Achieving Quality in Clinical Decision Making: Cognitive Strategies and Detection of Bias

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Abstract

Clinical decision making is a cornerstone of high-quality care in emergency medicine. The density of decision making is unusually high in this unique milieu, and a combination of strategies has necessarily evolved to manage the load. In addition to the traditional hypothetico-deductive method, emergency physicians use several other approaches, principal among which are heuristics. These cognitive short-cutting strategies are especially adaptive under the time and resource limitations that prevail in many emergency departments (EDs), but occasionally they fail. When they do, we refer to them as cognitive errors. They are costly but highly preventable. It is important that emergency physicians be aware of the nature and extent of these heuristics and biases, or cognitive dispositions to respond (CDRs). Thirty are catalogued in this article, together with descriptions of their properties as well as the impact they have on clinical decision making in the ED. Strategies are delineated in each case, to minimize their occurrence. Detection and recognition of these cognitive phenomena are a first step in achieving cognitive de-biasing to improve clinical decision making in the ED. **Key words:** emergency medicine; quality; decision making; cognitive strategies; heuristics; biases; cognitive disposition to respond. ACADEMIC EMERGENCY MEDICINE 2002; 9: 1184–1204.

DECISION MAKING

The ultimate cornerstone of high-quality care in emergency medicine is the accuracy, efficacy, and expediency of clinical decision making. It is a clear barometer of good care. There is ample reason to believe that decision making in emergency medicine has unique characteristics that distinguish it from decision making in other medical settings.[1] It is important, therefore, that we understand its special properties, and the range of strategies that emergency physicians use to make decisions.

Emergency physicians are required to make an unusually high number of decisions in the course of their work. In few other workplace settings, and in no other area of medicine, is decision density as high. Decision requirements depend upon uncertainty, and uncertainty levels are extremely high in the emergency department (ED). For the most part, patients are not known and their illnesses are seen through only small windows of focus and time. A number of other factors, unique to the ED milieu, constrain the decision-making process.[2] During the course of a shift, both clinical and nonclinical decisions are required and many considerations contribute to the decision burden, including resource availability, cost, and patient preferences (Table 1).

Continuously, emergency physicians are required to make decisions about allocating their own time and effort deciding who needs to be seen next, whether to initiate treatment immediately or wait, and how to deal with increasing numbers of patients. Typically, attending physicians may be required to maintain clinical responsibility for up to ten patients at a time, perhaps more if admitted patients are waiting in the ED. The process is similar to plate-spinning on sticks, where a significant number have to be maintained in motion without allowing one to slow and fall, and as one plate is taken off, it is replaced with another. It sometimes results in excessive cognitive loading.

Once the interaction with the patient is initiated, the first decision is often whether or not immediate action is required.[3] Further thinking and behavior of the clinician are largely driven by a search for a working diagnosis, often tightly coupled to treatment, and the goal of safe disposition or transfer. Once the chief complaint has been established, numerous important decisions are made in the course of taking the history of presenting illness (HPI), and past medical history (PMH). What questions are asked, and how they are asked,[4,5] may have a significant impact on the decisions that follow. What to examine in the physical examination and decisions around the significance of findings are

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TABLE 1. Clinical and Nonclinical Decisions

Clinical
Patient preferences
History of presenting illness, past medical history, physical exam
Test ordering
Interpretation of data: laboratory, imaging studies, electrocardiograms, other
Treatment
Referral
Diagnosis
Disposition
Teaching
Nonclinical
Allocation of resources
Priority setting
Administrative
Cost

equally critical. Next, decisions need to be made about what tests and imaging studies are required. Every test result needs to be assessed: Is the value abnormal or not? Might the abnormal value be a laboratory error? If it is abnormal, is it acceptable, or does it require an intervention? Is this abnormality expected in this patient? For imaging studies: Is the radiograph of the right patient? Has the correct radiograph been ordered? Is it the right side, and has the side been identified correctly? Is the film centered? Is the exposure reasonable? Is it abnormal or not? Are there other significant findings? Is this a variant or an abnormality? Similar considerations apply for the electrocardiogram (ECG): Is this the right patient? Have the leads been applied correctly? Is this a variant of normal? Is this an old or a new finding? Do I need to see old ECGs? What is the interpretation? Is immediate action required? What should that action be? The volume of decisions around the indications for, and choice of, procedures and treatment is similarly dense. Numerous further decisions will be made for other aspects of the clinical encounter, as well as for nonclinical activity.

Many of these decisions will be straightforward. For example, examining a panel of values for a complete blood count often requires no more than looking for abnormal values, and these may be flagged automatically. A second stage of decision making may then be required, however, to determine the cause of combinations of abnormalities. Similarly, an abnormal arterial blood gas may require up to ten separate decisions to determine the cause(s) of the abnormality. If the physician sees an average of three patients an hour, the total number of these individual decisions on each patient requiring a significant workup may go into the hundreds, and the total for a shift will be in the thousands. The sheer number of decisions can create stress and tension for the decision maker, which may compromise decision making. Other intrinsic operating features of the ED environment, such as resource limitations, interruptions, distractions, and the transitions of care that result from shift changes, may further increase the likelihood that clinical decision quality might not be maintained.[2,6]

How, then, is this decision density handled? It is clear that emergency physicians do not methodically go through a quantitative clinical utility approach to decision making; i.e., for the most part, they are not formal Bayesians. Instead, they appear to have developed several decision-making strategies that are part of an informal Bayesian approach,[7] which reduces decision complexity and builds economy and redundancy into the process (Table 2). They correspond more to the "recognition–primed decision" model advocated by Klein et al.[19] than to any formal, analytical decision-making process. These informal methods mediate what Reason has termed "flesh-and-blood" decision making, which occurs at the point where the "cognitive reality departs from the formalized ideal,"[8] and is schematized in Figure 1. It seems that emer-

TABLE 2. Strategies in Decision Making

Pattern recognition
Rule out worst-case scenario (ROWS)
Exhaustive method
Hypothetico-deductive method
Heuristics
Cognitive disposition to respond (CDR)

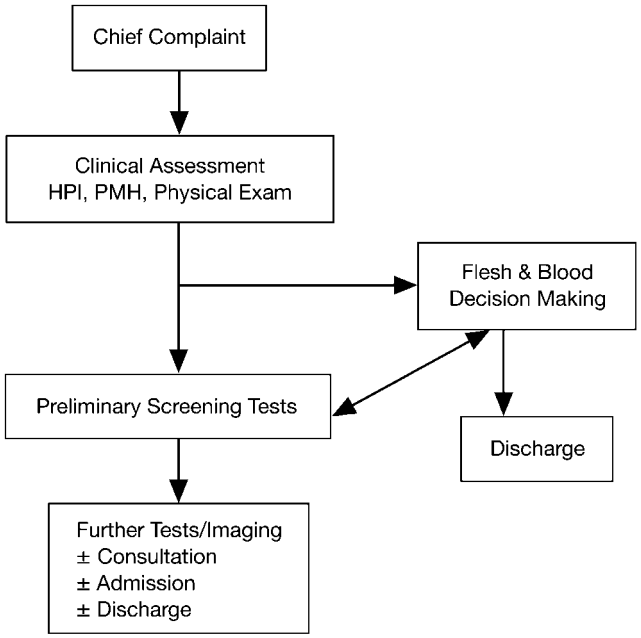

Figure 1. Overview of clinical decision making in the emergency department. HPI = history of present illness; PMH = past medical history.

gency physicians either make a flesh-and-blood decision fairly soon after the presentation of a patient at the ED, or they commit to a formal workup involving an array of tests, imaging techniques, and consultations. Good flesh-and-blood decision making saves time and resources, and characterizes physicians with good acumen. Many of the strategies they use have proved their efficacy with the test of time, but occasionally they fail. Therefore, it is important that emergency physicians understand how to detect the weaknesses and biases in each of these strategies.

PATTERN RECOGNITION

Combinations of salient features of a presentation often result in pattern recognition of a specific disease or condition. It reflects an immediacy of perception, and may result in *anchoring bias* (Tables 3 and 4). At the outset, these features are often visual and drive the process of perception in a largely *bottom-up* fashion (Fig. 2). Later, additional incoming data supplement the process. The beliefs and expectations of the clinician also exert an influence through a *top-down* process,[9] which is more of a goal-directed behavior. The combination and continuous interplay of these two processes enable the percept to be recognized and the problem solved. The obvious application of this strategy is in dermatological cases, but pattern recognition drives decision making in many other contexts in the ED. For example, a patient lying on a stretcher with excruciating flank pain and vomiting initiates the bottom-up perception that generates the diagnosis of ureteral colic. The presence of blood in the urine provides further supporting data. From the clinician's standpoint, past experience with this presentation and knowing that the patient has a history of urinary calculi provide top-down knowledge that guides and adds certainty to the diagnosis. As with many strategies, they work most of the time but occasionally fail. Several difficulties arise with pattern recognition: First, initial top-down processing biases such as the clinician's prior beliefs and expectations may lead to the selection of inappropriate data sets that misdirect subsequent reasoning and problem solving. Second, bottom-up data can be misleading; visual data, in particular, are vulnerable to misinterpretation.[10–12] A number of other possibilities can account for the initial presentation of this patient with severe flank pain. Also, the finding of hematuria is not specific to ureteral colic and may be a manifestation of other conditions, e.g., an abdominal dissecting aneurysm. Finally, not all incoming data are used objectively. For example, when *confirmation bias* is evident, data can be selectively marshaled to support a favored hypothesis. The biases described below appear to affect both top-down and bottom-up processing.

