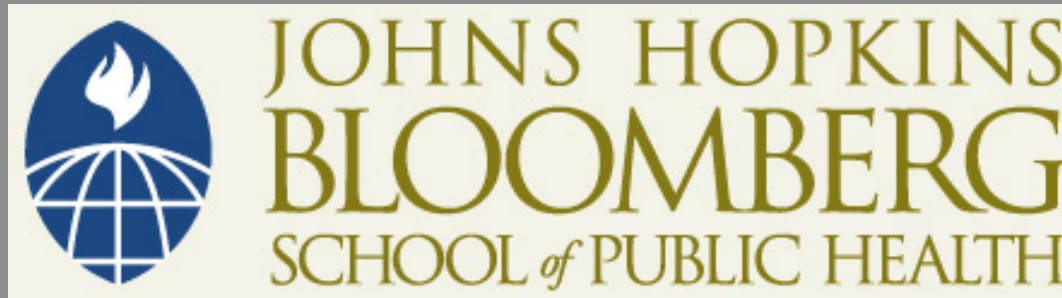


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The Science of Safety

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Section A

Accident Causation

“In place were not just one, but a series of safeguards—some human, some procedural, some technical—that were supposed to ensure an accident of this nature could never happen. Yet, quite clearly, these safeguards failed.”

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— *Gen. John Shalikashvili*
Chairman, Joint Chiefs of Staff



On April 14, 1994, two U.S. Air Force F-15 fighters accidentally shot down two U.S. Army Black Hawk helicopters over Northern Iraq, killing all twenty-six peacekeepers onboard.

Bhopal

- December 2–3, 1984
- Methyl isocyanate leak
- 8,000 killed



Bhopal: Multiple Failures

- Recent downsizing and maintenance cutbacks had greatly increased operator workload and fatigue
- Displays did not display historical “trend” data
- Operators required to make maintenance and operation record entries in English

- 100 major incidents per year
- 25–30 “hull losses” per year
- Observations show 2 errors per flight = 100 million per year

- 100 major incidents per year
- 25–30 “hull losses” per year
- Observations show 2 errors per flight = 100 million per year
- Which one of these is the right metric?

How Do Accidents Happen?



Individual Approach to Causation

- Errors arise primarily from aberrant mental processes, e.g., forgetfulness, inattention, poor motivation, carelessness, negligence, and recklessness

Systems Approach to Causation

- Basic premise: humans are fallible, errors are expected even in the best organizations
- Causes include traps in the workplace and organizational processes
- Countermeasures are based on the assumption that working conditions can be changed

How Do Accidents Happen?

- All complex systems are intrinsically hazardous—
 - Road, rail, and air traffic
 - Space missions
 - Nuclear reactors
- Generally heavily defended against failure
- Contain latent errors
- Routinely run in degraded modes
- Catastrophe requires multiple failures

Ideal: Each Defensive Layer Impenetrable

- In reality, defenses are like slices of Swiss cheese
- Holes continually opening, shutting, shifting
- Presence of holes in any one “slice” does not normally cause a bad outcome
- Accidents happen when the holes in many layers momentarily line up to allow an accident



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Section B

Human Performance

- Health care workers generally
 - Highly trained
 - Conscientious
 - Well-meaning
 - Use sophisticated treatment
- Errors and harm are common

Human Performance

- Skills
- Rules
- Knowledge

Individuals and System Design

- Role of individuals in error causation
- Not to point blame
- But to help us design systems that take this into account

Human Performance

- Skills
- Rules
- Knowledge

Skill-Based Errors

- You know what you are doing, but your actions don't go as planned (slips, lapses, fumbles)

Slips (Attention), Lapses (Memory), Fumbles (Execution)

You have a dentist's appointment but drive to work anyway

"Have a good flight." "You too."

You forget your colleague's name

Coffee misses mouth

Rule-Based Errors

- You think you know what you are doing, but fail to notice contraindications, apply a bad rule, or fail to apply a good rule (rule-based mistakes and/or violations)

Rule-Based Errors (If A, Then Do B)

- Crossing over the double-yellow line
- Ignoring the rule “Any female of child-bearing age is pregnant”

Knowledge-Based Errors

- You're not really sure what you are doing (knowledge-based mistakes in novel situations)

Knowledge-Based Errors

- Driving on an unfamiliar road
- Is it nerve, artery, vein?

Cognitive Biases in Decision Making

- Heuristics/cognitive dispositions to respond

Cognitive Biases in Decision Making

- Availability (recency)—things are more frequent if they come readily to mind
- Visibility bias

Cognitive Biases in Clinical Decision Making

- Overconfidence

Cognitive Biases in Clinical Decision Making

- Representativeness—if it looks like a duck . . .

Cognitive Biases in Clinical Decision Making

- Search satisficing—call off the search once something is found

Summary

- Doctors and nurses are human, too
- Human error inevitable