Reducing Diagnostic Error in the Intensive Care Unit

Engaging Uncertainty When Teaching Clinical Reasoning

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ABSTRACT

As medicine continues to advance with improvements in technology, factual information has become more easily available at the bedside. Nevertheless, diagnostic error remains a salient concern for the medical community and public. To address this problem, two fundamental characteristics of the physician remain important: curiosity and the ability to apply critical reasoning to solve problems, often in the setting of imperfect knowledge and uncertainty. Historically, the teaching and recall of factual information, illness scripts, and pattern recognition are emphasized early in medical education. Students are often left with the impression that there is a single correct answer for every question; discussions of uncertainty are rare. Consequently, discomfort with uncertainty is common among doctors. As attention to explicit teaching of clinical reasoning increases, one must consider how to incorporate uncertainty into that teaching and to transform the clinical learning environment to embrace uncertainty. The authors propose the use of several simple methods easily employed in the critical care setting to make uncertainty explicit by changing the language used for expressing differential diagnosis, incorporating probabilities into daily sign-outs, and by implementing inductive reasoning when teaching critical thinking to offer learners a strategy for working through unknown problems; these approaches may normalize uncertainty, improve comfort with it, and reduce the impact of cognitive bias in decision-making. Comfort with uncertainty may result not only in improved clinical experiences for learning by transforming a once negative cognitive experience to a positive one but also in reduced susceptibility to thinking errors.

Keywords:
critical thinking; clinical reasoning; uncertainty

The medical student and resident want to impress their supervising attending; the doctor wishes to reassure the frightened patient and family. Uncertainty has no place here; the intern is chastised—"put your nickel down!" Despite technological advances that enable medical providers to find factual information quickly, the challenge of medicine and the key to critical thinking remains the application of knowledge to solve problems and the ability to admit that one does not know the answer. As Dr. William Osler noted at the turn of the century, "medicine is a science of uncertainty and an art of probability" (1), which underscores that uncertainty propels doctors to explore a dilemma (the basis for intrinsic curiosity), to recognize cognitive dissonance, and to embrace the unknown to provide the best care for patients.

The clinical learning environment in medical schools and training programs has not typically prepared physicians to acknowledge uncertainty or provided them with strategies for dissecting difficult clinical problems, which may hamper reasoning abilities. Rather, medical schools have focused on tests with one best answer and objective structured clinical exams in which students are evaluated through a series of checkboxes. This may lead to the development of pro forma lists of diagnoses in which illness scripts are applied to the patient at hand and the learner creates a "differential" based on the key words or findings they heard and not based on the complexity of the patient in front of them. Type 1 thinking, use of heuristics, and pattern recognition prevail, perhaps facilitated by the time constraints, increasing work demands, and sleep deprivation of residency training (2). Though this method can lead to appropriate care in many instances, it is also frequently a recipe for diagnostic error.

The magnitude of diagnostic error has been a primary focus of the medical community over the past few decades. The Institute of Medicine's report, "Improving Diagnosis in Health Care," identified diagnostic processes as a major source of error and an area in which to enhance clinical training (3). Indeed, diagnostic error has been identified as a major source of malpractice claims (4), demonstrating the negative impacts on both providers and patients. These errors are infrequently esoteric diagnoses unfamiliar to the doctor; rather, they are common problems missed by the physician in a particular context, often representing a thinking error rather than a knowledge deficit. As doctors progress through training, the level and experience of the learner may shift the balance between knowledge and thinking as the source of error, with cognitive mistakes superseding factual gaps. In the intensive care unit (ICU), patients are at risk for adverse outcomes (5), with estimates of up to 40,000 ICU deaths in the United States related to misdiagnosis (6, 7). Although determining the exact impact of diagnostic error is challenging, these numbers signal an important area for intervention to improve care.

Recently, much attention has focused on the roles of cognitive bias and clinical reasoning on diagnostic error (8–10). Cognitive debiasing strategies have evolved to enhance metacognition and catch these errors (8, 11–13). But the biggest problem may be the predisposition of our minds to avoid uncertainty. Amos Teversky, who along with Daniel Kahneman did seminal work on how we think, noted, "The brain appears to be programmed, loosely speaking, to provide as much certainty as it can. It is apparently

designed to make the best possible case for a given interpretation rather than to represent all the uncertainty about a given situation" (14). Recently, one randomized study evaluated the role of language that called attention to uncertainty and found it led to discomfort among medical students (15), indicating that this topic is still poorly addressed in medical education curricula. Strategies to address this challenge have highlighted multiple potential approaches, which warrant future investigations (16–18), and the best method for incorporating medical uncertainty into the teaching of clinical reasoning in the fast-paced ICU clinical learning environment remains unsettled.

