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Human Factors Engineering Can Teach You How to Be Surprised Again

November 1, 2006
Gosbee JW. Human Factors Engineering Can Teach You How to Be Surprised Again. PSNet [internet]. 2006.
https://psnet.ahrq.gov/perspective/human-factors-engineering-can-teach-you-how-be-surprised-again

Perspective

Certain phrases are famously oxymoronic: "jumbo shrimp," "military intelligence." We chuckle at such terms, but they do little harm.

In the patient safety field, the term "expected complication" is both defeatist and ultimately self-fulfilling. For that reason, I propose that it be banished from our lexicon and our minds. I further propose that the liberated neurons be used to store the tools and concepts of human factors engineering, since these are an antidote to the "expected complication" way of thinking.

Human factors engineering is featured in many patient safety resources (1-3), including on this web site.(4, 5) When taught to health care providers, I have found that the concepts of human factors engineering often inspire two types of surprises. Novices in the field of patient safety are often surprised to discover that there are concepts and tools that can help them make sense of what previously seemed like mostly chaos. Their second surprise comes when the tenets of human factors engineering begin to allow them to challenge their conventional understanding of medical devices, software, and architecture. These revelations create the elusive "teachable moments," and the patient safety world should do its best to harness these moments and the accompanying energy and inspiration.

To illuminate your own mindset, quickly think of remedies to the following two patient safety events. Number one: A critical care physician gets distracted before entering a patient's room to remove a large-bore central line catheter. He removes the catheter while the patient is seated, instead of in the much safer supine position, and the patient suffers a fatal air embolus. Number two: Another patient is prescribed her migraine medication in nasal spray form. Although printed instructions call for one spray in *one* nostril, the patient doubles the intended dose by spraying into both nostrils (just as she has with all her previous nasal route medication [eg, Afrin]).

What solutions were you thinking of when you read these vignettes? In the central line case, perhaps you thought that the nurse should have warned the physician before removing the line. Or the physician should have taken a time out. In the second case, maybe the pharmacist should have demonstrated the use of this unique nasal medication. Or the patient should pay more attention to written directions on new medications.

Would your answers be different if the air embolus occurred when the patient was supine? Would you have called this an "expected complication" of the procedure and moved on? How about if the pharmacist had demonstrated the new nasal medication delivery to the patient, but the patient was non-compliant? Would you just shrug your shoulders—nothing we can do about that!—and accept the outcome? If these responses sound familiar, please continue reading.

Applying human factors engineering concepts helps us see both of these adverse events a bit less conventionally. People trained in this approach no longer simply see a central line being removed from a hole in the skin, but also from a hole in a hidden vein. Further, they realize that virtually every other catheter can be safely removed from their holes in human beings while patients are sitting upright. They also recognize that patients are exceptionally familiar with oral medications being administered through a single hole (the mouth), not through the double-barreled nose. Moreover, they appreciate that the average consumer has seen two-nostril administration demonstrated 3.8 billion times in advertisements but has seen one-nostril administration demonstrated less than a handful of times, if ever!

Applying the human factors engineering tool of *usability testing* would likely have illuminated these two design problems.(6,7) (Since I am not aware of any human factors engineering studies of either vignette, the following are educated guesses.) Such testing would likely have revealed many steps of catheter removal with glitches related to design issues with the catheter, connectors, bandaging, gloves, and tubing. Even better, asking novice users to perform the simulated task in a hurried, cramped, cluttered, and loud environment would provide the best "biopsy" of design troubles. Similarly, in informal usability tests that I carried out with two simulated patients, I found that both would have assumed the new nasal medication should be sprayed into both nostrils. Further formal testing would uncover the rate with which prospective patients would ignore what they would believe to be incorrect written guidance on the bottle (since it conflicts with their prior beliefs). In our old mindset, we could call this frequency the "expected complication rate" of taking this new nasal medication.

There are procedural steps that *should* be followed in the case of the air embolus.(8,9) But what about human factors engineering–inspired innovation? How can we harness the surprise that occurs when a provider or leader takes on a human factors engineering mindset for the first time, or when he or she is exposed to the results of usability testing? This new-found surprise makes us skeptical of conventional solutions, perhaps pushing us to develop an air-embolus–proof central catheter (admittedly a challenging task). Efforts could also focus on making the vein hole more obvious, or on making air flow into the system less possible or less dangerous.

The usability testing of the nasal medication delivery system would also offer up surprises. Perhaps the surprise would lead to all kinds of new thinking regarding how to match the design more closely to the expected 1:1 ratio of hole to dose. Although not seen or tried on the market, perhaps "single-nostril" medication should be delivered in a two-pronged container (with only one barrel containing active

medication).* The alternative of suturing one nostril shut seems overly aggressive.

It is central to human factors engineering that better products or processes come from keen observations of how people work and play on a daily basis.(10) The business literature on using surprise as a catalyst for creativity is in line with the idea that the human factors engineering mindset and usability testing can generate innovative interventions in the development of safety-prone devices and work areas.(11) For those who want to be surprised some more, there are an expanding set of resources.(3,12)

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***Acknowledgement:** Lisa Lau, a human factors engineer at VA National Center for Patient Safety, provided the author with the idea of the two-pronged nasal inhaler.*

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