Abstract:
Since the Institute of Medicine's initial report on medical error was published in 1999, understanding of the magnitude of this problem within health care continues to grow. Although medical error is a broad category that includes both system and human factors, diagnostic error, with significant consequences for patients and their families, bias is a common and often overlooked contributor. This type of error is complex, as it is rooted in clinicians' use of heuristics and their inherent or cognitive biases. The objective of this review is to define medical error and to explore the methods that can be used to reduce error in clinical practice. Using a case-based discussion, cognitive bias resulting in diagnostic error will be reviewed.

Keywords:
quality improvement; diagnostic error; cognitive bias; heuristics; emergency department

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Recognizing Bias, Reducing Error: A Case-Based Study for Improvement in the Emergency Department

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For the past 2 decades, an increased awareness of error within medicine has come to the forefront of the health care system. In 1999, the first estimate of the magnitude of the problem was described in the Institute of Medicine's (IOM) report, *To Err is Human.* Front page news reported 98 000 deaths and a million episodes of harm experienced by patients annually in the United States.[1] A second IOM report in 2000, *Crossing the Quality Chasm*, ushered in a new era of health care, with the national movement for patient safety and health care quality under way. The IOM proposed the "Six Aims" of quality care, defining "quality" as care that is safe, timely, efficient, equitable, effective, and patient centered. Care defined in this manner would ensure that each patient's health care interaction would be thoughtful, evidence based, and neither wasteful nor harmful.[2] The 2015 release of the IOM's *Improving Diagnosis in Healthcare* reported that efforts to improve quality and safety had yet to address one of the largest sources of harm within the system—the pervasive presence of diagnostic errors.[3]

Diagnostic error has been defined in many ways. According to the National Academies of Sciences, the patient-centered definition of *diagnostic error* is "… the failure to: (a) establish an accurate and timely explanation of the patient's health problem (s), or (b) communicate that explanation to the patient."[3] Such error can occur at any point along the diagnostic process (Figure 1). Errors related to incorrect or delayed diagnoses are complex and may involve factors inherent to the patient, the system, or the physician. Long before the 2015 report, Dr Mark L Graber, committed to the study of reducing harm within medicine, described 3 categories of diagnostic error. The first is "no fault" error, best characterized by the example of failure to diagnose a patient with a rare or uncommon disease presentation. The second type of error is systems based, for which the science of quality improvement offers rigorous methodology to recognize and mitigate any process that contributes to waste and/or harm. The third type of diagnostic error is cognitive error. The principle contributor to patient harm, cognitive errors are solely attributable to the clinician (Figure 2).[4,5]

BACKGROUND

Cognition is defined by the *Merriam-Webster Dictionary* as a conscious mental activity that includes thinking, understanding, learning, and remembering. Cognitive errors include both knowledge-driven factors, such as lack of experience or education, and cognitive bias. Cognitive bias is an *error* in cognition or "faulty thinking." Cognitive errors as the result of bias are thought to be responsible for 28% of all diagnostic errors reported.[6] Cognitive bias leads to decision making that deviates from reasoned objectivity and impacts behavior in all human beings, whether consciously or not. This is especially true in the emergency department (ED), where physicians make hundreds of decisions in a clinical environment of diagnostic uncertainty, high patient volume and acuity, and constant distractions. The use of *heuristics,* or mental shortcuts that allow people to solve problems and make judgments quickly and efficiently, reduces cognitive burden and allows the physician to make timely decisions regarding patient care. Heuristics allow for fast problem solving, curtailed computing, and quick "rule of

