CPOE: Computer Physician Order Entry Systems

Definitions

CPOE is commonly used as an abbreviation for the term computer-based physician order entry - even though it can involve health professionals who aren't physicians. Alternative terms include computer-based provider order entry and computerized prescription order entry (prescribing was the main focus of early systems - more recent systems offer a wider range of services).

CPOE systems are "clinical systems that utilize data from the pharmacy, laboratory, radiology and patient monitoring systems to relay the physician's or nurse practitioner's diagnostic and therapeutic plans and alert the provider to any allergy or ontraindication that the patient may have so that the order may be immediately revised at the point of entry prior to being forwarded electronically for the targeted medical action." [Computerized Physician Order Entry: Costs, Benefits and Challenges, A Case Study Approach, First Consulting Group, 2003.]

"Computer-based Provider Order Entry - CPOE is the portion of a clinical information system that enables a patient's care provider to enter an order for a medication, clinical laboratory or radiology test, or procedure directly into the computer. The system then transmits the order to the appropriate department, or individuals, so it can be carried out. The most advanced implementations of such systems also provide real-time clinical decision support such as dosage and alternative medication suggestions, duplicate therapy warnings, and drug-drug and drug-allergy interaction checking." [Osheroff et al, 2005].

Order Entry has four dimensions [...]:

1. entering information by the practitioner into a mobile healthcare computing device,
2. functionality (- what is ordered – prescriptions, lab, radiology, chemotherapy, others),
3. decision support directly linked with the function (for instance, duplicate therapy checking, drug-drug interaction, drug-allergy interaction, formulary interaction, alerts, etc.), and
4. the integration of this function into the IS system. [C. Peter Waegemann. Status Report 2002: Electronic Health Records]

Introduction

The publication of the US Institute of Medicine (IoM) report 'To Err is Human' in 1999 highlighted an unexpectedly high error rate in medical care in the USA, and brought to the fore the issue of patient safety and the need to eliminate medical error from hospitals. Since the appearance of this report, patient safety has become a primary concern in many national healthcare systems. Much effort has been put into devising ways to improve systems in many countries: the introduction of information technologies has been widely seen as part of the solution. Information technologies viewed to have the greatest potential to help improve safety standards in healthcare provision include electronic healthcare records and (in the USA and Canada in particular, but also in Europe and Australasia) CPOE systems supporting (minimally) automated medication and lab. test ordering and prescribing.

CPOE "first appeared when the El Camino hospital in Mountain View, California convinced the nearby NASA space center and Lockheed Corporation to help the hospital develop and implement the world's first [system] ... in 1971". In spite of much recent impetus from the IoM and other organisations concerned with patient safety such as the Leapfrog Group, CPOE has yet to achieve anywhere near universal coverage in the USA. But CPOE is widely seen as necessary to reducing medical error

and must be the most widely implemented information technology capable of providing decision support in healthcare.

According to a January 2003 report prepared by First Consulting Group for the American Hospital Association and the Federation of American Hospitals, an estimated 5% of American hospitals used CPOE in 2002. Ash et al [Ash et al, 2004] estimated that 9.6% of U.S. hospitals had CPOE "completely available", also in 2002. The Leapfrog Group (quoted in Healthcare Benchmarks and Quality Improvement) has estimated that "by the end of 2006, about 10% of all [US] hospitals will have completed CPOE implementation".

Many studies of live CPOE systems have been carried out. Most - but not all - suggest that CPOE has a very positive effect in reducing medical error. CPOE has also been shown to to improve decision-making capabilities, to have a positive effect on training and to reduce the length of stays in hospital. A recent paper by Kaushal et al [Kaushal et al et al, 2006] has gone as far as quantifying the cost effectiveness of using a CPOE system (in Brigham and Women's Hospital, Boston, over the period 1993-2002) resulting from the clinical benefits of the system.

CPOE functionality and benefits

- Enables doctors to enter prescription, lab. test and other orders for patient care straight into a hospital information system
- Replaces hand-written orders (legibility, completeness, readily and quickly accessible, improved communcations between phyician and pharmacist; no delay or loss ...)
- Supports ready access to patient data and patient assessment
- Can help improve patient safety and prevent medical errors and adverse drug events by checking the dosage etc. of medication given to patients by physicians or other health professionals
- Supports improved recording, data trails, quality assurance and error awareness and reporting
- Potential to improve efficiency and resource usage by integrating different departments - laboratory, imaging, nursing and medication records
- Cost-effectiveness benefits:
    - Can reduce additional and often avoidable costs (clinical, litigation ...) that can result from medication errors;
    - Can show test and medication costs - potential to reduce prescription costs;
    - Can reduce the number of duplicate tests;

CPOE and decision support

- "CPOE decision support includes: [automated] [medication checking,] drug dose, allergy, and interaction checking; duplicate order notification; recommendations for pre- or post-administration tests; access to clinical reference information, [research] and guidelines; and substitute medication and test recommendations." [The Commonwealth Fund (USA)]
- A system can also monitor patient treatment, ensuring, for example, that the right drug is administered to the right patient at the right time, and can issue an alert or reminders and suggest a a different course of treatment if a patient’s condition changes, if test results are abnormal etc.
- Can provide health professionals with immediate electronic access to their orders and comprehensive views of patient clinical data and lab results;

CPOE issues

- An expensive undertaking - initial high capital investment required (Kuperman and Gibson, 2003)
- Risk of a system generating medication errors e.g. through incorrect configuration or physician input
- Systems can't be bought "off the shelf" leading to integration issues with legacy systems - which may themselves need to be upgraded to support CPOE implementation.
- A system may require a great deal of on-site customisation prior to deployment to integrate with workflow processes of an individual hospital
- Change management issues
- User resistance to introduction of computer-based technologies
- May disrupt workflow for (and slow down) physicians, pharmacists and nurses, particularly if actions to try to ensure ready adoption in practice have not been carried out such as involvement of end users at development and implementation phases, usability testing with end-users, training, support
- Systems may need medical terminologies not in local use
- Potential problems related to the structure of health services in individual regions and countries: it may be more difficult to implement CPOE on a large

scale where health services tend to be structured around local, independent organisations (e.g. USA) rather than where services are centrally organised by national governments and supported by the taxpayer (much of Europe).
- Interoperability issues on local, regional and/or national scales affecting communcation
- May generate extra unnecessary information e.g. relatively unimportant alerts.

references

Kuperman GJ, Gibson RF. Computer physician order entry: benefits, costs, and issues. Ann Intern Med. 2003 Jul 1;139(1):31-9.

