ARTICLE

The Importance of Cognitive Errors in Diagnosis and Strategies to Minimize Them

Pat Croskerry, MD, PhD

ABSTRACT

In the area of patient safety, recent attention has focused on diagnostic error. The reduction of diagnostic error is an important goal because of its associated morbidity and potential preventability. A critical subset of diagnostic errors arises through cognitive errors, especially those associated with failures in perception, failed heuristics, and biases; collectively, these have been referred to as *cognitive dispositions to respond* (CDRs). Historically, models of decision-making have given insufficient attention to the contribution of such biases, and there has been a prevailing pessimism against improving cognitive performance through debiasing techniques. Recent work has catalogued the major cognitive biases in medicine; the author lists these and describes a number of strategies for reducing them ("cognitive debiasing"). Principle among them is metacognition, a reflective approach to problem solving that involves stepping back from the immediate problem to examine and reflect on the thinking process. Further research effort should be directed at a full and complete description and analysis of CDRs in the context of medicine and the development of techniques for avoiding their associated adverse outcomes. Considerable potential exists for reducing cognitive diagnostic errors with this approach. The author provides an extensive list of CDRs and a list of strategies to reduce diagnostic errors.

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The recent article by Graber et al.[1] provides a comprehensive overview of diagnostic errors in medicine. There is, indeed, a long overdue and pressing need to focus on this area. They raise many important points, several of which deserve extra emphasis in the light of recent developments. They also provide an important conceptual framework within which strategies may be developed to minimize errors in this critical aspect of patient safety. Diagnostic errors are associated with a proportionately higher morbidity than is the case with other types of medical errors.[2–4]

Dr. Croskerry *is associate professor, Departments of Emergency Medicine and Medical Education, Dalhousie University Faculty of Medicine, Halifax, Nova Scotia, Canada. He is also a member of the Center for Safety in Emergency Care, a research consortium of the University of Florida College of Medicine, Dalhousie University Faculty of Medicine, Northwestern University The Feinberg School of Medicine, and Brown Medical School.*

Correspondence and requests for reprints should be sent to Dr. Croskerry, Emergency Department, Dartmouth General Hospital Site, Capital District, 325 Pleasant Street, Dartmouth, Nova Scotia, Canada B2Y 4G8; telephone: (902) 465-8491; fax: (902) 460-4148; e-mail: ⟨xkerry@accesscable.net⟩.

Two responses to this article are printed after it.

The *no-fault* and *system-related* categories of diagnostic errors described[1] certainly have the potential for reduction. In fact, very simple changes to the system could result in a significant reduction in these errors. However, the greatest challenge, as they note, is the minimization of *cognitive* errors, and specifically the biases and failed heuristics that underlie them. Historically, there has prevailed an unduly negative mood toward tackling cognitive bias and finding ways to minimize or eliminate it.

The cognitive revolution in psychology that took place over the last 30 years gave rise to an extensive, empirical literature on cognitive bias in decision-making, but this advance has been ponderously slow to enter medicine. Decision-making theorists in medicine have clung to normative, often robotic, models of clinical decision making that have little practical application in the real world of decision making. What is needed, instead, is a systematic analysis of what Reason[5] has called "flesh and blood" decision-making. This is the real decision making that occurs at the front line, when resources are in short supply, when time constraints apply, and when shortcuts are being sought. When we look more closely at exactly what

cognitive activity is occurring when these clinical decisions are being made, we may be struck by how far it is removed from what normative theory describes. Although it seems certain we would be less likely to fail patients diagnostically when we follow rational, normative models of decision making, and although such models are deserving of "a prominent place in Plato's heaven of ideas,"[6] they are impractical at the sharp end of patient care. Cognitive diagnostic failure is inevitable when exigencies of the clinical workplace do not allow such Olympian cerebral approaches.

Medical decision makers and educators have to do three things: (1) appreciate the full impact of diagnostic errors in medicine and the contribution of cognitive errors in particular; (2) refute the inevitability of cognitive diagnostic errors; and (3) dismiss the pessimism that surrounds approaches for lessening cognitive bias.

