9. Niermeyer S, et al: Resuscitation in newborns. *Ann Emerg Med* 37:S110, 2001.
10. Kattwinkel J, et al: ILCOR advisory statement: Resuscitation of the newly born infant. *Pediatrics* 103:1, 1999 (URL: http://www.pediatrics.org/cgi/content/full/103/4/e56).
11 Anonymous: Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. Part 11 Neonatal resuscitation. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. *Circulation* 102(8 Suppl):I343, 2000.
12. Yeh TF: *Neonatal Therapeutics*. St Louis, Mosby, 1991.
13. Boychuk RB: The critically ill neonate in the emergency department. *Emerg Med Clin North Am* 9:507, 1991.
14 Landwirth J: Ethical issues in pediatric and neonatal resuscitation. *Ann Emerg Med* 22:502, 1993.
15 American Heart Association Emergency Cardiac Care Committee and subcommittees: Neonatal resuscitation. *JAMA* 268:2276, 1992.
16. Khan NS, Luten RC: Neonatal resuscitation. *Emerg Med Clin North Am* 12:239, 1994.
17 Chameides L, Hazinski MF (eds): *Textbook of Pediatric Advanced Life Support*. Dallas, American Heart Association, 2002.
18. Kattwinkel J, et al (eds): *Textbook of Neonatal Resuscitation*, 4th ed. Elk Grove Village, Ill, American Academy of Pediatrics and American Heart Association, 2000.
19. Cordero L, Hon EH Neonatal bradycardia following nasopharyngeal stimulation. *J Pediatr* 78:441, 1971
20. Marlow N: Do we need an Apgar score? *Arch Dis Child* 67:765, 1992.
21. Saugstad OD, Rootwelt T, Aalen O: Resuscitation of asphyxiated newborn infants with room air of oxygen—an international controlled trial. The Resair 2 study. *Pediatrics* 102:1, 1998 (URL. http://www.pediatrics.org/cgi/content/full/102/1/e1).
22. Zideman D, et al. Airways in pediatric and newborn resuscitation. *Ann Emerg Med* 37:S126, 2001
23. Berry AM, Brimacombe JR, Verghese C: The laryngeal mask airway in emergency medicine, neonatal resuscitation, and intensive care medicine. *Int Anesthesiol Clin* 36:91, 1998
24. Burchfield DJ, et al: Medications in neonatal resuscitation. *Ann Emerg Med* 22:435, 1993
25. Hein HA: The use of sodium bicarbonate in neonatal resuscitation: Help or harm? *Pediatrics* 91:496, 1993.
26. Quinton DN, O'Byrne G, Aitkenhead AR. Comparison of endotracheal and peripheral intravenous adrenaline in cardiac arrest. Is the endotracheal route reliable? *Lancet* 1:828, 1987
27. American Academy of Pediatrics: Emergency drug doses for infants and children and naloxone use in newborns: Clarification. *Pediatrics* 83:803, 1989.

CHAPTER

10 Clinical Decision Making

Dane M. Chapman, Douglas M. Char, and Chandra D. Aubin

PERSPECTIVE

Physicians must continually integrate vast amounts of medical information with their skills in clinical decision making. They must be thorough yet efficient in gathering data and use strategies that promote maximal diagnostic proficiency while limiting costs. These unique skills are neither adequately taught nor measured in medical schools and residencies. Emergency physicians have become some of the most facile and rapid decision makers in medicine. This is probably due to the nature of the specialty. Emergency physicians are bombarded by diagnostic and management decisions throughout a clinical shift. Many pertain directly to diagnosing and managing a patient's problem. Others are related to managing the staff, clinical environment, and educational responsibilities (Box 10-1). By better understanding the decision-making process, improved decision-making strategies can be developed and taught.

Both an adequate knowledge base of medical information and a repertoire of decision-making skills are necessary to diagnose and manage medical problems. Expert emergency physicians have learned to recognize disease and injury patterns and have developed sets of heuristics (rules of thumb) to make rapid decisions.[1,2] When patients' presentations do not fit an existing pattern or heuristic, emergency physicians move between several levels of clinical decision making depending on their clinical experience, the clinical situation, and time constraints.[3] Most errors in mental functioning affecting patients' care can be traced to defects in pattern recognition or in one or more of these levels of clinical decision making.[4-6]

Mental effort saved through improved decision making provides a "cognitive reserve" for emergency physicians to control their hectic environment with decreased occupational stress and potential burnout. With greater mental energy reserve, physicians are better able to expand their knowledge base and to consider patients' values and concerns.

DIAGNOSTIC APPROACH

When diagnosing or managing a patient's problem, there are decisions relating to both *medical inquiry* and *clinical decision making*. *Medical inquiry* refers to the

BOX 10-1. Typical Emergency Physician Decisions during a Clinical Shift

Diagnostic and Patient Management Decisions

Triage decisions: What patients need to be seen first?

Stabilization decisions: What management interventions are needed to stabilize the patient?

Diagnostic decisions: What clinical findings are needed to make the diagnosis?

