Designed for Workarounds: A Qualitative Study of the Causes of Operational Failures in Hospitals

Designed for Workarounds:
A Qualitative Investigation into the Causes of Operational Failures in Hospitals

Abstract: Frontline staff in hospitals can spend at least 10% of their time working around operational failures. However, scholars know little about the underlying causes of the failures and therefore have limited guidance on reducing operational failures. To address this research gap, we conducted a qualitative study of the sources of operational failures on two hospitals' nursing units. Our supporting evidence came from in-depth observations and interviews with employees from four nursing units and the support departments that provided materials needed for patient care. We find that nearly half (49%) of the 120 failures we observed were from violations of Spear and Bowen's (1999) design rules. In addition, a third of the failures were from issues not explicitly discussed in Spear and Bowen's framework. These breakdowns reflected low levels of internal integration (1) among departments and (2) between the work of supply departments and the needs of current patients. In short, the "supply-to-stock" supply departments were unable to meet the needs of the "supply-to-order" nursing work. This explanation contrasts with employees' perception that failures were caused other workers' errors, dilatoriness or incompetence. Our study thus suggests that applying Spear and Bowen's rules for work design and increasing the levels of internal integration of supply departments to the needs of their internal and end customers should reduce a majority of operational failures experienced by frontline service staff.

Key Words: healthcare, internal supply chain, operational failures

1. Introduction

The purpose of this paper is to reduce the frequency with which operational failures occur in hospitals by developing a deeper understanding of their underlying causes. Hospitals face a pressing need to improve efficiency, quality of care and patient experience (Berwick et al. 2006). Yet, many hospitals struggle to achieve these goals (Wachter 2010). A contributing factor to poor performance is that frontline care providers have to repeatedly work around operational failures to provide care, which wastes caregiver time, delays care, and contributes to safety problems (Beaudoin and Edgar 2003, de Leval et al. 2000, Gurses and Carayon 2007, Hall et al. 2010, Hendrich et al. 2008, Tucker 2004). Thus, a critical step in improving the performance of hospitals is to mitigate operational failures by identifying and addressing their underlying causes.

Operational failures are instances of missing or insufficient supplies, equipment, information and people to complete a work task (Tucker 2004). Prior research has primarily focused on categorizing the types of operational failures encountered by workers and quantifying their impact on outcomes. However, few studies have examined their underlying *causes* (Fredendall et al. 2009). This is an important omission because without an understanding of what contributes to operational failures, it will be challenging to reduce their frequency.

This paper helps close this gap by conducting a qualitative investigation of the causes of operational failures experienced by hospital nurses on medical/surgical wards. The authors, together with a team of 25 other people, conducted 112 hours of direct observation of medical/surgical nurses in two hospitals, documenting 120 operational failures that were directly observed. To understand the causes of these failures, the authors and team members also shadowed employees from the ancillary support departments that provided materials, medications, and equipment needed for patient care.

We used a grounded, inductive reasoning approach, which investigates a research question through iterative cycles of analyzing the qualitative data to allow patterns to emerge from the observations (Miles and Huberman 1994). We then compared what was learned to existing theories to discover which theories best reflect the underlying dynamics that were observed (Shah et al. 2008). Our methods are similar to those used by Fredendall et al (2009) and Shah et al. (2008). A difference between our study and those two studies is that we examined internal supply chains (ISC) across multiple departments within the same hospital, while Fredendall studied operational failures within a single department (perioperative surgical service department) and Shah studied the interorganizational supply chain across multiple independent organizations. We find that Spear & Bowen's (SB) (1999) theory of effective work design was useful for describing what we had observed to be the causes of operational failures. This theory was applied as an organizing framework after the observations were conducted and therefore represents a post hoc method for structuring our results (Shah et al. 2008).

Our study contributes to the growing literature on improvement in service organizations by providing additional insight about the underlying causes of operational failures in hospitals. First, we find that nearly half of the operational failures could be attributed to violations of SB's four rules about work design. To our knowledge, scant research has empirically quantified the link between violations of SB's design rules and operational failures. Second, we find that a third of the failures resulted from factors not explicitly stated in SB's rules. These factors related to low levels of internal integration among the departments in the ISC with each other and with patients' specific needs. Most prior research has examined the impact of internal integration on organizational level performance, such as the speed of new product development (Flynn et al. 2010), financial performance (Dröge et al. 2004), and cycle time (Shah et al. 2008). Our study extends this research stream by providing specific examples of how low levels of internal integration in the work routines of upstream supply departments inadvertently contribute to operational failures and workarounds experienced by frontline employees.

2. Literature Review

2.1. Operational failures

Many researchers have documented the existence of operational failures, referring to them as performance obstacles (Gurses and Carayon 2007), hassles (Beaudoin and Edgar 2003), blockages (Rathert et al. 2012) and situational constraints (Peters and O'Connor 1980, Villanova and Roman 1993). In this paper, we will refer to them as operational failures or problems. The primary focus of prior research has been on describing and quantifying the different types of operational failures experienced by workers. For example, categories of problems include ones related to information, tools and equipment, materials and supplies, budgetary support, help from others, and work environment aspects, such as lighting (Gilboa et al. 2008, Klein and Kim 1998, McNeese-Smith 2001, Peters and O'Connor 1980, Peters et al. 1985, Villanova 1996). Scholars have also quantified the negative impact of operational failures on organizational outcomes, such as productivity (Gilboa et al. 2008, Peters and O'Connor 1980, Peters et al. 1985). Operational failures have been shown to have a moderate impact on employee performance. For example, a meta-analysis of seven different kinds of work-related stressors—which, in addition to operational failures, included work-family conflict and job insecurity—found that operational failures had the largest correlation (-0.29) with job performance (Gilboa et al. 2008). More specifically related to our study, research on hospital nurses have found that approximately 10% of nurses' time is spent working around operational failures (Hendrich et al. 2008, Tucker 2004).

Studies have shown that operational failures can occur in ongoing, everyday work, particularly when the work is complex and requires inputs from multiple different departments within the organization, such as healthcare (Beaudoin and Edgar 2003, Gurses and Carayon 2007, Hendrich et al. 2008, Tucker 2004). They also result from the introduction of new equipment (von Hippel and Tyre 1993) or information technology (IT) systems (Ash et al. 2004, Halbesleben et al. 2010, Koppel et al. 2008). Changes in production technology can introduce obstacles for employees, either through deliberate work blockages created for safety reasons, or through inadvertent disconnects between how the IT system is designed and how work is actually performed (Ash et al. 2004, Halbesleben et al. 2010, Koppel et al. 2008).

A common response to operational failures is to work around them (Halbesleben et al. 2008, Kobayashi et al. 2005, Rathert et al. 2012, Spear and Schmidhofer 2005). Halbesleben et al. (2010) define a workaround as "a situation in which an employee devises an alternate work procedure to address a block in the flow of his or her work" (p.1). In the short term, workarounds are beneficial because they enable work to continue. However, if the employee does not expend additional effort to prevent recurrence, information that could be used to identify and remove underlying causes of the failure is lost, allowing operational failures to persist (Tucker and Edmondson 2003).

Operational failures and workarounds negatively affect organizations, employees, and customers. First, they erode employee productivity because of the additional time required to work around problems. This is particularly problematic situation for hospitals where nurses experience frequent operations failures because nursing labor is often hospitals' largest expense (Spear 2005, Tucker 2004). Furthermore, having to continually work around problems burns out employees and contributes to dissatisfaction and turnover (Beaudoin and Edgar 2003). Finally, operational failures delay care and can lead to errors that harm customers (Halbesleben et al. 2008, Jimmerson et al. 2005, Spear and Schmidhofer 2005).

