



# *Patient safety & human factors engineering in EMS & hospital performance*

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# Objectives

**“How can EMS systems be designed for lower adverse event rates?”**

- A safety engineering perspective
- Overview
  - Cases
  - Systems Approach
  - Human Factors Engineering
  - Just Culture
  - Event reporting



# Case

- 32 year old healthy man w/wife, young kids
- Presents to EMS with rapid heartbeat
  - Unstable SVT (chest pain, hypotension)
- Synchronized shock @100j → refractory
- Try again @ 200j → **VF Arrest**
- 60m resuscitation attempt → **patient dies**
- Code summary reveals that paramedic failed to put device in SYNC mode for second shock

# Case

## ■ Response?

- Fire the medic?
- Discipline her?
- Retrain the EMS?
- Forbid certain param. from converting?
- New policy Memo?

## ■ Primary cause

- Human error, inadequate training, familiarity with device?

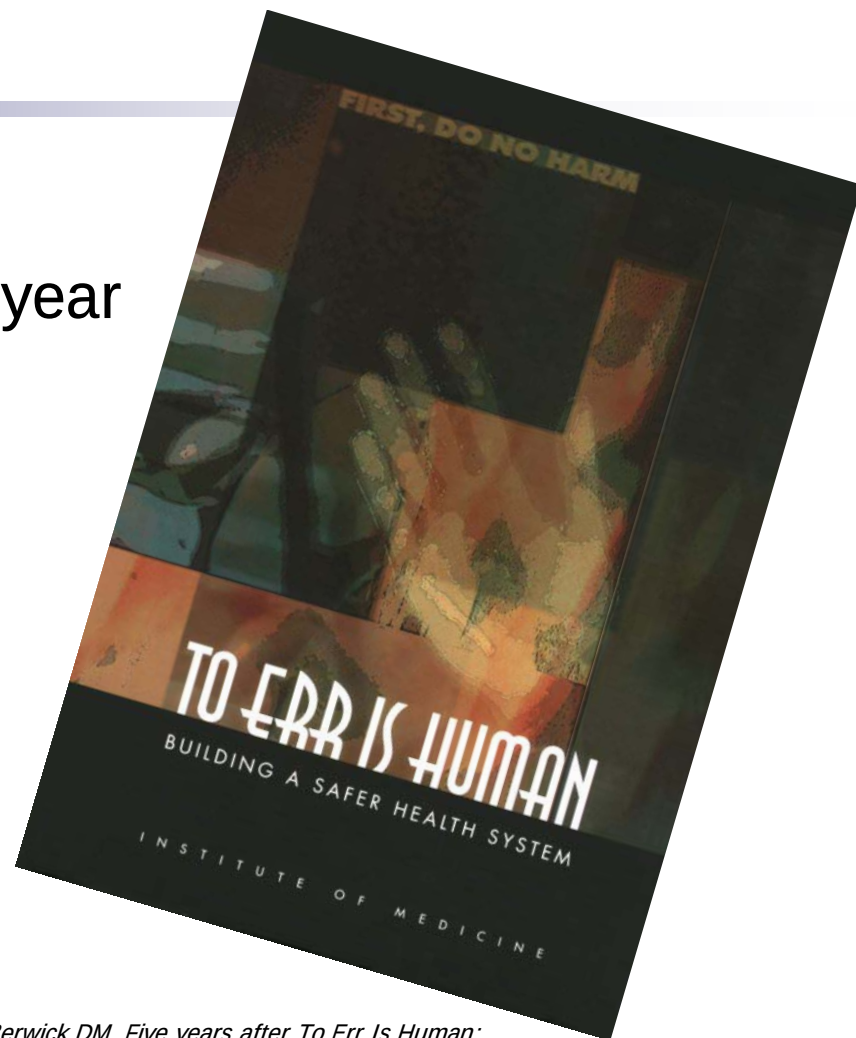




# The Problem

- IOM Report in 2000:
  - Est. 44,000-98,000 deaths/year
  - ED: highest rate. EMS??
- Government mandate:  
50% less error in 5 years
- 5 years later....  
**NO CHANGE!!**

-----**WHY?**-----



*Leape LL, Berwick DM. Five years after To Err Is Human: what have we learned? JAMA 2005; 293(19):2384-2390.*





# Systems Approach

Is the goal to : “Eliminate Error?”

