Viewpoint Paper

The Clinical Data Repository: A Challenge to Medical Student Education

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Abstract The implementation of comprehensive clinical data repositories carries implications for the medical informatics curriculum for pre-MD medical students. There is the risk that electronic health records will detract from students' acquisition of basic skills in inquiry and information management. It is possible, however, to create an application within the data repositories that will provide students with opportunities to practice their skills as they follow the evaluation and management of patients. 


The impending expansion of readily available patient data will bring with it significant implications for medical student education. It is foreseeable that all physicians will use electronic medical records and patients will have electronic personal health records that are accessible whenever and wherever they are needed. Berner and Moss discussed the added obligations that will accompany the benefits of having more information available to support medical decision making: recognition of time pressures, need for context-sensitive decision support, and legal and ethical concerns.

All of these have implications for medical student education. Time pressures and limitations to human information processing will make it impossible to view all of the extensive patient-related information that will be accessible. The data must therefore be processed by filtering mechanisms summarizing the data and showing trends. Students must consider the source and context of data, and realize that all data do not have equal reliability and accuracy. Students must also understand the filtering algorithms being employed. Such critical assessment of data is essential for a scientific approach to education and health care delivery.

Likewise, the expanded data will be used for improved context-sensitive decision support tools. These tools have been shown to improve patient safety and to reduce the cost of medical care. Medical students must learn not to accept the output of these tools without first understanding the decision-making principles that guide them.

This access to all of a patient's information carries with it the obligation to develop legal and ethical guidelines for its use. Such questions arise as, “who should have access to all of the data” and “who should control the access,” and “on the obverse, how much of the data is a physician obligated to obtain and review?” Likewise, access to records previously held in individual practice offices may expose sensitive professional differences among physicians. The role of the medical student in this environment will need to be clearly defined when restrictions are placed on how much individual patient information is available to an individual who has no direct responsibility for that patient's care. Medical students' understanding of these issues must be addressed in an informatics curriculum.

It is evident that the implementation of expanded clinical information technology requires implementation of a carefully expanded informatics curriculum. Expanded technology could also have the unintended consequence of reducing the opportunities and possibly the motivation for students to develop skills in the process of diagnostic inquiry: the gathering of preliminary data (history and physical examination); development of preliminary hypotheses (the “differential diagnosis” as applied to the individual patient); testing of those hypotheses with additional, reflective, study (laboratory testing); and acceptance or rejection of hypotheses (making a diagnosis).

The education of a medical student is placed at risk, for example, when a new patient is seen, whether in hospital or an outpatient setting, accompanied by a life-long database, complete with composite profiles of disease, trend analysis, and so forth. This database allows the physician to draw conclusions about the present problem with much greater efficiency and accuracy and hopefully to implement therapy more effectively. The medical student may not benefit from access to these data. The student may become a mere pattern-reader when emulating the physician. It is possible that the availability of the data will render some decisions so easy to make that the student will not even be aware of questions that were asked, nor understand the considerations underlying the decisions. The student may not be required to learn the process of evaluating the data.

An illustrative scenario:

A patient with respiratory symptoms has a solitary pulmonary nodule discovered on a chest radiograph. The nodule does not have any of the radiologic characteristics—one of several patterns of calcification—that make it almost certainly benign, so it is obligatory that it be evaluated as a possible malignancy. One of 500 chest radiographs demonstrates a lung nodule, 90% of which are inci-
dental radiological findings. A timely and accurate diagnosis of the etiology of the solitary pulmonary nodule is essential so that, if it is malignant, the patient has the greatest potential for cure.

Evaluation of that nodule includes specialized radiographic diagnostics, possibly invasive procedures such as trans-thoracic needle aspiration or bronchoscopy, and possibly surgical excision. But the best evidence that this nodule is benign is the demonstration that it has been present on previous chest radiographs and has not changed in at least two years.

The medical student is asked to locate the old films. "Go to the radiology department archives," or "call the other hospital and have them send the old films," or even "drive over there yourself and bring them back." "Why?" asks the inquisitive student, or even just the reluctant one. And so develops a teachable moment.

In the future world of Medical Informatics it is possible that none of these interactions will occur.

The radiology report is accompanied by all previous chest radiograph reports from multiple clinical settings, including measurements of the nodule if it was previously seen. If it has been detected previously and has not grown in two years, the case is closed. The student may never even know the question was asked.

In this setting, the traditional question asked of students "what information would you like to obtain now [to continue your evaluation of this patient]?" may have to be replaced by a less effective "what if" question to elicit the same kind of reasoning. Alternatively, a comprehensive clinical data repository permits the creation of a parallel information universe for the medical student, i.e., an electronic educational environment that is not pressured by time allocation and that supports medical student acquisition of competency in data management decision-making skills. In that environment, when the student is evaluating a real patient in real time but the data are initially withheld from the student, the student is required to request information before it is supplied. Following the initial contact with the patient, the student may request historic and current data based on hypotheses generated from preliminary findings. Students may pursue their hypotheses as far as the available data will permit, even those ideas that turn into blind alleys, and reach conclusions independently. In this hypothetical setting they may also focus on one patient problem at a time without the "noise" of data from other problems that a patient may have. To be sure, this approach is not real-world medicine, but it seems likely that the real world is going to get so far ahead of the fledgling clinicians that, if they are left there totally, they will be deprived of opportunities to think about patient evaluation and to develop those skills. The role of the faculty in such a setting will be similar to the role in traditional settings, guiding the student through clinical reasoning step-by-step. However, student and resident teaching encounters will likely have to be conducted separately.