Therapeutic decisions: What ongoing therapy is needed?

Disposition decisions: Will the patient need to be admitted? Where?

Other Decisions

Administrative decisions: What needs to change to maintain a safe working environment for patients and staff (e.g., diversion, call in backup, transfer, or discharge by ambulance)?

Educational decisions: How much do I inform the patient of his or her illness? When and how should medical students, residents, or staff be assigned to see a patient with an important clinical finding? Should the attending take time to teach if the emergency department is busy?

Interpersonal decisions: What do I do when conflicts arise with nursing, consultants, patients, or family members?

Well-being decisions: When and where will I go to the bathroom, take a lunch break, wash hands, or share uplifting humor?

Feedback decisions: Were my decisions today correct? Will I do things differently next time? If so, how? Did the diagnostic test help in my decision making?

cognitive and psychomotor skills or techniques used to gather medical data (i.e., data gathering) and includes history taking, physical examination, and diagnostic testing. *Clinical decision making* refers to the cognitive processes required to utilize the medical data obtained to evaluate, diagnose, or manage medical problems. *Clinical reasoning* involves both *medical inquiry* and *clinical decision making* and has been described as the scientific method of clinical medicine.[1,7]

Diagnostic and Management Processes of Clinical Decision Making

Emergency physicians operate in situations in which even small mistakes may cause high morbidity or mortality. The difficulty in teaching decision making in these situations is that experienced clinicians may have little insight into their own thought processes because much of their decision making occurs at preconscious levels using pattern recognition.[4,8,9]

Human factor specialists and cognitive scientists have intensely studied the diagnostic and management decision making of expert physicians to understand the underlying processes and to better teach them to novices. Four consistent diagnostic and management decision-making processes or strategies have emerged: (1) pattern recognition, (2) "rule-using" algorithm, (3) hypothetico-deductive, and (4) naturalistic or event driven.[1-3] The expert emergency physician utilizes all four diagnostic and management decision-making processes depending on the clinical situation.

Clinical Decision Making by the Pattern Recognition Process

Pattern recognition requires the memorization of a critical number of facts. A *fact* or *concept* is a group of objects, symbols, or events that are grouped together with common characteristics referred to by a collective name (e.g., acidosis, myocardial infarction). Facts relating to a certain disease may be memorized without knowing how to use them. Over time, experienced physicians can group together related facts such as disease-specific history and physical examination findings that allow pattern recognition or the "doorway diagnosis." To develop this expertise, most practitioners must experience hundreds or even thousands of encounters with patients.

For each new patient, the physician's task is to build a representation that links the patient's case to an existing knowledge structure (i.e., the disease pattern) and facilitates recall of important disease entities and patient-related information. Disease-oriented patterns contain little knowledge about pathology or physiology but a wealth of clinically relevant information about the disease, its consequences, and associated signs and symptoms.

This pattern recognition (or "skill-based") process corresponds to the lowest level of the clinical decision-making hierarchy.[2] Without conscious effort, pattern recognition decision making is automatic, operates briefly, and processes information rapidly and in parallel after being activated by sensory input or conscious thought.[1,2] Clinical acumen related to the skill of pattern recognition is cognitive rather than psychomotor and is developed over time and after exposure to many patients and disease presentations.

Clinical Decision Making by the Rule-Using Process

Higher on the clinical decision-making hierarchy is the ability to "use rules," which requires greater understanding than memorization or pattern recognition alone. The recognition of the pattern, however, is a prerequisite to applying the correct rule. At this level of decision making, solutions to familiar problems are governed by previously memorized rules of the "if X then Y" variety.[3,9] These rules include heuristics, algorithms, and clinical pathways. When clinicians are faced with atypical presentations or unusual symptom complexes not previously memorized, they may resort to using rules, heuristics, or algorithms to discriminate or classify symptoms, signs, or diagnostic study results into previously defined diagnostic or therapeutic groups. Similarly, related heuristics can be grouped into algorithms, such as those developed for the advanced cardiac life support course, allowing the physician to use agreed-upon rules of action in critical or high-stress situations in which higher levels of decision making are difficult. This is not unlike the situation in the airline industry, where pilots are required to follow the same algorithm or checklist before takeoff, thus minimizing the chance for human error.

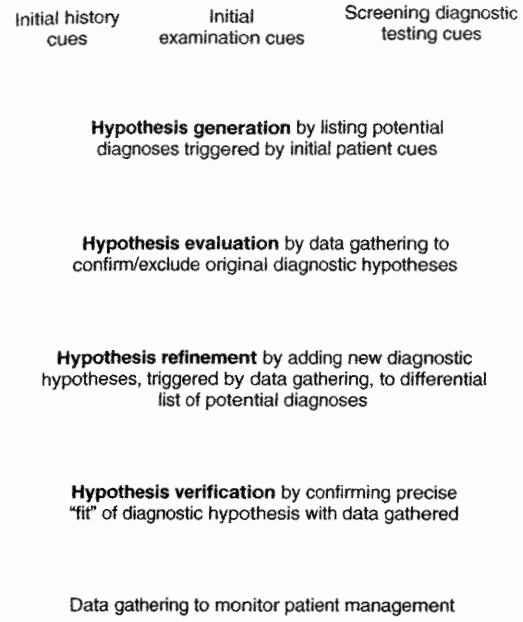

Figure 10-1. Relationship between medical inquiry (data gathering) and clinical decision making by the hypothetico-deductive process. Data gathering can include history taking, physical examination, or diagnostic testing.