[PubMed] []

" Several analyses have detected substantial quality problems throughout the health care system. Information technology has consistently been identified as an important component of any approach for improvement. Computerized physician order entry (CPOE) is a promising technology that allows physicians to enter orders into a computer instead of handwriting them. Because CPOE fundamentally changes the ordering process, it can substantially decrease the overuse, underuse, and misuse of health care services. Studies have documented that CPOE can decrease costs, shorten length of stay, decrease medical errors, and improve compliance with several types of guidelines. The costs of CPOE are substantial both in terms of technology and organizational process analysis and redesign, system implementation, and user training and support. Computerized physician order entry is a relatively new technology, and there is no consensus on the best approaches to many of the challenges it presents. This technology can yield many significant benefits and is an important platform for future changes to the health care system. Organizational leaders must advocate for CPOE as a critical tool in improving health care quality. "

Sittig DF, Stead WW. Computer-based physician order entry: The state of the art. J Am Med Inform Assoc. 1994;1:108–23

[PubMed] [PubMed Central]

" Direct computer-based physician order entry has been the subject of debate for over 20 years. Many sites have implemented systems successfully. Others have failed outright or flirted with disaster, incurring substantial delays, cost overruns, and threatened work actions. The rationale for physician order entry includes process improvement, support of cost-conscious decision making, clinical decision support, and optimization of physicians' time. Barriers to physician order entry result from the changes required in practice patterns, roles within the care team, teaching patterns, and institutional policies. Key ingredients for successful implementation include: the system must be fast and easy to use, the user interface must behave consistently in all situations, the institution must have broad and committed involvement and direction by clinicians prior to implementation, the top leadership of the organization must be committed to the project, and a group of problem solvers and users must meet regularly to work out procedural issues. This article reviews the peer-reviewed scientific literature to present the current state of the art of computer-based physician order entry. "

Longo DR, Hewett JE, Ge B, Schubert S. The long road to patient safety: a status report on patient safety systems. JAMA. 2005 Dec 14;294(22):2858-65.

[PubMed] []

" CONTEXT: Since the Institute of Medicine (IOM) reports on medical errors and quality, national attention has focused on improving patient safety through changes in "systems" of care. These reports resulted in a new paradigm that, rather than centering on individual errors, focuses on the "systems" necessary to facilitate and enhance quality and protect patients. OBJECTIVES: To assess the status of hospital patient safety systems since the release of the IOM reports and to identify changes over time in 2 states that collaborated on a patient safety project funded by the Agency for Healthcare Research and Quality. DESIGN, SETTING, AND PARTICIPANTS: Survey of all acute care hospitals in Missouri and Utah at 2 points in time, in 2002 and 2004, using a 91-item comprehensive questionnaire (n = 126 for survey 1 and n = 128 for survey 2). To assess

	changes over time, we also studied the cohort of 107 hospitals that responded to both surveys. MAIN OUTCOME MEASURES: Responses to the 91-question survey as well as changes in responses to the survey questions over an 18-month period. Seven latent variables were constructed to represent the most important patient safety constructs studied: computerized physician order entry systems, computerized test results, and assessments of adverse events; specific patient safety policies; use of data in patient safety programs; drug storage, administration, and safety procedures; manner of handling adverse event/error reporting; prevention policies; and root cause analysis. For each hospital, the 7 latent variables were summed to give an overall measure of the patient safety status of the hospital. RESULTS: Development and implementation of patient safety systems is at best modest. Self-reported regression in patient safety systems was also found. While 74% of hospitals reported full implementation of a written patient safety plan, nearly 9% reported no plan. The area of surgery appears to have the greatest level of patient safety systems. Other areas, such as medications, with a long history of efforts in patient safety and error prevention, showed improvements, but the percentage of hospitals with various safety systems was already high at baseline for many systems. Some findings are surprising, given the overall trends; for example, while a substantial percentage of hospitals have medication safety systems, only 34.1% [corrected] reported full implementation at survey 2 of computerized physician order entry systems for medications, despite the growth of computer technology in general and in hospital billing systems in particular. CONCLUSIONS: The current status of hospital patient safety systems is not close to meeting IOM recommendations. Data are consistent with recent reports that patient safety system progress is slow and is a cause for great concern. Efforts for improvement must be accelerated. "
Osheroff JA, Pifer EA, Teich JM, Sittig DF, Jenders RA. Improving Outcomes with Clinical Decision Suppport: An Implementer's Guide, Health Information Management and Systems Society (HIMSS), 2005. [] [HIMSS]	A " resource designed to help healthcare organizations use clinical decision support (CDS) to measurably improve key healthcare outcomes such as the quality, safety, and cost-effectiveness of care delivery. "
Bukunt S, Hunter C, Perkins S, Russell D, Domanico L. El Camino Hospital: using health information technology to promote patient safety. Jt Comm J Qual Patient Saf. 2005 Oct;31(10):561-5. [PubMed] []	" BACKGROUND: El Camino Hospital is a leader in the use of health information technology to promote patient safety, including bar coding, computerized order entry, electronic medical records, and wireless communications. OVERALL APPROACH TO QUALITY AND SAFETY: Each year, El Camino Hospital's board of directors sets performance expectations for the chief executive officer, which are tied to achievement of local, regional, and national safety and quality standards, including the six Institute of Medicine quality dimensions. He then determines a set of explicit quality goals and measurable actions, which serve as guidelines for the overall hospital. The goals and progress reports are widely shared with employees, medical staff, patients and families, and the public. ADDRESSING THE SIX IOM QUALITY AIMS: For safety, for example, the medication error reduction team tracks and reviews medication error rates. The hospital has virtually eliminated transcription errors through its 100% use of computerized physician order entry. Clinical pathways and standard order sets have reduced practice variation, providing a safer environment. CHALLENGES: Many projects focused on timeliness, such as emergency department wait time, lab turnaround time, and pneumonia time to initial antibiotic. Results have been mixed, with projects most successful when a link was established with patient outcomes, such as in reducing time to percutaneous transluminal coronary angioplasty for patients

with acute myocardial infarction. "

References: CPOE adoption and use

Cutler DM, Feldman NE, Horwitz JR. U.S. adoption of computerized physician order entry systems. Health Aff (Millwood). 2005 Nov-Dec;24(6):1654-63.

[PubMed] []

" Computerized physician order entry (CPOE) has been shown to reduce preventable, potential adverse events. Despite this evidence, fewer than 5 percent of U.S. hospitals have fully implemented these systems. We assess empirically alternative reasons for low CPOE implementation using data from various sources. We find that CPOE is related to hospital ownership and teaching status; government and teaching hospitals are much more likely than other hospital types are to invest in CPOE. Hospital profitability is not associated with CPOE investment. Although greater diffusion of CPOE is needed, it might have to await continuing publicity efforts and substantial reimbursement system changes. "

Ash JS, Gorman PN, Seshadri V, Hersh WR. Computerized physician order entry in U.S. hospitals: results of a 2002 survey. J Am Med Inform Assoc. 2004 Mar-Apr;11(2):95-9.

