

Examining the Unintended Consequences
of Computerized Provider Order
Entry System Implementation



by

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Abstract

Research within the field of *Computerized Provider Order Entry* system design and implementation has revealed important implications for healthcare professionals, especially within the paradigm of medication errors. The implications under examination in this paper arise in the form of unintended consequences of CPOE utilization. The objective of this paper is to offer an overview of CPOE systems and its relevance to patient safety, an examination of unintended consequences of system utilization as it pertains to system design and integration into workflow processes, a discussion of coping strategies employed in relation to these consequences, and conclude with recommendations for future strategies.

Keywords:

CPOE, Computerized Provider Order Entry, Unintended consequences, Nursing workflow, patient safety

Introduction

Successful implementation of computerized information systems can drastically decrease the margins of error occurring in most healthcare settings. Specifically, *computerized provider order entry systems* (CPOE) have been shown to reduce the incidence of serious medication errors – the most commonly preventable patient endured injury, by 55 percent (as cited in Poon, Blumenthal, Jaggi, Honour, Bates & Kaushal, 2004). Research within the field of CPOE design and implementation has revealed important implications for healthcare professionals, especially within the paradigm of medication errors. Although CPOE technology has been rigorously developed and tested over time, new types of medical error and risk for error have simultaneously surfaced (Vogelsmeier, Halbesleben, & Scott-Cawiezell, 2008). The implications under examination in this paper arise in the form of unintended consequences of CPOE utilization. While the term “consequence” denotes a negative outcome of events in most cases, examining unintended consequences has potential positive implications on the system’s efficiency, as well as on overall healthcare delivery, and risk management strategies. The objective of this paper is to offer an overview of CPOE systems and its relevance to patient safety, an examination of unintended consequences of system utilization as it pertains to system design and integration into workflow processes, a discussion of coping strategies employed in relation to these consequences, and conclude with recommendations for future strategies. Although CPOE is also used for ordering diagnostic and laboratory tests, the focus of this essay will revolve around nurse utilization of electronic medication administration records (eMAR), medication ordering processes, and drug administration.

The Role of CPOE in Safeguarding Patients

Simply put, a CPOE system is a computer application that allows a physician or their surrogates, to electronically input medical orders for patients under their care (Campbell, Sittic, Ash, Guappone, & Dykstra, 2006). These orders are communicated over a secured network and accessed by other healthcare professionals or departments responsible in carrying out the orders. Features include standardized physician orders, patient specific clinical decision support, safety alerts, with interdepartmental point of care utilization, and offers secure and permanent record keeping.

CPOE is an aggressive strategy that promotes medication error risk management and ultimately fosters safer patient care practices. Benefits of CPOE include nurse absolution of ascertaining illegible handwriting, alerts and signaling features that prompt staff of potential medication safety issues, and easy tracking of physician orders (Ash, Berc, & Coiera, 2004, Vogelsmeierm, Halbesleben, & Scott-Cawiezell, 2008). CPOE offers clarity of medication orders, which can increase nurse utilization, especially when time-consuming ambiguity is eliminated. The system supports safe drug administration in nursing practice by promoting the five rights of drug administration, while allowing the nurse to focus on the professional component of medication administration, such as ongoing patient assessment and adverse event monitoring (Keohane et al., 2008).

Unintended Consequences of CPOE

Conceptual Framework

In order to properly identify the unintended consequences that derive from CPOE utilization, one must understand what is meant by the term ‘unintended’. According to Campbell et al., (2006) *unintended consequences* refer to events that are neither the anticipated *nor* specific goals of the associated CPOE project (p. 548). Furthermore, the term ‘unintended’ refers to an event that lacks purposeful action or causation, and which could not of been predicted (Ash et al., 2007). There are two pronounced contexts in the literature where CPOE unintended consequences are encountered, and discussed below: a) unintended consequences surfacing as a result of system development/design and b) consequences as a result of CPOE integration into workflow processes.

Unintended Consequences as a Result of System Design

There are a number of unintended consequences that emerge as a result of CPOE system design. According to Vogelsmeierm, et al., (2008), unintentional artifacts of ineffective technological designs are extremely common and very disruptive to staff (p. 115). Workflow blocks, for example, arise in the form of computerized alerts and warnings that force nurses to carefully reconsider a process or drug administration that the system has deemed potentially unsafe. Unfortunately, the effects of having to constantly reconsider drug administration practices have been linked to providers feeling supervised, treated as stupid, distrusted, or resentful of being constantly interrupted (Ash et al., 2004). Furthermore, the initial shift from

paper to computer processes forces professionals to *'let go'* of the need for hardcopy documentation. Research conducted by Lee (2007) identified that such aspects led to nurses' distrust of the system's reliability, which increased worry that data might be lost or delayed in future transmissions.

