Medical Error and "Psycho-Physiology"

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In this issue of *Seminars*, Zenati et al[1] discuss using physiological parameters (eg, heart rate variability [HRV]) to indicate increasing levels of cognitive workload. The authors suggest that in the future, these variables could be used in the operating room to warn of impending cognitive overload—along with its associated risk of patient harm—and prompt a preventative intervention. Investigating cognitive workload and linking it to variables (eg, HRV) that might signal an impending medical error is innovative in exploring the relationships between biology, brain function, and medical error. Though Zenati's study[1] is preliminary and details linking HRV, root cause analysis, and the logistics of widespread practical applications still need further exploration, the concept of using this psychophysiological link to medical error is potentially very important.

Makary et al[2] estimated that medical error (though never recorded on any death certificate) was the third leading cause of death in the USA (~700 deaths/d) after heart disease and cancer. Kohn et al[3] estimated the total cost of medical error was $50 billion US—"wasted" money that could be spent toward research innovation as well as increased and better-quality access to services for patients. Diagnostic errors are among the most common medical errors[4–8] that doctors make, occurring in an estimated 20% of patient encounters[4–8] and these lead to significant disability and death. Approximately 50% of litigation cases against doctors relate to diagnostic errors with the most common diagnostic errors being cardiovascular conditions, infection, and cancer.[4–9]

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Central Message

Cognitive overload and cognitive biases cause medical error. Research correlating these psychological variables with physiological variables may allow preventative intervention to avert patient harm.

Diagnostic errors may relate to the way a healthcare provider's brain functions. In solving complex problems, there is an increase in *intrinsic* cognitive load which consumes considerable working memory (a fixed entity).[10] This *intrinsic* cognitive load can be overwhelmed if *extraneous* cognitive load (from information or tasks being presented poorly) is added, reducing one's ability to process complex information leading to errors.[10] Thus, it is important for organizations to have processes that make it easy to get information and perform tasks to minimize *extraneous* cognitive load.

Due to the limitations in cognitive bandwidth, cognitive biases (ie, shortcuts that the brain uses to more quickly come up with an answer) get used. Evidence suggests[4–9,11] that up to 80% of diagnostic errors occur due to cognitive biases. These biases can be divided into 3 large categories.[12] The first is heuristic failure where type-I fast reflexive thinking processes fail.[13] Overconfidence is the most common example of this pervasive and dangerous cognitive biases.[13,14] Furthermore, often the most overconfident individuals tend to be the most incompetent (the Dunning-Kruger effect).[15] The second type of cognitive biases relate to errors of context in which subjective external factors related to the setting affects one's approach to problem solving (eg, framing bias—where/how/by whom or the context information is presented in affects the decision). Last, errors of attribution is the cognitive biases where subjective internal factors related to culture or personality influence decisions (eg, appeal to authority bias—deferring to a senior/supervisor or "expert" independent of actual supporting data).[12]

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Several interventions to decrease cognitive errors[16] have been studied. These include interventions to improve knowledge and experience through simulation-based training; interventions to improve clinical reasoning and decision-making skills through reflective practice and active metacognitive review; and interventions to provide cognitive help using technological services to assist with diagnosis and facilitate access to information and specialists. However, most studies have been performed in trainees or in artificial settings, thus the results have been mixed.[16]

Zenati et al[1] bring up a different approach to the problem. They attempt to link physiological parameters to psychological parameters. This is very innovative and an important area to explore. Future research may include neuroimaging studies (eg, functional MRI) exposing subjects to various levels of cognitive load (intrinsic and extraneous) and looking at the rate of error in simulated patient scenarios. Studying various physiological parameters such as heart rate, heart rate variability, blood pressure, temperature, perspiration, respiratory rate, pupillary dilatation, and others to see which parameters correlate best with increased cognitive load may help develop real-time tools that could potentially be used in the future to detect an impending medical error secondary to cognitive processes as measured by physiological parameters. This could then allow real-time intervention to prevent patient harm. Exploring this new area of research combined with current areas of research may help to eventually remove medical error as the third leading cause of death in the USA.

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