For the first, the specialties in which diagnostic uncertainty is most evident and in which delayed or missed diagnoses are most likely are internal, family, and emergency medicine; this is borne out in findings from the benchmark studies of medical error.[2–4] However, all specialties are vulnerable to this particular adverse event. The often impalpable nature of diagnostic error perhaps reflects why it does not appear in lists of serious reportable events.[7] For the second, there needs to be greater understanding of the origins of the widespread inertia that prevails against reducing or eliminating cognitive errors. This inertia may exist because such errors appear to be so predictable, so widespread among all walks of life, so firmly entrenched, and, therefore, probably hardwired. Although the evolutionary imperatives that spawned them may have served us well in earlier times, it now seems we are left with cognitively vestigial approaches to the complex decision making required of us in the modern world. Although "cognitive firewalls" may have evolved to quarantine or avoid cognitive errors, they are clearly imperfect[8] and will require ontogenetic assistance (i.e., cognitive debiasing) to avoid their consequences. Accepting this, we should say less about biases and failed heuristics and more about *cognitive dispositions to respond* (CDRs) to particular situations in various predictable ways. Removing the stigma of bias clears the way toward accepting the capricious nature of decision-making, and perhaps goes some way toward exculpating clinicians when their diagnoses fail.

An understanding of why clinicians have particular CDRs in particular clinical situations will throw considerable light on cognitive diagnostic errors. The unmasking of cognitive errors in the diagnostic process then allows for the development of debiasing techniques. This should be the ultimate goal, and it is not unrealistic.

Certainly, a number of clear strategies exist for reducing the memory limitations and excessive cognitive loading[1] that can lead to diagnostic errors, but the most important strategy may well lie in familiarizing clinicians with the various types of CDRs that are out there, and how they might be avoided. I made a recent extensive trawl of medical and psychological literature, which revealed at least 30 CDRs,[9] and there are probably more (List 1). This catalogue provides some idea of the extent of cognitive bias on decision-making and gives us a working language to describe it. The failures to show improvement in decision support for clinical diagnosis that are noted by Graber et al.[1] should come as no surprise. They are likely due to insufficient awareness of the influence of these CDRs, which is often subtle and covert.[10] There appears to have been an historic failure to fully appreciate, and therefore capture, where the most significant diagnostic failures are coming from.

Not surprisingly, all CDRs are evident in emergency medicine, a discipline that has been described as a "natural laboratory of error."[11] In this milieu, decision-making is often naked and raw, with its flaws highly visible. Nowhere in medicine is rationality more bounded by relatively poor access to information and with limited time to process it, all within a milieu renowned for its error-producing conditions.[12] It is where heuristics dominate, and without them emergency departments would inexorably grind to a halt.[13] Best of all, for those who would like to study real decision making, it is where heuristics can be seen to catastrophically fail. Approximately half of all litigation brought against emergency physicians arises from delayed or missed diagnoses.[14]

If we accept the pervasiveness and predictability of the CDRs that underlie diagnostic cognitive error, then we are obliged to search for effective debiasing techniques. Despite the prevailing pessimism, it has been demonstrated that, using a variety of strategies[15,16] (Table 1), CDRs can be overcome for a number of specific biases.[16–23] It appears that there are, indeed, cognitive pills for cognitive ills,[22] which makes intuitive sense. This is fortunate, for otherwise, how would we learn to avoid pitfalls, develop expertise, and acquire clinical acumen, particularly if the predisposition for certain cognitive errors is hardwired? However, medical educators should be aware that if the pills are not sufficiently sugared, they may not be swallowed.

Yates et al.[24] have summarized some of the major impediments that have stood in the way of developing effective cognitive debiasing strategies, and they are not insurmountable. The first step is to overcome the bias against overcoming bias. Metacognition will likely be the mainstay of this approach. A recent cognitive debiasing technique using *cognitive forcing strategies* is based on metacognitive principles[10] and seems to be teachable to medical undergraduates and postgraduates.[25] Essentially, the strategy requires first that the learner be aware of the

List 1

Cognitive Dispositions to Respond (CDRs) That May Lead to Diagnostic Error*

Aggregate bias: when physicians believe that aggregated data, such as those used to develop clinical practice guidelines, do not apply to individual patients (especially their own), they are invoking the *aggregate fallacy*. The belief that their patients are atypical or somehow exceptional may lead to errors of commission, e.g., ordering x-rays or other tests when guidelines indicate none are required.

Anchoring: the tendency to perceptually lock onto salient features in the patient's initial presentation too early in the diagnostic process, and failing to adjust this initial impression in the light of later information. This CDR may be severely compounded by the *confirmation* bias.

Ascertainment bias: occurs when a physician's thinking is shaped by prior expectation; *stereotyping* and *gender* bias are both good examples.