RULE OUT WORST-CASE SCENARIO (ROWS)

The ROWS strategy is almost pathognomonic of decision making in the ED. Above all else, emergency physicians must not miss critical diagnoses. This is a form of pattern matching combining with the *availability* heuristic (Table 4). For most presentations the physician will have available, or carry mental templates of, the top five or so diagnoses that should be excluded. Thus, for chest pain the physician might match the presentation against the scenarios for unstable angina, acute myocardial infarct, aortic dissection, tension pneumothorax, and pericarditis. This is not an exclusive list of diagnostic possibilities for chest pain, but these are diagnoses that must be excluded before judicious disposition. For the most part, ROWS is a strategy of safety and errs on the side of caution. It also qualifies as a form of *value-induced bias* in that any biasing tendency toward worst-case scenarios increases the likelihood of detection of diagnoses that must not be missed. Similar "overreading" behavior has been described for radiologists.[13] One of the goals of developing clinical decision rules is to reduce value-induced biases in clinical behavior, thereby improving utilization of resources. ROWS is also an example of a generic *cognitive forcing strategy* (CFS) that increases the probability that all critical diagnoses have received consideration in the ED.[1] One of the important features of the availability heuristic, however, is its dependence on personal experience, and idiosyncratic applications of ROWS may lead to overutilization of resources.

TABLE 3. Failed Heuristics, Biases, and Cognitive Dispositions to Respond

Aggregate bias	Confirmation bias	Multiple alternatives bias	Posterior probability error	Sutton's slip
Anchoring	Diagnosis momentum	Omission bias	Premature closure	Triage-cueing
Ascertainment bias	Fundamental attribution error	Order effects	Psych-out error	Unpacking principle
Availability and non-availability	Gambler's fallacy	Outcome bias	Representativeness restraint	Vertical line failure
Base-rate neglect	Gender bias	Overconfidence bias	Search satisfying	Visceral bias
Commission bias	Hindsight bias	Playing the odds		Yin–yang out
				Zebra retreat

TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Aggregate bias	Ecological fallacy	The aggregate fallacy is when associations between variables representing group averages are mistakenly taken to reflect what is true for a particular individual, usually when individual measures are not available. Physicians may use the aggregate bias to rationalize treating an individual patient differently from what has been agreed upon through clinical practice guidelines for a group of patients (i.e., there is a tendency for some physicians to treat their own patients as atypical). However, the aggregate fallacy argument does not apply because clinical practice guidelines have been established on individual data. Further, the clinician's behavior may be augmented by a patient's demanding behavior. Thus, a particular patient judged to have a viral upper respiratory tract infection may be treated with an antibiotic for perverse (irrational) reasons, or a patient with an ankle sprain who doesn't satisfy the Ottawa Ankle Rules may be x-rayed. The aggregate bias may be compounded by those with a *commission bias*, who have a tendency to want to be seen as ''doing something'' for the patient.	Physician noncompliance and idiosyncratic approaches may result in patients' receiving tests, procedures, and treatment outside of accepted clinical practice guidelines. Patients may be inadvertently reinforced for demanding some kind of active intervention (antibiotic, x-ray, referral, etc.).	Physicians should recognize that the aggregate fallacy does not apply to clinical decision rules that have been validly developed. Unless there are compelling and rational reasons for doing otherwise, physicians should, therefore, follow clinical decision rules and clinical pathways. They should avoid the tendency to believe their patients are atypical or ''exceptions,'' and resist the temptation toward ''doing something.'' They should avoid having their clinical decision making influenced by demanding behavior of patients and relatives.	28
Anchoring	Tram-lining, first impression, jumping to conclusions	Anchoring is the tendency to fixate on specific features of a presentation too early in the diagnostic process, and to base the likelihood of a particular event on information available at the outset (i.e., the first impression gained on first exposure, the initial approximate judgment). This may often be an effective strategy. However, this initial impression exerts an overly powerful effect in some people and they fail to adjust it sufficiently in the light of later information. Anchoring can be particularly devastating when combined with *confirmation bias* (see below).	Anchoring may lead to a premature closure of thinking. Patients may be labeled with an incorrect diagnosis very early on in their presentation. Diagnoses, once attached, are difficult to remove (see *diagnosis momentum*, below) and may seal the patient's fate.	Awareness of the anchoring tendency is important. Early guesses should be avoided. Where possible, delay forming an impression until more complete information is in.	1, 10, 17, 29–31
Ascertainment bias	Response bias, seeing what you expect to find	Ascertainment bias occurs when the physician's thinking is pre-shaped by expectations or by what the physician specifically hopes to find. Thus, a physician is more likely to find evidence of congestive heart failure in a patient who relates that he or she has recently been noncompliant with his or her diuretic medication, or more likely to be dismissive of a patient's complaint if he or she has already been labeled as a ''frequent flyer'' or ''drug-seeking.'' Gratuitous or judgmental comments at hand-off rounds and other times can do much to seal a patient's fate. Ascertainment bias characteristically influences goal-directed, ''top-down'' processing. Stereotyping and gender biases are examples of ascertainment bias.	Ascertainment bias leads to pseudo-information, which subsequently may prove misleading. Any prejudgment of patients is dangerous and may result in underassessing or overassessing their conditions.	It is important for physicians to detach themselves from any type of pre-formed notion, expectation, or belief that will impact on subsequent interpretation of data. They should be alert for discriminatory comments about patients that may lead to unjustified expectations. Making negative or judgmental comments about patients before they have been assessed, especially at shift changeover, should be discouraged.	32
Availability and non-availability	Recency effect, common things are common (availability), the sound of hoofbeats means horses, out of sight out of mind (non-availability), zebra	Availability is the tendency for things to be judged more frequent if they come readily to mind. Things that are common will be readily recalled. The heuristic is driven by the assumption that the evidence that is most available is the most relevant. Thus, if an emergency physician saw a patient with headache that proved to be a subarachnoid hemorrhage (SAH), there will be a greater tendency to bring SAH to mind when the next headache come along. Availability is one of the main classes of heuristic and underlies *recency effect* (see below). Availability may influence a physician's estimates of base rate of an illness. Non-availability (out of sight out of mind), occurs when insufficient attention is paid to that which is not immediately present (zebras). Novices tend to be driven by availability, as they are more likely to bring common prototypes to mind, whereas experienced clinicians are more able to raise the possibility of the atypical variant or zebra.	Availability and non-availability lead to disproportionate estimates of the frequency of a particular diagnosis or condition. They both distort estimates of base rate (see *base rate neglect*, below), which influences pre-test probability. This may lead to faulty Bayesian reasoning and under- or overestimates of particular diagnoses.	Objective information should be gathered and used systematically to estimate the true base rate of a diagnosis, and clear clinical evidence is needed to support a particular diagnosis for the patient being seen. Physicians should be aware of the tendency to pay too much attention to the most readily available information, or be unduly influenced by high-profile, vivid, or recent cases. They should routinely question the soundness of their estimates or judgments—do they rely excessively on easily available evidence?	1, 8, 17, 26, 33

continued

TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them (*cont.*)

