Cognitive Forcing Strategies in Clinical Decisionmaking

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See brief commentary, p. 121.

Cognitive errors underlie most diagnostic errors that are made in the course of clinical decisionmaking in the emergency department. These errors are universal and are prevalent in the special milieu of the ED. Their properties appear to be distinct from those associated with the performance of procedures. They are often costly, but, importantly for both the patient and the physician, they are also highly preventable. Recent developments in education theory provide a means for minimizing and avoiding diagnostic error. Through the process of metacognition, clinicians can develop cognitive forcing strategies to abort such latent errors. Three levels of cognitive forcing strategies are described: universal, generic, and specific. Specific cognitive forcing strategies provide a formal cognitive debiasing approach to deal with what have previously been described as pitfalls in clinical reasoning. This metacognitive approach can be taught to practicing clinicians and to those in training to inoculate them against making diagnostic errors. The adoption of this method provides a systematic approach to cognitive root-cause analysis in the avoidance of adverse outcomes associated with delayed or missed diagnoses and with the clinical management of specific cases.

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INTRODUCTION

Considerable attention has been directed recently toward the new science of error prevention in health care.[1] A prerequisite to error prevention is an understanding of the nature of error processes. Over the past decade, each of the major benchmark studies[2-4] that have looked at medical error included observations on characteristics of error in the emergency department. All showed a vulnerability to error in clinical decisionmaking, in which clinicians are required to integrate knowledge base with novel situations in reasoning through a diagnosis or management plan. Not surprisingly, the specialties in which diagnostic error was most prevalent were internal medicine, family medicine, and emergency medicine. Several studies indicate that diagnostic errors are among the most consequential of errors in the ED.[5,6] In a study of trauma resuscitation, reasoning errors were found in 100% of cases studied.[7] Failure to diagnose accounted for approximately half of all closed claims in US EDs.[8] Occasionally, inaccurate data, such as an aberrant laboratory value or a false-negative imaging study, might lead to diagnostic error, but it is clear that because the process of forming a diagnosis mostly depends on a clinician's thinking, the overwhelming majority must be a result of cognitive errors. A comprehensive overview of diagnostic error has recently been published.[9] Such errors are largely preventable; however, there is very little helpful information in the description of an error as simply diagnostic. Like the Gordian knot, it should be unraveled to understand how it was put together. Thus, we need to start the process of dissecting diagnostic errors through cognitive root-cause analysis to understand their various and multiple causes. The purpose of this article is to shed some light on what underlies the pitfalls of diagnostic error and to offer strategies that minimize or prevent such error.*

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COGNITIVE ERROR

Cognition is involved in all human behavior, from the simple skill-based levels through the higher-order, rule-based behaviors to the most complex level of cognition involved in knowledge-based behavior (Table 1). This is the 3-level model of cognition, as proposed by Rasmussen and Jensen[10] and elaborated on by Reason.[11] The execution of a well-rehearsed, automatized motor skill (eg, intubation) requires little cognitive input other than simple visual and haptic (sense of touch) monitoring. An increased level of cognitive input is clearly needed for rule-based behaviors, but even complex medical acts, such as those directed by advanced cardiac life support algorithms, can be performed with minimum cognitive involvement. Knowledge-based cognitive behavior involves interpreting and understanding novel situations and problems against a background of specific domain knowledge (eg, integrating the presenting complaint, past medical history, physical examination, and laboratory findings in a patient with syncope). There is clearly some overlap in cognitive complexity between different levels. As experience and practice develops, some knowledge-based cognitive behaviors can be relegated to lower levels of cognitive involvement. For example, learning to drive a car initially requires operating at a knowledge-based level, but with practice, much of driving can be accomplished at an almost automatic level.

Cognitive error refers to error at any level in this hierarchy of thinking processes. Not surprisingly, it is mostly at the highest level, knowledge-based behavior, that cognitive error can lead to serious outcomes. Like affective errors, which arise when emotional variables

Table 1.
Levels of complexity of behavior.