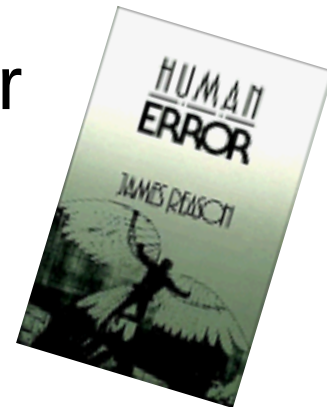
→ NO

- 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
- retraining, policy, memos, M&M, etc **do not** create sustained improvement in safety

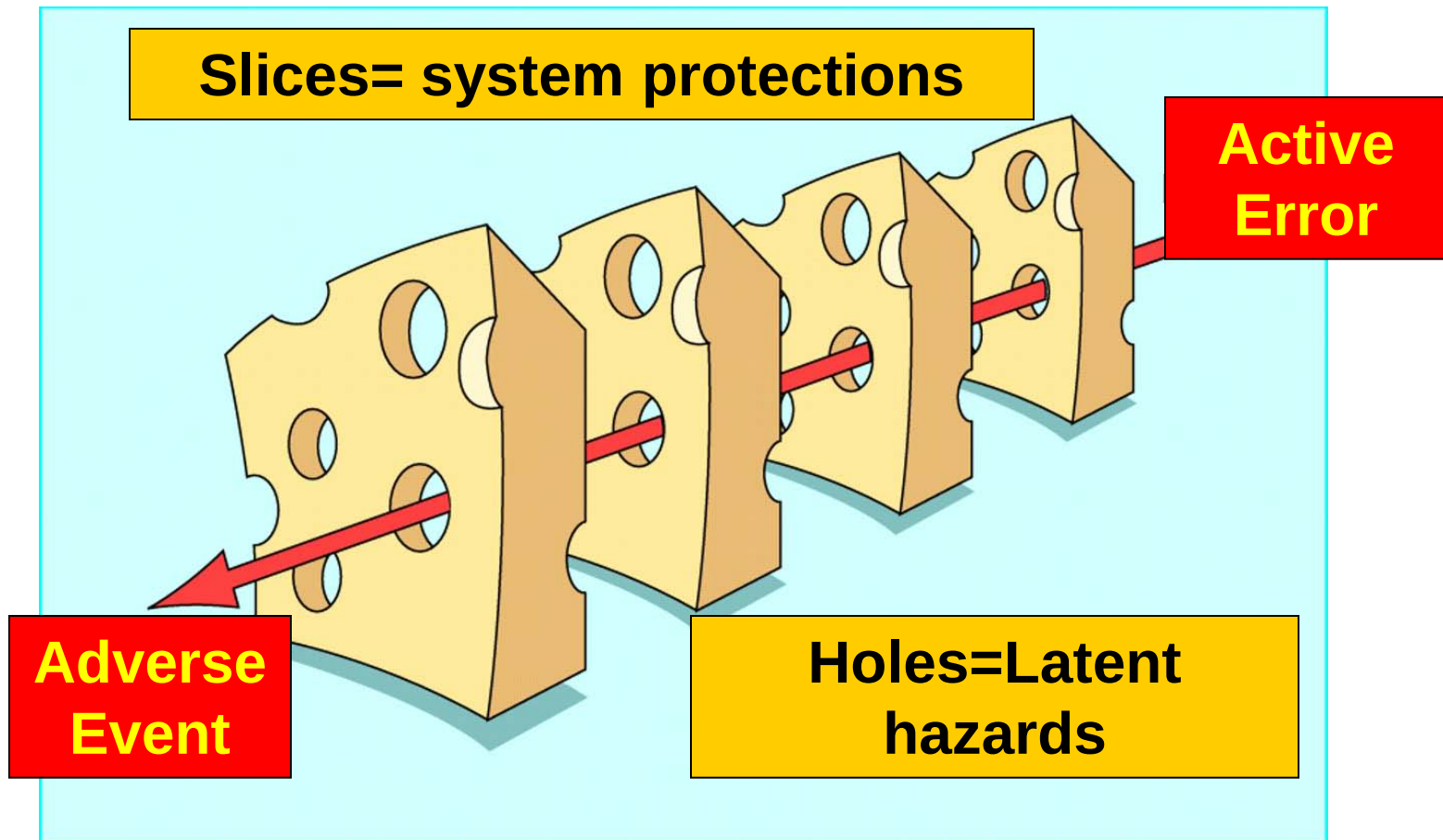


# Mitigating Human Error

- 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



# Swiss Cheese Model (Reason)





# Human Factors Engineering (HFE)



- Human Factors Engineering:
  - Optimizes the relationship between technology and the human user
  - Designs the system to match abilities
- “Designing for human use”
- How humans err is not the focus
- Prominent in aviation, nuclear, military