Clinical Decision Making by the Hypothetico-Deductive Process

Highest in the clinical decision-making hierarchy is the intellectual ability to make clinical decisions by problem solving using previous knowledge to create new solutions ("knowledge based"). The physician must originate a novel solution to a problem that requires conscious, analytic processing of stored knowledge, for example, finding a solution to a difficult disposition of a patient. Any departure from the routine clinical presentation where the disease pattern is recognized requires either a rule-based or hypothetico-deductive solution (Figure 10-1).[1,8,9]

Initial cues are perceived from the patient and the environment, and multiple diagnostic hypotheses are rapidly generated (*hypothesis generation*). Next, data-gathering inquiry strategies are used to collect relevant history, physical examination, and diagnostic study information. The cues and data are interpreted to confirm or reject the provisional hypotheses (*hypothesis evaluation*), a process that may lead to additional diagnostic hypotheses being generated (*hypothesis refinement*). Finally, the physician chooses and verifies the most likely diagnosis (confirmed by data) from among the provisional diagnostic hypotheses (*hypothesis verification*). Strategies useful in clinical decision making of the hypothetico-deductive variety include: generating *new and unusual ideas* (hypotheses) that relate to the problem; *avoiding premature judgment or closure*, such as labeling with a diagnosis that does not exactly "fit"; *breaking mental sets*, such as dismissing initial disease patterns to look at the problem differently (i.e., outside the box); and *classifying the essentials* by attending to relevant facts and conditions of the problem, such as pertinent positive and negative historical, physical examination, and diagnostic study findings.

Clinical Decision Making by the Naturalistic, or Event-Driven, Process

Clinical decision making by the naturalistic (event-driven) process characterizes emergency physicians who treat patients' signs or symptoms before definitive diagnoses have been determined.[2] This dynamic process is more likely to be utilized in emergency medicine than any other specialty. When presented with an unstable patient, certain therapeutic actions are necessary to stabilize the patient long before the cause of the instability is known. The atypical presentation is compared with an existing schema, and if no match is found on the basis of presenting cues, the expert clinician switches decision making from an evaluation of diagnostic possibilities to an evaluation of possible courses of action or therapeutic trials. In general, the number of available therapeutic or management options is smaller than the number of possible diagnoses. The emergency physician often uses a strategy of ruling out the worst-case scenario.[10] This strategy, coupled with a focus on stabilizing actions and not diagnoses, can rapidly prune the decision tree. When a satisfactory response to intervention is obtained, the search for the definitive diagnosis can often be truncated. The physician must be willing to accept a good or likely presumptive diagnosis instead of the definitive diagnosis.

Which Clinical Decision-Making Process Is Best?

Determining which clinical decision-making process is best depends on the experience of the clinician and difficulty or uniqueness of the medical problem. Inexperienced physicians who lack a broad mental set of disease patterns or schema may be exhaustive in their history taking and physical examination to discern sufficient cues to develop a differential diagnosis. They are often unfocused in ordering diagnostic tests because they cannot eliminate diagnostic possibilities on the basis of their undeveloped association of presenting signs, symptoms, and diagnostic study findings with clinical diagnoses. Experienced physicians, when faced with a complex patient who does not "fit" into their memorized set of disease frames, use details of history, physical examination, diagnostic tests, or therapeutic trials to assess the possibility of significant or life-threatening disease.

Many presentations of patients that require physicians to use the highest level of diagnostic decision making (hypothetico-deductive) early in their career are gradually "pushed down" to classification or discrimination tasks (pattern recognition) requiring little conscious thought or mental processing.

BOX 10-2. Heuristics for Optimal Decision Making in Emergency Medicine

Sit at patient's bedside to collect a thorough history.
Perform an uninterrupted physical examination.
Generate life-threatening and most likely diagnostic hypotheses.
Use information databases and expert systems to broaden diagnostic hypotheses.
Collect data to confirm or exclude life threats first, then most likely diagnoses.
Avoid diagnostic testing whenever possible by using readily available decision making algorithms (e.g., Ottawa ankle rules).
Order only those tests that will affect disposition or that will confirm or exclude diagnostic hypotheses.
Include decision rules on diagnostic testing order forms.
Use guidelines and protocols for specific therapeutic decisions to conserve mental energies while on duty.
Allow 2 to 3 minutes of uninterrupted time to mentally process each patient.
Mentally process one patient at a time to disposition.
Avoid decision making when overly stressed or angry. Take 1 to 2 minutes out, regroup, then make the decision.
Carry a maximum of 4 or 5 "undecided" category patients. Stop—make some dispositions.
Use evidence-based medicine techniques to substantiate decisions with evidence, understand the limitations of the evidence, and to answer specific questions, such as usefulness of diagnostic testing, management plans, and disease prognosis.