Level	Activity
Skill based	Wound repair, dislocation reduction, intubation
Rule based	Radiographic decision rules, clinical practice guidelines, algorithms
Knowledge based	Clinical decisionmaking, management decisions, diagnostic reasoning

enter into a physician's judgment, they are mostly covert and considerably less tangible compared with procedural errors (Table 2). Affective errors result from a complex interplay of emotions and cognition and would be expected at higher, knowledge-based levels of function. The other side of all errors is the effect they have on the affective state of those who mediated them.[12]

Although procedural errors are usually highly visible, cognitive errors can only be inferred from what people do or through accurate self-descriptions of thinking processes; some skilled observers can perform a detailed analysis through the process of introspection, although without a conscious awareness of what rule sets an individual is actually using, the process will be difficult.

Cognitive scientists have described cognitive biases phenomenologically in a wide range of experimental demonstrations,[13] which has led to predictions of the conditions under which they are likely to occur. Their incidence increases under conditions of uncertainty, especially when thinking is hurried or pressured and when heuristics (shortcuts or abbreviated thinking strategies) are used. Many cognitive errors are not readily apparent but lie latent,[11] waiting for the right conditions to reach their expression.

Table 2.
Comparison of properties of procedural, cognitive, and affective errors.

	Error Category		
Properties	**Procedural**	**Cognitive**	**Affective**
Visibility	High	Low	Moderate
Discreteness*	High	Low	Low
Witnessed	Usually	Not usually	Not usually
Awareness	High	Low	Low
Recorded	Yes	Rarely	No
Temporality	Close	Distant	Distant
Medical nature	High	Low	Very low
Familiarity†	High	Low	Very low
Preventability	High	High but difficult	High but difficult
Root-cause analysis	Amenable	Difficult	Very Difficult

*Discreteness refers to the perceived separateness or isolation of the event from those around it. Procedural errors are often distinct in this fashion, whereas cognitive and affective errors are not.
†Familiarity refers to the strength of the clinician's familiarity with the error. Causing a pneumothorax by insertion of a central line is well known to emergency physicians, whereas few would be familiar with the cause of cognitive and affective errors in their decisionmaking.

The more common cognitive errors are referred to as biases, and some appear to be very powerful and universal, affecting all walks of life. A number of these biases have been well illustrated in the context of medicine[14,15] and in emergency medicine in particular.[16,17] These biases have been extensively documented in what has been referred to as the rationalist paradigm to decisionmaking. Critiques have been offered of both the underlying concepts and methodology in this approach; nevertheless, it is clear that cognitive errors are widespread. Such errors must have their origin in failed heuristics, biases, or an underlying cognitive disposition to respond in some inappropriate fashion. The more recent paradigm embodied in the naturalistic decisionmaking approach takes issue with the artificially structured context (laboratory simulation) in which human decisionmaking has been studied and instead places an emphasis on the performance of decisionmakers in the dynamic, open-ended, and real world of decisionmaking.[18] Proponents of naturalistic decisionmaking take the view that such biases are not inevitable but that, in contrast to the structured conditions in psychology laboratories, decisionmakers in the real world incrementally revise and modify their strategies to optimize performance.[18] The particular suitability of the naturalistic model to decisionmaking in emergency medicine has been discussed.[17]

Although knowledge-based cognitive error clearly underlies the preventable adverse events that arise from the diagnostic errors that predominate in the ED, there has been little formal examination of them in this context. The ED environment has unique operating characteristics that predispose it to error[19] and that make it a natural laboratory for the study of error.[20]

If, as it appears, cognitive activity is the most critical part of a clinician's performance in the ED,[19] and if the biases and pitfalls in cognitive activity are as universal as has been suggested,[13] we might ask whether many cognitive errors in the ED are inevitable or whether there might be opportunities and strategies for avoiding them. We should certainly expect that they can be circumvented; otherwise, why should clinical acumen and expertise come with experience? In many fields, such expertise typically takes about 10 years to develop. Klein[21] describes several characteristics of experts that can be tied to 2 basic processes in decisionmaking: pattern recognition and mental simulation. This article applies the argument that these 2 processes underlie a core strategy, metacognition, which allows experts to avoid or minimize cognitive error in the ED. If the components of these covert metacognitive strategies used by experts can be analyzed, it might be possible to teach these strategies to novices, thereby inoculating them against making cognitive errors and shortening the road to attainment of expertise. Such an approach has been used in education with demonstrably successful outcomes.[22,23]

In essence, this amounts to developing new meta-decisionmaking approaches.[24] Furthermore, clinicians in practice might benefit from formal training in these strategies.

