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MEDICAL EDUCATION

Medical Education and Decision-Support Systems

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Only about 55 percent of patients receive evidence-based care [1]. If we want to increase the use of evidence-based medicine and raise the quality of care for all patients, the evidence must be at the fingertips of those making clinical decisions. In their ranking of evidence-based resources in terms of their effectiveness as decision-making aids, Strauss and Haynes place original journal articles at the bottom, followed by systematic reviews (Cochrane database), evidence-based journal abstracts (ACP Journal Club), and evidence-based textbooks (ACP PIER, Clinical Evidence); at the top, they argue, should be the computerized decision-support system (CDSS) [2]. Their argument is a practical one. For the practicing physician, evidence-based assistance must be "reliable, relevant, and readable" [2], and for the physician trainee, a CDSS that succinctly cites the evidence for specific orders has great educational promise. The CDSS also offers the opportunity to move a new therapy from newly published research to standard of care more quickly than the 17 years it currently takes [3, 4].

Both resident and attending physician should be expert in using electronic resources, not only because they are fast becoming ubiquitous, but because they improve care quality and resident education. It is for such reasons that, as a component of the Accreditation Council for Graduate Medical Education's "practice-based learning and improvement" competency, residents must use information technology to optimize learning. The American College of Physician's Teaching Medicine Series devotes a chapter in *The Theory and Practice of Teaching Medicine* [5] to medical informatics.

Improvements in Care

Use of CDSS can bring about a number of positive changes. Residents appreciated the guidance provided by an acute coronary syndrome order set in the emergency department more than experienced physicians did [6]. Also extremely important are the improvements to patient care: reductions in medication errors [7], increased prescription of analgesics [8], better compliance with national standards of congestive heart failure care [9], improvement in preventive care (e.g., higher rates of immunization and cancer screening) [10], and application of evidence-based guidelines for ventilator management and shock resuscitation in trauma care [11].

In our hospital, the VA Medical Center, for example, ACE inhibitor use or documentation of reason for non-use had been promoted with a laborious process of daily chart review and feedback to staff physicians. We surveyed residents about

their reasons for withholding ACE inhibitors and created order sets that provided focused teaching based on their answers (e.g., reassurance that patients on dialysis can be offered ACE inhibitors). As a result, ACE inhibitor use or documentation of non-use increased to 100 percent and the nurse positions dedicated to daily chart review were no longer needed.

Similarly, prophylaxis for deep venous thrombosis (DVT) in high-risk patients at our hospital succeeded only 68 percent of the time. Late in 2009, we instituted mandatory DVT prophylaxis fields in all admissions orders, including information on contraindications and alternatives to heparin. Through 2010, DVT prophylaxis was 80 percent—above the national average.

Improvements in Resident Education

Improved compliance creates opportunities for teaching and correcting misunderstandings (e.g., "clopidogrel prevents DVT"). When compliance was lower, there were too many failures for targeted teaching. On the basis of the feedback and errors, for example, we have added an option for prophylaxis in patients with heparin-induced thrombocytopenia and teaching on DVT incidence in cirrhosis.

Pitfalls of Computerized Systems and How to Avoid Them

Of course, some drawbacks come with the territory. Attending physicians occasionally express concerns that computerized systems encourage "cookbook medicine" because residents simply click off orders and do not actually write or type them. To our knowledge, this has never been studied in a formal manner. Furthermore, some of these concerns are mitigated by the complexity of many of the patients' conditions. Complex cases are less likely to be managed by a standardized order set.

In our hospital, the additional time spent on the computer away from the bedside and the need for closed charting rooms to prevent patient information being displayed publicly on screen have separated the nurses from the physicians. Our residents lament the loss of verbal communication with nurses, feeling it contributes to delays in medication and testing. Detrimental changes to nurse-resident communication and the impact of this on medical error rates should be quantified, and solutions should be studied and implemented.

Physicians have also complained about "alert fatigue" caused by the number of clinical alerts in the electronic medical record. We have found that some administrators, in their desire to meet performance measures and ensure patient safety, want language in order sets to cover all exceptions, but this led residents to opt out of our DVT prophylaxis order set early in implementation. Eliciting feedback, adjusting order sets and alerts, and focusing on the needs of the resident user are essential.

A good example of a thorough and effective CDSS development process is an electronic checklist developed by Riggio et al. at Thomas Jefferson University

Hospital (TJUH) [12]. TJUH had a computerized physician order entry system in place. To meet congestive heart failure and acute myocardial infarction quality measures (e.g., use of aspirin, beta blockers, and angiotensin-converting enzyme (ACE) inhibitors), a multidisciplinary team including a focus group of residents developed a checklist, embedded in the computerized discharge instructions, that required resident physicians to prescribe the recommended medications or choose from a drop-down list of contraindications. The checklist was vetted by several committees, including the medical executive committee, and presented at resident conferences for feedback and suggestions. Implementation resulted in a dramatic improvement in compliance.

Similarly, at the VA Medical Center in Memphis, which uses teaching order sets for the most common admission diagnoses, those order sets are reviewed periodically during daily turnover rounds and morning reports to encourage their use, and feedback from residents who opt out of the sets is used to improve them. The order sets have been effective in achieving many of the clinical performance measures required at VA hospitals.

Because users' trust in computerized decision-support systems is one significant determinant of their willingness to rely upon them, it is important to involve all stakeholders in the development of a CDSS [13]. This should result in a CDSS that is not only complete and based on the latest evidence but is also most compatible with the systems-based practice at a particular hospital.

Finally, while clinical management systems appear to be efficacious in general, *diagnostic* decision-support systems receive mixed reviews in the literature. Berner describes a study of internal medical residents using Quick Medical Reference (QMR), a diagnostic support system [14]. The residents tended to be strongly anchored to their prior diagnosis, but reported that they might change their diagnosis if it was not included in the QMR top ten. Another system, DXplain, expanded internal medicine residents' differential diagnosis list [15]. The residents generally found the system useful, but tended to use it infrequently. A study of psychiatry residents using a computer-based diagnostic system found it less effective in arriving at the correct diagnosis than traditional methods [16]. More research is required to understand and ameliorate the relationships between these systems and their users.

Conclusion

There is a need to train residents in more sophisticated access to evidence-based medicine sources. Residency training programs should consider a formal informatics curriculum that covers such topics as EBM literature searches, clinical decision-support systems, telemedicine, digital imaging, electronic medical records, and information security and privacy.

Residents also need to be involved in the development and use of clinical decision-support systems. Not only does the CDSS need to undergo a formal revision process at least annually to remain current, but hospitals and health care systems should also

collect data from the resident users on how well the computerized systems support care and learning. "Opting out" should be studied to get rid of unnecessary education and alerts and tailor informatics to resident needs.

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