CPOE system interface and data input requirements also introduce various unintended consequences. Firstly, the required typing skills, cognitive load, and standardized format for entering data often adds stress to nurses' heavy daily workload and decrease their satisfaction with using technology (Lee, 2007, p.295). System developers who neglect human factors when deciding on screen layout and color design (such as likelihood of non-system interruptions while using the system), run the risk of introducing new errors into practice by virtue of the *ease* of making such an error. Traditionally, nurses would go to individual charts to view specific orders (reducing the margin of error of possibly administering the ordered intervention on the wrong patient), while CPOE now forces each patient to be selected from a list of patients within the system. This new process along with the reality of nurses being regularly interrupted by competing urgencies and multitasking increases the risk of making an error. According to Ash et al., (2004), this mismatch between interface and use context often results in a *juxtaposition* error, the kind of error that can result when something is close to something else on the screen and the wrong option is too easily selected in error.

During development, CPOE systems require diligent review of current practices and policies. This rather positive unintended consequence forces existing clinical practices to be scrutinized and placed *'under the microscope'* so to speak (Laurie-Shaw, Taylor, & Roach, 2006, p. 56). Benefits from this unintended consequence include the revision of outdated policies, and

foster the reiteration of evidence-based practices.

Unintended Consequences as a Result of System Integration into Workflow Processes

Successful implementation of CPOE requires an appreciation of the complexities and unpredictability of the physicians' and nurses' workflow. Chances for successful adoption and utilization are higher when developers and implementers understand the manner in which health care professions interact with new technology and how workflow processes are effected as a result (Vogelsmeierm, et al., 2008).

Failure to ensure the system's compatibility with nursing workflow for example, may lead increased encounters of unintended consequences. In a study conducted by Vogelsmeierm, et al., (2008), nurses were non-compliant with the CPOE system's dual documentation requirement, viewed as cumbersome by staff since they had never documented in that manner before. Although dual documentation serves as the check-recheck principle of drug administration, this system requirement resulted in feelings of resistance to change, staff frustration, and discontentment (Vogelsmeierm, et al., 2008). Furthermore, some CPOE systems disrupt nursing authority to carry through verbal physician orders in an acute situation because they strictly demand a physician's authorization before the intervention can be implemented (Ash et al., 2004). Such a criteria not only puts patients' safety at risk (in terms of the urgency of the required intervention), but also reiterates power struggle issues of authority between physicians nurses.

eMAR utilization inevitably introduces new and/or more work into practice, and with this added

work, serious emotions surface. While attending to multiple alerts and reminders within the system, nurses are bombarded with technological stimulus especially in early stages of implementation. Traditionally, paper orders are received and transcribed personally by the primary care nurse. One is further prompted to look for new orders especially when the most responsible physician is physically on the unit performing rounds. With CPOE, physicians are commonly entering in orders from elsewhere within the organization. As a result, some nurses have experienced anxiety while on shift, enduring the constant fear of missing a new order, and therefore respond by constantly logging into the system to check for new orders, minutes spent away from the bedside that add up over a twelve hour shift. This is especially observed in teaching organizations where multiple residents, medical students, and physicians can be assigned to one patient and refining original admission orders frequently throughout the day. Moreover, this additional work is imposed on already burdened professionals and the tasks are often clerical and therefore economically inefficient (Ash et al., 2004, p. 105). Other negative emotions reported as a result of poor CPOE integration into workflow processes include frustration, ambivalence, feelings of resistance, disempowerment, and over reliance on electronic alerts which can skew or sometimes supersede professional judgment and feelings of cognitive overloading (Vogelsmeierm, et al., 2008, Ash et al., 2004).

Ergonomically, organizations may experience low user frequency rates and increased resistance when eMAR workstations are not readily accessible, resulting in unnecessary workflow interruptions. Such was the case experienced at a medical center in Taiwan where a consequence of insufficient computers forced nurses to compete with other healthcare providers (physicians or physicians' assistants) for computer access which decreased users' motivation to use the system (Lee, 2007, p. 299).

Coping Strategies Employed to Address Unintended Consequences

CPOE systems are designed to safeguard patients from medication errors by integrating rigorous clinical decision support and documentation processes into the system. If these processes however, are being perceived as inadaptable or cumbersome in the current environment, one is likely to begin undermining these features, rendering such precautions potentially useless (Vogelsmeierm, et al., 2008). Furthermore, when the root of an unintended consequence goes unresolved, coping strategies are developed in order to minimize the interruptions' effect on workflow and practice, or perhaps in order to, "fix the problem". According to Vogelsmeierm et al., (2008), this is seen when nurses engage in problem-solving behaviors that involve bypassing system requests. This unveils a particularly concerning strategy employed, referred to as the "workaround". Workarounds entail adopting both temporary and passive practices for use when addressing interruptions to normal workflow. Reported examples of CPOE workarounds include circumventing intentional blocks by omitting data or overriding alerts, and purposeful input of multiple incorrect medication doses in order to yield the physician's ordered amount, despite the warnings (Vogelsmeierm, et al., 2008). These high-risk practices compromise evidence-based discretion, and can lead to potentially fatal consequences. Workarounds serve only for the immediate moment, and according to Spear & Schmidhofer (2005), fail to contain the actual problem and thus foster the repetition of confounding factors.