Despite these negative effects, we know relatively little about the underlying causes of operational failures and what actions might mitigate the causes (Fredendall et al. 2009). We now describe the few studies that have examined specific contributors to operational failures. Fredendall et al (2009) found that a lack of standardization in the preparation of surgical trays led to equipment errors that were discovered during surgery. Bendoly and Hur's (2007) study demonstrated that chronic missing supplies on one hospital's nursing units were due to understaffing in the department responsible for stocking the supplies ("central supply").

These studies collectively suggest that operational failures result from breakdowns in the transfer of materials or information from one internal department (e.g. surgical services, central supply) to another (nurses and surgeons). The physical movement of materials through the organization from receiving to the point-of-use has been described as an ISC (Basnet 2012, Fredendall et al. 2009, Halbesleben et al. 2010, Pagell 2004, Shah and Singh 2001, Swinehart and Smith 2005). More precisely, an ISC is defined as the set of processes that provide customer-facing employees with the materials, information, equipment, and human resources that they need to provide service to customers (Fredendall et al. 2009, Halbesleben et al. 2010, Pagell 2004, Shah and Singh 2001, Swinehart and Smith 2005). In hospitals, the resources required for patient care also include medications. For brevity, we refer to these items as "materials." Materials flow through departments as they travel through the organization to be used in patient care (Vera and Kuntz 2007). Breakdowns in the flow of materials result in operational failures when nurses do not have materials needed for patient care.

To provide a specific example of ISCs in hospitals and how breakdowns could lead to operational failures, let us consider the ISC for medications (Halbesleben et al. 2010), which is shown in Figure 1. A physician uses a computerized physician order entry system to order a medication for a patient. This system relays the order to the pharmacy, where a pharmacist verifies the order and dispenses the medication. The medication may be delivered to the nursing unit by a pharmacy technician, who places the medication in one of several locations: a refrigerator, a drawer designated for the patient, or an automated dispensing device. Engineering is responsible for maintaining the refrigerator, while information technology (IT) is accountable for the computers and software used to order and dispense medications. Alternatively, the medication may be sent through a pneumatic tube system, which is dependent on engineering. A nurse administers the medication to the patient, and may need supplies to do so, such as syringes, which the central supply department stocks on the unit or a piece of equipment, such as a pump, which is maintained by biomedical equipment and cleaned by the sterile processing department. In addition, the nurse also may need to administer the medication with food, which dietary services supplies. In summary, the process of getting medications to patients involves nine departments, which are represented as circles in Figure 1: medical staff, pharmacy, nursing, engineering, central supplies, dietary, information technology, biomedical equipment, and sterile processing. An operational failure can occur in any of the steps and failures can be caused by a variety of factors including human error, delay, equipment malfunction, or miscommunication. It is often unclear to the nurse exactly why the operational failure occurred and where in the chain the breakdown was from.

---------- Insert Figure 1 about here ----------

2.2. .Design of Internal Supply Chain

The lean literature on ISC design is related to the sources of operational failures because effective process design for supplying workers with the required materials and equipment should prevent operational failures from occurring in the first place. In particular, we use Spear and Bowen's (SB's) (1999) framework of Toyota's process design rules. Their study can be viewed as an investigation of the design rules of an organization with highly functioning ISCs. Although SB's purpose was to discover the essence of Toyota's production system, we extend their rules to health care as a starting point for describing the causes of operational failures in hospitals. Our supposition is that violating these work design rules will result in operational failures in hospitals. We selected SB's framework to use an organizing mechanism for reporting our findings after we conducted our observations and analyses because we found that their four rules mirrored the structure of our results. We now describe their rules and link them to failures.

The first rule concerns the design of the *activities* in an individual's work routine. SB (1999) state that activities should be clearly specified so that the employee knows exactly what to do, in what order, at what time, and if the work was done correctly. If this design rule is broken, employees may complete work incorrectly or with high levels of variability, which can lead to problems. For example, in a study of operating rooms, Fredendall et al. (2009) found that variability in the equipment that surgeons requested as well as variability in how technicians executed their tasks caused mistakes in the preparation of surgical equipment trays. In addition, other research suggests that consistent execution of routines may increase resilience to errors by reducing the amount of mental capacity that employees need to devote to work, freeing up capacity for anticipating and preventing problems (Gittell 2002).

The second rule concerns the *connections* between internal customers and suppliers, which states that the process of requesting supplies should be highly specified and include details such as what is being requested, how much, and at what location. The connection must be direct between a specific customer and a specific supplier (rather than a pool of people), without any intermediaries, and include a yes-or-no response to each request so that the customer knows that the request was received and when to expect delivery (Spear and Bowen 1999). Specified connections prevent operational failures for several reasons. First, having a direct relationship between an internal customer and the supplier can improve communication and understanding between the two groups, which can pre-empt problems and aid in solution if they arise. For example, Gittell (2002) found that relational coordination—a team of employees from interdependent functions with shared goals and respectful working ties—fosters informal communication that helps the team successfully adjust to changing conditions. Second, receiving a yes/no response to one's request for material along with expected delivery time and location prevents having to repeatedly look to see whether the requested material has been delivered. In addition, should the material fail to appear, the person would know whether the delay was because the request was not received (in which case the person would not have received a response from the supply department) or because the department was just slow in responding (in which case the person would have received an acknowledgement of the request). Without this system of responding to requests, if the material is slow in arriving, the internal customer is likely to repeat the request, which creates confusion for the supplier as to whether there are two separate requests or only one request, repeated twice.

Third, Spear and Bowen (1999) state that the pathway of materials as they move through the organization to frontline employees must be simple and direct. In other words, materials must flow from and to specific people, rather than to the next available person or machine. A direct pathway is beneficial because it ensures traceability in the flow of materials, which is helpful for problem solving, and it enables workers to efficiently locate requested materials. Otherwise, employees may have to search in multiple storage locations for requested material.

The final rule specifies how improvement should be conducted. Improvement activities are performed at the lowest possible organizational level, under the guidance of an experienced person. Furthermore, improvement initiatives should be conducted as experiments, such that hypotheses are proposed and tested (Spear and Bowen 1999). This approach to resolving problems ensures that solutions to problems are implementable and have the desired impact, which should reduce future occurrences.

3. Methods

We conducted our study at two hospitals operated by an integrated healthcare organization with a total of 36 hospitals. We selected these hospitals because they were supported by our geographically-based grant. Data was gathered from October to December 2011 using multiple methods including surveys, direct observation and interviews.

We created multiple data sets to investigate the causes of operational failures. First, at the start of the research project, we surveyed eight department managers at the two hospitals about their existing performance metrics. We asked them to list the metrics that they used to gauge their department's performance on timeliness, quality, and cost. We also asked them to list the metrics they used to gauge how well their department met the needs of their internal customers and patients. Furthermore, we asked how much transparency they had about how their department's performance impacted patient care delivery on the hospital units.

In addition to these surveys, together with the larger team of 25 people, the authors observed employees as they worked in medical/surgical nursing units and in the departments that provided the materials, medications, equipment, food, and general support services needed for patient care. The team conducted a total of 66 observations over 112 hours. Thirty of these hours were spent observing support departments while the remainder was spent on nursing care. Observations consisted of shadowing participants while they did their job along with having open-ended conversations to understand the reasons behind each action. The team observed for two hours at a stretch, two times per day, for three or four days at each hospital. Our sample consisted of a variety of professionals, including nurses, nurses' aides, assistant nurse managers, charge nurses, unit assistants, pharmacists, pharmacy technicians, engineers, central supply technicians, biomedical engineers, dietary and IT staff. Study participants were offered an opportunity to refuse participation, although none did.