[PubMed] [PubMed Central]

" OBJECTIVE: To determine the availability of inpatient computerized physician order entry in U.S. hospitals and the degree to which physicians are using it. DESIGN: Combined mail and telephone survey of 964 randomly selected hospitals, contrasting 2002 data and results of a survey conducted in 1997. MEASUREMENTS: Availability: computerized order entry has been installed and is available for use by physicians; inducement: the degree to which use of computers to enter orders is required of physicians; participation: the proportion of physicians at an institution who enter orders by computer; and saturation: the proportion of total orders at an institution entered by a physician using a computer. RESULTS: The response rate was 65%. Computerized order entry was not available to physicians at 524 (83.7%) of 626 hospitals responding, whereas 60 (9.6%) reported complete availability and 41 (6.5%) reported partial availability. Of 91 hospitals providing data about inducement/requirement to use the system, it was optional at 31 (34.1%), encouraged at 18 (19.8%), and required at 42 (46.2%). At 36 hospitals (45.6%), more than 90% of physicians on staff use the system, whereas six (7.6%) reported 51-90% participation and 37 (46.8%) reported participation by fewer than half of physicians. Saturation was bimodal, with 25 (35%) hospitals reporting that more than 90% of all orders are entered by physicians using a computer and 20 (28.2%) reporting that less than 10% of all orders are entered this way. CONCLUSION: Despite increasing consensus about the desirability of computerized physician order entry (CPOE) use, these data indicate that only 9.6% of U.S. hospitals presently have CPOE completely available. In those hospitals that have CPOE, its use is frequently required. In approximately half of those hospitals, more than 90% of physicians use CPOE; in one-third of them, more than 90% of orders are entered via CPOE. "

Park RW, Shin SS, Choi YI, Ahn JO, Hwang SC. Computerized physician order entry and electronic medical record systems in Korean teaching and general hospitals: results of a 2004 survey. J Am Med Inform Assoc. 2005 Nov-Dec;12(6):642-7.

[PubMed] [JAMIA]

" OBJECTIVE: To determine the availability of computerized physician order entry (CPOE) and electronic medical record (EMR) systems in teaching and general hospitals in the Republic of Korea. DESIGN: A combined mail and telephone survey of 283 hospitals. MEASUREMENTS: The surveys assessed the availability of CPOE and EMRs in the hospitals, as well as inducement, participation, and saturation regarding CPOE use by physicians. RESULTS: A total of 122 (43.1%) hospitals responded to the survey. The complete form of CPOE was available in 98 (80.3%) hospitals. The use of CPOE was mandatory in 92 (86.0%) of the 107 hospitals that responded to the questions regarding the requirement of CPOE use. In 85 (79.4%) of the hospitals in which CPOE was in use, more than 90% of

	physicians used the system. In addition, physicians entered more than 90% of their total orders through CPOE in 87 (81.3%) hospitals. In contrast, a complete EMR system was available in only 11 (9.0%) of the hospitals. CONCLUSION: Of the teaching and general hospitals in the Republic of Korea that responded to the survey, the majority (80.3%) have CPOE systems, and a complete EMR system is available in only 9%. "
Kuperman GJ, Teich JM, Gandhi TK, Bates DW. Patient safety and computerized medication ordering at Brigham and Women's Hospital. Jt Comm J Qual Improv. 2001 Oct;27(10):509-21. [PubMed] []	" BACKGROUND: Medications are important therapeutic tools in health care, yet creating safe medication processes is challenging for many reasons. Computerized physician order entry (CPOE), one important way that technology can be used to improve the medication process, has been in place at Brigham and Women's Hospital (BWH; Boston) since 1993. CPOE AT BWH: The CPOE application, designed and developed internally by the BWH information systems team, allows physicians and other clinicians to enter all patient orders into the computer. Physicians enter 85% of orders, with the remainder entered electronically by other clinicians. CPOE AND SAFE MEDICATION USE: The CPOE application at BWH includes several features designed to improve medication safety--structural features (for example, required fields, use of pick lists), enhanced workflow features (order sets, standard scales for insulin and potassium), alerts and reminders (drug-drug and drug-allergy interaction checking), and adjunct features (the pharmacy system, access to online reference information). RESULTS AT BWH: Studies of the impact of CPOE on physician decision making and patient safety at BWH include assessment of CPOE's impact on the serious medication error and the preventable adverse drug event rate, the impact of computer guidelines on the use of vancomycin, the impact of guidelines on the use of heparin in patients at bed rest, and the impact of dosing suggestions on excessive dosing. CONCLUSION: CPOE and several forms of clinical decision support targeted at increasing patient safety have substantially decreased the frequency of serious medication errors and have had an even bigger impact on the overall medication error rate. "
Massachusetts Hospital CPOE Initiative. CPOE Readiness Roadmap Guide, 2005 [] [Massachusetts Technology Collaborative]	" The document ... covers eight different components of preparation for CPOE: A. CPOE Project Status B. Leadership C. Organizational Structure and Process D. Organizational Culture E. Care Standardization F. Clinician IT Experience G. Information Technology Management H. Information Technology Infrastructure. Each component includes a number of characteristics of the organization or the information technology in place that lays the foundation for eventual success with CPOE. When they are not present, the challenges ahead are greater; if a significant number are not present, projects can be delayed, stalled, or fail. Each of the readiness components is described in this information guide, along with a review of the importance to a successful CPOE project. Typical projects are also listed that hospitals can organize to address readiness gaps. It is hoped that the information in the feedback report, combined with the information in this handbook, will help CPOE project leadership in each hospital to increase readiness. "
Kaushal R, Bates DW. Information technology and medication safety: what is the benefit? Qual Saf Health Care. 2002 Sep;11(3):261-5. [PubMed] []	" Medication errors occur frequently and have significant clinical and financial consequences. Several types of information technologies can be used to decrease rates of medication errors. Computerized physician order entry with decision support significantly reduces serious inpatient medication error rates in adults. Other available information technologies that may prove effective for inpatients include computerized medication administration records, robots, automated pharmacy systems, bar

