A Framework for Classifying Factors That Contribute to Error in the Emergency Department

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The Institute of Medicine report in 1999 spurred a national movement in patient safety and focused attention on medical error as a significant cause of preventable injury and death. Throughout the past decade, the medical community has gradually acknowledged the fallibility of medical science and imperfections of our health care organizations. Before significant progress can be made to improve safety in health care, we must better understand the sources of error. This article is presented as one step in the process of change. A framework for classifying factors that contributed to errors identified in the emergency department (ED) is presented. The framework is, in its most basic form, a comprehensive checklist of all the sources of error uncovered in the course of investigating hundreds of cases referred to Stroger Hospital's emergency medicine quality assurance committee throughout the past decade. It begins with a look at error in the ED and then looks beyond the ED to examine error in the context of the wider health care system. It incorporates ideas found in safety engineering, transportation safety, human factors engineering, and our own experience in an urban, public, teaching hospital ED.

[*Ann Emerg Med.* 2003;42:815-823.]

METHODOLOGY

As a part of our quality improvement system, we have collected cases referred for review because of concerns about patient outcome, diagnostic errors, and medical judgment. Each case has been reviewed by multiple clinicians and analyzed to identify factors that contributed to problems in the management of the case. According to more than a decade of these reviews, we have accumulated a list of factors that have been implicated in medical errors. These factors have been incorporated into an outline that itemizes problems that we believe most directly caused or contributed significantly to preventable morbidity or mortality. These factors are presented in an organizational scheme adapted from the now classic framework of Vincent et al[1] and discussed in the context of current safety literature.[2] We propose that this information may be used to guide retrospective investigations, inspire and direct system improvements, and develop prospective incident monitoring systems that are uniquely designed for emergency medicine.

0196-0644/2003/$30.00 + 0
doi:10.1016/mem.2003.384

INTRODUCTION

The safety movement in medicine is in its infancy. We may make progress, as have other high-risk organizations before us, by adopting attitudes open to investigations and flexible toward change. Reason[3,4] describes several features of a safety-conscious culture. First, there must be an awareness of imperfection and risk and an urgency to improve. Then, the organization acknowledges and looks for error. Incident reporting is encouraged and is anonymous or nonpunitive. As errors, events, and near misses are identified, there is a systematic and thorough assessment of factors that contribute to risk and harm. Once causal factors are identified, personnel are retrained and the system is redesigned to minimize risk. Finally, ongoing incident monitoring and surveillance is maintained to effect long-term change.

This article addresses the systematic and thorough assessment of factors that contribute to risk and harm and presents a framework for classifying factors that contribute to risk in our system. As we identify factors, we propose strategies to address each type of error.

For the purpose of this article, error is defined as a failure to meet some realistic expectation (an action, process, diagnosis, or endpoint).[5] This view of error does not imply fault; it acknowledges the failure of an imperfect world. The focus is on perfecting the system to optimize performance.

First, the scope of care to critique is defined, then a framework for error classification is described. The goal of this model is to detect as many contributing factors as possible, with the aim of identifying factors that can help to devise better health care systems and provide optimal heath care delivery.

