A Business Process Management Approach to Perioperative Supplies/Instrument Inventory and Workflow

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Abstract

This study examines business process management practices applied to monitor, measure, and improve a hospital’s perioperative supply workflow and corresponding inventory management. This paper identifies how dynamic technological activities of analysis, evaluation, and synthesis applied to internal and external organizational data can highlight complex relationships within integrated hospital processes to target opportunities for improvement and ultimately yield improved process capabilities. The identification of existing limitations, potential capabilities, and the subsequent contextual understanding are contributing factors that yield measured improvement within a hospital’s perioperative process. Based on a 10-year longitudinal study of a large 909 registered-bed teaching hospital, this case study investigates the impact of integrated information systems to identify, qualify, and quantify business analytics used to improve perioperative efficiency and effectiveness across patient quality of care, operational efficiency, and financial cost effectiveness. The theoretical and practical implications and/or limitations of this study’s results are also discussed with respect to practitioners and researchers alike.

1. Introduction

Hospitals in the United States currently face increasing pressure to provide objective evidence of organizational quality, efficiency, and effectiveness [6]. The American Recovery and Reinvestment Act of 2009, the Joint Commission on Accreditation of Healthcare Organizations (TJC), and Centers for Medicare & Medicaid Services (CMS) require performance reporting and clinical outcomes improvement. With the rising cost of healthcare in the United States, the public demand for healthcare transparency and accountability, and the current economic environment—managing, improving, and optimizing flexible, cost-effective healthcare processes are critical success factors [18] for any hospital. To meet these demands, administrators and medical professionals alike must focus technology-enhanced practices that yield high quality of care and patient safety, coupled with increased efficiency and cost effectiveness. Integrated hospital information systems (IS) and information technology (IT) provide measurement and subsequent accountability for healthcare quality and cost, creating a dichotomy (e.g. quality versus cost) that represents the foundation for healthcare improvement [7]. These performance challenges require leveraging IS and IT to meet these requirements, especially in a large teaching hospital (e.g. academic medical center).

A hospital’s perioperative process provides surgical care for inpatients and outpatients during preoperative, intra-operative, and immediate post-operative periods. Accordingly, the perioperative sub-processes (e.g. preoperative, intra-operative, and post-operative activities) are sequential where each activity sequence paces the efficiency and effectiveness of subsequent activities. As a result, a hospital’s perioperative process is tightly coupled to patient flow, patient safety, patient quality of care, and stakeholders’ satisfaction (i.e. patient, physician/surgeon, nurse, perioperative staff, and hospital administration). The challenge of delivering quality, efficient, and cost-effective services affects all perioperative stakeholders.

Perioperative improvements ultimately affect not only patient quality of care, but also the operational and financial performance of the hospital. From an operational perspective, a hospital’s perioperative process requires multidisciplinary, cross-functional teams to maneuver within complex, fast-paced, and critical situations—the hospital environment [19]. Implementing improvements that will result in timely patient flow through the perioperative process is both a challenge and an opportunity for hospital stakeholders, who often have a variety of opinions and perceptions for the focus of improvement efforts.

Similarly, from a hospital’s financial perspective, the perioperative process is typically the primary source of hospital admissions, averaging between 55 to 65 percent of overall hospital margins [22]. Macario et al. [15] identify 49 percent of total hospital costs as variable, with the largest cost category being the perioperative process (e.g. 33 percent). Likewise, perioperative supplies and equipment can account for more than 50 percent of a hospital’s inventory assets, yet the hospital industry only allocates approximately 21 percent of its total costs to supplies when compared to manufacturing that allocates 50 to 70 percent [6].
This research investigates whether traditional manufacturing inventory management practices are adaptable to business process management (BPM) within the hospital environment. This study highlights supplies and instrument workflow as well as inventory management within a hospital’s perioperative process. This case study identifies the assessment, development, and implementation of a redesigned supply workflow to provide complex change dynamics for improvement to the overall perioperative process. Specifically, the use of internal and external best-practice benchmarks provide the framework for targeting improvement and evoking perioperative process changes by managing perioperative inventory turns, optimizing closing suture and hand-held instrument utilization, and redesigning the perioperative supply workflow. The investigation method covers a longitudinal study of an integrated clinical scheduling information system (CSIS) within a large, teaching hospital. The implementation of the agile CSIS and subsequent contextual understanding of the perioperative process and sub-processes prescribed opportunity for measured improvements. Empowered individuals driven by integrated internal and external organizational data facilitate the case results.

