Abstract

In hospitals, a handoff occurs when responsibility for care of a patient is transferred to another caregiver, along with information about the patient’s condition, treatment plans, and orders. Prior studies report that flawed handoffs contribute to adverse events, but few studies have closely analyzed this from an information processing perspective. We report on a case study of medication administration processes and related information quality issues associated with handoffs in one hospital. Applying an interdisciplinary lens (informed by prior work on health care quality, process management, and accounting information systems) this case study reveals evidence that handoffs both contribute to process and data flaws and can help reveal and correct prior errors. Our findings highlight the importance of designing clinical systems and processes that systematically prevent threats to the validity, accuracy, completeness, and timeliness of clinical data and that use handoffs to detect and correct these four types of errors.

1. Introduction

Prior research finds that flawed handoffs contribute to adverse events (patient discomfort, harm, or death) in hospital settings. A handoff occurs when responsibility for care of a patient is transferred to another care-giver, along with information about the patient’s condition, treatment plans, and orders. Handoffs take place when the patient is admitted to hospital, is moved from one unit to another, such as from the emergency department or intensive care unit to surgery, or is discharged. Handoffs also occur when nurses or doctors change shifts, attending physicians consult with specialists, or whenever data, information or clinical judgments about specific patients are communicated among clinicians (doctors, physician assistants, nurses), pharmacists, or laboratory technicians. Thus, a patient handoff serves several functions:

- **Transfer of Responsibility** for patient care: passed from one clinician or clinical team to another.
- **Transfer of Data**: pertinent data about patient (age, blood type, etc.), his condition (symptoms, vital signs), test results, and procedures performed -- are transferred via speech, paper, or information system (often via two or three of these media).
- **Transfer of Information**: Information (as opposed to specific facts) regarding caregiver plans for tests and/or procedures to be performed is conveyed via paper form or a clinical information system.
- **Conveyance of Clinical Judgment**: Assessments of patient condition, prognosis, and other aspects are conveyed, usually via speech.

Understanding how flawed handoffs lead to adverse events is important for designing better processes and clinical information systems, and minimize preventable adverse events.

In this paper, we focus on how handoffs affect a specific type of adverse event: medication errors. The Institute of Medicine [4] reported that about 400,000 preventable medication-related injuries occurred in US hospitals in 2006. Reasons include drug interactions, allergies, similar labels on dissimilar products, confusion about product names, and miscommunication between clinicians and patients or pharmacists and among clinicians (e.g., physician to physician, physician to nurse). Computerized provider order entry (CPOE) and electronic medication administration records (EMAR) are promoted as systems that help reduce medication errors. Yet, despite the benefits, CPOE systems reportedly also cause or propagate medication errors [25]. In this paper we examine how handoffs cause medication errors and how handoffs help detect erroneous information caused by previous process steps and stop that information from being used in subsequent steps. We examined evidence gathered in a case study at a
community hospital as it prepared to roll out CPOE, EMAR, and other software applications aimed at improving the efficiency and quality of patient care. We asked clinicians, pharmacists, members of the executive team (CEO, COO, CNO, CMO, CIO) and administrators to reflect on medication administration challenges and issues. Specifically, we sought answers to three research questions:

1. In reflecting on medication administration processes, what handoff challenges do administrators and clinicians identify? Which challenges involve the data, information or judgments that are conveyed, and which involve the medium/media by which these are conveyed (speech, paper, system or some combination of these)?
2. How do effective handoffs detect prior mistakes, thus helping to prevent medication errors?
3. Recognizing that clinical activities take place within a complex, dynamic institutional context, how do specific contextual aspects affect handoffs and related data, information and judgments?

2. Theory

We applied an interdisciplinary lens, drawing on prior research in health care quality, process management, and accounting control theory, which are reviewed next.

2.1. Prior research on handoffs

Flawed handoffs are implicated in many adverse events, such as medication errors that result in patient discomfort, injury, or death, delayed procedures (such as medication administration and transplants), patient dissatisfaction, and provider concerns about their ability to provide adequate care [5, 10, 23, 30, 34]. Thus, improving handoff processes is seen as a key to improving health care quality [3, 30]. Guidelines issued by JCAHO (Joint Commission on Accreditation of Healthcare Organizations) [19] aim to reduce miscommunication during handoffs.