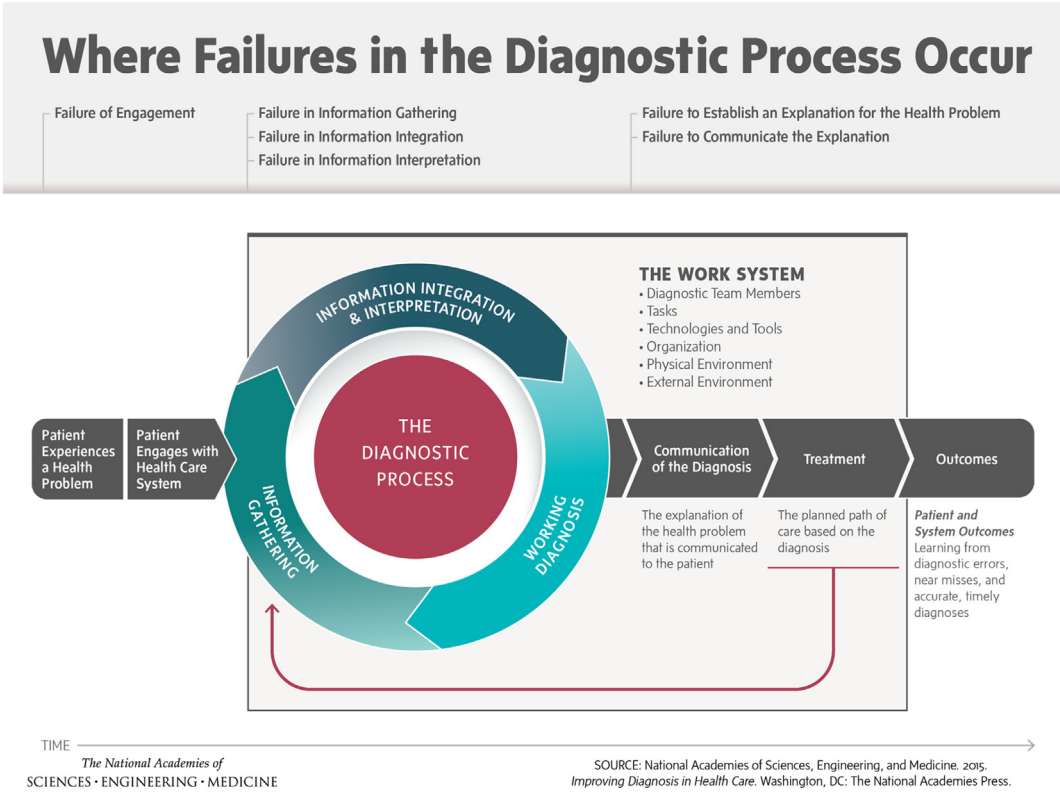

Figure 1. Conceptual model for the diagnostic process.

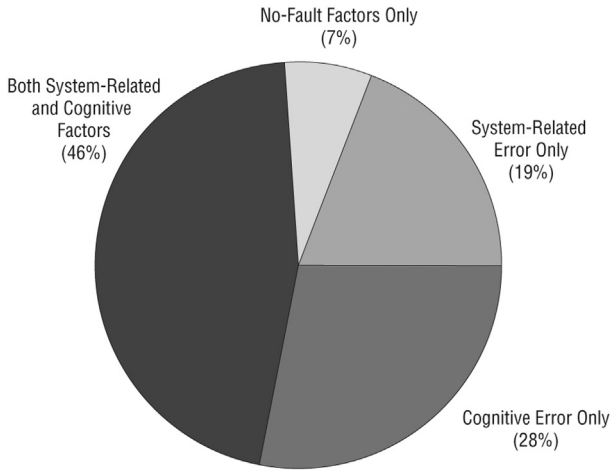

Figure 2. Factors contributing to diagnostic error.The categories of factors contributing to diagnostic error in 100 patients.[4]

thumb" decisions. Reliance solely on these mental shortcuts, however, increases the chance for cognitive bias and diagnostic error. The following case illustrates how cognitive biases contributed to significant diagnostic delay.