# Principles

- Know

- 

- 

- Ensure

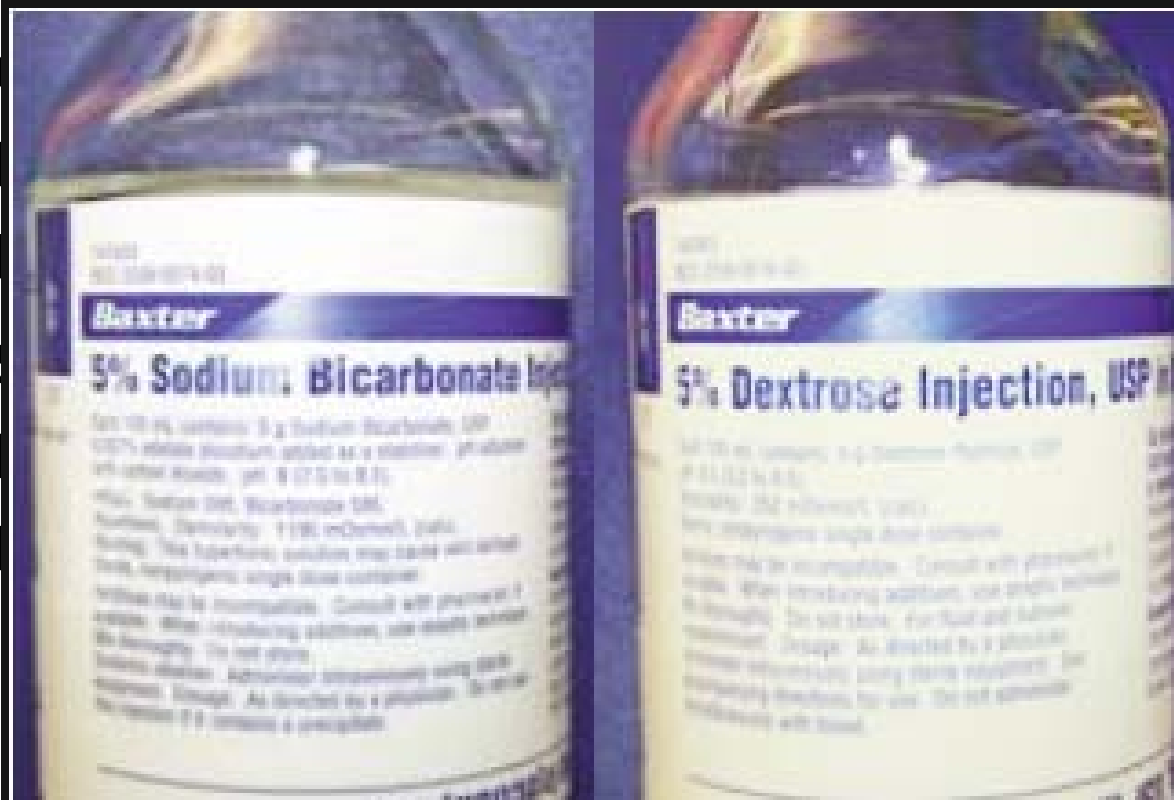
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- 

- Human

- Un

- Evidence-based (NOT designer's "common sense")





# Back to Case

- Design issues
  - Lack of user feedback
    - Device silently leaves sync mode
  - Lack of forcing function
    - Allows unsynchronized shock for SVT
- Standardization issues
  - Hospital had several different makes
- Liability issues, culture of blame
  - Prior cases known, others not





# Defibrillator Usability Study

- Fourteen paramedic participants
- Four tasks: 2 routine, 2 emergent
- Two defibrillator models
- SimMan™ patient simulator
- *50% of paramedics inadvertently delivered an unsynchronized countershock for SVT*
  - **71% of participants 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.



# Potential EMS Responses: What is the impact?

- Fire or discipline the paramedic?
  - Creates culture with incentive to hide errors
  - Results in less experienced workforce
- Retrain the whole paramedic staff?
  - Ineffective way to improve system reliability
- Study past events?
  - Requires culture change
  - Requires true protected reporting



