JAMIA
Original Investigations

Research Paper ■

Types of Unintended Consequences Related to Computerized Provider Order Entry

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Abstract **Objective:** To identify types of clinical unintended adverse consequences resulting from computerized provider order entry (CPOE) implementation.

Design: An expert panel provided initial examples of adverse unintended consequences of CPOE. The authors, using qualitative methods, gathered and analyzed additional examples from five successful CPOE sites.

Methods: Using a card sort method, the authors developed a categorization scheme for the 79 unintended consequences initially identified and then iteratively modified the scheme to categorize 245 additional adverse consequences resulting from fieldwork. Because the focus centered on consequences requiring prevention or remedial action, the authors did not further analyze reported unintended beneficial (positive) consequences.

Results: Unintended adverse consequences (UACs) fell into nine major categories (in order of decreasing frequency): 1) more/new work for clinicians; 2) unfavorable workflow issues; 3) never ending system demands; 4) problems related to paper persistence; 5) untoward changes in communication patterns and practices; 6) negative emotions; 7) generation of new kinds of errors; 8) unexpected changes

care personnel who use, maintain, or manage CPOE systems. Specifically, we gathered perspectives regarding CPOE from three groups: clinical end-users, IT staff, and administrators. We broadly define *clinical end-users* as those health care providers and other clinical staff (e.g., physicians, pharmacists, nurses, ward secretaries, etc.) who work with CPOE systems. *IT staff* includes those who implement, configure, maintain, and support CPOE systems, whether or not their primary professional background is technical or clinical in nature. Finally, *administrative staff* refers to those who manage organizational implementation of CPOE, through establishing policies and procedures, assuring compliance with local and federal guidelines, and making high-level CPOE-related resource allocation decisions.

Background

Theoretical Framework

Diffusion of Innovations (DOI) theory served as the framework for this study. *Diffusion* has been defined by Everett Rogers as "the process by which an innovation is communicated through certain

Table 2 ■ Unintended Consequences and Their Frequencies of Occurrence

Unintended Consequence	Frequency (%) $n = 324$
More/new work for clinicians	19.8
Workflow issues	17.6
Never ending system demands	14.8
Paper persistence	10.8
Changes in communication patterns and practices	10.1
Emotions	7.7
New kinds of errors	7.1
Changes in the power structure	6.8
Overdependence on technology	5.2
Total	100

cians. If taped, these interviews were subsequently transcribed. The project selected certain clinicians, and hospital and IT administrators, based on their long history and involvement with both the institution and the implementation of the CPOE systems, to undergo debriefing through formal oral history interviews with open-ended questioning. Rather than observing these clinicians interacting with CPOE systems, project members instead asked them to describe the development and adoption of these systems in their respective organizations. Interviews were audiotaped and transcribed by experienced oral-history transcriptionists.

During nine months of field data collection (August, 2004 through April, 2005) project team members spent 390 total hours observing roughly 95 clinical providers interacting with CPOE systems in various settings. The 32 semi-structured interviews totaled approximately 43 hours. Transcripts from these interviews and the Menucha conference, and field notes comprised 1,894 single spaced, typed pages. The project team collected and compiled the field notes and interview transcriptions using qualitative research software (N6, QSR International Pty. Ltd., Melbourne, Australia, 2002).

Data Analysis

The project research team of six individuals met 36 times to analyze data. Using a card sort method,[9] researchers developed a categorization scheme for the 79 unintended adverse consequences identified by the expert panel. Individual team members identified UACs in specifically assigned transcripts. During team meetings, consensus developed regarding which quotes represented UACs and how these UACs could be categorized. Using a grounded theory approach, the categories emerged from the data, rather than from preconceived expectations.[10] Researchers then iteratively modified the initial categorization scheme as they reviewed the 245 additional unintended consequences identified during fieldwork. After several months of analysis, common themes emerged. The team formalized its list of UAC categories. The final list was both simple (consisting of only nine categories) and comprehensive (the categories directly covered all observed UACs).

Results

Introduction

Nine major types of unintended consequences emerged from the data. Table 2 lists the UACs and their frequencies of occurrence. A detailed discussion of each UAC type follows below, including direct quotations from speakers who articulated an issue particularly well. Table 3 (available as a JAMIA on-line supplement at www.jamia.org) includes additional quotes relevant to each type of UAC. Because study subjects were promised confidentiality, researchers edited statements to protect confidentiality whenever original statements potentially identified either speakers or the observation site.

Types of Unintended Adverse Consequences

Type 1: More/New Work for Clinicians

Clinical systems can potentially create new work for all staff members (e.g., both clinical and non-clinical staff). The present UAC focuses on the ever-increasing workload of clinicians. Despite the common CPOE implementation goal of providing a better "patient overview" to the clinician, many CPOE systems make clinicians do more work to get this overview than before CPOE implementation. The CPOE systems may engender new work by requiring that clinicians: (a) enter new information (e.g., justification for a treatment selection) not previously required; (b) respond to excessive alerts that may contain non-helpful information (e.g., non-specific medication interactions with no application to the current patient); or (c) expend extra time in completing non-routine, complex orders (e.g., selecting among differing doses and types of insulin to be administered at different times for a diabetic patient).

