Computerised prescribing for safer medication ordering: still a work in progress

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Received 5 August 2015
Revised 6 October 2015
Accepted 11 October 2015
Published Online First 29 October 2015

To cite: Schiff GD, Hickman T-TT, Volk LA, *et al*. *BMJ Qual Saf* 2016;**25**:315–319.

Fuelled by compelling evidence that computerised provider order entry (CPOE) improves medication safety and the infusion of tens of billions of federal electronic medical record (EMR) stimulus dollars, electronic medication prescribing in the USA has gone from <10% to >70% of prescriptions being written electronically in just the past six years.[1–4] Most medications are now ordered electronically both inside and outside the hospital, and they are being sent in electronically to pharmacies. Although many of the initial obstacles to the widespread adoption of CPOE such as physician resistance, lack of standards for electronically transmitting prescriptions to pharmacies and lack of standards for drug databases (leading some organisations to resort to 'home-grown' solutions) have been largely overcome, CPOE remains a work in progress. A series of studies by the U.S. Institute of Medicine and Office of the National Coordinator for Health Information Technology (HIT) have recently spotlighted a number of potential safety risks.[5–7]

To better understand these risks and the opportunities for improvement, particularly as they relate to drug names and drug ordering, the U.S. Food and Drug Administration Center for Drug Evaluation and Research's Division of Medication Error Prevention and Analysis contracted the Brigham and Women's Hospital (BWH) Center for Patient Safety Research and Practice to study CPOE and risks that could potentially lead to medication errors.

The findings from this 2-year investigation have recently been compiled into a White Paper entitled *Computerized Prescriber Order Entry Medication Safety (CPOEMS): Uncovering and Learning from Issues and Errors*.[8] It documents issues about which policy and patient safety leaders, along with clinicians, pharmacists and patients, need to be aware to minimise the risk of CPOE-related errors. Here, we share the main findings and our own perspectives based on this review of 10 CPOE systems (four inpatient, six outpatient) at six sites, including two 'home-grown' systems developed in our academic medical centre plus several implementations of leading commercial systems.

In the first phase of the project, the BWH team worked with the sites to assess CPOE workflows and screen designs using a standardised evaluation tool and set of test orders. The BWH team of pharmacists, physicians, patient safety and informatics experts created the CPOE Assessment Tool (CAT) to standardise the assessment of features across these 10 systems.[8] The CAT included a series of medication ordering scenarios designed to investigate the systems and to capture CPOE functions and screen displays. We found remarkable variability and myriad error-prone features, user frustrations and unexpected glitches.

In the second phase, the team collected and reviewed safety reports and system changes from these 10 systems to identify and better understand CPOE safety problems. Additionally, we prospectively emailed daily queries to users in our own system who discontinued CPOE orders with the discontinuation reason being 'error (erroneous entry)'. We asked users to provide details suggesting the reason(s) for the errors. Box 1 summarises the findings of the variety of problems we uncovered in the project, most of which were seen in multiple systems.

Particularly relevant safety examples included:

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Box 1 Summary of computerised prescriber order entry (CPOE) issues identified by the CPOE medication safety project

Inconsistencies in display of drugs, drug names and workflow within and between systems

- Drug name displays, even in the same systems, use a mix of various brand/products versus generic names; combination products' components; names truncated at times.
- Challenges and risks were seen when prescribers used multiple, different systems (eg, inpatient vs outpatient, >1 system) that often display drug names differently.

Issues with ease and accuracy in finding desired drug and regimen

- Searches can return overwhelming number of results, including non-medications such as lab tests orders (eg, supplemental potassium vs orders for serum potassium level), rarely used preparations or even withdrawn drugs, poorly filtered to individual patient. No narrowing of choices by patient setting (eg, oncology) or indication (see figure 1).
- Searches for desired product often fail to retrieve the drug (eg, typing brand name in system that relies on generic names returns no matches).
- Potentials for look-alike and pull-down 'menu adjacency' errors; items can be overlooked because they are buried beneath truncated drop-down displays.

Wrong patient errors

- Ability to enter orders on wrong patient without visual/workflow affordances (eg, patient picture) or warnings such as 'smart alerts' to recognise/prevent entering inconsistent orders, particularly when multiple charts are open simultaneously.

Issues with comments and other free text fields in the prescription order

- Confusion regarding whether text comments are intended for ordering provider, the pharmacist and/or patient (ie, should be placed on the label).
- Despite some benefits, such as added communication of prescriber intention to pharmacist, free text produces various undesirable consequences such as non-standardised messages; free text sig information that bypasses decision support protections, and use of text for information that would be more standardised and safer if coded.
- Failure of systems to 'learn' from sig comments (ie, collect and analyse instances where the prescriber has to resort to free text) as markers and workarounds for potentially needed CPOE improvements.

