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Paul A. Bergl and Rahul S. Nanchal

Diagnostic Error: Why Now? **1**

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Diagnostic errors remain relatively understudied and underappreciated. They are particularly concerning in the intensive care unit, where they are more likely to result in harm to patients. There is a lack of consensus on the definition of diagnostic error, and current methods to quantify diagnostic error have numerous limitations as noted in the sentinel report by the National Academy of Medicine. Although definitive definition and measurement remain elusive goals, increasing our understanding of diagnostic error is crucial if we are to make progress in reducing the incidence and harm caused by errors in diagnosis.

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Paul A. Bergl and Yan Zhou

Epidemiologic studies of diagnostic error in the intensive care unit (ICU) consist mostly of descriptive autopsy series. In these studies, rates of diagnostic errors are approximately 5% to 10%. Recently validated methods for retrospectively measuring error have expanded our understanding of the scope of the problem. These alternative measurement strategies have yielded similar estimates for the frequency of diagnostic error in the ICU. Although there is a fair understanding of the frequency of errors, further research is needed to better define the risk factors for diagnostic error in the ICU.

Dual Process Theory and Cognitive Load: How Intensivists Make Diagnoses **27**

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Improving clinical reasoning in order to reduce frequency of diagnostic errors is an important area of study. The authors discuss dual process theory as a model of clinical reasoning and explore the role that cognitive load plays in clinical reasoning in the intensive care unit environment.

Decision Making: Healthy Heuristics and Betraying Biases **37**

Courtney W. Mangus and Prashant Mahajan

Critical care settings are unpredictable, dynamic environments where clinicians face high decision density in suboptimal conditions (stress, time constraints, competing priorities). Experts have described two systems of human decision making: one fast and intuitive; the other slow and methodical. Heuristics, or mental shortcuts, a key feature of intuitive reasoning, are often accurate, applied instinctively, and essential for efficient diagnostic decision making. Heuristics are also prone to failures, or

cognitive biases, which can lead to diagnostic errors. A variety of strategies have been proposed to mitigate biases; however, current understanding of such interventions to optimize diagnostic safety is still incomplete.

Enhancing Analytical Reasoning in the Intensive Care Unit

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Mark Barash and Rahul S. Nanchal

Clinical reasoning is prone to errors in judgment. Error is comprised of 2 components—bias and noise; each has an equally important role in the promulgation of error. Biases or systematic errors in reasoning are the product of misconceptions of probability and statistics. Biases arise because clinicians frequently rely on mental shortcuts or heuristics to make judgments. The most frequently used heuristics are representativeness, availability, and anchoring/adjustment which lead to the common biases of base rate neglect, misconceptions of regression, insensitivities to sample size, and fallacies of conjunctive, and disjunctive events. Bayesian reasoning is the framework within which posterior probabilities of events is identified. Familiarity with these mathematical concepts will likely enhance clinical reasoning. Noise is defined as inter or intraobserver variability in judgment that should be identical. Guidelines in medicine are a technique to reduce noise.

Diagnostic Stewardship: Appropriate Testing and Judicious Treatments

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Yasaman Fatemi and Paul A. Bergl

Diagnostic stewardship encompasses the entire diagnosis-to-treatment paradigm in the intensive care unit (ICU). Initially born of the antimicrobial stewardship movement, contemporary diagnostic stewardship aims to promote timely and appropriate diagnostic testing that directly links to management decisions. In the stewardship framework, excessive diagnostic testing in low probability cases is discouraged due to its tendency to generate false-positive results, which have their own downstream consequences. Though the evidence basis for diagnostic stewardship initiatives in the ICU is nascent and largely limited to retrospective analyses, available literature generally suggests that these initiatives are safe, feasible, and associated with similar patient outcomes. As diagnostic testing of critically ill patients becomes increasingly sophisticated in the ensuing decade, a stewardship mindset will aid bedside clinicians in interpreting and incorporating new diagnostic strategies in the ICU.

Intensive Care Unit Decision-Making in Uncertain and Stressful Conditions Part 2: Cognitive Errors, Debiasing Strategies, and Enhancing Critical Thinking

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Megan Christenson, Anuj Shukla, and Jayshil J. Patel

Diagnostic errors are considered a blind spot of health care delivery and occur in up to 15% of patient cases. Cognitive failures are a leading cause of diagnostic error and often occur as a result of overreliance on system 1 thinking. This narrative review describes why diagnostic errors occur by shedding additional light on systems 1 and 2 forms of thinking, reviews literature on debiasing strategies in medicine, and provides a framework for teaching critical thinking in the intensive care unit as a strategy to promote learner development and minimize cognitive failures.

- Learning from Missed Opportunities Through Reflective Practice** 103
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- Identification of diagnostic errors is difficult but is not alone sufficient for performance improvement. Instead, cases must be reflected on to identify ways to improve decision-making in the future. There are many tools and modalities to retrospectively reflect on action to study medical decisions and outcomes and improve future performance. Reflection in action—in which diagnostic decisions are considered in real-time—may also improve medical decision-making especially through strategies such as structured reflection. Ongoing regular feedback can normalize the discussion about improving decision-making, enable reflective practice, and improve decision making.
- Promoting Critical Thinking in Your Intensive Care Unit Team** 113
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- Effective and efficient critical thinking skills are necessary to engage in accurate clinical reasoning and to make appropriate clinical decisions. Teaching and promoting critical thinking skills in the intensive care unit is challenging because of the volume of data and the constant distractions of competing obligations. Understanding and acknowledging cognitive biases and their impact on clinical reasoning are necessary to promote and support critical thinking in the ICU. Active educational strategies such as concept or mechanism mapping can help to diagnose disorganized thinking and reinforce key connections and important clinical and pathophysiologic concepts, which are critical for inductive reasoning.
- Enhancing Diagnosis Through Technology: Decision Support, Artificial Intelligence, and Beyond** 129
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- Patient care in intensive care environments is complex, time-sensitive, and data-rich, factors that make these settings particularly well-suited to clinical decision support (CDS). A wide range of CDS interventions have been used in intensive care unit environments. The field needs well-designed studies to identify the most effective CDS approaches. Evolving artificial intelligence and machine learning models may reduce information-overload and enable teams to take better advantage of the large volume of patient data available to them. It is vital to effectively integrate new CDS into clinical workflows and to align closely with the cognitive processes of frontline clinicians.
- A Research Agenda for Diagnostic Excellence in Critical Care Medicine** 141
Christina L. Cifra, Jason W. Custer, and James C. Fackler
- Diagnosing critically ill patients in the intensive care unit is difficult. As a result, diagnostic errors in the intensive care unit are common and have been shown to cause harm. Research to improve diagnosis in critical care medicine has accelerated in past years. However, much work remains to fully elucidate the diagnostic process in critical care. To achieve diagnostic excellence, interdisciplinary research is needed, adopting a balanced strategy of continued biomedical discovery while addressing the complex care delivery systems underpinning the diagnosis of critical illness.