Proposed solutions include standardizing handoff processes (by establishing clear rules) and communication (by using standard written or computerized forms and maps and verbal protocols), avoiding interruptions, focusing on patients, collaborating with other providers involved in the handoff, and handoff-specific training [3, 7, 10, 27, 29, 37, 34]. Some proposed remedies are influenced by studies of highly reliable handoff processes in contexts such as aviation and racing [10]; others are grounded in clinical practice. For example, nursing education emphasizes a patient- and process-focused approach [32]. Since nurses administer medications, they are the last line of defense, so training emphasizes information verification; nurses are expected to question doctors’ orders before carrying them out if they suspect that the orders contain incorrect information.

Although promising, some proposed process improvement remedies may not be appropriate for all clinical situation, due to high staff turnover [10], ambiguous patient information [30], and treatment diversity (different medical decisions, information and handoff tasks required for each patient). Improvements that entail standardized communication may result in errors if forms do not completely capture all information required for each specific handoff type, or if caring for a particular patient requires information that is not usually transmitted during a normal handoff. Even where standards exist, distractions and competing priorities may lead clinicians to skip a check or overlook data revealed in a check. Also, nurses may not always voice their concerns, either because of low self-efficacy or other reasons related to the higher status accorded doctors. Some researchers contend that standardization may be undesirable; they argue that the inherently unstructured and ambiguous nature of a handoff interaction makes it valuable for accurate information recording, analysis, and trust building among medical providers [30].

2.2. Conceptual lenses for this investigation

Hospitalized patients usually receive medications from nurses, who are trained to attend to the “five rights” (right patient, drug, time, dose, and route of administration) [12]. Still, medication errors are a persistent problem [1, 24]. Information transfer during handoffs (from patient to nurse, doctor to pharmacy, pharmacy to doctor and nurse, and nurse to patient) is a significant cause of medication errors [16]. One study reported that admission medication errors occurred in 26% of cases for prescriptions and 33% for over-the-counter medications. Discharge medication errors occurred in 19% of cases [6].

Many errors can occur before the actual medication administration (the final “handoff” from nurse to patient), due to flaws in previous activities -- including previous handoffs. Thus, we propose that understanding the causes of medication errors requires adopting an end-to-end view of the entire care process [8], for which a business process management (BPM) lens [26] is appropriate. BPM, a methodology for “managing, improving and controlling processes,” has its roots in quality management, six sigma, process
improvement and reengineering [26]. Other engineering and design disciplines -- such as systems engineering, human factors and quality engineering -- have also been utilized in patient safety studies [9, 13]. These approaches center on the work systems of medical professionals and their impact on care processes and patient outcomes [9]. For our study, we selected BPM because, as explained below, it is particularly well suited to an end-to-end, cross-functional perspective, classifying activities for improvement, and defining the care process -- all important elements in understanding handoffs.

First, BPM suggests that improving handoffs without considering the entire cross-functional care process (across various departments and job roles) may only lead to local optimization. Although process methodologies and tools such as Six Sigma, Lean, and failure modes and effects analysis (FMEA) have been used to analyze and improve medical handoffs [6, 10, 28, 34], the focus has been primarily on the handoffs themselves, rather than on end-to-end care processes. For example, an improvement such as avoiding interruptions may be difficult to implement without adopting a full process view, with potential ramifications across an entire hospital’s operating procedures and physical set-up. Also, collaboration among providers during handoffs may be difficult if they do not have a clear view of the end-to-end cross-functional care process [27].

Second, BPM enables the classification of handoff activities as value added, non-value-added, and control, and encourages the elimination of non-value added steps. Thus handoff improvement efforts should focus on value-added and control aspects, such as clarifying ambiguous information and catching errors made previously [30], rather than considering handoffs as non-value-added steps to be eliminated or automated. Indeed, studies report that handoff automation through CPOE systems contributes to the propagation of medication-related errors made in previous care activities [25, 31].