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Base-rate neglect	Representativeness exclusivity	Emergency physicians tend not to be formal Bayesians and instead make judgments based on how well the patient's presentation matches their mental prototype for a particular diagnosis. This is an example of the *representativeness* heuristic (see below). It involves using a heuristic that emphasizes how things typically present in the natural setting of the emergency department (ED) (substantive approach) rather than adopting specific decision rules and statistics, typified by ''subjective expected utility theory'' (formalistic approach). In many instances, the substantive approach is successful but occasionally this heuristic may be used to the exclusion of other important considerations such as the base rate or prevalence of that disease. Failing to adequately take into account the prevalence of a particular disease is referred to as base rate neglect. Some diagnoses that are made in the ED are unambiguous but many will be uncertain and have probabilities attached to them. Probabilities are only estimates and depend on the personal experience of the clinician. Prior probability (pre-test) reflects the physician's belief about the likelihood of the diagnosis prior to any testing. The posterior probability (post-test) reflects the revised belief about the likelihood of the diagnosis once the test result is known. The efficacy of the test is a function of its sensitivity and specificity. Bayes' rule combines these variables: the pre-test probability with the test result and the efficacy of the test, and the validity of the approach depends upon objective data about disease prevalence. Thus, if a physician gives all possible explanations for pleuritic chest pain equal pre-test probabilities then they are effectively being assigned equal prevalence rates; i.e., true base rates are being neglected. Testing for pulmonary embolus (worst-case scenario) is more likely to be done, and its post-test likelihood overestimated. Some will argue that the rule out worst-case scenario (ROWS) strategy forces a distortion of Bayesian reasoning by giving undue emphasis to remote possibilities. This erring on the side of caution will result in overutilization but would be considered by many to be an acceptable downside.	Base-rate neglect may result in overestimates of unlikely diagnoses, leading to wastefulness and overutilization of resources. The pursuit of esoteric diagnoses is occasionally successful and the intermittent reinforcement sustains this behavior in some physicians.	Physicians should be wary of relying on representativeness to the exclusion of other data. They should have reliable estimates of disease prevalence in their geographical area, and be familiar with the principles underlying Bayesian reasoning and the judicious ordering of tests. In particular, they should be aware that interpretation of diagnostic tests depends on disease prevalence.	18, 34–38
Commission bias	Actions speak louder than words	Commission bias is the tendency toward action rather than inaction. An error arises when there is an inappropriate committal to a particular course of action. It is more likely to occur in someone who is overconfident, and reflects an urge to ''do something.'' It satisfies the obligation of *beneficence* in that harm can only be prevented by actively intervening. However, it is more likely to violate the obligation of *non-malfeasance* (refraining from an action that exposes the patient to unnecessary risk or harm), as well as the opening caveat of the Hippocratic oath ''First do no harm.'' Thus, errors of commission are less likely than errors of omission. Errors of omission typically outnumber errors of commission. Commission bias may be augmented by team pressures or by the patient. It may underlie *ascertainment bias*, which tends to result in physicians ''doing something'' (prescribing an antibiotic, ordering an x-ray), i.e., committing to an action when the clinical practice guidelines promote inaction as the best course.	Commission errors tend to change the course of events, because they involve an active intervention, and may therefore be less reversible than an error of omission. The premature adoption of a diagnosis (see *premature closure*) is a tacit form of commission error.	Before committing to an intervention, physicians should review the evidence very closely. Is the act justified? What are the consequences of the action? Is there a danger associated with it? Are there other options? Is it irrevocable? How much of it can be reversed?	39

Confirmation bias	Belief bias, following hunches, pseudodiagnosticity, positive testing, effort after meaning, relevance bias	This is a powerful bias, which may seriously confound problem solving and clinical decision making. When a hypothesis is developed on relatively weak or ambiguous data, it may later interfere with superior and more plentiful data. Such subsequent data might not be treated objectively and may be ignored. Confirmation bias is reflected in a tendency to look for confirming evidence to support the hypothesis, rather than look for disconfirming evidence to refute it. In difficult cases, confirming evidence feels good, whereas disconfirming evidence undermines the hypothesis and means that the thinking process may need to be re-started, i.e., looks like more work, requiring more mental effort. It may lead to the collection of redundant data that may be used to bolster confidence in a hypothesis that has been adopted. When the problem space is large (too many possibilities), confirmation bias may reflect a selective tendency to focus on data that appear relevant to a currently held hypothesis, and settle for a satisfactory but not optimal result (see *search satisfying*). This case of confirmation bias is referred to as *relevance bias*, and again may result in neglecting a search for disconfirming evidence. Confirmation bias may seriously compound errors that arise from *anchoring*, where a prematurely formed hypothesis is inappropriately bolstered.	Confirmation bias leads to the preservation of hypotheses and diagnoses that were weak in the first place. The bias may result in much wasted time and effort, and may completely miss the correct diagnosis.	Physicians should attempt to mentally monitor the hypothesis refinement stage of clinical decision making. They should avoid *pseudodiagnosticity effect*, responding to statistically nondiagnostic information that has been gathered (positive testing) with the expectation it will be consistent with a previously adopted hypothesis. They should seek out disconfirming evidence that will challenge the hypothesis under consideration. One piece of disconfirming evidence may be worth ten pieces of confirming evidence. On the way to development of a diagnostic formulation, checks should be made to see that competing hypotheses have been given adequate consideration.	1, 8, 18, 40–43
Diagnosis momentum	Diagnostic creep	Diagnosis momentum refers to the tendency for a particular diagnosis to become established without adequate evidence. It has some similarities with, but differs from *premature closure* (see below). Premature closure occurs when a physician adopts a particular diagnosis without adequate verification, whereas diagnosis momentum may involve several intermediaries including the patient. Typically, the process starts with an opinion, not necessarily a medical one, of what the source of the patient's symptoms might be. As this is passed from person to person (e.g., friend or relative to patient to paramedic to nurse to physician), the diagnosis gathers momentum to the point that it may appear almost certain by the time the patient sees a physician. As with *premature closure*, a diagnosis that gathers momentum tends to suppress further thinking, sometimes with disastrous outcomes. Attaching a diagnostic label is a convenient short-hand way of communicating. It invariably means that someone else's thinking has been inherited. It may result in the patient's having tried self-medication before seeking help. Besides these and other time-delays, further dangers imposed by this process are that it may result in further delays or misdirection at ED triage (see *triage cueing*), and may unduly influence the unwary caregiver. Physicians should always be wary when a patient begins the exchange by volunteering his or her own diagnosis.	Diagnoses may gather momentum without gathering verification. Delayed or missed diagnoses lead to the highest disabilities and are the most costly. Allowing the wrong label to stay on a patient may seal his or her fate.	In the ED, extreme caution should be exercised for any patient who comes prediagnosed. This is especially important at shift change, and hand-off rounds. If a patient is transferred to a physician's care with a diagnosis, the evidence should be carefully reviewed to ensure concurrence.	7

continued

TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them (*cont.*)

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Fundamental attribution error	Judgmental behavior, negative stereotyping	Fundamental attribution error is the tendency to blame people when things go wrong rather than circumstances. Thus, someone's behavior may be explained by attributing it to the dispositional qualities of a person rather than to situational circumstances. We have a strong inclination to make such attributions in a social context and carry them over into the ED. Thus, judgments are made about certain groups of patients e.g., alcoholics, ''frequent flyers,'' drug-seekers, somatizers, and those with personality disorders. We hold them responsible for their behavior, imagining they have as much control over it as we do, and attributing insufficient consideration to their social or other circumstances. Generally we tend to be less judgmental about ourselves than others (*actor-observer bias*), and are more inclined to take the credit for success than accept responsibility for failure (*self-serving attributional bias*); this may lead to overconfidence. There also exists a *self-punishing attribution bias*, reflected in the often harsh reaction we have toward ourselves when we make an error; i.e., there appears to be a strong tendency in some physicians to attribute blame to themselves rather than look for systemic or circumstantial explanations. The biases described here are distinct from the illusion of control that underlies *attribution bias*, the tendency to attribute outcomes to unrelated events, e.g., rain dances. However, attribution bias might explain why some clinicians occasionally persist in superstitious, idiosyncratic behaviors.	Fundamental attribution error reflects a lack of compassion and understanding for certain classes of patient and may result in inappropriate or compromised care. Some studies have suggested attribution error may worsen the condition of some psychiatric patients.	Physicians should avoid being judgmental about the behavior of others. It is impossible to be aware of all the circumstances that contribute to a person's behavior. They should try to imagine a relative or themselves in the same position. Care should be consistent across all groups of patients, especially for minorities and the marginalized. It is very important to remember that for psychiatric patients, the behavior is often the only manifestation of the underlying disease.	1, 9
Gambler's fallacy	Monte Carlo fallacy, law of averages, sequence effect	If a coin is tossed ten times and comes up heads each time, the gambler's fallacy is the belief that the 11th toss will be tails; i.e., that the sequence will reverse. Although the 50:50 odds of heads or tails remains the same (the coin has no memory), there is a tendency to believe the sequence cannot continue. An example of the gambler's fallacy in the ED is the situation where the emergency physician sees a series of chest pains. If the first, second, and third patients are all diagnosed with an acute coronary syndrome (ACS), an inertia begins to build whereby the physician begins to doubt that the sequence can continue. Thus, there may develop an increasing tendency to believe that the likelihood of a subsequent patient with chest pain having ACS has diminished—that the sequence cannot continue. All these patients, of course, are independent of each other and should be objectively assessed on their own merits, but it appears that sequences or runs can give rise to superstitious behavior and influence decision making. Except under epidemic conditions, the ED is one of the few areas in medicine where the disease of one patient may influence the management of another. The gambler's fallacy is contrasted with *posterior probability error* (see below), where, for different reasons, the belief is that the sequence will not reverse but continue.	The fallacy erroneously changes the pre-test probability of a particular diagnosis for a patient. This may result in the diagnosis receiving insufficient consideration and being delayed or missed.	When unusually sequences or runs are experienced, physicians should remind themselves of the laws of probability and the independence of diagnoses. Effectively, the physician must restart his or her approach with each new patient.	31, 56