The following sections review previous literature on BPM, key performance indicators (KPIs), and inventory management efforts in healthcare. Following the literature review, we present our methodology, case study background, and a discussion of the observed results from the redesigned perioperative supply workflow. By identifying a holistic framework for analysis, evaluation, and synthesis of end-to-end process measures with established benchmarks, this paper prescribes an a priori environment to support perioperative supply workflow measurement, control, and process improvement. The conclusion also addresses study implications and limitations.

2. Literature Review

Industry competition, first mover advantage on innovations, adaptation of better management practices, and/or government regulations are a few of the drivers for process improvements. Traditionally, the hospital environment lacked similar industrial pressures beyond government regulations. However, hospitals and specifically perioperative management currently face increasing pressure to provide objective evidence of patient outcomes in respect to organizational quality, efficiency, and effectiveness [5], all while preserving clinical quality standards.

Administrators and medical professionals must focus on both the patient quality of care as well as management practices that yield efficiency and cost effectiveness. To this end, inventory management practices borrowed from the manufacturing industry, coupled with a BPM approach, provide a framework to target and measure process improvement [11, 31]. Measured utilization of these practices is not a result from any lack of research as an extensive body of knowledge exists concerning the application of these approaches in healthcare [2, 9, 11, 12, 13, 17, 21]. However, the literature suggests that such management practices and interventions can yield positive results with significant variations in implementation success.

2.1 Business Process Management

Specifically, this study examines BPM practices applied to monitor and measure improvement within a hospital’s perioperative supplies and instrument workflow as well as the corresponding inventory management. This study uses the BPM definition provided by Jeston and Nelis [11, p. 10] as “the achievement of an organization’s objectives through the improvement, management, and control of essential business processes.” The authors further elaborate that process analysis is integral to BPM, where there is no finish line for improvement. Hence, this study views BPM as an organizational commitment to iterative process improvement that meets organizational objectives. Hence, BPM embraces the concept of continuous process improvement (CPI) aligned to business strategy.

CPI is a systematic approach to understanding the process capability, the customer’s needs, and the source of observed variation. Tenner and DeToro [31] views CPI as an organizational response to an acute crisis, a chronic problem, and/or an internal driver. The incremental improvement gains occur through an iterative cycle of analysis, evaluation, and synthesis or plan-do-study-act [34] to minimize observed variation. CPI encourages bottom-up communication at the day-to-day operations level and requires process data comparisons to control metrics. Doubt can exist as to: whether the incremental improvement addresses symptoms versus causes; whether the improvement effort is sustainable year after year; and/or whether management is in control of the process [11].

BPM embraces the ability to quantify organizational control metrics, aligned with strategy. Business analytics is the body of knowledge identified with technology solutions that incorporate dashboards, performance management, definition and
delivery of business metrics, as well as data visualization and data mining [33]. Business analytics within BPM focus on the effective use of organizational data and information to drive positive business action [31]. The effective use of business analytics demands knowledge and skills from subject matter experts and knowledge workers. Similarly, Wears and Berg [36] concur that IS and/or IT only yield high-quality healthcare when the use patterns are tailored to knowledge workers and their environment. Therefore, BPM success has a strong dependence on contextual understanding of end-to-end core business processes [11].

2.2 Key Performance Indicators (KPIs)

An integral part of CPI is information about performance before and after the intervention. Thus performance measurement is an essential requirement for purposeful BPM. Early in the IT literature, Ackoff [1] proposed IS design should embed feedback as a control to avoid management misinformation. Zani [38], Rockart [23], along with Munroe and Wheeler [20], proposed the selection and supervision of defined data as KPIs to assist management in qualifying measurement of CSFs and subsequently managing organizational action (i.e. business processes) through IS feedback. Similarly, the perioperative process is becoming increasingly information intensive and doubt exists as to whether the contextual understanding of perioperative process management can meet the increasing hospital environmental demands for value and cost management [5].