# Power off...

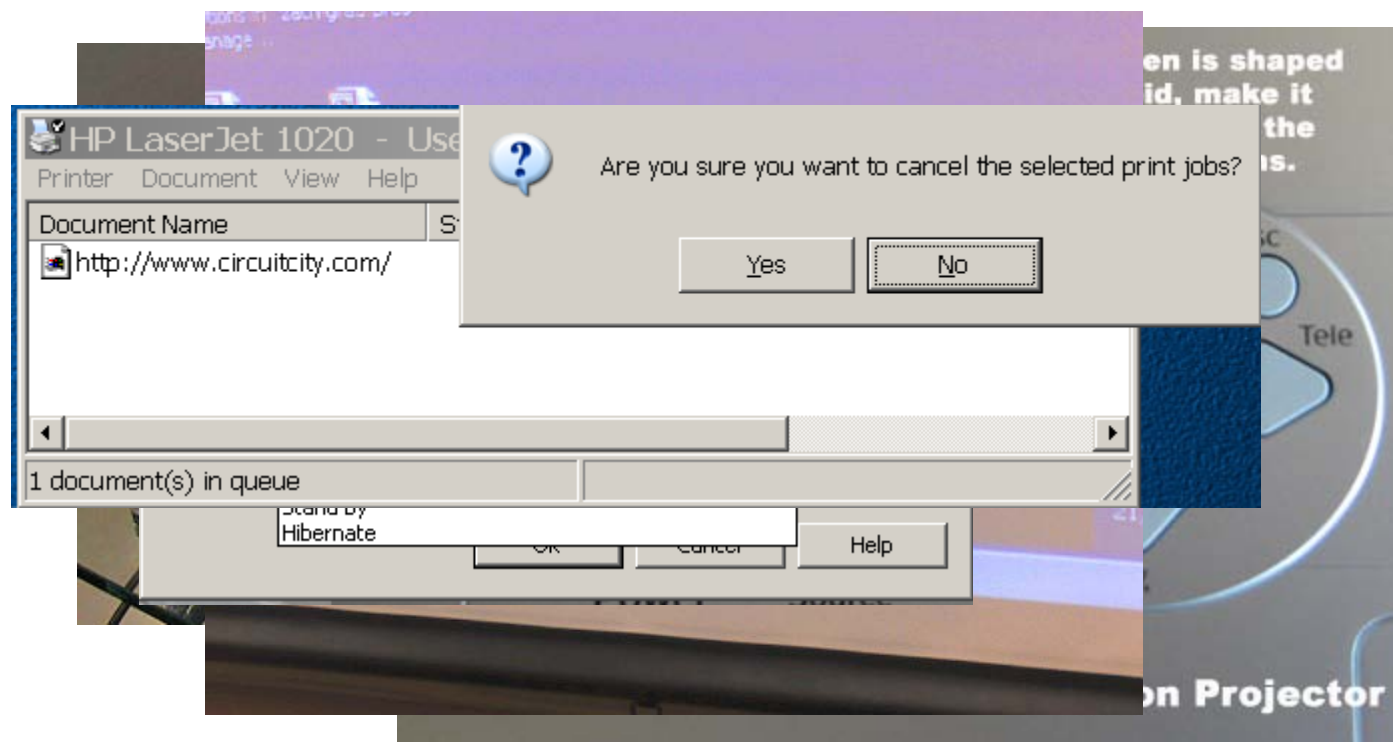


1. Hoyer CS, Christensen EF, Eika B. Adverse Design of Defibrillators: Turning off the machine when trying to shock. *Annals of Emergency Medicine*. Nov 2008
2. [www.EMSafePatient.com](http://www.EMSafePatient.com)





# Huh?



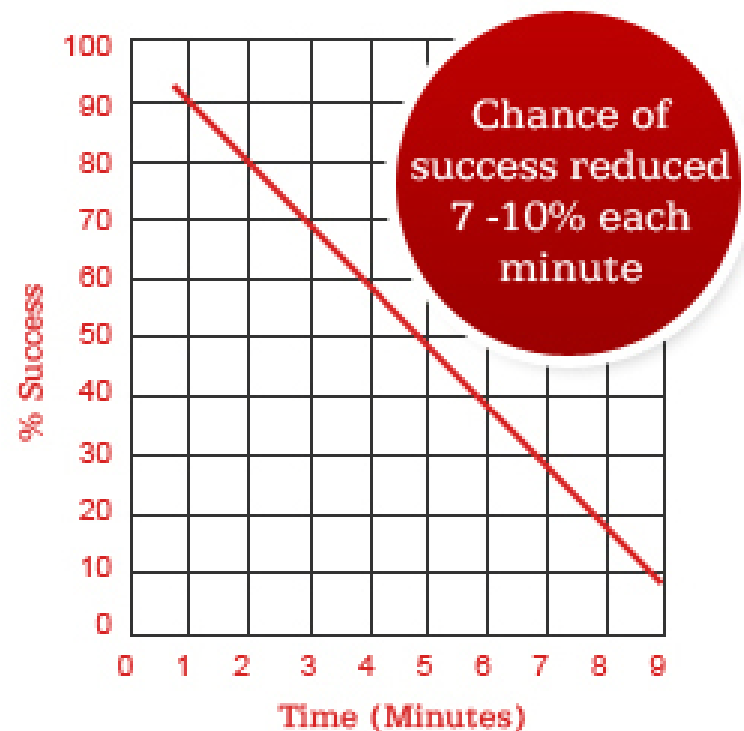
Hoyer CS, Christensen EF, Eika B. *Adverse design of defibrillators: turning off the machine when trying to shock.* Ann Emerg Med. 2008;52:512-514.





# What would you do?

- QA report comes in— a provider has pushed the wrong button and patient died...
- What would your agency's response be?
- How many times has this happened that you don't know about?



Survival from Sudden Cardiac Arrest.



# Safety Attitudes

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

*--Dr. Lucian Leape; Professor, Harvard School of Public Health  
Testimony to congress*





# Culture in EMS

- It is BAD to make a mistake
- Human error is preventable through:
  - Training
  - Remediation
  - Guidelines
  - Protocols
  - Fear of discipline, etc
- When adverse events occur → “Who is at fault?”
  - “Name, Blame and Train” approach



# Would this work elsewhere?



**dread factor**





# Culture in Aviation

- It is assumed that errors will occur
  - Even the best pilots will make errors in judgment or action
  - Thus, Aviation system design absorbs error via
    - Event reporting
    - Automation
    - Redundancy
    - Buffers
      - Ex) Cockpit crew resource management (CRM)