On average, 5.7 of 25 team members observed at a given time. Having a team enabled us to simultaneously observe several people within the same nursing unit as well as support department personnel. The individuals who helped us with the observations included support department managers and front-line employees from the two hospitals, nurse managers from the nursing units we observed, and staff nurses. All observers collected qualitative data in a different hospital from the one in which they worked. The authors standardized the observation process by instructing observers how to conduct an observation. Observers took notes on blank paper and then summarized what they had discovered using "contact summary sheets" (Miles and Huberman 1994). The sheet had space to record the person's position, any observed operational failures, the causes of these failures (if known), what actions were taken in response, and the amount of time spent on the failure. These sheets were one of our primary data sources.

After each two-hour observation block, the team members who had conducted observations gathered together to provide a verbal report of their observations. They reported on who was observed, what his or her role was, and the key incidents that were directly observed (Gilmore 2002, IDEO 2011, Lin et al. 2011). Verbally describing key events from all of the different observers' perspectives allowed a more complete understanding of events to emerge. For example, one nurse might have done an activity (e.g. tampering with a computer to make it appear broken so that no one else would take it away from her), which resulted in a different nurse encountering an operational failure. As this example illustrates, having a group discussion enabled different perspectives of the same incident to surface, which provided a deeper understanding of the causes of operational failures. The debrief discussions were recorded and transcribed, replacing real names with pseudonyms. The debrief transcripts supplemented information from the contact summary sheets.

In addition to the observations, the authors interviewed managers and staff from all nine departments involved in the ISC. We conducted interviews of either one or two people at a time and asked about the challenges they faced, how departments coordinated their work and how work requests were transmitted across boundaries. The interviews were recorded and transcribed as well. **Table 1** provides details on the number of people who participated in observations, interviews and their departments.

---------- Insert **Table 1** about here----------

After gathering the observation and interview data, the authors conducted qualitative analysis, which involved multiple iterations of collectively distilling and connecting the information gathered from the various observations and interviews (IDEO 2011). Our goal was to develop a conceptual framework that explained the causes of operational failures (Miles and Huberman 1994). We first used the contact summary sheets to create a database of the operational failures that were directly observed, which became our primary data and informed our qualitative analysis. To increase our understanding to the causes and consequences of the problems in this dataset, we read the debrief transcripts with particular focus on extracting information that was directly related to the operational failures that we had observed. We used a grounded approach (Glaser and Strauss 1967, Miles and Huberman 1994, Strauss and Corbin 1998) to distilling ("coding") our qualitative data. Coding was a crucial step process because it enabled us to focus on the important aspects of the observations without experiencing data overload (Miles and Huberman 1994). To enable all of the authors to have a grounded understanding of the operational failures, we divided the transcripts among us and all extracted information. Before doing this, however, we established inter-rater reliability by having all authors code the same transcript. We then compared which sentences we had individually highlighted as important. Our inter-rater reliability was .72 (kappa), which indicated substantial agreement (Landis and Koch 1977). This high inter-rater reliability provided confidence that we could divide the transcripts among us to identify and extract key passages. We then succinctly summarized the main issue from each passage onto a single sticky note. This resulted in 680 notes, which formed the initial building blocks that we used to create our framework.

Over the course of eight workdays, we used a structured process to convert the qualitative data that had been extracted onto the 680 sticky notes into a coherent framework. First, we clustered notes that had the same or similar information (e.g. all of the sticky notes that mentioned an operational failure due to a computer being out of batteries were grouped together). We then engaged in pattern coding to create a higher-level classification of how the events related to each other (Glaser and Strauss 1967, Miles and Huberman 1994, Strauss and Corbin 1998).

To illustrate the process, we had multiple sticky notes related to computers. The computers were on wheels and were to be shared by all the care providers working in a unit. We began by placing all of the sticky notes related to computers in a cluster. They described the various situations related to computers that we had observed, such as a nurse having to walk a long way to find an available electrical outlet to plug the computer in; and a nurse having to try three different computers before finding a working one. Other sticky notes described how nurses engaged in hoarding behaviors, such as placing ownership signs on computers (e.g. "Mary's computer"). To generate a deeper, collective understand of the causes of operational failures related to computers, we combined related codes into "meta" themes (e.g. hoarding and sabotage were collapsed into one category) and allowed new categories to emerge (e.g. defensive behaviors) (Miles and Huberman 1994). We then organized the higher level categories to depict relationships among them. For example, we had a cluster of sticky notes describing the nonresponsive computer repair process and another cluster describing the lack of available electrical outlets. We linked these clusters to the shortage of working computers, which in turn lead to defensive behaviors. In summary, by combining all the pieces of the computer story gathered across multiple observations together, we strove to create a cohesive set of insights that summarized the causes of operational failures related to computers.

After establishing an initial set of insights, we compared our results to existing literature relevant to operational failures. We found that our framework had similarities with SB's four rules (1999) because the causes could be categorized as being related to activities, connections, pathways, and improvement activities. Therefore, the authors coded the causes of the 120 failures using SB's four rules. Within each of these four broad categories, we created subcategories derived from the specifics of SB's rules, as well from our initial set of insights. We also had an "other" category for failures that did not fit the categories. First, the authors individually coded each failure in the dataset, which could be coded with multiple causes. We then discussed the coding of each failure until we reached an agreement on the codes to apply.

4. Results

While shadowing nurses, we directly observed 120 operational failures. On average, a nurse experienced one failure every 37 minutes and working around them consumed 12% of their day. These results are similar to prior research on operational failures, lending credibility to our data (Hendrich et al. 2008, Tucker 2004). As shown in **Table 2**, 36% of the operational failures were related to work activities, 20% to connections between internal and external suppliers, 14% to the flow of materials and services along pathways, 12% to improvement, and the remaining 18% were "other" issues, such as insufficient training or software glitches.

A second way to report the causes of failures is to divide them into whether or not their causes could be mapped onto SB's four rules. We discovered that 49% of the failures we observed were caused by violations explicitly mentioned by SB. However, 34% stemmed from low levels of internal integration in a manner not described by SB (1999). The remaining 18% remained in the "other" category.

We define internal integration as the extent to which separate departments within an organization efficiently work together to meet end customers' needs (Kahn and Mentzer 1998, O'Leary-Kelly and Flores 2002, Pagell 2004). For our study, two aspects of internal integration were particularly salient: the extent to which internal supply departments' activities were designed to satisfy the *current* end customer's *specific* needs, and the extent to which internal supply departments effectively coordinated their activities such that the customer-facing department had the supplies and equipment needed at the right time to provide service.

We assert that the distinctive features of healthcare delivery: the large variability and continually evolving nature of end customer demand as well as the highly technical, specialized knowledge of functional areas—create the need for high levels of internal integration. Without internal integration, operational failures occur, which the care givers then work around. Therefore, hospitals may need to augment SB's design rules with practices specifically designed to address their environment. Below, we describe each of the four categories of causes (activities, connections, pathway, and improvement), providing detail on operational failures resulting from violations of SB's rules, as well as associated conditions that stemmed from low internal integration not described by SB's rules.

3.1 Activities

Within the activity category, as SB's framework predicts, failures were caused by a lack of standard procedures and criteria for assessing the accuracy of actions. This is similar to Fredendall's finding (2009) about how unstandardized processes resulted in missing surgical equipment. In our dataset the largest cause of failures (13% of all failures) was because an individual neglected to do an activity that he or she should have done. In one instance, a hungry patient could not get a meal tray because his physician had not entered a dietary order.