Clinical decision support (CDS): poor consistency, reliability, efficiency

- Variability: alerts fire inconsistently depending on user, the way an order is placed (eg, if ordered from 'favourites' or an order set) may or may not fire depending on, whether it was an initial order versus refill, change after upgrades, or which system was being used.
- Over-firing of CDS alerts, with many false positive or irrelevant alerts that are not sufficiently specific to that patient or care context, leading to large-scale ignoring/overriding of most alerts.
- While alerts are commonly ignored or overridden, useful information about reasons is generally not being captured or analysed.
- Lack of standardisation and use of third-party drug compendia (either bundled with CPOE software systems or third-party commercial vendors who supply decision support data) versus the development and local customisation of alerts.

Interoperability/communication issues between CPOE systems and pharmacies

- Problems directing prescriptions to patient's desired pharmacy; electronic transmissions still being sent/received as faxes requiring manual re-entry into pharmacy systems.
- Paucity of two-way communication (eg, feedback from pharmacies on patient adherence, issues related to CPOE prescriptions they receive).
- Drug discontinuations by prescribers in the CPOE system that are not transmitted to outpatient pharmacies; this is particularly dangerous when a medication is stopped for adverse effects and pharmacy continues to dispense refills.
- Prescribing controlled substances electronically requires inefficient, often less secure, separate paper processes.

Medication reconciliation (maintaining and updating accurate, current list of medications): issues and tools

- Poorly developed tools for organising and efficiently reconciling multiple medication lists and orders, particularly across different systems or transitions (eg, from inpatient to outpatient setting).
- Lack of clearly shared operational definitions for terms commonly used in reconciliation modules (eg, 'not taking') with unclear roles and responsibilities for non-physician staff to work with patients to update medication lists.

Widespread failure to identify, understand, track, share and learn from CPOE issues/errors

- Errors often go unnoticed, unreported and those that are, are often inadequately analysed, tracked, shared and fixed.
- Multiple silos within organisations where CPOE problems reside (safety reports, help desk logs, vendor reports and databases) that are rarely integrated and leveraged for improvement.
- Failure of CPOE vendors to transparently share errors, insights, ways to improve.
- Paucity of systematic mechanisms for sharing, acting on health information technology safety learning recommendations slowing collective learning and improvements.

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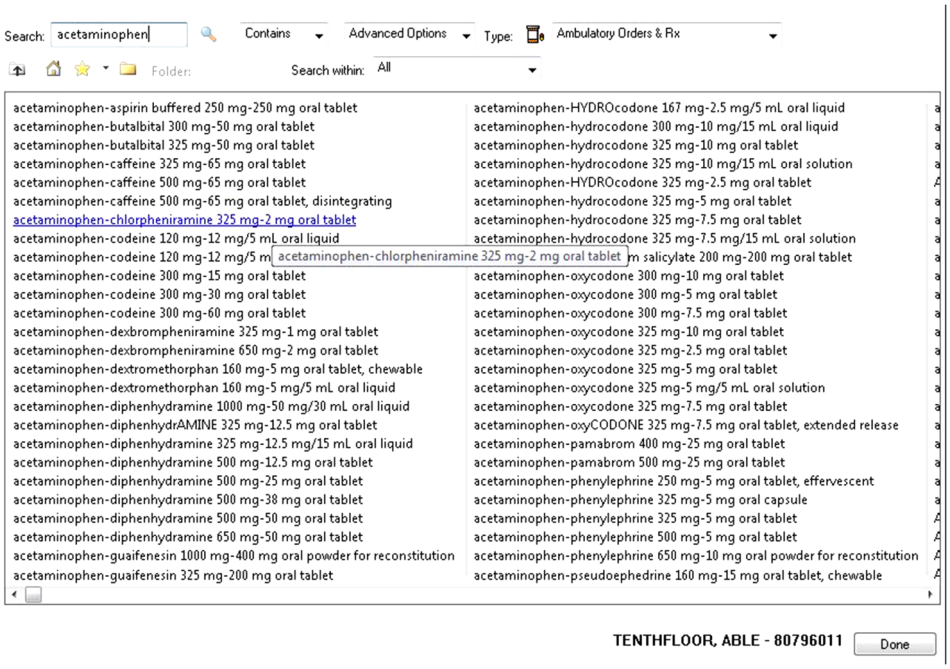

Figure 1 Illustration of the overwhelming number of acetaminophen (paracetamol) products/choices that are displayed when a prescriber enters a simple search for acetaminophen in a widely used commercial inpatient computerised provider order entry system.