By eventually emphasizing the lower cognitive processes of recognizing disease patterns and using decision-making algorithms and clinical pathways, clinicians can efficiently and proficiently diagnose and manage undifferentiated patients with less mental effort. When lower cognitive processes are consistently utilized, discrete facts previously memorized about a particular disease are often forgotten by the expert who easily retains the ability to diagnose and manage patients efficiently but must struggle to maintain "the edge" in factual recall. Following heuristic rules of thumb in clinical decision making can create a framework for gaining the information and insight necessary to make the best decision (Box 10-2).

Multitasking–Simultaneous Processing

Multitasking is a key characteristic of the emergency physician who can process simultaneous workups on from five to seven patients. Time and motion observations of emergency physicians at an academic medical center suggest that only 10% to 20% of their time is spent multitasking.[11] By increasing the degree of multitasking, physicians can significantly improve their clinical decision-making efficiency without necessarily having to decrease their decision-making thoroughness and proficiency.[12] Optimally, emergency physicians would see patients upon arrival to the emergency department because the time between the arrival and first seeing a physician is a major determinant in patients' satisfaction and throughput times. An initial evaluation, including a brief history, physical examination, and selection of the appropriate clinical decision-making pathway, maximally affects patients' throughput and decreases length of stay (LOS).

Data-gathering techniques that permit multitasking, such as the complaint-based templates with specific prompts and other forms of bedside charting, decision-making algorithms included as part of physician ordering forms, on-line order entry, and the problem-oriented medical record can all contribute to increased decision-making efficiency and to decreased LOS for the patient. With Center for Medicare-Medicaid Studies documentation requirements for attending physician supervision, and increased emphasis on patient-focused and timely care, multitasking needs to increase to degrees not yet achieved at most academic medical centers.

Heuristics of Diagnostic and Management Decision Making in Emergency Medicine

A number of important heuristics guiding diagnostic and management decision making have been identified by emergency medicine decision-making experts.[8-10] We have combined several of these rules into an emergency medicine decision-making algorithm (Figure 10-2).

1. *Rule out life or limb threats first (i.e., think the worst).* Upon identifying life or limb threats, the emergency physician must also decide whether direct intervention is necessary to mediate or prevent the patient's deterioration. These decisions are typically based on incomplete data. If no life threat is identified, the physician must consider other serious diseases consistent with the patient's complaint and work to exclude them before accepting less serious, plausible diagnostic hypotheses.
2. *Determine whether more than one active pathologic process is present.* A single diagnosis, although appealing, is not always appropriate. The physician must remain open minded with a continually probing data-gathering approach: "Is this all there is?"
3. *Try a diagnostic-therapeutic trial.* Administering a stabilizing therapy that also provides diagnostic information is an important decision-making strategy in the emergency department. The results of the trial may provide precise information or may just help differentiate the seriously ill patient from others, for example, glucose in the unconscious patient.
4. *Determine the bottom line.* Practicing emergency medicine is filled with uncertainty. Is a diagnosis possible or even necessary when life threats have been ruled out? Is hospitalization appropriate for the patient, even without making a final diagnosis? When the emergency department workup is complete, the physician is often left with unanswered questions that may not really affect the bottom line. If the bottom line is affected, that is, patients' safety,

