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PATIENT SAFETY NETWORK

Using Human Factors Engineering and the SEIPS Model to Advance Patient Safety in Care Transitions

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Human factors engineering or ergonomics (HFE) is a scientific discipline broadly focused on interactions among humans and other elements of a system. The International Ergonomics Association defines HFE as "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance." [1] The goal in HFE is to improve interactions between people and other elements of the work system, such as technologies, tasks, and the physical environment. This work is done by conducting a thorough analysis of the entire system in which these interactions occur; then based on this understanding, the systems can be designed to support performance and enhance safety and well-being. HFE interventions commonly focus on people, tools, technology, procedures, and processes. As a field of study, HFE originated in the 1940s in the field of aviation. Since then, it has been used to improve systems in electric power plants, manufacturing plants, and healthcare, among other fields.[2] In healthcare, HFE focuses on designing systems around the end-user to improve performance, safety, and efficiency, using psychology, sociology, and other behavioral sciences to improve the experience for all who interact with other elements of the system. The data required to create improvements is collected through multiple methods, including observation, interview, focus group, survey, and review of archival data. These data provide a thorough understanding of the work system—that is, people, tasks, tools and technologies, the physical environment, and organizational conditions—of the setting in question. With an understanding of how interactions among all work system elements (including people) can go right or wrong, HFE uses human-centered design processes and methods to address problems and improve the overall work system design.

Application of Human Factors Engineering in Healthcare

HFE has been used in healthcare to improve patient safety for more than 20 years. Its use has increased in the last 5-10 years. Early use of HFE focused on applications like improving the design of medical devices or other equipment and technologies commonly used in healthcare settings, such as intravenous (IV)

pumps and IV tubing. Improvements included the redesign of tubing and catheters so that clinicians were physically incapable of attaching IV tubing to an epidural catheter. This type of solution inherently addresses core design problems rather than relying on humans to adapt and avoid error. Another place where HFE has been systematically applied over time is in health information technology (IT). Within health IT, HFE has been used to improve training interfaces, system usability, and overall performance in a care setting.[3]

As the use of HFE in healthcare to improve patient safety has matured, the focus has expanded from devices or work system elements of care into the application of HFE within larger processes of care. As healthcare systems, technology, and processes increase in complexity, HFE approaches were designed to tackle these complex systems. Further motivating the use of HFE in healthcare was the development and expansion of conceptual models based on HFE principles and theories, such as the Systems Engineering Initiative for Patient Safety (SEIPS) model.[4] The SEIPS model was developed to help guide research and development of HFE system-based approaches toward improving safety in healthcare delivery settings.[5] The SEIPS model, and its subsequent versions, SEIPS 2.0, SEIPS 3.0, and SEIPS 101, depict key characteristics and interactions between three core components, the work system, process, and outcomes. Each model has a slightly different emphasis on the core components and has evolved as healthcare complexity has increased. One area in which complexity in healthcare has increased is in the use of IT systems in healthcare. Technology now has a prominent role in many aspects of healthcare delivery including admissions, discharge, diagnosis, and monitoring patient progress. It is important to understand how technology can be applied in healthcare for efficient, productive, and safe outcomes. Researchers have explored the use of HFE to improve the safety of IT systems. For example, researchers used HFE methods and principles to create a clinical decision support (CDS) for pulmonary embolism diagnosis by emergency department physicians. Researchers found that the HFE-designed CDS enabled physicians to improve diagnostic decision making and perform tasks faster while reporting a lower workload and higher satisfaction.[6]

Care transitions are another area of increasing complexity in healthcare. From an HFE perspective, care transitions are a process that spans two distinct work systems. To improve the safety of care transitions, it is important that healthcare professionals from each work system involved in the care transition (e.g., the emergency department and the skilled nursing facility or the hospital and primary care practice) possess a shared mental model of the goals and optimal processes for a safe and effective care transition. A shared mental model means that cross-functional teams are in alignment with the steps and processes that are undertaken at a given time. However, one study has shown that healthcare professionals involved in care transitions often have misaligned mental models across healthcare settings in terms of roles as well as communication processes and tools.[7] Designing the system to support safer care transitions requires the inclusion of healthcare professionals from both sides of the transition.

Recognizing that the patient and care partner represent the constant elements of the patient journey, SEIPS 2.0 emphasizes patient engagement and SEPIS 3.0 addresses the entirety of the patient journey. Recent HFE research has highlighted the importance of incorporating the patient and care partner in the care transition process and in emergency department disposition decision making.[8] The care partner and the patient are knowledge brokers in the patient's care, emphasizing the need to include them in the care

coordination and transition processes, especially during discharge.[9] This research incorporates the important roles of both the patient and care partner in transitions, which are complex, multiphase, and longitudinal rather than episodic.

Patient Safety Learning Labs

As the lead funding agency in patient safety research, between 2014 and 2019, AHRQ funded 30 Patient Safety Learning Labs (PSLLs) which use a systems engineering approach to allow researchers and practitioners to evaluate clinical processes and enhance work and information flow to improve patient safety. These labs have focused on a range of care settings, locations of care, and diseases, and have produced a number of insights into improving safety; several labs have focused specifically on HFE. Systems engineering focuses on the development and oversight of a system to address a need. HFE, a connected discipline of systems engineering, centers specifically around human interaction with other elements of work systems.[10]

A recent PSLL uses HFE to improve older adult care transitions. The PSLL equipped older adult patients who have a patient safety passport. The patient safety passport is a multicomponent intervention to support safe care transitions of older adults after an emergency department visit.[11] An HFE approach was used to design and implement the patient safety passport by means of HFE approaches such as work systems analysis and participatory ergonomics. Another PSLL also examined patient transitions, specifically medication transitions, or changes in medications such as a new prescription or deprescribing of an existing prescription.[12] Other PSLLs have used HFE to analyze failure to rescue and address radiology ordering and follow-up.

Future Directions

HFE and work system design are central to creating end-to-end, well-designed processes in which optimal patient safety is at the forefront, especially during care transitions, which represent an important checkpoint to identify and remediate risk. The keys to improving patient safety are understanding relationships among healthcare settings involved in care transitions, having a clear understanding of processes through effective communication channels, and engaging patients and care partners. In addition, the role of technology in healthcare will continue to expand; incorporating HFE into the technology design and implementation process offers a way to strengthen patient safety and anticipate risk. Healthcare delivery continues to evolve; increasing complexity of care is a natural byproduct of that evolution. HFE offers an essential path forward to navigating that complexity to build safe processes and outcomes for all patients.

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