand, I knew that. But I didn’t have her antibiotic in my hand; I had her epidural medication in my hand.”

- Julie Thao

Knowledge and Compassion Focused on You
EVENT
Oxygen tubing erroneously connected to a needleless IV port

POTENTIAL FOR HARM
High

CASE STUDY
- A patient’s oxygen tubing became disconnected from his nebulizer and was accidentally reattached to his IV tubing Y-site by a staff member who was completing a double shift.
- The patient died from an air embolism, even though the connection was broken within seconds.

THE JOINT COMMISSION SAFETY TIP
Identify and manage conditions and practices that may contribute to healthcare worker fatigue, and take appropriate action.
HUMAN FACTORS IN INDUSTRY
HUMAN FACTORS IN INDUSTRY

Password strength: strong

Password must:
- Have at least one letter
- Have at least one capital letter
- Have at least one number
- Not contain multiple identical consecutive characters
- Not be the same as the account name
- Be at least 8 characters
- Not be a common password
- Not be used in past year
“Incompetent people are, at most, 1% of the problem. The other 99% are good people trying to do a good job who make very simple mistakes and it's the processes that set them up to make these mistakes.”

Dr. Lucian Leape
Harvard School of Public Health
WHY HUMAN FACTORS?
PRINCIPLES OF HUMAN PERFORMANCE
HUMANS ARE FALLIBLE.

- Under normal conditions, humans have 5-7 errors per hour.
- Under stressful/emergency/unusual conditions, humans have an average of 11-15 errors per hour.
- Performance is made worse when the person is:
  - Doing the same thing over and over
  - Doing more than one thing at a time
  - In a hurry
  - Under a high workload
UNDERSTANDING HUMAN FALLIBILITY (IN COMPLEX SYSTEMS)
What we mean when we talk about systems...

Human in the system

What we mean when we talk about systems...

- Doing the same thing over and over
- Doing more than one thing at a time
- In a hurry
- Under a high workload

CONCEPTS IN HUMAN PERFORMANCE

- Skill-based behavior, automaticity (Doing the same thing over and over, in a hurry, high workload)
- Vigilance (Doing the same thing over and over, in a hurry)
- Multi-tasking Task switching & interruptions (Doing more than one thing at a time)
CONCEPTS IN HUMAN PERFORMANCE

• Skill-based behavior, automaticity (Doing the same thing over and over, in a hurry, high workload)
• Vigilance (Doing the same thing over and over, in a hurry)
• Multi-tasking Task switching & interruptions (Doing more than one thing at a time)
Levels of Behavior and Error

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<tr>
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<th>Conscious</th>
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<tbody>
<tr>
<td>Improvisation in unfamiliar environments</td>
<td>Trial &amp; Error</td>
</tr>
<tr>
<td>No routines or rules available to help handle</td>
<td>1. Misapply good rule</td>
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</tbody>
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<thead>
<tr>
<th>Rule-Based</th>
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<tr>
<td>Protocolized behavior</td>
<td>2. Not apply good rule</td>
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<td>Process, Procedure</td>
<td>3. Apply bad rule</td>
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<thead>
<tr>
<th>Automaticity-Skill-Based</th>
<th>Slips and lapses</th>
</tr>
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<tbody>
<tr>
<td>Automated Routines</td>
<td>Automatic</td>
</tr>
<tr>
<td>Require little conscious attention</td>
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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)
**Levels of Behavior and Error**

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**Conscious**

- Trial & Error
  - 1. Misapply good rule
  - 2. Not apply good rule
  - 3. Apply bad rule

**Slips and lapses**

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Conscious
Trial & Error
1. Misapply good rule
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Slips and lapses
Automatic

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<td>No routines or rules available to help handle</td>
<td>Process, Procedure</td>
<td>Require little conscious attention</td>
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</tbody>
</table>

**Conscious Trial & Error**

1. Misapply good rule
2. Not apply good rule
3. Apply bad rule

**Slips and lapses**

---

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)
Skill-Based Behavior and Error

• When it happens
  • Well-practiced situations, take place without conscious control as smooth, automated, and highly integrated behavior
  • Errors of omission
    – Failing to take out the wire during central line insertion
    – Types/causes – post-completion errors, interruptions
  • Errors of commission
    – Nurse enters dosage incorrectly while programming infusion pump
    – Causes – biases, interference with competing tasks
Automaticity-Based Behavior and Error

Every-day examples
“So I got her IV, her antibiotic and her epidural bag. Both bags had ends that received IV tubing. I had her antibiotic in my hand, I knew that. But I didn’t have her antibiotic in my hand; I had her epidural medication in my hand.”

- Julie Thao

MedStar Health
National Center for
Human Factors in Healthcare

Knowledge and Compassion Focused on You
## Prevalence of Automaticity-Based Errors

<table>
<thead>
<tr>
<th>Domain</th>
<th>% Accidents/Incidents due to skill-based errors</th>
<th>Dataset &amp; Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation (Commercial)</td>
<td>60.5%</td>
<td>199 accidents in the United States from 1990-1996; data from NTSB and FAA (Wiegman &amp; Shappell, 2001)</td>
</tr>
<tr>
<td>Aviation (Maintenance)</td>
<td>48%</td>
<td>Survey of 550 aircraft maintenance personnel in Australia (Hobbs et al., 2007)</td>
</tr>
<tr>
<td>Mining</td>
<td>~58.9%</td>
<td>508 cases from Australia (2004-2008) (Patterson &amp; Shappell, 2010)</td>
</tr>
<tr>
<td>Medical Intensive Care</td>
<td>~53%</td>
<td>120 adverse events in 79 patients; 54 preventable adverse events. In total examined 391 patients with 420 unit admissions in 1490 patient days (Rothschild, 2005)</td>
</tr>
<tr>
<td>Railways</td>
<td>63%</td>
<td>19 rail accidents in Australia (Baysari et al., 2009)</td>
</tr>
</tbody>
</table>
### Approaches to Dealing with Errors

<table>
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<tr>
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**Conscious**
- Can be addressed through training

**Automatic**
- Not prevented by training, discipline or policy change

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CONCEPTS IN HUMAN PERFORMANCE

- Skill-based behavior, automaticity (Doing the same thing over and over, in a hurry, high workload)
- Vigilance (Doing the same thing over and over, in a hurry)
- Multi-tasking Task switching & interruptions (Doing more than one thing at a time)
“We just need to be more vigilant”
Vigilance

Vigilance tasks - monitoring tasks that require sustained attention over a long period of time

Airport security

Double-checks in pathology labs
Vigilance - The “Vigilance Decrement”


What about double-checking?

Table 2: Adherence rate to double-checking policy steps.