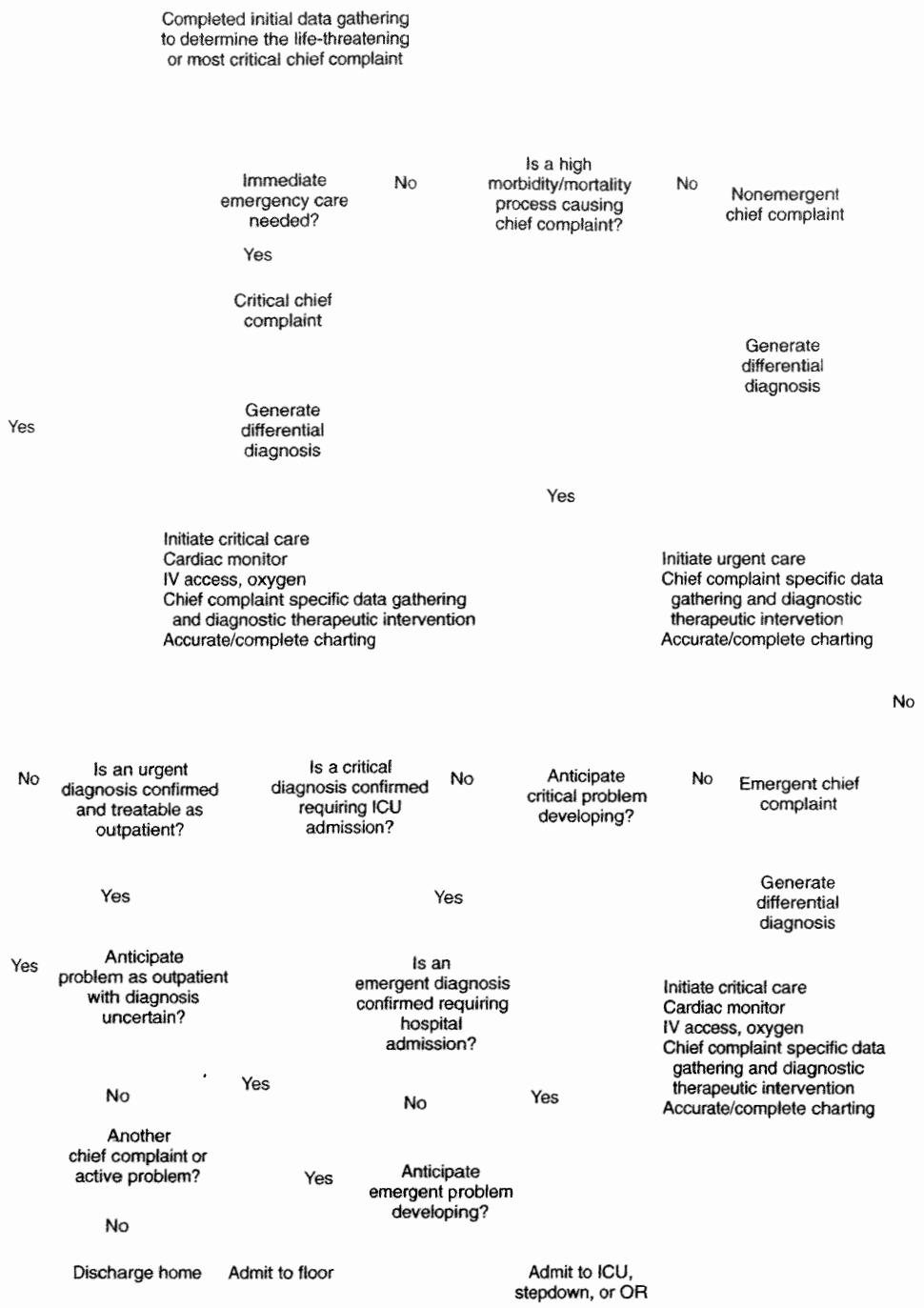

Figure 10-2. Emergency medicine clinical decision-making algorithm. ICU, intensive care unit; OR, operating room.

the answers must be addressed before making the disposition.

5. *Close the disposition and follow-up loop.* Emergency physicians have a unique relationship with other physicians. This relationship is based on the concept of "our" patient. We share responsibility for the health and welfare of the patients in our care with other providers.
6. *Understand fully why the patient is in the emergency department, and then meet the patient's expectation.* The stated chief complaint may not be the real reason for the visit. The emergency physi-

cian must often look beyond the written chart and spoken word to uncover which of the patient's fears and concerns prompted the visit to the emergency department. Such clues are easily missed in our hectic work environment.

7. *Use emergency department resources fully but understand that emergency department personnel and facilities cannot be all things to all people.* The emergency physician has a responsibility to maintain the highest level of quality in terms of staffing, equipment, and care. Recognizing what the emergency department is not and knowing the facility limitations are equally important.

ERRORS IN MEDICAL INQUIRY AND CLINICAL DECISION MAKING

According to a landmark Institute of Medicine report on medical error, 44,000 people die in U.S. hospitals each year as a result of medical error.[13] With overcrowding, brief encounters with patients, and the chaos of a busy emergency department, emergency physicians are at particularly high risk. An emergency physician frequently reflects upon recently completed shifts hoping that nothing significant was missed and that in all the chaos and constraints of limited resources, no injury might have occurred because of an incorrect decision or missed (or misinterpreted) information.[2] Because of the nature of the practice, feedback is rare and, when received, is often negative. Still, feedback and knowledge of adverse events are crucial to the learning process.[8] Because it is assumed that avoidable events will occur, systems, such as computerized physician order entry, are being designed to enhance patients' safety.[14]

Although there is no universally accepted classification of practitioner adverse events in medicine, three broad categories can be used as a framework.[2-5] These parallel the well-accepted domains of learning: (1) *affective events* pertain to physician attitude and are most frequently those involving physician communication skills and patients' complaints about physician conduct; (2) *psychomotor events* are those related to procedural or technical skill; and (3) *cognitive events* are those that occur during medical inquiry (data gathering) or clinical decision making resulting from a faulty knowledge base (pattern recognition or memorization of facts); faulty use of rules, heuristics, or protocols (rule-using); or faulty synthesis using the hypothetico-deductive decision-making process. A more detailed listing is given in Table 10-1.