CASE PRESENTATION

An adolescent boy with a history of insulin-dependent diabetes mellitus was referred by his pediatrician to a community hospital ED for evaluation. According to his grandmother, the child appeared "altered" at home and had mild elevation to his blood sugars. During the triage assessment, the patient made several confusing statements, including answering a routine safety screening question with, "I want to kill myself and my mother." His initial blood glucose was 190 mg/dL by finger stick point-of-care testing, and he was placed in a psychiatric evaluation room due to his suicidal/homicidal statement at triage. His initial vital signs consisted of a heart rate of 124, blood pressure of 151/96, and a normal temperature, rate of respiration and oxygen saturation. The physician arrived to the bedside approximately 30 minutes after rooming, with his later notations on the physical examination indicating no abnormalities except for the patient's "odd statements." An emergent psychiatric evaluation was requested, and the physician ordered blood and urine testing, with specific screening for diabetic ketoacidosis (DKA). Two hours later, laboratory data revealed an elevated glucose of 186 mg/dL with no acidemia and no ketones in his urine. The psychiatric evaluation was delayed due to high patient volume and need for other mental health assessments throughout the ED. At this time, an attempt was made to transfer the patient to the pediatric unit for admission and monitoring of his hyperglycemia. The pediatric service expressed concern about the patient's safety and transfer of care prior to psychiatric clearance.

During the wait for psychiatric evaluation, further alteration in the patient's mental status was noted 2 hours later, with persistence of tachycardia, stable respiratory status, but no recheck of the previously elevated blood pressure. A urine drug screen analysis was performed and proved negative for drugs of abuse. The psychiatrist arrived to the bedside but was unable to complete an evaluation because of the teen's inability to respond appropriately to questioning. The daytime shift ended and staffing changed, with the patient now 6 hours into his ED visit.

The newly arrived emergency physician noted the patient's abnormal mental status, tachycardia, negative toxicology, and absence of DKA by laboratory testing and ordered computed tomography (CT) head imaging. The noninfused head CT showed a poorly defined abnormality concerning for the presence of blood, and a magnetic resonance imaging scan (MRI) was ordered. Because of the increasing agitation of the patient, the MRI was delayed, awaiting preparation for monitored sedation. The MRI result showed extensive cerebral venous sinus thrombosis with evidence of early herniation. The patient underwent intubation, was started on anticoagulation, and transferred by helicopter to a tertiary care center for neurosurgical and critical care. The patient survived multiple neurosurgical procedures, after bleeding developed during anticoagulation, and was discharged from inpatient care to long-term rehabilitation.

COGNITIVE BIAS AND DIAGNOSTIC ERROR

Numerous biases and heuristics have been described in the literature. Patrick Croskerry, MD, PhD, a pioneer in the field of cognitive and diagnostic error, has detailed and categorized cognitive bias in numerous publications, highlighting their distinct impacts on medical decision making by emergency physicians.[7] According to Croskerry, cognitive errors associated with bias in the ED fall into: (1) errors of pattern recognition; (2) pitfalls related to reliance on heuristics and short cuts; and (3) "ROWS" or "rule out worst-case scenario" lists, which often lead to overtesting.[8] Familiarity with these broad categories and individual biases is vital to understanding error that can undermine medical decision making and clinical judgment, particularly in ED setting (Table 1).

Using Crosskerry's categorization of biases, we can better understand error in the case presented, including the cognitive biases of *framing, anchoring, availability heuristic,* and *premature closure*, all of which contributed to the delay in diagnosing a life-threatening condition.[9] The initial statement by the patient regarding suicidal intent prompted the triage nurse to focus on a psychiatric condition. This phenomenon, known as *framing*, refers to the context in which information is presented. It is easy to see how the initial triage decision led to a series of events which delayed accurate diagnosis and prompt therapy. The *availability heuristic*, or the likelihood of a diagnosis based on what is common or more familiar, also impacted the thinking and actions of the physician and nursing staff. An adolescent with altered behavior due to a psychiatric illness is more common than a life-threatening intracranial process.