Availability: the disposition to judge things as being more likely, or frequently occurring, if they readily come to mind. Thus, recent experience with a disease may inflate the likelihood of its being diagnosed. Conversely, if a disease has not been seen for a long time (is less available), it may be underdiagnosed.

Base-rate neglect: the tendency to ignore the true prevalence of a disease, either inflating or reducing its base-rate, and distorting Bayesian reasoning. However, in some cases, clinicians may (consciously or otherwise) deliberately inflate the likelihood of disease, such as in the strategy of ''rule out worst-case scenario'' to avoid missing a rare but significant diagnosis.

Commission bias: results from the obligation toward beneficence, in that harm to the patient can only be prevented by active intervention. It is the tendency toward action rather than inaction. It is more likely in over-confident physicians. Commission bias is less common than omission bias.

Confirmation bias: the tendency to look for confirming evidence to support a diagnosis rather than look for disconfirming evidence to refute it, despite the latter often being more persuasive and definitive.

Diagnosis momentum: once diagnostic labels are attached to patients they tend to become stickier and stickier. Through intermediaries (patients, paramedics, nurses, physicians), what might have started as a possibility gathers increasing momentum until it becomes definite, and all other possibilities are excluded.

Feedback sanction: a form of *ignorance trap* and *time-delay trap* CDR. Making a diagnostic error may carry no immediate consequences, as considerable time may elapse before the error is discovered, if ever, or poor system feedback processes prevent important information on decisions getting back to the decision maker. The particular CDR that failed the patient persists because of these temporal and systemic sanctions.

Framing effect: how diagnosticians see things may be strongly influenced by the way in which the problem is framed, e.g., physicians' perceptions of risk to the patient may be strongly influenced by whether the outcome is expressed in terms of the possibility that the patient might die or might live. In terms of diagnosis, physicians should be aware of how patients, nurses, and other physicians frame potential outcomes and contingencies of the clinical problem to them.

Fundamental attribution error: the tendency to be judgmental and blame patients for their illnesses (dispositional causes) rather than examine the circumstances (situational factors) that might have been responsible. In particular, psychiatric patients, minorities, and other marginalized groups tend to suffer from this CDR. Cultural differences exist in terms of the respective weights attributed to dispositional and situational causes.

Gambler's fallacy: attributed to gamblers, this fallacy is the belief that if a coin is tossed ten times and is heads each time, the 11^{th} toss has a greater chance of being tails (even though a fair coin has no memory). An example would be a physician who sees a series of patients with chest pain in clinic or the emergency department, diagnoses all of them with an acute coronary syndrome, and assumes the sequence will not continue. Thus, the pretest probability that a patient will have a particular diagnosis might be influenced by preceding but independent events.

Gender bias: the tendency to believe that gender is a determining factor in the probability of diagnosis of a particular disease when no such pathophysiological basis exists. Generally, it results in an overdiagnosis of the favored gender and underdiagnosis of the neglected gender.

Hindsight bias: knowing the outcome may profoundly influence the perception of past events and prevent a realistic appraisal of what actually occurred. In the context of diagnostic error, it may compromise learning through either an underestimation (illusion of failure) or overestimation (illusion of control) of the decision maker's abilities.

Multiple alternatives bias: a multiplicity of options on a differential diagnosis may lead to significant conflict and uncertainty. The process may be simplified by reverting to a smaller subset with which the physician is familiar but may result in inadequate consideration of other possibilities. One such strategy is the three-diagnosis differential: ''It is probably A, but it might be B, or I don't know (C).'' Although this approach has some heuristic value, if the disease falls in the C category and is not pursued adequately, it will minimize the chances that some serious diagnoses can be made.

Omission bias: the tendency toward inaction and rooted in the principle of nonmaleficence. In hindsight, events that have occurred through the natural progression of a disease are more acceptable than those that may be attributed directly to the action of the physician. The bias may be sustained by the reinforcement often associated with not doing anything, but it may prove disastrous. Omission biases typically outnumber commission biases.

Order effects: information transfer is a U-function: we tend to remember the beginning part (primacy effect) or the end (recency effect). Primacy effect may be augmented by anchoring. In transitions of care, in which information transferred from patients, nurses, or other physicians is being evaluated, care should be taken to give due consideration to all information, regardless of the order in which it was presented.