METACOGNITION

The concept of metacognition was introduced in the 1970s by Flavell[25] and developed in the context of psychological education theory. Essentially, it means thinking about thinking. It describes an individual's ability to stand apart from his or her own thinking, to observe it, and to recognize opportunities for using interventional thinking strategies. It distinguishes adult from child thinking and the thinking of experts from that of nonexperts. Metacognition has been described as one of the "distinguishing hallmarks of adult human intelligence"[26] and is characterized by a number of core features (Table 3).

First, there has to be an awareness of the learning process itself: was the piece of information important enough to commit to memory and was appropriate attention paid to it; has enough time been spent acquiring a specific piece of knowledge; has it been rehearsed adequately; and can it be recalled appropriately, especially under conditions of stress? Thus, individuals need to know their own limitations of memory and be aware of strategies to cope with any failings that have manifested in the past and that might appear in the future. It is a necessary feature that the individual go beyond immediate perception and develop a perspective for the broader picture, ignoring stimuli that distract from the detection of the critical signal (such as occurs in visual illusions).[27] Thus, individuals come to recognize incongruity, ambiguity, atypical presentations, and instances when data are not fitting together. This allows them to avoid the errors that might arise using the representativeness heuristic (ie, the tendency to look for prototypical presentation of disease).[28] Experts with good metacognitive skills are better able to recognize when they are not performing well and are better able to criticize themselves realistically; that is, they are able to

Table 3.
Features and descriptors of metacognition.[21]

Feature	Descriptor
Awareness of requirements of learning process	Learning effective decisionmaking requires significantly more than the simple acquisition of domain knowledge. Medical educators should direct more effort at the specific cognitive requirements of clinical decisionmaking.
Recognition of limitations of memory	The burgeoning complexity of modern medicine has increased cognitive load. Clinicians need cognitive aids that will lessen this burden on memory.
Ability to appreciate perspective	Decisionmakers need the capacity to see the often broader range of possibilities than the problem initially appears to offer (ie, the ability to step back from the immediate problem at hand).
Capacity for self-critique	Overconfidence in judgment is a serious error. Clinicians should cultivate a capacity for reflection on their decisions and especially a willingness to reexamine them in light of new information or input from other team members.
Ability to select strategies	The complexity of medical decisionmaking demands an aptitude for selection of different and novel strategies to deal with the wide range of clinical problems and scenarios. In particular, cognitive debiasing strategies need to be further developed and refined.

reliably self-monitor. Finally, and most importantly for this discussion, effective metacognition involves the ability to actively select a strategy to deal with problems in decisionmaking. This constitutes a deliberate cognitive intervention in the thinking process. Just as children exhibit tremendous cognitive growth in the first decade of life when acquiring these metacognitive refinements, nonexperts take a similar period to develop good judgment and effective cognitive skills in a specific domain of expertise. Specifically, what was initially experienced as novel, knowledge-based cognitive behavior can, with accumulated experience, become skill- or rule-based behavior. This accounts for the expediency and economy seen in expert decisionmaking.

COGNITIVE FORCING STRATEGIES

A prerequisite to minimizing or avoiding cognitive error is to develop a general working knowledge of cognitive error theory. Often, clinicians have little sensitivity, insight, or awareness of their own cognitive processes and, especially, of the considerable number of biases that might affect their thinking.[17,29] Traditional medical training has placed insufficient emphasis on this important aspect of clinical performance. The first step, then, is to develop an educational agenda for teaching about error in the setting of emergency medicine, especially with regard to cognitive error (Table 4). Recently, an outline for such an agenda has been proposed,[30] together with a specific curriculum for emergency medicine.[31] A compendium of heuristics, biases, and cognitive dispositions to respond that might adversely influence decisionmaking in emergency medicine has also been developed.[32] The next step is to develop strategies to deal with particular classes of cognitive error, as well as an awareness of how generic heuristics and cognitive biases might exert an influence across a wide range of clinical situations. The final and crucial step is to develop strategies to deal with specific situations (Table 4).

