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Date: May 30, 2015

Subject: SIGHealth Best Paper Submission

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Paper: "*A Balanced Perspective to Perioperative Process Management Aligned to Hospital Strategy*"

International Journal of Health Information Technology and Informatics , 2014, 9(4), pages 1-19.

DOI: 10.4018/ijhisi.2014100101

URL: http://www.igi-global.com/article/a-balanced-perspective-to-perioperative-process-management-aligned-to-hospital-strategy/124116

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International Journal of Healthcare Information Systems and Informatics

October-December 2014, Vol. 9, No. 4

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A Balanced Perspective to Perioperative Process Management Aligned to Hospital Strategy

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ABSTRACT

Dynamic technological activities of analysis, evaluation, and synthesis can highlight complex relationships within integrated processes to target improvement and ultimately yield improved processes. Likewise, the identification of existing process limitations, potential capabilities, and subsequent contextual understanding are contributing factors that yield measured improvement. Based on a 120-month longitudinal study of an academic medical center, this study investigates how integrated information systems and business analytics can improve perioperative efficiency and effectiveness across patient quality of care, stakeholder satisfaction, clinical operations, and financial cost effectiveness. This case study examines process management practices of balanced scorecard and dashboards to monitor and improve the perioperative process, aligned to overall hospital goals at strategic, tactical, and operational levels. The conclusion includes discussion of study implications and limitations.

Keywords: *Balanced Scorecard Metrics, Business Process Management, Integrated Hospital Information Systems, Performance Dashboards, Perioperative Process, Strategic Alignment*

1. INTRODUCTION

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).

DOI: 10.4018/ijhisi.2014100101

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 as to where improvement is needed. The challenge of delivering quality, efficient, and cost-effective services affects all healthcare stakeholders. Perioperative improvements ultimately affect not only patient quality of care, but also the operational and financial performance of the hospital itself. 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 (McClusker et al., 2005).

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 (Peters & Blasco, 2004). Macario et al. (1995) identified 49 percent of total hospital costs as variable with the largest cost category being the perioperative process (e.g. 33 percent). Given the rising cost of healthcare, the public demand for healthcare transparency and accountability, and the current economic environment—managing and optimizing a quality, efficient, flexible, and cost-effective perioperative process are critical success factors (CSFs), both operationally and financially, for any hospital.

Recently, the focus of healthcare in the United States has shifted toward monitoring and improving clinical outcomes to meet new regulatory and reimbursement requirements. Likewise, hospitals in the United States must report and improve clinical outcomes more now due to the American Recovery and Reinvestment Act of 2009 and the Joint Commission on Accreditation of Healthcare Organizations (TJC) / Centers for Medicare & Medicaid Services (CMS) core measures. These performance and reporting challenges require leveraging information systems (IS) and technologies (IT) to meet these demands. Furthermore, hospital administration could benefit by considering the strategic IS and business alignment challenges experienced in other industries over the past decades (Luftman & Ben-Zvi, 2010) as well as within the healthcare industry (Bush, 2009). With respect to hospital IS/IT alignment, this study investigates the research question of how business process management (BPM) is an applicable approach for perioperative process management as well as overall hospital's strategic vision execution with monitored clinical outcomes.

This study highlights BPM practices of balanced scorecards (BSC) and dashboards within a hospital's perioperative process. Empowered individuals driven by integrated internal and external organizational data facilitate the case results. The investigation method covers a longitudinal study of an integrated clinical scheduling information system (CSIS) within the perioperative process of a large, teaching hospital (e.g. academic medical center). The implementation of an agile CSIS and subsequent contextual understanding of the perioperative process and its sub-processes prescribed opportunity for measured improvements. Specifically, the extension of business analytics into BSCs and dashboards at different levels (e.g. strategic, tactical, and day-to-day operations), coupled with internal and external best-practice benchmarks, provide the framework for targeting improvement opportunities and evoking improvement changes to the perioperative process. The planning and development of the BSCs and dashboards also provide change dynamics for evaluation and improvement to the overall perioperative process. This case study also identifies complex dynamics within the perioperative process nested in the hospital environment.

The following sections review previous literature on BPM and BPM efforts in healthcare, as well as healthcare performance indicators and quality measures. Following the literature review, we present our methodology, case study background, and a discussion of the observed results from the BSCs and dashboard efforts. 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 process measurement, control, and improvement aligned to hospital strategy. 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 examples of the many factors that drive process improvements. Traditionally, the hospital environment lacked similar industrial pressures beyond government regulations. However, hospital administration currently face increasing pressure to provide objective evidence of patient outcomes in respect to organizational quality, efficiency, and effectiveness (CMS, 2005; CMS, 2010; PwC, 2012), all while preserving clinical quality standards.

Hospital administrators and medical professionals must focus on both the patient quality of care as well as management practices that yield efficiency and cost effectiveness (PwC, 2012). To this end, industrial and operations management practices of BSC, business analytics, and dashboards borrowed from BPM provide a framework to target and measure process improvement (Jeston & Nelis, 2008; Kaplan & Norton 1996; Tenner & DeToro, 1997). Measured utilization of these practices is not a result from lack of research as a body of knowledge exists concerning their application in healthcare (Albanese et al., 2010; Fairbanks, 2007; Herzer et al., 2008; Kruskal et al., 2012; Kujala et al., 2006; Zbinden, 2002). Moreover, the literature suggests that such approaches and interventions can yield positive results with significant variations in implementation success.

2.1. Business Process Management (BPM)

Specifically, this study examines BPM applications of BSCs and dashboards to monitor and measure improvement within the perioperative process, aligned to hospital strategy. This study uses the BPM definition provided by Jensen and Nelis (2008, 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 management and analysis is integral to BPM, where there is no finish line for improvement. Hence, this study views BPM as an organizational commitment to consistent and iterative process performance improvement that meets organizational objectives. To this end, BPM embraces the concept of continuous process improvement (CPI) aligned with business strategy.

CPI is a systematic approach toward understanding the process capability, the customer's needs, and the source of observed variation. Tenner and DeToro (1997) views CPI as an organizational response to an acute crisis, a chronic problem, and/or an internal driver. The incremental realization of improvement gains occurs through an iterative cycle of analysis, evaluation, and synthesis or plan-do-study-act (Walton, 1986) 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 (Jensen & Nelis, 2008).