The ICU can be a busy and distracting setting for learners given the complexity and acuity of patients. Despite the large amount of physiological data frequently available, it is an ideal location to demonstrate the role of uncertainty in the diagnostic process and to change the emotional valence of uncertainty from negative to positive, thereby countering some of the most common cognitive biases (e.g., anchoring, premature closure, availability bias), all of which may be brought to bear, as Tversky noted, "…to make the best possible case for a given interpretation." Although there are multiple approaches to address diagnostic uncertainty in the ICU, we believe that the first step is to change the atmosphere surrounding uncertainty and to employ several simple strategies both to make uncertainty explicit and to provide the learner with the tools to address it.

MAKING UNCERTAINTY EXPLICIT

The first step to address uncertainty is to define it explicitly in the clinical setting. Bhise and colleagues completed a systematic review and found that the literature lacked a clear definition of clinical

uncertainty (19). They identified key attributes of diagnostic uncertainty as perception, impedance on appropriate action or thought, and its dynamic nature. Using these characteristics, they proposed the definition of diagnostic uncertainty as a "subjective perception of an inability to provide an accurate explanation of the patient's health problem." This definition simplifies a complex phenomenon, reducing it to its foundational component; uncertainty about the patient becomes a personal and aversive experience for the physician, for which confidence may be a balm.

Uncertainty can have a two-dimensional structure that includes aleatoric uncertainty, inherent random variability because of chance, and epistemic uncertainty, which refers to incomplete decision-making because of the limitations of an incomplete knowledge base (18). The complexity of uncertainty as a construct, however, has led to multiple taxonomies, which have been proposed to allow for more nuanced interventions (20–22). To the medical student and resident in the clinical setting, discussing the uncertainty in this granular detail is too time consuming and may confuse rather than elucidate the issue at hand. We would propose focusing on a definition that identifies diagnostic uncertainty's core component, the subjective perception of the need to explain all that is happening to one's patient; it is experienced by the physician, it is typically associated with a negative or distressing sensation, and it regards the patient at hand.

As Tversky noted, we may be programmed to avoid uncertainty; the unconscious takes over and pushes us in a direction in which we may not wish to travel (14). This is likely because of the negative valence that surrounds uncertainty and our

psychological need to avoid unpleasant emotions. As a result, physicians may then order unnecessary labs, procedures, or referrals for their own reassurance (23).

The hidden curriculum—or the unwritten and often unintended lessons, values, and perspectives that students learn from observation of others—which rewards decisive action, is often present on rounds and inhibits admission of uncertainty. Although decisive action may be necessary to stabilize an acutely deteriorating patient, those often reflexive actions (e.g., give a fluid bolus for a fall in blood pressure) should be way stations to more formal analysis of the underlying problem and not confused with a thoughtful appraisal of the situation at hand.

We believe the best way to encourage decisiveness while acknowledging diagnostic uncertainty during rounds, and thereby inviting analytical thought, is by avoiding asking for a differential diagnosis; rather, ask for a list of hypotheses, preferably based on physiological and pathophysiological mechanisms (24). The word "diagnosis" describes a distinct disease and may convey a final answer, with associated certitude, rather than a supposition. The term "hypothesis" on the other hand connotes an idea to be tested because the answer is not yet known. Students may feel more comfortable using the term "diagnosis" (15), possibly because they may believe that there is a correct answer about which they need to demonstrate their competence. Alternatively, they may imagine the possibility of two or more correct answers that may provide similar results for the patient and at least get credit for providing one (16).

But what if the student said, "I am not sure, but I have a hypothesis"? Stating that one does not know should be encouraged;

this makes the uncertainty explicit and is the first step to normalizing the intellectual state and engaging the team in further thought. As Ilgen and colleagues argued, uncertainty should "serve as a catalyst for ongoing skepticism of a working hypothesis" (25); one should be using uncertainty to one's advantage as a stimulus to facilitate ongoing monitoring and thinking as a clinical situation unfolds. When uncertainty is explicitly identified, the attending physician may help facilitate a "diagnostic time-out" and perhaps turn the routine expert, one with detailed knowledge and efficient recognition of patterns who is prone, nonetheless, to fitting an unknown case into a familiar mold previously seen, into an adaptive expert, one who identifies novel problems as a point of departure to explore, learn, and adjust their thinking to arrive at a solution (26, 27).