However, we found that even when an internal supplier's activities complied with SB's activity rule of work being highly specified, the downstream internal customer could nonetheless experience an operational failure if the supplier's activities were not performed to meet specific needs of the patient. This lack of integration of internal suppliers' activities with end customers' needs accounted for 6% of all failures. The work of the sterile processing department employees provides an example. Nurses put used intravenous pumps in the dirty utility room, which the sterile processing department then cleaned and placed in the clean utility room. The sterile processing department technician's cleaning and restocking of intravenous pumps—although performed in accordance with their department's process—often did not meet the needs of current patients because the department's work was driven by the pump usage of *discharged* patients rather than by the needs of *current* patients. For example, we observed a specific type of pump (triple) that was needed by a patient, but was unavailable in the clean utility room. The technician had done his job of cleaning dirty pumps and restocking them on the unit, however, the work did not match patients' needs. In summary, we found that operational failures were caused by the combination of highly variable end customer needs and supply departments that "supplied-to-stock" rather than tailoring delivery to meet the specific needs of patients.

3.2 Connections

Five percent of failures were due to violations of SB's rule that connections must (1) be clear in terms of how requests are made and (2) provide feedback to the requestor that the request was received and what the expected delivery time is. In addition, another 5% of the failures stemmed from insufficient restocking requests by internal customers when the supply was running low. Our observations suggested that this occurred because there was no easy, automatic way to re-order materials that were running low. For example, we observed nurses use the last of a particular item on the unit (e.g. ice cream) without notifying the internal supplier to restock that item. As a result, the next nurse who needed the item would find an empty shelf. There was a clear way (phone call) for the nurses to make a request to restock an item as specified by SB, but we did not observe anyone do this.

The most frequent connection-related cause (8% of problems overall) was not specifically represented by SB's connection rule. These failures stemmed from a lack of internal integration as manifested by deficient knowledge transfer between internal suppliers and internal customers. Although the customer-supplier connection was specified, direct, and included a yes/no signal for communication, there were instances when the internal customer lacked enough knowledge to continue processing the material efficiently. For example, we observed a nurse search unsuccessfully for over an hour for two bags of IV medication that she needed for her patient, despite the fact the pharmacy had confirmed they had been delivered to the unit. The nurse did not realize that due to the amount of a certain type of medication in the bags, the bags were placed in the medication refrigerator, the one place out of eight possible storage locations where the nurse had not looked. In this instance, the supplier-customer connection was direct and had a clear yes/no response (and there was a designated storage location per rule 3), but the connection was inefficient because knowledge of the algorithm for determining the storage location was not communicated to the nurse. Prior research has similarly found that essential knowledge is often not transferred across discipline boundaries because it is so central to one discipline's work that they do not realize that other disciplines do not possess it (Carlile 2002, Carlile 2004, Kellogg et al. 2006, Malone and Crowston 1990, Orlikowski 2002).

3.3 Pathways

With regard to pathways, violations of Spear and Bowen's (1999) rule that pathways must be pre-specified and direct with no forks or loops accounted for 6% of all failures. For example, many materials on units did not have a single, designated storage location, and thus nurses had to look in multiple places to find items.

In addition to the SB-related causes, we found that the most frequent cause related to pathways (8% overall) was due to poor handoffs of materials between departments. Specifically, although pathways were direct and specified, some did not facilitate successful handoffs of materials from one step in the process to the next. This happened when multiple departments were responsible for taking action to process the material, with the specific department responsibility dictated by the particular circumstances. As a result of the variability in responsibility, materials stalled mid process because each department thought that it was the responsibility of another department to process the material. We refer to an inadequate handoff as "a gap in the process." Gaps occurred at the interface between departments and were frequently related to equipment repair and cleaning. To illustrate, we describe the gap in the process for IV poles. If a patient who had an IV pole was discharged from a room, the environmental services (EVS) department would clean the pole and leave it in the room. Thus, the next patient to be placed in that room would have an IV pole available. However, if the discharged patient did not have a pole, then EVS would clean the room, but would not find a clean IV pole for the next incoming patient. Under these conditions, nurses were supposed to find an IV pole for the new patient. As a result of the ambiguity about whether or not a clean IV pole should be in a newly cleaned room; and who was responsible for IV poles, nurses frequently discovered when the new patient arrived to his room that there was no IV pole, and then she had to scramble to try to find one.

3.4 Improvement Processes

The fourth category was related to improvement processes. SB's improvement rule stipulates that changes to the activities, connections, and pathways within an ISC should be conducted by the scientific method, namely by postulating a hypothesis and testing it to see if it had the desired impact. An implicit assumption of this rule is that improvement activities take place, but they are not effective. We found instead that improvement activities were not even occurring despite the frequent operational failures we observed. Although problems were not directly caused by violations of the improvement rule, a lack of awareness and motivation to resolve them enabled failures to persist. Thus, as a precursor to SB's rule, it appears that triggers for improvement efforts are needed. In the hospitals we studied, for example, there were no methods or systems, such as meetings between the supply departments and the nursing units, which exposed failures and enabled discussion of potential solutions. The hospital did not use tools to understand delays in the flow of materials through the organization, such as the supplier-inputs-process-outputs-customers (SIPOC) tool advocated by six-sigma proponents (Anil et al. 2004). In addition, there were few measures of system-wide performance. To provide evidence of the lack of triggers for improvement efforts, we surveyed department managers on their department's performance metrics. As **Table 3** shows, of the departments surveyed, only nursing had a majority of metrics (60%) that measured the overall hospital system's ability to meet end customers' needs. The support departments' metrics were predominantly measuring their own department's performance. For example, all of the pharmacy's metrics evaluated their own performance, such as the average time to verify an order, rather than tracking their performance in the big picture of overall system performance. As a result, departments could think they performed well on department-level measurements, such as meeting department delivery time and labor-cost targets, but remain unaware of their organization's poor performance on system-level measures, such as the overall timeliness of medication administration to patients.

---------- Insert Table 2 about here ----------

---------- Insert Table 3 about here ----------

3.5 Employees' Responses to and Beliefs about Operational Failures

We now describe the dynamics caused by operational failures. Nurses compensated for the lack of reliability in the supply of materials to the units by hoarding functional items. Forty-four percent of the nurses whom we interviewed stated that the equipment needed to do their job was often unavailable and that it was an accepted practice to "go shopping" in the dirty utility room, in other patients' rooms, or on other units. For example, one nurse said, "If you can't find it, you go get it, no matter where it is." We also observed nurses violate policy by personally claiming shared equipment for their entire shift by putting notes (e.g. "Mary's computer") on computers so that other care providers—who also needed to use the equipment to do their jobs—would feel social pressure not to use these items. More drastically, we observed nurses make functioning equipment appear broken. For example, one observer saw a computer-savvy nurse rotate the text display on a shared-use computer by 90 degrees to discourage other people from using it. A second observer's nurse attempted to use this computer, but abandoned it due to the rotated screen text. These hoarding behaviors exacerbated the shortage of functional equipment, which contributed to the number of operational failures.

With regard to employees' beliefs about the causes of operational failures, we found that employees attributed problems to deficient individuals in other departments. We spoke with employees from all nine departments involved in the ISC, and everyone expressed satisfaction with their own department's work. No one in the support departments expressed the belief that their department's routines could be changed in a way that would improve overall ISC performance. Thus, people seemed unaware of the low levels of internal integration and its contribution to operational failures. When reflecting on operational failures, people attributed poor performance to shortcomings of workers in other departments rather than to suboptimal design of activities, connections, pathways, and improvement processes. For example, a sterile processing worker attributed poor performance to a general lack of training in the organization, stating, "I don't know why our organization doesn't care about training." This attribution to individuals created an impediment to improvement because people did not recognize the opportunity to work collaboratively across boundaries to improve organizational work systems.