Affective Processes Affecting Clinical Decision Making

Affective events occur not because of deficient medical knowledge or faulty decision making directly but rather because of physician perception or attitude.[9] Anger, overconfidence, prejudice, or fear may bias a physician's mental set during decision making. What is perceived during history taking and the physical examination may be influenced by *attitudinal bias.* For example, stereotypical cultural differences in expression of severity of pain may lead a physician to develop a negative bias, which in turn may lead to undertreatment of pain or perhaps to failure to consider a more severe diagnosis. This can also occur when we have a negative personal reaction, such as anger, or because we consider such patients responsible for their own disease—called the *attribution error.* Techniques to avoid these types of errors include approaching each patient as if the patient were a blank slate (no impression) and viewing the patient as if he or she were a family member. If we can recognize these personal biases and separate ourselves from them, we can remain more open to alternative diagnoses and potentially reduce errors in medical decision making.

Psychomotor Processes Affecting Clinical Decision Making

Psychomotor adverse events usually occur during emergency procedures and can directly harm a patient if performed incorrectly. Improper technique may also result in emergency physician morbidity, such as needlestick-induced infectious disease inoculation. Distraction omission and acting out of "force of habit" also lead to psychomotor events in that undesired actions occur that cause injury or subject patients to unnecessary risk. Reviewing procedures beforehand and letting staff know when to avoid interruptions can reduce these types of events. Important diagnostic information may not be obtained or critical treatment rendered in a timely fashion because of an improperly performed procedure or because a necessary procedure was delayed or withheld owing to lack of technical competence.

Cognitive Processes in Medical Inquiry Affecting Clinical Decision Making

History taking, physical examination, and diagnostic test selection are data-gathering skills that form the basis of potential cognitively based adverse events. A thorough review of systems and screening physical examination of major organ systems of all emergency department patients can markedly limit adverse events resulting from *faulty clinical data gathering.* Use of complaint-based templates for charting that include specific prompts can reduce omissions but at the same time may impair clinical decision making by providing a structured but limited cognitive domain. Emergency department efficiency is directly related to diagnostic testing strategy. A common, significant error in data gathering is to order tests without completing an adequate history or performing a physical examination. This *unfocused diagnostic testing error* wastes time and resources and may confound optimal decision making. Often a rapid but thorough history and physical examination eliminate the need for expensive and time-consuming diagnostic tests. Another source of inefficiency is the practice of using the *"trial and error" diagnostic testing* approach in which diagnostic tests are ordered sequentially

Table 10-1. Errors Influencing Clinical Decision Making

Domain of Learning	Cognitive Control Mode	Cognitive Deficiency	Faulty Process Leading to Error
Affective domain: attitude, communication			Fear or anger can lead to negative, impulsive, or irrational behavior
			Cultural stereotyping
			Attribution error; blaming patients for their illness
Psychomotor domain: technical motor skill			Distraction omissions; taking one action, intending another
			Force of habit; invoking an action unconsciously
			Improper technique can lead to morbidity or mortality
Cognitive domain:			
I. Medical inquiry (data gathering)			Faulty history and physical examination data gathering
			Confirmation bias; only seeing what you want to see, "ignoring cues"
			Unfocused diagnostic testing; tests ordered do not help rule in or rule out hypothesis
			"Trial-and-error" test ordering
			"Shotgun" test ordering
II. Diagnostic decision making:			
1 Pattern recognition	Schematic control mode, automatic, parallel processing, rapid, preconscious	Memory-based, error of actions, "slips," "lapses"	"Slips"; well practiced preconscious mental routine improperly applied
			"Lapses"; failures in memory that result in omissions and inefficiencies
			Coning of attention; overfocus on single source of information despite other sources
			Revision under stress; recently learned behavior replaced by older familiar one
			Missed cues; tendency to recognize only what has been memorized
			Biased memory; relying only on what you "know" from prior experience, discounting other possibilities
2. Using rules/ heuristics	Attentional control mode, conscious, sequential processing	Rule based, misapplied expertise, using wrong rule, "mistake"	Using wrong heuristic—incorrect rule or clinical pathway
			Using correct heuristic incorrectly
			Representativeness error; patient atypical for given diagnosis—discounted
			Availability heuristic; using the first information that comes to mind
3. Hypothetico-deductive			
A. Hypothesis generation	Attentional control mode, effortful, slow, conscious, difficult to sustain, sequential processing	Problem-solving, knowledge-based, error of conscious thought, "mistakes"	*Faulty hypothesis generation—failure to consider a diagnostic hypothesis, maintaining a narrow view of possible diagnoses or hypotheses*
			Context or situational bias; "patients in urgent care, thus not really sick"
			"Sutton's slip"; consider only the "obvious" (i.e., bank is where the money is)
			"Psych out"; failure to consider medical diagnosis due to psychiatric diagnosis
			"Playing the odds"; faulty estimate of disease prevalence
			"Anchoring"; accepting previously applied labels without questioning diagnosis
			"Ying-yang out"; presuming you have nothing to add to a prior workup
B. Hypothesis evaluation			*Faulty hypothesis evaluation—failure to interpret cues and data properly (wrong hypotheses are confirmed or rejected)*
			"Posterior probability"; misinterpret history, physical, or laboratory results due to prior label
C. Hypothesis refinement			*Faulty hypothesis refinement—failure to revise list of diagnostic hypotheses to explain results of data gathered*
			Overconfidence; unquestionable belief in the validity of chosen course
D. Hypothesis verification			*Faulty hypothesis verification—failure to verify "fit" of diagnosis to data*
			"Zebra retreat"; rare diagnosis considered but not pursued despite cues
			"Premature closure"; latching onto a presumptive diagnosis and not considering other possibilities
III. Management decision making	Naturalistic, event-driven process	Rigid, unwilling to act without complete data	Unwilling to accept a good or likely presumptive diagnosis before making critical time-dependent therapeutic decisions

Preparing a differential diagnosis and determining the data necessary to refine the list will determine what tests or interventions need to be ordered.