# Too soft, you say?





# Just Culture:

## The Three Behaviors

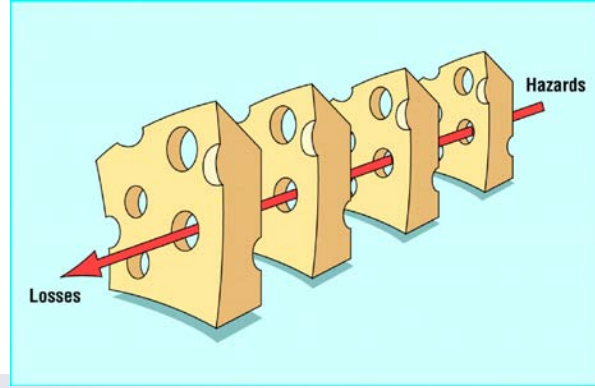
| Normal Error                                                                                                                                                                                                                        | At-Risk Behavior                                                                                                                                                                                                                                                                    | Reckless Behavior                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Inadvertent action: slip, lapse, mistake</i></p> <p>Manage through changes in:</p> <ul style="list-style-type: none"><li>• Processes</li><li>• Procedures</li><li>• Training</li><li>• Design</li><li>• Environment</li></ul> | <p><i>A choice: risk not recognized or believed justified</i></p> <p>Manage through:</p> <ul style="list-style-type: none"><li>• Removing incentives for At-Risk Behaviors</li><li>• Creating incentives for healthy behaviors</li><li>• Increasing situational awareness</li></ul> | <p><i>Conscious disregard of unreasonable risk</i></p> <p>Manage through:</p> <ul style="list-style-type: none"><li>• Remedial action</li><li>• Punitive action</li></ul> |
| Support                                                                                                                                                                                                                             | Coach                                                                                                                                                                                                                                                                               | Sanction                                                                                                                                                                  |

Adapted from: David Marx, Just Culture. Outcome Engineering 2008: [www.JustCulture.org](http://www.JustCulture.org)





# System Design



- After potential errors are identified, systems can be designed to compensate for the error
  - “Keep the error from reaching the patient.”

*“Every system is perfectly designed to achieve exactly the results it gets”*

*--Donald Berwick, MD*



# 1<sup>st</sup> Step: hazard Identification

- Must anticipate errors to design system protections
  - Study near misses
    - “Today’s near misses are tomorrows adverse events”
    - Learn from the experiences of others
    - Helps identify trends
  - Study of error & adverse events
    - Qualitative studies
    - Event reporting systems

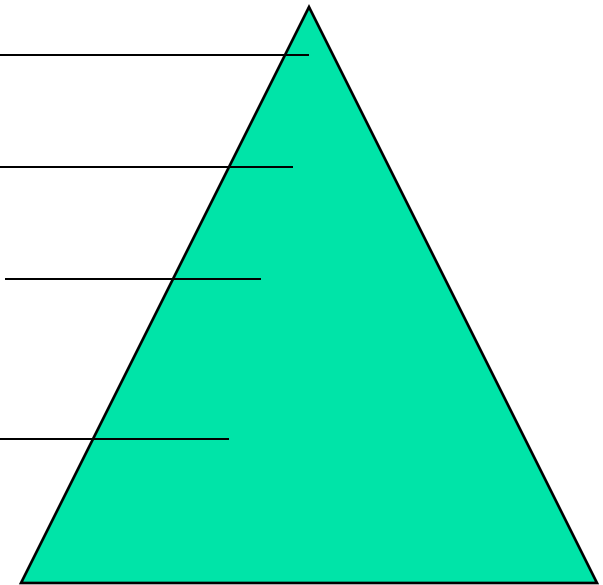
Fairbanks, Crittenden, O’Gara, et al. *EMS Provider Perceptions of the Nature of Adverse Events and Near Misses in Out-of-Hospital Care: An Ethnographic View*. Academic Emergency Medicine July 2008; 15(7):633–640.





