Computerized Physician Order Entry and Online Decision Support

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Abstract

Computerized physician order entry (CPOE) and decision support systems (DSS) can reduce certain types of error but often slow clinicians and may increase other types of error. The net effect of these systems on an emergency department (ED) is unknown. The consensus participants combined published evidence with expert opinion to outline recommendations for success. These include seamless integration of CPOE and DSS into systems and workflow; ensuring access to Internet-based and other online support material in the clinical arena; designing systems specifically for the ED and measuring their impact to ensure an overall benefit; ensuring that CPOE systems provide error and interaction checking and facilitate weight- and physiology-based dosing; using interruptive alerts only for the highest-severity events; providing a simple, vendor-independent interface for institutional customization of CPOE alert thresholds; maximizing the use of automated systems and passive data capture; and ensuring the widespread availability of CPOE and DSS using secure wireless and portable technologies where appropriate. Decisions regarding CPOE and DSS in the ED should be guided by the ED chair or designee. Much of what is believed to be true regarding CPOE and DSS has not been adequately studied. Additional CPOE and DSS research is needed quickly, and this research should receive funding priority. DSS and CPOE hold great promise to improve patient care, but not all systems are equal. Evidence must guide these efforts, and the measured outcomes must consider the many factors of quality care.
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The electronic medical record holds great potential for improving the quality of medical care. The ability to rapidly retrieve many (or all) aspects of the medical record from an institution is already in place in institutions around the country. This is fundamental to the care process, but it is not the most exciting promise of computers in medicine. It is the potential for computers to add value by providing decision support to clinicians that may be the most intriguing aspect of medical informatics. Systems that guide clinicians toward better decisions and improved patient care will revolutionize medicine. Decision support can also be a powerful needs assessment tool that can be used to provide individualized educational opportunities for clinicians. Most decision support systems (DSS) are developmentally in their infancy. A number of groups are focusing on the potential for improved patient care through computerized physician order entry (CPOE) systems with embedded decision support.[1–4] CPOE and decision support are closely related in that much of the purported value of CPOE lies in its integration with decision support rules that may reduce medication error.[1,5–7] This report discusses the state of knowledge regarding DSS and CPOE and proposes recommendations based on that discussion.

We defined decision support as any information added by a system to assist the clinician's decision-making process. This includes (but is not limited to) the following:

- Reference material (e.g., journals, textbooks, and medication guides)
- "Expert systems" that assist in diagnosis (e.g., Bayesian systems, neural networks and other forms of artificial intelligence, clinical decision rules)
- Rule-based systems that provide clinical alerts (e.g., drug–allergy, drug–drug, and drug–diagnosis interaction checking or a CPOE system that alerts when a physician attempts to prescribe a fluoroquinolone to a child)
- Scoring systems and formulae (e.g., the PORT pneumonia mortality score)
- Data tags that add context (e.g., adding an "L" for "Low" next to a laboratory value)

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- Systems that assist in therapeutic decisions (e.g., CPOE that automatically suggests insulin and glucose for a hyperkalemic patient)
- Computer-based implementations of clinical pathways that facilitate and standardize entry of diagnostic and therapeutic orders
- Algorithms and tools to enhance physician efficiency and patient satisfaction (e.g., suggesting the next patient to be seen)

"Quality medical care" is a multifaceted concept that cannot be captured through a single metric. Efficiency, compliance with "best practice," efficacy, safety, and patient satisfaction are all important measures of patient care. The potential for decision support to improve individual facets of quality patient care has been well demonstrated, but its capacity to simultaneously adversely affect other facets of quality patient care must be recognized.

For example, CPOE has been well demonstrated to reduce medication-related error.[8–12] However, CPOE and dosing calculators do not entirely eliminate error and may introduce new types of error.[2,6,13–16] It has been shown that weight-based drug dosing calculators are faster for complex calculations and may be more accurate than hand calculations.[14,17,18] Many CPOE systems have dosing calculators. However, the net effect of CPOE can be to slow clinicians.[2,19,20] Medication error is an important issue in the ED, but diagnostic error may be an even greater problem in the ED.[21,22] Spending more time at the bedside than necessary may not improve patient outcome,[23] but spending enough time to obtain an adequate history and physical examination is critical to the ability to correctly make a diagnosis.[24] It has been postulated that the high volume of patients and the speed with which they must be seen may be compromising the clinician's ability to make a correct diagnosis.[21,22] Therefore, CPOE/DSS that demand time from physicians have the potential to decrease medication error while increasing the overall likelihood of error. There are well-publicized CPOE implementation failures, in part due to concerns over time demands and patient safety.[25,26]