	coding, "smart" intravenous devices, and computerized discharge prescriptions and instructions. In outpatients, computerization of prescribing and patient oriented approaches such as personalized web pages and delivery of web based information may be important. Public and private mandates for information technology interventions are growing, but further development, application, evaluation, and dissemination are required. "
Bobb A, Gleason K, Husch M et al. The epidemiology of prescribing errors: the potential impact of computerized prescriber order entry. Arch Intern Med. 2004 Apr 12;164(7):785-92. [PubMed] []	" BACKGROUND: Adverse drug events (ADEs) are the most common cause of injury to hospitalized patients and are often preventable. Medication errors resulting in preventable ADEs most commonly occur at the prescribing stage. OBJECTIVES: To describe the epidemiology of medication prescribing errors averted by pharmacists and to assess the likelihood that these errors would be prevented by implementing computerized prescriber order entry (CPOE). METHODS: At a 700-bed academic medical center in Chicago, Ill, clinical staff pharmacists saved all orders that contained a prescribing error for a week in early 2002. Pharmacist investigators subsequently classified drug class, error type, proximal cause, phase of hospitalization, and potential for patient harm and rated the likelihood that CPOE would have prevented the prescribing error. RESULTS: A total of 1111 prescribing errors were identified (62.4 errors per 1000 medication orders), most occurring on admission (64%). Of these, 30.8% were rated clinically significant and were most frequently related to anti-infective medication orders, incorrect dose, and medication knowledge deficiency. Of all verified prescribing errors, 64.4% were rated as likely to be prevented with CPOE (including 43% of the potentially harmful errors), 13.2% unlikely to be prevented with CPOE, and 22.4% possibly prevented with CPOE depending on specific CPOE system characteristics. CONCLUSIONS: Prescribing errors are common in the hospital setting. While CPOE systems could improve practitioner prescribing, design and implementation of a CPOE system should focus on errors with the greatest potential for patient harm. Pharmacist involvement, in addition to a CPOE system with advanced clinical decision support, is vital for achieving maximum medication safety. "
Doolan DF, Bates DW. Computerized physician order entry systems in hospitals: mandates and incentives. Health Aff (Millwood). 2002 Jul-Aug;21(4):180-8. [] [Health Affairs]	" Concerns with health care quality and medical errors are evident in media reports and research studies. A number of studies have demonstrated that computerized physician order entry (CPOE) can reduce medication error rates. In response, the California government and the Leapfrog Group have called for hospitals to implement CPOE for medications. However, few hospitals now use CPOE. Barriers include the large investment needed and the state of commercial CPOE systems. We argue that government, employers, and insurers should share the costs of CPOE and should fund further research into its benefits and means of implementation. "
Jennifer Dohrn, Editha Tuazon Reyes, and Lisa Willers. Annotated Bibliography for CPOE. HIMSS. [] [HIMSS]	" The search criteria included keywords: CPOE, success, implementation, case studies and medication errors. The search was limited to the English language between the years 1998-2003. The search engines and databases queried were: Google, OVID, Lexis-Nexis, MEDLINE, and Business Source Elite E-Journals. Thirty-five articles were reviewed, and the best 20 were selected for this annotated bibliography. These 20 articles were classified as research articles, journal articles, or coming from trade journals. The 20 articles were further critiqued and earned either good (7), very good (1), or excellent (12) ratings and placed into one of three sub-categories: implementation considerations (7), change management strategies (7), and implementation case studies (6). ... "

References: CPOE evaluation

Classen DC, Avery AJ, Bates DW. Evaluation and certification of computerized provider order entry systems. J Am Med Inform Assoc. 2007 Jan-Feb;14(1):48-55. Epub 2006 Oct 31.

[PubMed] []

" Computerized physician order entry (CPOE) is an application that is used to electronically write physician orders either in the hospital or in the outpatient setting. It is used in about 15% of U.S. Hospitals and a smaller percentage of ambulatory clinics. It is linked with clinical decision support, which provides much of the value of implementing it. A number of studies have assessed the impact of CPOE with respect to a variety of parameters, including costs of care, medication safety, use of guidelines or protocols, and other measures of the effectiveness or quality of care. Most of these studies have been undertaken at CPOE exemplar sites with homegrown clinical information systems. With the increasing implementation of commercial CPOE systems in various settings of care has come evidence that some implementation approaches may not achieve previously published results or may actually cause new errors or even harm. This has lead to new initiatives to evaluate CPOE systems, which have been undertaken by both vendors and other groups who evaluate vendors, focused on CPOE vendor capabilities and effective approaches to implementation that can achieve benefits seen in published studies. In addition, an electronic health record (EHR) vendor certification process is ongoing under the province of the Certification Commission for Health Information Technology (CCHIT) (which includes CPOE) that will affect the purchase and use of these applications by hospitals and clinics and their participation in public and private health insurance programs. Large employers have also joined this focus by developing flight simulation tools to evaluate the capabilities of these CPOE systems once implemented, potentially linking the results of such programs to reimbursement through pay for performance programs. The increasing role of CPOE systems in health care has invited much more scrutiny about the effectiveness of these systems in actual practice which has the potential to improve their ultimate performance. "

Wolfstadt JI, Gurwitz JH, Field TS, Lee M, Kalkar S, Wu W, Rochon PA. The effect of computerized physician order entry with clinical decision support on the rates of adverse drug events: a systematic review. J Gen Intern Med. 2008 Apr;23(4):451-8.

[PubMed] []

" CONTEXT: Computerized physician order entry (CPOE) with clinical decision support (CDS) has been promoted as an effective strategy to prevent the development of a drug injury defined as an adverse drug event (ADE). OBJECTIVE: To systematically review studies evaluating the effects of CPOE with CDS on the development of an ADE as an outcome measure. DATA SOURCES: PUBMED versions of MEDLINE (from inception through March 2007) were searched to identify relevant studies. Reference lists of included studies were also searched. METHODS: We searched for original investigations, randomized and nonrandomized clinical trials, and observational studies that evaluated the effect of CPOE with CDS on the rates of ADEs. The studies identified were assessed to determine the type of computer system used, drug categories being evaluated, types of ADEs measured, and clinical outcomes assessed. RESULTS: Of the 543 citations identified, 10 studies met our inclusion criteria. These studies were grouped into categories based on their setting: hospital or ambulatory; no studies related to the long-term care setting were identified. CPOE with CDS contributed to a statistically significant (P < or = .05) decrease in ADEs in 5 (50.0%) of the 10 studies. Four studies (40.0%) reported a nonstatistically significant reduction in ADE rates, and 1 study (10.0%) demonstrated no change in ADE rates. CONCLUSIONS: Few studies have measured the effect of CPOE with CDS on the rates of ADEs, and none were randomized controlled trials. Further research is needed to evaluate the efficacy of CPOE with CDS across the various clinical settings. "

Kilbridge PM, Welebob EM, Classen DC. Development of the Leapfrog methodology for evaluating hospital implemented inpatient computerized physician order entry systems. Qual Saf Health Care. 2006 Apr;15(2):81-4. [PubMed] []	" The 1999 Institute of Medicine report raised public awareness of the frequency and cost of adverse drug events in medicine. In response, in November 2000 a coalition of healthcare purchasers announced the formation of the Leapfrog Group, an organization dedicated to making "great leaps forward" in the safety and quality of health care in America. Their first target-computerized physician order entry (CPOE)-was selected specifically for its potential to reduce harm to patients from medications. The Leapfrog inpatient CPOE standard included a requirement that the organization operating CPOE should demonstrate via a test that their inpatient CPOE system can alert physicians to at least 50% of common serious prescribing errors. This paper outlines the development of this test which evaluates the ability of implemented CPOE systems to prevent the occurrence of medication errors that have a high likelihood of leading to adverse drug events. A framework was developed to include 12 different categories of CPOE based decision support that could prevent prescribing errors leading to adverse drug events. A scoring system was developed based on the known frequency and severity of adverse drug events. Simulated test patients and accompanying simulated test medication orders were developed to evaluate the ability of a CPOE system to intercept prescribing errors in all 12 decision support categories. The test was validated at a number of inpatient sites using both commercially available and custom developed CPOE systems. A web based application was developed to allow hospitals to self-administer the evaluation. "
Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. Arch Intern Med. 2003;163:1409–16 [PubMed] [Arch Intern Med.]	" Background Iatrogenic injuries related to medications are common, costly, and clinically significant. Computerized physician order entry (CPOE) and clinical decision support systems (CDSSs) may reduce medication error rates. Methods We identified trials that evaluated the effects of CPOE and CDSSs on medication safety by electronically searching MEDLINE and the Cochrane Library and by manually searching the bibliographies of retrieved articles. Studies were included for systematic review if the design was a randomized controlled trial, a nonrandomized controlled trial, or an observational study with controls and if the measured outcomes were clinical (eg, adverse drug events) or surrogate (eg, medication errors) markers. Two reviewers extracted all the data. Discussion resolved any disagreements. Results Five trials assessing CPOE and 7 assessing isolated CDSSs met the criteria. Of the CPOE studies, 2 demonstrated a marked decrease in the serious medication error rate, 1 an improvement in corollary orders, 1 an improvement in 5 prescribing behaviors, and 1 an improvement in nephrotoxic drug dose and frequency. Of the 7 studies evaluating isolated CDSSs, 3 demonstrated statistically significant improvements in antibiotic-associated medication errors or adverse drug events and 1 an improvement in theophylline-associated medication errors. The remaining 3 studies had nonsignificant results. Conclusions Use of CPOE and isolated CDSSs can substantially reduce medication error rates, but most studies have not been powered to detect differences in adverse drug events and have evaluated a small number of "homegrown" systems. Research is needed to evaluate commercial systems, to compare the various applications, to identify key components of applications, and to identify factors related to successful implementation of these systems. "
Kaushal R, Jha AK, Franz C et al. Return on investment for a computerized physician order entry system. J Am Med Inform Assoc. 2006 May-Jun;13(3):261-6. [PubMed] []	" OBJECTIVE: Although computerized physician order entry (CPOE) may decrease errors and improve quality, hospital adoption has been slow. The high costs and limited data on financial benefits of CPOE systems are a major barrier to adoption. The authors assessed the costs and financial benefits of the CPOE system at Brigham and Women's Hospital over ten