# 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

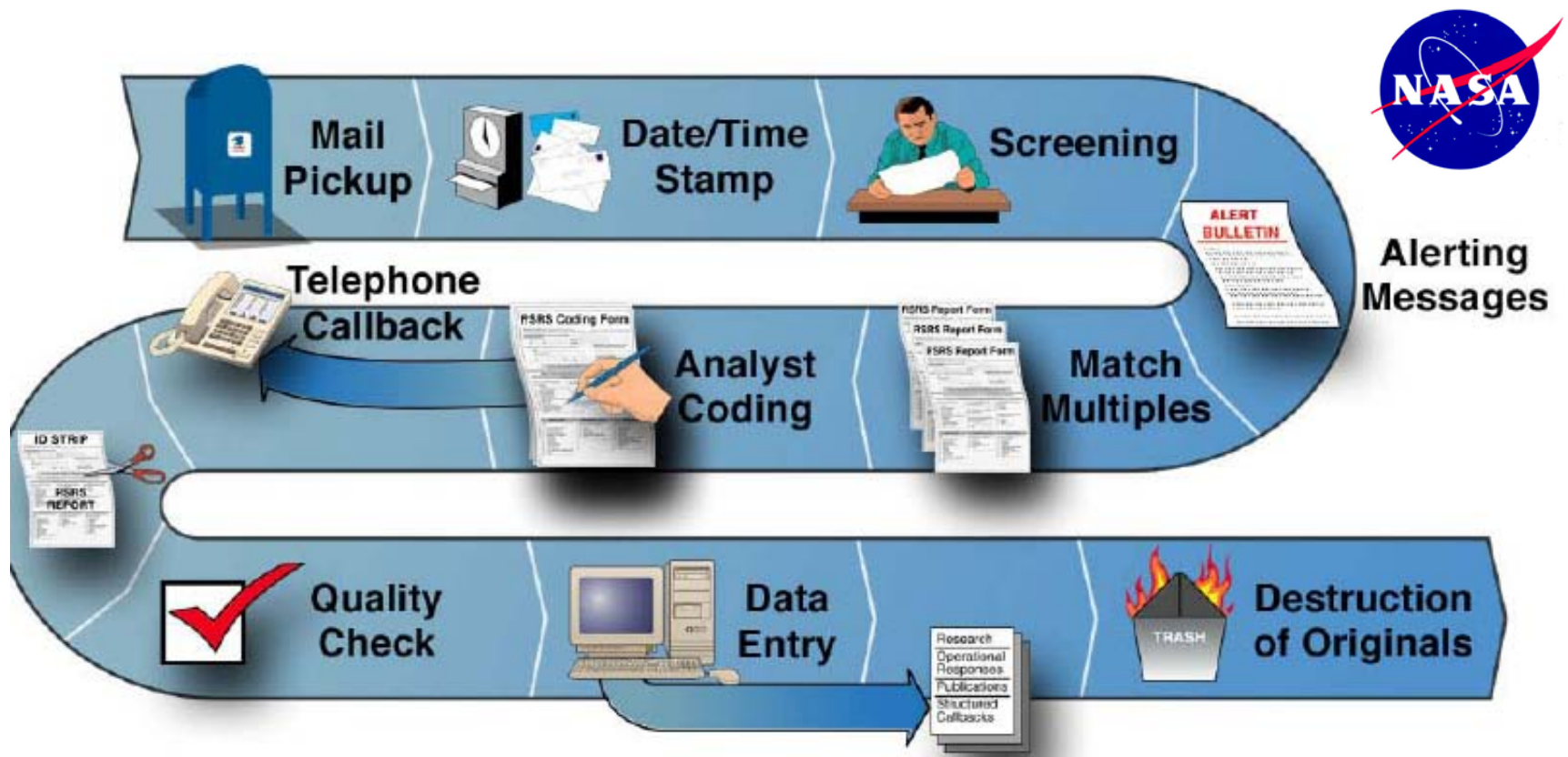


*Bird, 1969*

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



# ASRS





35 years later...

ROCHESTER

# Democrat and Chronicle

JANUARY 12, 2009

DemocratandChronicle.com

75 CENTS NEWSSTAND

## Amerks consider outdoor game

■ Team owner, operators of two city stadiums intrigued by idea.

KEVIN ORLOZZIA

STAFF WRITER  
The operators of Rochester's two downtown stadiums have informally discussed the possibility of hosting an outdoor American Hockey League game

next winter, and Rochester Americans owner Curt Styrkes says he's definitely intrigued by the idea. "I'd do it in a heartbeat," Styrkes said. "I would definitely like to explore the possibility."

Styrkes likes the idea for two reasons: The game would bring a unique event to Rochester, and participating in what likely would be just the fifth outdoor professional regular-season game in North America would return the Amerks to prominence in the community. The Amerks' poor on-ice

performance in 2007-08, coupled with the off-ice turmoil that plagued the team's former ownership group, left a large percentage of sports fans uninterested in the team. "It would definitely get the fan base excited," said Rob Clark, owner of the Rochester Rhinos and the operator of the soccer sta-

**Roofless hockey**  
A list of other outdoor games. 4A

dium formally known as PAETEC Park. In the wake of the NHL's second Winter Classic on New Year's Day, when the Chicago Blackhawks and Detroit Red Wings played

at Wrigley Field in Chicago, Clark has already taken a cursory look at bringing a hockey game to his stadium.

The first Winter Classic was on Jan. 1, 2008, at Ralph Wilson Stadium in Orchard Park between the Buffalo Sabres and the

AMERKS PAGE 4A

## At-risk students show benefits of puppy love



## Airlines set U.S. safety record

■ American carriers suffer no fatalities over two-year stretch.

ALAN LEV  
USA TODAY  
For the first time since the dawn of the jet age, two consecutive years have passed without a single air-

since they have passed without a passenger fatality, the analysis found. That makes the two-year string even more impressive, aviation safety experts

# Airlines set U.S. safety record

■ American carriers suffer no fatalities over two-year stretch.