Outcome bias: the tendency to opt for diagnostic decisions that will lead to good outcomes, rather than those associated with bad outcomes, thereby avoiding chagrin associated with the latter. It is a form of *value* bias in that physicians may express a stronger likelihood in their decision-making for what they hope will happen rather than for what they really believe might happen. This may result in serious diagnoses being minimized.

List 1

Continued

Overconfidence bias: a universal tendency to believe we know more than we do. Overconfidence reflects a tendency to act on incomplete information, intuitions, or hunches. Too much faith is placed in opinion instead of carefully gathered evidence. The bias may be augmented by both *anchoring* and *availability*, and catastrophic outcomes may result when there is a prevailing *commission* bias.

Playing the odds: (also known as *frequency gambling*) is the tendency in equivocal or ambiguous presentations to opt for a benign diagnosis on the basis that it is significantly more likely than a serious one. It may be compounded by the fact that the signs and symptoms of many common and benign diseases are mimicked by more serious and rare ones. The strategy may be unwitting or deliberate and is diametrically opposed to the rule out worst-case scenario strategy (see *base-rate neglect*).

Posterior probability error: occurs when a physician's estimate for the likelihood of disease is unduly influenced by what has gone on before for a particular patient. It is the opposite of the *gambler's fallacy* in that the physician is gambling on the sequence continuing, e.g., if a patient presents to the office five times with a headache that is correctly diagnosed as migraine on each visit, it is the tendency to diagnose migraine on the sixth visit. Common things for most patients continue to be common, and the potential for a nonbenign headache being diagnosed is lowered through posterior probability.

Premature closure: a powerful CDR accounting for a high proportion of missed diagnoses. It is the tendency to apply premature closure to the decision-making process, accepting a diagnosis before it has been fully verified. The consequences of the bias are reflected in the maxim: ''When the diagnosis is made, the thinking stops.''

Psych-out error: psychiatric patients appear to be particularly vulnerable to the CDRs described in this list and to other errors in their management, some of which may exacerbate their condition. They appear especially vulnerable to *fundamental attribution error*. In particular, comorbid medical conditions may be overlooked or minimized. A variant of psych-out error occurs when serious medical conditions (e.g., hypoxia, delerium, metabolic abnormalities, CNS infections, head injury) are misdiagnosed as psychiatric conditions.

Representativeness restraint: the representativeness heuristic drives the diagnostician toward looking for prototypical manifestations of disease: ''If it looks like a duck, walks like a duck, quacks like a duck, then it is a duck.'' Yet restraining decision-making along these pattern-recognition lines leads to atypical variants being missed.

Search satisfying: reflects the universal tendency to call off a search once something is found. Comorbidities, second foreign bodies, other fractures, and coingestants in poisoning may all be missed. Also, if the search yields nothing, diagnosticians should satisfy themselves that they have been looking in the right place.

Sutton's slip: takes its name from the apocryphal story of the Brooklyn bank-robber Willie Sutton who, when asked by the Judge why he robbed banks, is alleged to have replied: ''Because that's where the money is!'' The diagnostic strategy of going for the obvious is referred to as *Sutton's law*. The slip occurs when possibilities other than the obvious are not given sufficient consideration.

Sunk costs: the more clinicians invest in a particular diagnosis, the less likely they may be to release it and consider alternatives. This is an entrapment form of CDR more associated with investment and financial considerations. However, for the diagnostician, the investment is time and mental energy and, for some, ego may be a precious investment. *Confirmation bias* may be a manifestation of such an unwillingness to let go of a failing diagnosis.

Triage cueing: the triage process occurs throughout the health care system, from the self-triage of patients to the selection of a specialist by the referring physician. In the emergency department, triage is a formal process that results in patients being sent in particular directions, which cues their subsequent management. Many CDRs are initiated at triage, leading to the maxim: ''Geography is destiny.''

Unpacking principle: failure to elicit all relevant information (unpacking) in establishing a differential diagnosis may result in significant possibilities being missed. The more specific a description of an illness that is received, the more likely the event is judged to exist. If patients are allowed to limit their history-giving, or physicians otherwise limit their history-taking, unspecified possibilities may be discounted.

Vertical line failure: routine, repetitive tasks often lead to *thinking in silos*—predictable, orthodox styles that emphasize economy, efficacy, and utility. Though often rewarded, the approach carries the inherent penalty of inflexibility. In contrast, lateral thinking styles create opportunities for diagnosing the unexpected, rare, or esoteric. An effective lateral thinking strategy is simply to pose the question: ''What else might this be?''