4. Propositions about Integrated Internal Processes

We propose that *the more the activities, connections, pathways, and improvement processes of internal supply departments are integrated across departments and with the needs of current customers, the lower the frequency of operational failures experienced by the customer-facing employees.* We predict that operational failures occur at the interface where a supply department "supplies-to-stock" for a department that in turn has to provide "make-to-order" services. Furthermore, operational failures will be more frequent when there is greater variability in the materials and equipment needed by the end customers. In the hospital setting, these conditions equate to nursing units with short lengths of stay and high variability in patient diagnoses, such as medical/surgical units. We therefore predict that medical/surgical units will experience more operational failures than specialized, long-term care units, such as bone marrow transplant units.

This is because stocking a standard set of materials on a unit with highly fluctuating patient diagnoses is unlikely to satisfy actual customer demand, given the day-to-day variability in what supplies are needed and the storage space limitations of most units. Furthermore, because nurses are responsible for delivering care to their patients, they compensate for unreliable supply systems by working around the problem. In other words, although the failures result from a lack of internal integration, the deficiency manifests as workarounds.

5. Discussion

This study examined the causes of operational failures in the medical/surgical units at two hospitals. We found that nearly half of the failures we observed could be categorized as violations of Spear and Bowen's (1999) work design rules. However, a third stemmed from a lack of internal integration of departments with each other and with current customers' needs. Departments emphasized their own performance, and thus processes were designed to maximize departmental efficiency rather than timeliness of service delivery to end customers. Nurses, in turn, compensated for the poorly integrated supply systems by working around the failures because they were in the unique position of having both the clinical knowledge to translate patients' orders into resource needs and the responsibility for providing patient care.

We found that the hospitals had low levels of internal integration, in part, because of how the supply departments were designed and managed. Supply department activities were not always performed to meet current patients' needs, knowledge was not transferred across department boundaries, and pathways had gaps, all of which stalled the delivery of materials. Lastly, there was no forum for continuously improving the ISC.

When there are low levels of internal integration, supply departments are unable to reliably deliver what current customers need due to the high levels of variability in end customer needs (Anderson et al. 2005). An implication of our finding is that operational failures in hospitals result from a system design that is low on internal integration rather than from other reasons hypothesized by the employees we interviewed, such as poor motivation, a lack of training, or human error. Thus, to reduce operational failures, hospital managers need to redesign ISCs so they can be more responsive to end customers' needs and so that handoffs of materials from department to department are more efficient. Furthermore, there must be a greater level of communication and collaboration between the various departments involved in the ISC instead of merely monitoring and rewarding performance at the department level, which may inadvertently result in a situation where supply departments appear productive, but customer-facing employees encounter frequent failures.

5.1. Implications for Research

Our research joins the stream of operations-based literature examining ISC in service organizations (Eisenstein and Iyer 1996, Fredendall et al. 2009, Halbesleben et al. 2010, Shah and Singh 2001, Swinehart and Smith 2005). In particular, we contribute to the literature on ISC integration by applying Spear and Bowen's (1999) framework to hospitals to discover the causes of operational failures. Similar to Pagell's (2004) study of ISC integration, we highlight the importance of measurement and cross-departmental communication. However, as Fredendall et al. (2009) point out, Pagell's framework is not a precise fit for the hospital setting because the clinical licensing requirements makes it difficult to use job rotation and cross functional teams to drive communication across departments. Our study instead highlights the importance of process design and collaboration across ISC departments as a mechanism for high performance.

Our study builds on Fredendall et al.'s (2009) by finding that operational failures can occur even when employees correctly follow standardized work routines. For optimal performance in this setting, routines across departments need to be connected with one another and to end customer needs, and there needs to be unambiguous assignment of responsibility for material processing.

Several literatures are pertinent to our findings about the causes of operational failures and the solution of increasing internal integration in the ISCs of hospitals. The importance of having ISC-level measures of performance is analogous to aligned incentives in the supply chain literature (Lee 2004, Narayanan and Raman 2004) and shared goals for relational coordination (Gittell 2002, Gittell et al. 2000). The need for shared goals between marketing and manufacturing to align conflicting objectives between these two departments has been well studied (Pagell 2004), but to our knowledge, fewer studies have examined the impact of a lack of system measures for supply departments within a service organization. This is an important contribution because unlike marketing and manufacturing, which arguably have different goals (sell more product versus manufacture at low cost), and therefore have competing objectives, the departments in a linearly-flowing ISC are arguably more similar and are tasked with the joint responsibility for providing required equipment and materials to the patient.

Deliberate knowledge transfer across department boundaries is a key aspect of the literatures on organizational knowledge (Carlile 2002, Carlile 2004, Kellogg et al. 2006, Malone and Crowston 1990, Orlikowski 2002) and relational coordination (Gittell 2002, Gittell et al. 2000). We contribute to the scant research on knowledge transfer across different communities of practice within organizations (Bechky 2003, Carlile 2002). Prior research has found knowledge transfer challenges in new product development teams (Carlile 2002, Iansiti and Clark 1994) and custom production of manufacturing equipment (Bechky 2003). We build on this research by showing that problems with knowledge transfer also apply to routine work of service organizations. Similarly, Gittell (2000) has researched coordination among clinical disciplines, but she has primarily considered the clinical work of developing plans of care for patients. Although this is an important part of the work of a hospital, it is an incomplete representation because it does not consider the interaction between non-clinical departments and clinical workers. Thus, our work extends Gittell's studies (2000, 2002) by examining coordination among non-clinical support departments and nursing units.

5.2. Implications for Practice

Our study has lessons for managers of service organizations. Workarounds occurred at the interface between a support department that used predetermined "routines" (Adler 1995) to drive its work tasks and a customer-facing department that used "practice" (Faraj 2006) for customized patient care. The support departments insulated themselves from end-customer demand, artificially creating a low level of uncertainty in their tasks. However, because of the high level of uncertainty in patients' conditions, nurses had to use practice, which is an unfolding set of tasks (rather than a predetermined list) that emerge in real time as one attempts to achieve an end goal (Faraj 2006). To avoid workarounds, managers should create a method for customer-facing employees to request and receive customer-specific supplies in a timely fashion from routine-driven support departments. One method of accomplishing this would be to have an assigned customer support person for a specific department who provides frequent restocking of the unit.

In addition, managers need to create an organizational focus on ISC-level design and performance. Employees are unlikely to recognize systemic causes of workarounds because they often blame poor performance on other people's shortcomings rather than on poor work-system design (Institute of Medicine 2001). Similarly, uninformed managers might not recognize the need for a system-level focus because their department may be meeting departmental-level goals and have hard-working employees who execute tasks successfully. Unfortunately, these are false feedback mechanisms which can mask poor system-level performance. Our research builds on other operations management studies that found that managers' uninformed intuition about work systems can lead to suboptimal decisions (White et al. 2011). Our paper contributes to the body of operations management lessons for white collar work (Hopp et al. 2009, Hyer et al. 2009).