<table>
<thead>
<tr>
<th>Steps observed for all drugs</th>
<th>Double-check adherence rate</th>
<th>Double-check adherence rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug due</td>
<td>1,848</td>
<td>92</td>
</tr>
<tr>
<td>Correct drug</td>
<td>1,964</td>
<td>98</td>
</tr>
<tr>
<td>Correct dosage formulation</td>
<td>1,798</td>
<td>90</td>
</tr>
<tr>
<td>Dose calculation</td>
<td>591</td>
<td>30</td>
</tr>
<tr>
<td>Measurement of dose</td>
<td>1,972</td>
<td>99</td>
</tr>
<tr>
<td>Drug route</td>
<td>1,943</td>
<td>97</td>
</tr>
<tr>
<td>Drug expiry date</td>
<td>1,895</td>
<td>95</td>
</tr>
<tr>
<td>Allergy check</td>
<td>1,851</td>
<td>93</td>
</tr>
<tr>
<td>Patient identity</td>
<td>1,919</td>
<td>96</td>
</tr>
<tr>
<td>Administration to patient</td>
<td>1,667</td>
<td>83</td>
</tr>
<tr>
<td>Documentation to medication record</td>
<td>1,987</td>
<td>99</td>
</tr>
<tr>
<td>IV Drugs only: n = 302</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug diluent &amp; volume</td>
<td>280</td>
<td>93</td>
</tr>
<tr>
<td>LV volume</td>
<td>277</td>
<td>92</td>
</tr>
<tr>
<td>Rate of I.V bolus</td>
<td>213</td>
<td>71</td>
</tr>
<tr>
<td>Flush syringes labelled</td>
<td>203</td>
<td>67</td>
</tr>
</tbody>
</table>

http://worchcapital.blogspot.com/2015/02/psychology-of-markets-confirmation.html
Alsulami, 2013
Vigilance

Improving "double-checks"

Vigilance - Combatting the Vigilance Decrement

Look for opportunities to reduce vigilance tasks

CONCEPTS IN HUMAN PERFORMANCE

• Skill-based behavior, automaticity (Doing the same thing over and over, in a hurry, high workload)
• Vigilance (Doing the same thing over and over, in a hurry)
• Multi-tasking Task switching & interruptions (Doing more than one thing at a time)
Multi-Tasking
There is a time cost to every interruption or task switch measured by the **RESUMPTION LAG**.

**Multi-tasking Task Switching Corrected**

- Primary Task: (writing email)
- Interruption Lag: Period just prior to the onset of the interruption.
- Suspend Primary Task: Work on Interrupting Task (answer phone)
- Resumption Lag: The time it takes you to reorient and begin work on your primary task.
- Resume Primary Task
There is a time cost to every interruption or task switch measured by the **RESUMPTION LAG**.
How Disruptive are Interruptions?

Skill-based Error Rates by Condition

10 Fold Increase !!!

Percent Error

Control Condition

Interrupted Condition

Ratwani & Trafton, 2008

MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You
Errors by Interruption Length

10-30 Fold Increase !!!

Percent Error

Control 8 sec 15 sec 30 sec 60 sec

Ratwani & Trafton, 2010

MedStar Health
National Center for Human Factors in Healthcare

Focused on You
Workload and Error Rates

Byrne and Bovair, 1997

Percent of Errors

No Load

Load

Low Capacity

High Capacity

~5 Fold Increase !!!
Multi-tasking - Task Switching Corrected

- Dangers of multi-tasking and interruptions:
  - Errors
  - Cognitive workload
  - Fatigue
  - Efficiency

MITIGATING THE HARM OF HUMAN FALLIBILITY (IN COMPLEX SYSTEMS)
## Approaches to Dealing with Errors

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- Improvisation in unfamiliar environments
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#### Rule-Based
- Protocolized behavior
  - Process, Procedure

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

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**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)
So what do we do to mitigate the harm of human fallibility?
So what do we do to mitigate the harm of human fallibility?

**Hint:** “We don’t redesign humans; We redesign the system within which humans work”
Strategies for supporting human performance

- Decrease distractions (when possible)
- Decrease memory load
- Minimize chances for perceptual confusion
- Display system status
- Make the execution of an action, state of the system, and reaction of the system visible
- Provide perceptual cues and reminders
- Provide various levels of warnings or alerts
Mitigating Errors – Beyond Training and Policies

Decrease distractions (when possible)
Mitigating Errors – Beyond Training and Policies

Decrease memory load

PREDNISONE DOSING

- Pred 
- 40 mg x 2 days
- 30 mg x 1 day
- 20 mg x 2 days
- 10 mg x 2 days

(20 mg)
Mitigating Errors – Beyond Training and Policies

- Minimize chances for perceptual confusion
Mitigating Errors – Beyond Training and Policies

Display system status

Mitigating Errors – Beyond Training and Policies

Make the execution of an action, state of the system, and reaction of the system visible

http://inspiredehrs.org/designing-for-clinicians/drug-alerts.php
Mitigating Errors – Beyond Training and Policies

Provide perceptual cues and reminders –

![Confirm Navigation dialog box](image)

Mitigating Errors – Beyond Training and Policies

Provide perceptual cues and reminders – not just pop-up alerts!

<table>
<thead>
<tr>
<th>Category</th>
<th># Removed</th>
<th># Canceled</th>
<th># Overridden</th>
<th># Total alerts</th>
<th>% Overridden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug-Allergy</td>
<td>606</td>
<td>0</td>
<td>12,689</td>
<td>14,429</td>
<td>88%</td>
</tr>
<tr>
<td>Drug-Disease</td>
<td>455</td>
<td>0</td>
<td>1,742</td>
<td>4,497</td>
<td>39%</td>
</tr>
<tr>
<td>Drug-Dose</td>
<td>40</td>
<td>0</td>
<td>2,093</td>
<td>2,435</td>
<td>86%</td>
</tr>
<tr>
<td>Duplicate Ther. Class</td>
<td>1,388</td>
<td>0</td>
<td>32,939</td>
<td>37,259</td>
<td>88%</td>
</tr>
<tr>
<td>Drug-Drug</td>
<td>1,017</td>
<td>0</td>
<td>22,100</td>
<td>25,439</td>
<td>87%</td>
</tr>
<tr>
<td>Pediatric</td>
<td>89</td>
<td>0</td>
<td>14,063</td>
<td>15,250</td>
<td>92%</td>
</tr>
<tr>
<td>Pediatric</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>29</td>
<td>86%</td>
</tr>
</tbody>
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Matt Scanlon MD, Professor of Pediatrics, Medical College of Wisconsin, USA
Mitigating Errors – Beyond Training and Policies

Provide perceptual cues and reminders – not just pop-up alerts!