KPIs in managing and optimizing a hospital’s perioperative process are monitoring when surgical cases start as well as use of an operating room (OR). OR schedules are tightly coupled to an individual OR suite, patient, and surgeon. When preoperative tasks are incomplete or surgical supplies are not readily available at time of surgery, the scheduled case is delayed as well as the subsequent scheduled cases in the particular OR suite or for the particular surgeon.

The following scenario of operational, tactical, and strategic KPIs illustrate the complexity, dynamic nature, and nested relationships among hospital processes. Operational and tactical KPIs in managing and optimizing a hospital’s perioperative process include monitoring the percentage of surgical cases that start on-time (OTS) and the number of first-of-the-day surgical cases (FCOD OTS) that start on-time, as well as OR turn times (TURNS) and utilization (UTIL) [3, 10]. The Thomson Group [32] noted how OR suite TURNS between cases, along with a flexible and efficient perioperative work environment, are CSFs for physician/surgeon satisfaction, which in turn is a CSF for hospital margin. Poor KPIs on operational and tactical metrics (i.e. OTS, FCOD OTS, TURNS or UTIL) affect strategic CSFs of patient safety, patient quality of care, surgeon/staff/patient satisfaction, and hospital margin [18, 21].

2.3 Perioperative Inventory Management

Similar to the manufacturing industry, IS and IT in healthcare provide no direct income from customers (e.g. patients), yet the literature supports that these technologies can deliver similar value in healthcare through process improvement. Typically, hospital administrators want perioperative IS to yield positive financial effects. Specifically, perioperative management has priorities such as: (1) inventory reduction; (2) obtaining accurate surgical procedure and cost data to improve standardization and reduce costs; and (3) detailed clinical and financial data [17]. Moreover, the perioperative process has experienced nurses and surgeons with strong clinical knowledge and understanding as to the numerous supplies, instruments, and equipment needed [16]. Improved inventory management practices are critical in meeting these requirements as supplies and instruments associated with surgical procedures represent a significant hospital investment—more than 50 percent of hospital inventory assets and costs [6]. On the contrary, inaccurate or unnecessary supplies/instruments delivered for a surgical procedure increase perioperative costs due to decreased KPIs, unnecessary restocking, and potential waste.

OR utilization, inventory volume, supply usage, and equipment usage yield perioperative costs [12]. Macario [14] differentiated between costs and a charge—a cost is a monetary amount of hospital expenditures for resources, where a charge is a billable monetary amount for medical care. Many perioperative costs are not transferable to patients due to ‘standard of care’ [30] consensus. However, patient morbidity and co-morbidity does differentiate consensus ‘standard of care’ for a particular patient and allow particular costs to transfer to charges. As a result, improved inventory management practices directly and indirectly affect perioperative financials [5, 17].

Hospitals also present unique challenges to inventory management due to the complexity of their internal supply chain, with supplies distributed through requisition-based systems and/or through automatic Par level replenishment via a central storage [13]. With respect to the perioperative
process, inventory management improved practices include integration between the CSIS and supply order IS, just-in-time push of surgical case carts, continual updating of surgical preference cards, increasing inventory turnovers (e.g. turns), standardizing surgical procedures, and vendor consignment of high unit-cost items [17, 22]. Also adaptable to the perioperative process are the lean manufacturing principles of visual management and the elimination of eight wastes [9].

3. Research Method

The objective of this study is to examine the adaptability of manufacturing inventory management practices, coupled with a BPM approach, to provide a framework for targeting and measuring improvement within a hospital’s perioperative process. To this end, case research is particularly appropriate [8, 37]. An advantage of the positivist approach [35] to case research allows concentrating on a specific hospital service in a natural setting to analyze the associated qualitative problems and environmental complexity. Hence, our study took an in-depth case research approach.