DEFINING THE SCOPE OF FACTORS THAT INFLUENCE EMERGENCY MEDICAL CARE

Incident monitoring systems have been developed by a number of specialties to identify and track common types of errors.[6-10] They begin by defining some scope of patient care to examine. For critical care, this is the ICU; for anesthesia, it is the operating room. An organizational scheme for emergency care is presented in Figures 1, 2, 3, and 4. This framework examines 10 areas (Figure 1). A systematic and thorough review of each of these areas ensures that too much focus is not put on any one point in time or on any stage of evaluation, neglecting other relevant causes of errors. First, the patient is assessed for risk profile to identify features that may predispose him or her to harm. The remaining 9 areas track patients as they move through the health care system. The referral network into the emergency department (ED) is examined next, including outside hospitals, private physicians' offices, clinics, nursing homes, and other health care settings (Figure 2). Access to our system is then critiqued, including transfers between institutions, walk-ins, and emergency transport services (ambulance and helicopter). Communication with the referral network, by telephone or telemetry, is reviewed. Eventually, all patients enter the ED through triage, where individual treatment priorities must be balanced by available resources and where there is the first direct contact between the patient and the hospital system. Once the patient enters the ED, each interface between patient and clinician is subject to review. Traditional quality reviews tend to focus on single patient-clinician encounters, with a tendency to exaggerate the role of the last person touching the patient. In contrast, we suggest that each patient-clinician interface be assessed, emphasizing the role of the team and teamwork in error prevention and rescue (Figure 3). System factors are then analyzed, beginning with the local ED environment, followed by the wider hospital environment and finally outside factors that influence services available to patients (Figure 4). Each layer of influence is examined for its contribution to care, beginning at the point of harm and then probing deeper into the system to uncover more distant, latent sources of error. Along each step, interactions and communication between team members and transitions to new teams are evaluated. In contrast to many models, a fourth dimension was examined: time. Rather than freeze the moment of harm, this model evaluates the events preceding injury (the latent factors) and those after harm (to assess the ability to recognize and rescue

Figure 1.
General outline of medical error classification.

I. Patient factors
II. Outside systems
III. ED access: EMS, transfers
IV. Triage
V. Human error
VI. Teamwork failure
VII. Local ED environment: the microsystem
VIII. Hospital environment: the macrosystem
IX. Hospital administration and third-party factors
X. Community, society, health care policy

from harm), which provides additional information useful in analyzing how to prevent, recognize, and respond to error.

FACTORS THAT CONTRIBUTE TO ERROR

The following is a step-by-step examination of the factors that contribute to error, including human and system factors.[11-13]

Patient Factors

Certain patient characteristics render the patient prone to harm. Patients who are critically ill, are demented, are delirious, are under the influence of substances, have language or communication barriers, are uncooperative, or are simply uninformed may be unable to contribute important details about their medical history. Comorbid conditions may complicate the presentation of their illness and place them at greater risk for medical complications. Patients' lifestyles or behavior may elicit affective bias. Some of these factors can be modified, but many cannot. However, well-designed systems can incorporate plans to meet special needs. Improved staffing with translators and social workers, anticipation of complications in those prone to harm, and education to help care providers recognize and modify their responses to their own personal biases are just a few actions that might help identify risk and, in some cases, avoid errors. The more patient factors we recognize to be a marker of risk, the better our systems can cope with the specific challenges patients present.

Outside Systems and ED Access

This model extends our investigation to the care patients receive even before they arrive at the ED. EDs may be the first to recognize patterns of error from the community. Negligent care at nursing care facilities, unexpected deaths in outpatient centers, and other mishaps may be reportable to public health officials. Although these errors are not "our" failures, we can use the opportunity to alert others to the need for change. Our model also critiques out-of-hospital care provided by the emergency medical services (EMS) system. Emergency medicine is responsible for the education and medical control of emergency medical technicians and paramedics and is accountable for the quality of out-of-hospital care provided in the field and during transport. Emergency medicine exists in part to provide care in catastrophic illness and injury. Although we strive to perfect our skills to meet that challenge, some-