<table>
<thead>
<tr>
<th>Component Results</th>
<th>Value</th>
<th>Units</th>
<th>Standard Range</th>
</tr>
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<tbody>
<tr>
<td>WBC</td>
<td>6.7</td>
<td>K/UL</td>
<td>4.5-11.0</td>
</tr>
<tr>
<td>RBC</td>
<td>4.51</td>
<td>MIL/UL</td>
<td>3.5-5.0</td>
</tr>
<tr>
<td>Hgb</td>
<td>14.1</td>
<td>G/DL</td>
<td>12.0-15.0</td>
</tr>
<tr>
<td>Hct</td>
<td>44.3</td>
<td>%</td>
<td>36.0-48.0</td>
</tr>
<tr>
<td>MCV</td>
<td>93.7</td>
<td>FL</td>
<td>79.0-101.0</td>
</tr>
<tr>
<td>MCH</td>
<td>30.2</td>
<td>PG</td>
<td>25.0-35.0</td>
</tr>
<tr>
<td>MCHC</td>
<td>33.3</td>
<td>%</td>
<td>31.0-37.0</td>
</tr>
<tr>
<td>RDW-CV</td>
<td>12.4</td>
<td>FL</td>
<td>11.0-16.0</td>
</tr>
<tr>
<td>Platelet Count</td>
<td>221</td>
<td>K/UL</td>
<td>150-420</td>
</tr>
<tr>
<td>MPV</td>
<td>9.2</td>
<td>FL</td>
<td>7-10</td>
</tr>
</tbody>
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Mitigating Errors – Beyond Training and Policies

**Provide perceptual cues and reminders – not just pop-up alerts!**

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<tr>
<td>Hgb</td>
<td>L</td>
<td>11.1 G/DL</td>
<td>12.0-15.0</td>
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<tr>
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<td>42.3 %</td>
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<td>7-10</td>
<td></td>
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<tr>
<td>Bands</td>
<td>P Pending %</td>
<td>0-1</td>
<td></td>
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Mitigating Errors – Beyond Training and Policies

Provide perceptual cues and reminders – not just pop-up alerts!

Issue with patients being discharged before registration had been completed, build registration check into physician’s discharge workflow.
Mitigating Errors – Beyond Training and Policies

Provide various levels of warnings or alerts

MOVING FORWARD
Conclusion - Moving Forward

• Review:
  • Humans are fallible, but this fallibility has been well-described by science
  • Fallibilities include:
    – High incidence of “errors of automaticity”
    – Poor performance on vigilance tasks
    – Dangers of task-switching, interruptions
  • Since we understand these fallibilities, we can design safer systems to mitigate harm related to these fallibilities

• Where we’re going next:
  • Using these concepts in creating a culture of safety
Thank you

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Natalie.C.Benda@MedStar.Net
Applying a Systems Approach to Create a Culture of Safety

Kate Kellogg, MD, MPH, CPPS
Associate Medical Director, National Center for Human Factors in Healthcare, MedStar Institute for Innovation, MedStar Health
Associate Medical Director, Quality and Safety, MedStar Health
Assistant Professor of Emergency Medicine, Georgetown University School of Medicine

@KateKelloggMD
#HF safety
#IHICongress
98,000 deaths annually

2000
Causes of Death in the US, 1997

- Accidents: 96k
- Medical errors: 98k
- Lung disease: 109k
- Stroke: 160k
- Cancer: 540k
- Heart disease: 727k

Adapted from: Bleich S. Medical errors: five years after the IOM report. *Issue Brief (Commonw Fund)*. 2005;(830):1-15
Causes of Death in the US, 2013

Motor vehicles: 34k
Firearms: 34k
Suicide: 41k
COPD: 149k
Medical error: 251k
Cancer: 585k
Heart disease: 611k

0.7% of admissions with preventable lethal adverse event

Adapted from: BMJ 2016;353:i2139, http://www.bmj.com/content/353/bmj.i2139
Bungee Jumping

0.0002% of jumps with lethal adverse event

"you're supposed to tie the rope to meeeeee"

1 in 500,000
ERROR
Lack of accountability
Carelessness
Incompetence
80% of flights involve one or more errors
Human Factors

The scientific discipline focused on
(1) understanding human capabilities and
(2) designing tools and machines, systems, and processes for **safe**, **efficient**, and **effective** use.

**Human Factors**

- Psychology
- Physiology
- Cognitive Science
- Industrial Engineering
- Anthropometry
- Interaction Design
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
Just Culture
“The single greatest impediment to error prevention in the medical industry is that we punish people for making mistakes.”

--Lucian Leape
## Just Culture:
The Three Behaviors

<table>
<thead>
<tr>
<th>Normal Error</th>
<th>At-Risk Behavior</th>
<th>Reckless Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Inadvertent action: slip, lapse, mistake</em></td>
<td><em>A choice: risk not recognized or believed justified</em></td>
<td><em>Conscious disregard of unreasonable risk</em></td>
</tr>
<tr>
<td>Manage through changes in:</td>
<td>Manage through:</td>
<td>Manage through:</td>
</tr>
<tr>
<td>• Processes</td>
<td>• Removing incentives for At-Risk Behaviors</td>
<td>• Remedial action</td>
</tr>
<tr>
<td>• Procedures</td>
<td>• Creating incentives for healthy behaviors</td>
<td>• Punitive action</td>
</tr>
<tr>
<td>• Recurrent training</td>
<td>• Increasing situational awareness</td>
<td></td>
</tr>
<tr>
<td>• Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Environment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Support</th>
<th>Coach</th>
<th>Sanction</th>
</tr>
</thead>
</table>

For each 1 serious injury...
10 minor injuries
30 property damage injuries
600 incidents with no visible injury or damage

Bird, 1969
Prevention of Heart Disease

Primary Prevention
- Healthy Lifestyle
- Don’t Start Smoking

Secondary Prevention
- Screening for Risk Factors
- Control of Risk Factors (HTW, DM)

Tertiary Prevention
- CAD: Management After Heart Attack
- Optimizing Management of Heart Failure
MedStar Health’s Integrated Patient Safety Transformational Model (PST)™

**Proactive**
- **Primary Prevention**: Design System for High Quality and Safety, Low Risk
- **Secondary Prevention**: Identify and mitigate existing hazards
- **Tertiary Prevention**: Recover and learn from events

**Reactive**
- **Safety Event**
Operationalize (PST)^TM: Primary Proactive

1. People
   • Selection
   • Training
   • Expectations
2. Safety Culture
3. Clinical Excellence
4. Patient Satisfaction
5. Process Design
6. Standard Work
7. Device Selection
8. Built Design

Design System for High Quality and Safety, Low Risk

MedStar Health National Center for Human Factors in Healthcare
Operationalize PST™: Secondary Proactive

1. Event & Error Reports
2. Risk Mgt /Claims Data
3. Peer Review, OPPE
4. Patient Complaints
5. SSE/Near Miss Reviews
6. Good Catch Program
7. EMR Analytics
8. NRC Picker comments
9. Google/Zocdoc/etc
10. Follow-Up Calls
11. Associate Engagement Survey
12. Survey on Patient Safety

Identify and mitigate existing hazards
Operationalize PST™: Tertiary

Recover and learn from events

Event Response (Candor)
1. Early Notifications
2. Early Review/Go Team (RCA²)
3. Care for Pt & Family
   • Optimize Care
   • Communication & Transparency
   • Disclosure & Apology
   • Bill Hold & Reconciliation
4. Care for Caregiver
5. Impact Change: System-focused
Operationalize PST™: Tertiary

Recover and learn from events

Event Response

Early Review/Go Team (RCA²)