It is important to understand the difference between the cognitive forcing strategies proposed here and heuristics. Confusion around the term "heuristic" has arisen because of changing definitions over time. Recently, a detailed overview of changes in its use has

Table 4.
Levels, requirements, and exemplars of cognitive forcing strategies.

Level	Requirement	Exemplars
Universal	Acquisition of knowledge	Decisionmaking in the ED requires a thorough understanding of basic error theory. A working knowledge of the major cognitive errors is a necessary requirement. The fundamental strategy of cognitive debiasing techniques, particularly metacognition, needs to be fully appreciated.
Generic	Understanding of the major classes of heuristics used in decisionmaking in the ED	Familiarization with the major classes of heuristics allows prediction of the various circumstances under which they might fail. For example, there is a tendency to anchor onto salient or vivid features of a variety of patient presentations and fail to adjust this first impression as more evidence becomes available. In many instances, there is also a widespread tendency to search for prototypical features of disease as the representativeness heuristic is applied, resulting in atypical presentations being misdiagnosed. "Search satisficing," calling off a search once a significant finding has been made, can result in failure to detect coingestants in poisonings, failure to find additional fractures or significant soft tissue injuries, failure to consider comorbid illness (especially in psychiatric patients), and failure to find additional foreign bodies. The availability heuristic might result in a disproportionate emphasis (or de-emphasis) on a particular diagnosis, depending on how readily the diagnosis can be brought to mind. The heuristic often arises when the true base rate of the disease is ignored.
Specific	Awareness of specific scenarios in which the error is known to occur	A number of situations occur in the ED in which classic pitfalls are predictably made: failure to consider a closed-head injury in an inebriated patient, incomplete consideration of AMI mimics before initiating thrombolysis, inadequate assessment of immunocompromise status in patients with animal bite wounds, failure to fully assess the medical status of psychiatric patients before transferring to a psychiatric facility, and failure to consider tetanus immune status in patients with open wounds. Decisionmakers must be aware of these predictable pitfalls so that appropriate cognitive forcing strategies can be judiciously applied.

been provided.[33] The original Greek definition of a heuristic is "serving to find out and discover" and described a system of training that required the student to "find out things for himself."[34] Fifty years ago, heuristics were generally defined as "strategies that guide information search and modify problem representations to facilitate solutions."[33] In emergency medicine, these strategies have been described as "a cognitive process that simplifies clinical decisionmaking operations, describing the everyday intuitive decisions that emergency physicians make without resorting to formal decision analysis."[17] This, and the most recent evolution of the term,[33] is closely allied to the recognition-primed model of decisionmaking proposed by naturalistic decisionmaking, referred to earlier. Heuristics and biases have many legitimate uses and do not necessarily lead to cognitive error. For example, the heuristic and bias toward ruling out the worst-case scenario, often used by emergency physicians, is specifically intended to avoid missing an important diagnosis.

In contrast to heuristics, cognitive forcing strategies are a specific debiasing technique that introduces self-monitoring of decisionmaking. They are designed to prevent clinicians from pursuing a pattern-recognition path that typically will lead to error. Because cognitive processes are covert and often not accessible to direct inspection, they are not amenable to the form of "baked in" forcing functions described by Lewis and Norman,[35] such as those used in the computerized order-entry systems that prevent specific medication errors from being made.[36] As they have been described here, they are rules that depend instead on the clinician consciously applying a metacognitive step and cognitively forcing a necessary consideration of alternatives.