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# Event Reporting in Medicine

- IOM recommends reporting systems
- Failure of most in medicine
  - No incentive, cumbersome
  - Classified by end-user
  - Most not anonymous submissions
  - Most require patient and provider names



# EMS Event Reporting

- Few EMS Event Reporting Systems
  - Individual systems
    - State System: *Pennsylvania*
    - Local system: *Houston*
  - National systems
    - MEPARS (defunct)
    - Helmet Fire ([www.HelmetFire.com](http://www.HelmetFire.com))
  - Collections of stories (not analyzed)
    - IAFC ([www.EMScloseCalls.com](http://www.EMScloseCalls.com))



# Success Story: Helmet Fire

- Pilot: Physician Hazard Reports
  - Old system: 5 physician reports in 2 years
  - 15 week pilot: 299 sessions = 20 per week
  - Average time: 02m 33s // Median: 02m 00s
  - Attendings, residents, PAs
- Larger ED program planned
- EMS program planned

Reference: Fairbanks, Squires, Nobay et al. *Participation Rates and Emergency Medicine Provider Perceptions of an Error Reporting System with User-Centered Design* (Abstract). Academic Emergency Medicine April 2009 16(4): S245.





# Why the success?

- Designers took into consideration:
  - Work environment— when can they do it?
  - Human capabilities— the reality
  - Focused on ease of use
    - Touchscreen, fast, logical, fast, accessible, fast,
  - “Process-improvement-loop”
    - Providers receive weekly feedback
    - Easy to see the value



PATIENT CARE

ERROR PREVENTION

ORGANIZATIONAL ISSUES

SESSION / PATIENT INFO

FINISH

**Who was involved? (optional)**

|           |                 |
|-----------|-----------------|
| MD        | Mid-level       |
| Nurse     | EMT / Paramedic |
| PCT       | Admin Staff     |
| Patient   | Family Member   |
| Volunteer | Other           |

**Incident time? (optional)**

|             |             |
|-------------|-------------|
| 0700 - 1500 | 2300 - 0700 |
| 1500 - 2300 | N/A         |

**Your qualifications? (optional)**

|           |                 |
|-----------|-----------------|
| MD        | Mid-level       |
| Nurse     | EMT / Paramedic |
| PCT       | Admin Staff     |
| Patient   | Family Member   |
| Volunteer | Other           |

**Your experience level? (optional)**

|              |             |
|--------------|-------------|
| Attending    | Fellow      |
| Resident     | Student     |
| Charge Nurse | Staff Nurse |
| Other        |             |

**Your specialty? (optional)**

|               |              |
|---------------|--------------|
| Emergency Med | Pediatric EM |
| Pediatrics    | Other        |

**Pt Name (Optional)**

(Last, First, Middle Initial)

**Pt Medical Record # (Optional)**

**Submitter's Name (Optional)**

**Occurrence Date (Optional)**



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**ABORT SESSION**

**◀ BACK**

**NEXT ▶**



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# Next Step?





# What we can do now

- EMS Managers
  - Abandon the “name, blame, and train” mentality
  - Use non-punitive QA systems (educational)
  - Participate in an event reporting system
    - Study near misses and adverse events
  - Assume error will occur → create buffers

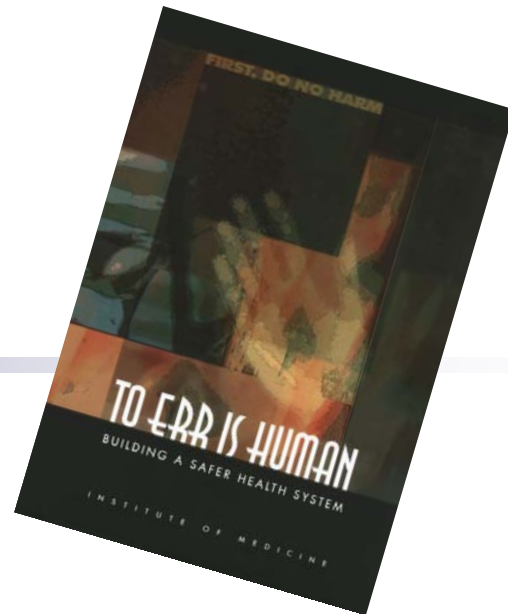


# Final Thoughts...

## ■ 5 years later....

### Why No Change?

- No “dread factor” (as in nuclear & aviation)
- Focus is STILL on the individual
- Stop “name, blame, train, and shame”
- Need to learn the problems
  - Local reporting?
  - National reporting?
  - Change the culture?