5.3. Limitations and Future Research

Our study has several limitations. First, we use qualitative data to draw descriptive conclusions. These constraints limit our ability to formally test relationships among constructs and performance measures. The development of a set of standard measures of integration to end customer needs would enable researchers to test our framework's impact on performance. Furthermore, we collected data from only four units in two hospitals, limiting the generalizability of our study. Examining more hospitals, as well as other service industries, would strengthen our conclusions and the overall applicability of our framework. An important question for future research is what specific measures organizations can take to improve integration of their ISCs. Longitudinal research testing could specify which dimensions impact improvement in performance over time. A related extension would be the development and testing of interventions to improve integration. By testing whether various interventions have the anticipated positive impact on performance measures, researchers could more accurately gauge the value of specific practices to create more integrated environments. Finally, we leave it to future research to test whether workarounds occur more frequently at interfaces between routine-driven and practice-driven departments within ISCs than at interfaces where both departments' work is driven by the needs of the end customers.

5.4. Conclusions

The design and operation of ISCs represent important drivers of efficiency, job satisfaction, and quality, but are understudied in service organizations. By better leveraging the competencies of the different communities of practices responsible for delivering customer service, organizations can reduce operational failures, freeing up employees' time to provide service. Achieving the goal of reducing operational failures will require an explicit emphasis on integrating the routines of the different departments within organizations to meet the needs of end customers.

References

Adler, P. S. 1995. Interdepartmental interdependence and coordination: The case of the design/manufacturing interface. *Organ. Sci.* **6**(2), 147-167.

Anderson, E. G., D. Morrice, G. Lundeen. 2005. The "physics" of capacity and backlog management in service and custom manufacturing supply chains. *System Dynamics Review* **21**(3), 217-247.

Anil, R., V. Seshadri, A. Chavala, M. Vemuri. 2004. A methodology for managing multidisciplinary programs with six sigma approach.

Ash, J. S., M. Berg, E. Coiera. 2004. Some unintended consequences of information technology in health care: The nature of patient care information system-related errors. *Journal of American Medical Informatics Association* **11**(2), 104-112.

Basnet, C. 2012. Measuring internal supply chain integration. *Management Research Review*

Beaudoin, L. E., L. Edgar. 2003. Hassles: Their importance to nurses' quality of work life. *Nursing Econ.* **21**(3), 106-113.

Bechky, B. A. 2003. Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organ. Sci.* **14**(3), 312-330.

Berwick, D. M., D. R. Calkins, C. J. Mccannon, A. D. Hackbarth. 2006. The 100,000 lives campaign: Setting a goal and a deadline for improving health care quality. *Journal of the American Medical Association* **295**(3), 324-327.

Carlile, P. R. 2002. A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organ. Sci.* **13**(4), 442-455.

Carlile, P. R. 2004. Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organ. Sci.* **15**(5), 555-568.

De Leval, M. R., J. Carthey, D. J. Wright, V. T. Farewell, J. T. Reason. 2000. Human factors and cardiac surgery: A multicenter study. *The Journal of Thoracic and Cardiovascular Surgery* **119**(4), 661-672.

Dröge, C., J. Jayaram, S. K. Vickery. 2004. The effects of internal versus external integration practices on time-based performance and overall prformance. *J. Oper. Manage.* **22**(12), 557-573.

Eisenstein, D. D., A. V. Iyer. 1996. Separating logistics flows in the Chicago public school system. *Oper. Res.* **44**(2), 265-273.

Faraj, S. X. 2006. Coordination in fast-response organizations. *Manage. Sci.* **52**(8), 1155-1169.

Flynn, B. B., B. Huo, X. Zhao. 2010. The impact of supply chain integration on performance: A contingency and configuration approach. *J. Oper. Manage.* **28**(1), 58-71.

Fredendall, L. D., J. B. Craig, P. J. Fowler, U. Damali. 2009. Barriers to swift, even flow in the internal supply chain of perioperative surgical services department: A case study. *Dec. Sci.* **40**(2), 327-349.

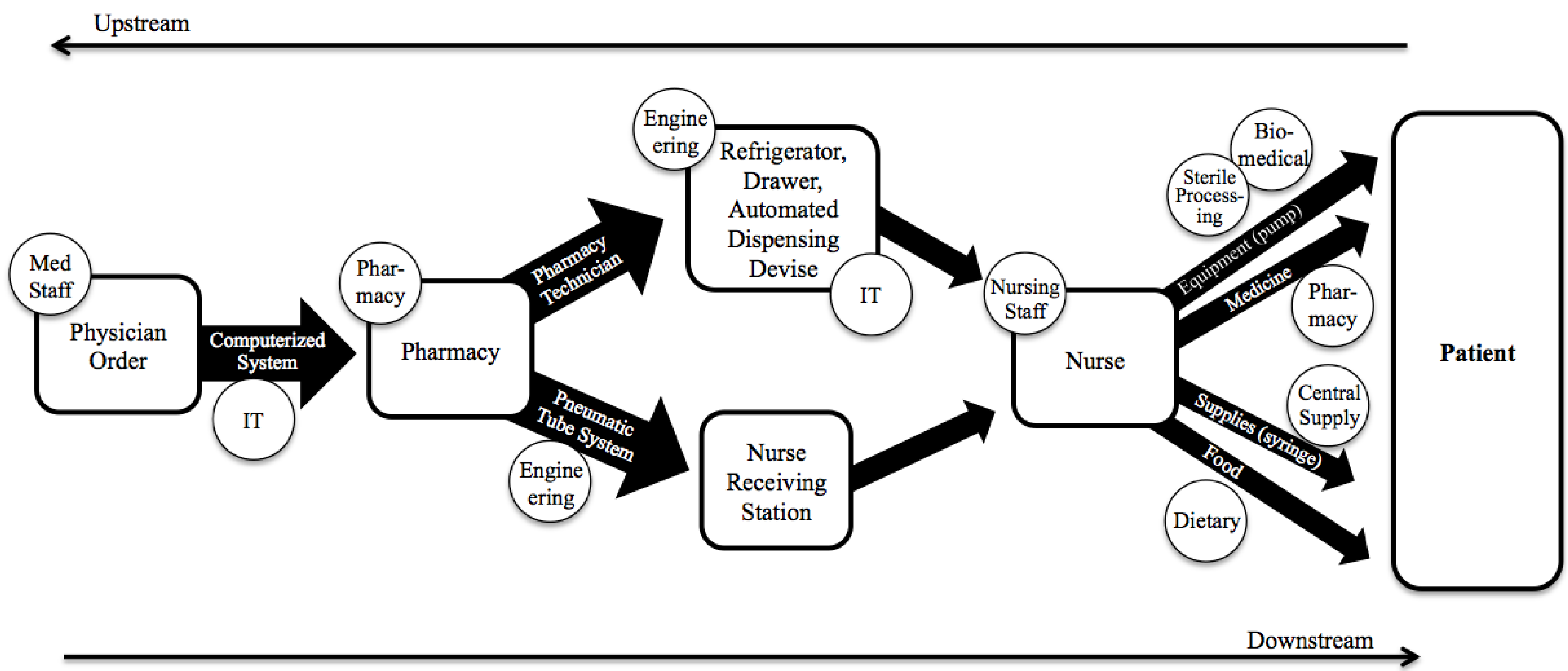
Gilboa, S., A. Shirom, Y. Fried, C. Cooper. 2008. A meta-analysis of work demand stressors and job performance: Examining main and moderating effects. *Personnel Psychology* **61**(2), 227-271.

Gilmore, D. 2002. Understanding and overcoming resistance to ethnographic design research. *Interactions* **9**(3), 29-35.