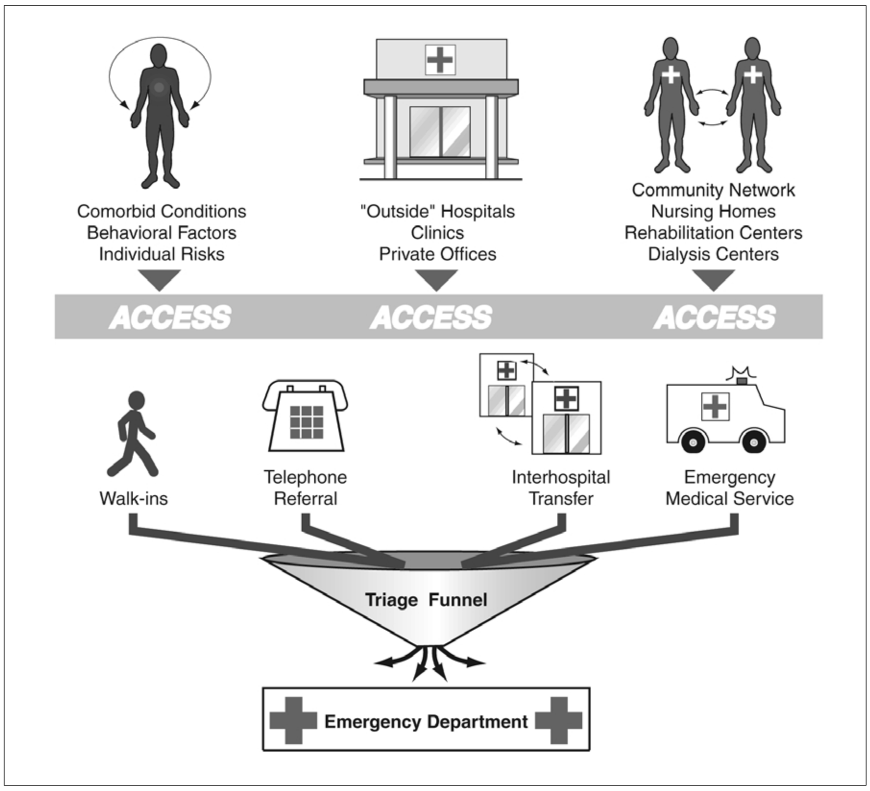

Figure 2.
The referral network into the ED.

times the greater good may be served by preventing the injury and optimizing care even before patients arrive at the ED.

Triage

All patients enter the ED through triage. The triage process should be scrutinized and modified to meet the needs of the ED as it varies by patient load, staffing, and resources. Triage errors include rule-based violations, insufficient triage rules, and errors in judgment (unwillingness or inability to override established rules).

Human Error

Most errors are multifactorial. Ultimately, however, most error eventually passes through the hands of a care provider. Even when the primary cause of harm is system failure, there is usually a human standing at the bedside. The human component of medical error is the most tangible, the most visible, and the most disturbing.

It is useful to distinguish between errors of planning and errors of execution.[14,15] Errors in planning are primarily cognitive: the clinical assessment was wrong or the planned intervention was flawed. In contrast, errors

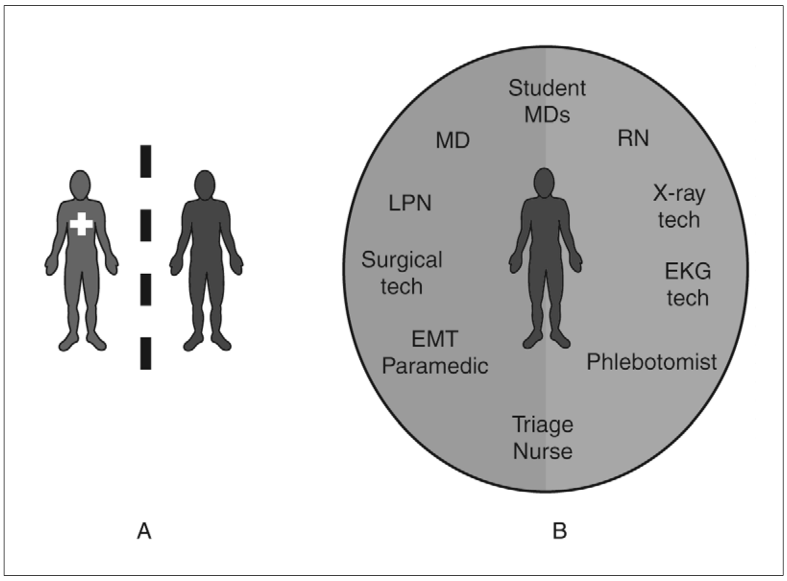

Figure 3.
A, *Traditional view of single patient-clinician interface.* ***B,*** *Multidimensional perspective emphasizing teamwork.*