Premature closure, in which one stops the search for the correct diagnosis once a diagnosis is made, was also revealed by this case. Despite the vital sign abnormalities and relatively normal blood work, the physician was still inclined to think (or was biased toward) the patient having a psychiatric or diabetes-related etiology to his altered behavior and mental state. In hindsight, the clinical data required a broader diagnostic differential, with a comprehensive search for the etiology of altered behavior, tachycardia, and hypertension. Possible diagnoses included a sympathomimetic or anticholinergic toxidrome from drug ingestion or polypharmacy exposure. However, a toxicologic workup was not initiated on arrival, and when pursued hours later, it was limited to common drugs of abuse as detected by urine drug screen. This failure to pursue a diagnosis could have resulted from physician's inattention to signs and symptoms, multiple distractors in a busy ED, or a knowledge gap concerning toxicologic poisoning. Complications from

TABLE 1. Table of cognitive bias related to health care.

Cognitive bias	Definition	Example
Framing effect	Information presented in a way that impacts future decisions	A patient triaged to Urgent Care with abdominal pain and vomiting is more likely to be diagnosed with gastroenteritis than considered to have appendicitis.
Anchoring bias	Focus on an initial impression despite the availability of new information	The teenager with history of migraine who presents with headache and photophobia is diagnosed with migraine and discharged despite the symptoms of neck pain and low-grade fever.
Availability heuristic	Jumping to diagnoses that are more familiar or currently prevalent	The toddler with high fever, tachycardia, fever, and vomiting in winter time is diagnosed with flu, and his sepsis is missed.
Premature closure	Accepting a diagnosis without considering other available information	A child in a car accident with an obvious arm fracture is casted and sent home, although still in pain. His liver laceration goes undetected.
Confirmation bias	Focusing only on information which validates an initial impression	The teen girl with a history of social withdrawal who presents with shortness of breath and feels better after Ativan is discharged with a diagnosis of anxiety, and her pulmonary embolism goes undetected.
Diagnostic momentum	When an initial diagnostic label limits one's ability to consider alternative diagnoses	The young girl sent from the pediatric office with lower abdominal and flank pain and a diagnosis of suspected pyelonephritis never has the appropriate study to find her ovarian torsion.
Ascertainment bias	When impressions are shaped based on prior knowledge or interaction	The teenager with a history of substance abuse presents with significant back pain and is diagnosed with dependency and discharged, missing his epidural abscess.

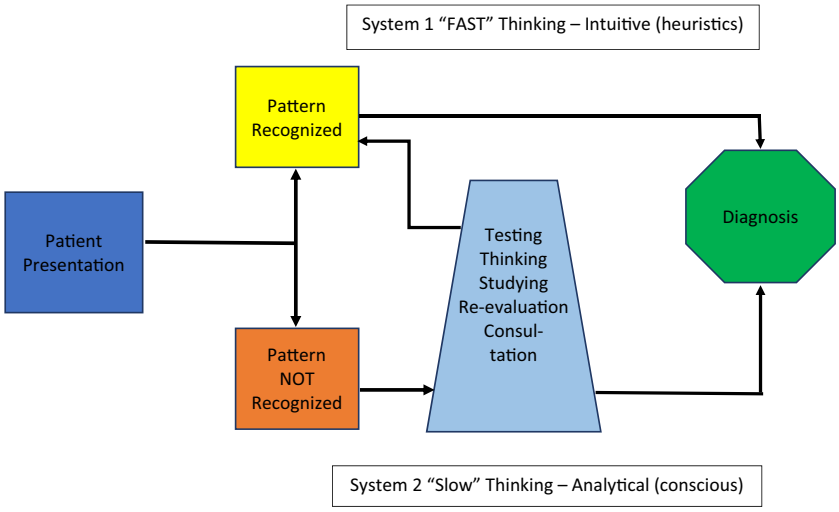

Figure 3. Representation of the dual process model for diagnostic decision making.

diabetes could lead to altered mental status as well, but the lack of significant hyperglycemia, acidosis, or ketonuria ruled out DKA as a possibility. A central nervous system infectious or traumatic etiology could produce altered behavior and mental status, which was not pursued in the workup of this patient. Finally, all of these biases contributed to *anchoring* by the physician, who relied on the initial impression and failed to adjust clinical evaluation and treatment despite new information.