Gittell, J. H. 2002. Coordinating mechanisms in care provider groups: Relational coordination as a mediator and input uncertainty as a moderator of performance effects. *Manage. Sci.* **48**(11), 1408-1426.
Gittell, J. H., K. M. Fairfield, B. Bierbaum, W. Head, R. Jackson, M. Kelly, R. Laskin, S. Lipson, J. Siliski, T. Thornhill, J. Zuckerman. 2000. Impact of relational coordination on quality of care, postoperative pain and functioning, and length of stay: A nine-hospital study of surgical patients. *Medical Care* **38**(8), 807-819.
Glaser, B. G., A. L. Strauss. 1967. *The Discovery of Grounded Theory.* Aldine de Gruyter, Hawthorne, NY.
Gurses, A. P., P. Carayon. 2007. Performance obstacles of intensive care nurses. *Nursing Res.* **56**(3), 185-194.
Halbesleben, J. R. B. 2010. The role of exhaustion and workarounds in predicting occupational injuries: A cross-lagged panel study of health care professionals. *J. Occupational Health Psychol.* **15**(1), 1-16.
Halbesleben, J. R. B., G. T. Savage, D. S. Wakefield, B. J. Wakefield. 2010. Rework and workarounds in nurse medication administration process: Implications for work processes and patient safety. *Health Care Manage. Rev.* **35**(2), 124-133.
Halbesleben, J. R. B., D. S. Wakefield, B. J. Wakefield. 2008. Work-arounds in health care settings: Literature review and research agenda. *Health Care Manage. Rev.* **33**(1), 2-12.
Hall, L. M., C. Pedersen, L. Fairley. 2010. Losing the moment: Understanding interruptions to nurses' work. *J. Nursing Admin.* **40**(4), 169-176.
Hendrich, A., M. Chow, B. Skierczynki, Z. Lu. 2008. A 36-hospital time and motion study: How do medical-surgical nurses spend their time? *Permanente J.* **12**(3), 25-34.
Hopp, W. J., S. M. R. Iravani, F. Liu. 2009. Managing white-collar work: An operations-oriented survey. *Prod. Oper. Manage.* **18**(1), 1-32.
Hyer, N. L., U. Wemmerlöv, J. A. Morris Jr. 2009. Performance analysis of a focused hospital unit: The case of an integrated trauma center. *J. Oper. Manage.* **27**(3), 203-219.
Iansiti, M., K. B. Clark. 1994. Integration and dynamic capability: Evidence from product development in automobiles and mainframe computers. *Industrial and Corporate Change* **3**(3), 557-605.
Ideo. 2011. *Human-Centered Design Toolkit.* IDEO, Palo Alto, CA.
Institute of Medicine. 2001. *Crossing the Quality Chasm: A New Health System for the 21st Century.* National Academy Press, Washington, DC.
Kahn, K. B., J. T. Mentzer. 1998. Marketing's integration with other departments. *Journal of Business Research* **42**(1), 53-62.
Kellogg, K. C., W. J. Orlikowski, J. Yates. 2006. Life in the trading zone: Structuring coordination across boundaries in postbureaucratic organizations. *Organ. Sci.* **17**(1), 22-44.
Klein, H. J., J. S. Kim. 1998. A field study of the influence of situational constraints, leader-member exchange, and goal commitment on performance. *Acad. Manage. J.* **41**(1), 88-95.
Kobayashi, M., S. R. Fussell, Y. Xiao, F. J. Seagull. 2005. Work coordination, workflow and workarounds in a medical context. ACM Press, New York.
Koppel, R., T. Wetterneck, J. L. Telles, B.-T. Karsh. 2008. Workarounds to barcode medication administration systems: Their occurrences, causes, and threats to patient safety. *Journal of the American Medical Informatics Association* **15**(4), 408-423.
Landis, J. R., G. G. Koch. 1977. The measurement of observer agreement for categorical data. *Biometrics* **33**(1), 159-174.
Lee, H. 2004. The triple-A supply chain. *Harv. Bus. Rev.* **82**(10), 102-112.
Lin, M. C., B. L. Hughes, M. K. Katica, C. Dining-Zuber, P. E. Plsek. 2011. Service design and change of systems: Human-centered approaches to implementing and spreading service design. *Int. J. Des.* **5**(2), Online.
Malone, T. W., K. Crowston. 1990. *What is coordination theory and how can it help design cooperative work systems?* Proceedings of the 1990 ACM conference on Computer-supported cooperative work, Los Angeles, CA. 357-370
McNeese-Smith, D. K. 2001. Staff nurse views of their productivity and nonproductivity. *Health Care Manage. Rev.* **26**(2), 7-19.
Miles, M. B., A. M. Huberman. 1994. *Qualitative data analysis: an expanded sourcebook.* Sage, Thousand Oaks, CA.
Narayanan, V. G., A. Raman. 2004. Aligning incentives in supply chains. *Harv. Bus. Rev.* **82**(11), 94-102.
O'leary-Kelly, S. W., B. E. Flores. 2002. The integration of manufacturing and marketing/sales decisions: Impact on organizational performance. *J. Oper. Manage.* **20**(3), 221-240.
Orlikowski, W. J. 2002. Knowing in practice: enacting a collective capability in distributed organizing. *Organ. Sci.* **13**(3), 249-273.

Pagell, M. 2004. Understanding the factors that enable and inhibit the integration of operations, purchasing and logistics. *J. Oper. Manage.* **22**(5), 459-487.
Peters, L. H., E. J. O'connor. 1980. Situational constraints and work outcomes: The influences of a frequently overlooked construct. *Acad. Manage. Rev.* **5**(3), 391-397.
Peters, L. H., E. J. O'connor, J. R. Eulberg. 1985. Situational constraints: Sources, consequences, and future considerations. JAI Press, Greenwich, CT.
Rathert, C., E. S. Williams, E. R. Lawrence, J. R. B. Halbesleben. 2012. Emotional exhaustion and workarounds in acute care: Cross sectional tests of a theoretical framework. *International Journal of Nursing Studies* 0),
Shah, J., N. Singh. 2001. Benchmarking internal supply chain performance: Development of a framework. *J. Supply Chain Manage.* **37**(1), 37-47.
Shah, R., S. M. Goldstein, B. T. Unger, T. D. Henry. 2008. Explaining anomalous high performance in a health care supply chain. *Dec. Sci.* **39**(4), 759-789.
Spear, S., H. K. Bowen. 1999. Decoding the DNA of the Toyota Production System. *Harv. Bus. Rev.* **77**(5), 96-106.
Spear, S. J. 2005. Fixing health care from the inside, today. *Harv. Bus. Rev.* **83**(9), 78-91.
Spear, S. J., M. Schmidhofer. 2005. Ambiguity and Workarounds as Contributors to Medical Error. *Annals of Internal Medicine* **142**(8), 627-630.
Strauss, A., J. Corbin. 1998. *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory.* Sage Publications, Thousand Oaks, CA.
Swinehart, K. D., A. E. Smith. 2005. Internal supply chain performance measurement: A health care continuous improvement implementation. *Int. J. Health Care Quality Assurance* **18**(7), 533-542.
Tucker, A. L. 2004. The impact of operational failures on hospital nurses and their patients. *J. Oper. Manage.* **22**(2), 151-169.
Tucker, A. L., A. C. Edmondson. 2003. Why hospitals don't learn from failures: Organizational and psychological dynamics that inhibit system change. *California Management Review* **45**(2), 1-18.
Vera, A., L. Kuntz. 2007. Process-based organization design and hospital efficiency. *Health Care Manage. Rev.* **32**(1), 55-65.
Villanova, P. 1996. Predictive validity of situational constraints in general versus specific performance domains. *Journal of Applied Psychology* **81**(5), 532-547.
Villanova, P., M. A. Roman. 1993. A meta-analytic review of situational constraints and work-related outcomes: Alternative approaches to conceptualization. *Hum. Resource Manage. Rev.* **3**(2), 147-175.
Von Hippel, E., M. J. Tyre. 1993. How learning by doing is done: problem identification in novel process equipment. *Research Policy* **24**(1-12.
Wachter, R. M. 2010. Patient safety at ten: Unmistakable progress, troubling gaps. *Health Affairs* **29**(1), 163-173.
White, D. L., C. M. Froehle, K. J. Klassen. 2011. The effect of integrated scheduling and capacity policies on clinical efficiency. *Prod. Oper. Manage.* **20**(3), 442-455.