Gender bias	Sex discrimination	True gender bias arising from specific attitudes toward a particular gender has to be distinguished from a mistaken belief that gender is a factor in the etiology of a disease. There are many factors that may contribute to an apparent gender bias and these must be carefully excluded. The charge of gender bias on clinical decision making is often a diagnosis of exclusion, and has been referred to as ``bias measuring bias.'' For example, increased survival rates in one gender over another for a particular disease do not necessarily mean that care was different; pathophysiological differences between genders may influence survival. Further, the behavior of the patient may be contributory to the treatment bias. Also, one gender may not view the disease as seriously and may be less compliant with prescribed medication, or one gender may be more likely to exert a preference over how their disease should be managed. If there are different gender patterns for presentation to the ED for specific complaints, there may develop an altered perception among caregivers regarding the influence of gender; e.g., female victims of domestic violence are more inclined to seek ED care than male victims, thus emergency caregivers may be more vigilant for signs of domestic violence in females compared with males. Gender bias generally results in an overdiagnosis of the favored gender, or an underdiagnosis of the neglected gender. Even if gender bias does not influence diagnosis, it may impact on subsequent treatment of the disease; e.g., because of gender stereotyping, physicians and nurses may be inclined to offer analgesics less frequently to male patients compared with females.	Gender bias leads to the gender of the patient exerting an influence on clinical decision making when gender is known not to be relevant to the etiology of the disease.	Physicians should be aware of the potential impact of gender bias on decision making. Audits and outcome measures should be made in the ED to determine any effects due to true gender bias.	57
Hindsight bias	``Knew it all along'' effect, retroscope analysis, wisdom after the fact, creeping determinism, outcome knowledge	When we know the outcome, it profoundly influences how we perceive past events. After an event has occurred, there is a tendency to exaggerate the likelihood that would have been assessed for the event before it occurred. Thus, when events are viewed in hindsight, there is a strong tendency to attach a coherence, causality, and deterministic logic to them such that no other outcome could possibly have occurred. Hindsight bias may distort the perception of previous decision making, such as occurs at morbidity and mortality rounds. Many decision errors appear transparent in hindsight. Usually, hindsight does not take into account the prevailing conditions at the time the decision was made. The clarity of vision that appears to emerge in hindsight can influence future decision making in that we may tend to overestimate our ability to perform better. We have a tendency to misremember what we knew in foresight. This ``hindsight wisdom'' gives us an unrealistic assessment of our decision-making abilities and we develop an illusion of control. It may contribute to a misplaced confidence in our abilities.	Hindsight bias may prevent a realistic appraisal of what actually occurred, and compromise learning from the event. It may lead to both under- and overestimations of the clinical decision maker's abilities.	Physicians should be aware of how readily things seem to fit together, and are explained in hindsight. They should be careful of being made to feel bad about decisions that were made, and of losing confidence in their decision making capabilities. This usually occurs because the outcome is known and ambient conditions are not usually taken into account. They should beware of an overconfidence that might result from the clarity of vision that the retroscope offers.	1, 8, 44

continued

TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them (*cont.*)

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Multiple alternatives bias	Status quo bias, wallpaper phenomenon	Imagine having to choose a new wallpaper when there are only two options. Many would find the choice relatively easy. If now the options are expanded to five, it becomes increasingly difficult, the decision making process becomes delayed, and there is a tendency to revert back to choosing between the original two (or even staying with the original). In a particular clinical situation of relatively low complexity, a physician may feel comfortable about choosing between two alternatives. If the options now expand, physicians appear to experience difficulty with the additional choices, and tend to fall back on the status quo. Paradoxically, it appears that instead of the new alternatives' inviting a wider range of choice and treatment options, from which the physician might evaluate the benefits and risks to choose the most superior, the uncertainty and conflict drive the physician back to more conservative behavior. For example, assume a physician has established a practice of using thrombolytic A in acute myocardial infarction. He subsequently receives information about a new thrombolytic, B, which appears to be a reasonable alternative to A. Then a third thrombolytic, C, becomes available, which also appears efficacious. The rational approach would be to evaluate the evidence for all three thrombolytics and choose the best available. However, the multiple alternatives bias predicts that, at least at the outset, there would be a tendency to revert to A, because the multiple choices generate conflict and uncertainty. This a variant of the *status quo bias*—preferring the known to the unknown. Exhortations are often made to ''stick with what you know,'' but the multiple alternatives bias goes a little further than that in creating an irrational inertia against optimizing choice among competing alternatives. The bias has been described only in the context of medical choices for treatment, but may have applicability in diagnostic situations. For example, if a physician had decided on a choice between two working hypotheses, but additional information emerges that raises additional and reasonable possibilities, the bias would predict that the tendency to avoid conflict and added uncertainty inclines the physician back to choosing among the original hypotheses.	Situations that create multiple alternatives can lead to irrational decision making, and result in suboptimal treatments and, perhaps, missed diagnoses.	To optimize decision making and minimize bias, physicians should avoid simply trying to select the best option from an array of options. Instead, they should clearly identify all competing options and compare each one individually with the status quo. This should ensure that any change is an improvement over what existed earlier.	58
Omission bias	Temporizing, tincture of time, watchful expectancy, watchful waiting, let well enough alone	Omission bias is the tendency toward inaction, or reluctance to treat. Inaction is preferred over action through fear of being held directly responsible for the outcome. Blame tends to be directed at the last person to have touched the patient. It has its origin in the idea that when a bad outcome occurs, blame will be more likely if you did something rather than did not. It also fits the ''First do no harm'' part of the Hippocratic oath, and the principle of *non-maleficence*. It is preferable that an event is seen to happen naturally rather than have the event directly attributed to the action of a physician. This tendency toward inaction may explain why passive euthanasia is preferred over active euthanasia, even though the end result is identical. The bias may be sustained by the reinforcement that often comes from not doing anything (tincture of time, watchful waiting, temporizing), human physiology having a natural tendency to restore homeostasis, and the body having a tendency to recover from most acute insults.	While inaction may often be the most appropriate course, omission bias may lead to disastrous outcomes in the ED. Temporizing in urgent conditions may result in the development of worsening emergencies.	The maxim ''When you think of it is the time to do it'' is often applicable. Some medical conditions evolve very quickly in the ED and it is prudent to anticipate as early as possible when an intervention might be required. One quality that characterizes the competent emergency physician is a willingness to act decisively.	8, 22, 39, 45–47

		Omission bias leads to deliberate omission errors, and is distinguished form the majority of errors of omission that arise from non-deliberate, cognitive failures: slips, lapses, mistakes, and distractions. These are among the most prevalent of any error type. They typically outnumber commission errors. In a study of trauma management, they accounted for approximately half of all errors.			
Order effects	Primacy, recency	There are many occasions in the ED when information is transferred from one person to the other. It happens at the outset between the patient and the triage nurse, between the patient and physician, between nurses and physicians, between physicians and physicians, and between nurses and nurses. An important feature of information transfer is that recall is biased as a U-function. We tend to remember more of information transferred at the beginning of the exchange (*primacy effect*) and sometimes even more about what was transferred toward the end of the exchange (*recency effect*). What we tend not to remember is the information in the middle. (This feature of recall was humorously demonstrated in the movie *A Fish Called Wanda*. Kevin Kline is repeatedly unable to remember the ''middle bit'' of various instructions he is given.) Primacy effect may be augmented by *anchoring*, where attentional locking onto salient and vivid features increases their chances of being remembered. Primacy effect for patients can result in strong initial impressions, creating an inertia that may require considerable work to overcome later.	Order effects may result in selective parts of information being remembered. Primacy effect can result in strongly polarized views of patients at the outset that can influence subsequent decision making (see *visceral bias*).	Given recall biases, we should make efforts to record pertinent information and rely less on memory. We should understand that placing information (especially if it is vivid or charged) at the beginning or end of exchanges will affect its recall. This phenomenon may be used to advantage or disadvantage.	9
Outcome bias	Chagrin factor, value bias	The outcome bias reflects the tendency to judge the decision being made by its likely outcome. We tend to prefer decisions that lead to good outcomes than those that lead to bad outcomes. *Value bias* refers to the tendency of people to express a stronger likelihood for what they hope will (or will not) happen rather than what they believe will happen. We tend to believe that positively valued events are more likely to happen than negatively valued events. The more objective evidence accumulates, the weaker the value bias becomes. These intrusions of what we want (affect) rather than what we believe (cognition) can compromise decision making.	Allowing personal hopes and desires to enter clinical decision making reduces objectivity and may significantly compromise the process.	Besides being mindful of this tendency, physicians should strive to obtain objective data. The more there is, the weaker the bias.	1, 38, 45, 48–50
Overconfidence bias		Overconfidence may be an effort to maintain a positive self-image, and may play a role in *hindsight bias*. It is described as *self-serving attribution bias*. It is a dangerous personal characteristic in medicine, and especially in the ED. In general, we usually think we know more than we do, often without having gathered sufficient information, and generally place too much faith in our own opinions. Those who are overconfident tend to spend insufficient time accumulating evidence and synthesizing it before action. They are more inclined to act on incomplete information and hunches. When overconfident people believe that their involvement might have a significant impact on outcomes (whether it actually does or not), they tend to believe strongly that the outcome will be positive. Thus, they disproportionately value their contribution. Overconfidence can potentiate badly with *anchoring* and *availability*, leading to an overreliance on readily available (rather than valuable) *information*.	Overconfidence may result in significant errors of both omission and commission and result in unwarranted interventions, costly delays, or missed diagnoses.	Efforts should be made to answer the following: Has intelligence gathering been systematic? How much is really known? Has evidence been gathered in a logical and thorough fashion, and does it support our estimates and judgment? Has too much reliance been placed on anchors, or too readily available information?	18, 51, 52

