DEVELOPMENT OF THE JAGIM LEAN REAL TIME LOCATION SYSTEMS MODEL FOR HEALTHCARE

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MASTER OF SCIENCE

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ABSTRACT

The critical challenge for healthcare today is to be a high quality/low cost provider. However, healthcare is struggling to meet the challenge in terms of quality, outcomes and cost. Healthcare is in need of a blueprint for transformation, leveraging new knowledge and innovation, while consistently and reliably delivering quality and controlling cost. Integrating the process change methodology of Lean with the enterprise visibility afforded by RTLS offers a wealth of exciting options for transformation, yet there is no existing model or defined body of research regarding the application of RTLS within a Lean methodology. The purpose of this project was to design a new model to be known as the Jagim Lean RTLS Model for Healthcare, that integrates the methodology of Lean with the capabilities of RTLS with nursing as a central figure in the healthcare delivery transformation process.

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Committee Members

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DEDICATION

I would like to dedicate this project to my husband, Gary, for his unwavering support and patience for my work and educational pursuits. I also want to dedicate this project to my sons, Andrew, Benjamin and Eric. You have been and always will be the lights of my life and my inspiration. According to scriptures, "to whom much is given, much is expected". You have been blessed with many gifts and talents and I know that you will make an amazing difference in this world. Never doubt in your ability to change the world.

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CHAPTER 1. HEALTHCARE'S DRIVE FOR EFFICIENCY

Introduction

The central challenge in healthcare is to be a high quality/low cost provider. Unfortunately, this challenge is proving increasingly difficult to achieve. Many innovations emerge almost daily, but the standing of U.S. healthcare on a variety of quality measures puts the world's wealthiest nation low on the list of developed countries. Additionally, costs seem to routinely rise faster each year than the cost of living. The present paper makes an audacious claim in the face of these humbling trends. Better quality care at lower cost can be achieved if two process-oriented management techniques are integrated, Lean management from the days of Deming and Toyota and real time location systems (RTLS) currently being made possible through new and emerging technologies. These ideas have not been connected formally to date, but the present paper argues for the value of such a connection.

Purpose and Statement of the Problem

Integrating the process change methodology of Lean with the enterprise visibility afforded by RTLS offers a wealth of exciting options for transformation, yet there is no existing model or defined body of research regarding the application of RTLS within a Lean methodology. Studies and process improvement projects have primarily focused on the use of Lean to reduce waste and create a more streamlined approach to a process. However, RTLS and its ability to provide real time data allowing visibility into process flows and the opportunity for automation of process, has the potential to greatly expand the scope, success and power of Lean.

The purpose of this project is to design a new model to be known as the Jagim Lean RTLS Model for Healthcare, that integrates the methodology of Lean with the capabilities of RTLS. Combining the Lean and RTLS approaches creates two synergies. First, both approaches focus on process and there is much to be accomplished in improving healthcare quality and reducing

cost with improvements in process. Among other accomplishments, improved process will reduce medical errors and waste, two major concerns in today's healthcare. Second, combining the Lean and RTLS approaches creates the synergy with each approach complementing gaps in the other. The combined model is meant to provide guidance for nurses, hospitals and healthcare leaders as they consider options for selecting tools and technologies to support their quest to become a high-quality provider of care at lower-cost. As part of the design process, the model will be evaluated by several subject matter experts to assure the logic and usefulness of the model. The actual implementation of the model is beyond the scope of the current project.

Background

Many changes have occurred in healthcare, healthcare delivery, and healthcare financing in the last twelve years. The hospital leaders of today face a formidable challenge. According to Mayer and Jensen (2012), in the face of increasing capacity constraints and the rising cost of resources, hospitals must change processes in a way that allows them to become a high quality/low cost provider of care. While healthcare has experienced an explosion in knowledge and innovation to manage previously fatal conditions, it has fallen significantly short on such fundamentals as quality, outcomes, cost, and equity. Actions that could potentially improve quality have been cut short by "missed opportunities, waste, delays and medical errors". Waste alone is estimated to have contributed $750 billion in unnecessary health spending in 2009 (Institute of Medicine [IOM], 2012). Healthcare must design a blueprint for transformation, leveraging new knowledge and innovation, while consistently and reliably delivering quality and controlling cost.