	years. DESIGN: Cost and benefit estimates of a hospital CPOE system at Brigham and Women's Hospital (BWH), a 720-adult bed, tertiary care, academic hospital in Boston. MEASUREMENTS: Institutional experts provided data about the costs of the CPOE system. Benefits were determined from published studies of the BWH CPOE system, interviews with hospital experts, and relevant internal documents. Net overall savings to the institution and operating budget savings were determined. All data are presented as value figures represented in 2002 dollars. RESULTS: Between 1993 and 2002, the BWH spent $11.8 million to develop, implement, and operate CPOE. Over ten years, the system saved BWH $28.5 million for cumulative net savings of $16.7 million and net operating budget savings of $9.5 million given the institutional 80% prospective reimbursement rate. The CPOE system elements that resulted in the greatest cumulative savings were renal dosing guidance, nursing time utilization, specific drug guidance, and adverse drug event prevention. The CPOE system at BWH has resulted in substantial savings, including operating budget savings, to the institution over ten years. CONCLUSION: Other hospitals may be able to save money and improve patient safety by investing in CPOE systems. "
Judge J, Field TS, Deflorio M et al. Prescribers' Responses to Alerts During Medication Ordering in the Long Term Care Setting. J Am Med Inform Assoc. 2006 [PubMed] []	" OBJECTIVE Computerized physician order entry with clinical decision support has been shown to improve medication safety in adult inpatients, but few data are available regarding its usefulness in the long-term care setting. The objective of this study was to examine opportunities for improving medication safety in that clinical setting by determining the proportion of medication orders that would generate a warning message to the prescriber via a computerized clinical decision support system and assessing the extent to which these alerts would affect prescribers' actions. DESIGN The study was set within a randomized controlled trial of computerized clinical decision support conducted in the long-stay units of a large, academically-affiliated long-term care facility. In March 2002, a computer-based clinical decision support system (CDSS) was added to an existing computerized physician order entry (CPOE) system. Over a subsequent one-year study period, prescribers ordering drugs for residents on three resident-care units of the facility were presented with alerts; these alerts were not displayed to prescribers in the four control units. MEASUREMENTS We assessed the frequency of drug orders associated with various categories of alerts across all participating units of the facility. To assess the impact of actually receiving an alert on prescriber behavior during drug ordering, we calculated separately for the intervention and control units the proportion of the alerts, within each category, that were followed by an appropriate action and estimated the relative risk of an appropriate action in the intervention units compared to the control units. RESULTS During the 12 months of the study, there were 445 residents on the participating units of the facility, contributing 3,726 resident-months of observation time. During this period, 47,997 medication orders were entered through the CPOE system - approximately 9 medication orders per resident per month. 9,414 alerts were triggered (2.5 alerts per resident-month). The alert categories most often triggered were related to risks of central nervous system side-effects such as over-sedation (20%). Alerts for risk of drug-associated constipation (13%) or renal insufficiency/electrolyte imbalance (12%) were also common. Twelve percent of the alerts were related to orders for warfarin. Overall, prescribers who received alerts were only slightly more likely to take an appropriate action (relative risk 1.11, 95% confidence interval 1.00, 1.22). Alerts related to orders for warfarin or central nervous system side effects were most likely to engender an appropriate action, such as ordering a recommended laboratory test or canceling an ordered drug. CONCLUSION Long-term care facilities must implement new system-level approaches with the potential to

	improve medication safety for their residents. The number of medication orders that triggered a warning message in this study suggests that CPOE with a clinical decision support system may represent one such tool. However, the relatively low rate of response to these alerts suggests that further refinements to such systems are required, and that their impact on medication errors and adverse drug events must be carefully assessed. "
Zhan C, Hicks RW, Blanchette CM, Keyes MA, Cousins DD. Potential benefits and problems with computerized prescriber order entry: analysis of a voluntary medication error-reporting database. Am J Health Syst Pharm. 2006 Feb 15;63(4):353-8. [PubMed] []	" PURPOSE: The potential benefits and problems associated with computerized prescriber-order-entry (CPOE) systems were studied. METHODS: A national voluntary medication error-reporting database, Medmarx, was used to compare facilities that had CPOE with those that did not have CPOE. The characteristics of medication errors reportedly caused by CPOE were explored, and the text descriptions of these errors were qualitatively analyzed. RESULTS: Facilities with CPOE reported fewer inpatient medication errors and more outpatient medication errors than facilities without CPOE, but the statistical significance of these differences could not be determined. Facilities with CPOE less frequently reported medication errors that reached patients ($p < 0.01$) or harmed patients ($p < 0.01$). More than 7000 CPOE-related medication errors were reported over seven months in 2003, and about 0.1% of them resulted in harm or adverse events. The most common CPOE errors were dosing errors (i.e., wrong dose, wrong dosage form, or extra dose). Both quantitative and qualitative analyses indicate that CPOE could lead to medication errors not only because of faulty computer interface, mis-communication with other systems, and lack of adequate decision support but also because of common human errors such as knowledge deficit, distractions, inexperience, and typing errors. CONCLUSION: A national, voluntary medication error-reporting database cannot be used to determine the effectiveness of a CPOE system in reducing medication errors because of the variability in the number of reports from different institutions. However, it may provide valuable information on the specific types of errors related to CPOE systems. "
Galanter WL, Didomenico RJ, Polikaitis A. A trial of automated decision support alerts for contraindicated medications using computerized physician order entry. J Am Med Inform Assoc. 2005 May-Jun;12(3):269-74. [PubMed] []	" BACKGROUND: Automated clinical decision support has shown promise in reducing medication errors; however, clinicians often do not comply with alerts. Because renal insufficiency is a common source of medication errors, the authors studied a trial of alerts designed to reduce inpatient administration of medications contraindicated due to renal insufficiency. METHODS: A minimum safe creatinine clearance was established for each inpatient formulary medication. Alerts recommending cancellation appeared when a medication order was initiated for a patient whose estimated creatinine clearance was less than the minimum safe creatinine clearance for the medication. Administration of medications in patients with creatinine clearances less than the medication's minimum safe clearance were studied for 14 months after, and four months before, alert implementation. In addition, the impact of patient age, gender, degree of renal dysfunction, time of day, and duration of housestaff training on the likelihood of housestaff compliance with the alerts was examined. RESULTS: The likelihood of a patient receiving at least one dose of contraindicated drug after the order was initiated decreased from 89% to 47% ($p < 0.0001$) after alert implementation. Analysis of the alerts seen by housestaff showed that alert compliance was higher in male patients (57% vs. 38%, $p = 0.02$), increased with the duration of housestaff training ($p = 0.04$), and increased in patients with worsening renal function ($p = 0.007$). CONCLUSION: Alerts were effective in decreasing the ordering and administration of drugs contraindicated due to renal insufficiency. Compliance with the alerts was higher in male patients, increased with the duration of