As BPM requires alignment to strategic objectives, a BSC approach (Kaplan & Norton, 1996) embraces the ability to quantify organizational control metrics aligned with strategy across perspectives of: (1) financial; (2) customer; (3) process; and (4) learning/growth. Business analytics is the body of knowledge identified with the deployment and use of technology solutions that incorporate BSCs, dashboards, performance management, definition and delivery of business metrics, as well as data visualization and data mining. Business analytics within BPM focus on the effective use of organizational data and information to drive

positive business action (Turban et al., 2008). The effective use of business analytics demands knowledge and skills from subject matter experts and knowledge workers. Similarly, Wears and Berg (2005) concur that IS/IT only yield high-quality healthcare when the use patterns are tailored to knowledge workers and their environment. Therefore, BPM success through BSCs and dashboards has a strong dependence on contextual understanding of end-to-end core business processes (Jensen & Nelis, 2008).

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 (1967) proposed IS design should embed feedback as a control to avoid management misinformation. Other authors (Zani, 1970; Rockart, 1979; Munroe & Wheeler, 1980) 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, hospital processes are becoming increasingly information intensive and doubt exists as to whether process management understanding can meet the increasing hospital environmental demands for value and cost efficiency (Catalano & Fickenscher, 2007).

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 operating room (OR) turn times (TURNS) and utilization (UTIL) (Barnes, 2010; Herzer et al., 2008). The Thomson Group (2010) 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 (Marjamaa et al., 2008; Peters & Blasco, 2004).

2.3. Healthcare Quality Benchmark Standards

Healthcare industry benchmark standards focus on patient quality of care via self-reported outcome measures or patient satisfaction survey results. The CMS and the Hospital Quality Alliance (HQA) began publicly reporting inpatient quality reporting (IQR) outcomes on 30-day mortality measures for acute myocardial infarction (AMI) and heart failure (HF) in 2007 and for pneumonia (PN) in 2008 (CMS, 2010).

Patient satisfaction measures began development as the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey in 2002. The collaboration effort was between CMS and the Agency for Healthcare Research and Quality (AHRQ), another federal agency under the Department of Health and Human Services. The evolved HCAHPS survey measures report patient perspectives on care received across items that encompass ten key topics: (1) communication with doctors, (2) communication with nurses, (3) responsiveness of hospital staff, (4) pain management, (5) communication about medicines, (6) discharge information, (7) cleanliness of the hospital environment, (8) quietness of the hospital environment, (9) overall rating of the hospital, and (10) whether the patient would recommend the hospital to family and friends (HCAHPS, 2012).

In 2005, CMS began a major priority to encourage improvements in the quality of care provided to Medicare beneficiaries (CMS, 2005). The result was pay-for-performance (P4P) or value-based purchasing (VBP) as a CMS payment model that rewards healthcare

providers for meeting certain performance measures in quality and efficiency. In a 2007 study, hospitals reporting both public and P4P achieved modestly greater quality improvements than hospitals engaged only in public reporting (Lindenauer et al., 2007). In 2008 as an additional rule to P4P, CMS included disincentives of reducing payments for negative consequences of care that should never occur, as defined by the National Quality Forum, including hospital infections under the surgical care improvement project (SCIP) (NQF, 2008).

3. RESEARCH METHOD

The objective of this study is to examine BPM practices of BSCs and dashboards within a hospital's perioperative process that target opportunities and measure improvement, aligned to hospital strategy. To this end, case research is particularly appropriate (Eisenhardt, 1989; Yin, 2003). An advantage of the positivist approach (Weber, 2004) to case research allows concentrating on specific hospital processes 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 an academic medical center (e.g. University Hospital), licensed for 1,044 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 120-month study, we conducted field research and gathered data from multiple sources including interviews, field surveys, site observations, field notes, archival records, and document reviews.

The initial perspective of this research focused on University Hospital's perioperative process for its 32 general operating room (OR) suites. Perioperative Services is the University Hospital department that coordinates the hospital's perioperative process across Admissions, PREP having 42 beds, Post Anesthesia Care Unit (PACU) having 45 beds, and Central Sterile Supply (CSS).

4. CASE BACKGROUND

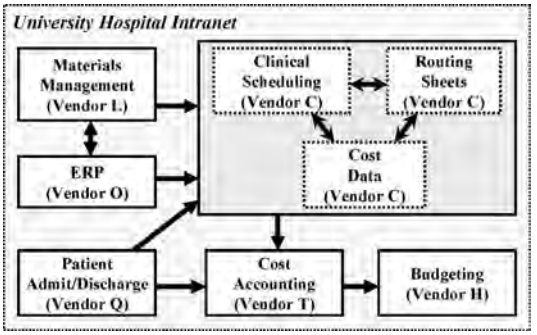
Perioperative Services implemented a new CSIS in 2003, after using its prior CSIS for 10 years. The old CSIS and its vendor were not flexible in adapting to new data collection needs of Perioperative Services. Figure 1 depicts University Hospital's CSIS architecture as of October 2004. University Hospital 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 0); (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 three modules for clinical scheduling, routing sheets, and cost data.

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.

4.1. November 2004

University Hospital opened a new diagnostic and surgical facility in November 2004, which covers three-fourths of a city block rising 12 stories. Perioperative Services were relocated into three floors, with ORs located over two floors and CSS located separately on the 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 equipped with new standardized equipment as well as equipment by surgical specialty. Within six

Figure 1. IS architecture (October 2004)



weeks of occupying the new perioperative facility, scheduling KPIs reflected chaos. On-time surgical case starts plunged to 18% during December 2004. Within a highly competitive hospital industry, having only 18% OTS 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 innovations—existing perioperative processes were disparate within the new environment.

4.2. Perioperative Continuous Process Improvement (CPI)

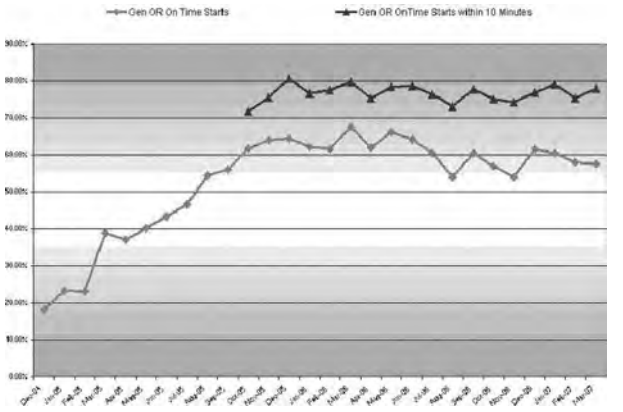
In January 2005, perioperative concerns were laid out before a quickly convened executive council. The meeting included the chief executive officer, the chief financial officer, the chief information officer, the chief nursing officer, and top representatives of surgeons, anesthesia, and Perioperative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

University Hospital's executive team launched a CPI effort to address the perioperative crisis through soft innovations (Ryan et al., 2008). The executive team and numerous task forces, formed to address specific problems and/or opportunities, were chartered to systematically identify issues and enlist working managers for solutions that focus on patient care and safety, attack difficult questions, and no issue was "off-limits."