In order for hospitals to transform themselves to high quality/low cost organizations, the clinical, operational and financial cores of the organization must become one. Top-down leadership, elmination of waste through lean process change and leveraging technology to

support real-time data and knowledge must become key strategies for leaders and staff to make effective and smart decisions. The transformational alignment of the cores along with the strategies to achieve successful outcomes are depicted in Figure 1, an original graphic illustrating this relationship.

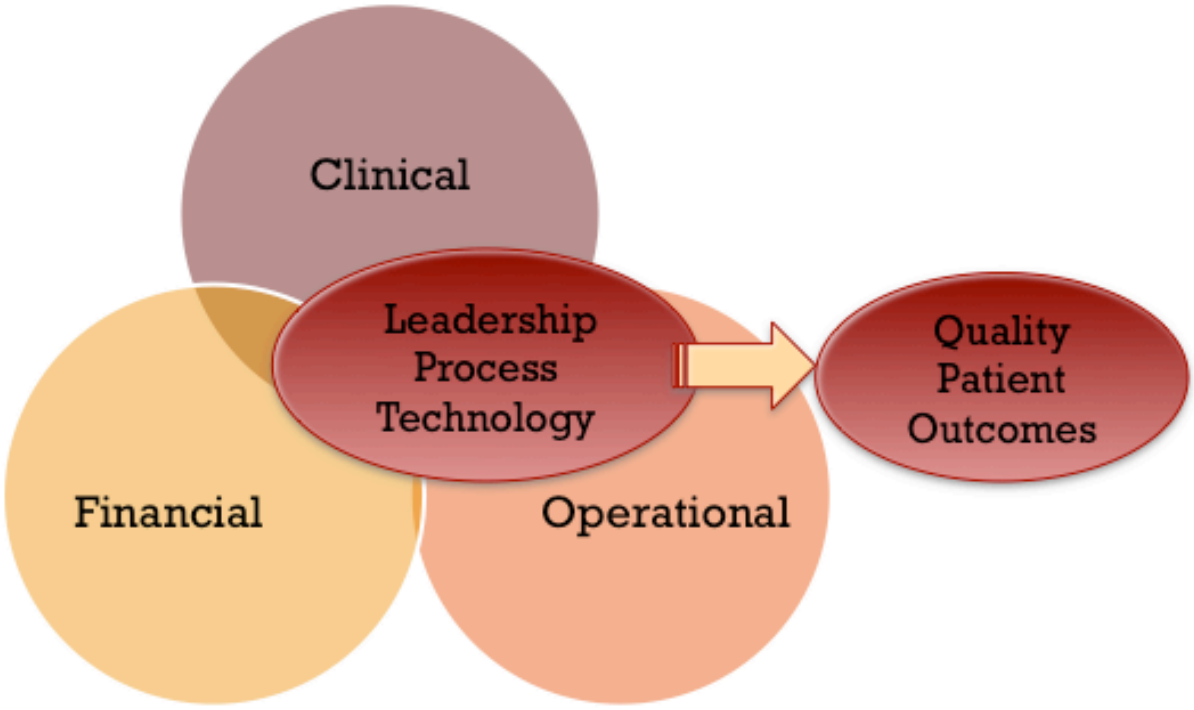


Figure 1. Healthcare Transformation Strategy

Transformation in health care is about the creation of a dynamic state of promoting improvement. Gamm (2007) defines transformation as a significant realignment of values and processes in the provision of healthcare. Transformational change strategies are those that challenge organizations to realign values, processes and structures in order to support a dynamic state of improvement. It takes a sincere commitment on the part of an organization from the top down in order to achieve transformation. Organizations will often adopt various organizational technologies to support their transformation innovations. According to Gamm

(2007), organizational technologies can involve innovations in information systems, administrative technologies and processes, social technology and communications, clinical technology tools and disease management. Wise and effective organizational leaders will focus on process first, leveraging innovative technology to support the process and reach the desired outcomes (Maurno & Sirico, 2010, p.152).