	housestaff training, and increased in patients with more severe renal dysfunction. "
Aarts J, Berg M. Same systems, different outcomes--comparing the implementation of computerized physician order entry in two Dutch hospitals. Methods Inf Med. 2006;45(1):53-61. [PubMed] []	" OBJECTIVES: To compare the outcome of the implementation of computerized physician order entry (CPOE) systems in two Dutch hospitals. METHODS: Qualitative research methods, including interviews in both hospitals, observations of system in use, observations of staff meetings and document analysis were used to understand the implementation of CPOE. The transcribed texts and implementation documents were analyzed for relevant concepts. The transcripts and field notes were analyzed using a heuristic success and failure model with medical work as the primary focus. RESULTS: Occasions that determined the outcome of the implementation were classified according to factors that may influence the success or failure of implementing systems. CONCLUSIONS: The themes and patterns that emerged from the data helped validate the concept of medical work as the primary focus of our analysis model; in addition the concept of a support base necessary to accept changes in medical work that result from introducing CPOE may help to understand the different implementation outcomes. "
Colpaert K, Claus B, Somers A et al. Impact of computerized physician order entry on medication prescription errors in the intensive care unit: a controlled cross-sectional trial. Crit Care. 2006 Jan 26;10(1):R21 [PubMed] [Critical Care Forum]	" ABSTRACT : INTRODUCTION : Medication errors in the intensive care unit (ICU) are frequent and lead to attributable patient morbidity and mortality, increased length of ICU stay and substantial extra costs. We investigated if the introduction of a computerized ICU system (Centricity Critical Care Clinisoft, GE Healthcare) reduced the incidence and severity of medication prescription errors (MPEs). METHODS : A prospective trial was conducted in a paper-based unit (PB-U) versus a computerized unit (C-U) in a 22-bed ICU of a tertiary university hospital. Every medication order and medication prescription error was validated by a clinical pharmacist. The registration of different classes of MPE was done according to the National Coordinating Council for Medication Error Reporting and Prevention guidelines. An independent panel evaluated the severity of MPEs. We identified three groups: minor MPEs (no potential to cause harm); intercepted MPEs (potential to cause harm but intercepted on time); and serious MPEs (non-intercepted potential adverse drug events (ADE) or ADEs, being MPEs with potential to cause, or actually causing, patient harm). RESULTS : The C-U and the PB-U each contained 80 patient-days, and a total of 2,510 medication prescriptions were evaluated. The clinical pharmacist identified 375 MPEs. The incidence of MPEs was significantly lower in the C-U compared with the PB-U (44/1286 (3.4%) versus 331/1224 (27.0%); P < 0.001). There were significantly less minor MPEs in the C-U than in the PB-U (9 versus 225; P < 0.001). Intercepted MPEs were also lower in the C-U (12 versus 46; P < 0.001), as well as the non-intercepted potential ADEs (21 versus 48; P < 0.001). There was also a reduction of ADEs (2 in the C-U versus 12 in the PB-U; P < 0.01). No fatal errors occurred. The most frequent drug classes involved were cardiovascular medication and antibiotics in both groups. Patients with renal failure experienced less dosing errors in the C-U versus the PB-U (12 versus 35 serious MPEs; P < 0.001). CONCLUSION : The ICU computerization, including the medication order entry, resulted in a significant decrease in the occurrence and severity of medication errors in the ICU. "
Caudill-Slosberg M, Weeks WB. Case study: identifying potential problems at the human/technical interface in complex clinical systems. Am J Med Qual. 2005 Nov-Dec;20(6):353-7.	" Many who would like to improve patient safety in health care have advocated for the widespread adoption of computerized physician order entry and electronic medical records. However, unforeseen consequences of this new technology may put patients at greater risk of harm, not less. The authors present a clinical scenario that demonstrates system

[PubMed] [SAGE publications]	vulnerabilities in the interface between humans and such technology. Furthermore, the authors suggest that managers could anticipate these vulnerabilities by using techniques such as cause-and-effect analysis or failure mode and effect analysis, both before the installation of electronic medical records and as ongoing surveillance mechanisms. The case study demonstrates that adoption of technology is not a quick fix to the patient safety issue; proactive and ongoing efforts to address the human factors issues raised by the introduction of new technology will be required to prevent patient harm. "
Cheng CH, Goldstein MK, Geller E, Levitt RE. The Effects of CPOE on ICU workflow: an observational study. AMIA Annu Symp Proc. 2003;:150-4. [PubMed] []	" Computerized physician order entry (CPOE) has had demonstrated benefits in error reduction and guideline adherence, but its implementation has often been complicated by disruptions in established workflow processes. We conducted an observational study of the healthcare team in an intensive care unit after the implementation of mandatory CPOE. We found that policies designed to increase flexibility and safety led to an increased coordination load on the healthcare team, and created opportunities for new sources of error. We attribute this in part to implicit assumptions in the CPOE system design that execution of physician orders is a linear work process. Observational workflow studies are an important tool to understand how to redesign CPOE systems so as to avoid harm and achieve the full potential of benefit for improved patient safety. "