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TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them (*cont.*)

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Playing the odds	Frequency gambling, law of averages, odds judgments	An *odds judgment* in the ED is the physician's opinion of the relative chances that a patient has a particular disease or not. It is clearly influenced by the actual prevalence and incidence of the disease. *Playing the odds* refers to the process by which the physician, consciously or otherwise, decides that the patient does not have the disease on the basis of an odds judgment; i.e., the decision has been primarily determined by inductive thinking (the physician's perception of the odds), rather than by objective evidence that has ruled out the disease. Typically, this occurs before any workup of a patient, but may also occur in patients who have been worked up but for whom the results remain equivocal. Again, influenced by his or her opinion regarding prevalence and incidence, the physician may reach a decision that the patient does not have the disease. It is clear, too, that odds judgments will be influenced by *availability*, leading to fluctuating (subjective) opinions about prevalence and incidence. In the ED there are many conditions that present equivocally. The signs and symptoms of an acute aortic dissection may be comparable in the early stages to those of constipation. However, benign conditions overwhelmingly outnumber the serious ones, and, more often than not, playing the odds will be a relatively effective strategy. Should the more rare condition be present, the failure to consider it could have a serious outcome. Use of the strategy probably increases under conditions of fatigue and/or circadian dysynchronicity.	Playing the odds clearly runs the risk of important conditions being missed. It is antithetical to the ROWS strategy.	Although estimates of probability are an integral feature of any decision-making process, ED physicians should be aware that playing the odds should not be influential, especially in the initial stages of decision making. At the time of disposition, if there is residual doubt and the diagnosis remains equivocal, it is important that physicians review the available evidence and reflect on their thinking. This is particularly important when they are fatigued.	12, 18
Posterior probability error	History repeats itself	If a physician bases his or her estimate of the likelihood of disease on what has gone before, a posterior probability error may occur. For example, if a patient has had six visits to an ED with a headache in the last year and on each occasion has been diagnosed as having migraine, to make the assumption that the patient has migraine on the seventh visit is a posterior probability error. Assuming that the previous diagnoses were all correct, the probability that this headache is migraine is high, but there is also a possibility that the headache is due to some other less benign cause such as a subarachnoid hemorrhage. There is no reason why migraineurs should not get subarachnoid hemorrhages, and the symptoms and signs may be very similar. Every presentation of this patient to an ED requires a thorough assessment of the complaint of headache, and no assumptions should be made that a particular diagnosis is present until the evidence justifies it. There is also the possibility that previous visits have been misdiagnosed, in which case the posterior probability error will result in the further propagation of a series of errors. For all patients, presentation at the ED mandates an appropriate history and physical exam and whatever investigations are indicated. Patients with somatization disorder are particularly vulnerable to posterior probability error. Making posterior probability assumptions about likely diagnoses and performing cursory examinations are fraught with error in the ED.	Posterior probability error may result in a wrong diagnosis being perpetrated, or in a new diagnosis being missed.	Physicians should be alert to the dangers of basing their clinical decisions on past decisions. In situations involving repeat visits, they should mentally emphasize the need for objectivity in assessment of the patient, without considering past diagnoses. A helpful strategy is to ignore old records, disregard any comments by other physicians or nurses about the patient, and focus on the chief complaint and physical exam before reviewing past medical history.	31, 56

Premature closure	Counting chickens before they are hatched	Physicians typically generate several diagnoses early in their encounter with a clinical problem. Premature closure occurs when one of these diagnoses is accepted before it has been fully verified. The tendency to apply closure to the problem-solving process can result from vivid presenting features that may be convincing for a particular diagnosis, or by anchoring on to salient features early in the presentation. Attaching a diagnosis to a patient provides a convenient, short-hand description (see *diagnosis momentum*). It may also reflect some laziness of thought and a desire to achieve completion, especially under conditions of fatigue or circadian dysynchronicity.	Premature closure tends to stop further thinking.	As far as is possible in the circumstances, physicians should keep an open mind about the diagnostic possibilities in a clinical case. They should be careful that a working diagnosis does not prematurely become the *de facto* diagnosis. Absolute verification of the hypothesis may be unattainable, but the diagnosis must be subjected to tests of adequacy, coherence, parsimony, and falsification.	10, 17, 53
Psych-out error		A psych-out error is any error involving psychiatric patients. They are especially vulnerable to error in the ED, and many of the errors described here are pervasive in the management of psychiatric patients. An overriding problem is that psychiatric patients do not fit the ''model'' type of patient that the ED likes to see. *Fundamental attribution error* results in judgmental behavior and the paradoxical view that the patient is somehow responsible for his or her condition. Crude ''negative reinforcing'' attitudes of caregivers may even exacerbate the patient's condition. Countertransference can result in poor treatment of several conditions (see *visceral bias*), especially of personality disorders. *Search satisficing* can lead to the search being called off once a psychiatric diagnosis has been made and comorbid medical illnesses may go undetected; there is a historic failure of EDs to medically stabilize psychiatric patients before disposition. Also, there is a tendency to see behavioral abnormalities as psychiatric in origin; hence, a number of significant illnesses that are associated with behavioral changes may be misdiagnosed as psychiatric illness. This may be a reflection of pursuing the obvious (*Sutton's slip*) or *anchoring* onto behavior and overlooking the possibility of underlying medical illness. There may be further problems with *posterior probability error* when a patient with a history of ED visits for psychiatric problems presents with a new nonpsychiatric condition. This is especially true for those with somatization disorder.	The variety of errors associated with psychiatric patients can lead to inadequate medical stabilization, missed medical diagnoses, and exacerbation of their current conditions. In addition, abnormal behaviors associated with certain medical conditions may be mistakenly assumed to be psychiatric in origin.	Any psychiatric patient, or anyone exhibiting abnormal behavior, should present a red flag to the emergency physician. Several forcing strategies should be used to ensure that the psych-out errors are not made. Encourage all staff to refrain from any judgmental remarks or ''negatively reinforcing'' behavior. All physical complaints should be carefully assessed, holding to the same standards as those for nonpsychiatric patients. Any patient being referred to a psychiatric facility should have a thorough history and physical examination to ensure medical stabilization prior to transfer. EDs should develop management protocols containing forcing functions for psychiatric patients. Patients diagnosed with somatization disorder should have explicit ED management plans developed in consultation with their primary caregivers.	1, 31
Representativeness restraint	Prototypical error, similarity—matching error, persistence forecasting error	*Representativeness* underlies the medical maxim: if it looks like a duck, walks like a duck, and quacks like a duck, it is a duck. Representativeness is one of the principal heuristics. It strongly influences a number of different aspects of decision making. It is a powerful heuristic for emergency physicians because it underpins the pattern recognition strategy referred to earlier. The patient's signs and symptoms are matched against the physician's mental templates for their representativeness. Thus, we often base our decision about whether or not something belongs to a particular category by how well it matches the characteristics of members of that category. The prototype is the most representative member of the class. Traditionally medical education has taught about prototype recognition. Thus, medical students are generally more concerned with being able to list all the signs and symptoms of unstable angina than list those ''atypical'' patients in whom the diagnosis is occasionally missed. As with most heuristics, it is a useful strategy. It allows us to organize our environment and put things in their proper places. However, if we develop an overreliance on the heuristic, we tend to misidentify atypical variants of a category. Further, the representativeness heuristic tends to be insensitive to pre-test probabilities and, therefore, neglects prevalence. *Representativeness restraint* is the error that occurs when the physician restrains from considering a particular diagnosis for a patient because the patient is not sufficiently representative of the class. The error underlies the 4% or so patients who are sent home from the ED with an acute myocardial infarct. Typically, the diagnosis is missed in unrepresentative patients (young, diabetic, female, geriatric, psychiatric).	Representativeness restraint results in delayed or missed diagnosis, mainly because aspects of the patient's presentation are atypical.	As with many of the other CDRs, awareness helps in avoiding it. When patient presentations do not match prototypes for disease, physicians should alert themselves to the possibility of the error, and remind themselves of prevalence issues. More studies are needed to delineate the characteristics of patients who are misdiagnosed and more emphasis in training should be placed on the recognition of ''equivalents'' and atypical variants.	1, 17, 29