Impact Change: System-focused

Safety Event

Reactive

Tertiary Prevention

Knowledge and Compassion Focused on You
Retained foreign body events
Recommendation types

- Training
- Policy reinforcement
- Counseling
- Review
- Vague
- Compliance check
- Risk management
- Policy change
- Forms/paperwork change
- Physical environment change
- IT structure change
- Institutional change
- Refer out

Recommendation types

- Training
- Policy reinforcement
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- Review
- Vague
- Compliance check
- Risk management
- Policy change
- Forms/paperwork change
- Physical environment change
- IT structure change
- Institutional change
- Refer out

WORDS HAVE POWER
<table>
<thead>
<tr>
<th>Features</th>
<th>Traditional RCA</th>
<th>New Event Review</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timing</strong></td>
<td>2-4 weeks</td>
<td>Immediate-72 hours</td>
</tr>
<tr>
<td><strong>Causal factors</strong></td>
<td>Usually focused on human error</td>
<td>Focused on system</td>
</tr>
<tr>
<td><strong>Solutions</strong></td>
<td>Generally weak</td>
<td>Strong, systems-focused</td>
</tr>
<tr>
<td><strong>Follow up</strong></td>
<td>Sporadic</td>
<td>Planned, extends months-years</td>
</tr>
</tbody>
</table>
IHI National Patient Safety Foundation

RCA²

RCA² Improving Root Cause Analyses and Actions to Prevent Harm

National Patient Safety Foundation
268 Summer Street | Boston, MA 02210 | 617.391.9900 | www.npsf.org

MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You

www.npsf.org/RCA2
AHRQ: CANDOR Toolkit


MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You
Event Review 2.0

Immediate Response
- Inform system leadership
- Care for patient and family/Early disclosure
- Care for caregiver
- Gather time sensitive info

In Depth Event Review
- Interviews
- Understanding the context
- Identify causal factors
- Identify core team

Confirmation & Consensus Meeting

Solutions Meeting
- Templates, project management techniques and documentation

Follow Up

MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You
Event Review 2.0

Immediate Response
- Inform system leadership
- Care for patient and family/Early disclosure
- Care for caregiver
- Gather time sensitive info

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MedStar Health

Knowledge and Compassion Focused on You
The solution of a problem lies in the understanding of a problem; the answer is not outside the problem, it is the problem.

- Jiddu Krishnamurti
Keys to successful interviews

- 1:1
- Establish rapport/comfort
- No leaders/direct supervisors
- Include patient/family as appropriate
- Include staff not directly involved
Get in the tube
Key questions

• What is supposed to happen?
• What usually happens?
• What happened this time?
Organizational Influences
- Resources
- Culture
- Policies and procedures

Supervisory Hazards
- Inadequate oversight
- Emergency procedures
- Supervisory breach

Conditions for Hazards
- Physical environment
- Tools/technology
- Associate condition
- Patient condition
- Coordination of care

Hazards
- Errors – decision vs. skills based
- Violations

Modified from: Shappell SA, Wiegmann DA. The Human Factors Analysis and Classification System – HFACS; 2000
Event Review 2.0

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Knowledge and Compassion Focused on You
5 Rules of Causation

• RCA$^2$ Appendix 3
• Adapted for patient safety by David Marx
• Purposes
  – Avoid typical reactions to error
  – Yield deep analysis and better recommendations
• Describe
  – Cause
  – Effect
  – Event

Department of Veterans Affairs, Veterans Health Administration, NCPS Triage Cards™ for Root Cause Analysis (version October 2001)
Rule 1: Clearly show the “cause and effect” relationship

• Incorrect:
  – A resident was fatigued

• Correct:
  – Residents are scheduled 80 hours per week, which led to increased levels of fatigue, increasing the likelihood that dosing instructions would be misread.
Rule 2: Use specific and accurate descriptors for what occurred, rather than negative and vague

• Incorrect:
  – The manual is poorly written.

• Correct:
  – The pump’s user manual had 8 point font and no illustrations; as a result nursing staff rarely used it, increasing the likelihood that the pump would be programmed incorrectly.
Rule 3: Human errors must have a preceding cause

• Incorrect:
  – The resident selected the wrong dose, which led to the patient being overdosed.

• Correct:
  – Drugs in the Computerized Physician Order Entry (CPOE) system are presented to the user without sufficient space between the different doses on the screen, increasing the likelihood that the wrong dose could be selected, which led to the patient being overdosed.
Rule 4: Violations of procedure are not root causes, but must have a preceding cause

• Incorrect:
  – The techs did not follow the procedure for CT scans, which led to the patient receiving an air bolus from an empty syringe, resulting in a fatal air embolism.

• Correct:
  – Noise and confusion in the prep area, coupled with production pressures, increased the likelihood that steps in the CT scan protocol would be missed, resulting in the injection of an air embolism from using an empty syringe.
Rule 5: Failure to act is only causal when there is a pre-existing duty to act

• Incorrect:
  – The nurse did not check for STAT orders every half hour, which led to a delay in the start of anticoagulation therapy, increasing the likelihood of a blood clot.

• Correct:
  – The absence of an assignment for designated RNs to check orders at specified times increased the likelihood that STAT orders would be missed or delayed, which led to a delay in therapy.
Event Review 2.0

**Immediate Response**
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**Solutions Meeting**

**Follow Up**

MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You
Strong Actions

- Architectural/physical plant changes
- New devices with usability testing
- Engineering control (forcing function)
- Simplify process
- Standardize equipment or process
- Tangible involvement by leadership
## Intermediate Actions

<table>
<thead>
<tr>
<th>Redundancy</th>
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</tr>
<tr>
<td>Enhanced documentation/communication</td>
</tr>
</tbody>
</table>
Weaker Actions

Double checks
Warnings
New procedure/memorandum policy
Training
Consider

• Short versus long term solutions
• Ease/cost of implementation
• Select a suite of recommendations
Measurement & Follow up
“Insanity: Continuing to do the same thing and expecting different results.”
Thank you

Kate Kellogg, MD, MPH, CPPS
@KateKelloggMD
Kathryn.M.Kellogg@MedStar.Net
Usability: Why It Matters for Patient Safety

Natalie Abts, MS,
Usability Services Senior Program Manager
National Center for Human Factors in Healthcare
MedStar Institute for Innovation, MedStar Health

@Natalie_Abts
#HFsafe
#IHICongress
Everyday Usability
### Usability in Healthcare

<table>
<thead>
<tr>
<th>Component Results</th>
<th>Value</th>
<th>Units</th>
<th>Standard Range</th>
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</thead>
<tbody>
<tr>
<td>WBC</td>
<td>2.7</td>
<td>K/UL</td>
<td>4.5-11.0</td>
</tr>
<tr>
<td>RBC</td>
<td>4.51</td>
<td>MIL/UL</td>
<td>3.5-5.0</td>
</tr>
<tr>
<td>Hgb</td>
<td>11.1</td>
<td>G/DL</td>
<td>12.0-15.0</td>
</tr>
<tr>
<td>Hct</td>
<td>42.3</td>
<td>%</td>
<td>36.0-48.0</td>
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<tr>
<td>MCV</td>
<td>93.7</td>
<td>FL</td>
<td>79.0-101.0</td>
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<tr>
<td>MCH</td>
<td>31.2</td>
<td>PG</td>
<td>25.0-35.0</td>
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<tr>
<td>MCHC</td>
<td>33.3</td>
<td>%</td>
<td>31.0-37.0</td>
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<tr>
<td>RDW-CV</td>
<td>12.4</td>
<td>FL</td>
<td>11.0-16.0</td>
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<td>Platelet Count</td>
<td>221</td>
<td>K/UL</td>
<td>150-420</td>
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<tr>
<td>MPV</td>
<td>9.8</td>
<td>FL</td>
<td>7-10</td>
</tr>
<tr>
<td>Bands</td>
<td>P</td>
<td>Pending</td>
<td>0-1</td>
</tr>
</tbody>
</table>
Usability in Healthcare, cont.