Traditionally, the specific situations in which errors are likely to be made have been referred to as "pitfalls." Awareness of pitfalls, a form of expert, insider knowledge, naturally develops over time in any sphere of activity as specific problems are repeatedly confronted. All disciplines of medicine have their specific pitfalls, as well as caveats for avoiding them. A classic example comes from the locomotor examination. It is widely appreciated that when a patient complains of pain in a joint, there is a natural tendency for inexperienced clinicians to focus their attention (anchor) on that joint and restrict their examination accordingly; therein lies the pitfall. More experienced clinicians know that pain in a joint might be referred from the joint above or below the joint that is painful. Therefore, the caveat or cardinal rule is to always examine the joint above and the joint below to avoid this pitfall. Similarly, in the reading of radiographs in the ED, a universal pitfall among the inexperienced is to call off the search once a salient abnormality has been found. This has led to the maxim "the most commonly missed fracture in the ED is the second."[16] The cardinal rule or forcing strategy in this case, therefore, is that when a fracture or significant soft tissue abnormality is found, the search should be continued for other findings. These pitfalls refer to cognitive errors, and the caveats or cardinal rules, as we shall see, are the cognitive forcing strategies.

Thus, a particular plan of cognitive action to deal with a specific problematic situation is a cognitive forcing strategy,[17] an extension of the educational concept of cognitive strategy instruction.[37] Although an expert clinician in the ED might use a particular cognitive strategy to cope with a problem, he or she might not necessarily be aware of it or have insight into the process. Those with good judgment might be less conscious of these abilities than those who observe them.[38] The term "cognitive forcing strategy" implies a deliberate, conscious selection of a particular strategy in a specific situation to optimize decisionmaking and avoid error. The forcing feature of a cognitive strategy derives from "forcing functions,"[35] which can be built into system design such that error is minimized or avoided. An example is a design that does not allow a driver to lock the car doors until the key has been removed from the ignition: the system design forces the driver to avoid the error of locking the key in the car.

Universal Cognitive Forcing Strategy

Knowledge of error theory, and cognitive error in particular, is a prerequisite for developing a level of understanding at the universal level. It is a forcing strategy insofar as there is an obligation to perform this cognitive step to appreciate how metacognitive processes work. Thus, specialized knowledge and level of awareness is, itself, a cognitive forcing strategy. The clinician forces himself into a position in which he can use metacognitive theory. Without this stage, the other 2 cannot follow. Such awareness might accomplish several goals: (1) clinicians become more cognizant of the range of pitfalls they can expect and therefore learn to avoid; (2) a language or lexicon develops that allows more ready description, communication, understanding, and prediction of common errors; (3) the heightened awareness promotes greater diligence in clinical practice; and (4) there will be a clearer vision about what research is necessary to investigate cognitive error in clinical practice.[14]

Generic Cognitive Forcing Strategy

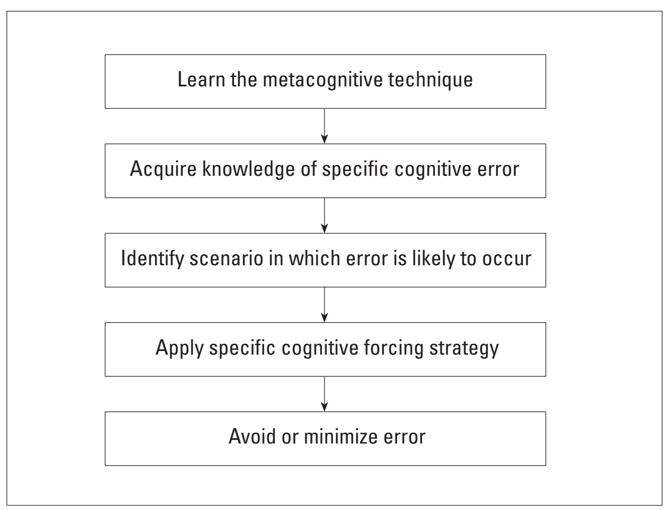
The choice of a particular cognitive forcing strategy in the generic class depends on this knowledge. For example, consider search satisficing error.[39] "Satisficing" refers to the general tendency to call off a search once something has been found. As we have noted, it is readily demonstrated in radiographic interpretation by the tendency of physicians to decrease their vigilance once a positive finding has been made on the radiograph. But it is also exemplified in other situations, such as failing to look for coingestants in the context of a self-poisoning, failing to look for medical problems once a psychiatric diagnosis has been found, unwillingness to accept that patients might have more than one diagnosis, or failing to look for a second foreign body once the first has been found. The generic cognitive forcing strategy for this error is to force oneself always to conduct a secondary search or survey once a positive finding has been made or when a search has failed to turn up an expected finding.