Similar to refocusing the language used during rounds, the conversation between residents when the care of the patient is being transferred from one team of providers to another provides an opportunity to make uncertainty explicit. Studies evaluating language regarding uncertainty between residents are limited. One study found that few residents who responded to critical incidents involving diagnostic uncertainty had discussed their dilemma with fellow residents and nonattending team members (28). We propose that sign-outs between residents are one place to make uncertainty explicit. When communicating about patients without definitive diagnoses, the residents should present the patient's active problem(s) as hypotheses with high, medium, or low likelihood. For the overnight covering resident who gets an urgent call about a patient, this may avoid framing biases and prevent anchoring to the

diagnosis provided at the time of transfer of the care of the patient.

ADDRESSING UNCERTAINTY THROUGH INDUCTIVE REASONING

When teaching critical thinking in the context of diagnostic uncertainty, two different strategies may be applied: hypothetico-deductive reasoning (29) and inductive reasoning (30). Hypothetico-deductive reasoning centers on moving from a few observations quickly to a differential diagnosis (type 1 thinking; what patterns emerge quickly); one then deduces what one knows about each diagnosis and looks for the best match between the patient and diagnostic options. This approach, though fast and often accurate in experienced hands, may seduce the more novice student or resident, who may be relying on illness scripts, to believe that they are certain about the answer to the problem; in addition, the approach is subject to a range of cognitive biases, including premature closure, confirmation bias, and availability bias (8). Furthermore, if patterns don't emerge, or you can only think of one diagnosis, what do you do? In contrast, inductive reasoning emphasizes the importance of using the data (the symptoms, physical findings, and lab results) of a case to develop an intermediate hypothesis based on mechanisms of disease that can explain what is being observed. This process relies not on rote memorization of a list that accompanies a sign or symptom but instead on understanding the underlying pathophysiology that accounts for the problem, which forms the basis for reasoning from the observed derangement to arrive at a possible diagnosis. After giving fluid as a reflex for the hypotensive patient, you go back to the basic principles of hemodynamics: mean arterial pressure − central venous pressure = cardiac output × systemic vascular resistance. You deconstruct cardiac output into stroke volume and heart rate and consider the impact of problems with preload (from bleeding to tension pneumothorax), contractility (acute ischemia to cardiomyopathy), and afterload on the right ventricle (pulmonary embolism). In doing so, the individual begins to link facts (physical exam, laboratory studies) to create new hypotheses, which can be tested and ultimately result in a diagnosis. "I may not know the answer, but I know how to think about the problem." Routine experts look at unknowns and fit them into a pattern they have seen before; adaptive experts, using inductive processing, use the unknown as a starting point for exploration to ultimately create a new solution (27). Trained in inductive reasoning, the learner can embrace rather than be fearful of the uncertainty; there is a way out, a strategy to address the uncertainty, which now carries a positive rather than negative emotional valence.

SUPPORTING CRITICAL THINKING

The clinical learning environment is determined by the dynamic interplay of social interactions, organizational cultures and structures, and the physical and virtual spaces that determine the learner's experiences and perceptions (31) and may be a target for intervention to improve learning and patient care (32). We are all born with great curiosity and a sense of exploration; just watch any toddler examine the world. Yet our traditional education system often leads to a weakening of these traits in students (33). Factors that may thwart learner's curiosity in the ICU include, but are not limited to, managing multiple tasks with limited time

and stressors inherent to high-acuity patients that may overwhelm the learner.

Supportive faculty may lead to improved learning (34), whereas poor learning environments have been shown to have a negative correlation with patient outcomes (35). To enhance clinical reasoning in the ICU, one can create an environment that rewards good questions, that encourages the refusal to accept the most common explanation, and that embraces uncertainty and models the inductive process as a strategy to resolve dilemmas and solve problems. As a result, the learner's curiosity is fostered by embracing uncertainty and by applying a positive valence surrounding uncertainty, and the faculty's ability to cultivate curiosity may serve as a mechanism to improve the clinical learning environment and potentially patient outcomes.

SUMMARY

By refocusing our language on hypotheses to return clinical medicine to its scientific roots, by making uncertainty explicit in our communication with other members of the team, and by providing a strategy to deal with uncertainty via inductive reasoning, critical thinking can be enhanced in the ICU. Although the ICU is a busy environment with frequent distractions, these simple approaches can augment curiosity and the motivation to explore, reason, and learn.

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