The medical literature is filled with examples of cognitive bias that negatively impacts clinical reasoning and patient care. The initial labeling of a patient's condition is the first step in care that can introduce bias, particularly in the ED setting. For example, patients with a history of substance abuse may present with symptoms indicative of medical or surgical illness. These can be minimized or ignored, attributed instead to the behavior of a drug addict, leading to delayed and/or missed diagnoses. This is an example of *ascertainment bias*, in which prior knowledge of a patient shapes the current impression.

Patients who present with psychological complaints are often assigned a lower acuity, thus a lower triage priority, unless they pose an immediate risk due to agitation. In addition, triage decisions related to assignment of a diagnosis rather than a chief complaint may result in placement of a patient into a diagnosis-specific room. For example, the symptoms attributed to behavioral health diagnoses may place the patient in specialized rooms equipped for isolation, restraint, and safety precautions but which may hinder the initiation of a comprehensive medical workup or potential resuscitation. When studied in intensive care and inpatient units, patient location has been associated with morbidity and mortality. In one study, patients roomed further from nursing stations were shown to have higher mortality rates. Likewise, patients located on floors unrelated to their diagnosis (eg, a cardiac patient on a surgical floor) or far from their service team had higher readmission and mortality rates.[10,11]

In the final analysis of the literature on medical error, we can extrapolate from these results the many risks for diagnostic error. Labeling of patients with a diagnosis at triage, past behavioral health diagnoses, the practice of assigning patients to disease-specific rooms, inattention to available data, and the tendency to diagnose that which is common or familiar can all contribute to provider-related bias in the ED.

STRATEGIES TO OVERCOME BIAS

In overcoming cognitive bias, the first important step for clinicians is to understand the heuristics and biases that impact decision making. The second step, understanding how we use this information to reduce diagnostic error, is critical. In Croskerry's words, we must first "overcome the bias against overcoming bias."[7] Many strategies to achieve this goal have been proposed, including teaching medical students and trainees to recognize and avoid specific biases.[7] Timely feedback is another strategy that allows physicians to understand their diagnostic errors and, it is hoped, prevent such mistakes in the future.[12]

Dr Graber instructs that specific training, education, and awareness around cognitive biases and

heuristics can lessen their effect and reduce diagnostic error. The understanding and familiarity of metacognition, or "thinking about thinking," may be one place for physicians to start. *Metacognition* refers to an individual's higher-order thinking or awareness of thinking processes when setting about to understand, learn, and solve problems. Understanding the characteristics of the dual processing systems of the mind, and the differences between "intuitive" (type 1) and "analytic" (type 2) thought and how they relate to cognitive failure, can be taught early in medical training (Figure 3).[13] Graber also suggests that the use of a subspecialty consult, second opinion, and clinical decision support systems may dampen the effect of cognitive error on mistakes in diagnosis.[5] However, further work is necessary to assess whether any of these proposed strategies can lead to a positive impact on patient care.

SUMMARY

Our adolescent patient's case was used to illustrate the impact of cognitive bias on clinical care and outcome. The link between bias and patient care has been well described in multiple medical settings but is particularly relevant to the ED, where hundreds of decisions are made with speed, efficiency, and profound clinical impact. It also highlights the need for further research into strategies to combat one's tendency toward heuristics, the mental shortcuts which may improve efficiency but contribute to diagnostic error. Through a better understanding of our own cognitive biases, we can work to achieve the IOM's tenets of quality, providing care that is safe, timely, effective, efficient, equitable, and patient centered.[2]

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