Our research site is a large teaching hospital (University Hospital), licensed for 909 beds and located in the southeastern region of the United States. University Hospital is one of two magnet hospitals in the state and the U.S. News and World Report has repeatedly recognized University Hospital as a Best Hospital over the past two decades. Concentrating on one research site facilitated the research investigation and allowed the continued collection of longitudinal data. This study spans activities from 2003 to 2013. During the 10-year study, we conducted field research and gathered data from multiple sources including interviews, field surveys, site observations, field notes, archival records, and document reviews.

4. Case Background

The initial perspective of this research focused on University Hospital’s perioperative process for its 32 general OR suites. Perioperative Services is the University Hospital department that coordinates and manages the hospital’s perioperative process across Pre-admissions, Admissions, Surgical Preparation (PREP), Post Anesthesia Care Unit (PACU), and Central Sterile Supply (CSS).

Figure 1 depicts University Hospital’s CSIS architecture as of October 2004. University Hospital had six main IS: (1) a large scale hospital materials management IS, which included pharmacy, material and medical device management (Vendor L); (2) a large scale enterprise resource planning IS (Vendor O); (3) a patient record Admit/Discharge IS (Vendor Q); (4) a cost accounting IS (Vendor T); (5) a financial budgeting IS (Vendor H); and (6) a CSIS (Vendor C) that included modules for clinical scheduling, routing sheets, and cost data.

Figure 1 - IS architecture (October 2004)

All IS were integrated with uni-directional constraints placed on sensitive information. The institutional intranet served as portal access to extend each of the six IS. User authentication via the intranet was single entry with particular user-IS rights and privileges negotiated upon authentication.

Perioperative Services implemented the current CSIS in 2003, after using its prior CSIS for 10 years. The old CSIS and its vendor were not flexible in adapting to new perioperative data collection needs. The new CSIS from vendor C was equipped with OLAP tools, a proprietary structured query language, and both operational and managerial data stores (i.e. operational data and a separate perioperative data mart). The new CSIS used flexible routing templates or surgical preference cards (SPC), customizable to specific surgical procedures as well as specific surgeons (e.g. capture point of surgical care data as well as particular supplies and instruments needed). Initially, University Hospital outsourced the route sheet building and deployed over 300 customized SPCs across 14 surgical specialty services (SSS). Table 1 highlights the expanded growth of SPCs available by SSS within the CSIS as of December 2012.

The perioperative scheduling staff (e.g. registered nurses with extensive perioperative experience) build the routing sheets for each SSS procedure, with the option to customize the routing for surgeon specific requests or patient specific needs. In turn, the routing sheets dictate the people, devices, equipment, and supplies needed in each OR suite during each scheduled surgical case. During each surgical case, OR team members document and log activities from each OR suite into the CSIS for the duration of the SSS case procedure. Figure 2
depicts an example of a SPC detail for an open appendectomy, which identifies all equipment, supplies, and instruments needed. Figure 3 illustrates how the CSIS uses filters on the same SPC to view particular surgical components such as suture.

Table 1 – CSIS SPCs as of December 2012

<table>
<thead>
<tr>
<th>Surgical Specialty Service</th>
<th>SPCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BURN – Trauma burns</td>
<td>43</td>
</tr>
<tr>
<td>CARDIO –Cardiovascular &amp; Thoracic</td>
<td>954</td>
</tr>
<tr>
<td>ENT – Ear, Nose, &amp; Throat</td>
<td>1,000</td>
</tr>
<tr>
<td>GI – Gastro-intestinal</td>
<td>490</td>
</tr>
<tr>
<td>GYN – Obstetrics, oncology, incontinence</td>
<td>874</td>
</tr>
<tr>
<td>NEURO – Neurological</td>
<td>763</td>
</tr>
<tr>
<td>ORAL - Oral Maxil Facial</td>
<td>425</td>
</tr>
<tr>
<td>ORTHO – Orthopedic, replace joint/device</td>
<td>1,260</td>
</tr>
<tr>
<td>PLAS – Plastic surgery</td>
<td>1,255</td>
</tr>
<tr>
<td>SURG ONC – Surgical oncology</td>
<td>325</td>
</tr>
<tr>
<td>TX – Transplants (liver, renal)</td>
<td>277</td>
</tr>
<tr>
<td>TRAUMA – Trauma, MASH</td>
<td>278</td>
</tr>
<tr>
<td>URO – Urology</td>
<td>505</td>
</tr>
<tr>
<td>VASCULAR – arteries &amp; blood vessels</td>
<td>574</td>
</tr>
<tr>
<td>Other – Miscellaneous</td>
<td>692</td>
</tr>
<tr>
<td><strong>Combined Total</strong></td>
<td><strong>9,715</strong></td>
</tr>
</tbody>
</table>