Third, BPM provides tools for identifying clinical process “suppliers” and “customers” (and their respective requirements and constraints), and for analyzing handoffs as critical internal process interfaces, for which senders and recipients of information and their needs can be defined and control points established.

Through application of a BPM lens in previous studies [6, 8] we identify several end-to-end process activities relevant to medication administration (See Table 1). It is important to note that while most studies limit the term “handoff” to situations when a clinician or clinical team conveys responsibility, data, information, and judgments to another clinician or team, other studies take a broader view of the entities involved. We include the patient as an active participant in some (not all) handoffs. For example, an incapacitated patient cannot take any responsibility for his/her care, but a mother who has just given birth may be quite an active partner in her care.

The patient care process presented in Table 1 usually includes many iterations between various process steps for verification or clarification, parallel activities, and sometimes partial duplication of information [6]. During each handoff, information is needed by participants. The clinician (physician, intern, resident, specialist, PA, or nurse) who is handing off the patient is an important information source; others include the patient, his/her family, pharmacy, laboratories, electronic monitoring devices, an electronic health record (EHR), and other clinical applications and databases. Information is conveyed via speech, paper, and/or system – often via more than one medium simultaneously. Handoffs also produce new information which is stored in clinicians’ heads, on paper, and/or in a system. The quality of information remains a significant problem.

\begin{tabular}{|l|}
\hline
\textbf{Table 1. Medication-related handoffs (H) in hospital patient care processes} \\
\hline
\textbf{Admission} & \\
\hline
1. Nurse documents existing medication list, if any, from patient conversation (H) & \\
2. Medication list is forwarded to pharmacist (H) & \\
3. Pharmacist creates medication administration record (MAR) & \\
4. MAR is forwarded to other providers (nurse, doctor) (H) & \\
\hline
\textbf{Hospitalization} & \\
\hline
5. Doctor prescribes, changes or discontinues medications & \\
6. Medication order is forwarded to pharmacy (H) & \\
7. Pharmacist verifies and approves order and updates (MAR) & \\
8. MAR is forwarded to other providers (nurse, doctor) (H) & \\
9. Nurse retrieves medication (usually from floor-specific medication cabinet or from pharmacy if not available) (H) & \\
10. Nurse administers medication (H) & \\
\hline
\textbf{Discharge} & \\
\hline
11. Doctor creates discharge prescription & \\
12. Nurse educates patient (H) & \\
13. Hospital forwards medication list and discharge summary to follow-up provider (if any) (H) & \\
\hline
\end{tabular}

To better understand the quality of information transfer in handoffs, we propose using an information quality lens. Accountants have long employed various techniques to identify and address information quality issues in transaction processing systems and related business processes through which financial data flow [14, 22, 36]. Auditors help to verify that information quality is assured throughout a process and in related systems and databases [18, 20]. Their aim is to ensure that financial transaction data exhibits “representational fairness,” consisting of the traits of validity (data describes an event which was properly authorized and actually occurred), accuracy (data correctly describes relevant aspects of the event),
completeness (a record is captured for every relevant event), and timeliness (available when needed) [2]. A false invoice or payment to a fictitious recipient would fail to pass a validity test; the recorded transaction was not authorized. If the record of an event is incorrect (such as indicating that 1000 products were sold when the correct number is 100, or that a product was sold for $100 versus the correct price of $200), the record fails the accuracy test. If no record was made of an authorized transaction that took place, completeness is violated. If a decision-maker or process participant does not have access to information when it is needed, timeliness is violated.

These data quality traits aptly apply to physicians’ orders and data describing administered medications, tests, and procedures. Errors identified in previous studies [5] can thus be classified as compromising validity (unauthorized drug, additional dose, incorrect route), accuracy (incorrect dose), completeness (failure to administer dose) and timeliness (delay in administering dose). The benefit of using this perspective is that best practices for preventing, detecting and correcting information quality problems in other settings can be used to analyze clinical processes and suggest improvements.

3. Case methodology and findings

Sections 3.1, 3.2 and 3.3, respectively, describe our methodology, the case context, and our findings.