Ibuprofen
(Examples are Motrin, Advil, and others)
Dosing Chart

<table>
<thead>
<tr>
<th>Weight in Pounds</th>
<th>Weight in Kg</th>
<th>Total Dose 50mg/kg dose</th>
<th>Infant Oral Dose 10mg/kg dose</th>
<th>Infant Oral Dose 10mg/kg dose</th>
<th>Infant Oral Dose 24 hours</th>
<th>Infant Oral Dose 24 hours</th>
<th>Caplets 100mg</th>
<th>Caplets 100mg</th>
<th>Caplets 100mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 lbs</td>
<td>5.5</td>
<td>55 mg</td>
<td>11 ml 1/2 tabs</td>
<td>2.75 ml 3/4 tabs</td>
<td>3.5 ml</td>
<td>4.5 ml</td>
<td>2 caplets</td>
<td>2 caplets</td>
<td>2 caplets</td>
</tr>
<tr>
<td>15 lbs</td>
<td>6.8</td>
<td>66 mg</td>
<td>13 ml 3/4 tabs</td>
<td>3.5 ml 3/4 tabs</td>
<td>4 ml</td>
<td>5 ml</td>
<td>3 caplets</td>
<td>3 caplets</td>
<td>3 caplets</td>
</tr>
<tr>
<td>18 lbs</td>
<td>8.1</td>
<td>81 mg</td>
<td>16 ml 3/4 tabs</td>
<td>4 ml</td>
<td>6 ml</td>
<td>7 ml</td>
<td>3 caplets</td>
<td>3 caplets</td>
<td>3 caplets</td>
</tr>
<tr>
<td>20 lbs</td>
<td>9</td>
<td>90 mg</td>
<td>18 ml 3/4 tabs</td>
<td>4.5 ml</td>
<td>7.5 ml</td>
<td>9 ml</td>
<td>3 caplets</td>
<td>3 caplets</td>
<td>3 caplets</td>
</tr>
<tr>
<td>24 lbs</td>
<td>10.9</td>
<td>109 mg</td>
<td>22 ml 3/4 tabs</td>
<td>5 ml</td>
<td>9 ml</td>
<td>11 ml</td>
<td>3 caplets</td>
<td>3 caplets</td>
<td>3 caplets</td>
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<tr>
<td>28 lbs</td>
<td>12.7</td>
<td>127 mg</td>
<td>27 ml 3/4 tabs</td>
<td>6.5 ml</td>
<td>12.5 ml</td>
<td>16 ml</td>
<td>4 caplets</td>
<td>4 caplets</td>
<td>4 caplets</td>
</tr>
<tr>
<td>30 lbs</td>
<td>13.6</td>
<td>136 mg</td>
<td>30 ml 3/4 tabs</td>
<td>8 ml</td>
<td>15 ml</td>
<td>20 ml</td>
<td>5 caplets</td>
<td>5 caplets</td>
<td>5 caplets</td>
</tr>
<tr>
<td>34 lbs</td>
<td>15.5</td>
<td>155 mg</td>
<td>35 ml 3/4 tabs</td>
<td>10 ml</td>
<td>17 ml</td>
<td>25 ml</td>
<td>6 caplets</td>
<td>6 caplets</td>
<td>6 caplets</td>
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<tr>
<td>38 lbs</td>
<td>17.3</td>
<td>173 mg</td>
<td>40 ml 3/4 tabs</td>
<td>12 ml</td>
<td>20 ml</td>
<td>30 ml</td>
<td>7 caplets</td>
<td>7 caplets</td>
<td>7 caplets</td>
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<tr>
<td>40 lbs</td>
<td>18.2</td>
<td>182 mg</td>
<td>44 ml 3/4 tabs</td>
<td>13 ml</td>
<td>25 ml</td>
<td>35 ml</td>
<td>8 caplets</td>
<td>8 caplets</td>
<td>8 caplets</td>
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<tr>
<td>45 lbs</td>
<td>20.5</td>
<td>205 mg</td>
<td>50 ml 3/4 tabs</td>
<td>15 ml</td>
<td>30 ml</td>
<td>45 ml</td>
<td>9 caplets</td>
<td>9 caplets</td>
<td>9 caplets</td>
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<tr>
<td>50 lbs</td>
<td>22.3</td>
<td>228 mg</td>
<td>60 ml 3/4 tabs</td>
<td>18 ml</td>
<td>40 ml</td>
<td>60 ml</td>
<td>10 caplets</td>
<td>10 caplets</td>
<td>10 caplets</td>
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<tr>
<td>55 lbs</td>
<td>25.0</td>
<td>250 mg</td>
<td>70 ml 3/4 tabs</td>
<td>21 ml</td>
<td>50 ml</td>
<td>75 ml</td>
<td>11 caplets</td>
<td>11 caplets</td>
<td>11 caplets</td>
</tr>
<tr>
<td>60 lbs</td>
<td>27.3</td>
<td>273 mg</td>
<td>85 ml 3/4 tabs</td>
<td>25 ml</td>
<td>65 ml</td>
<td>90 ml</td>
<td>12 caplets</td>
<td>12 caplets</td>
<td>12 caplets</td>
</tr>
<tr>
<td>65 lbs</td>
<td>29.5</td>
<td>295 mg</td>
<td>100 ml 3/4 tabs</td>
<td>30 ml</td>
<td>85 ml</td>
<td>120 ml</td>
<td>15 caplets</td>
<td>15 caplets</td>
<td>15 caplets</td>
</tr>
<tr>
<td>70 lbs</td>
<td>32</td>
<td>320 mg</td>
<td>120 ml 3/4 tabs</td>
<td>35 ml</td>
<td>110 ml</td>
<td>150 ml</td>
<td>18 caplets</td>
<td>18 caplets</td>
<td>18 caplets</td>
</tr>
<tr>
<td>75 lbs</td>
<td>34</td>
<td>340 mg</td>
<td>140 ml 3/4 tabs</td>
<td>40 ml</td>
<td>130 ml</td>
<td>170 ml</td>
<td>21 caplets</td>
<td>21 caplets</td>
<td>21 caplets</td>
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<tr>
<td>80 lbs</td>
<td>36.5</td>
<td>365 mg</td>
<td>160 ml 3/4 tabs</td>
<td>45 ml</td>
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<td>200 ml</td>
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<tr>
<td>85 lbs</td>
<td>38.5</td>
<td>385 mg</td>
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<td>225 ml</td>
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<td>30 caplets</td>
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<tr>
<td>90 lbs</td>
<td>41.0</td>
<td>410 mg</td>
<td>200 ml 3/4 tabs</td>
<td>55 ml</td>
<td>200 ml</td>
<td>250 ml</td>
<td>35 caplets</td>
<td>35 caplets</td>
<td>35 caplets</td>
</tr>
<tr>
<td>95 lbs</td>
<td>43.1</td>
<td>431 mg</td>
<td>220 ml 3/4 tabs</td>
<td>60 ml</td>
<td>225 ml</td>
<td>300 ml</td>
<td>40 caplets</td>
<td>40 caplets</td>
<td>40 caplets</td>
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<tr>
<td>Over 95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date:

Your child’s weight today is:

Administer Ibuprofen as on the above chart every 6 to 8 hours for fever.
F.Y.I: 1 teaspoon = 5ml

Note: Do not administer Ibuprofen to any child under 6 months of age without first speaking with your Pediatrician.
Usability:
The extent to which a product can be used by:
  • specified users to achieve
  • specified goals with
  • effectiveness, efficiency and satisfaction in a
  • specified context of use
Usability is…

1: User Interface Design
- Displays and Controls
- Screen Design
- Clicks & Drags
- Colors & Navigation

2: Cognitive Task Support
- “Workflow Design”
- Smart Data Visualization
- Support Cognitive Work Functionality
Why Do We Have Unusable Products?

- Manufacturer design deficiencies
- Regulations do not ensure usability
- Products may not fit into work system

What Happens When Products Are Not Usable?

- Use errors more likely
- Responsibility falls on front line workers to adapt and address problems
Shared Responsibility for Usability

Vendors and Developers
- Prioritize usability
- User-centered design

Healthcare Systems
- Support testing
- Engage in training
- Evaluate devices before purchase

Researchers/Govt.
- Provide tools/support
- Regulation that facilitates usability
MedStar Health’s Integrated Patient Safety Transformational Model (PST)™

Proactive

Primary Prevention
Design System for High Quality and Safety, Low Risk

Realities of Actual Context

Proactive

Secondary Prevention
Identify and mitigate existing hazards

Proactive

Safety Event

Reactive

Tertiary Prevention
Recover and learn from events

Knowledge and Compassion Focused on You
PRIMARY PREVENTION
<table>
<thead>
<tr>
<th>Product Phase</th>
<th>Usability Tool Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptualization</td>
<td>Ethnography</td>
</tr>
<tr>
<td></td>
<td>Focus Groups and Interviews</td>
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<tr>
<td></td>
<td>Legacy Systems Evaluations</td>
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<tr>
<td>Analysis</td>
<td>Use Cases and User Profiles</td>
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<td></td>
<td>Task Analysis</td>
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<td>Failure Modes and Effects Analysis</td>
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<tr>
<td>Design</td>
<td>Heuristic Evaluation</td>
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<td>Iterative Prototype Testing</td>
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<td></td>
<td>Instruction and Labeling Assessments</td>
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<tr>
<td>Evaluation</td>
<td>Formative User Testing</td>
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<td>Procurement</td>
<td>Environmental Analysis</td>
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<td>Comparative Usability Testing</td>
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<td>Risk Verification</td>
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<tr>
<td>Implementation</td>
<td>Work Systems Analysis</td>
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<td>Training Evaluation</td>
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<td></td>
<td>In-Situ Testing</td>
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<tr>
<td>Monitoring</td>
<td>Adverse Event Investigation</td>
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<td></td>
<td>Root Cause Analysis</td>
</tr>
<tr>
<td></td>
<td>Risk and Hazard Analysis</td>
</tr>
</tbody>
</table>
Primary Prevention – Bed Usability Study

- Comparison usability study between four beds (2 ICU, 2 MedSurg) produced by two manufacturers
- Evaluated use scenario with target end users (ICU and MedSurg nurses)
- Identified issues related to safety and usability
Bed Interface Usability Issues
Primary Prevention – What Can You Do?

• Advocate for usability testing and capture of performance data before product purchase
• Consider human factors principles and the role of the work system when reviewing new products
• Anticipate potential use problems that could be addressed during implementation
SECONDARY PREVENTION
MedStar Health’s Integrated Patient Safety Transformational Model (PST)™

**Proactive**
- **Primary Prevention**: Design System for High Quality and Safety, Low Risk
- **Realities of Actual Context**: Design System for High Quality and Safety, Low Risk

**Proactive**
- **Secondary Prevention**: Identify and mitigate existing hazards

**Reactive**
- **Tertiary Prevention**: Recover and learn from events
Secondary Prevention – Hazard Analyses

• Example 1: Poor bed alarm usability a suspected factor in recent patient falls
• Example 2: Nursing complaints about difficulties using new therapeutic beds
Bed Interface Usability Issues
Systems Effects of Poor Usability

- Workflow issue – staff sends working beds to be repaired
- Resources issue – disposable chair alarms utilized when beds are “broken”
- Interoperability issue – bed cable and chair alarm cable identical and utilize the same connection
- Training issue – hands-on training is variable; incorrect information is passed on to new employees

Carayon et al., (2006)
Therapeutic Bed Usability Issues
Secondary Prevention – What Can You Do?

• Identify problems (e.g. workarounds, near misses, inefficiencies) and assess role of device
• Evaluate devices with usability tools (e.g. heuristic evaluation)
14 Usability Heuristics
(Nielsen, 1994; Sneiderman, 1998; Zhang, 2003)

1. Consistency and standards
2. Visibility of system state
3. Match between system and world
4. Minimalist
5. Minimize memory load
6. Informative feedback
7. Flexibility and efficiency
8. Good error messages
9. Prevent errors
10. Clear closure
11. Reversible actions
12. Use users’ language
13. Users in control
14. Help and documentation
## Preventative Actions

<table>
<thead>
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<th>Intermediate</th>
<th>Weak</th>
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</tr>
<tr>
<td></td>
<td>Standardized communication tools</td>
<td>Enhanced documentation/communication</td>
</tr>
</tbody>
</table>

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MedStar Health
National Center for Human Factors in Healthcare

Knowledge and Compassion Focused on You
TERTIARY PREVENTION
MedStar Health’s Integrated Patient Safety Transformational Model (PST)™

Proactive

Primary Prevention
Design System for High Quality and Safety, Low Risk

Realities of Actual Context

Secondary Prevention
Identify and mitigate existing hazards

Proactive Safety Event

Reactive Tertiary Prevention
Recover and learn from events

Knowledge and Compassion Focused on You
Bed Rail Serious Safety Event
Manufacturer Suggested Solution
New Bed Rail Modification
Tertiary Prevention – What Can You Do?