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TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them (*cont.*)

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Search satisficing	Bounded rationality, keyhole viewing	Search satisficing is the tendency to call off a search once something is found. Most searches in everyday life are initiated because a single known thing has been lost and, consequently, the search will be called off once it has been found. However, in the ED searching contingencies are fundamentally different. There is often more than one thing to be found, we are not always sure what it looks like, we do not always know where to look, and we often do not find anything. When a fracture is found, there may be second or third fractures or radiographic signs of significant soft-tissue injury; in self-poisonings, there may be co-ingestants; there may be more than one foreign body in a wound or an eye or an orifice; patients may have more than one diagnosis, especially if the patient has a psychiatric diagnosis. In all of these cases, satisfying oneself that the search is over once something has been found will be erroneous. Finding something may be satisfactory, but not finding everything is suboptimal. An additional problem is that the search may not have been conducted in the right place, in which case the search will be called off once there appears to be nothing to be found.	Calling off the search once something has been found can lead to significant further findings' being missed. For example, significant traumatic injuries rarely occur in isolation; there will usually be other findings. Searching in the wrong place will result in nothing being found.	Once a search has been completed, and if something has been found, the immediate question should be ''Is there anything else to be found?'' and a secondary search should commence. If the search does not yield anything, the follow-up question should always be ''Have I been looking in the right place?'' Alternate search domains might need to be considered.	1, 8, 54, 55
Sutton's slip	Going for the obvious, going for where the money is, Occam's razor mistake, KISS error	Sutton's law is a clinical saw based on the diagnostic strategy of ''going for where the money is.'' It takes its name from the Brooklyn bank robber, Willie Sutton. When asked by the judge at his trial why he robbed banks, Sutton is alleged to have said ''Because that's where the money is'' (actually, he didn't say it; it was said by a reporter writing up the trial). Going for the obvious makes sense, but it is often associated with persistent behavior attempting to diagnose the obvious, failing to look for other possibilities, and calling off the search once something is found (see *search satisficing*). When treatment is tightly coupled to the diagnosis, and the ''obvious'' diagnosis has been accepted, the outcome may be catastrophic; e.g., the initial presentation and electrocardiogram findings in aortic dissection may mimic those of acute myocardial infarct and, in the interests of saving time, thrombolysis may be initiated. Sutton's law is also characterized by Occam's razor, the principle of parsimony in philosophy and psychology, and by the popular acronym KISS (keep it simple, stupid). Applications of Sutton's law, Occam's razor, and KISS may often be successful and may avoid costly, time-delaying diagnostic tests. However, whenever they are used there should be an awareness of the associated pitfalls. Sutton's slip is the error associated with Sutton's law.	Sutton's slip results in a missed diagnosis or failure to make additional diagnoses. When treatment is tightly coupled to diagnosis, the result can be disastrous. Apparently successful applications of Sutton's law should be viewed critically as the law is often applied retrospectively and is subject to marked *hindsight bias*.	Awareness of the perils of application of Sutton's law is often sufficient enough to avoid Sutton's slip. The simple strategy of working to keep options open, and considering other possibilities, even when positive findings have been made, will reduce the error.	10, 17, 31

Triage-cueing	Geography is destiny	Triage-cueing is a phenomenon mostly restricted to the ED, but it potentially exists wherever there is a triage process between the patient and the point of care at which definitive assessment is made. Typically there is a process of abbreviated assessment during which a paramedic or nurse is required to make an estimate of the acuity of the illness. Whatever biases or cognitive dispositions exist for physicians, they are amplified many times over during the triage process, due to this forced abbreviation. It may incorporate a number of different biases (*anchoring, diagnosis momentum, overconfidence, fundamental attribution error, Sutton's slip, availability, ascertainment bias*, and others), and result in a decision that may lead to further errors; e.g., a patient complaining of visual problems may be triaged to an eye room when, in fact, the source of his problem is methanol toxicity. Thus, the geographical disposition of patients from triage predetermines how they may be seen and diagnosed by the physician and, importantly, how their destiny might unfold.	Triage-cueing results from an abbreviated assessment that is known to be imperfect. It may miss, underassess, or overassess the acuity or severity of a patient's condition, and misdirect the patient within the ED. The consequence of triage-cueing is that bias applied at the outset may be propagated within the ED. It may lead to delayed or missed diagnosis, or overutilization of resources.	Physicians should remind themselves of the inherent vulnerability of the triage process and be aware of the influence of geographical cues on their own thinking. They should not hesitate to have the patient redirected within the ED.	7
Unpacking principle	Support theory, discounting unspecified possibilities	The judged likelihood of a particular event or possibility increases when a more detailed or explicit description is available. The more specific the description we receive, the more likely we judge an event to be. If all the various possibilities in a problem space are not specified (are not unpacked), we have a tendency to ignore them. Unpacking is a strategy to improve the availability (see *availability heuristic*, above) of all possibilities and/or events. Not surprisingly, alternate descriptions of the same event, situation, or possibility may lead to different judgments about their likelihood of occurrence. Description and specification occur in the process of communication, which occurs along several different paths in the ED. First, the specificity in chief complaint and history of presenting illness that a patient provides to a physician will vary according to the patient's ability, i.e., his or her powers of observation, ability to express himself or herself clearly in describing signs and symptoms, and communication skills. Thus, the patient might influence the physician's perceived probability of a particular diagnosis. Most physicians are aware of this and will initiate directed questioning if the detail is poor. The second application of the principle comes from within the physician: the avoidance of *anchoring* and, instead, unpacking the full range of possibilities for a particular condition, reduces *overconfidence* and improves the likelihood that it will not be missed by the physician. Third, critical communication occurs in interactions between physicians and physicians. An example would be justifying a computed tomography (CT) scan for a patient with headache to a radiologist. If the physician simply requests a CT of the head to rule out an intracranial mass, it might be less likely to succeed than if the rationale for the CT were to exclude a number of specific possibilities such as intracranial hematoma, subarachnoid hemorrhage, cavernous sinus thrombosis, and brain abscess. When more possibilities are raised, the judged probability of finding something goes up and the radiologist might be more willing to conduct the procedure. Indeed, some emergency physicians have intuitively appreciated the unpacking principle and use it as a strategy to overcome inertia or resistance to getting things for their patients (but see *aggregate fallacy*). The unpacking principle also applies in the referral process, where, in equivocal cases the referring physician may choose to build a case, becoming increasingly detailed and specific, to improve the likelihood of acceptance. This is a form of *framing effect*, in which different presentation formats can be shown to influence decision making.	Failing to unpack all relevant possibilities may result in delayed or missed diagnoses.	Physicians should be aware that lack of specificity, or impoverished descriptions by patients of their symptoms, does not change the likelihood of the disease being present. In these cases, the physician should be satisfied that a full account of the illness has been elicited. Deliberate efforts should be made at the outset of problem solving to unpack all relevant possibilities, to decrease the likelihood that a condition will be overlooked. Unpacking may be employed as a strategy to discipline the physician's approach to his or her own decision making, and in the teaching of clinical decision making to others. It may also be seen as a framing strategy to improve the likelihood that requests for special tests and consultations will be accepted.	59, 60