Figure 2 –Detail of an Open Appendectomy SPC

Figure 3 – Open Appendectomy SPC Suture Filter

4.1 November 2004

University Hospital opened a new diagnostic and surgical facility in November 2004. Perioperative Services relocated into three floors, with ORs located over two floors and CSS located on a third. The move expanded Perioperative Services to cover an additional floor and nine additional ORs.

The new facility housed 40 state-of-the-art OR suites (32 general OR), each having new standardized as well as surgical specialty equipment. Within six weeks of occupying the new facility, scheduling KPIs reflected chaos. OTS case starts plunged to 18% during December 2004. Within a highly competitive hospital industry, having only 18% OTS cases was unacceptable as 82% of scheduled surgeries experienced delays and risked patient care and safety. University Hospital had failed to adjust its perioperative process to compensate for the introduction of radical innovation and existing processes were disparate in the new environment.

4.2 Perioperative Process Improvements

In January 2005, perioperative concerns were laid out before a quickly convened executive council that included the chief executive officer, the chief financial officer, the chief information officer, the chief nursing officer, and top representatives of surgeons, anesthesia, and Perioperative Services. The meeting resulted in a changed management structure with the formation of a cross-functional, multidisciplinary executive team, chartered and empowered to evoke change. The executive team consisted of a cross-section of perioperative stakeholders (i.e. surgeons, nurses, anesthesiologists, and perioperative management).

University Hospital’s executive team launched a CPI effort in 2005 to address the perioperative crisis through soft innovations [24]. The executive team’s charter was to systematically identify issues and enlist working managers for data-driven solutions that focus on an improved perioperative process, where no issue was “off-limits.” As a result, the executive team enlisted numerous task forces to address specific problems and/or opportunities, which served as the foundation of the BPM approach.

Since the OR relocation in 2004, University Hospital has sustained an annual 10% growth in surgical case procedures in its original 32 general OR suites (GENOR). University Hospital’s Perioperative Services also broadened its scope to include 36 additional OR suites as well as a pre-operative assessment clinic that services the University Hospital System. Perioperative Services’ expanded management efforts include 8 cardio-vascular OR suites (CVOR), 19 OR suites at the Highlands Hospital campus (HHOR), and 9 OR suites at the Eye Foundation Hospital (CEFH). During this time, University Hospital has continued its systematic BPM approach to perioperative process management across all of its surgical locations and services, achieving improvement success that targeted
heuristic OR scheduling [25], hospital-wide patient flow [26], preoperative clinic benchmarking and re-engineering [27], radio-frequency identification implementation [28], and balanced scorecard performance dashboards [29].

5. Results and Discussion

The executive team and perioperative management consistently focused on data-driven, end-to-end CPI. Initially to facilitate perioperative CPI efforts, the executive team and subsequent task groups defined perioperative process KPIs based on internal process data collected through the CSIS and external industry standards. These KPI metrics benchmarked previous months’ data to establish trends for tracking improvement and/or targeting areas for improvement. This BPM approach also identified improvement opportunities in perioperative supplies/instrument inventory and workflow.

University Hospital maintains pockets of perpetual inventory for specific departments and periodic inventory with Par levels in others, conducting physical inventory in September of each year. Within the perioperative process, CSS pushes supply/instrument inventory to all ORs via three channels: 1) Case carts stocked specifically for a scheduled surgical case from a SPC pick list; 2) standard supplies moved to an OR Core holding area on each OR floor; and/or 3) a specific requisition from OR staff.