Many CPOE systems slow the speed at which clinicians can carry out the clinical documentation and ordering processes.[11] This loss of efficiency often recovers over time.[12] Simply learning to use CPOE takes time and attention away from demanding schedules. If their patient loads are not decreased temporarily during training periods, clinicians work longer hours to complete their combined electronic and clinical work.[13] The indiscriminant, excessive generation of clinical alerts by CPOE systems can also slow clinicians as they pause to decipher alerts, deliberate on whether and how to respond, and potentially document reasons for not complying with alerts.

Administrators and researchers commonly leverage CPOE to collect information not directly related to patient care. The time burden for doing so usually falls on clinicians. One noted: *"It seems like every new organizational mandate filters down to the. . . fingertips. . .of our primary care physicians in the form of something else that needs to be entered through the computer and the feeling is 'Well, they have a computer, so it's easy for them to do that' but the cumulative effect [on the physicians] of all those tasks is not fully appreciated."*

When CPOE systems are poorly integrated with other clinical information systems, clinicians find it time-consuming to log in to different systems using different account names and passwords. In some cases, data from one system must be entered manually into another, doubling the work. In addition, built-in functionality such as "cut and paste" may proliferate redundant text in electronic records that clinicians must navigate in order to have a complete picture of the patient. One physician said: *"There is no way for me to really know what's new, but I keep seeing chunks of the same text over and over so I have to read every word. Most of it isn't useful."*

Type 2: Unfavorable Workflow Issues

tude" greater than for less-integrated, less closely-coupled clinical systems.

As a CPOE system evolves, users rely more completely on the software and demand ever more sophisticated functionality for clinical support. As medical practices evolve, corresponding new features must be added to the original implementation. Over time, complex interactions among the numerous software features can make the installation both unmanageable and outdated, such that the system needs to be replaced with a newer (and "cleaner") version: *"The fact that you develop a critical mass of code, doing anything radically different becomes extremely difficult when you have an installed user base that you are supporting. So a lot of the early rapid flexibility and leeway you had in the early years of implementation you get stuck with . . . and it isn't easy to sort of wipe things clean and start over."*

Type 4: Problems Related to Improper Persistence

Many CPOE vendors advertise products as

tive tasks.[19] Shifting from paper-based order generation to CPOE is bound to evoke strong emotional responses as users struggle to adapt to the new technology.

We noted a wide variety of emotional responses to CPOE, including both strongly negative and highly positive emotions. Negative comments predominated. The amount of time a CPOE system had been in use strongly correlated with the level of positive emotions the system elicited. For example, one nurse described her first impression of a CPOE system in this manner: *"At first we hated every second of it. I mean we were all like 'I have sick patients here. I'm busy. I don't have time to sit here [at the computer] for twenty minutes.' It was a pain."* Most agree that the high level of negative emotions decreases over time: *"It gets better."*

Type 7: Generation of New Kinds of Errors

Studies have indicated that CPOE adoption can generate new kinds of health care–practice related errors, while others have described roles for CPOE in both preventing and causing medication errors.([4,20–25]) Here, we focus on new types of errors that emerge when CPOE replaces paper-based ordering.

New CPOE-related errors result from: problematic electronic data presentations; confusing order option presentations and selection methods; inappropriate text entries; misunderstandings related to test, training, and production versions of the system; and workflow process mismatches. System designs (including poor data organization, data omissions, etc.), and end-user confusion about system functionality contribute to new forms of errors. When users make data entry selections from pick lists (drop down lists), a new class of "juxtaposition errors" results from making a wrong selection without realizing it. For example, long, dense pick lists predispose a provider to selecting a patient name adjacent to the intended name. The system should provide adequate feedback on who was selected (e.g., displaying the selected name in large letters on the next screen). If this does not occur, the user may proceed to enter an entire set of orders on the wrong patient. "Backing out" such erroneous orders before they are executed can be problematic. Similar errors occur whenever pick lists facilitate selection of other order parameters.

CPOE systems manage massive amounts of clinical information. However, CPOE workstation screens cannot display large amounts of data simultaneously. Thus, clinicians must learn

Whether the power base is centralized or decentralized plays an important role in occurrence of UACs. Centralized power structures use top-down, hierarchical formats to mandate compliance with organizational rules and to enforce procedure standardization. Decentralized arrangements lead to greater variations in CPOE system configuration and utilization, and increased competition and conflict among departments. Conflicts create significant problems for IT departments, and lead to problems with the application consistency, clinical coordination, and evaluation of impact on patient care.

When many departments participate in CPOE implementation, significant unanticipated power shifts occur. Viewed as the new enforcer of standards, the IT department gains power, even when other departments mandate the standards. This can be frustrating to

hardware and software upgrades a necessity. With each change, implementers should expect unintended consequences. As changes occur, users must be retrained and quality assurance measures must be reassessed. The lesson is that planning must allocate adequate resources for ongoing improvements.

- *Paper persistence:* While electronic medical record systems trend toward "going paperless," health care organizations, as a whole, do not. Vendors and administrators alike must understand differences between having

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