Online emergency medicine reference texts available on personal digital assistants (PDAs) have been shown to provide clinical information more rapidly than text-based resources and seem to be an improvement over paper-based texts.[27] However, decision support during the process of documentation has a less clear-cut benefit proposition; it has been shown to improve the quality of documentation but often does not affect clinician adherence to recommended guidelines for high-quality care.[28–31]

While DSS hold great promise to improve patient care and measurably succeed in that regard on many fronts, the net effect on the complex emergency department (ED) and its patients is often unclear. As with all changes to a complex system, the analysis of ED CPOE or DSS must look at many aspects of quality of care before the overall impact can be determined. The following recommendations endeavor to provide guidance by maintaining that global perspective.

RECOMMENDATION 1

Clinicians avoid fragmented systems that necessitate changing applications, changing geographic location, or redefining context to seek out data for each task. Seamless and timely integration of comprehensive decision support into all elements of clinical workflow, documentation, CPOE, and clinical information systems is a highly desirable goal.

Discussion. Decision support is highly effective when it is automatic and seamless.[5,9,32–35] When clinicians must actively search for decision support tools and then enter (or reenter) the clinical data that are required to generate output, the utility and efficiency as well as the use of decision support decrease.[35–42] Neural networks and other decision-support tools have been shown to improve the diagnostic and therapeutic abilities of clinicians,[12,33,35,43–45] but these nonintegrated DSS are not commonly used for routine care. For example, one study showed that while users found a diagnostic support system useful, it was actually used by each clinician less than once a day.[38] The Consensus Committee believes that decision support should be evidence-based and should seamlessly link to that evidence.

Further Study. Optimal interfaces for decision support have not been developed or studied. This should be a high research priority.

Evidence Summary. Data and expert opinion.

RECOMMENDATION 2

Clinically important information resources and references available over wide area networks provide an important cornerstone for clinical care. Full Internet access, or at least access to all major general medical and emergency medicine–specific Web sites, should be available throughout the clinical area. If full Internet access is not provided, decisions regarding resource accessibility should rest with the ED chair or designee.

Discussion. Internet-based Web sites have demonstrated capability to provide decision support.[38,41,46–48] The Consensus Committee recommends that EDs provide clinicians with access to high-quality medical Web sites, with the clinician desktop set up to promote use of helpful Internet-based resources. Some have raised concerns that full Internet access may compromise system security or staff productivity as clinicians shirk clinical duties in favor of

online games, ''Web surfing,'' and personal e-mail management. Others believe that systems that limit Internet access will inevitably also block valuable online medical resources. Whether these concerns are purely theoretical or actually bear out in practice is unclear. However, if full Internet access is not provided, site accessibility should rest in the hands of the ED chair or designee.

Further Study. Research is needed to assess the effect on quality of patient care and physician workflow when full versus limited Internet access is available in the ED. For example, when unlimited Internet access is available, is there a measurable effect on patient throughput due to clinicians who are ''playing'' on the computers? Or, how often are physicians unable to rapidly answer a clinical question when Internet access is limited to a centrally managed list of ''approved sites''? A description of actual usage patterns under various control and security scenarios would also be useful.

Evidence Summary. Data and expert opinion.

RECOMMENDATION 3

Clinical practice requires immediate access to recognized, authoritative reference materials and calculation aids that are up to date and represent best evidence. Important electronic clinical resources that should be available for all emergency medicine clinicians include, at a minimum, appropriate emergency medicine reference texts, a medication reference, MEDLINE, a pregnancy calculator, common medical formula calculators, a clinical guideline repository, a medical image repository, and other resources the ED chair (or designee) deems necessary, including resources available only through institutional subscription.

Discussion. There are data to suggest that many of these electronic resources are clinically useful, more so than their nonelectronic counterparts.[6,14,17,49] These form the core set of basic decision support resources that have been available in most EDs (usually in physical rather than digital format) for decades. Electronic versions are often more readily updated, are harder to steal or lose, and can be made more portable than their physical counterparts.