Finally, emergency physicians are also subject to *confirmation bias*, that is, diagnosing what is preconceived and interpreting test results in that light. Therefore, in the patient with an atypical presentation of chest pain, T wave changes on the electrocardiogram might be labeled "nonspecific" rather than "possibly ischemic."

Cognitive Defects in Pattern Recognition Decision Making

If physicians do not have an adequate knowledge base or if their knowledge is not organized for appropriate retrieval when presented with a novel, undiagnosed patient, cues that may be obvious to the expert are missed (i.e., *error of "missed cues"*). Later, when interviewing and examining patients, cues characteristic of the disease are missed because the clinician does not know what to look for. To be most useful, typical and atypical symptoms and signs of disease processes need to be organized in such a way that they can be recalled when the clinician uncovers the distinguishing cues of a disease. Pattern recognition errors may be due more to lack of having memorized a sufficient number of disease frames than to inability to recall details within a particular disease frame. The clinician need only develop broader lists of diagnostic hypotheses that are associated with presenting symptoms and signs to avoid this error. The clinician should not be afraid to stop and ask the question, "What am I missing?" Physicians are also more likely to make errors under stressful situations. Recently learned behaviors are often replaced by older familiar outdated ones. The physician may also gain additional prompts of potential diagnostic hypotheses using heuristics or the hypothetico-deductive process of decision making or by making an appropriate referral to someone who can.

Cognitive Defects in Using Rules (Protocols, Practice Guidelines, and Clinical Pathways)

Common errors in decision making at the level of using rules, protocols, and clinical pathways typically result from either not having the correct rule or applying the correct rule improperly. The challenge is to determine which clinical rule can be most appropriately applied to generate a diagnosis and management plan for the constellation of symptoms and signs of each patient's presentation. Faulty application of the wrong rule or heuristic leads to errors in diagnosis and management similar to those of the premature closure variety. Common sense suggests that if the rule does not fit the situation, it is probably the wrong rule.

Cognitive Problems in Hypothetico-Deductive Clinical Decision Making

When presenting symptoms, signs, and diagnostic test results do not fit any validated clinical rule or protocol, decision-making strategies must be used to create new facts or rules not previously originated or created. Making a correct diagnosis in an as yet unrecognized disease process or in an unrecognized association among multiple disease processes requires problem-solving skills similar to those used in scientific research. Using "peripheral brains" such as readily available reference texts, handheld electronic databases, and real-time, on-line literature searches frees up mental capacity to allow physicians to focus on creative decision making.

Errors at this level of the clinical decision-making process are typically related to misjudging either the need for novel diagnostic hypotheses (hypothesis generation, hypothesis evaluation, and hypothesis refinement) or diagnostic accuracy (hypothesis verification). Termed *mistakes*, such errors can occur whenever the clinician's analytic processing activities are disturbed, interrupted, or missing key data.[2,4] Mistakes are triggered by personal stress, fatigue, task overload, environmental distractions, and lack of clinical knowledge. Perfect execution of a faulty management plan for a patient is an example of a mistake. In contrast, poor execution of an appropriate management plan could be due to errors in pattern recognition (a "slip" or "lapse" in memory) or to errors in rule using.

Problems in Management Processes of Clinical Decision Making

Errors can lead to inappropriate management and often result in bad outcomes for patients. Making the right management decision is often more important than making the right diagnostic decision. This is often the case with critically ill or injured patients. Intervention based on very limited data supercedes an exhaustive evaluation. Being rigid or unwilling to act without complete data leads to errors of omission. Use of guidelines and protocols to "drive" actions and interventions (advanced trauma life support, advanced cardiac life support, pediatric advanced life support) can reduce this type of error.[3] The complex management decision to admit or discharge a patient can be "pushed down" from the synthetic, knowledge-based decision-making process to the rule-using process by implementing a heuristic designed to prevent inappropriate discharges when diagnoses are uncertain (see Figure 10-2).

Decision analysis, the methodology of weighing mathematically the pros and cons of various options in complex decision making, may be most useful for choosing from various therapeutic options when a diagnosis has been made. Decision analysis utilizes a branching decision tree in which probabilities are calculated for each step of the decision tree.[1] This technique has not yet significantly affected emergency medicine because of the lack of real-time computing, the limited number of predetermined clinical pathways, and the difficulty of fitting psychological or social factors into the mathematical models. However, these limitations are rapidly dissolving, and this technique may greatly facilitate emergency physician management decision making in the future.

