Setting the Educational Agenda and Curriculum for Error Prevention in Emergency Medicine

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Abstract. Graduate and postgraduate medical education currently teaches safety in patient care by instilling a deep sense of personal responsibility in student practitioners. To increase safety, medical education will have to begin to introduce new concepts from the "safety sciences," without losing the advantages that the values of commitment and responsibility have gained. There are two related educational goals. First, we in emergency medicine (EM) must develop a group of safety-educated practitioners who can understand and implement safe practice innovations in their clinical settings, and will be instrumental in changing our professional culture. Second, EM must develop a group of teachers and researchers who can begin to deeply understand how safety is maintained in emergency care, develop solutions that will work in emergency department settings, and pass on those insights and innovations. The specifics of what should be taught are outlined briefly. Work is currently ongoing to identify more specifically the core content that should be included in educational programs on patient safety in emergency care. Finally, careful attention will have to be paid to the way in which these principles are taught. It seems unlikely that a series of readings and didactic lectures alone will be effective. The analysis of meaningful cases, perhaps supplemented by high-fidelity simulation, seems to hold promise for more successful education in patient safety. **Key words:** education; safety; errors; emergency medicine; curriculum. ACADEMIC EMERGENCY MEDICINE 2000; 7:1194–1200

THE ACQUISITION of medical knowledge is incremental. It is a process of gradually building on a framework established according to the scientific method and the epistemological tenets of the discipline.[1] New quanta of information are accepted and added to existing dogma. Paradoxically, perhaps the greatest discovery in the last decade of the last millennium was not of new data, but of a latent phenomenon already embedded within clinical practice, medical error. From this discovery, a new and critically important discipline has emerged—*the science of error prevention in health care*.[2]

Any new field, at its beginning, has numerous problems of scope, methods, theories, and definitions. One of the most important problems this field faces is how to transfer newly-gained knowledge and information to current and future practitioners and researchers. At the outset we need to ask several questions: 1) Who should be educated? 2) What should be taught? 3) How should it be taught? 4) Who should teach it?

The significant change in our professional culture that is needed can be advanced through longitudinal educational initiatives. We acknowledge that the design of effective teaching methods and curricula will be an iterative process that will evolve as the science develops and through feedback from those whom we teach.

1. Who should be educated? The formal pedagogical approach is to include all those in training within the educational system, i.e., students of medicine, nursing, pharmacy, social work, paramedicine, and other allied fields. This constitutes the first educational sphere (Fig. 1).

However, the educational mandate extends beyond the classroom and the floor of the emergency department (ED). One of the greatest hurdles will likely be the education of our colleagues in current practice. It is one thing to introduce a new way of thinking to those in training; they are a captive audience and will readily pick up the attitudes and customs we teach and adopt ourselves. But it is quite another to change the attitudes and belief systems of those currently in practice in whom habits are well entrenched. Old dogs take longer to learn new tricks. Considerable effort will be re-

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quired to socialize existing faculty into the new culture of medical error reduction. The level of consciousness must be raised and techniques for attitude change must be explored to ensure widespread acceptance of the need to study, monitor, and report medical errors.

The second educational sphere will also include blunt-end personnel, the administrators, managers, and supervisors. All will need a basic grounding in general error theory, and in the science of medical error in particular. Only then can we begin to address some of the challenges in creating institutional changes in systems and practices. Current reporting systems grossly underestimate the base rate of error,[3] and those concerned with risk management and continuous quality improvement (CQI) programs will need to re-examine their methods and procedures for collecting meaningful and useful data. We should not underestimate the considerable institutional inertia against timely and appropriate error management that currently exists, and that presents a formidable obstacle to the development of a culture of safety.