References: issues

Schedlbauer A, Prasad V, Mulvaney C, Phansalkar S, Stanton W, Bates DW, Avery AJ. What evidence supports the use of computerized alerts and prompts to improve clinicians' prescribing behavior? J Am Med Inform Assoc. 2009 Jul-Aug;16(4):531-8. Epub 2009 Apr 23. [PubMed] []	" Alerts and prompts represent promising types of decision support in electronic prescribing to tackle inadequacies in prescribing. A systematic review was conducted to evaluate the efficacy of computerized drug alerts and prompts searching EMBASE, CINHAL, MEDLINE, and PsychINFO up to May 2007. Studies assessing the impact of electronic alerts and prompts on clinicians' prescribing behavior were selected and categorized by decision support type. Most alerts and prompts (23 out of 27) demonstrated benefit in improving prescribing behavior and/or reducing error rates. The impact appeared to vary based on the type of decision support. Some of these alerts (n = 5) reported a positive impact on clinical and health service management outcomes. For many categories of reminders, the number of studies was very small and few data were available from the outpatient setting. None of the studies evaluated features that might make alerts and prompts more effective. Details of an updated search run in Jan 2009 are included in the supplement section of this review. "
Gross PA, Bates DW. A Pragmatic Approach to Implementing Best Practices for Clinical Decision Support Systems in Computerized Provider Order Entry Systems J Am Med Inform Assoc. 2007 Jan-Feb;14(1):25-8. Epub 2006 Oct 26. [PubMed] [JAMIA]	" Incorporation of clinical decision support (CDS) capabilities is required to realize the greatest benefits from computerized provider order entry (CPOE) systems. Discussions at a conference on CDS in CPOE held in San Francisco, California, June 21–22, 2005 produced several papers in this issue of JAMIA. The first paper reviews CDS for electronic prescribing within CPOE systems;1 the second describes current controversies regarding creation, maintenance, and uses of CPOE order sets for CDS;2 and the third presents issues related to certification as a potential means of validating CPOE systems for widespread use.3 This manuscript summarizes all of the discussions at the meeting and provides a pragmatically oriented view of how to implement CPOE with CDS. "

Kuperman GJ, Bobb A, Payne TH et al. Medication-related clinical decision support in computerized provider order entry systems: a review. J Am Med Inform Assoc. 2007 Jan-Feb;14(1):29-40. Epub 2006 Oct 26. Review. [PubMed] []	" While medications can improve patients' health, the process of prescribing them is complex and error prone, and medication errors cause many preventable injuries. Computer provider order entry (CPOE) with clinical decision support (CDS), can improve patient safety and lower medication-related costs. To realize the medication-related benefits of CDS within CPOE, one must overcome significant challenges. Healthcare organizations implementing CPOE must understand what classes of CDS their CPOE systems can support, assure that clinical knowledge underlying their CDS systems is reasonable, and appropriately represent electronic patient data. These issues often influence to what extent an institution will succeed with its CPOE implementation and achieve its desired goals. Medication-related decision support is probably best introduced into healthcare organizations in two stages, basic and advanced. Basic decision support includes drug-allergy checking, basic dosing guidance, formulary decision support, duplicate therapy checking, and drug-drug interaction checking. Advanced decision support includes dosing support for renal insufficiency and geriatric patients, guidance for medication-related laboratory testing, drug-pregnancy checking, and drug-disease contraindication checking. In this paper, the authors outline some of the challenges associated with both basic and advanced decision support and discuss how those challenges might be addressed. The authors conclude with summary recommendations for delivering effective medication-related clinical decision support addressed to healthcare organizations, application and knowledge base vendors, policy makers, and researchers. "
Saathoff A. Human factors considerations relevant to CPOE implementations. J Healthc Inf Manag. 2005 Summer;19(3):71-8. Review. [PubMed] []	" Although many studies have discussed the benefits of computerized provider order entry (CPOE), the actual number of hospitals using this technology remains low because of the many challenges that accompany the implementation of CPOE in healthcare facilities. It is common for user resistance to challenge implementation efforts. As more hospitals undertake CPOE implementations, a solid understanding of how to foster acceptance of CPOE is necessary to reap the benefits of medical error reduction, improved quality of care, and decreased healthcare costs. The principles and practices of human factors can be used to bolster physician satisfaction and increase usability, thereby increasing the chances of success for CPOE implementation. This article reviews the recent literature regarding CPOE and human factors, discussing how the human factors principles of task analysis, interface design, and computer supported cooperative work can be utilized to promote user acceptance and enhance CPOE implementation efforts. "
Levick D, Lukens HF, Stillman PL. You've led the horse to water, now how do you get him to drink: managing change and increasing utilization of computerized provider order entry. J Healthc Inf Manag. 2005 Winter;19(1):70-5. [PubMed] []	" Community hospitals served by predominately private-practice physicians face difficult challenges in implementing computerized provider order entry (CPOE), but there are techniques and incentives that can be employed to change physician behavior Various techniques were used to increase CPOE utilization at Lehigh Valley Hospital, a three-campus, 750-bed tertiary community hospital in eastern Pennsylvania. Those techniques included presenting studies supporting CPOE as a way to improve patient care, recognizing support with small trinkets, providing individual access to computers, adding clinical decision support, and bringing peer pressure to bear Ultimately, financial compensation for the educational time required to learn to use and become proficient with the system was employed and had the greatest impact on behavior Measuring utilization of the CPOE system with data extracted from the hospital's clinical information system, CPOE utilization by physicians increased to 57 percent from 35 percent after a financial compensation program was initiated. Utilization

	declined to 42 percent several months after completing the first phase of the program and increased to 54 percent after a second phase was initiated. "
Koppel R, Metlay JP, Cohen A et al. Role of computerized physician order entry systems in facilitating medication errors. JAMA. 2005 Mar 9;293(10):1197-203. [PubMed] []	" CONTEXT: Hospital computerized physician order entry (CPOE) systems are widely regarded as the technical solution to medication ordering errors, the largest identified source of preventable hospital medical error. Published studies report that CPOE reduces medication errors up to 81%. Few researchers, however, have focused on the existence or types of medication errors facilitated by CPOE. OBJECTIVE: To identify and quantify the role of CPOE in facilitating prescription error risks. DESIGN, SETTING, AND PARTICIPANTS: We performed a qualitative and quantitative study of house staff interaction with a CPOE system at a tertiary-care teaching hospital (2002-2004). We surveyed house staff (N = 261; 88% of CPOE users); conducted 5 focus groups and 32 intensive one-on-one interviews with house staff, information technology leaders, pharmacy leaders, attending physicians, and nurses; shadowed house staff and nurses; and observed them using CPOE. Participants included house staff, nurses, and hospital leaders. MAIN OUTCOME MEASURE: Examples of medication errors caused or exacerbated by the CPOE system. RESULTS: We found that a widely used CPOE system facilitated 22 types of medication error risks. Examples include fragmented CPOE displays that prevent a coherent view of patients' medications, pharmacy inventory displays mistaken for dosage guidelines, ignored antibiotic renewal notices placed on paper charts rather than in the CPOE system, separation of functions that facilitate double dosing and incompatible orders, and inflexible ordering formats generating wrong orders. Three quarters of the house staff reported observing each of these error risks, indicating that they occur weekly or more often. Use of multiple qualitative and survey methods identified and quantified error risks not previously considered, offering many opportunities for error reduction. CONCLUSIONS: In this study, we found that a leading CPOE system often facilitated medication error risks, with many reported to occur frequently. As CPOE systems are implemented, clinicians and hospitals must attend to errors that these systems cause in addition to errors that they prevent. " Note: the Eclipsys system studied was not considered state-of-the-art and was replaced by a more up-to-date system in the hospital.
Horsky J, Kuperman GJ, Patel VL. Comprehensive analysis of a medication dosing error related to CPOE. J Am Med Inform Assoc. 2005 Jul-Aug;12(4):377-82. [PubMed] [JAMIA]	" This case study of a serious medication error demonstrates the necessity of a comprehensive methodology for the analysis of failures in interaction between humans and information systems. The authors used a novel approach to analyze a dosing error related to computer-based ordering of potassium chloride (KCl). The method included a chronological reconstruction of events and their interdependencies from provider order entry usage logs, semistructured interviews with involved clinicians, and interface usability inspection of the ordering system. Information collected from all sources was compared and evaluated to understand how the error evolved and propagated through the system. In this case, the error was the product of faults in interaction among human and system agents that methods limited in scope to their distinct analytical domains would not identify. The authors characterized errors in several converging aspects of the drug ordering process: confusing on-screen laboratory results review, system usability difficulties, user training problems, and suboptimal clinical system safeguards that all contributed to a serious dosing error. The results of the authors' analysis were used to formulate specific recommendations for interface layout and functionality modifications, suggest new user alerts, propose changes to user training, and