From an administrative perspective, unintended consequences can occasionally be managed by highlighting tradeoffs. For instance, the time exerted into entering or retrieving data from the system by health care providers, is offset by the amount of information instantly accessed at the

point of care/bedside offering convenience and increased productivity (Ash et al., 2007). Tradeoffs involve accepting an unavoidable consequence in return for a beneficial outcome, and reiterating this positive outcome may be effective in increasing buy-in.

Recommendations and Strategies for Future Implementations

Once an unintended consequence has been experienced, there are only two choices of action one can take: avoid, or, confront the consequence. Avoidance yields dangerous workarounds that fail to discern the root of the problem. The organization's lack of clarity over the underlying interrupting issues and its ability to tolerate ambiguity, are in fact characteristics of an error-prone environment (Spear & Schmidhofer, 2005). In other words, operating a CPOE system with unattended unintended consequences should be viewed *as an accident waiting to happen*. To minimize this risk, organizations should encourage end-users to report unintended consequences as they occur in order for the appropriate resolution to be considered promptly and diligently. According to Spear and Schmidhofen (2005), organizations should view unintended consequences (positive or negative), as "deviations" from the desired normal and thus promptly investigate the discrepancy in order to foster process improvement, not workarounds.

Many unintended consequences can be managed if rigorous system development priorities are set during initial design/implementation stages. For example, successful implementation depends on considering end-user perceptions of how the system will impact staff workflow, recognizing perceived barriers to system adoption, and being strategically prepared to work through user resistance (Lee, 2007). Particular concentration should be given to ensuring that the processes involved in CPOE utilization are integrated as smoothly as possible into routine practices. This will decrease staff resistance and increase work and system efficiency, maximizing the benefits of the CPOE system (Keohane, et al., 2008). A successful strategy for facilitating system integration into work processes and increase staff buy-in is known as the *parallel strategy*. The parallel

strategy is employed during the initial implementation phases. Staff are asked to use the system simultaneously with paper chart routines. Although this strategy initially requires a short period of time where staff are forced into dual documentation, Lee (2007) found that this strategy built user trust in the new system as well as its credibility, further demonstrating that it worked as well, if not better, than the traditional system.

The testing period prior to implementation is the critical period where known unintended consequences should be discussed and addressed. Due to their potential severity, strategies to minimize the possibility of performing juxtaposition errors during the development stage should be reinforced and prioritized. Design strategies such as incorporating the use of “hot keys” to facilitate ease of charting, or increasing the fields where free text charting is possible, have also been documented as successful system implementation attributes (Lee, 2007). Finally, the use of end-user focus groups to test screen layout and error margins for example, can offer beneficial insight into process improvement prior to the official launch of the system. Addressing known unintended consequences prior to going live, increases the systems chances of success, by eliminating the factors that were once ‘surprises’ during previous CPOE implementation attempts.

Conclusion

Successful adoption of CPOE systems can significantly refine medication ordering and administration practices and decrease the potentially fatal incidences of drug related adverse events. The intent of this paper was to examine the critical issue of unintended consequences and the context from which they arise. Although positive unintended consequence were also identified in this essay, the most common occurring unintended consequences examined weigh

heavily on end-users' routine practices, and can potentially compromise the very patient safety measures the system is designed to preserve. The effects of unintended consequence avoidance were shown to result in the undesirable practice of workarounds, while attention given to the consequence can result in process re-consideration and tradeoffs. Commitment to an unintended consequence management strategy during the system development phase can help decrease their occurrences and/or impact on practice, and increase user buy-in early on. Such strategies should include processes that examine the root causes of the consequences and incorporate end-user recommendations. Working together to iron out the unintended consequences affecting practice. Unintended consequences of CPOE 12 promotes participatory planning, which can inadvertently empower end-users, and will likely facilitate successful CPOE implementation and adoption.

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Author Bio

Bren Moniz is a student pursuing a Master of Nursing at the University of Toronto, Canada, with a focus in nursing administration. She graduated with honours from Brock University with a BScN in 2005 and has since worked in Emergency Nursing. Currently in her final term of the program, her practicum concentration is in nursing and clinical informatics focusing on online clinical documentation implementation at a local teaching hospital. Her areas of interest for future career endeavors include information systems' analysis and to leverage nursing informatics as a specialty role by articulating and addressing the challenges Advanced Nursing Practice faces within this paradigm.