Human Factors Analysis in Patient Safety Systems

A health care system submitted a root cause analysis (RCA) to The Joint Commission for a sentinel event that involved a patient whose blood levels were not drawn frequently enough to monitor the thinness of her blood while receiving a continuous heparin infusion. The patient had been started on a heparin infusion on an orthopedic unit and then was later transferred to a cardiac unit. The order set for the heparin infusion was not entered properly, leaving out the automatic order for blood tests every 6 hours. During the handoff report, the nurses did not discuss when the next blood test would occur to monitor the heparin infusion. For 24 hours, the patient went without blood tests until an oncoming nurse questioned the situation during the handoff report. At this time, the off-going nurse also reported that the patient had been complaining of a headache for several hours. A computerized tomography (CT) scan showed intracerebral hemorrhage. When the patient's mental status deteriorated, the family chose not to proceed with surgery due to the patient's

Human factors engineering designs processes to support human strengths and mitigate human weaknesses.

multiple comorbidities and recent decrease in quality of life. She expired three days later. Although the organization had conducted a thorough RCA, The Joint Commission asked it to revise the RCA and consider human factors issues that led to the event and implement more strategies that incorporate human factors solutions, which would more reliably prevent the event from occurring again.

Human factors analysis (also referred to as human factors engineering) is an essential step to designing equipment, procedures, tasks, and work environments because research shows that human failures cause 80% to 90% of errors.[1] "The most common root causes of sentinel events are human factors, leadership, and communication," says Ronald Wyatt, MD, medical director, Office of Quality and Patient Safety at The Joint Commission. "And I argue that leadership and communication are also human factors."

> ***"We cannot change the human condition, but we can change the conditions under which humans work."***
> ***— James Reason****

Despite the pervasive occurrence of human failure, the average health care provider may not have a clear understanding of all that human factors entails. "Human factors is a human-centered science using tools and methods to enhance the understanding around human behavior, cognition, and physical capabilities and limitations, and applying this knowledge to designing systems in support of these capabilities and limitations," says Erin Lawler, MS, human factors engineer at The Joint Commission. "In health care, close calls or incidents manifest when processes do not match or support the known human cognitive and physical limitations and capabilities."

Humans Are Not Perfect

When performing a human factors analysis, the main point to understand is that humans have known limitations; they are not perfect.[2] Human factors experts classify human errors in three categories[3]:

1. Knowledge-based (errors made due to lack of knowledge or experience with a particular process or situation)
2. Rule-based (misinterpretation or misuse of relevant data or applying the wrong rule)
3. Skill-based (attention and memory failures, including omitted tasks)

The sidebar, below, defines key human factors concepts.

"You have to look at all the human factors, such as group think, normalization of deviance, and poor supervision," says Wyatt. "These are the human factors–related failures that result in a failed complex system, and

Quick Guide to Human Factors Terminology

When learning about human factors analysis, it can feel like learning a new language. Some key human factors terms are defined below:

Close Call – An unsafe event occurred but did not cause patient harm (also known as a "free lesson")[2,3]

Incident – Patient harm resulted due to an unsafe event[2]

Active Failures – Unsafe acts committed by front-line staff at the point of care[4] (subcategorized into errors and violations)

- Errors – Honest mistakes due to poor decision making, lack of skill, or perceptual deficits[2,5]

- Violations – A deliberate disregard for safety regulations that either occur routinely (such as work-arounds) or under exceptional circumstances[2–5]

Latent Failures – Underlying weaknesses in systems or processes that may be caused by poor design, poor systems, or poor leadership.[4] Latent failures are further categorized by the following[1]:

- Organizational factors (resources, culture, and processes)

- Supervision issues (failure to correct known problems, inadequate supervision)

- Preconditions for unsafe acts (environmental factors and human factors)

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* Reason J. Human error: Models and management. *BMJ*. 2000 Mar 18; 320(7237):768-770.

they happen in hospitals and health care organizations every day."

Humans can become even more prone to error when their physical environment impedes work efforts. "We have to look at the environment or the physical conditions that contributed to an error," says Wyatt. "The noise level, the lighting, distractions, how equipment is designed, the characteristics and steps involved in the task, and even how the culture contributes to the error."

Using Human Factors to Analyze the Patient Safety System

Human factors analysis naturally operates within the context of the patient safety system. (*See* the *Comprehensive Accreditation Manual for Hospitals* for the new chapter, "Patient Safety Systems," for more information on a proactive approach to preventing patient harm as well as further information about patient safety systems. The chapter is also available online at http://www.jointcommission.org/assets /1/6/PSC_for_Web.pdf.) "Systems thinking is part and parcel to human factors engineering," says Lawler. "In human factors engineering, we consider each layer of a system and its interconnected components in terms of how to design in support of human strengths and compensate for limitations."