Given the slow learning curve associated with the OR relocation and radical innovation disruption, a new KPI was established to track surgical case OTS within 10 minutes. This particular KPI provided motivation for CPI and was retired in 2008. Figure 2 represents the perioperative process improvement in the surgical case OTS through May 2007.

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). Perioperative Services has also assumed the management and scheduling of an additional 36 ORs that include 8 cardio-vascular OR suites (CVOR), 19 OR suites at the Hygh Hospital campus (HHOR), and 9 OR suites at the Eye Foundation Hospital (CEFH). University Hospital has continued a systematic approach to perioperative CPI across all of its surgical locations and services, achieving improvement success that targeted perioperative process analysis and redesign (Ryan et al., 2010), heuristic OR scheduling (Ryan et al., 2011a), hospital-wide patient flow (Ryan et al., 2011b), preoperative clinic benchmarking and re-engineering (Ryan et

Figure 2. OTS KPIs December 2004 to May 2007



al., 2012), and radio-frequency identification implementation (Ryan et al., 2013). Figure 3 depicts the improved patient flow through the University Hospital Health System (UHHS) resulting from these CPI efforts.

5. RESULTS AND DISCUSSION

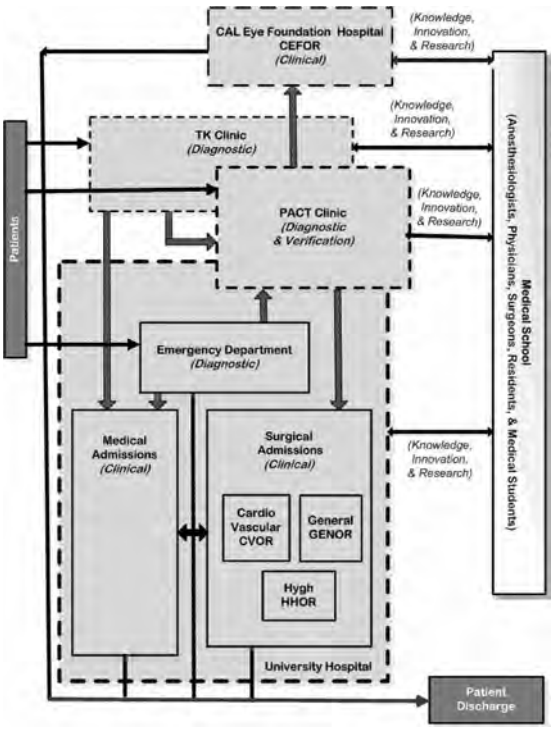
The executive team and perioperative management consistently focus on data-driven, end-to-end CPI efforts. Initially as needed to facilitate perioperative process management and improvement, the executive team and subsequent task groups defined process control measures based on internal process data collected through the CSIS and external industry standards. Initially, these control measures benchmarked previous months' metrics to establish trends for tracking improvement and/or targeting areas for improvement. When reviewing what could have been done better during the initial CPI efforts, the executive team and Perioperative Services management recognized the need to involve perioperative stakeholders in the entire improvement process and not just end-result to-do lists. As a result in 2008, the executive team launched an initiative to categorize, qualify, and quantify perioperative performance measures for process management and control feedback as well as meet regulatory requirements for CMS and TJC. The initiative set out to identify and define measures associated with core perioperative processes, establish a BSC of measures, and develop a means to disseminate the process feedback to perioperative stakeholders. The following sections elaborate on the initiative's results through May 2013.

5.1. Core and Operational Measures

The identification and definition of perioperative operational control measures has been an iterative evolution for University Hospital since 2005, similar to the core healthcare industry quality standards coordinated and adopted by CMS and TJC. University Hospital currently has 53 core and operational measures identified and defined at the strategic level that measure perioperative performance on a monthly or quarterly basis. Each measure maps to a process, definition, outcome, data source, data type, personnel responsible, reporting frequency, and control target. Table 1 represents a sample of the 53 strategic core and operational measures.

Table 2 lists the specific strategic outcome categories and number of associated core and operational measures. The 53 strategic measures are spread over outcome categories that cover patient safety, patient satisfaction, patient satisfaction— HCAPHS, employee satisfaction, patient throughput, mortality/readmissions, financial, and IQR quality measures over

Figure 3. UHHS improved patient flow



AMI, HF, PN, and SCIP. Table 3 lists all 53 measures by financial, customer, or process BSC perspective.

5.2. Multi-Level Balanced Scorecards (BSCs)

The 53 core and operational measures by BSC perspective provide an initial foundation for a BSC strategic approach to managing and controlling University Hospital's perioperative process. However, the strategic measures are at a high managerial level. Many other financial, customer, and process measures are available at lower tactical and even lower day-to-day operations levels. Perioperative stakeholders use the lower level measures to monitor and control perioperative process performance. For example, surgical location (e.g. GENOR, CVOR, HHOR, or CEFH) and/or surgical specialty (i.e. orthopedics) reflect tactical level performance measures. Table 4 lists all 17 surgical specialty services (SSS) performed across the four surgical locations.

University Hospital currently has 32 perioperative measures identified and defined at the tactical level to measure monthly perioperative performance by surgical location and/or specialty. The CSIS captures, stores, or derives a majority of these measures. Similarly as with the strategic measures, each tactical measure maps to a process, definition, outcome, data source, data type, personnel responsible, reporting frequency, and control target. Table 5 lists specific tactical outcome categories and the number of associated measures. The corresponding 32 tactical measures reflect outcome categories that cover quality, satisfaction, financial, and IQR SCIP quality. Table 6 lists all 32 measures by financial, customer, or process BSC perspective.