As early as 2006, perioperative management noted multiple inventory receipts within the perpetual inventory for every inventory usage across particular perioperative supplies. In 2010, the executive team launched an initiative to assess the status of perioperative supply management and workflow due to increasing inventory values and slowing inventory turns metrics. The processes reviewed included: (1) inventory/Par level management, (2) replenishment processes, and (3) technology. The process data reviewed identified inventory reduction as well as process improvement opportunities to sustain reduced perioperative supply/instrument costs. The analysis of the assessment yielded the following themes:

- Scheduling inaccuracy
- Lack of SPC maintenance and SPC inaccuracies
- Work duplication in CSS case cart picking due to lack of trust in case scheduling and SPC.
- Charge capture issues where items left off the SPC may not get charged
- Abundance of unused supply/instrument returns to CSS after case completion produce CSS over-ordering opportunities.

- The breakdown in supply workflow process effects overall inventory management.

Figure 4 depicts the breakdown of inventory across University Hospital in May 2011, where perioperative supply inventory had reached $15.5M. Inventory turns had slowed to 3.7 against an industry average of 9, which represented 3.2 months supply. These KPIs reflected a breakdown in the supply workflow process. However, responsible actors interact among the ORs, Core supply on each OR floor, and CSS. The BPM efforts among these perioperative actors yielded a process redesign to ensure effective supply inventory management.

The following sections elaborate on the analysis, evaluation, and synthesis of process improvement and redesign efforts through May 2013. Figure 5 depicts the redesigned supply workflow segments and the following sections summarize each segment’s efforts.

5.1 Scheduling

To address the scheduling and SPC inaccuracies, a major task force recommendation was for scheduled cases to have specific and required information that includes accurate location, procedure, specific equipment, and supply needs from consistently updated SPCs. A review of each of

![Figure 4 – Inventory Cost by Department May 2011](image)

![Figure 5 – Redesigned Supply Workflow Process](image)
the 9,715 SPCs yielded the removal of 1,937 SPCs, which reduced the total by 20 percent. Table 2 identifies the resulting SPCs by SSS as of May 2013.

Table 2 – Revised CSIS SPCs as of May 2013

<table>
<thead>
<tr>
<th>Surgical Specialty Service</th>
<th>SPCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BURN – Trauma burns</td>
<td>26</td>
</tr>
<tr>
<td>CARDIO – Cardiovascular &amp; Thoracic</td>
<td>946</td>
</tr>
<tr>
<td>ENT – Ear, Nose, &amp; Throat</td>
<td>1,030</td>
</tr>
<tr>
<td>GI – Gastro-intestinal</td>
<td>460</td>
</tr>
<tr>
<td>GYN – Obstetrics, oncology, incontinence</td>
<td>611</td>
</tr>
<tr>
<td>NEURO – Neurological</td>
<td>763</td>
</tr>
<tr>
<td>ORAL - Oral Maxil Facial</td>
<td>236</td>
</tr>
<tr>
<td>ORTHO – Orthopedic, joint/device</td>
<td>1,208</td>
</tr>
<tr>
<td>PLAS – Plastic surgery</td>
<td>681</td>
</tr>
<tr>
<td>SURG ONC – Surgical oncology</td>
<td>329</td>
</tr>
<tr>
<td>TX – Transplants (liver, renal)</td>
<td>194</td>
</tr>
<tr>
<td>TRAUMA – Trauma, MASH</td>
<td>203</td>
</tr>
<tr>
<td>URO – Urology</td>
<td>533</td>
</tr>
<tr>
<td>VASCULAR – arteries &amp; blood vessels</td>
<td>558</td>
</tr>
<tr>
<td><strong>Combined Total</strong></td>
<td><strong>7,778</strong></td>
</tr>
</tbody>
</table>

Surgical procedures with revised SPCs for: (1) CVOR went live in February 2013, (2) GENOR went live in April 2013, and (3) HHOR went live in May 2013. In March 2013 and April 2013, the CVOR actual revenue increased $500K over prior months, as depicted in Figure 6. Similar expectations exist as revised SPC usage occurs in GENOR (May 2013) and HHOR (June 2013).