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Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Vertical line failure	Thinking in silos, thinking in grooves, thinking inside the box	Much of our cognitive activity in the ED is straightforward. Many problems encountered require a vertical, straightforward approach that leads to a clear diagnosis and management. This approach emphasizes economy, efficacy, and utility, and is invariably rewarded. Thus, the presentation of a patient with flank pain, nausea, and hematuria will inevitably lead to a presumptive diagnosis of ureteral colic. However, this orthodox approach is so well reinforced, that it may become ingrained and lead to a reduced flexibility in those situations that require some lateral thinking. The currently overused expression ''outside the box'' is meant to convey the idea of lateral thinking. Generally, lateral thinking is most appropriate for problems that require creative and imaginative solutions. Given the predictable and often prosaic nature of ED problems, there will not be much call for lateral thinking, and conventional thinking will usually suffice. Occasionally, however, the ability to break away from silo thinking, and the constraints of verticality, is a useful attribute. Thus, lateral thinkers will be able to steer themselves away from the obvious and consider other possibilities. In the example above, the same signs and symptoms could be due to a dissecting abdominal aneurysm. It is not the ability to conjure up rare or exotic diagnoses that is important, but, instead, the capability to step outside the apparent constraints of the problem domain boundaries. This is especially important in those situations where the data or findings do not quite fit together. Lateral thinking in the appropriate situation often characterizes those with clinical acumen and those who can avoid vertical line failure. Regression to more rigid and inflexible thinking styles is likely under conditions of fatigue.	Rigidity and inflexibility in the approach to clinical problems may lead to important diagnoses' being delayed or missed.	Physicians should explore and understand the concept of lateral thinking, and appreciate the constraints imposed by vertical thinking. Exercises can be done to develop an appreciation of the lateral thinking style. It can be improved through practice. A useful question to ask, especially when everyone appears to be going in the same direction and a diagnosis is gathering momentum, is ''What else might this be?''	31, 61, 62
Visceral bias	Countertransference, emotional involvement	Ideally, all clinical decisions should be made objectively and should be consistent from one patient to the next. In practice, however, this is not so. We develop both positive and negative feelings toward patients, which may impact on decision quality. These are examples of *affective error.* Thus, when our viscera are aroused, we do not make good decisions. The concepts of *transference* (feelings the patient develops towards the therapist) and *countertransference* (feelings the therapist develops toward the patient) were originally developed in psychiatry, but have come to be used in a broader context, including social behavior. When the physician develops positive countertransference toward a patient in the ED, it can influence decision making. It may lead to underinvestigation through *outcome bias* (preferring decisions that lead to good rather than bad outcomes—thus, not ordering a test that might indicate a bad outcome for the patient) as well as *value bias* (the tendency of people to express a stronger likelihood for what they hope will happen rather than what they believe will happen, as well as the belief that positively valued events are more likely to happen than negatively valued events). It may also lead to overinvestigating for fear of missing something critical. Both under- and overinvestigating behaviors are seen in ''corridor consultations'' and in attitudes of physicians toward the illnesses of their family members. Sexual attraction toward a patient is a special example of positive countertransference and can clearly influence clinical decision making.	Affective errors may reduce quality of clinical decision making, and lead to under- and overinvestigating behaviors, and other forms of mismanagement. Diagnostic error and a lower standard of care for some patients may result.	Physicians should monitor their affective state as a matter of professional responsibility. When they recognize that their emotions are involved, they should realize the impact this may have on decisions about the patient's care. To avoid errors arising from positive countertransference, including sexual attraction, the patient should be transferred to another physician's care. It might be desirable to handle negative countertransference in a similar way, but if no option is available, then strenuous efforts must be made to overcome affective biases to deliver objective and sound care.	1, 63, 64

		Developing negative countertransference typically results in compromised care and may exacerbate the patient's condition. The classic example is the patient with borderline personality disorder. The diagnosis of the patient can almost be made on the basis of his or her having alienated everyone in the ED within a short time of arrival. Physicians and nurses develop negative feelings toward these patients, mostly through fundamental attribution error. They tend to hold the behavior of the patient to the same social standards in which they believe, and that others should be capable of the same degree of control as they have. They seem not to understand that the patient's behavior is the manifestation of his or her disease. The management and care of these patients are often substandard.			
Yin-yang out	Serum rhubarb (UK), standing stool velocities (Canada)	The assumption underlying the yin-yang out is that because the patient has been ``worked up the yin-yang'' for a pre-existing condition prior to presenting to the ED, it is unlikely that further effort will be productive and this lets the ED out. In the UK, exhaustive workups are said to have covered all possibilities, having included the measurement of serum rhubarb levels, and in Canada, the ultimate workup includes measures of standing stool velocities. The perception is that everything that can be done has been done, and enthusiasm for further assessment and investigation in the ED is at a low ebb. There is often a high probability that the emergency physician is correct, but the approach may lead to error. The origin of the error probably lies in a combination of heuristics and errors: *fundamental attribution error*—the problem is seen as being more of the patient than of the system that has failed to diagnose the condition; *representativeness*—the patient is seen as characteristic of a class of ``frequent flyers'' or others who use the ED inappropriately; *anchoring*—early on in the exchange, or at the sight of the thickness of the patient's old chart, physician and nurses may develop feelings of futility, which will mitigate against objective decision making; and a form of *playing the odds*, or gambling that the ``failure to find anything'' sequence will continue. On many occasions the outcome will be as predicted and, despite the best efforts of the ED, no further light is thrown on the patient's diagnosis. However, the yin-yang out strategy cannot be justified for several reasons: 1) every patient presenting to the ED deserves as much attention, respect, and consideration as any other, 2) the disease process underlying the patient's condition may have evolved or reached a point where it is diagnosable, and might even be emergent, 3) there may be a concurrent disease presenting in similar fashion, 4) emergency physicians should recognize the special advantage they enjoy in being able to bring fresh and unbiased thinking to a problem that may have escaped resolution by others, 5) if the ED visit does prove inappropriate, it may present an opportunity to refer for psychiatric assessment (e.g., for somatoform disorder), which may be helpful in the future management of the patient; 6) the latest ED visit may provide an opportunity for the physician to direct the patient appropriately, perhaps by drawing up a management plan to advise the patient of the best recourse in times of need.	The patient has not only been failed professionally by taking the yin-yang out, but an opportunity may also have been missed to diagnose the patient's condition. There is also the possibility that an alternative condition, presenting in similar fashion, will be missed.	Patients who have been exhaustively worked up prior to coming to the ED should raise red flags. They should be seen as potential sources of error and extra vigilance should be taken. Emergency physicians should see opportunities rather than despair in the management of these patients in the ED.	17, 31

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TABLE 4. Catalogue of Failed Heuristics, Biases, and Cognitive Dispositions to Respond (CDRs) with Descriptors, Consequences, and Strategies to Avoid Them (*cont.*)

Failed Heuristic/ CDR/Bias	Synonyms/ Allonyms	Descriptors	Consequences	Avoiding Strategy	Refs.
Zebra retreat	Lack of courage of convictions	Zebra retreat occurs when a rare diagnosis (zebra) figures prominently on the differential diagnosis but the physician retreats from it for various reasons, resulting in the diagnosis being delayed or missed. There are a number of barriers to pursuing rare diagnoses; e.g., 1) the physician may anticipate inertia in the system such that there might be resistance to, or lack of support for, pursuing the diagnosis, or that there will be difficulty in obtaining special and costly tests to confirm the diagnosis; 2) the physician may be self-conscious about seriously entertaining a remote and unusual diagnosis, and gaining a reputation for being esoteric; 3) the physician might fear that he or she will be seen as unrealistic and wasteful of resources; 4) the physician may have underestimated the base-rate for the diagnosis; 5) the ED may be very busy and the anticipated time and effort to pursue the diagnosis might dilute the physician's conviction; 6) the physician is underconfident; 7) team members may exert coercive pressure to avoid wasting the team's time; 8) inconvenience of the time of day or weekend and difficulty getting access to specialists; 9) unfamiliarity with the diagnosis might make the physician less likely to go down an unfamiliar road; 10) fatigue or other distractions may tip the physician toward retreat. Any one or a combination of these reasons results in a failure to verify the initial hypothesis.	The zebra retreat results in a delayed or missed diagnosis. This may have more than the usual significance because zebras are usually not simple diagnoses. Further, the failure of the ED to diagnose unusual illness may give reassurance to others that the zebra is unlikely.	If the physician has a reasonable conviction at the outset, and if it is important to make the diagnosis in a timely fashion, then the diagnosis must be pursued, whatever obstacles are present or anticipated. Physicians should be aware of systemic and other influences that provide inertia against pursuing medical investigations, and be prepared to challenge them.	17, 31

EXHAUSTION

The strategy of exhaustion is defined as "the painstaking, invariant search for (but paying no immediate attention to) all medical facts about the patient, followed by sifting through the data for the diagnosis."[14] This is largely a primitive strategy that is typical of the novice. Medical students characteristically engage in exhaustive workups, creating inappropriately large data banks before attempting to make a diagnosis. The exhaustive approach reflects the high degree of uncertainty that prevails in early training. However, with the development of experience and clinical acumen, data searching becomes more economical and directed. Nevertheless, exhaustive strategies may appear in the decision making of experienced clinicians. They will occasionally be used when uncertainty is high, such as when a particularly esoteric diagnosis is being considered, or when the physician is seeking additional thinking time for residual uncertainty.[15] Fatigue and circadian dysynchronicity can have a negative impact on clinical decision making[16]; as physicians become increasingly sleep-deprived and fatigued, exhaustive strategies may appear, reflecting regression to an earlier form of decision making. Under circumstances of clinical discrimination failure, these strategies may be manifested by increased resource utilization.