At the day-to-day operations level, performance measures reflect more tallies, totals,

Table 1. Sample strategic measure

Outcome Category	Measure	Source	Operational Definition	Sch	Rpt	Target
Patient Safety	Time Outs Documented	CSIS	OR / Bedside procedures	Mth	Avg	TJC

Table 2. Strategic outcomes

Strategic Outcome	Measures
Patient Safety	4
Patient Satisfaction	4
HCAHPS	3
Employee Satisfaction	2
Patient Throughput	4
Mortality/Readmissions	4
Financial	3
IQR Quality Measures	29 AMI–5, HF–8, PN–6, SCIP-10

Table 3. 53 strategic perioperative process measures

Time Outs Documented	Average Length of Stay (Days)	AMI- ACEI/ARB for LVSD	PN-Pneumonia Vaccinations
Hospital Nosocomial Infection Marker Rate (NIM Rate)	Length of Stay Index (Actual / Expected)	AMI- PCI within 90 min	PN-Antibiotic Selection
NIM Benchmarking Rating	Percent occupancy (Inpatients Only)	AMI-Readmission Rate	PN-Blood Cultures before ABX in UED
NIM Benchmarking Rating Change	Discharges by Noon	HF- Discharge Instructions-Activity	PN-Readmission Rate
Nurses kept you informed	Mortality (Number)	HF- Discharge Instructions-Diet	SCIP-Prophylactic ABX given within 1hr of incision
Staff sensitivity to inconvenience	Mortality Rate (deaths / total admits)	HF- Discharge Instructions-Weight Monitoring	SCIP-Prophylactic ABX d/c within 24/48hrs (Overall)
Staff addressed emotional needs	Mortality Index (Actual / Expected)	HF- Discharge Instructions-Symptoms Worsening	SCIP-Prophylactic ABX d/c within 48hrs (CV)
Response to concerns/complaints	Re-admissions	HF- Discharge Instructions-Follow-Up	SCIP-Prophylactic ABX d/c within 24hrs (Hips & Knees)
% definitely yes would recommend UH	Net Revenue - Adjusted (Actual $M)	HF- Discharge Instructions-Medications	SCIP-Prophylactic ABX d/c within 24hrs (Colon)
Pain Well Controlled (% Always)	CMS-Medicare (YTD)	HF-ACEI/ARB for LVSD	SCIP-Prophylactic ABX d/c within 24hrs (Vascular)
Nurse listened carefully to you (% Always)	Operating Margin	HF-Readmission Rate	SCIP-Prophylactic ABX d/c within 24hrs (GYNX)
RN Turnover Rate (%) (YTD)	AMI- Aspirin at Arrival	PN-ABX within 6hrs of arrival (overall)	SCIP-Post-Op Glucose
RN Recruitment Vacancy (%)	AMI- Beta Blocker at Discharge	PN-Flu Vaccinations	SCIP-Prophylactic VTE Assessment/Order
SCIP-Prophylactic VTE received			
Employee	Customer	Process	

Table 4. University hospital's surgical specialty services (SSS)

Surgical Specialty Services (SSS)		
BURN – Trauma burns	**OPH** – Ophthalmology	**TX** – Transplants (liver, renal)
CV – Cardio-vascular	**ORAL** – Oral Maxil Facial	**TRAUMA** – Trauma, MASH
ENT – Ear, Nose, & Throat	**ORTHO** – Orthopedic, joint / device replacement	**URO** – Urology
GI – Gastro-intestinal	**PLAS** – Plastic surgery	**VASCA** – Vascular – arteries
GYN – Obstetrics, oncology, incontinence	**SURG ONC** – Surgical oncology	**VASCULAR** – blood vessels
NEURO – Neurological	**THOR** – Thoracic	

Table 5. Tactical outcomes measured

Tactical Outcome	Measures
Quality	13
Satisfaction	2
Financial	7
IQR Quality Measures	SCIP-10

Table 6. Tactical measures

Unit of Service (UOS)	Time Outs Documented	On Time Starts	SCIP-Prophylactic ABX given within 1hr of incision
Actual Supply $ / UOS	Brief Post Op Notes	#1 Delay Reason	SCIP-Prophylactic ABX d/c within 24/48hrs (Overall)
AS / UOS Variance	H&P 24hr update	% Case = Turn Time	SCIP-Prophylactic ABX d/c within 48hrs (CV)
EVOR+Perf Supply / UOS	Point of Use Sterilization	Turn Times under 45min	SCIP-Prophylactic ABX d/c within 24hrs (Hips & Knees)
CG / UOS Variance	Blood Admin	Preop-Nurse Ready Time	SCIP-Prophylactic ABX d/c within 24hrs (Colon)
7AM-7PM Case HRS / 8HR UTIL	Hair Removal	SCIP-Post-Op Glucose	SCIP-Prophylactic ABX d/c within 24hrs (Vascular)
Case Volume	PACU-LOS	SCIP-Prophylactic VTE Assess/Order	SCIP-Prophylactic ABX d/c within 24hrs (GYNX)
% Cases done by 5PM	Canceled Cases	PACU-Pain on DC	SCIP-Prophylactic VTE received
Financial	Customer		Process

and worksheets that are required by individual sub-process (i.e. PREP, PACU, CSS, etc.), surgical specialty, and/or by specific OR suite (i.e. Main OR 508). The granularity of performance measures at the day-to-day operations level allows aggregation at higher tactical and strategic levels. The multi-level BSC approach allows different perspectives (e.g. strategic, tactical,

and/or day-to-day operations) of perioperative process performance as well as addressing end-to-end process performance.

The BSC for the day-to-day operations measures are more reflective of process components than end-to-end process segments as at the tactical level. The list of all day-to-day operations measures is too large to include in this paper, as most data elements within the CSIS are or are potential day-to-day operations measures. Table 7 lists examples of major day-to-day operations measures by BSC perspectives of financial, customer, and process.

5.3. Perioperative Process Dashboards

Perioperative stakeholders pull BSC measures as needed. The strategic and tactical BSC measures reside on a secured, virtual drive accessible by any perioperative stakeholder who has sufficient rights and privileges within the CSIS. As previously mentioned, the majority of the day-to-day operations BSC measures reside within the CSIS with similar stakeholder access.

At the close of each monthly reporting period, Perioperative Services compiles the strategic, tactical, and day-to-day operations BSC measures into electronic dashboards that measure perioperative performance across each managerial level. These dashboards are then pushed out to update the BSC virtual drive as well as University Hospital administration, directors, and managers. Each University Hospital surgeon receives dashboards for their respective SSS and surgical locations. Team leaders also post the strategic and relevant tactical BSC dashboards in their specific areas. Therefore, BSC dashboards are pushed out monthly for stakeholder dissemination upward and downward.

Figure 4 illustrates an example of a strategic dashboard reflecting perioperative core measures aligned to University Hospital's strategic objectives. Each monthly measure is color coated to depict:

- **Green:** Measure is at or above target
- **Yellow:** An area of concern, as measure is within 10 points below target
- **Red:** Failing, as measure is below 10 points from target

The color-coding on each measure reflects opportunity for the BSC learning/growth perspective and improvement.

Figure 5 illustrates two examples of the 22 current tactical dashboards (i.e. 1 combined for all surgical locations, 4 individual surgical locations, and 17 SSS). The first tactical dashboard is a composite of the GENOR and CVOR surgical locations. The second tactical example is for the orthopedics SSS (e.g. ORTHO). ORTHO cases are performed in the surgical OR suites of GENOR and HHOR. All tactical dashboards use the same color code sequence of green, yellow, and red as noted with the strategic dashboards.