It is clear, too, that other of society's sectors should be targeted by these educational efforts. The third sphere includes those not directly involved in the delivery of health care. An attitude shift needs to occur in the general public so there are more realistic and sympathetic views of the health care system and its inherent fallibility. It is fairly easy to imagine, for example, what the current stance toward blaming might be in the British patient advocacy group Sufferers of Iatrogenic Neglect (SIN). A similar innuendo was conveyed in the acronym for the Quality in Australian Health Care Study (QAHCS) published in 1995.[4] The notion that errors are sins, or due to incompetence, is pervasive in society. A better general understanding of human and systemic error in the delivery of health care would make for better partnerships and collaboration in minimizing error. However, an overtolerance of error might lead to complacency and inertia. We must make clear to the public our fundamental, sustained, and serious commitment to systematic change to make things better. We should be careful, too, that focusing the public's attention on medical malfeasance does not lead to a greater insecurity and wariness in the public.[2] If we seriously undermine the healers, we reduce their power to heal.

It is especially important that we direct educational efforts at the legal system. The current atmosphere and structure of malpractice litigation are major impediments to cultural change.[2,5] An effective reporting system will be crucial to the science of medical error, yet, an honest and full disclosure of errors from health professionals is unlikely unless we can achieve liability reform in a legal system that currently "induces secrecy and silence."[2]

Clearly, too, those who design our work areas and the instrumentation that we use need to have a good working knowledge of error theory. Not surprisingly, the interface between worker and workplace can be a significant source of error.[6] The importance of human factors engineering (HFE) and safety in the training of health care personnel is emphasized in the Institute of Medicine (IOM) report,[7] and the American Nurses Association lists HFE as one of its seven areas of competence.[8] Proponents of HFE make a good case that those responsible for medical software, instrumentation, and work area design need feedback and direction from clinicians and risk managers to guide "user-centered design" and reduce error.[9–11] Good craftspeople do not blame their tools, but they might make fewer errors with better tools.

The outermost educational sphere containing local and federal government agencies is a critical focus. The state has an obligation to protect the

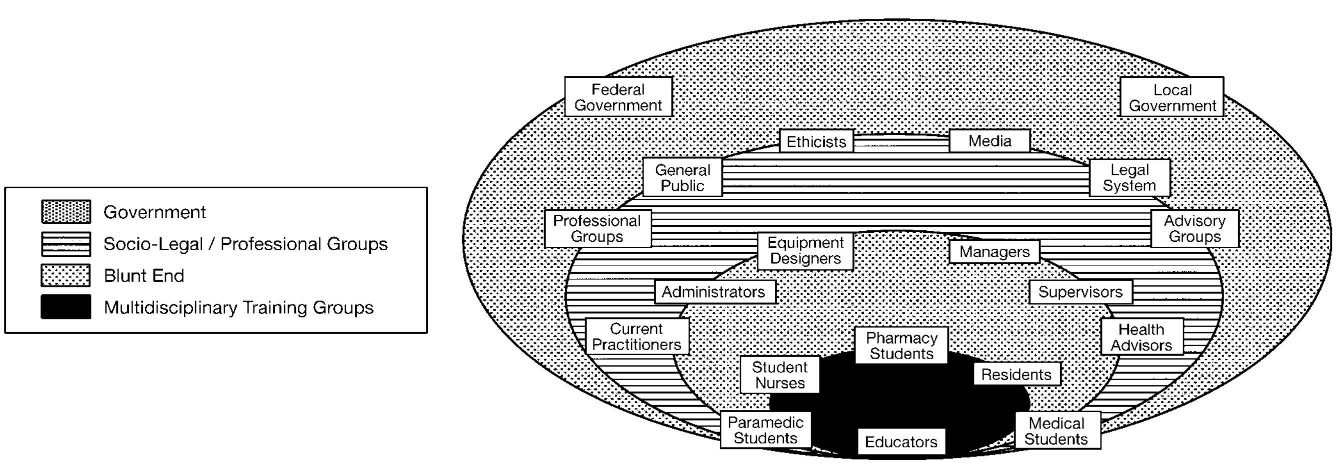

Figure 1. Four spheres of educational influence.