	address error-prone steps of the KCl ordering process to reduce the risk of future medication dosing errors "
Han YY, Carcillo JA, Venkataraman ST, Clark RS, Watson RS, Nguyen TC, Bayir H, Orr RA. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. Pediatrics. 2005 Dec;116(6):1506-12. [PubMed] []	" OBJECTIVE: In response to the landmark 1999 report by the Institute of Medicine and safety initiatives promoted by the Leapfrog Group, our institution implemented a commercially sold computerized physician order entry (CPOE) system in an effort to reduce medical errors and mortality. We sought to test the hypothesis that CPOE implementation results in reduced mortality among children who are transported for specialized care. METHODS: Demographic, clinical, and mortality data were collected of all children who were admitted via interfacility transport to our regional, academic, tertiary-care level children's hospital during an 18-month period. A commercially sold CPOE program that operated within the framework of a general, medical-surgical clinical application platform was rapidly implemented hospital-wide over 6 days during this period. Retrospective analyses of pre-CPOE and post-CPOE implementation time periods (13 months before and 5 months after CPOE implementation) were subsequently performed. RESULTS: Among 1942 children who were referred and admitted for specialized care during the study period, 75 died, accounting for an overall mortality rate of 3.86%. Univariate analysis revealed that mortality rate significantly increased from 2.80% (39 of 1394) before CPOE implementation to 6.57% (36 of 548) after CPOE implementation. Multivariate analysis revealed that CPOE remained independently associated with increased odds of mortality (odds ratio: 3.28; 95% confidence interval: 1.94-5.55) after adjustment for other mortality covariables. CONCLUSIONS: We have observed an unexpected increase in mortality coincident with CPOE implementation. Although CPOE technology holds great promise as a tool to reduce human error during health care delivery, our unanticipated finding suggests that when implementing CPOE systems, institutions should continue to evaluate mortality effects, in addition to medication error rates, for children who are dependent on time-sensitive therapies. "
(No authors listed.) Healthcare Benchmarks Qual Improv. 2006 Feb;13(2):16-7. Study: implementation of CPOE can raise mortality. [[PubMed FIND .....] []	" Using CPOE systems can take significantly more time, leading to costly delays in patient care. The system works best with patients who don't require many meds to save their lives. Once a hospital has made a financial commitment, it's difficult to get administration to drop a system. "
Sengstack PP, Gugerty B. CPOE systems: success factors and implementation issues. J Healthc Inf Manag. 2004 Winter;18(1):36-45. [PubMed] []	" The medication error dilemma has come to the forefront of most hospitals' improvement agendas. The most often cited solution to the problem has been computerized provider order entry (CPOE) systems. These systems have significant potential to improve errors associated with illegibility as well as inappropriate drug use and dosing. On the other hand, CPOE system implementation is fraught with barriers that impede acceptance and use of these systems. Knowing what strategies have proven successful and what upfront analysis is required can help increase the chances of success and ultimately improve the quality of patient care. "
Shortliffe EH. CPOE and the facilitation of medication errors. J Biomed Inform. 2005 Aug;38(4):257-8. [PubMed] []	" "

References: CPOE and decision support

Kawamoto K, Lobach DF. Clinical decision support provided within physician order entry systems: a systematic review of features effective for changing clinician behavior. AMIA Annu Symp Proc. 2003;:361-5. Review.

[PubMed] []

" Computerized physician order entry (CPOE) systems represent an important tool for providing clinical decision support. In undertaking this systematic review, our objective was to identify the features of CPOE-based clinical decision support systems (CDSSs) most effective at modifying clinician behavior. For this review, two independent reviewers systematically identified randomized controlled trials that evaluated the effectiveness of CPOE-based CDSSs in changing clinician behavior. Furthermore, each included study was assessed for the presence of 14 CDSS features. We screened 10,023 citations and included 11 studies. Of the 10 studies comparing a CPOE-based CDSS intervention against a non-CDSS control group, 7 reported a significant desired change in professional practice. Moreover, meta-regression analysis revealed that automatic provision of the decision support was strongly associated with improved professional practice (adjusted odds ratio, 23.72; 95% confidence interval, 1.75-infiniti). Thus, we conclude that automatic provision of decision support is a critical feature of successful CPOE-based CDSS interventions. "

links

- Leapfrog Group - "an initiative driven by organizations that buy health care who are working to initiate breakthrough improvements in the safety, quality and affordability of healthcare for Americans."
- Leapfrog Group CPOE factsheet
- HIMSS - Healthcare Information and Management Systems Society (US healthcare industry's membership organization - advocates use of healthcare information technology to improve patient safety and quality of care...")
- Agency for Healthcare Research and Quality (AHRQ) (US Department of Health and Human Services)
- Joint Council on Accreditation of Healthcare Organizations (JCAHO) (mission: "improve the safety and quality of care provided to the public through the provision of health care accreditation" ...)
- NCQA: National Committee for Quality Assurance
- URAC - organization offering accreditation and certification programs to ensure health care quality
- Institute for Healthcare Improvement - based in Cambridge, Massachusetts, campaigns to improve health care worldwide
- ECRI - "a nonprofit health services research agency ...[whose] ... mission is to improve the safety, quality and cost-effectiveness of healthcare"
- e-prescribing [OC]
- Health information technology adoption, programmes and plans [OC]
- MEDERRORS.com from Cerner Bridge Medical
- World Alliance for Patient Safety (WHO)
- National Patient Safety Agency (UK) - "Special Health Authority created to co-ordinate the efforts of all those involved in healthcare, and more importantly to learn from, patient safety incidents occurring in the NHS."
- Sweden National Board of Health and Welfare Patient safety - Socialstyrelsen, Patientsäkerhet
- Australian Commission on Safety & Quality in Health Care

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page history

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