BOX 10-3. Heuristics for Minimizing Errors in Clinical Decision Making

Avoid the biggest obstacle to the correct diagnosis—a previous diagnosis.
Avoid inheriting someone else's thinking whether it is related to diagnostic or personal bias.
Check for critical past medical history and risk factors for serious disease or poor outcome.
Pay attention to vital signs and nurses' and Emergency Medical Service (EMS) notes.
Avoid premature closure if the diagnosis is not certain—enlist the patient as a partner in that uncertainty, arrange for appropriate follow-up, and give specific precautions in written form.
Beware of high-risk times—patient sign out (see and touch all), high-volume or high-acuity times, and times of personal fatigue.
Beware of high-risk patients—hostile, violent, or abusive patients, patients with alcohol or drug abuse, psychiatric patients, and patients who elicit a negative visceral response.
Beware of the return visit—this is an opportunity to correct what was missed during the previous visit.
Beware of high-risk diagnoses—myocardial infarction (MI), pulmonary embolus (PE), subarachnoid hemorrhage (SAH), tendon and nerve injuries, retained foreign bodies, intracranial hemorrhage (ICH) in intoxicated patients, vascular catastrophes in elderly patients, appendicitis, meningitis, ectopic pregnancy, and testicular torsion. Rule out the worst-case scenario or high-risk diagnoses first.
Beware of the *nonfit*—when the presumptive diagnosis does *not* match the symptoms, signs, or diagnostic tests—recognize the nonfit and reevaluate and refine diagnostic hypotheses.

Using Heuristics to Reduce Adverse Events

Emergency physicians can limit their adverse events related to clinical decision making by recognizing potential bias and sources of error and developing "error-reducing heuristics" (Box 10-3). By identifying subsets of patients in whom clinicians are more likely to make errors, associated bias and negative emotional reactions that could cloud clinical judgment can be avoided. Such subsets would include patients with a different cultural or language background; patients who elicit a negative emotional reaction, such as the abusive or potentially drug-seeking patient; and chemically altered or psychiatric patients. Physicians can choose to avoid inheriting someone else's diagnostic or personal bias by "seeing and touching all" patients who are signed out to them. When faced with a case in which "something is not quite right" or the fit is not precise, clinicians need to rethink their diagnostic hypothesis generation and verification strategy. To limit the adverse effect of personal fatigue and workload on their clinical judgment, emergency physicians can choose to adjust their own clinical schedules Physicians can also use *metacognition*, the process by which one reflects upon and regulates what one is thinking, and, in so doing, incorporate error avoidance techniques presented in Table 10-1.[3,6,9] Perhaps most important, when mistakes occur, clinicians must be willing to admit their mistakes and discuss them with others so that all can learn to minimize human error in the emergency department setting.

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REFERENCES

1. Elstein AS, Schwarz A. Clinical problem solving and diagnostic decision making: Selective review of the cognitive literature. *BMJ* 324:729, 2002
2. Wears RL: Comments on clinical decision making: An emergency medicine perspective. *Acad Emerg Med* 7:411, 2000.
3. Kovacs G, Croskerry P: Clinical decision making: An emergency medicine perspective. *Acad Emerg Med* 6:947, 1999.
4. Wears RL, Leape LL: Human error in emergency medicine. *Ann Emerg Med* 34:370, 1999.
5. Leape LL: Error in medicine. *JAMA* 272:1851, 1994.
6. Graber M, Gordon R, Franklin N: Reducing diagnostic errors in medicine: What's the goal? *Acad Med* 77:981, 2002.
7. Chapman DM, Calhoun JG, Davis WK, VanMondfrans AP: Acquiring clinical reasoning competency: Group versus individual practice using patient management computer simulations. *Acad Emerg Med* 4:511, 1997.
8. Cosby KS, Croskerry P: Patient safety: A curriculum for teaching patient safety in emergency medicine. *Acad Emerg Med* 10:69, 2003.
9. Croskerry P: Achieving quality in clinical decision making: Cognitive strategies and detection of bias. *Acad Emerg Med* 9:1184, 2002.
10. Hamilton G: *Emergency Medicine: An Approach to Clinical Problem Solving*, 2nd ed. Philadelphia, WB Saunders, 2003.
11. Moche JA, Gauer KA, Chapman DM: Emergency medicine faculty time utilization: Implications for faculty funding and medical student and resident education. *Acad Emerg Med* 6:413, 1999.
12. Chisholm CD, Collison EK, Nelson DR, Cordell WH: Emergency department workplace interruptions: Are emergency physicians "interrupt-driven" and "multitasking"? *Acad Emerg Med* 7:1239, 2000.
13. Kohn LT, Corrigan JM, Donaldson MS (eds): To Err Is Human: Building a Safer Health System. Institute of Medicine report. Washington, DC, National Academy Press, November 21, 1999.
14. Kyriacou DN, Coben JH: Errors in emergency medicine: Research strategies. *Acad Emerg Med* 7:1201, 2000.