Figure 1. Internal Supply Chain for Medications in the Two Hospitals



Circles = Departments responsible for the process step or equipment, materials, or information.

Table 1. Details from Research Phase: Observations and Interviews

Perspective	Observations				Interviews				Observations and Interviews	
Perspective	**Hosp.1**	**Hosp. 2**	***Total***	***Total Hours***	**Hosp. 1**	**Hosp. 2**	***Total***	***Total Hours***	**Total No. of Observations and Interviews**	**Total Hours of Observations and Interviews**
Physician	0	1	*1*	*2*	0	1	*1*	*0.7*	**2**	**2.7**
Pharmacy	2	1	*3*	*4*	0	0	*0*	*0*	**3**	**4.0**
RN	21	27	*48*	*82.3*	12	4	*16*	*7.2*	**64**	**89.4**
Engineer	1	0	*1*	*2*	0	0	*0*	*0*	**1**	**2.0**
Central supplies	1	0	*1*	*2*	0	0	*0*	*0*	**1**	**2.0**
Nutrition	1	1	*2*	*4*	0	0	*0*	*0*	**2**	**4.0**
CPED	1	1	*2*	*4*	0	1	*1*	*0.3*	**3**	**4.3**
Biomed	1	1	*2*	*2.7*	0	0	*0*	*0*	**2**	**2.7**
EVS	4	2	*6*	*9.2*	1	0	*1*	*0.3*	**7**	**9.6**
IT	0	0	*0*	*0*	3	0	*3*	*0.3*	**3**	**0.3**
Total	32	34	*66*	*112.2*	16	6	*22*	*8.7*	**88**	**120.9**

Table 2. Categorization of the Sources of Operational Failures into Activities, Connections, Pathway and Improvement (N=120 problems)

Category	**Example problem**	**Number**	**Pct. of category**	**Pct. of total problems**
Work Activities				
Work not done, done incorrectly or against policy	Patient arrives on unit after lunch time and needs a lunch tray, but has no dietary order from physician for food. Nurse calls physician to request that he put an order in the computer system.	22	37%	13%
Space, equipment insufficient	Computers on wheels are plugged into the electrical outlets in front of the sink area because that is the only place where outlets are. Nurse has to push computers out of the way every time she washes her hands. (Two nurses observed, n=2)	19	32%	11%
Work not customized for end customer needs	*Patient's medications require a triple pump to administer them, but there was no triple pump in the clean or dirty utility room.*	*10*	*17%*	*6%*
Conflicting orders	Patient requested she be authorized to purchase a hospital bed for when she was discharged home. Physician approved, but the medical equipment approver did not. Nurse has to resolve the inconsistency.	6	10%	4%
Work design/routine leads to problems	Change in policy requires nurse to have patient sign the discharge instructions, and them make a photo copy for the patient to keep. Photocopier is far from the patient room, resulting in inefficient process (long walk back and forth from copier to patient room).	3	5%	2%
Total		**60**		**36%**
Connections				
Transfer of knowledge between internal supplier and internal customer	*Nurse looked in four different locations for bags of IV medication. She called the pharmacy, who told her they "had been delivered", but the nurse never found them. Due to the amount of Lidocaine in the IV bags, they were in the medication refrigerator, in compliance with a storage rule known by pharmacy, but not by the nurse.*	*13*	*38%*	*8%*
No trigger to request work by internal supplier	The linen cart was out of pants (and none had been ordered).	8	24%	5%
Problem with timing of connection (too slow, or request interrupts work)	Nurse was interrupted by another nurse who asked her a question while she was preparing medications, despite the fact that the nurse was wearing a 'do not interrupt' medication sash	8	24%	5%

Status or work request unknown or difficult to contact the supplier	Nurse needed to get a hold of the patient's physician, but her pager number was not in the list of physicians and their phone numbers.	3	9%	2%
Lack of IT compatibility	Nurse called the laboratory to tell them about the lab test for the patient even though it was already in the main computer system because the laboratory is on a different IT system and can't see the laboratory orders in the main system.	2	6%	1%
Total		**34**		**20%**
Pathways				
Gap in the process of getting materials through the organization	*There are not enough functioning computers on the unit, they take a long time to reboot, and run out of batteries if not plugged in but there are few outlets on the unit. The nurse went to use a computer, but the display image had been rotated by 90 degrees by another nurse to prevent others from taking "her" computer.*	*14*	*58%*	*8%*
No designated storage locations	Had to look around for a flashlight because there is no designated storage location for flashlights.	10	42%	6%
Total		**24**		**14%**
Improvement				
No meetings between ISC departments	*There were not enough working vital sign monitors.*	*12*	*60%*	*7%*
No measures of overall system performance	*Scanners, which are maintained by the IT department, are not working, delaying medication administration by the nurses.*	*8*	*40%*	*5%*
Total		**20**		**12%**
Other				
Equipment failure	Bed rail broke. Bar code scanner was not working.	18	60%	11%
IT software problems	Unit assistant unable to process patient's admission because more than one physician was writing a discharge in IT system	5	17%	3%
Interruption of work	Nurse was documenting her care of her patient when she was interrupted to help another nurse pull her patient up in bed.	5	17%	3%
Insufficient training	The nurse didn't know the weight requirement for patients to be included in a bariatric study.	2	7%	1%
Total		**30**		**18%**

*Does not sum to 120 problems because problems could receive multiple codes

Italics = Not explicitly mentioned by Spear and Bowen's (1999) rules

Table 3. Level of Analysis of Department Performance Measures as Reported by Department Managers

Department	Timeliness	Quality	Cost	Internal Satisfaction	Patient satisfaction	Information about impact	% process level
Dietary	Completed work within time frame	*Taste of food*	Cost of meals	None	*Rating on food and courtesy of employees*	Too little	40%
Pharmacy	Average time to verify a medication order	Accuracy of order verification	Pharmacy-level inventory, equipment, labor costs	Average time to verify a medication order	None	Too little	0%
Environmental Services (EVS)	Average time to clean a discharged room	Adherence to standard cleaning procedure	EVS labor expenses versus budget.	% of rooms cleaned within time limits	*Patient satisfaction with room cleanliness*	Depts. should accurately enter when a bed is ready for patient discharge	20%
Materials Management	None	*Number of open orders to be filled*	Materials-management's expenses versus budgeted	None	None	Limited insight	20%
Nursing	*% of patients transferred from ED to floor in two hours. Time from written discharge until patient is out the door.*	*Difference between scheduled medication administration time versus actual. Patient falls, Patient satisfaction.*	Nursing unit's expenses versus budgeted for materials, equipment, labor.	Nursing staff satisfaction with job environment.	*Patient satisfaction with nurse communication and responsiveness.*	limited information about how nursing actions impacts other departments' performance. We hear about our [negative] impact on EVS, but no hard data.	60%
Sterile Processing	None	Documented complaints	None	None	Not applicable	No comments	0%
Biomedical	Time to respond to individual problem	None	None	*Annual survey internal cust. satisfaction*	Not applicable	Equipment records are on line	20%
Engineering	Timeliness to respond to repair request	*Repeat calls about the same problem*	None	*Repeat calls*	Not applicable	Little information	40%

Italics= Process-level measure; normal font = Department-level measure