Specific Cognitive Forcing Strategy

As was noted earlier, the particular situation that gives rise to a predictable cognitive error is often referred to as a pitfall. Many clinicians develop specific cognitive forcing strategies from vivid lessons they have learned from past experience, usually associated with an unanticipated or adverse outcome (ie, from the availability heuristic).[40] Features of the clinical scenario might trigger recall of a similar situation that led to a bad outcome. For example, consider the case of an animal bite wound after which sepsis develops in the patient and it is later revealed that a history of splenectomy had not been elicited. In the future, each time an animal bite case is presented to the physician involved in this case, it is likely that a deliberate attempt will be made to elicit a history of immunocompromise: the physician has learned from his own pitfall. This example can be used to illustrate the various steps in choosing a specific cognitive forcing strategy (Figure).

The first step in developing a cognitive forcing strategy involves initial training in the theory of metacognition. The individual is taught the value of stepping back from the immediate situation and reflecting on his or her thinking process. Thus, instead of going directly to the many important issues involved in the assessment of the wound (associated neurovascular or tendon injury?; underlying organ or bone injury?), and how it should be treated (pressure irrigation?; appropriate for suturing?; immediate or delayed repair?; prophylactic immunization, antibiotics, or both?; what follow-up?), the physician instead steps back cognitively and observes, "This patient has an animal bite wound."

Figure.
Steps in using a cognitive forcing strategy.



Besides assessment and repair of the wound, what other issues absolutely must be considered? This is the metacognitive step.

The next step requires knowledge of particular cognitive errors. In this example, the relevant error is one of omission; that is, the physician might omit a critical step. One of the most significant errors of omission for a patient who has had an animal bite wound lies in failing to elicit a history of immunocompromise where it exists, either frank immunocompromise (eg, asplenia, neutropenia, active cancer, AIDS with CD4 count <400) or underlying predisposition (eg, steroid use, alcoholism, debilitation, complement deficiency, sickle cell disease). This is especially important because, in responding to the past medical history inquiry, the patient might not necessarily see the connection between these conditions and his or her present complaint. Errors of omission arise in a variety of ways in the ED (eg, failure to record vital signs, failing to elicit relevant past medical history, failing to see a significant finding on a radiograph, failing to order tetanus immunization, failure to arrange appropriate follow-up). Certain presenting complaints in the ED require only a focused history, but for others, more critical detail is required.

The third step requires identification of the particular scenario in which the cognitive error is likely to occur. In this example, the situation is clearly defined. Any bite wound, human or animal, is usually straightforward, although ambiguity occasionally arises in cases of assault (eg, clenched-fist injuries).

The fourth step, the selection of a cognitive forcing strategy, in this example is again clear. In the case of an animal bite wound, the cognitive forcing strategy requires that the clinician should always work through a checklist of immunocompromise indicators in eliciting a past medical history. In apparently straightforward cases in which the patient appears healthy, the physician might not necessarily see the connection between past medical history and the presenting complaint unless forced through an immunocompromise checklist. The final step, avoiding the omission error of failing to detect immunocompromise and vulnerability to an opportunistic infection, has therefore been accomplished.

A final example will serve to further illustrate the steps involved in applying a cognitive forcing strategy. Thrombolytic therapy, now widespread in emergency medicine, carries the potential for a potentially catastrophic outcome caused by tight coupling between the treatment and underlying conditions. Tightly coupled systems are time dependent, produce an immediate effect, have an invariant sequence, and are relatively inflexible.[41] The inherent pitfall lies in thrombolyzing a patient who appears to be experiencing an acute myocardial infarction (AMI) but instead has a condition that mimics it (eg, left ventricular aneurysm, non-AMI with atypical ST-segment morphology, benign early repolarization, acute pericarditis, aortic dissection). In one series, 30% of patients with non-AMI ST-segment elevation incorrectly received thrombolysis.[42] Approximately 1 in 300 patients experiencing thoracic aortic dissection will erroneously receive thrombolysis.[43,44] In a Canadian autopsy study, the diagnosis was missed in 35%.[45] Eight cases of patients with pericarditis who inadvertently received thrombolysis were reported between 1986 and 1996. Of these, 4 had complications of cardiac tamponade, death, or both.[46] For many of these AMI mimics, the initial ECG interpretation might be compounded through the influence of several heuristics: representativeness, anchoring compounded with confirmation bias, and search satisficing.

The representativeness heuristic drives the decision-maker toward a search for prototypical features that will allow the patient to be categorized. Unfortunately, both aortic dissection and pericarditis mimic AMI. Both might present with retrosternal chest pain, shortness of breath, diaphoresis, and associated ST-segment elevation. Indeed, in the vast majority of patients, this constellation of signs, symptoms, and ECG changes typically will be represented in patients experiencing an AMI. Thus, the representativeness heuristic works well most of the time but not all of the time. Anchoring or "tram lining" describes the cognitive tendency to lock on to salient features in the initial presentation. Thus, the physician might anchor to the symptoms and signs at the initial presentation and fail to shift from this first impression. Confirmation bias occurs when the subsequent ECG findings, other information from the patient's medical history, and further test results are marshaled to support the initial diagnosis. This bias reflects a failure to adjust the initial impression and seriously compounds the error.[17] Satisficing is the tendency to call off the search for other diagnostic possibilities once a satisfactory solution has been found and might result in premature diagnostic closure[47] or "freezing,"[48] which hinders any search for new information. "Pseudodiagnosticity," the use of irrelevant information in the process of decisionmaking, might contribute to the freezing phenomenon, and strategies have been developed to offset this tendency. One such approach investigated a competing hypothesis heuristic, essentially a strategy that requires that specific diagnostic information (especially pivotal findings) be evaluated across all hypotheses under consideration in a particular clinical problem. The strategy forces a dependence, in part, on information required for the normative Bayesian approach[49] but does not require formal calculation of the various probabilities needed for the full Bayesian method (a process that clinicians are disinclined to complete). This proved to be a teachable cognitive skill that enhanced the clinical judgment of medical students and residents.[50] In the present example, use of the competing hypothesis heuristic would lead to an evaluation of the various symptoms and signs across the likely working diagnoses and might result in a more thorough assessment of AMI mimics.

The combined effect of these various cognitive failings results in a violation of at least 2 of the 10 cardinal rules of decisionmaking delineated by Yates[51]: the failure to adequately consider (1) alternate possibilities and (2) the consequences of the tightly coupled action, in this case thrombolysis.

The next step is to identify the circumstances under which this potentially devastating error might occur. At present, this is straightforward because the number of conditions for which thrombolysis is indicated in emergency medicine is well circumscribed.

The final step, selection of the cognitive forcing strategy, simply requires a cognitive forcing of Yates' cardinal rule. In this case, the cognitive forcing strategy is the conscious act of systematically addressing the following question: have all possible mimics been reliably excluded through history of presenting complaint, past medical history, symptoms and signs, and appropriate imaging studies? The built-in time pressures associated with thrombolysis inexorably work against such reflective action, but the application of a cognitive forcing strategy forces the cognitive reflection required to avoid this devastating and often fatal pitfall.