As psychologist James Reason, PhD, explains, errors can be viewed using the person approach, wherein people are often blamed for the error and then trained to prevent the error from happening again, or the system approach, wherein humans are assumed to be fallible, errors are expected, and the organization takes steps to address the latent failures that often lead up to the human error.[4]

"We consider systems thinking as a departure from the tendency to blame," says Lawler. "Systems thinking would ask what systems-based conditions and context compelled a failure, an event, or a close call. It is not so much that a human factor caused a failure; more so, there was a failure to recognize the human factor and design to support that human factor." Lawler provides a list of questions she would ask when considering how human factors affects the system (*see* box at right).

Examining Close Calls and Incidents

Human factors engineers believe it is just as important to analyze an incident, as it is a close call, believing that both reflect a failure in the system. However, health care leaders often analyze only the incidents that cause patient harm and not as many close calls. "A traditional view of safety is a reduction or absence of adverse outcomes or incidents," says Lawler. "If safety is quantifiably measured by having as

Using Human Factors Questions to Analyze the System

1. What are the goals? Do end users/teams have a shared goal, shared understanding of that goal, tools, and resources to achieve the goal?

2. Is information available, timely, perceptible, and understandable?

3. Is there unnecessary complexity among work processes and technology or opportunities to standardize, simplify, streamline?

4. How is the system designed with cognitive considerations such as attention, recognition, memory, and cognitive biases in mind?

5. Are the environment and tools supportive of the various end users/teams and work being performed? Are they intuitively designed or designed for error? Is the ambient setting such that information can be effectively seen, heard, communicated?

6. What are the organizational goals, priorities, and incentives? Does the organization provide the necessary resources, conditions, leadership, and culture to perform work safely? How are end users empowered to recognize and report potential hazards and events? How are "things that go well" recognized and understood?

few adverse outcomes as possible—striving towards zero— then organizations may dedicate more time and resources towards learning from such incidents. In the end, given the volume of close calls, tracking and trending versus in-depth investigation may come down to what Erik Hollnagel, PhD, refers to as the efficiency-thoroughness trade-off—in this case trading thoroughness for efficiency."

Incorporating Human Factors Before and After Patient Safety Incidents

Human factors should be considered in root cause analyses (RCAs) and failure mode and effects analyses (FMEAs). Although a human factors analysis is not specifically required by Joint Commission standards, Wyatt explains that thorough RCAs and FMEAs include human factors analysis. "When we review an RCA for

a sentinel event or any patient harm event, we can't consider that RCA thorough and credible unless you look at the human factors that contributed to the outcome," says Wyatt.

Although RCAs reactively review a safety incident and FMEAs proactively plan to prevent safety incidents, human factors analyses can be applied to both. "Proactively, we ask how can we design the system (considering processes, technology, environments, interactions, leadership structure, resources, and so on) to support end users' cognitive and physical strengths and compensate for their limitations," says Lawler. "Reactively, we ask how the system failed to support or compensate for these considerations."

Addressing Active vs. Latent Failures

To complete a thorough RCA or FMEA with human factors analysis, organizations must address active and latent failures; however, organizations often struggle to address the latent failures of a system or process. "We still see a tendency to address active failures more frequently than latent failures," says Lawler.

The most common strategies to address active failures include training and policy changes. "While training, education, and policy changes are important to consider, as stand-alone interventions, they are considered less sustainable or 'weaker actions' given their reliance on human behavior and memory," says Lawler. "Moreover, training

and education will not address more systemic issues related to lack of resources, inadequate staffing, and other latent failures. Addressing latent failures often requires a hard look deep within an organization. Stronger actions, such as standardizing technology, human factors–based engineering fixes, implementing evidence-based team coordination strategies, and changing the culture, may take more time and resources, but evidence suggest they are more sustainable, more effective, and less resource intensive over time."

Strategies for Addressing Human Factors in a Process or System

There are many ways to apply human factors engineering to improve or redesign a process or system. Some human factors engineering strategies are more reliable than others, but several strategies implemented together can create a reliable safety net. (*See* human factors engineering strategies including level of reliability, listed in Table 1, below.)

"The goal is to establish and sustain a more resilient, adaptable health care organization that is attuned to the possibility of failure, empowered and equipped to respond and learn, and able to contain or dampen hazardous conditions before they harm patients," says Lawler. **TS**

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Table 1. Human Factors Engineering Strategies

Most Reliable	Forcing functions or physical stops that prevent incorrect actions (such as regulators that are incompatible among disparate gases)
	Computerized automation (such as procedural stops incorporated into smart infusion pumps which do not allow a medication to be infused at rates that are too high or low)
	Human-machine redundancy (such as the redundant task of visually checking medications and then scanning medication bar codes so that a computer can check the medications as well)
Somewhat Reliable	Checklists for high-risk procedures (such as inserting a central line)
	Forced pause in a process to recheck details and steps (for example, time-out to prevent wrong-site surgery)
	Reminders (for example, clinical decision support in electronic medical records that reminds a physician of a patient's allergy when prescribing penicillin)
	Standardization of equipment and supplies across the organization
	Planned error-recovery opportunities in which providers build time in the process to self-check or double-check another person's work (such as requiring two nurses to separately calculate chemotherapy doses or continuous heparin infusion rates)
Least Reliable	Education and training
	Rules, policies, and procedures

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