3.1. Methodology

A case study was conducted at “Community Hospital” (CH), located in a U.S. metropolitan area. Data were gathered by means of on-site semi-structured interviews conducted with 16 individuals in the fall of 2009: the Chief Executive Officer, Executive Vice President, Senior VP/Chief Operating Officer, Chief Information Officer and a project leader in Clinical Informatics, Pharmacy Director, a Pharmacist, VP of Medical Affairs, Hospitalist Program Medical Director, Division of Geriatrics Chief, Chief Nursing Officer, two other nurse managers (Director, Outcomes; Senior Director, Risk Management), two floor nurses, and a physician’s assistant. Interviewees were asked to describe CH’s efforts to improve patient safety in general and in medication administration processes. Other questions related to individuals’ roles (e.g., the CEO discussed strategic priorities, including patient safety initiatives; the CIO discussed IS issues and project priorities). Interviews of 30 to 60 minutes in length were recorded and professionally transcribed. The research team toured a medical/surgical unit and examined various internal hospital reports. We prepared a repository of key documents, including these reports and other information provided on the hospital’s web site and in news accounts.

Analysis followed the constant-comparative method [35]. Factual coding was done on the interview transcripts and other documents, to capture a timeline of key events and descriptive data about CH, its governance and descriptions of critical incidents. In a comparative coding step we classified interview segments into themes previously identified in the literature (e.g., strategic priorities, regulatory and organizational challenges) and in our broader study of data and process quality issues in health care. In an open coding step we identified themes that were not previously anticipated, such as a theme about “educating rather than punishing” individuals who make medication errors. Factual, comparative, and open codes derived from the interview data were compared across interviewees and also (where possible) triangulated against information provided from other sources, such as hospital planning documents and quality reports. Through an iterative process of interpretation [33] we considered relationships among themes and their deeper meaning. For example, we explored relationships among the hospital’s capacity constraints, handoff information media, and medication errors.

3.2. Case context: “Community Hospital”

CH, formed in a merger of two hospitals, is the third largest hospital in its US metropolitan area, behind a prominent tertiary care hospital and another large community hospital. It serves both a large Medicaid (low-income) population and a large Medicare (geriatric) population, and offers a full range of medical and surgical care, substance abuse treatment, psychiatric care, and rehabilitation services.

At the time of our interviews several major projects were underway to modernize and expand their facilities, and the CEO hoped to win state approval to increase their medical/surgical capacity. He and other clinical and administrative leaders mentioned insufficient capacity as a major institutional pressure.

The CEO emphasized the hospital’s commitment to measuring and monitoring clinical processes and
outcomes. For example, when data revealed that a number of joint replacement patients suffered post-surgical pulmonary embolisms, a team did a root-cause analysis and proposed changes which were institutionalized, leading to a substantial reduction in this condition. A similar approach was taken to reduce other hospital-acquired conditions, such as infections. Each month the executive team, top clinical leaders, and board of directors receive reports on key metrics and discuss progress or setbacks in these clinical quality indicators. The hospital also participates in a benchmarking activity sponsored by a hospital consortium, of which CH is a member. CH’s information systems organization was preparing to test and launch several major clinical systems over the next few years, including CPOE and EMAR, to be implemented in phases in various hospital departments.

3.3. Case findings

We elicited interviewees’ views regarding obstacles to perfect medication administration. We learned of ongoing challenges in how CH attempts to ensure that information about patients and ordered and administered medications is valid, accurate, complete, and timely. Interviewees discussed various challenges and noted that clinical contexts vary in complexity, number of clinicians and hospital units involved, and other aspects. Herein we describe a relatively simple medication administration scenario in a non-urgent care situation from patient admission through discharge. Table 2 highlights key value-added activities, outputs, and handoffs between clinicians and systems. Using the handoffs (lettered for reference) in Table 2, we identify potential risks in Table 3 and mitigating controls in Table 4.

The Chief Nursing Officer stated that nurses are supposed to check that the medication administration record (MAR) includes the patient’s weight, and to flag illegible orders before they are sent to the pharmacy. However, “… This doesn’t always happen: … If (nurses) don’t pay attention… the pharmacist has to deal with an illegible order”. On average, nearly 125 orders per day need to be verified (of about 600 orders per day total). “Think of all that work, to have someone do that!”