# Resources

(links also on [www.MedicalHumanFactors.com](http://www.MedicalHumanFactors.com))

## FUN EASY READS

- Just Culture: Balancing Safety and Accountability, Sidney Dekker (2008) [\[link\]](#)
- The Design of Everyday Things, Don Norman (1988) [\[link\]](#)
- Set Phasers on Stun, Steve Casey (1998) [\[link\]](#)
- *No More Blame and Shame: developing event-reporting systems may go a long way to reducing patient care errors in EMS.* Emergency Medical Services, Sept 2008. [\[link\]](#)

## RESOURCES

- Evaluating and Improving Quality in EMS – Vol 3. National Association of EMS Physicians, 2009 [\[link\]](#)
  - Quality Management in Prehospital Care, 2nd Edition. R Swor (Ed). National Association of EMS Physicians, 2005 [\[link\]](#)
- Helmet Fire [www.HelmetFire.com](http://www.HelmetFire.com)
- Handbook of Human Factors and Ergonomics in Health Care and Patient Safety, Pascale Carayon (2007) [\[link\]](#)
- Patient Safety in Emergency Medicine, Croskerry, Cosby, Schenkel, and Wears (2009) [\[link\]](#)
- Mistake-Proofing the Design of Health Care Processes, John Grout (2007) [\[link\]](#)



***Patient Safety is  
Everyone's Job!***

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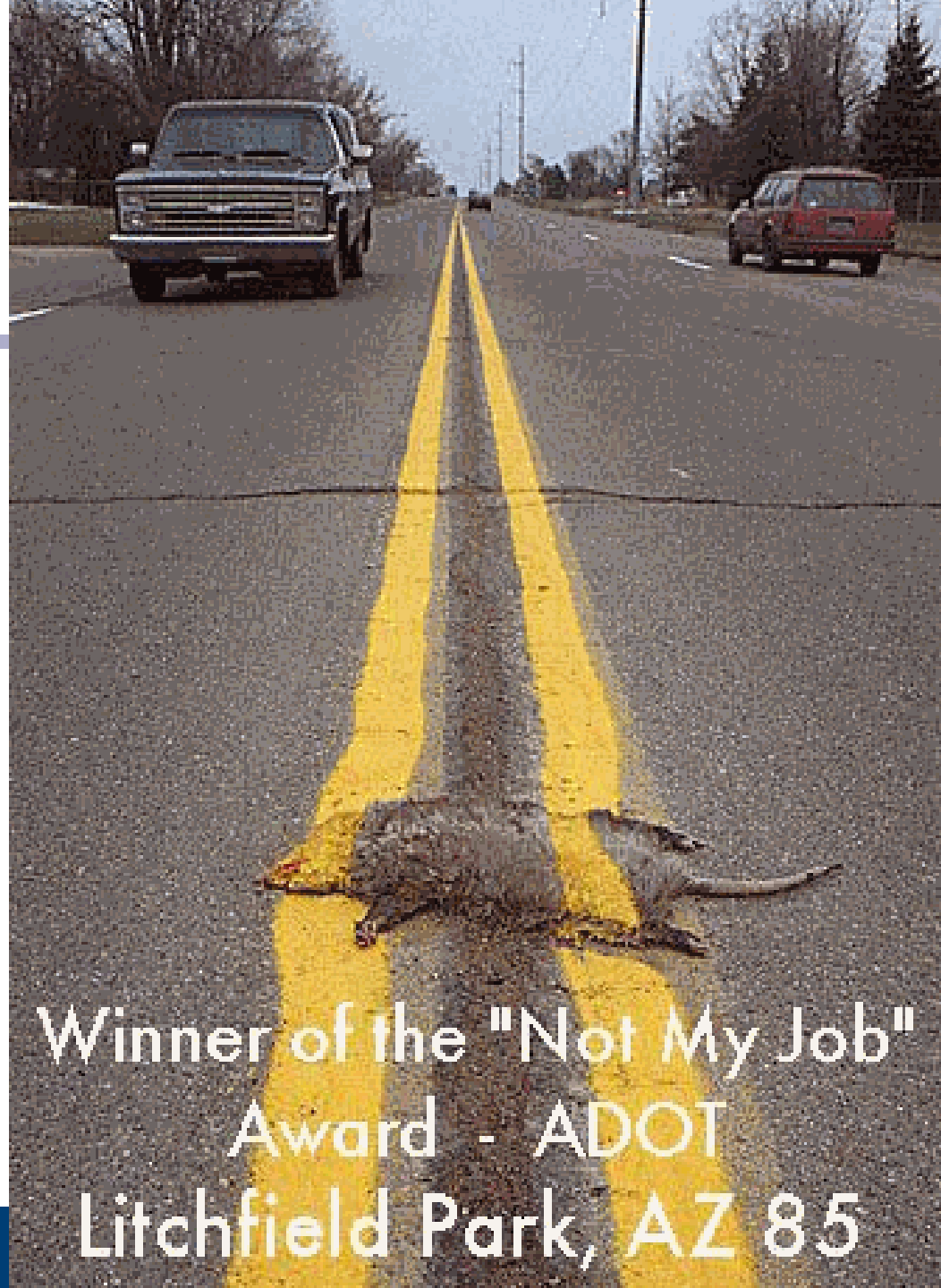
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[www.MedicalHumanFactors.com](http://www.MedicalHumanFactors.com)



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**Winner of the "Not My Job"**  
**Award - ADOT**  
**Litchfield Park, AZ 85**