![Figure 6 – CVOR Revenue per Unit of Service](image)

5.2 Case Preparation

To address the work duplication in CSS due to lack of trust in SPCs, revised procedures reinforced that all OR supplies are to flow through CSS. Pick lists, generated by revised/updated SPCs associated with a specific surgical case, determine the supply/instrument inventory to populate a given case cart. CSS staff prepares case carts up to 8-hours in advance and carts are sealed. Par levels (e.g. equal to), based upon current historical usage, were developed to be systematically updated quarterly.

Specific role responsibilities for actors in the Case Preparation segment for CSS staff include the head lead nurse director (HLND) in CSS, CSS technicians, and OR Staff. The HLND reviews surgical schedules 2-3 days in advance to check on loane instrument trays and implants as needed, as well as contact specific vendor representatives as needed. CSS Staff receive the next day’s OR schedule and corresponding SPCs from CSIS at 2pm.
limits confined to products in hand to. CSS technicians will also in the Returns segment pushed through from RN. As a result, ORs from 2PM to 7AM, ent unused supply waste.

Staff must notify the OR Team Leader of the discrepancy for documentation and correction.

5.3 Intra-operative Case Charge Capture

OR inventory is delivered, stored and picked from CSS. Surgical cases begin with basic supplies, ties, and stick ties to prevent unused supply waste. OR rooms have consistent basic supplies, with surgical specialty items stored in small rolling carts for easy transfer to an assigned OR. In order to address charge capture issues during the intra-operative process, the sterile OR Core supply holding area staffs supply technicians as well as trained clinical support staff for OR coverage.

Reducing suture utilization was a process improvement opportunity identified. As a result, OR specialty carts contain small suture totes, replacing suture trees, and closing suture is held until needed to reduce suture inventory and waste. The average suture cost per surgical case (excluding transplants and open-heart cases) from the analysis data was $48.68. Benchmark for hospitals with substantial heart cases (e.g. The Cleveland Clinic performs >8000/year) is $61.54 suture cost per case, hence the noted exclusion. Moving the suture usage KPI target to the 25th percentile yields a target metric of $30.76 or a difference of $17.92 that equates to over $430K at the current University Hospital annualized case volume of 24K cases.

Specific role responsibilities for actors in the Intra-Operative Case and Charge Capture segment for CSS staff include the HLND and technicians in CSS. For CSS staff, technicians respond to requests from OR staff and deliver OR supplies via elevator. CSS Technicians also turnover instruments/sets between cases in the OR decontamination (for flash sterilization). The HLND also turns over trays between cases including the wrapping and sterilizing in CSS.

In the OR, circulating nurses are responsible for (1) inputting supplies used by charge capture, (2) locating supply items used by description or item numbers to input charges, or (3) complete the non-file form if an item is not located. Circulating nurses also collect additional supplies from the respective OR Core holding area or CSS as needed.

5.4 Returns

To minimize the abundance of unused inventory returns to CSS after surgical case completions, an improved process for all ORs occurs hourly. The sterile OR Core holding inventory transitioned to become ‘back up’ and ‘STAT’ supplies managed by OR Core technicians, with storage limits confined to space within two white bins.

Role responsibilities within the Returns segment include Core technicians, OR Staff, and CSS Technicians. Core technicians place specialty items back on shelves in Core holding areas, send CSS stock back to CSS and re-stock shelves in the Cores when time is available or leave the items for the evening shift.

The OR Staff is responsible to: (1) use any extra supplies from white bins to stock cupboards in OR, (2) put away specialty items in Core, (3) separate CSS items from specialty items, and (4) place items in white bins for return to CSS if not used first. OR Staff will also notify CSS staff if a particular supply item is low or a specialty item needs reordering.

