Patient safety rubric

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The Crucial Role of Human Factors Engineering in the Future of Safe Perioperative Care and Resilient Providers

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Despite the many advances in technology, there still are high levels of preventable harm in anaesthesia care leading some to characterize our profession's approach to care as "primitive, fragmented, and cavalier".[1]Surgery is more aggressive than before, less with the knife, more with scopic interventions, yet our patients are older, overweight, have multiple co-morbidities, and are more fragile. More than 18 years after the Institute of Medicine report, the evidence suggests that we are still harming many patients, yet the types of errors are changing.[2]Healthcare costs continue to rise at alarming rates while quality of care is highly variable, forcing hospitals to demand more safety, efficiency, and harder work from their clinical staff.

Technology is at the forefront of new design processes and has seen an exponential growth impacting how we work in the operating room while imposing a huge cognitive load that impedes our attention.[3]Anaesthesiologists are struggling with the question of how to evaluate the impact and value of new technologies and different systems such as electronic medical records (EMR) and robotics, especially when devices promise to benefit patient safety.[4]

The value of many innovations in technology for anaesthesia such as EMR and integrated patient monitors, lies in their ability to predict patient deterioration before patient harm and its impact on the cognition, and vigilance of medical personnel-processes such as attention, workload, and reasoning.[5]In evaluating the impact of new technology, the unit of analysis cannot be the new box or capability in isolation; rather, it must be the larger task performance, workload, and information processing quality that includes the anaesthesiologist and other personnel's cognitive processes, and the set of tools that influence their decision making.[6]

What is Human Factors Engineering?

Human factors engineering is the application of knowledge about human behaviour, abilities, limitations, and other characteristics of medical device users to the design of medical devices/drugs including mechanical and software-driven user interfaces, systems, tasks, user documentation, and user training to enhance and demonstrate safe and effective use.[7]The operating room is a complex technical environment in which highly trained **sub-specialists** interact with each other using sophisticated equipment to care for patients with a wide range of diseases and significant co-morbidities.[8]Anaesthesiologists work under human factor constraints[9]in complex, technology-infused, rapidly changing, time-constrained, and stressful work environments where effective performance demands expert knowledge, appropriate problem-solving strategies, and fine motor skills.[10]

In order to improve patient safety under anaesthesia we must first better understand the real workload-as-is vs. the imagined and perceived work of the perioperative continuum.[11]It is critical to understand how technology and automation affect how clinicians actually work and view their work, what factors make sense to them (clinical sense-making),[12]what factors work well (or not so well), what distracts their attention, and why despite cutting edge technology, adverse events such as wrong medications, tubing miscommunications, and missed key information, continue to occur. Issues that impact human performance and increase the risk of errors include factors that directly enable decision making, such as perception, attention, memory, reasoning, and judgement. Still other factors directly impact the quality of the decisions by anaesthesiologists, and their ability to carry out the intended action in spite of extraneous factors such as distraction, noise, low intensity times, and competing cognitive demands.[13]

New thinking and understanding of machine human interactions are needed to attenuate the growing cognitive workload on anaesthesia providers, and perhaps in the future we might benefit from the machine monitoring the vigilance of the anaesthesiologist.[14]We are being challenged to re-think our workflow and ensure technology supports our growing cognitive workload and our willingness to tell the truth to our surgical colleagues.[15]The science of human factors can be used to design approaches to enhance communication and integration of teamwork to enhance shared understanding satisfaction (situational awareness) and improve care processes delivery.[16,17]Examples of these applied human factors techniques include cognitive task analysis,[18]process mapping,[19]failure mode and effects analysis,[20]and human reliability analysis assessment.[21]These tools can help extract detailed information about a system's performance such as time and motion studies that can inform us about risks to the system's resilience and how best to help ensure we are learning from these processes.[22]The complexity of clinical processes and the large number of interdependent mediating variables may not be amenable to traditional empirical or risk assessment methods and will require adaptive and pragmatic approaches.[23]

Developing automation and robots to collaborate with anaesthesiologists

Happily, the science of anaesthesiology has begun to learn deep lessons from complex high-risk systems such as in aviation, nuclear power, space travel, and chemical processing where it is highly undesirable to wait for a serious accident to happen before analysing a system's safety attributes.[24]This has led to a resurgence of interest in the science of systems science,[25]near miss analysis,[26]and rare event phenomenology.[27]

Human-centred automation developments have contributed to great improvements in patient safety.[28]Successful examples of these lessons include smarter alarm management, anaesthesia-machine forcing functions, total intravenous anaesthesia, fatigue and distraction management strategies, and crew resource and team training management focused on non-technical skills.[29]While automation has brought great productivity increases, studies of the impact of automation on human performance show that automated devices can create new cognitive burdens on clinicians, especially during high-tempo periods and non-routine cases that create new forms and opportunities for errors and patient harm.[30]Research is needed to evaluate the utility and impact of these new technologies and it is becoming clear that the success or failure of new technology depends on the context in how using a device (in situ) influences physician cognitive processes and cooperative activity.[31]

Getting anaesthesiologists ready for the future workplace

The future clinical workplaces are going to look very different; it is important that we consider the implications for more effective training and design of anaesthesia work settings.[32]It is essential to consider how to prepare current anaesthesiologists who will be called upon to adapt their tasks, techniques, processes, and cultures and what the ideal workload and fatigue management approaches are.[33]Training the next generation of anaesthesiologist researchers and clinicians will require formal and easily accessible education tools, patient safety methods, and continuous quality improvement approaches, preferentially done in a formal training and skills centre.[34,35]

Conclusions

The physical and information architectures determine if clinical system innovations can be deployed to improve the perioperative flow of patients, preventing infections, and enhancing team workflow, communication, and satisfaction. The next-generation of anaesthesia work settings must being conceived as an integrated whole rather than a collection of parts. A human factors approach is needed to engage clinicians, architects, and engineers to address perioperative flow, comprehensive data availability, safety, teamwork, and data overload (including alarm fatigue) and its implications for planning the physical built environment.[36]We can learn from other industries about more effective integration of robotics, better self and patient monitoring, smarter automation, better team communication, andresilience to provide more patient centred, safe and reliable care.

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