TABLE 1. Curriculum

Core Session	Target Group
Basic error theory (Table 2)	All groups
Team dynamics	All groups
Coping with error	All groups
Feedback	All groups
Communication	All groups
Procedural errors	Discipline-specific/some overlap
Affective errors	Patient contact groups
Cognitive errors	All groups
Human factors engineering	All groups

public, and government may feel obliged to take regulatory action in any area where public safety appears to be threatened. This *precautionary principle*[12] may generate a new set of problems and errors, and lead to enforced regulations with attendant penalties for violations. Thus, new innovations and solutions may generate new hazards, especially when imposed from outside the system. The present initiative is prudent, therefore, in that by making our educational objectives clear we might be allowed a greater say in the design and function of the new system. This is preferable to having one imposed upon us.

2. What should be taught? The content will depend upon which of the educational spheres is being targeted. For the purposes of the present discussion and the remainder of this paper, only the first sphere is considered. However, much of what is proposed also applies to clinicians already in practice. Different techniques and strategies will be required to effect change in each of the spheres.

The starting point of the educational curriculum for those in training should be basic error theory (Table 1). One of the difficulties here is that the area belongs to no discipline in particular, although the major developments have come from the behavioral sciences. Other significant contributions have been made by engineering, the military, and industry, notably aviation. It would be impractical and unreasonable to expect students to research this literature and develop a working knowledge of the diverse languages and terminologies of the respective disciplines. Instead, emergency medicine (EM) educators should develop a series of core sessions on error theory, with topics selected for their relevance and expressed in a language that is comprehensible to the target audience. A selected bibliography would be provided for those interested in further and more advanced study. A suggested list of core content topics is given in Table 2.

In 1995, the Interdisciplinary Generalist Curriculum Project was initiated to foster an interdisciplinary approach toward education in the health professions.[15] This important initiative aimed to break down traditional territorial barriers and promote teamwork. We believe that the core program should be shared and concurrently taught to the various disciplines of medicine, pharmacy, nursing, paramedicine, and allied fields. The historical approach to health care education has been that each discipline develops and pursues its own curriculum independently of the allied disciplines. This inevitably produces fragmentation, with different groups operating in isolation and occasionally in opposition. In a study of closed claims in the ED, teamwork failures were implicated in more than 40% of cases.[16] In contrast, a multidisciplinary curriculum would foster a team approach, cultivate team *distributed cognition*,[17] and lead to the breakdown of formal, horizontal and vertical divisions of labor that may contribute to ED error.[14,16,18] Such an innovative multidisciplinary approach to teaching the science of medical error, involving trainee physicians, nurses, and pharmacists, was successfully initiated several years ago at Michigan State University.[6]

The core curriculum should also include educational initiatives directed toward the individual response to error. Historically, physicians have taken the major responsibility for adverse outcomes, both emotionally and legally. The individual response has often been maladaptive, involving excessive self-recrimination and the use of inappropriate and counterproductive defense mechanisms.[19–22] While a better understanding and more open discussion of error will go some way toward de-mystifying it, further insights might be gained from faculty who have expertise in coping with and minimizing the impact of medical error. With the more distributed responsibility that teamwork brings, adverse outcomes will have a wider impact, and these sessions should again be multidisciplinary.

Each discipline should identify meaningful patterns in practice that indicate impending error. A classic example in EM is our vulnerability to the phenomenon of *anchoring bias*.[23] This is the tendency to focus on early presenting features of illness, and may result in *premature diagnostic closure*.[24] The conclusions we reach depend on where we begin and what we allow as our starting points, or anchors. However, once insight has developed into cognitive biases and such patterns are known, students can be trained to recognize scenarios that carry a potential for a particular type of error. This situational assessment approach is embodied in the “recognition-primed decision model” described by Klein.[25] Once the situation has been recognized, *cognitive forcing strategies* may be used to abort the error.[23]

The activities of all disciplines can be broken down into three areas: procedural, affective, and cognitive.[24] Each discipline has a repertoire of procedural skills that is fairly specific, although some overlap occurs. For example, intubation is largely the province of paramedics and physicians, whereas the administration of medication and issues around drug interaction and compatibility are more the domain of nurses and pharmacists. Each discipline should address the potential sources of error that might arise from its procedures and collaborate with other disciplines where appropriate.

Affective errors are made primarily by those who interact with patients: nurses, physicians, paramedics, and social workers. In part, they arise from transference and attribution phenomena.[23] The extent to which actions and decisions in EM are influenced by affective variables is very much underappreciated. Currently, there is little core content in any of the health care disciplines that draws attention to this covert and important source of error.

By far the greatest proportion of our time in the ED is spent in cognitive activity.[23] A number of cognitive biases and flaws have been described in the cognitive sciences literature.[26] These appear to be universal and have been demonstrated in a variety of professional groups. We should expect that they would affect all disciplines, with the most vulnerable groups being physicians, paramedics, and nurses. Several studies have attempted to correct cognitive bias, with varying degrees of success.[27] A major advantage of educating those who are in training is that there will have been little reinforcement or entrenchment of at least some of these biases, so the training process can serve to inoculate against developing them in the future. For practicing clinicians, some inertia will need to be overcome in changing longstanding beliefs and behaviors, and the task will be correspondingly more difficult.

Another core feature should be the role of feedback. It is difficult to imagine any progress being made unless we can learn from errors. Learning to drive a car would be extremely difficult without knowing the consequences of turning the steering wheel in the wrong direction, or applying the footbrake or gas pedal too hard. All of these actions, as well as the more sophisticated ones, such as the judgment of relative speed and distance in overtaking, are acquired through seeing the consequences of our thoughts and actions. In the absence of feedback, we tend to assume that our performance is satisfactory. Importantly for this discussion, we learn more from our mistakes than from our successes. Errors are a rich source of learning material.

However, the unique design and operation of EM and the ED result in extraordinary deficiencies in providing appropriate feedback to its personnel. Patients are usually unknown to the nurses and physicians, and there is little continuity of care. The current practice of EM is almost diametrical to the provision of feedback.[28] Complex cases are left at the end of the shift to another team, and unless deliberate efforts are made to follow up, the outcomes are never known. Many undiagnosed and interesting cases are referred to specialty services and disappear forever into a void. Also, access is being lost to the ultimate criterion standard of feedback, the clinical autopsy. Despite the historically persistent 40% discordance between clinical diagnosis and that revealed at autopsy, the clinical autopsy rate is declining significantly.[29] Further, when an autopsy is performed, coroners and pathologists do not routinely provide the results to the attending emergency physician (EP).

TABLE 2. Core Content Topics

Basic error theory
Classification and taxonomy of errors
Root cause analysis
Systems error/process measures/Swiss cheese theory[13]*
Cognitive psychology theory
Clinical decision making
Experience/acumen/sapiential authority[14]
Endogenous factors affecting performance (shiftwork, fatigue, burnout)
Countermeasures/forcing functions/interlocks
Error identification and reporting strategies/continuous quality improvement
Preventability theory
Basic dynamics of teamwork

*For complete citations, see the reference list.

The overall problem is compounded further by our unwillingness to provide direct feedback when the outcome may reflect negatively on the clinical management. Positive feedback is clearly important too, and often lacking. Health care providers generally expect a high standard of themselves, but it is important occasionally to receive affirmation of that. We learn through feedback. It is the critical feature in the acquisition of any procedural, affective, or cognitive skill. Emergency medicine must teach the importance of feedback and the implementation of specific strategies to optimize it. Everyone is in the feedback loop, including the patient.

Feedback is one component of the larger problem of communication. Good communication skills are especially important in the ED, where critical information is being transmitted, often under time pressures. Despite the generally tight coupling of interdisciplinary relationships, problems in communication can arise from the vertical and horizontal organization referred to earlier, as well as discipline-specific language. Each discipline has id-

TABLE 3. Teaching Techniques

Didactic sessions
Small-group/tutorials
Problem-based learning
Workshops
Narrative accounts/clinical cases/vignettes
Computer interactive/graphics
High-fidelity simulation
Apprenticeship/mentoring
Selected reading materials

iosyncrasies of language, and operates with a distinct set of priorities. Effective teamwork needs clear communication and common priorities, and these should be an integral part of the educational curriculum.

Finally, the curriculum will need an HFE component.[6] It is clear that information technologies have the potential to significantly improve decision making and reduce medical error. It should be recognized, too, that innovations can sometimes create new sources of error.[30] Health care professionals who use software and medical instrumentation are the best source of feedback to the companies who design them. Good feedback results in better design and fewer errors.

After the core program has been completed, the respective disciplines can take responsibility for education in supplementary discipline-specific topics, but these should not be exclusive of other disciplines. For example, there already exists a substantial literature on medication errors.[7] This area could be developed by pharmacy faculty and then jointly presented to pharmacists, nurses, physicians, and paramedics.

3. How should it be taught? It has become abundantly clear over the last few decades that there is more to teaching than the traditional didactic method. We now have a number of techniques that can make education more effective and interesting (Table 3).

Didactic sessions remain a useful basic technique for getting information across to large groups efficiently in a short space of time, and will form an integral part of most educational curricula. Presentations can be made more effective with visual aids such as videos, graphics, and cartoons.

Small groups/tutorials were pioneered in medical education at McMaster University Medical School in the 1960s as the vehicle for its innovative *problem-based learning* (PBL) program. Historically, the tutorial system had originated in the major English universities, Oxford and Cambridge. The majority of medical schools in North America now use tutorial-based PBL to foster self-directed learning.[31] Problem-based learning is defined as "the learning that results from the process of working toward the understanding or resolution of a problem,"[31] and is considered more nurturing and enjoyable than traditional methods.

Narrative accounts and clinical cases (war stories) have long been a feature of clinical teaching. They may suffer from the typical problems associated with anecdotal accounts such as selective reminiscence, embellishment or exaggeration, failure to take account of ambient conditions, and lack of statistical validity. Nevertheless, if these limitations are recognized, they can serve as a vivid, powerful tool for gaining the attention of trainees, as well as practicing clinicians. This is reflected in the observation that case reports are the most frequently read sections of medical journals, and supports the naturalistic model of decision making that domain expertise is acquired only through a combination of experience and the relating and repetition of meaningful stories.[32,33] Thus, if the session facilitator for PBL error training is an experienced clinician, this personal, experience-based strategy would be a useful adjunct. In contrast to the passive role students play in didactic sessions, PBL involves students actively and responsibly in the learning process. *Workshops* share many of the features and advantages of small-group learning. Through their less structured and more open-ended format, they allow greater freedom of thought and creativity, and encourage novelty in the search for solutions.

High-fidelity simulation is a powerful technique and can work in several ways. It allows us now to revise the maxim "see one, do one, and teach one." Essentially, simulation includes all techniques whereby the novice can mentally rehearse or "walk through" a clinical problem "off line" without having to experience the real problem personally. It is a way of gaining experience without experience. For example, near virtual reality in procedural tasks (e.g., intubation, ultrasound) can be achieved using sophisticated inanimate models. The old maxim should now become "see virtually many, do the real thing with much more competence and confidence, and direct the next student to the model." A different kind of mental rehearsal for intubation can be achieved through the technique of using a microcamera to videotape the actual process for a variety of different intubations.[34] This again allows thorough mental rehearsal before attempting the real procedure.

For cognitive problems, mental rehearsal through simulation can be achieved in several ways. After a short didactic session in which a series of cognitive biases and errors are described, video records can be made of actors playing out scripts of clinical scenarios in which the same biases and errors are demonstrated. Students can analyze the tape repeatedly until all the errors have been detected. Alternatively, after the didactic session some students themselves can act out the scripts to role-play the various errors, while their colleagues perform the analysis.