Visceral bias: the influence of affective sources of error on decision-making has been widely underestimated. Visceral arousal leads to poor decisions. *Countertransference*, both negative and positive feelings toward patients, may result in diagnoses being missed. Some attribution phenomena (*fundamental attribution error*) may have their origin in countertransference.

Yin-Yang out: when patients have been subjected to exhaustive and unavailing diagnostic investigations, they are said to have been worked up the Yin-Yang. The *Yin-Yang out* is the tendency to believe that nothing further can be done to throw light on the dark place where, and if, any definitive diagnosis resides for the patient, i.e., the physician is let out of further diagnostic effort. This may prove ultimately to be true, but to adopt the strategy at the outset is fraught with the chance of a variety of errors.

*The terms used to describe the various CDRs above are those by which they are commonly known in the psychology and medicine literature, as well as colloquially. Some, such as *feedback sanction* and *hindsight bias*, are indirect, reflecting more on processes that interfere with physician calibration. There is considerable overlap among CDRs, some being known by other synonyms. These, together with further detail and citations for the original work, are described in Croskerry P. Achieving quality in clinical decision making: cognitive strategies and detection of bias. Acad Emerg Med. 2002;9:1184–1204. The above list was based on material in that article and in an earlier work.[27]

Table 1

Cognitive Debiasing Strategies to Reduce Diagnostic Error*

Strategy	Mechanism/Action
Develop insight/ awareness	Provide detailed descriptions and thorough characterizations of known cognitive biases, together with multiple clinical examples illustrating their adverse effects on decision-making and diagnosis formulation.
Consider alternatives	Establish forced consideration of alternative possibilities e.g., the generation and working through of a differential diagnosis. Encourage routinely asking the question: What else might this be?
Metacognition	Train for a reflective approach to problem solving: stepping back from the immediate problem to examine and reflect on the thinking process.
Decrease reliance on memory	Improve the accuracy of judgments through cognitive aids: mnemonics, clinical practice guidelines, algorithms, hand-held computers.
Specific training	Identify specific flaws and biases in thinking and provide directed training to overcome them: e.g., instruction in fundamental rules of probability, distinguishing correlation from causation, basic Bayesian probability theory.
Simulation	Develop mental rehearsal, "cognitive walkthrough" strategies for specific clinical scenarios to allow cognitive biases to be made and their consequences to be observed. Construct clinical training videos contrasting incorrect (biased) approaches with the correct (debiased) approach.
Cognitive forcing strategies	Develop generic and specific strategies to avoid predictable bias in particular clinical situations.
Make task easier	Provide more information about the specific problem to reduce task difficulty and ambiguity. Make available rapid access to concise, clear, well-organized information.
Minimize time pressures	Provide adequate time for quality decision-making.
Accountability	Establish clear accountability and follow-up for decisions made.
Feedback	Provide as rapid and reliable feedback as possible to decision makers so that errors are immediately appreciated, understood, and corrected, resulting in better calibration of decision makers.[26]

*Based on information from: Slovic and Fischhoff (1977),[19] Fischhoff (1982),[15] Arkes (1986),[16] Plous (1993),[23] Croskerry (2002),[9] and Croskerry (2003).[10]

various cognitive pitfalls, and second that specific forcing strategies be developed to counter them.

Much of clinical decision making, as Reason[5] notes, is where "the cognitive reality departs from the formalized ideal." This cognitive reality is extremely vulnerable to error. The problem is that cognitive error is high-hanging fruit and difficult to get at, and there will be a tendency to pursue more readily attainable goals. There is a story about a jogger who came across a man on his knees under a streetlight one evening. He explained that he had dropped his wedding ring. The jogger offered to help him search, and he accepted. With no luck after a half hour, the jogger asked the man if he was sure he had dropped the ring at the place where they were searching. The man replied that he actually dropped it several yards away in the shadows. "Then why are we looking here?" asked the jogger. "Because the light is better," came the reply.

Real solutions to cognitive diagnostic errors lie in the shadows, and they will be difficult to find. One very clear goal in reducing diagnostic errors in medicine is to first describe, analyze, and research CDRs in the context of medical decision making, and to then find effective ways of cognitively debiasing ourselves and those whom we teach. Not only should we be able to reduce many cognitive diagnostic errors, but we may also be pleasantly surprised to find how many can be eliminated.

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