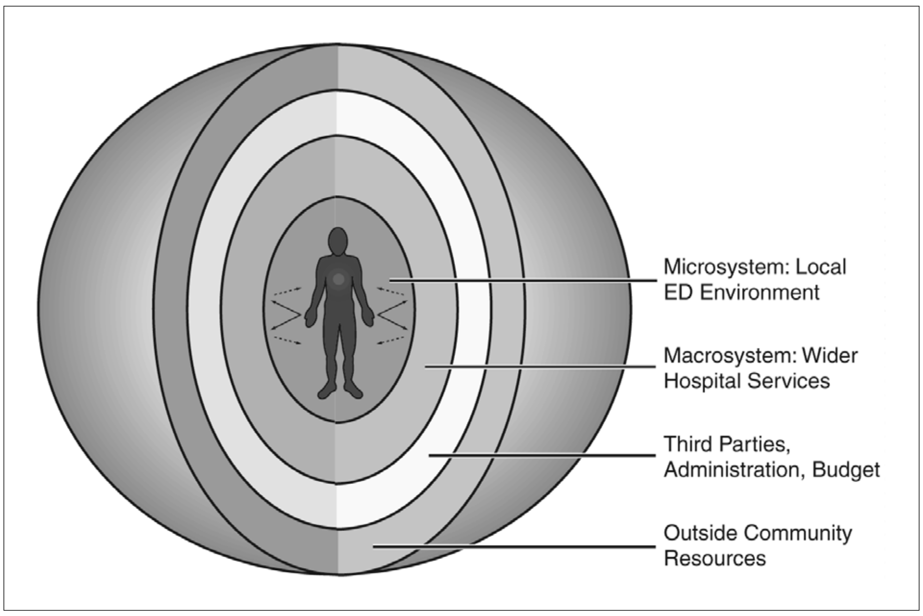

Figure 4.
An organizational scheme of system factors that influence emergency care.

in execution occur when the plan for diagnostic workup and treatment was not carried out as intended. Errors in execution are more directly linked to system problems, miscommunication, or teamwork failure.

This model further divides human error into 4 categories: cognitive, skill-set (interpretive and procedural), task-based, and personal impairment. This classification helps identify particular types of corrective actions best suited to each type of error.

Cognitive Error. Emergency physicians perform 2 main roles: they resuscitate the acutely ill and solve diagnostic problems. Although the first involves great risk from rapid interventions in extremely ill patients, it is the second role that is most problematic. Diagnostic failures accounted for the majority of the adverse events in EDs reported by the Harvard Practice Study, and most were judged as negligent.[16] Such critique may be harsh; retrospective reviews of medical decisions are subjective and prone to hindsight bias.[17] Nonetheless, the nature of emergency medicine practice is such that these types of error are relatively common; some may be inevitable. Poor access to medical records, incomplete information,[18] noisy chaotic environments with multiple distractions,[19] a variety of undifferentiated patient problems and injury severity, and time pressures all make the ED environment ripe for error.[20] Because a poorly devised plan places patients at risk regardless of the ability of the team to execute the plan, these errors are inherently serious.

A number of authors have described the diagnostic process and where it can go wrong.[21-25] This framework goes beyond the recognition of flawed decisions to categorize cognitive error into classifications that offer strategies for correction. In the model presented here, we have found it useful to divide the common cognitive processes used in medicine into lower-level cognition and higher-level cognition.

Lower-level cognition applies to the basic cognitive skills used by the novice, including data acquisition, history taking, physical examination, and recognition of the basic patterns of common diseases. Novice errors are largely caused by inexperience. Use of patient simulation and better supervision during clerkships may prevent some errors. Knowledge gaps can be identified and fixed. Error-tolerant systems can be designed to prompt the inexperienced in likely high-risk or commonly problematic situations. Memory aids and practice guidelines can be made available. Unfortunately, lower-level cognitive error is not limited to just the novice. Even highly motivated, attentive, and experienced clinicians will occasionally experience slips and lapses that are an inherent part of being human.[14,15] Systems designed with redundancy, cross-checking, and forcing functions[15] might prevent some of these errors. The most astute clinicians in excellent systems may err when atypical presentations or new diseases confront the system; Graber et al[21] label these as inevitable "no fault" diagnostic errors. The relentless march of medical progress, the introduction of new technologies and medications, changes in treatment standards, and the continual growth in medical science ultimately challenge us all. Of all specialties, emergency medicine is probably most likely to experience occasional lower-level cognitive failure because of the endless diagnostic possibilities of unscreened disease and the urgent drive toward action so inherent in emergency situations.

In contrast to the novice, mature clinicians rely on their experience to recognize patients who do not easily fall into clear categories and do not fit a straightforward algorithmic approach. When these cases arise, the expert follows a more formal approach to decisionmaking. Some may err by failing to apply scientific principles to their decisions. Historically, medical decisions were largely based on practitioner experience, intuition, and judgment. An increasingly scientific foundation for decisionmaking has been built throughout the past few decades. The risks of disease in populations are better defined. Diagnostic tests have well-established sensitivities and specificities. Diagnostic endpoints are established with more objective data. The application of these skills lags behind their availability, however.[26] Medical education still relies largely on mentoring and apprenticeships to teach clinical practice. The largely internal process of decisionmaking is elusive; observers have little to gain by watching the senior physician stroke his beard. Medical education for new students and established practitioners can offer improved training in the scientific principles of medical decisionmaking. Some of this work can be eased by the development of diagnostic and treatment guidelines and expert consensus statements. There is hope, not yet fully realized, that computer support systems may eventually play a greater role in improving real-time decisions.

Sometimes we are at a loss to explain how we err. Cognitive science offers some insight into how human decisionmaking can go awry and perhaps how some errors can be avoided.[27] Much of bedside decisionmaking requires sorting clinical data. Not all information is pertinent. Much of what is pertinent is not available. Sometimes the clinical clues are contradictory. Clinicians must decide what information to accept, what to ignore, when to aggressively search for additional information, and when to call off the search for additional data and make a decision. Without this ability to filter data, most would be locked into indecision and unable to act. Cognitive bias explains in part how we perceive risk and filter data.[28,29] Understanding the role of cognitive bias and applying cognitive forcing strategies may minimize some cognitive errors.[30,31]

Even the best-trained clinicians, skilled in the scientific basis of medical decisions and aware of their own cognitive biases, will face uncertainty. Their actions in the face of incomplete information and risk may determine their success.[24,32,33] Dörner[34] found that the best performers in computer-simulated models of decision-making in complex systems were those who assessed the outcome of each step they took and refined subsequent actions according to their experience. In the face of uncertainty, poorly defined illness, and risk, clinicians need strategies for decisions. The ability to recognize these moments, to reassess and reformulate ideas, and to be flexible in decisionmaking is a skill that can be acknowledged and taught.

Obviously, the role that systems contribute to cognitive error should not be minimized. Clinicians are more prone to cognitive error in a disorganized or dysfunctional system.[35] Clinicians often prevent errors by recognizing and compensating for system failures. Likewise, safer systems can be designed to absorb and buffer error, detect common errors, and avert harm.

Skill-set error. Clinician error can also occur with specific interpretive skills, such as reading ECGs and radiology studies or interpreting laboratory tests. These studies produce hard data that are fixed and unchanging and can be independently reviewed and critiqued at a time distant from the patient encounter. Unlike human memory, these data do not decay over time. These interpretive skills can be separated for specific efforts at remediation. Corrective actions can begin with education and improved feedback. Systems can be designed to provide timely access to second opinions, reliable reporting mechanisms, and formalized procedures for amended reports.

Errors with procedural skills include complications resulting from invasive procedures. These skill-set errors are easy to identify and can be remedied by additional course work, personal study, and laboratory practice. Training should focus on optimal technique to avoid common errors and offer guidelines on how to anticipate, detect, and treat complications. Recent developments in high-fidelity clinical simulation provide improved technology that may help reduce errors from inexperience.[36] System reform can provide better means to detect and respond to complications.

Task-based error. Task-based errors include failure of routine behaviors such as regular bedside care, attention to vital signs, and proper monitoring of patients. Task-based errors generally reflect work overload, inattentiveness because of distraction or fatigue, or teamwork failure. Although these are observed as failures of human behavior, organizational and system faults set the background preconditions that foster an environment of risk.[2]

Personal impairment. Finally, an attempt is made to identify personal factors that impair job performance. Affective error merits special attention. Prejudice and bias are common in humans; occasionally they affect patient care. Fatigue, illness, substance abuse, and emotional distress can all adversely affect performance.[37] Residency training programs may identify high-risk personality types more prone to error, such as overzealous risk takers or overly timid noninterventionalists. Counseling, mentoring, and role playing during residency training can help address personality traits that themselves pose risk.

Taking a Balanced Approach to Human Error and System Failure

Individuals have often taken the blame for harm; however, we should recognize that the human component to health care delivery is also the strongest protection against harm. The human element is always the most resourceful, adaptive, and flexible in recognizing and responding to errors. The fact that many errors occur in systems each day yet do not result in harm attests to the ability of care providers to detect, intervene in, and compensate for system failure.

Teamwork failure. Most of medical education focuses on individual patient-clinician encounters without much attention to the organizational complexity of emergency medicine practice. Actual health care delivery depends on not only excellent clinical skills of individuals but also effective interaction among the body of people providing care. The MedTeams Research Consortium cites teamwork failure as a primary or contributing factor in more than half the malpractice claims they reviewed involving death or major permanent impairment.[38] During even a brief ED visit, multiple physicians, students, nurses, and technicians must interact in the care of each patient. The patient may be caught in a vast network of people as shifts change and new team members take over, as specialists are called for consultation, and as responsibility is transferred from the emergency team to an inpatient team. Coordinating the actions of such a large network can be problematic. This model emphasizes communication between team members, across shifts, between teams, and across specialty boundaries. Teams may fail because of interpersonal conflicts or disputes about specialty boundaries. These problems should be identified and corrected before they affect patient care. Team failure can also occur when team members are assigned duties and responsibilities for which they are unqualified. Particularly in training programs, teams must be established with appropriate supervision of inexperienced team members.

The local ED environment: the microsystem. Errors happen when systems are stressed, overloaded, or malfunctioning. Many resources must be fully functional at all times in a busy ED. Is staffing appropriate? Is equipment functioning? Are supplies stocked? Are communication lines open (telephones, pagers)? Are policies and guidelines sufficient to meet the demands of the ED? Streamlining the routine functions of the ED and keeping equipment, supplies, and personnel adequate for the unexpected are essential to emergency preparedness.

The hospital environment: the macrosystem. The ED is the portal to the greater hospital-wide system. It relies heavily on the resources of the hospital for diagnostic and therapeutic services. Even the best-stocked and best-run ED cannot function well if the hospital services are not easily accessible. Hospital problems become ED problems. Clinical directors and hospital administrators must work jointly to solve system problems. Timely access to patient services, consultants, inpatient beds, and specialty treatments are critical to the overall care given patients.

Hospital administration and third parties. Emergency care may be hindered by factors outside the realm of physician decisionmaking and local administrator authority. These factors may lie outside our established expertise and immediate job descriptions; they are not necessarily beyond our ability to affect. Budgetary constraints may limit access to necessary services. Insurance companies may limit authorization for care. Policies and regulations may be misdirected and have unintended consequences. Clinicians are in the position to recognize these deficiencies. Rather than ignore them as outside our realm of influence, we can collect examples of adverse outcomes and argue for change. Documenting need, demonstrating harm, and informing policymakers of important issues can result in meaningful reform at a local and national level.

Community level. Much of the business of emergency medicine comes from unmet needs in society. Issues of homelessness, substance abuse, physical and sexual abuse, domestic violence, and gang violence all touch the ED daily. At some point, most EDs will have opportunity to interact with community service agencies. A healthy relationship with the community will ensure that the basic needs of the population base are met.

We meet the needs of a patient for only a moment in time. Just as we critique access to the ED, so also we should concern ourselves with the care patients receive after leaving the ED. Providing access to primary care and ensuring continuity of care beyond the ED requires a tight referral network. The ED system should work to optimize our relationships with the network of providers who take over when the patient leaves our domain. We can overcome many of the limitations imposed by time-pressured ED visits and extend our influence beyond the limited ED visit. The role each hospital and ED plays in its community may help define what problems and complications it treats.

FUTURE DIRECTION

The attitude and philosophy of each department may ultimately dictate how successful this approach (or any approach) is. Providing a constructive manner to deal with error and opportunity to develop creative solutions to the problems that plague our practice can foster improvement.[39] Medicine has been slow to recognize organizational risk. A variety of safety models already exists in other disciplines for examining, understanding, and minimizing risk.[40] No single model has been widely accepted in medicine. Even as we search for and debate the ideal model, the Veterans Affairs Administration has adopted a process known as Healthcare Failure Modes Effects and Analysis.[41] This technique is used to itemize the steps in a designated process of care. Each step is assessed prospectively for the likelihood of failure and the potential severity of harm that might result from failure. Steps that meet a critical score are proactively designed with controls to minimize the chance of failure. Other safety models have a variety of approaches, many that may prove useful in medicine. The framework of error presented here is not intended to compete with any. Indeed, the approach that we describe might be useful for collecting data to determine what steps are most appropriate for a Healthcare Failure Modes Effects and Analysis assessment. It is our hope that this framework might be used for retrospective investigations and prospective assessments of risk.

This model is comprehensive to a fault. No single case will need investigation of all levels suggested by this review; however, probing questions from each of these categories will occasionally uncover unexpected sources of error and unexpected solutions. This model is purely qualitative. It does not attempt to determine to what extent each error contributed to outcome, and it does not weight active or latent factors differently. All error is viewed as a source of potential harm and deserving of critique. Until we determine what changes will bring about the most significant improvements in our system, we have committed to a broad and expansive search for errors and their solutions. The more we understand about medical error, the more likely we can predict, anticipate, and ultimately prevent harm. The next step will require developing strategies to attack and diminish factors that contribute to error. Eventually we need to understand enough about error to reform health care systems in collaboration with hospital administrators, system designers, health care policymakers, patients, their families, and society as a whole. Changes in how patients view their care, how physicians are trained, how hospitals and EDs are designed, and how health care policy is made can all affect error reduction. Error is an important measure of our system. This model is presented as an attempt to embrace error for the opportunity it affords to improve our medical decisions and design safer systems.

I thank Robert L. Wears, MD, MS, for his encouragement and editorial assistance.

Received for publication December 20, 2001. Revisions received March 16, 2002; January 20, 2003; and June 10, 2003. Accepted for publication June 18, 2003.

Supported in part by a grant from the Agency for Healthcare Research and Quality, AHRQ grant HS 11552.

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