Thus, metacognition generally describes the process of actively stepping back from the pushes and pulls of the immediate situation (de-anchoring), reminding oneself of the limitations and failings of memory, seeing the clinical problem in a wider perspective than that dictated by the obvious presentation (representativeness error), perhaps reminding oneself of specific lapses or failures in the past (availability), and finally activating known cardinal rules or caveats (cognitive forcing strategies). This more dynamic style of decisionmaking fits the naturalistic decisionmaking model and adds strength to the preferred approach, much as Cohen[18] has advocated. Also, it appears to create an explicit opportunity for improving transfer of effective decisionmaking across a wide variety of clinical problems. Transfer of learning is a critical concept in education theory. It describes the ability to use acquired knowledge and problem-solving strategies in novel situations. The cognitive distance between one type of problem to another novel problem is described as "near" when the problems are similar and "far" when they are dissimilar. Typically, transfer knowledge has been difficult to achieve in a variety of contexts, including medicine,[52] but, as Kuhn[9] notes: "Transfer of knowledge is important in all aspects of education but particularly so when teaching residents to avoid commission of diagnostic errors." Although they remain to be tested, generic cognitive forcing strategies, in particular, might shorten the transfer distance by providing a bridge, or cognitive scaffold, between apparently dissimilar problems.

Many experienced clinicians will perform these steps as a matter of habit, perhaps without any particular insight into or knowledge of metacognition. Obviously, such styles of thinking clearly existed long before the concept of metacognition was formally described.

However, the advantage of framing this cognitive debiasing approach in these terms is that it enables us to dissect, analyze, and gain some understanding of what goes into expertise in clinical decisionmaking and the development of clinical acumen. Furthermore, knowing how the metacognitive process works allows us to train students and inexperienced clinicians in its use, ultimately helping them minimize or avoid diagnostic errors, as well as the errors surrounding the management of particular clinical conditions. This approach has been taught as a half-day course (Applied Cognitive Training in Acute-Care Medicine) in the undergraduate medical program at Dalhousie University for the past 3 years and has proved a popular innovation.[53]

Overall, the strategy of metacognition is a form of cognitive debiasing designed to help clinicians make better decisions. Its advancement here is based on compelling evidence that cognitive biases impose a low ceiling on the quality of clinical decisionmaking in the ED. Of several major strategies for improving decisionmaking, however, the debiasing approach has historically received an inconsistent application in practice for a variety of reasons.[54] Applying these in the context of emergency medicine, they are that (1) many emergency physicians do not routinely predict bad outcomes and, therefore, register surprise when they occur; (2) some believe bad outcomes are due to chance and, thus, any effort to intervene would be futile; (3) there appears to be some inertia against the relevance, implications, and, therefore, the practical significance of cognitive biases in clinical decisionmaking; (4) some indeed might accept that biases enter into clinical judgment but remain unconvinced of the efficacy of debiasing approaches; and (5) some might have acquired or developed cognitive biases as deeply ingrained habits and, having little insight or awareness of them, would be unreceptive to a debiasing approach. These 5 reasons provide further forms of individual and cultural bias that will need further study in the evolution of this approach.

In conclusion, many of the serious and preventable errors made in the ED are diagnostic. However, labeling an outcome as a misdiagnosis is simply a descriptive exercise that sheds little or no light on what actually occurred. It seems likely that cognitive error underlies the majority of diagnostic errors. Thus, what is needed is a good grounding and understanding of cognitive error.

Work in cognitive psychology over the past 30 years has delineated many of these errors and biases, as well as their universality. They are very clearly in operation in the special environment of the ED, and strategies must be developed to deal with them. Cognitive debiasing techniques have considerable potential for application in clinical decisionmaking and provide the means at our disposal.

First, emergency physicians need to have a good working knowledge of the typical cognitive errors that are found in the ED. Second, training should be made available to clinicians and students in metacognition, the basic principles of which, as outlined here, are fairly straightforward and teachable. Third, clinicians and students need to be instructed in the development and application of generic and specific cognitive forcing strategies. Finally, a number of prevailing biases against cognitive debiasing will need to be overcome to make this approach work.

Urging clinicians to be more careful, cautious, or vigilant accomplishes little. Without changes to our approach, we will, like Alexander the Great, continue to slash through the knot, instead of carefully untangling it. With the aforementioned approach, we can demystify diagnostic error and bring it to an analyzable state. The ultimate goal is to reduce error in the most vulnerable part of our clinical performance, the process of clinical decisionmaking.

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