• Assess problems using similar methods to secondary interventions

• Focus on strong actions if possible
  • Device modifications may be higher probability after an event if reported to manufacturer
  • Ensure solutions are evaluated realistically before implementation
  • Consider removing device if problem cannot be mitigated
Conclusion

- Poorly designed devices can affect the other aspects of the work system
- Usability tools can be utilized during all stages of the device lifecycle to prevent use errors and unsafe conditions
- When possible, focus on strong actions to mitigate potential use errors and unsafe conditions
Thank you

Natalie Abts, MS

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Thinking Differently About Safety: Resilience Engineering and Health IT

Rollin J. (Terry) Fairbanks, MD, MS, CPPS
Assistant Vice President, Ambulatory Quality & Safety, MedStar Health
Founding Director, National Center for Human Factors in Healthcare
Attending Emergency Physician, MedStar Washington Hospital Center
Professor of Emergency Medicine, Georgetown University School of Medicine

@TerryFairbanks
#HFsafety
#IHICongress
Context: Human Factors

“We don’t redesign humans; We redesign the system within which humans work”
Complex Adaptive Systems: 
*work as done – vs - work as imagined*

How managers believe work is being done (rules)

\[\text{GAP}\]

Every-day work: How work IS being done

Adapted from: Ivan Pupulidy
Safety I: Why did they give the wrong vial?

Safety II: Why did they give the right vial all the other times?
Safety-I

- What goes wrong
- Defined by failure
- Achieved by constraints
- Critical inquiry

Safety-II

- What goes right
- Defined by success
- Achieved by adaptability
- Appreciative inquiry

Hollnagel, Wears, Braithwaite; From Safety I to Safety II White Paper, 2015
three contrasting safety models

- **ultra resilient**
  - **context:** taking risks is the essence of the work
  - **cult** of fighter spirit, champions, heroes, villains
  - **safety model:** power to experts
    - "give me best chances and safest tools to survive in these adverse conditions and make exploits"
  - **safety training:** learning through shadowing, acquiring professional experience, "training for zebra", working on knowing one's own limitations

- **HRO model**
  - **context:** risk is not sought out, but it is inherent in the activity
  - **cult** of group intelligence and adaptation to changing situations
  - **safety model:** power to the group,
    - ability of the group to organize itself (roles), to provide mutual protection to its members, to apply procedures, to react to anomalies, to adapt, perceive changes and make sense of changes in the context
  - **training** in teamwork to gain knowledge of abilities and adaptability in applying procedures to suit the context

- **ultra safe**
  - **context:** risk is excluded as much as possible
  - **cult** of applying procedures and safety rules by an effective supervisory organization
  - **safety model:** power to the regulators
    - of the system to avoid exposing front-line actors to unnecessary risks
  - **training** in teamwork to apply procedures and manage work even if abnormal events occur

---

**Unknowable events model**

**HRO model**

**Ultra safe**

---

**MedStar Health**

**National Center for Human Factors in Healthcare**

**R.L. Wears, MD MS PHD**

**Knowledge and Compassion Focused on You**
Resilience depends on ...

Recognizing when adaptive capacity is failing or becoming inadequate

Recognizing the threat of exhausting buffers

Detecting the need change priorities in trade-offs

Changing viewpoint beyond the nominal state

Learning new ways to adapt
Example: Spinal Epidural Abscess
How does this apply to Health IT?
The Two Bins of Usability

1: User Interface Design
- Displays and Controls
- Screen Design
- Clicks & Drags
- Colors & Navigation

2: Cognitive Task Support
- “Workflow Design”
- Smart Data Visualization
- Support Cognitive Work
- Functionality

Photo Credit: Robert L. Wears, MD PhD
<table>
<thead>
<tr>
<th>ID</th>
<th>Diagnosis</th>
<th>Assigned To</th>
<th>Bed</th>
<th>Assignment</th>
<th>Status</th>
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<tr>
<td>F77</td>
<td>Fever</td>
<td>IUPT</td>
<td>TT03</td>
<td>MM11</td>
<td>F V</td>
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<tr>
<td>F37</td>
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<td>ML04</td>
<td>PR00</td>
<td>TT03</td>
<td>V</td>
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<tr>
<td>M83</td>
<td>Palpitations</td>
<td>IM01</td>
<td>SL08</td>
<td></td>
<td>D</td>
</tr>
<tr>
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<td>IUPT</td>
<td>LH01</td>
<td>MM04</td>
<td>FD V</td>
</tr>
<tr>
<td>M62</td>
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<td>IM01</td>
<td>LH01</td>
<td>MM04</td>
<td>FD V</td>
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<td>IUPT</td>
<td>LH01</td>
<td>MM04</td>
<td>FD V</td>
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<tr>
<td>F58</td>
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<td>IM01</td>
<td>SB01</td>
<td>SS02</td>
<td>FD V</td>
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<td>IUPT</td>
<td>GM01</td>
<td>MM04</td>
<td>F V</td>
</tr>
<tr>
<td>M66</td>
<td>Eye Pain</td>
<td>IM01</td>
<td>SL08</td>
<td>GM04</td>
<td>F V</td>
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<tr>
<td>F94</td>
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<td>IM01</td>
<td>SB15</td>
<td>GM01</td>
<td>D</td>
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<tr>
<td>M42</td>
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<td>IM01</td>
<td>GM01</td>
<td>MM04</td>
<td>FD V</td>
</tr>
<tr>
<td>F80</td>
<td>RUG ABD PAIN</td>
<td>IM01</td>
<td>SB01</td>
<td>SS02</td>
<td>F V</td>
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<tr>
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<td>BG05</td>
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<td>F D V</td>
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<tr>
<td>F44</td>
<td>Nausea and Vomiting</td>
<td>IUPT</td>
<td>BG05</td>
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<td>F V</td>
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<td>F48</td>
<td>SOB With Fever (?PNA / CAP)</td>
<td>IM01</td>
<td>TC02</td>
<td>TA00</td>
<td>V</td>
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<tr>
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<td>FD V</td>
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<td>F24</td>
<td>flank/low back pain</td>
<td>IM01</td>
<td>HS03</td>
<td>SM11</td>
<td>FD V</td>
</tr>
</tbody>
</table>
Prescription Writing Task
[FIND DRUGS]

Drug: bactrim

Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS po bid x 3 days
Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS 2 po bid x 7 days (C-MRSA dose)
Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS po bid x 14 days
Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS po bid x 7 days

MedStar Health
National Center for Human Factors in Healthcare
Knowledge and Compassion Focused on You
### Plain Films

<table>
<thead>
<tr>
<th>L</th>
<th>R</th>
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<tbody>
<tr>
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<tr>
<td>Elbow</td>
<td></td>
</tr>
<tr>
<td>Femur</td>
<td></td>
</tr>
<tr>
<td>Foot</td>
<td></td>
</tr>
<tr>
<td>Forearm</td>
<td></td>
</tr>
<tr>
<td>Hand</td>
<td></td>
</tr>
<tr>
<td>Humerus</td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td></td>
</tr>
<tr>
<td>Tib/Fib</td>
<td></td>
</tr>
</tbody>
</table>