1. *Prescribers encountered problems finding the medication they wanted to order*. Search functions differed across the systems, and users were sometimes unaware of the various ways that drugs could be found listed in their system(s). Examples include the inability to search on more familiar brand names in some systems, return of an overwhelming number of drugs and drug products (see figure 1), which both made the intended drug hard to find and at times led to serious errors, and sometimes dangerous 'auto-complete' drug 'sigs' (directions on the label) that displaced or contradicted intended orders and regimens.
2. *In the inpatient setting, users had difficulties temporarily placing orders 'on hold'*. Some systems have options to suspend drugs only when patients enter the operating room. Other systems can hold orders for only a few drugs. We found multiple examples of related safety issues such as failures to restart anticoagulation after being held for surgery.
3. *Failure to transmit CPOE medication discontinuation orders to outpatient pharmacies*. When a previously electronically prescribed medication is discontinued in the CPOE system, this is recorded in the local CPOE EMR, but there is no notification of a discontinuation order sent to the pharmacy. This creates a serious vulnerability (particularly for drugs discontinued due to adverse reactions) with patients having repeated refills dispensed despite being discontinued by the prescriber in the CPOE system.[9]
4. *Patient identification and wrong patient errors*. While wrong patient errors can occur with paper and CPOE, there is added vulnerability in CPOE because of the ease with which the wrong patient name can be selected, or when multiple charts are open simultaneously on the user's screen).[10] We found this was the leading cause of prescriptions being entered and then discontinued with the reason for the discontinuation being given as entered in error.
5. *Persistence of coexisting 'paper' and electronic prescriptions*. This was found mainly for controlled substances. Despite the planned implementation of CPOE for opiates and other controlled drugs, this has not been realised for numerous reasons, creating workflow issues and inefficiencies.
6. *Inconsistent clinical decision support (CDS) design, implementation and firing*. In some CPOE systems, the CDS varied according to the user's role. We found, as have others, that whether CDS fires may vary depending on who is placing the order or whether a drug is being ordered by brand or generic name or from a favourites menu. Sometimes, this appeared to represent smart customisation to tailor to the individual users; other times the inconsistencies appeared to be unintended CDS design glitches. Many alerts were confusing and/or poorly designed with >90% over-ride rates (suggesting insufficient attention to false-positive alerts and poor capabilities of organisations to effectively monitor how their alerts and clinicians are behaving).
7. *Variable use of commercial drug databases versus local customisation*. Sites variably used the CDS features of their off-the-shelf commercial drug compendia, finding them poorly designed to meet their needs. Instead, they often undertook extensive customisation that, at times, required error-prone manual efforts to maintain with each software release.

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Beyond the specific issues with CPOE systems, we found a worrisome lack of organised systems to collect and learn from these errors, both locally within organisations and nationally. At the study sites, we found a serious dearth of systematic collection or analysis of problems and an absence of organised 'interoperable' data and taxonomies to allow data to be shared and connected to other error reports. We also found a lack of systems to report, classify, track, learn from and share the errors and problems that were identified. Rather, problems were compartmentalised into various organisational silos such as computer help desk logs, medication safety reports, vendor feedback comments or requests for decision support modifications that rarely coalesced into a picture that connected the dots on problems users and the organisation were experiencing.

Further, we uncovered failures to connect user frustrations with potential and actual safety issues. Not only does patient care suffer when, for example, frustrated physicians search but are unable to find a desired drug, this may lead them to resort to potentially dangerous workarounds such as placing drug dosing information into free text comments fields where dose limit checks cannot be performed. The inability to check drug dosing can lead to dangerous overdoses or other types of errors—a problem we also found in our prior studies.[5]

Problematic communication failures were also evident in safety reports we reviewed, such as the above example of failure to notify outpatient pharmacies when a medication is discontinued. Unlike orders to start a drug, which are transmitted to the patient's pharmacy triggering the dispensing of a drug, discontinuation orders that inactivate a drug in the CPOE record are not currently transmitted to outpatient pharmacies. Additionally, pharmacists, as the downstream recipients of electronic drug orders, encounter a myriad of other issues and problems emanating from CPOE systems. However, most organisations do not have well-developed approaches to tap into their rich experience with problem prescriptions. Even when pharmacists do report issues, these are often handled as 'one-offs' and there are not good approaches for aggregating the issues they identify.

RECOMMENDATIONS

Meaningful progress depends on learning from actual use and issues and users' experiences. The following recommendations drawn from the White Paper reinforce similar recommendations for improving patient safety in general, and HIT in particular,[6 7 11] and are essential to gain traction and accelerate progress.

Pay increased attention to human factors design and workflow issues to address recurring problems: We identified issues such as brand versus generic name confusion in searching and displays, suboptimal context relevant 'filtering' of drug choices (see figure 1), difficulties in reconciling medications from multiple prescribers and sources, problems routing prescriptions to the proper pharmacy, challenges facing prescribers who must use multiple CPOE systems with no standardisation of displays or workflows and CDS that generates more false positives than clinically meaningful alerts.