As of May 2013, there are 18 day-to-day operations dashboards used to generate the 22 tactical dashboards. Figure 6 contains examples of day-to-day operations dashboards. The first example in Figure 6 is a summary of late and OTS cases by OR suite by OR location for May 2012. The second example is a partial listing of SSS block time utilization by OR suite by day-of-week for May 2012. The third example shows surgical case completions by OR time slots (i.e. 7AM-3PM, 3PM-5PM, 5PM-7PM, 7PM-9PM, and remaining cases after 9PM) by OR location and in total.

Lastly, all dashboards are views of the original BSC data measures, stored in the CSIS or on the secured virtual drive. Perioperative stakeholders may manipulate data within each dashboard for task group analysis or graphing (e.g. data visualization), but the archived measures have read only access capabilities to ensure data integrity.

5.4. Data Visualization

Figure 7 illustrates examples of line charts representing perioperative KPI measures versus time. Charts are useful to identify trends in the financial, customer, and process BSC perspectives. The first four data visualization examples

Table 7. Day-to-day operations measures

After Hour Cases	Time Outs	Cases done 7AM - 3PM
OR Time Used	Instrument Counts	Cases done 3PM - 5PM
% OR Use Time	OR Pauses	Cases done 5PM - 7PM
% Completed 7PM - 9PM	Average Case Time (Minutes)	% Completed 7AM - 3PM
Cases done 7PM - 9PM	Volume Shifts	% Completed 3PM - 5PM
Case Volume	Minute Shifts	% Completed 5PM - 7PM
Available Block Time (12 Hrs.)	Cases Turned	Remaining Cases
Block Time Utilization	% Turn Time Met	% Remaining Cases
Available Block Time (Minutes)	First Case Ontime Starts	Block Time
Minutes Blocked	On Time Starts	Total Cases
SSS Utilization	OR Suite Utilization	OR Suite Cases
Financial	Customer	Process

Figure 4. Strategic Dashboard Examples

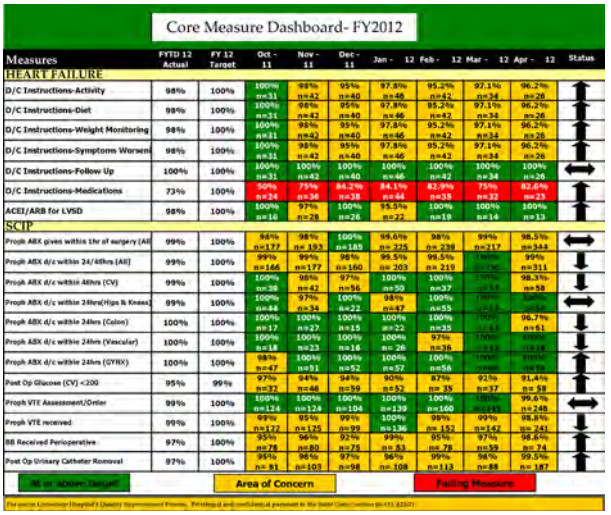
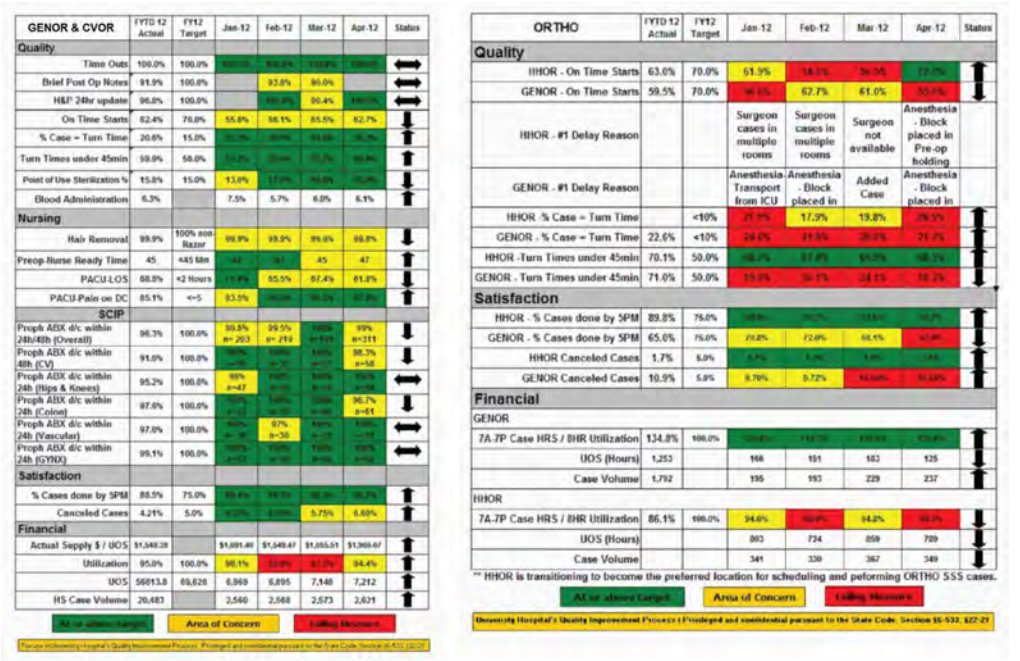


Figure 5. Tactical dashboard examples



GENOR & CVOR	FYTD 12 Actual	FY12 Target	Jan-12	Feb-12	Mar-12	Apr-12	Status
Quality							
Time Outs	100.0%	100.0%					
Brief Post Op Notes	91.9%	100.0%		93.8%	86.0%		
H&P 24hr update	96.8%	100.0%					
On Time Starts	62.4%	70.0%	55.6%	66.1%	65.5%	62.7%	
% Case = Turn Time	20.6%	15.0%					
Turn Times under 45min	59.9%	50.0%					
Point of Use Sterilization %	15.8%	15.0%	13.0%				
Blood Administration	6.3%		7.5%	5.7%	6.0%	6.1%	
Nursing							
Hair Removal	99.9%	100% non Razor	99.9%	99.9%	99.8%	99.8%	
Preop-Nurse Ready Time	45	<45 Min			45	47	
PACU-LOS	88.8%	<2 Hours		85.5%	87.4%	81.8%	
PACU-Pain on DC	85.1%	<=5	83.5%				
SCIP							
Proph ABX d/c within 24h/48h (Overall)	96.3%	100.0%	99.5% n= 203	99.5% n= 218	99% n=191	99% n=311	
Proph ABX d/c within 48h (CV)	91.0%	100.0%				98.3% n=58	
Proph ABX d/c within 24h (Hips & Knees)	95.2%	100.0%	98% n=47				
Proph ABX d/c within 24h (Colon)	97.0%	100.0%				96.7% n=61	
Proph ABX d/c within 24h (Vascular)	97.0%	100.0%		97% n=30			
Proph ABX d/c within 24h (GYNX)	99.1%	100.0%					
Satisfaction							
% Cases done by 5PM	88.5%	75.0%					
Canceled Cases	4.21%	5.0%			5.75%	6.60%	
Financial							
Actual Supply $ / UOS	$1,549.28		$1,691.40	$1,549.47	$1,655.51	$1,966.67	
Utilization	95.0%	100.0%	96.1%			94.4%	
UOS	56013.8	59,628	6,969	6,895	7,148	7,212	
HS Case Volume	20,483		2,560	2,568	2,573	2,621	