While nurses play a pivotal role in ensuring that the right meds are given to the right patient, physicians also mentioned some close calls. One involved a clerical error: “The wrong name was stamped on the order sheet. … (which was) supposed to be pre-stamped with the name of the patient… A secretary (had) put the order sheet back in the wrong chart. It was one of the few double rooms, and she put it in the chart of the patient’s roommate.” CH only has a few double rooms (most are singles), so this type of error is infrequent. Nurses mentioned another issue: multiple patients with the same name on the unit (common names such as “Smith” or members of a family involved in the same accident for which they are being treated): “I’ve had three Smiths on the floor at the same time… We put stickers on the door, the chart, and in the other room: ‘Caution: Patient has similar name.’”

Table 2. Value-added activities, outputs, and handoffs in medication administration

<table>
<thead>
<tr>
<th>Role</th>
<th>Output(s)/activities</th>
<th>Value-added activities (numbered)</th>
<th>Handoff description (italized, lettered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse Intake info</td>
<td>1. Interview patient and record patient history</td>
<td>A. Handoff of patient and history data to doctor.</td>
<td></td>
</tr>
<tr>
<td>Doctor Orders</td>
<td>2. Examine patient: Repeat some questions asked by intake nurse. Order X-rays, medication, etc…</td>
<td>B. Handoff of patient, intake information, doctor’s orders to PA.</td>
<td></td>
</tr>
<tr>
<td>Physician assistant Medication reconciliation</td>
<td>3. Medication reconciliation: Interview patient, record on paper form. Check what drugs patient is taking, compatibility with ordered meds, whether same/equivalent drugs are in formulary. C. Give form to unit secretary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit secretary Fax receipt</td>
<td>No value added activities.</td>
<td>D. Fax order to pharmacy</td>
<td></td>
</tr>
<tr>
<td>Pharmacist Medication orders in system</td>
<td>4. Review Order</td>
<td>5. Enter into pharmacy system</td>
<td>6. Resolve potential drug interactions along with other system-generated warnings</td>
</tr>
<tr>
<td>Pharmacy system MAR</td>
<td>8. Create medication administration record (MAR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital personnel</td>
<td>9. No value added activity</td>
<td>G. Paper MAR delivered to “nurse server” cabinet</td>
<td></td>
</tr>
<tr>
<td>Nurse MAR record</td>
<td>10. Retrieve MAR</td>
<td>11. Record withdrawal from computerized medication cabinet (which also records withdrawal) or other source (e.g., refrigerator)</td>
<td>12. Administer medication following five rights</td>
</tr>
<tr>
<td>Doctor Rx</td>
<td>14. Create discharge prescription (Rx)</td>
<td>15. Educate patient</td>
<td>16. Hand deliver paper forms (if any) to patient</td>
</tr>
</tbody>
</table>

Table 3 and mitigating controls in Table 4.
Table 3. Handoff risks identified

<table>
<thead>
<tr>
<th>Handoff</th>
<th>Risks and information attributes potentially affected: V=validity, A= Accuracy, C= Completeness, T= Timeliness</th>
<th>Sample supporting interviewee quotations (italicized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Failure to capture patient data: A, C; could also affect T</td>
<td>Patient feigns great pain in attempt to get a narcotic: V</td>
</tr>
<tr>
<td>B</td>
<td>Failure to capture patient data: A, C; could also affect T</td>
<td>Patient may not report every drug he is currently taking: C</td>
</tr>
<tr>
<td>C</td>
<td>Failure to capture patient data: A, C; could also affect T</td>
<td>You may be taking something for your blood pressure that the institution doesn’t carry: A, C</td>
</tr>
<tr>
<td>D</td>
<td>Nurse says a distracted secretary may fail to fax order: C, T</td>
<td>The secretary might be taking 10 phone calls: A</td>
</tr>
<tr>
<td>E</td>
<td>Data-entry errors by pharmacist: A</td>
<td>Sometimes it’s a pharmacy mistake... They print it at 100 mg... V</td>
</tr>
<tr>
<td>F</td>
<td>No risks identified by participants</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>No risks identified by participants</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Interruptions and distractions: V, A, T</td>
<td>A phone call, a code, a patient falls, a doctor asks you to help with something: A</td>
</tr>
</tbody>
</table>