While vendors are already required to attest that they use user-centred design to be certified, they actually do so at highly variable rates.[12] Public information about usability scores of EHRs will be valuable. Research is also needed about how to improve the usability of EHRs.

Enhance content and workflows for electronic information flowing to and from pharmacies: New standards permitting the transmittal of CPOE drug discontinuations and capturing the reason for taking a medication should be implemented. Currently, these capabilities are languishing due to failure to implement these features—features that could overcome a number of the CPOE error-prone limitations we identified (such as detecting wrong patient errors and dispensing discontinued medications).[9]

Improve identification and reporting of problems: This requires lowering barriers for front-line staff to turn frustrations into fruitful reporting, ideally with a few simple clicks capturing screenshots and briefly describing issues. This should be coupled with real-time support (not being placed on hold while in the middle of a busy clinic, nor getting a call back 20 min later after prescriber has moved on to next patient, nor having someone 'log a ticket' for a later call) to both make it worthwhile to place the support call and better capture the range of questions, concerns and problems that users experience. While this may appear to be a substantial resource investment by organisations, it is trivial relative to the expense of confused, frustrated, providers who resign themselves to poor, unsafe systems and workarounds.

Create organised systems for aggregating, analysing, tracking and integrating problem and error data: Organisations need to develop intelligence to learn and improve their medication systems. They should start with information captured from the above reporting and help desk calls and insights, and extend this to include medication safety reports, feedback from downstream pharmacists and pharmacies, review of CDS response behaviours (eg, which alerts have 99% over-ride rates or inexplicably stop firing after upgrades) and review of medications discontinued due to error.

Establish and use standardised taxonomies for classifying and sharing CPOE-related errors and reports: This would facilitate both internal organising and tracking of reports and sharing across diverse organisations such as Patient Safety Organisations, vendors, Institute for Safe Medication Practices, malpractice

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insurers and others who are recipients of reports of medication errors that may be related to CPOE.

A report recommending implementation of an HIT Safety Center for the USA has just been released[13]—it could play an important role in this domain, especially around aggregation of reports, and identification and promulgation of best practices.

Initial criticisms of CPOE focused largely on workflow issues related to the additional time taken to enter orders and the difficulties institutions faced when attempting to implement CPOE systems. These are real problems. But so are the hazards and missed opportunities that exist even for CPOE systems implemented as intended. Writing prescriptions via CPOE systems that provide thoughtful and helpful support for prescribing decisions represent the path to greater medication safety. But we clearly still have a long way to go before we fully harness the potential of CPOE and create mechanisms for identifying and addressing the risks created by these systems.

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Acknowledgements The authors would like to acknowledge contributions of FDA staff: Carol Holquist, RPh, Office of Regulatory Operations, Office of Generic Drugs; Kendra Worthy PharmD, Division of Medication Error Prevention and Analysis (DMEPA), Office of Medication Error Prevention and Risk Management (OMEPRM), Office of Surveillance and Epidemiology (OSE), Center for Drug Evaluation and Research (CDER); and Vicky Borders-Hemphill PharmD, DMEPA, OMEPRM, OSE, CDER, for their scientific support. In addition, t The authors thank Katrina Garry, Denise Jones and Rita Noel, OSE Contracts Management Team, for their administrative support. They also acknowledge the contributions for the CPOEMS project staff and team members at the six collaborating centres: Arbor Quist, Alejandra Salazar, RPh, PharmD, AAHIVS, Mary G. Amato, PharmD, MPH, Sarah Patricia Slight, MPharm, PhD, PGDip, MPSI, MRPharmS, Thomas Dean Sequist, MD, MHP, Beverly Loudin, MD, MPH, David Smith, RPh, PhD, Jason Adelman, MD, MS, William Galanter MS, MD, PhD, Bruce Lambert, PhD, Ross Koppel, PhD, John D. McGreevey III, MD.

Contributors GDS, T-TTH, AW: writing of the manuscript, data analysis and review. LAV: critical review of the manuscript and overseeing the administrative aspects of the project. DWB: critical review of the manuscript, provided ideas and important concepts included in the manuscript.

Funding US Food and Drug Administration (HHSF223201000008I/HHSF22301005T).

Competing interests DWB is a co-inventor on patent no. 6029138 held by Brigham and Women's Hospital on the use of decision support software for medical management, licensed to the Medicalis Corporation. He holds a minority equity position in the privately held company Medicalis, which develops web-based decision support for radiology test ordering. He consults for EarlySense, which makes patient safety monitoring systems.

Ethics approval Partners IRB.

Provenance and peer review Not commissioned; externally peer reviewed.

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