HYPOTHETICO-DEDUCTIVE METHOD

The goal-directed reasoning that underlies the hypothetico-deductive method has been well described in the medical literature,[10,14] and in decision making in the ED.[1,17] A good practical definition of the approach is ". . . the formulation, from the earliest clues about the patient, of a 'short list' of potential diagnoses or actions, followed by the performance of those clinical (history and physical) and paraclinical (e.g., laboratory, x ray) maneuvers that will best reduce the length of the list."[14] Both top-down (goal-directed) and bottom-up (data-driven) processes referred to above are involved (Fig. 2). When there are little data available, e.g., the arrival of a comatose patient in the ED, the top-down process predominates, and various hypotheses are generated from known causes of coma. As data become available (e.g., toxic screen, arterial blood gases, blood work), causation seeking occurs and these hypotheses undergo refinement as bottom-up processes rise to meet the former (Fig. 2). Hypotheses are subject to *verification, adequacy, parsimony*, and *falsification,*[10] for which there may be special requirements in the ED.[17] Inadvertently, *premature diagnostic closure* is a major default of hypothesis generation (Table 4).

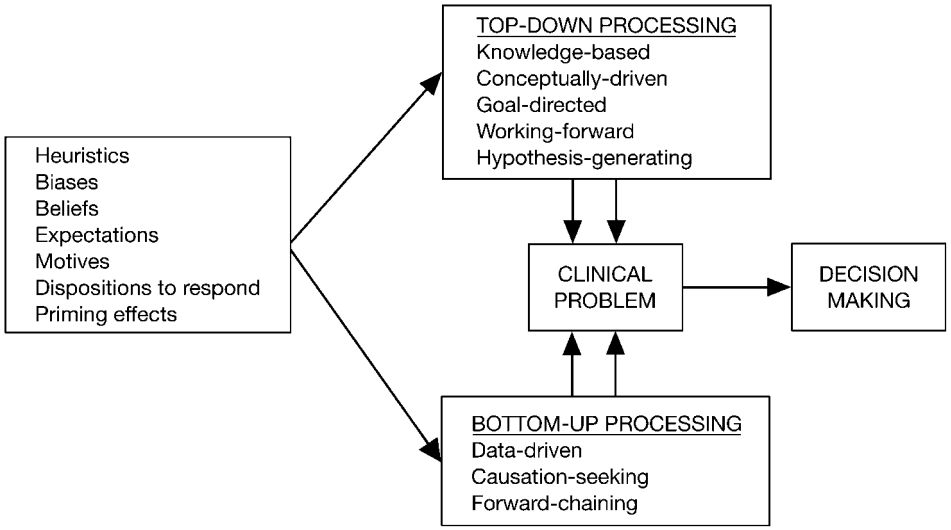

Figure 2. Cognitive influences on *Top-down* and *Bottom-up* processing in clinical decision making.

HEURISTICS

Of the various strategic approaches to problem solving and decision making, the use of heuristics is one of the most interesting, yet challenging, for emergency medicine. The cognitive revolution, which took place in the last quarter of the 20th century, stimulated extensive research that, eventually, gave rise to an empiric theory underlying heuristics and biases. The heuristic method of learning refers to a system in which learners are encouraged to explore, investigate, and discover things for themselves. It results in experiential learning and the development of ''rules learned on the job.'' Thus, carpenters developed ''rules of thumb'' to provide a crude estimate of the length of an object when a ruler might not be immediately at hand. Clearly, the method is less precise but it is practical, faster, and adequate for the majority of cases.[18] Heuristics, then, provide short cuts in problem solving and clinical decision making, which, for the majority of cases, work well. When they succeed, we describe them as economical, resourceful, and effective, and when they fail, we refer to them as cognitive biases. A number of heuristics have been described, estimated to be in the order of ''about two dozen.''[19] There is much anecdotal evidence for their use in emergency medicine.

COGNITIVE DISPOSITION TO RESPOND (CDR)

Failed heuristics are often seen as biases and labeled as cognitive errors. ''Bias'' often simply means that someone has an inclination to respond in a particular fashion, but common usage may carry negative connotations, occasionally of prejudice. It might be appropriate, instead, to refer to a bias as a *cognitive disposition to respond* (CDR), which, although more cumbersome, might encourage a more objective search for the etiology of biases. Heuristics and CDRs are on a dimension of consciousness from deliberate at the heuristic end to preconscious, or an incomplete awareness, at the CDR end. Using this new term may promote a more analytic and causal approach in the explanation of flawed reasoning. It should be emphasized that the CDR, itself, is neither a failing nor an error; it is only when CDRs result in an adverse outcome that they become cognitive errors. Interestingly, virtually every cognitive error is judged preventable in hindsight. Importantly, cognitive error underlies delayed or missed diagnoses, a frequent cause of medical error[20] and, perhaps, the most costly of all medical errors. They are particularly common in family practice, internal medicine, and emergency medicine.[21–23] Studies of diagnostic errors in patients admitted from the ED have found wide ranges of rates from less than 1%[24] to 12%.[25] These studies did not include data on patients who were not admitted, who comprise the majority of patients seen in the ED. It would be expected that diagnostic error would be particularly prevalent in the ED for all the reasons enumerated above, and especially because speed and economy of thought are at a premium.[1] Thus, there should be considerable incentive to understand the use of heuristics and CDRs in emergency medicine.

CATALOGUE OF FAILED HEURISTICS, BIASES, AND CDRs

Previously, no catalogue of heuristics, biases, and CDRs existed. An effort is made here to describe those that may lead to error. Thirty are listed in

alphabetical order in Table 3, and their general properties and characteristics are described in Table 4. Many of them have been well researched in the cognitive psychology literature, but there are relatively few studies investigating their application in medicine. The catalogue not only gives a comprehensive list of heuristics and CDRs, but also establishes the basis of a language or a lexicon through which we can more readily describe our cognitive errors. Such a language provides a convenient short-hand description of what we are thinking and, importantly, may also allow us to control the ways in which we think.

COGNITIVE DE-BIASING

The increasing use of clinical decision rules, as well as other aids that reduce uncertainty and cognitive load, e.g., computerized clinical decision support, will improve certain aspects of clinical decision making, but much flesh-and-blood clinical decision making will remain and there will always be a place for intuition and clinical acumen. Thus, we need to know whether we can make clinicians better decision makers without simply waiting for the improved judgment that comes with the benefit of accumulated experience. There seems to be a strong belief, evidenced by the classic work of Kassirer and Kopelman,[10] that learning ''clinical cognition'' and de-biasing is possible in medicine. There have been challenges to the notion that cognitive bias can be overcome.[19] Indeed, this may be a formidable task, but experts and masters emerge by overcoming weak cognitive tendencies, biases, and flawed heuristics. One uniquely distinguishing characteristic of those who make high-quality decisions is that they can largely free themselves from the common pitfalls to which novices are vulnerable. A rite of passage in all disciplines of medicine is learning about clinical pitfalls that have been identified by the discipline's experts. This is a form of de-biasing, saying in effect: ''Here is a typical error that will be made, and here is how to avoid it.'' In nonmedical settings convincing arguments have been made for overcoming the major cognitive biases,[26] and there is research evidence, too, that judgments can be improved by de-biasing procedures.[27] Also, the educational principle of metacognition, by which clinicians could be trained to observe their own thinking,[1] would appear to have considerable potential for cognitive de-biasing. Overall, there appears to be considerable promise for cognitive de-biasing. The challenge lies in finding effective and imaginative ways to accomplish it for physicians in training, and in practice.

CONCLUSIONS

The overall argument presented here is that the failure to explain human performance in terms of statistics and probability theory, our ''imperfect rationality,'' and Reason's concern for the failure of the formalized ideal to match cognitive reality,[8] can be explained by judgmental heuristics and biases. It is clear that many decisions in the ED are not based on the formal, mathematical, statistical approach described by expected utility theories. Instead, the ways that emergency physicians choose between alternatives are more likely driven by the types of processes described here. Error arising from decision making can be accounted for by one or more of these biases, or cognitive dispositions to respond in a particular way. It is relatively easy, in hindsight, to explain most, if not all, of cognitive error within this framework. These cognitive failings are not unique to physicians—they are exhibited in all occupations.

A better knowledge of the mechanisms underlying each of the heuristics, biases, cognitive tendencies, and errors described here allows most of poor decision making in the ED to be explained. Many of these errors occur under conditions of uncertainty—often at early stages in the decision-making process, when entropy is at its highest, and when flesh-and-blood decision making predominates. In contrast, when we have clear, unambiguous data, such as that which emerges from formal decision making, then fewer mistakes occur. Some of the CDRs described here, however, stop us from getting from the flesh-and-blood decision-making level to the formal decision level. Many of these errors will be exacerbated under conditions of stress—when decision density is particularly high, when physicians are fatigued or suffering the effects of dysynchronicity, or when systemic pressure exists such as occurs under conditions of RACQITO (resource availability–continuous quality improvement trade-off[1]). Detection and recognition of these cognitive phenomena are a first step in achieving cognitive de-biasing, and will go some way toward the improvement and refinement of clinical decision making in the emergency department.

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