ORTHO	FYTD 12 Actual	FY12 Target	Jan-12	Feb-12	Mar-12	Apr-12	Status
Quality							
IHOR - On Time Starts	63.0%	70.0%	61.9%				
GENOR - On Time Starts	59.5%	70.0%		62.7%	61.0%		
IHOR - #1 Delay Reason			Surgeon cases in multiple rooms	Surgeon cases in multiple rooms	Surgeon not available	Anesthesia - Block placed in Pre-op holding	
GENOR - #1 Delay Reason			Anesthesia Transport from ICU	Anesthesia - Block placed in	Added Case	Anesthesia - Block placed in	
IHOR -% Case = Turn Time		<10%		17.9%	19.8%		
GENOR - % Case = Turn Time	22.6%	<10%					
IHOR -Turn Times under 45min	70.1%	50.0%					
GENOR - Turn Times under 45min	71.0%	50.0%					
Satisfaction							
IHOR - % Cases done by 5PM	89.8%	75.0%					
GENOR - % Cases done by 5PM	65.0%	75.0%					
IHOR Canceled Cases	1.7%	5.0%					
GENOR Canceled Cases	10.9%	5.0%					
Financial							
GENOR							
7A-7P Case HRS / BHR Utilization	134.8%	100.0%					
UOS (Hours)	1,253		168	151	183	125	
Case Volume	1,792		195	193	229	237	
IHOR							
7A-7P Case HRS / BHR Utilization	86.1%	100.0%					
UOS (Hours)			803	734	859	709	
Case Volume			341	330	367	349	

** IHOR is transitioning to become the preferred location for scheduling and performing ORTHO SSS cases.

show OTS, UOS-total expenses, OR utilization, and completed cases 7AM-5PM from October 2008 to June 2011. The fifth example is one chart that shows OTS from October 2008 to December 2012. The sixth example shows Press-Ganey HCAPHS results for overall hospital and visitor/family ratings from Q3 2008 to Q1 2013.

All of the BSC measures at each managerial level can be pulled into a data visualization chart to report perioperative process performance. All six of the data visualization examples in Figure 7 show positive trends for financials, customer, and process perspectives of the BSC measures.

5.5. Goal Setting and Process Improvement Aligned to the Hospital Strategic Plan

The 2008 perioperative BPM initiative established BSC (e.g. financial, customer, and process) measures and a means to disseminate process feedback to perioperative stakeholders at the strategic, tactical, and operational levels.

However, the perioperative process is not the exclusive core process included in University Hospital Health System's strategic vision. Updated in 2010 and labeled AMC21, UHHS' strategic plan reaffirms the core healthcare industry standards coordinated and adopted by CMS and TJC, while complimenting core hospital process measures. Table 8 lists the foundation or strategic pillars that support AMC21 strategic goals. Furthermore, the vision within AMC21 is for UHHS to be the preferred academic medical center of the 21st century with characteristics where: a) patients want to come for care; b) employees want to work; c) faculty want to practice and conduct research; d) students, residents, and fellows want to learn; e) and donors want to give to a better future. These five characteristics in the UHHS vision exemplify the desired strategic outcomes of AMC21 goals and the four AMC21 strategic pillars reflect core BSC measures. Likewise, the perioperative BPM initiative nests within the overall execution of the AMC21 goals and

Figure 6. Day-to-day operations dashboards

General OR			
Suite	Late	On Time	Total Cases
GENOR508	5	13	18
GENOR509	7	12	19
GENOR510	6	15	21
GENOR511	8	11	19
GENOR512	8	12	20
GENOR515	6	11	17
GENOR516	8	13	21
GENOR517	2	20	22
GENOR518	5	14	19
GENOR701	5	16	21
GENOR702	5	17	22
GENOR703	5	17	22
GENOR704	4	18	22
GENOR705	6	15	21
GENOR706	5	17	22
GENOR707	12	8	20
GENOR708	9	12	21
GENOR709	9	9	18
GENOR710	6	15	21
GENOR711	4	16	20
GENOR712	2	20	22
GENOR713	3	19	22
GENOR714	3	19	22
GENOR715	8	14	22
GENOR716	5	15	20
GENOR717	8	13	21
GENOR718	7	15	22
GENOR719	10	11	21
GENOR720	4	16	20
GENOR721	7	13	20
GENOR722	7	13	20
CYSTO	5	9	14
ENDO	4	5	9
GEN Total	198	463	661

GENOROn Time Starts: 70.05%

CVOR			
Suite	Late	On Time	Total Cases
CVOR 501	4	9	13
CVOR 502	7	12	19
CVOR 503	6	10	16
CVOR 504	7	9	16
CVOR 505	11	7	18
CVOR 506	9	6	15
CVOR 507	4	11	15
CVOR 508	1	0	1
ENDO	4	2	6
CV Total	53	66	119

CVOR On Time Starts: 55.46%

CEFH			
Suite	Late	On Time	Total Cases
CEFOR1	12	9	21
CEFOR2	12	9	21
CEFOR3	11	11	22
CEFOR4	5	15	20
CEFOR5	13	9	22
CEFOR6	13	10	23
CEFOR7	8	15	23
CEFOR8	7	13	20
CEFOR9	8	14	22
CEF Total	89	105	194

CEFH On Time Starts: 54.12%

HHOR			
Suite	Late	On Time	Total Cases
HHGI01			0
HHGI02			0
HHOR0	4	13	17
HHOR0	2	16	18
HHOR0	3	13	16
HHOR0	6	14	20
HHOR0	7	9	16
HHOR0	8	11	19
HHOR0	6	15	21
HHOR0	6	15	21
HHOR09			0
HHOR1	2	7	9
HHOR11			0
HHOR1	4	8	12
HHOR1	3	13	16
HHOR1	2	17	19
HHOR1	3	11	14
HHOR1	2	6	8
HH Tot	58	168	226

HHOR On Time Starts: 74.34%

May 2012
Health System On Time Starts
66.83%

May - 2012

Block Time Utilization

Overall Block Utilization 98.5%

All time 7A-7P with 8HR denominator to equalize across services - Except CEFHOR

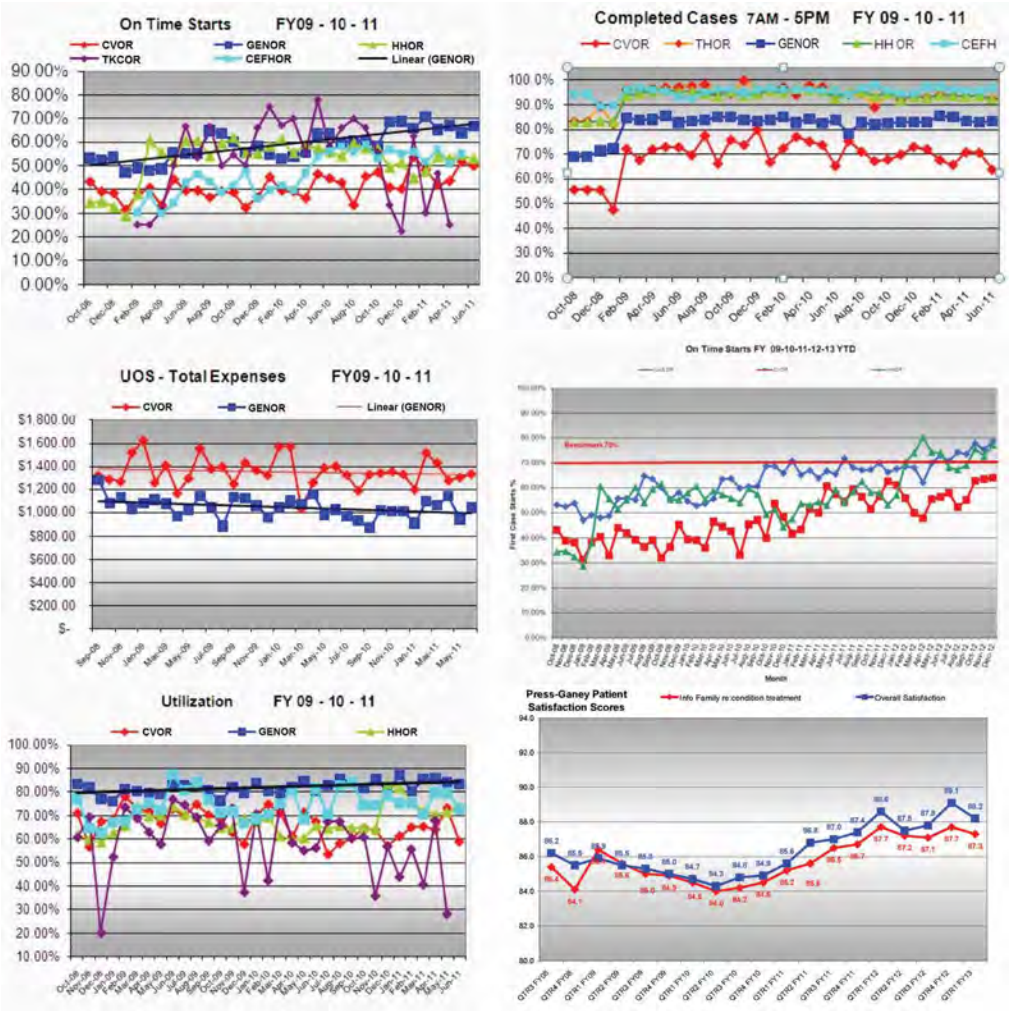
Available Days	3.0 Monday	5.0 Tuesday	5.0 Wednesday	5.0 Thursday	4.0 Friday	22.0 Weekly Block Total	Weekly Room Total
Main OR 701	Trauma - 8	Surg Onc - 8	Surg Onc - 8	Trauma - 8	Trauma - 8	BLOCK TOTAL	ROOM TOTAL
Total Cases	9	4	11	8	13	45	57
Avg Case Time	170	305	190	193	173	189	189
Total Time	1531	1221	2124	825	2255	7956	9654
% of Utilization	106.32%	50.88%	88.50%	34.38%	117.45%	75.14%	91.42%

Main OR 702	SURG ONC - 8	GI - 8	SURG ONC - 8	Surg Onc - 8	SURG ONC - 8	BLOCK TOTAL	ROOM TOTAL
Total Cases	6	5	9	6	7	33	41
Avg Case Time	213	264	259	309	335	276	261
Total Time	1278	1321	2332	1853	2348	9128	10707
% of Utilization	88.61%	55.04%	97.17%	77.21%	122.19%	86.44%	101.39%

Main OR 703	GI - 12	GI - 12	GI - 12	GI - 12	GI - 12	BLOCK TOTAL	ROOM TOTAL
Total Cases	5	8	12	8	8	41	45
Avg Case Time	245	242	197	256	168	222	218
Total Time	1223	1935	2368	2364	1345	8935	9806
% of Utilization	84.93%	80.63%	98.67%	98.00%	70.05%	84.61%	92.86%

Data Element	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	FY12
GenOR Cases done 7AM - 3PM	1187	1169	1119	1222	1249	1226	1212	1238	9622
GenOR Cases done 3PM - 5PM	234	236	201	230	214	186	222	236	1761
GenOR Cases done 5PM - 7PM	123	146	121	129	121	124	148	134	1046
GenOR Cases done 7PM - 9PM	71	77	80	81	66	70	63	76	583
GenOR Remaining Cases	85	80	92	61	78	92	91	97	676
GenOR % Completed 7AM - 3PM	69.8%	69.4%	69.4%	70.9%	72.3%	72.2%	69.8%	69.5%	70.3%
GenOR % Completed 3PM - 5PM	13.8%	13.8%	12.5%	13.3%	12.4%	11.0%	12.8%	13.4%	12.9%
GenOR % Completed 5PM - 7PM	7.2%	8.5%	7.5%	7.5%	7.0%	7.3%	8.5%	7.5%	7.6%
GenOR % Completed 7PM - 9PM	4.2%	4.5%	5.0%	4.7%	3.8%	4.1%	3.6%	4.2%	4.3%
GenOR Remaining Case %	5.0%	4.7%	5.7%	3.5%	4.5%	5.4%	5.2%	5.4%	4.9%
All Cases done 7AM - 3PM	2754	2720	2599	2792	2800	2662	2670	2688	21676
All Cases done 3PM - 5PM	394	392	334	376	348	308	373	373	2898
All Cases done 5PM - 7PM	172	233	184	187	160	183	205	196	1540
All Cases done 7PM - 9PM	98	103	102	110	98	99	91	109	810
All Remaining Cases	103	105	113	79	102	119	111	123	856
All % Completed 7AM - 3PM	78.2%	76.6%	78.8%	78.8%	79.4%	78.9%	77.4%	77.0%	78.0%
All % Completed 3PM - 5PM	11.2%	11.0%	10.8%	10.6%	9.9%	9.2%	10.8%	10.7%	10.4%
All % Completed 5PM - 7PM	4.9%	6.6%	5.5%	5.3%	5.1%	5.4%	5.9%	5.6%	5.5%
All % Completed 7PM - 9PM	2.8%	2.9%	3.1%	3.1%	2.8%	2.9%	2.6%	3.1%	2.9%
All Remaining Case %	2.9%	3.0%	3.4%	2.2%	2.9%	3.5%	3.2%	3.5%	3.1%

Figure 7. KPI data visualization



vision. However, the UHHS strategic vision needed a more holistic BPM tool.

To align process improvements and stakeholder efforts with the AMC21 vision, UHHS administration also implemented an intranet-based goal setting and reporting tool to leverage existing process data via integrated IS and provide an extended business intelligence application layer across UHHS, similar to the perioperative CSIS/BPM tool, but with an entire UHHS system focus. The "Reach for Excellence" (RFE) layer provides process management capabilities for qualitative and quantitative measures, across UHHS, measurable and aligned to AMC21 pillars and goals. The purpose for the RFE layer is to provide an objective tool to measure process and stakeholder performance toward strategic, tactical, and operational goals that support the AMC21 vision. Individual employee goal setting towards achieving AMC21 is a formalized RFE activity integrated into the UHHS employee evaluation and performance review process. As a result, all hospital stakeholders (e.g. physicians, surgeons, nurses, staff, and administrators) at strategic, tactical, and operational levels have action

Table 8. UHHS' AMC21 strategic goals and pillars

AMC21 Strategic Pillars	AMC21 Strategic Goals
1. Quality 2. Satisfaction 3. Financial Performance 4. Knowledge Advancement	1. Delivering outstanding patient care 2. Developing advancements in scientific discovery and biomedical research 3. Providing a strong foundation of education and training for professionals

plans, RFE goals, and resulting merit increases that align with the AMC21 pillars, goals, and ultimately vision.

Rather than identify tactics, projects, or activities, RFE goals are quantitative, objective, aggressive, and realistic outcomes, where fewer rather than more is better. RFE goals will change focus as AMC21 progress advances. Consequently, each year UHHS administration reviews opportunities for improvement and identifies the most important outcomes needed. Many RFE goals do not change annually, as they are important outcomes for success. However, the iterative nature of the goal setting process yields aggressive targets for more familiar goals. As a result, administrators set goals so stakeholders focus on specific areas and the goal setting process aligns RFE process outcomes and stakeholder action to AMC21 strategy—a very powerful process management tool.

Figure 8 illustrates the 2012 AMC21 dashboard reflecting UHHS process measures aligned to AMC21 strategic pillars via RFE goals. The School of Medicine goals (9) are distinguishable from UHHS (15) and each goal carries a color-coated rating and indicator on performance. RFE goals use the four strategic pillars as modified BSC categories to reflect and categorize where targeted opportunities align to the AMC21 vision and goals. The color-coded performance and rating hierarchy is as follows:

- **5:** Dark Green = Stretch (achieved about 20% of the time)
- **4:** Green = Partial Stretch (achieved about 50% of the time)
- **3:** Light Green = Target (achieved about 80% of the time)
- **2:** Yellow = Partial Accomplishment
- **1:** Red = No Accomplishment

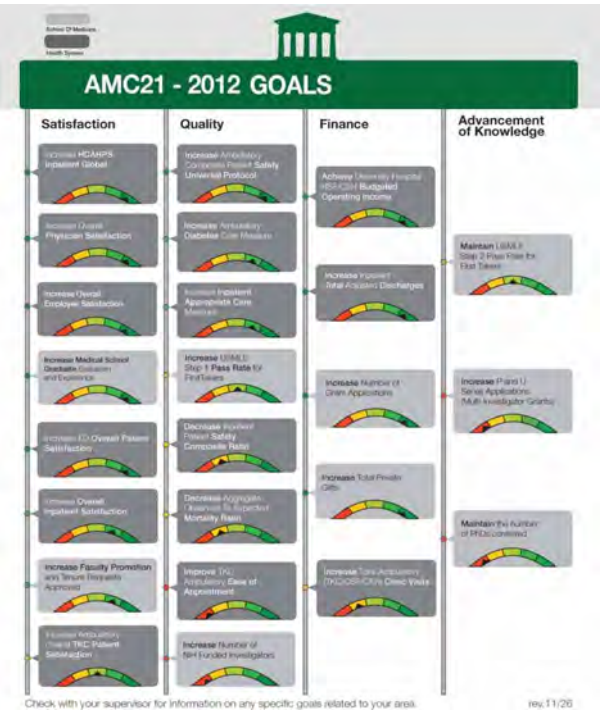
The RFE strategic goals reflect multiple core UHHS processes that are necessary to achieve the AMC21 vision. Six 2012 goals had no or partial accomplishment while 18 had 80% or more accomplishment. Perioperative processes depicted previously in Figure 7 influenced portions of RFE goals across satisfaction, quality, and finance pillars that were achieved 80% of the time or better during 2012.

6. CONCLUSION

Empowered individuals, integrated IS, and a holistic framework for perioperative process management allows University Hospital to take control and improve its perioperative process. The BSC approach to identify process measures gives stakeholders an end-to-end (e.g. holistic) view for financial, customer, and process perspectives. Patients are clearly customers, as well as PACU is a customer to an OR suite, or an OR suite is a customer to PREP. Also, revenue or margins are clearly financial, as well as surgical cases performed between 7PM to 9PM or cases remaining after 9PM. Moreover, the RFE goal layer affords University Hospital opportunities for process improvement aligned to AMC21 vision. The modified BSC approach to BPM gives stakeholders an end-to-end (e.g. holistic) view for AMC21 pillars, RFE goals, and hospital strategy execution.

Adopting the holistic framework for BSC measures at strategic, tactical, and day-to-day operations levels further educates hospital stakeholders on the benefits of integrated IS

Figure 8. AMC21 2012 pillars and RFE goals



for process measurement, control, and improvement. The cycle of analysis, evaluation, and synthesis reinforces communication and stimulates individual as well as collective organizational learning.

Our case study contributes to the healthcare IT literature by examining how CPI, BSC, performance dashboards, business analytics, and process management 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 healthcare BPM and strategy alignment 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 to create their own version of process management, control, and improvement aligned to strategy within the hospital environment.

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