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EDITORIAL

Strategic Allocation of a Finite Resource: Clinician Brain Power

Health care delivery is a complex and, at times, overwhelming environment in which to work. Clinicians are expending cognitive resources ("brain power") well above the intrinsic mental energy required to give care to patients due to inefficient workflows, suboptimal policies, documentation requirements, the structure of payment, and regulatory factors. Many clinicians feel that aspects of the clinical care environment are barriers rather than facilitators to delivering high-quality care (1). These unnecessary burdens have serious implications for quality of care, access, and patient experience. They also contribute to the high rates of occupational distress among clinicians (2) and a form of "brain injury" associated with pathophysiologic changes (3, 4).

In their article, Kissler and colleagues report the results of a scoping review to understand the state of the field related to a specific challenge created by this complexity: clinician attention allocation (that is, "brain resource allocation") (5). They define attention as "a state of presence, focus, and selective incorporation of information within clinical environments." The purpose of the review was to identify and characterize the literature on clinician attention, compile the metrics used to measure attention, and create a framework of key concepts related to clinician attention. Of the 6448 articles screened, 585 met inclusion criteria. About 80% of the included studies were descriptive, and 20% were investigational. More studies (66%) focused on barriers to clinician attention than on facilitators of attention. The authors derived a 6-category framework to organize the current literature:

1. definitions of attention,
2. evaluation of the clinical environment's effect on attention,
3. personal factors affecting attention,
4. relationships between interventions and factors that affect attention and patient outcomes,
5. the effect of clinical alarms and alarm fatigue on attention, and
6. the effect of health information technology on attention.

This framework and summary of the literature provides further support of the concept of an "ecology of attention" previously proposed by some authors of the review (6). "Ecology" comes from the field of biology and holistically describes the interrelationship between an organism and its environment. The concept of an ecology of attention encourages clinical and operational leaders to acknowledge human limitations, recognizing that attention is a finite resource, and to design systems and environments to allocate this resource optimally to advance quality, safety, and patient experience (which depends on clinician well-being) sustainably.

Humans have a finite amount of working memory used to perform cognitive tasks (7). Attention is 1 dimension of the broader construct of cognitive load. Cognitive load comprises 3 components: intrinsic, germane, and extraneous. The inherent difficulty of the material being processed (for example, assessing symptoms, determining diagnosis) determines intrinsic cognitive load. Germane cognitive load involves creating mental models of information in working memory to be stored in or retrieved from long-term memory (for example, learning or recognizing symptoms of congestive heart failure or the therapeutic interventions to treat it). Extraneous cognitive load is unnecessary load that better design can remove. Examples relate to the way information is organized or presented, or the milieu in which it is encountered (for example, how teamwork, scheduling, billing, and workflows are designed). To optimize humans' brain resource allocation, systems should be designed to *support* intrinsic cognitive load, *minimize* germane cognitive load, and ruthlessly *eliminate* extraneous cognitive load. An operating room with an experienced, prepared team, working together with minimal interruptions in a coordinated way to perform a complex surgery, is an example of a scenario characterized by high intrinsic, minimal germane, and low extraneous cognitive load.

The fields of human factors and ergonomics (deeply embraced by aviation, safety science, and space exploration) provide a tested framework for organizations and the health care delivery system to approach this problem. The human factors and ergonomics approach aspires to optimize the physical, cognitive, and organizational ergonomics in place to support humans so they can complete tasks with optimal skill and reliability (7). Although many physicians are familiar with physical ergonomics, the concept of cognitive and organizational ergonomics may be less familiar. Through its attention to both worker well-being and system efficiency, the application of human factors and ergonomics to health care offers tremendous potential to improve quality of care, enhance patient experience, and reduce occupational distress while simultaneously enhancing efficiency (8) and improving economic performance (9).

Minimizing cognitive load and fostering an ecology of attention in health care requires a paradigm shift historically analogous to the transformative impact germ theory had on health care. The recognition that microbial infections were a major driver of illness and iatrogenic complications led to changes in our thinking that translated to sterile technique for procedures, hand washing, isolating patients with infectious conditions,

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and other changes to the way work is performed that have saved countless lives. Recognizing that cognitive overload is fundamentally reducing safety, quality, clinician well-being, and patient experience and adopting human factors and ergonomics principles could similarly transform health care.

Clinician attention should be allocated or "spent" in the right places. Incremental initiatives intended to enhance safety (for example, Best Practice Alert pop-ups) might undermine safety if they overwhelm working memory and take attention away from other important activities. Health care organizations must work in partnership with human factors and ergonomics experts to evolve the design of the clinical work environment. The foundational concepts and system principles of human factors and ergonomics and brain resource allocation must be made understandable to all clinicians and health care leaders (10).

Implementation of human factors and ergonomics in health care requires that government, health care organizations, and regulatory and accrediting agencies recognize the problem of excessive cognitive load and that sufficient investment be made to apply these principles to the clinical care environment. Evaluation of the incremental cognitive load that each new initiative or task places on clinicians is also required. The existing quality and safety improvement infrastructure of many health care organizations provides a scaffold from which to build these efforts. LEAN process engineering teams often look for and reduce financial waste and inefficiency. These approaches can be adapted to consider extraneous cognitive load as the "waste" to be removed.

The complexity of the daily work for most health care professionals now exceeds human beings' finite cognitive load capacity. Without embracing cognitive load theory and the ecology of attention, ongoing efforts to improve quality, safety, and patient experience are likely to fail and occupational burnout and attrition among health care workers increase. Adoption of human factors and ergonomics principles can help the health care delivery system address this issue and enable the provision of high-quality, compassionate, and cost-effective care in a sustainable manner. Realizing this potential will require a mindset shift among health care leaders and investment by government and health care organizations.

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References

1. **Shanafelt TD, Schein E, Minor LB, et al.** Healing the professional culture of medicine. Mayo Clin Proc. 2019;94:1556-1566. [PMID: 31303431] doi:10.1016/j.mayocp.2019.03.026
2. **Harry E, Sinsky C, Dyrbye LN, et al.** Physician task load and the risk of burnout among US physicians in a national survey. Jt Comm J Qual Patient Saf. 2021;47:76-85. [PMID: 33168367] doi:10.1016/j.jcjq.2020.09.011
3. **Arnsten AFT, Shanafelt T.** Physician distress and burnout: the neurobiological perspective. Mayo Clin Proc. 2021;96:763-769. [PMID: 33673923] doi:10.1016/j.mayocp.2020.12.027
4. **Savic I.** Structural changes of the brain in relation to occupational stress. Cereb Cortex. 2015;25:1554-1564. [PMID: 24352030] doi:10.1093/cercor/bht348
5. **Kissler MJ, Porter S, Knees M, et al.** Attention among health care professionals: a scoping review. Ann Intern Med. 18 June 2024. [Epub ahead of print]. doi:10.7326/M23-3229
6. **Kissler MJ, Kissler K, Burden M.** Toward a Medical "Ecology of Attention." N Engl J Med. 2021;384:299-301. [PMID: 33503689] doi:10.1056/NEJMp2027190
7. **Harry E, Sweller J.** Cognitive load theory and patient safety. In: Ruskin KJ, Steigler MP, Rosenbaum SH, eds. Quality and Safety in Anesthesia and Perioperative Care. Oxford Univ Pr; 2016:16-21.
8. **International Ergonomics and Human Factors Association.** What is Ergonomics (HFE)? Accessed at https://iea.cc/about/what-is-ergonomics on 23 May 2024.
9. **Hendrick HW.** Determining the cost-benefits of ergonomics projects and factors that lead to their success. Appl Ergon. 2003;34:419-427. [PMID: 12963328] doi:10.1016/S0003-6870(03)00062-0
10. **Privitera MR.** Promoting clinician wellbeing and patient safety using human factors science: reducing unnecessary occupational stress. Health. 2022;14:1334-1356. doi:10.4236/health.2022.1412095