The CSS technicians receive and re-shelf unused supplies from white bins. CSS technicians will also separate OR Core items sent down in white bins and send the items back up to the Core holding areas.

5.5 Inventory Management (OR | Core | CSS)

Role responsibilities in the Inventory Management segment include the Administrative Director, the CSS HLND and Lead Instrument Technician, as well as the OR Core technicians. The Administrative Director interacts with vendors signing-in with products in hand to verify if vendor presence is expected and/or needed in the OR. The Director also (1) runs specific inventory reports and/or data from CSIS as needed and (2) is a member of the Product and Technology committee (i.e. executive team task force) that reviews new supplies, instruments, and equipment, and (3) reviews non-file item orders for 1st level approval.

Within CSS, the Lead Instrument Technician is responsible for: (1) ordering all CSS supplies to OR Budget, and (2) ordering all replacement instruments, (3) monitoring orders placed by Core technicians, (4) checking on back orders, and (5) responding to
supply issue phone calls. The CSS HLND coordinates implant specialist orders and implants as well as approving all non-file orders via the materials management and ERP systems. In the OR, the Core technicians place re-stocking orders daily, store outside stock, and re-stock OR suture.

The Inventory Management segment of the redesigned supply workflow also yielded potential process improvement opportunities for reducing hand-held instrument inventory as well as increasing inventory turns. The average annual instrument cost per OR suite from the analysis data was $12,160 compared to an annual target benchmark from hospital standards of $5,000 per OR suite. Reducing hand-held instrument replacements to industry best practice equates to over $385K per year in instrument inventory savings.

Table 3 – Increasing Inventory Turns

<table>
<thead>
<tr>
<th>Department</th>
<th>Current State</th>
<th>Measurable Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR</td>
<td>Turns</td>
<td>Inventory</td>
</tr>
<tr>
<td>7.7</td>
<td>$31,487,145</td>
<td>$1,003,945</td>
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<tr>
<td>6.0</td>
<td>$9,642,097</td>
<td>$5,644,944</td>
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<tr>
<td>8.0</td>
<td>$7,221,648</td>
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<tr>
<td>10.0</td>
<td>$5,785,318</td>
<td>$5,701,823</td>
</tr>
<tr>
<td>12.0</td>
<td>$4,821,099</td>
<td>$10,666,042</td>
</tr>
</tbody>
</table>

Table 3 depicts how increasing inventory turns in phases to best practice levels is attainable and yields a sizeable perioperative process improvement. The first target was set to 6 turns in 6 months, which was achieved during 2012 and generated over $5.8M in inventory savings. The second target is 8 turns in 12 months and the final target is 10 turns in 18 months. Table 3 depicts inventory turn levels and potential savings at each level.

6. Conclusion

This study highlighted supplies/instrument workflow as well as inventory management within a hospital’s perioperative process. Empowered individuals, integrated IS, and a holistic framework for analysis, evaluation, and synthesis of end-to-end processes prescribed an a priori environment to support perioperative improvement through BPM. Moreover, traditional inventory management practices, borrowed from the manufacturing industry, were adaptable to BPM within the hospital environment. Specifically, maintenance of SPCs, redesigning the perioperative supply workflow, decreasing closing suture and hand-held instrument utilization, and managing perioperative inventory turns targeted opportunities and evoked changes to the perioperative supply inventory in excess of $6.6M over two years. The CPI/BPM cycle of analysis, evaluation, and synthesis also reinforces communication and stimulates individual as well as collective organizational learning.

Our case study contributes to the healthcare IT literature by examining how CPI, BPM, and inventory management practices are applicable to the hospital environment. This study prescribes an a priori framework to foster their occurrence. This paper also fills a gap in the literature by describing how hospital process data is both a performance measure and a management tool.

This study was limited to a single case, where future research should broaden the focus to address this issue along with others that the authors may have inadvertently overlooked. The case examples presented in this study can serve as momentum for perioperative process and inventory management methodology, comprehension, and extension. The study’s results should be viewed as exploratory and in need of further confirmation. Researchers may choose to further or expand the investigation; while practitioners may apply the findings within the hospital environment.

7. References:


