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A Guide for Developing Patient Safety Curricula for Undergraduate Medical Education

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Introduction

In its 1999 report, the Institute of Medicine identified medical error as an important factor in mortality of hospitalized patients, contributing to as many as 98,000 deaths annually.[1] These errors are costly as well, incurring an annual cost of as much as 30 billion dollars in lost income and excessive health care expenditures. As prevalent as these errors are, 35% of internal medicine clerkship directors had, in 2000, "little or no familiarity with the Institute of Medicine's report."[2] This unacceptable level of error in health care, and lack of awareness of its importance send a clear call to educators to address the issue of patient safety. This call extends to all dimensions of medical education, including undergraduate medical education.[3] In fact, one could argue that patient safety belongs first in a medical school curriculum, and that it should be an ongoing educational endeavor, one that continues throughout a physician's career. However, one may justifiably wonder about the optimal method for implementing a patient safety curriculum in the medical school.

Many approaches to undergraduate medical education have included an informatics-based platform. In particular, the design and implementation of computer-based instructional materials have revolutionized the way preclinical and clinical subjects have been taught in medical schools over the past decade. Very few of these materials, however, have focused on patient safety, and given their success in preclinical and clinical domains, an informatics-centric approach to teaching patient safety should be considered.

The evidence of need for a medical school curriculum related to patient safety is compelling. It has been observed that physician trainees use the mechanisms of denial, discounting, and distancing to define and defend medical error.[4] In a review of medical error, Lester and Tritter noted that recurrent themes in errors, such as uncertainty, fallibility, and exclusivity of judgment, are probably rooted in medical education.[5] Others[6,7] have called for the implementation of programs and materials necessary for teaching medication or general patient safety in medical schools. Most compelling of all, Rosebraugh et al.[3] surveyed medical school clerkship program directors to ascertain the prevalence and depth of educational programs related to medical errors. Only 16% of respondents provided formal lectures about medication errors, yet most (65%) said they would incorporate short educational modules about errors and adverse events, if they were available. Boreham et al.[8] concluded that medical errors result from the "lack of a knowledge base which integrate[s] scientific knowledge with clinical know-how." Clearly, there is a real need for patient safety curriculum material that is useful at the undergraduate medical education level for reducing medical errors at all levels and that will

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provide the knowledge base medical students require for safe medical practice. The patient safety curriculum also needs to be carried forward into the practical setting of clerkships in organizations with cultures that support improvement and safety.

James Reason described two types of error: active and latent.[9] *Active errors* are produced by human hands and are possibly addressable through appropriate education and practice. *Latent errors* result from poorly designed or implemented systems or procedures. These errors are likely addressable through the education of system developers and management and tangentially through the education of users. Either way, informatics has an important role to play in the development of educational materials that can attenuate the risk of medical error committed by medical students.

This paper provides a summary of how the articles included in this special JAMIA supplement may be used to design or refine medical school curricula in patient safety. Medical students could benefit from a problem-based learning curriculum in patient safety that lays the groundwork for understanding the types of errors, especially as they occur in the context of technology-laden patient care and research settings. The problem-based learning format would encourage discussion, collaboration, quality improvement, and the value of learning from error in a variety of informatics domains related to clinical practice. To this end, four such domains are discussed: clinical systems, human factors and communication, knowledge representation, and protection of confidentiality.

The Papers in This Issue

Clinical Information Systems

The presence of clinical information systems is increasing in every patient care setting. These systems support specialized, often complex, tasks, such as order entry, laboratory and radiology reporting, clinical data entry and retrieval, and decision support. Medical students will be exposed to these systems earlier in their career; they will be expected to train on these systems quickly and to use them accurately as soon as they arrive on the inpatient floor or in the outpatient clinic for their first clinical rotation. Often, an information system educates the user, wittingly or unwittingly. Systems that use clinical guidelines for improving care have burgeoned over the past decade, but it is not yet clear that guideline-based systems actually improve care, because the extent of physician adherence to guidelines in the first place is unknown.

Goldstein et al. report on a guideline-based decision support system (ATHENA) to improve care for hypertension. This paper provides an excellent introduction to the design, implementation, use, and limitations of clinical decision support systems, all of which would be helpful for educating medical students about the appropriate role and use of these systems. In addition to Goldstein et al, Advani et al. address the problem of how these systems are used in practice by means of a specialized quality indicator language that can be used by guideline authors so that adherence to their intentions can be scored for quality assessment. Medical students could benefit from using this tool, both in formulating guidelines as practice exercises and in assessing the quality of care in a clinical setting.

Other clinical information systems focus more on monitoring. Boëlle et al. report on a surveillance system for capturing adverse anesthesia events. This system provides a good example of how specialized surveillance systems can easily be implemented, even in a complicated setting such as the operating room. Also in the anesthesia domain, Sawa and Ohno-Machado report on a decision support system that uses set theory to reduce errors. This system generates dynamic checklists of intraoperative problems, which would be useful in teaching medical students about the kinds of problems that can arise in the operating room and in developing strategies for dealing with them. Another approach to surveillance, using the ICD-9 as a representation of chief complaint and therefore a sensitive and predictive sensor of epidemics, is reported by Tsui et al. Although the focus of this paper was on bioterrorism surveillance, the methods could be applied to the surveillance of medical errors. Given the ubiquity of the ICD-9 coding system, this paper provides medical students with a good introduction to how the system can be used for surveillance purposes.

In another approach to surveillance, Einbinder and Scully used a retrospective approach to identifying adverse drug events (ADEs) from a clinical data warehouse. They found that a substantial number of ADEs occurred annually in their site, and these results should be useful to medical students in understanding the magnitude of the problem. In their work correlating ADEs with medication errors, Gandhi et al. found no difference in the rates of these events between manual and computerized prescribing systems. This suggests that practitioners should be equally vigilant in prescribing on either type of system. Expanding the domain to the more general adverse event (AE), Murff et al. found an even larger prevalence: they identified AEs in 31% of patients on retrospective review of discharge summaries using an electronic abstracting tool.

Human Factors and Communication

The increasing interest in patient safety has led to identifying the factors associated with human-computer interaction and communication that may increase the likelihood of medical errors. McKnight et al. found that providers have difficulty obtaining the type of information they need, even though such information is available. Access to this information is a key variable in the successful meeting of diagnostic and treatment needs, and the authors propose that this phenomenon suggests a computerized-solution. Furthermore, awareness of this problem in itself is an important step in mitigating the risks associated with poor communication. Zhang et al. postulate that the problem of medical errors will not be solved within medicine. Rather, this is a problem for cognitive science and engineering, as it is primarily a human factors issue. They argue that there is a system hierarchy of medical errors grounded in cognitive processes. This paper provides an excellent means for stimulating discussion of a potentially controversial subject that the problem of medical errors may eventually be solved by non-medical disciplines.

Nowhere in clinical practice is the realm of human factors and communication research more germane than in high-throughput clinical areas such as operating rooms and emergency departments. Weinger and Slagle performed a task analysis and workload assessment to evaluate clinical decision making among anesthesiologists. This research focused on the identification of nonroutine events associated with seven surgical procedures, and the prospective collection of these events as a means of identifying changes in clinical processes and practices to improve patient safety. Moss et al. documented the patterns of communication of an operating room charge nurse. Strategies for improving communication, such as an electronic operating room schedule, available throughout the hospital's clinical areas, as well as the implementation of an asynchronous messaging system, were offered as two ways of reducing the communication overload the charge nurse often experiences.

Knowledge Representation

The development of knowledge representation suitable for capturing adverse events relies on agreement by a number of regulatory and professional bodies as to the form and content of controlled vocabularies, ontologies, and taxonomies. Nebeker et al. provide a review of the problem of conflicting taxonomies and even definitions as they pertain to adverse drug events.

Rather than offer a solution to the problem, this paper is an excellent resource for understanding the problems associated with defining, describing, and reporting ADEs. Stetson et al. describe their initial efforts at developing an ontology, using the Unified Medical Language System, to model medical errors. The authors use a conceptual graph notation to define the schemas for communication space, information needs, and errors, which they considered to be foundational information for identifying the concepts related to medical errors.

Protection of Confidentiality

The confidentiality of patient information is coming under ever-increasing scrutiny, especially with the advent of HIPAA. Clinicians need to become more aware of the need for preserving confidentiality, as additional types of information become available and are represented in print and electronic media. Breaches of confidentiality can be seen rightly as medical errors in their own right, because they potentially stand to compromise patient care and confidence. Medical students need to learn early on in their careers that preserving patient confidentiality is a sacred trust that is not limited solely to clinical data but rather extends to data collected in research settings as well.

Two papers in this issue address the data needs of researchers, in balance with the need to preserve confidentiality. Dreiseitl et al. and Ohno-Machado et al. discuss the use of anonymized data in research, where sensitive data is purposely ambiguated to avoid linkage or identification. Such data can be disambiguated, however, through the use of the anonymization algorithm originally used on the data. Ohno-Machado et al. go so far as to show that inferences, such as those obtained from predictive models, can be constructed from ambiguated data, which further demonstrates that reliance on the ability of anonymization algorithms to preserve confidentiality may be misplaced and should be reconsidered. These discoveries have tremendous implications for preserving the anonymity of people represented in research or other data, and these implications should be discussed with medical students, whether or not they plan on a research career.

Implications for Undergraduate Medical Education

The education of clinicians to the importance of avoiding medical errors and mitigating risks to patients should be paramount in any medical school curriculum. Yet very few training programs identify formal education in medical errors or patient safety. More positively, however, most programs would use patient safety training materials if they were available.

The papers in this supplement of *JAMIA* have a special informatics focus on at least four different dimensions, which address the needs of users, developers, and ultimately, patients as the primary stakeholders in patient safety. To provide the best care possible, medical students need to understand the implications of information technology in medicine: that as attractive as it is in improving patient care, practitioners have a responsibility to understand its supportive, and at times potentially compromising, role in patient safety. In addition, medical students need to understand the extent of medical knowledge held by their patients and sources of information available to patients about their own health. As informatics solutions increasingly help solve the problem of reducing the prevalence and effect of medical errors, it is critical that the papers in this supplement be incorporated into a medical school curriculum about patient safety. Doing so will help students understand the source of the problem, its effects, and possible solutions.

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