A further technique is to place students in a laboratory-simulated clinical situation with actors. An audio and video record is made of their behavior, clinical performance, and decision making. Various distractions can be introduced to manipulate the situational difficulty.[35] The tape is later reviewed and systematically analyzed by the students and instructor. This technique is not limited to clinical topics, but can be used to enhance communication, prioritization, teamwork, and resource management skills in critical situations.

4. Who should teach it? Just as the specialty of EM grew out of a public demand for improved quality of medical care and expertise in the "emergency room,"[36] so too has the *science of error prevention in health care* grown from a public demand for safe medical care. The foremost advocate of the public in this regard is the National Patient Safety Foundation, established under the auspices of the American Medical Association in 1997 and committed to the improvement of patient safety in the delivery of health care.

At the inception of any new science, there will be no formally trained faculty to teach it. This point was made clearly by Leape following his presentation at the recent British Medical Association conference on medical error.[37] Those who are currently interested in the science of error prevention in medicine, and who have brought it to its inception, are by definition its first teachers. They must provide the initial academic constructs that will describe the field. This is in fact the purpose of this document. The establishment of training programs will further define it and lead to a second generation of teachers and researchers who can carry on the work. As an immediate step, consideration should be given to developing a fellowship year for EM residents in the science of medical error reduction.

Much of the pioneer work in the field of error came from diverse fields such as the behavioral sciences, industry, and engineering. Medicine has been a fairly late arrival, with anesthesia taking the early initiative.[38] We anticipate that future faculty will be multidisciplinary, at least in a consultative capacity, and should include industrial and cognitive psychologists, sociologists, specialists in human factors engineering and organizational behavior, and systems design/process analysts. The faculty should develop a specific curriculum and hold regular seminars and workshops to promote and develop interdisciplinary communication and relationships; *listservs* should be made available to provide inventories of faculty expertise and interests, and to facilitate curriculum reform as needed.[31] The primary teaching should probably be done by EPs, nurses, paramedics, or pharmacists with a special interest, and specialized training, in the science of error reduction. Appropriate funding will be necessary for program development, as well as protected teaching time.

A potential problem with multidisciplinary faculty is that significant difficulties might arise with language. Therefore, a major goal of the faculty should be to ensure the development of a jargon-free and straightforward language of error, one that is easily understood and readily communicated among the various disciplines of emergency health care. Some core terms that originated in other disciplines will need to be preserved and introduced into the language of emergency personnel. However, it is also likely that the language will incorporate new terms providing a lexicon unique to the discipline of EM.[23,39]

Emergency caregivers may have other roles to play in the development of this new science by virtue of their work environment. Among the various specialties, the highest level of clinical uncertainty exists in EM. If there were no uncertainty there would be no need for decisions, and it is clearly the specialty with the highest decision density. Decision-making processes inevitably involve error, which makes the ED a natural laboratory for the study of medical error in complex and uncertain environments.[40]

Emergency physicians provide a unique resource to health care systems. The nature of the work in EM requires emotional resilience, physical stamina, intestinal fortitude, cognitive flexibility, and other personal attributes. Emergency medicine is the only specialty that requires its practitioners to remain current in, and regularly communicate and interact with, each of the other specialties. Emergency personnel are probably the most eclectic of the various disciplines.

It has been proposed that hospitals set up patient safety boards and acquire cross-disciplinary experts in HFE and in the science of medical error reduction.[11] Such programs might benefit from the coordination and guidance of a professional educator.[31] From the foregoing it would appear that residency-trained EPs, with a fellowship year in the science of medical error and HFE, would be ideal candidates for these positions. Their work portfolio might consist of serving as teaching faculty for medical error science, hospitalist work in HFE and error reduction, and independent investigation of serious adverse events, as well as clinical and research time in the ED.

We are responsible here for the initiation of the educational process, but its fine tuning will require input from many others. The early educators have one great advantage. They are guided by recent memory of the development of EM as a speciality science. It is only fitting that they are now in the forefront of the development of error prevention in EM as a special science and the educational process through which to teach it.

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