Technically, such partitioning of the data can be accomplished. A "need to know" security system and partitioning will be required to protect electronic data repositories. The design of the student interface will require collaboration with clinical educators and have to include not only the inquiry strategies but also algorithms for feedback, redirection, and reinforcement. With a system providing such a parallel clinical universe for the medical student, the student is able to remain in the clinical setting; that is, working with actual patients and participating in and observing their care, while at the same time developing requisite diagnostic skills, beginning with the basics of data gathering and information management.

The student begins by obtaining the patient's history and performing a physical examination, then records findings and initial diagnostic impressions. These observations are then compared electronically with the record entered by the resident or attending physician as well as previous records. Any discrepancies lead to the return of the student to the bedside to confirm or modify his findings and then to discussion.

The student enters initial orders for further evaluation of the patient. These, too, are compared electronically with the record and discrepancies are marked for discussion. All of this is done in a formative manner, not implying that the student is wrong for differing.

The student is then given the results of the requested studies and, in some instances, is asked to justify the request before being given the results. Of course, if the test was not performed, this becomes a topic for further discussion—whether and why it was not indicated or was even contraindicated. Pertinent prior data may also be made available at this time, perhaps only if requested.

The student orders a chest radiograph and receives the report along with the image itself. The solitary pulmonary nodule is there and, with some electronic digital manipulation, the student can determine that it is not calcified. He is unsure what to do next so he searches the published literature or consults a textbook by way of the same computer terminal where he is reviewing the radiograph. This ability to access reference information in the place and at the time it is needed provides "just in time" and in-context education for residents, practitioners, and others as well.

The student reads about CT scans, MRI, PET scans, bronchoscopy, and biopsies. He also learns about the predictive value of reviewing previous radiographs. Returning to the patient record, he requests and reads previous reports along with the radiographic images for his own comparison. He finds that this nodule was present four and six years ago and has not changed. It is almost certainly benign. He can move on to the next problem.

There is considerable value embedded in this approach in contrast with providing the student with all available data at the outset. It requires that the student think critically and justify conclusions and requests. While there may be some disadvantage to separating the student from the main flow of this patient's care, as information technology advances this approach will become even more valuable, ensuring that students continue to acquire basic clinical thinking skills at the same time that they are learning to navigate through a data-filled clinical environment.

The initial assessment of the student's work is done electronically and provides opportunities for self-directed learning. It also makes better use of limited faculty time and energy by allowing the student-faculty interaction to begin at a more advanced level. It is likely that the faculty working with medical students in this environment will derive more satisfaction from guiding the students into the acquisition of clinical skills from the point where the information system and self-study have taken them than from teaching them by beginning with the interpretation of myriads of data. Following the inquiry process, the students will also benefit from discussion of how to separate relevant from non-
relevant data and how to find data that are buried in the record.

**Application of the Clinical Model to Pre-clinical Preparation**

It would be a short additional step to extend such a database design to create hypothetical or fictional clinical cases. Many medical schools use problem-based learning (PBL) to reinforce basic science learning in clinical context. Clinical problems are presented in the guise of patient “protocols” that contain only the data the authors select to include. Students then study the anatomic, physiologic, pathologic underpinnings of the problems. As the students approach their clinical “clerkships,” that is, toward the end of the second year in the traditional curricular calendar, they begin to develop their clinical diagnostic skills. If PBL cases were attached to actual but fictionalized comprehensive patient databases, students could evaluate those patients using their understanding of basic pathogenesis and pathophysiology. Rather than being given data through fixed protocols, they could be required to obtain data through inquiry. With faculty tutelage they could begin to practice clinical inquiry and study the science behind their findings. This approach could be a new tool for demonstrating clinical correlation with the basic sciences.

This approach to the development of computer-based cases would be relatively simple, yet effective. It would complement other approaches to case development, such as basing simulated cases on known manifestations of disease or the creation of entire case records by clinicians.

**Summary**

Medical student education continues to be challenged by changes in the health care environment. The growth of medical informatics imposes new obligations, including the need to assure that students have data management skills, that they operate with sensitivity to ethical and legal issues raised by greater access to patient data, and that they become adept at using decision support tools. Comprehensive patient data repositories make it possible that the student will become lost in the task of interpreting data without an understanding of why or how the data were generated.

These technological advances in health care can be applied to improve medical student clinical education, indeed to move it to new heights. A partnership among clinical educators, health care specialists, technologists, and medical informaticians can produce educational tools that will support the acquisition and reinforcement of some very basic physician skills in ways heretofore only possible in the company of master clinicians. Such tools will also prepare medical students to operate in and to manage the information-rich clinical environment of the future.

**References**