Further Study. What electronic resources do clinicians use when seeking out additional information? How can these resources be successfully integrated into the existing electronic medical record to make them readily available to the clinician? How useful is this integration in terms of measurably improving the quality of patient care?

Evidence Summary. Data and expert opinion.

RECOMMENDATION 4

The guiding principle when evaluating outcomes of CPOE and DSS should be "first, do no harm." When new initiatives are introduced, their impact on quality should be measured. Decision support systems and CPOE may improve one aspect of quality care at the expense of another; such trade-offs should be carefully assessed to ensure that a net benefit (or at least no net harm) is achieved.

Discussion. The Consensus Committee strongly notes that the various CPOE systems and implementations are not equivalent.[4] CPOE may be beneficial at one institution[50,51] while detrimental at another.[25] The software and implementation plan should be carefully chosen based on the success of prior implementations and past performance at similar sites. Diverse metrics of quality should be followed after installation to ensure a beneficial effect is achieved. The ideal metrics for assessing CPOE have not been defined, but they will certainly quantify the various types of errors, severity of those errors, adherence to accepted guidelines for care, effectiveness of symptom relief, throughput times, time to primary intervention for serious diseases, walkout rates, mortality, unplanned return visits, integration with follow-up care, and patient and clinician satisfaction. To be successful, it is likely that CPOE systems will have to be time-neutral in their impact on ED physician time, and this should be measured and demonstrated. However, many aspects of quality of care can be difficult to measure, and effects can be mixed. The available metrics should supplement, not replace, the broad-based judgment of ED clinical leadership.

Further Study. What is the overall effect of CPOE on an ED system? (This is a very high-priority study question.) What are the optimal metrics for assessing DSS or CPOE? Which metrics most strongly predict that success in one hospital will be replicable at another hospital? Which specific systems have the greatest positive impact on patient quality when compared ''head to head''?

Evidence Summary. Case reports and expert opinion.

RECOMMENDATION 5

Computerized physician order entry systems for the enterprise often do not function well in the ED, leading to a reduced quality of care. CPOE systems intended for use in the ED should be designed specifically for the ED.

Discussion. The ED environment tends to be high-volume, high-acuity, and highly unpredictable. Systems that are designed for inpatient floors may not work well in the highly chaotic environment of the

ED, whereas systems that work well in the ED often work well throughout the enterprise.[52] Orders in the ED may be more limited in scope than those on a medical floor. Obscure ''send-out'' tests are rarely ordered from the ED, and virtually every test is considered ''stat.'' Forcing the ED clinician to wade through lists of tests, medications, and imaging studies that are not available or appropriate to the ED and insisting on manually setting a ''stat'' priority level to every order are just a few examples that demonstrate the need for CPOE systems that are specifically designed for the ED environment. A designee of the ED chair should guide the creation of ED order sets and the integration of the decision-support elements. Formal usability testing in an ED environment by the vendor before commercialization is desirable.

Further Study. What design parameters are most closely correlated with a successful ED implementation?

Evidence Summary. Expert opinion.

RECOMMENDATION 6

Computerized physician order entry systems should provide support for standard drug, allergy, and clinical-context interaction checking as well as weight-, age-, and physiology-based dosing. The systems should also provide clinicians with a variety of context-specific medication information elements and assist in managing third-party payer formulary issues.

Discussion. The most powerfully demonstrated published benefit of CPOE systems has been the ability to reduce medication error, particularly related to interactions and incorrect dosing due to patient size or physiology issues (such as hepatic or renal insufficiency).[6,10,51,53] This should be considered a fundamental benefit of CPOE and should be a prerequisite for its use. At the point of ordering, medication information such as indications and dosing should be readily available. Formulary issues are more easily and effectively managed by a computer and should be incorporated into the system to benefit the patient as well as the provider and the institution. There are data to show that doing so can lead to more effective prescribing and greater compliance with formulary requirements.[11]

Evidence Summary. Data and expert opinion.

RECOMMENDATION 7

Decision support systems and CPOE should be as non-intrusive as possible. Interruptive alerts and alarms should be reserved for high-severity events. Other categories of information should be available for review by users but should not interrupt physician workflow.

Discussion. Recurrent interruptions in flow frustrate the user, particularly when these interruptions have low clinical utility. It is well known that confirmations and warnings are ignored when they occur as a matter of routine rather than only at times of major importance.[54–58] Thus, interruptive warnings for low-risk interactions may compromise patient safety by causing users to ignore more critical warnings. Minor concerns (such as minor and rare drug interactions) should be available to the interested user in a non-interruptive way. The insistence on interrupting user flow with minor concerns is a common cause of CPOE implementation failure. Decision support should be ubiquitous, transparent, and efficient.

Further Study. Are interruptive alerts appropriate? If so, when, and if not, what alternatives exist that can be shown to be equally or more effective?

Evidence Summary. Data and expert opinion.

RECOMMENDATION 8

Decision support systems, especially those used in the context of CPOE, should provide a mechanism whereby each institution can modify the decision rules and alerts to fit specific local and role-based needs. These modifications should be made through a simple, site-administered interface, without requiring vendor intervention. Individual end users should be able to configure the system to display alerts of lesser severity if desired.

Discussion. Each institution should not be forced to ''reinvent the wheel'' by creating a set of basic CPOE decision support rules and identifying important drug–drug interactions. These should be provided by default by the vendor. Institutions must be able to adjust the level of severity for an interaction that will generate a high-level alert to meet their regional needs. In addition, there is evidence that users in different roles and at different levels of training should have different threshold settings for interactions that generate a high-level alert.[59] The optimal threshold for high-level alerts needs further study. New medications are placed on the market constantly, and new interactions are commonly found. The CPOE software must be easily updateable and allow individual institutions to adjust the settings as needed, using a simple interface that does not require vendor intervention or programming.

Further Study. What is the optimal threshold for high-level alerts at various levels of training and by role?

Evidence Summary. Data and expert opinion.

RECOMMENDATION 9

Automated processes are inherently more reliable than manual and volitional processes. Sensor-based technologies such as bar codes and radio frequency identification (RFID) can help to document administration of medication, provide additional safety checks, and reduce or eliminate patient identification errors. Additional initiatives and further research in this area should be given a high priority.

Discussion. Bar code scanning and related technologies for administration of medication were enthusiastically endorsed by the members of the discussion group. However, there was little real-world experience with this technology among the group members. The technology is in its infancy but has the potential to decrease the likelihood of wrong patient–drug errors, facilitate automated documentation of medication administration, and allow a last-second safety check to ensure that the medication is safe for the patient with regard to allergies, interaction with other medications the patient is taking, and physiologic concerns such as hepatic and renal function.[60] These potential benefits come with less clinician input time than that required by CPOE. However, there are theoretical risks to bar code scanning that have been raised,[61] and bar code scanning may add some additional time cost to the nurse administering the medication.[62] Proximity sensors for emergency physicians may speed log-on and increase security. The Consensus Committee believes that these technologies will bring efficiencies to ED care but that their implementations may be more challenging than expected.

Further Study. The actual effect of bar code scanning and sensor-based technologies on patient safety, patient ED throughput, nursing time, physician time, and documentation should be studied and quantified. This requires urgent study.

Evidence Summary. Expert opinion.

RECOMMENDATION 10

For effective integration into physician workflow, DSS and CPOE must be widely available, both at the bedside and at other locations throughout the ED. Mobile wireless technologies are an essential component of this widespread availability in an intensive clinical environment such as the ED.

Discussion. In typical ED practice, clinicians frequently receive information on which they must act almost immediately. Barriers to immediate action in response to new information increase the likelihood of errors of omission.[63] Without ubiquitously available hardware and software resources for CPOE, ED efficiency will suffer, clinicians will become frustrated, patient safety may be threatened, and implementations are likely to fail.

Further Study. The hardware requirements to optimize successful CPOE implementation are not known and need urgent study.

Evidence Summary. Data and expert opinion.

CONCLUSIONS

This is a watershed moment for decision support in emergency medicine. Online decision support and CPOE are among the most exciting events on the medical horizon. The possibility of significantly and measurably benefiting patient care is just around the corner. However, due to the high-complexity, high-chaos, high-stress nature of the ED, if CPOE fails it will do so first in the ED. There is a risk of multiple large-scale failures casting a pall not only on CPOE but also over online decision support in general. By maintaining an eye on the ED system as a whole rather than limiting our focus to the most easily measurable direct effects, we can successfully design and implement CPOE and DSS that will positively transform emergency care. These recommendations may help to guide that process.

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