We also note another important process variation: when a patient is treated in the ED, pharmacists are less involved in reviewing medications (since meds may need to be administered immediately). ED nurses are less focused on documenting medication administration, although the smart medication cabinet helps. “Pharmacy will know that patient; at least [the medication cabinet] will say for this patient, this was pulled out ... there’s that amount of documentation, but no pharmacy is verifying that order.”

Table 4. Medication administration controls

<table>
<thead>
<tr>
<th>Handoff</th>
<th>Current medication administration process controls</th>
<th>Quotation example(s)(italicized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>If information is incomplete in one step, subsequent value-added steps may note this and retrace the process or follow-up with those responsible for completing previous steps.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>There’s a lot of back and forth that goes on between the pharmacist and physicians, as far as verification of the order.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>If handwritten order is illegible or partially legible at any stage until entered into the system, clarification is needed.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>If you can’t read it your role is to stop ... and call the provider.</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Automated error alerts</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Quiet zone signage for pharmacy and nursing</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Nurse should follow up if alerted to a medication administration order that extends beyond 2 hours.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change-of-shift bedside reporting, consistent with guidelines recently promulgated by JCAHO.</td>
<td></td>
</tr>
</tbody>
</table>

Interviewees mentioned that hospital capacity issues (more than half of the time, inpatient units are at full capacity) lead to handoff errors. On the day we visited, the medical/surgical floor was at full capacity; more than 20 patients were temporarily bedded in the ED. This creates problems for the ED and handoff challenges for the medical/surgical floor. A paper chart is started for the patient while in the ED. So long as this chart accompanies the patient to the floor, information is not lost (however, timeliness is threatened when the information is not in the system, and also the chart sometimes does get misplaced). A doctor connected the dots among capacity constraints, room assignments, and medication administration...
errors: “We had three Smiths; two were across the hall from each other. That’s something that might be approached in bed assignment. But when you are boarding people in the hall it’s hard to be fussy about where to put your patients. That introduces an opportunity for error.”

These comments highlight the necessity of considering the broader context of care. For example, at CH it seems that extra vigilance is required to ensure both information quality and care quality during transitions of care, especially between the ED and the inpatient units.

We identified many points during hospitalization when errors can occur and distort information subsequently needed during a handoff. Like in other hospitals, many CH interviewees believed CPOE and EMAR will reduce errors. The Chief Nursing Officer stated that CPOE will “put the right controls into place, the right rules so those things can be corrected.” Rollout was expected to start a few months after our interviews, with implementation to be completed in 2011. One doctor noted that without CPOE, illegible handwriting or missing data requires that the pharmacist “go back to the individual who wrote that.” Other expected benefits included improved completeness and timeliness: “if [medications] are ordered post-op, you’ll have that electronic record of when it was administered in OR, so that you can make sure that if you are in a Q4 hour schedule or a Q6 hour schedule, you’re hitting those times as required.”

Despite the expected benefits, some interviewees felt that some of the process “ills” identified above will not be “cured” by new systems. Several interviewees were concerned that when CPOE is implemented in their unit, a problem will arise because the ED, ICU and surgical recovery units will implement CPOE later: “Patients moving from unit to unit, what do we have to do when they are going from electronic to paper and back to electronic? In and out of the ICU, because the ICU’s not coming up [not going to be on the CPOE system yet], there’s a lot of stuff.” Others expressed concern that “alert fatigue” might occur in response to the CPOE system: “In computerization there’s all these automatic warnings and alerts that come up. They come up so often that they’re almost always overridden by the pharmacist [...] I think when we get it here it would be overridden by the docs.” Another issue identified in our interviews concerned resident training: “I hear that [EMAR] doesn’t work well in a teaching situation, if a few residents are in a clinic, which is common....If you the teacher in a residency program you want the resident to document their thought process and how they got to their conclusion and what they saw, and that stuff isn’t embedded in the EMAR.” This is a particularly important issue, since in our interviews residents were often implicated in medication errors, and an automated system seems to eliminate an important control for detecting gaps in residents’ knowledge. Lastly, interviewees suggested that CPOE may introduce process changes that could increase clinicians’ cognitive load and potentially lead to more errors: “A lot of things ... go on behind the scenes; things that providers have to care about, that they never even knew happened before.”

4. Discussion and conclusions

Hospitals aim to provide safe, reliable, error-free patient care. Handoffs need to convey valid, accurate, complete and timely data, information and judgments. Thus, those who design clinical processes and systems need to focus on the conveyance of clinical data, information and judgments in a manner similar to the attention given financial transactions. Application of the BPM and information quality lenses helped us to identify potential errors of many types, as well as opportunities to catch those errors in the end-to-end patient care process.

4.1. Key findings and insights

Consistent with prior work, our study found that handoffs give rise to errors which can cause patient harm. Inherent in all handoffs is the potential to communicate incorrect or incomplete information. Our study findings confirm that information can be distorted or lost because of misspelled orders, illegible forms, facility limitations (patients bedded in hallways), random circumstances (patients with similar names), and technical limitations (some departments not using automated systems). And, due to limitations inherent to verbal and written media, some clinical observations and judgments are inevitably “lost in translation” between individuals and across various media.

Our study also reveals that handoffs can reduce patient harm by detecting errors committed in previous clinical steps (possibly unrelated to the handoff), or during a handoff. For example, the recipient of conveyed data, such as a specialist physician, may, by virtue of their knowledge or expertise, connect the dots of evidence and decide to order an additional test or change a treatment plan. When a handoff succeeds in detecting prior mistakes, it ensures that these mistakes will not affect subsequent steps in the clinical process. Further, a handoff recipient may notice that an ordered medication could harm this patient, due to either
Allergies, a dosage error in the prescription, or interaction with other drugs. By questioning the information conveyed in the handoff, this recipient helps to detect a mistake and prevent its propagation. We also find that patients are important sources of information and may help catch errors.

Use of the BPM lens allowed us to identify opportunities to reduce errors. For example, distractions were repeatedly discussed as a problem for pharmacists and nurses. This suggests that hospitals need to redesign workspaces and processes and redefine roles and responsibilities in order to reduce distractions. Furthermore, use of the accounting information systems lens helped us identify specific threats to clinical information quality (to validity, accuracy, completeness and timeliness). Our recognition of accountants’ emphasis on prevention, detection, and correction helped us identify ways that hospitals can prevent, detect and recover from clinical errors. For example, since our respondents emphasized that it is not feasible to eliminate all distractions, we conclude that, in addition to taking steps to prevent medication errors, hospitals should also implement stronger processes and systems for detecting and correcting errors, especially in those clinical contexts with high levels of interruptions.

We conclude that the BPM and accounting information systems lenses are complementary methodologies which hospitals can use to improve medication administration process quality. We further conclude that by looking holistically at end-to-end clinical processes, hospitals can identify those patient care situations that may require increased vigilance and a higher level of error checking. For example, our study finds that constrained capacity is a high-risk condition that increases the opportunity for errors. As increasing capacity in order to prevent overcrowding is not always feasible, hospitals can minimize the risk of errors by continuously monitoring patient demand versus hospital capacity in order to detect potential problems, and designing an action plan in order to immediately correct capacity imbalances if they occur.

Information systems such as CPOE have the opportunity to facilitate valid, accurate, complete and timely transfer of data, information and clinical judgments, but cannot be completely relied on to prevent errors. Thus, one of the primary objectives of systems designers should be to encourage clinicians to think and be aware of potential breakdowns in the information flow as well as the potential value-added and control features of each information source. Some of our interviewees’ comments implied that automation reduces one’s need to think. We conclude that the implementation of an automated system increases the need for clinician awareness to prevent the propagation of errors.

Overall, our findings lead us to conclude that clinicians and system designers need to be both “near-sighted” and “far-sighted.” They need to design clinical processes and systems that systematically prevent threats to the validity, accuracy, completeness and timeliness of clinical data, and that use handoffs to systematically detect and correct these four types of errors. Designers of processes and systems need to focus closely on fine details of the care process, the data, information, and judgments needed during handoffs, and specific information quality requirements. They also need to step back and consider how handoffs and related medication administration processes are affected by the broader institutional context and by interdependencies among sub-processes (such as the relationship between the billing system and the medication administration system), choices made by suppliers and partners (such as the pharmaceutical companies’ choices about packaging and labeling), and resource constraints (such as hospital bed shortages).

4.2. Contributions, limitations, and suggestions

While prior studies emphasized provider-provider handoffs, this case study examines these as well as system-provider and patient-provider handoffs. By using the BPM view we identified handoff disadvantages and advantages in the end-to-end patient care process. By applying the information quality lens drawn from accounting, we examined handoffs at a finer level of granularity. Our analysis of medication administration processes at CH revealed issues of validity, accuracy, completeness, and timeliness in patient care handoffs. Future studies can explore the feasibility of applying other techniques from the discipline of accounting information systems, particularly techniques that systematically assess the adequacy of manual and automated preventive, detective and corrective controls.

For practice, this study clarifies how patient care handoffs both lead to medication errors and help to reduce them. These observations can help hospital administrators identify best practices and aid improvement efforts. The study findings highlight important handoff features that need to be considered when designing and implementing clinical information systems such as CPOE and EMAR. In particular, our findings point out a possible unintended consequence of automating medical processes: clinicians may too readily accept information conveyed by an automated system. While the use of
CPOE or EMAR helps protect clinical information quality, errors made prior to transmission can still be propagated if detective controls are not properly implemented or error warnings are ignored. Clinical information systems are not a panacea; they should be designed and implemented with utmost care if patient safety is to be assured. In particular, following the BPM view we recommend that clinicians be made more aware of the potential for medication administration errors during the end-to-end patient care process. Training should emphasize how flawed patient handoffs lead to dangerous information errors, how well designed and executed handoffs can bring such errors to light, and how handoffs can reveal prior clinical mistakes.

We conducted a single case study at one point in time. A key strength of this research methodology is that we were able to examine one aspect of clinical care – medication administration processes – from multiple conceptual angles and informed by multiple participants. By triangulating our interview data against other CH data sources (such as the CH annual and quality reports and other documents), we were able to paint a richer picture than can be obtained via other methodologies. Through a process of data comparison and interpretation, we were able to “connect the dots” among issues, see for example how the hospital’s constrained capacity created a challenging condition for effective patient handoffs and medication administration. A limitation of our single-case methodology is that we are not yet able to generalize to a broader population. A next step would be to conduct similar case studies at comparison hospitals (community hospitals of similar size and with similar patient populations) as well as at hospitals which differ markedly on some dimensions (such as much smaller rural community hospitals or much larger tertiary-care teaching hospitals). Further research can also gather longitudinal and cross-sectional data about both manual and automated medication administration and handoff processes.

Our study contributes to the healthcare IT literature by investigating a key aspect of clinical care – handoffs – and their impact on medication administration processes, prior to a planned implementation of new clinical information systems. A recent meta-analysis of health information systems impacts finds that experts consider healthcare IT to be key to improving efficiency and quality of care [11]. However, introduction of a new system disrupts extant work routines and may lead to clinical mistakes if appropriate steps are not taken to insure successful implementation [15]. Last, but not least, physicians’ acceptance of the new IT system may depend more on its perceived usefulness than on its ease of use [17]. Thus, understanding existing handoff processes, with their advantages and disadvantages, can contribute to more successful healthcare IT solutions.

This work also contributes to identifying weaknesses and strengths of handoffs so that ontologies for advanced integrated healthcare solutions [21] that support improved data sharing and higher quality outcomes can be further developed. In looking at handoffs across the entire care process we are exploring both the complexities, challenges, and advances in sharing data, information and clinical judgments between patients, physicians, nurses, pharmacists, and others. These insights can enable better pre- and post-IT implementation comparisons, and promote future enhancements to current health information systems evaluation frameworks [38].

5. References