### CT

<table>
<thead>
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<th>L</th>
<th>R</th>
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<tbody>
<tr>
<td>Abdomen</td>
<td>Spine</td>
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<tr>
<td>Chest</td>
<td></td>
</tr>
<tr>
<td>C-Spine</td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td></td>
</tr>
<tr>
<td>Pelvis</td>
<td></td>
</tr>
</tbody>
</table>

### MRI

<table>
<thead>
<tr>
<th>L</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rad Subdepts</td>
<td>Skip</td>
</tr>
</tbody>
</table>

### HEAD AND NECK

- Panorex Complete
- Soft Tissue Neck

### UPPER EXTREMITY

- Shoulder Left
- Shoulder Right
- Humerus Left
- Humerus Right
- Elbow Left
- Elbow Right
- Radius/Ulna Left
- Radius/Ulna Right
- Wrist Left
- Wrist Right
- Finger Left Thumb
- Finger Left Index
- Finger Left Middle
- Finger Left Ring
- Finger Left Little
- Finger Right Thumb
- Finger Right Index
- Finger Right Middle
Multiple inpatient PEs occur over 2 years

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

Why are those doctors so non-compliant?
DVT-PE Prophylaxis Pathway

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
DVT-PE Prophylaxis Pathway

DVTTEST, LT FORTY M 24 Y
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
DVT-PE Prophylaxis Pathway

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 physicians
- Increase in appropriate prophylaxis rates
  
  50% → 66% → 93%

Case Studies of Human Factors in Patient Safety & Guided Event Review

Rollin J. (Terry) Fairbanks, MD, MS, CPPS
Assistant Vice President, Ambulatory Quality & Safety, MedStar Health
Attending Emergency Physician, MedStar Washington Hospital Center
Professor of Emergency Medicine, Georgetown University
Bringing this all together

RCA EVENT REVIEW
What is the impact on the safety culture?
(Annie’s story)

https://www.youtube.com/watch?v=zeldVu-3DpM
Glucometer RCA…

• Patient with hx of poorly-controlled BG levels
  – Admitted to diabetic unit at hospital
  – Pt appears normal or hyperglycemic
• Accucheck indicates critically low BG
  – Misinterpreted by tech and RN as critical high
• Pt given repeated doses of insulin
  – Altered, rapid response called
  – Receives D50, Glucagon, & D10 drip
• Stays in ICU for 3 days: MAJOR EVENT
Nurse Suspended
One week later...

Repeated Incident

- Same scenario, different unit
- Multiple RNs, NP involved
- All misinterpreted critical LO as critical HI

**THIS WAS A NORMAL ERROR**

Did disciplinary response make us safer?
Patient 08092011
Date 08/09/11 12:44

Out of Reportable Range

⚠️ Critical Value; Repeat; Lab draw for >600.

OK
How could you miss it?
Glucometer Video
“Critical Low” 0.1% (119/80,000)
## Procurement:
**Who determines wording?**

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Text of ‘Out of Reportable Range’ message popup</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Critical value; Repeat; Lab Draw for &gt; 600.</td>
</tr>
<tr>
<td>B</td>
<td>RR Lo = result &lt;40; RR Hi = result &gt;600</td>
</tr>
<tr>
<td>C</td>
<td><strong>Out of range: repeat test to confirm</strong></td>
</tr>
<tr>
<td>D</td>
<td>Critical value; repeat within 15 mins; notification required; lab draw for &gt;600</td>
</tr>
<tr>
<td>E</td>
<td>Critical value; you must repeat immediately; STAT glucose Lab draw for RR HI</td>
</tr>
<tr>
<td>F</td>
<td>Repeat test</td>
</tr>
</tbody>
</table>
One week later…
Repeated Incident

• Same scenario, different unit
• Multiple RNs, NP involved
• All misinterpreted critical LO as critical HI

THIS WAS A NORMAL ERROR

Did disciplinary response make us safer?
What is the impact on the safety culture? (Annie’s story)

https://www.youtube.com/watch?v=zeldVu-3DpM
What *is* the cause of our safety problem?

BAD PEOPLE?
Bad providers?
Incompetence?
Carelessness?
Lack of accountability?

Complex, Messy System
- Health IT
- Medical Devices
- Processes

Individual Blame Culture

‘Just Try Harder’ ...is not a strategy

Knowledge and Compassion *Focused on You*
EXAMPLES, EXAMPLES, EXAMPLES…
Example: Defibrillator Case

![Graph showing survival from sudden cardiac arrest over time](graph.png)

- **Chance of success reduced 7-10% each minute**

**Survival from Sudden Cardiac Arrest.**

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National Center for Human Factors in Healthcare

Knowledge and Compassion **Focused on You**
Defibrillator Case

- Patient has cardiac arrest
- Nurse with patient
- Charges unit to shock...
- Presses “on” button
- Machine powers down
  - 2-3 minute delay in shock
Defibrillator Case = COMMON ERROR

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

Improvisation in unfamiliar environments
No routines or rules available to help handle

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

**Automaticity-Skill-Based**
Automated Routines
Require little conscious attention

**Trial & Error**
1. Misapply good rule
2. Not apply good rule
3. Apply bad rule

Slips and lapses

---

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)
Slips and Lapses: Common

Policies, Inservices, Discipline, Training, Vigilance, "Mindfulness"

To Err Is Human
Building a Safer Health System

Knowledge and Compassion Focused on You
“Skills-Based Error”
= Slips and Lapses
= Automatic Mode Errors

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 yo, sustained SVT & chest pain
- Primary interventions unsuccessful
- 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 counter shock for SVT
  - 71% of participants never aware

Vendor Response

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

MORE EXAMPLES…

(TBA, based on audience participation)
Develop **Sustainable** Solutions

Develop **Effective** Solutions

Consider Solutions in Context  
(*work as actually done*)

Focus on HAZARDS- be proactive

Build Resilience→Culture & Empowerment
4 things leaders can do tomorrow

1. Follow Systems Approach...
   ...& Be a Learning Organization.

2. Shift resources to $1^o$ and $2^o$ prevention

3. Implement Just Culture and start the change
   - Senior Leaders to frontline workers

4. Follow an event review process based on safety science
   - NPSF’s new “RCA squared” (npsf.org)
   - AHRQ’s new “CANDOR” (ahrq.gov)
“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…

• 18 years later…. No Change?
  – Need a true systems approach
Discussion

Thank you

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DISCUSSION

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Recap

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Georgetown University School of Medicine
#Hfsafety / #IHIcongress
Panel Discussion

Facilitated by Raj Ratwani, PhD
Center Director & Scientific Director
National Center for Human Factors in Healthcare

Panel Faculty
National Center for Human Factors Engineering in Healthcare
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