Lean, as a means of process improvement, is considered by many to be a critical element for successful transformation in healthcare. According to Graban (2012), "lean is a tool set, a management system, a philosophy and a methodology that allows hospitals to improve the quality of care for patients by eliminating waste, and reducing errors and waiting times" (Graban, 2012, p.1). Lean is founded on the highly successful Toyota Production System (TPS). Toyota leaders, Eiji Toyoda and Taiichi Ohno, developed the Toyota Production System over many decades, starting in 1945 in the aftermath of World War II. The Japanese were heavily influenced by Dr. W. Edwards Deming, an American statistician. Dr. Deming advised the Japanese to build the best quality products and as a result, customers would buy them. Deming further suggested that in order to achieve quality, it had to be built into every step of the process. Dr. Deming also promoted the training and development of workers to assure the desired quality of work outcomes. Toyota went on to create a culture where everyone was challenged to eliminate waste and defects, and allowed all employees to be involved in work processes. Toyota has a reputation for high employee satisfaction as a result of its reverence and respect for it's employees, valuing each as a skilled scientist. The Toyota Production System allowed Toyota to become a leader in auto manufacturing by striving towards the perfection of quality, while relentlessly eliminating waste (Jimmerson, 2007, pp.1-4). The transference of TPS into a strategy for manufacturing, known as "lean" production occurred in the 1990 book *The Machine that Changed the World* (Womack,Jones & Roods 1990). The successes in manufacturing were being noticed by other industries. By the end of the 1990's, thoughtful leaders in healthcare

were beginning to look at Lean as a potential solution to the quality and waste issues healthcare was facing (Kenney, 2011, p.2).

When implementing Lean in healthcare, the patient becomes the customer and is placed at the center of the service delivery process in order to focus on value to the patient (Teich & Faddoul, 2013). Lean becomes not only a methodology, but a philosophy and culture for how work is done in an organization. Using Lean, an organization can improve the quality of its services by identifing waste in seven critical areas of health care environments: waste of overproduction; waste of time on hand; waste in transportation; waste of processing; waste of stock on hand; waste of movement; and waste of making defective products (Bush, 2007). By the elimination of waste through continuous improvement and respecting the people engaged in the work, Lean has the ability to transform healthcare quality (Graban, 2012). Healthcare organizations, such as Virginia Mason and Pittsburg Regional Healthcare Initiative (Sirio et al., 2003), have used lean in their pursuit of creating the "perfect patient experience" (Kenney, 2011). Use of Lean as primary methodology in the delivery of healthcare is occurring worldwide. Countries such as the United Kingdom, Canada, New Zealand and Australia have recognized the need for change and the value of Lean (NHS Confederation, 2006).

Similar to Lean, RTLS is being implemented in hospitals to improve quality, safety, and efficiency and reduce cost (Maurno & Sirico, 2010, p.154). An RTLS system allows for the location in real time of people and assets within a sensory network by associating a tag, a small wireless device, with each person or asset. The sensory network can be designed using a variety of technologies such as radio frequency, wifi, zigbee, ultrasound, and/or infrared (Malik, 2009, p.9). Depending upon the technology used, RTLS can support a variety of applications (Malik, 2009, p.15). Accuracy can range from presence-based which means knowing something is in a particular building or zone, down to sub-room level such as a bay in a hospital recovery room (Malik, 2009, p.13). RTLS technology can provide applications for asset management, patient

flow, and temperature and humidity monitoring of refrigeration units and locations such as pharmacy storage rooms and labs. Depending on the capabilities of the system architecture, the RTLS technology may be integrated with other systems and solutions such as electronic health records, dashboards, nurse call systems, tracking boards and mobile devices.

Usage of RTLS in healthcare is still relatively new. According to KLAS, a research firm specializing in monitoring and reporting on the performance of healthcare vendors, an estimated 10 to 15 percent of the healthcare market is currently utilizing a RTLS solution. In the *KLAS Real-Time Location Systems (RTLS) 2011: Maximizing the ROI*, study findings indicated that 95 percent of responding organizations using RTLS cited operational efficiency gain (KLAS, 2011). Seventy-five percent of organizations reported improved equipment utilization and staff efficiency through the use of RTLS. Yet even with noted success, adopters also reported their greatest lesson learned was the need to adjust staff workflow to incorporate RTLS use, build organizational awareness of the many ways in which RTLS can be used, and strengthen RTLS infrastructure before the date of user "go live" or start date to improve adoption and maximize the return on investment (KLAS, 2011). So while efficiencies were noted, those implementing RTLS realized the way in which the implementation occurred impacted the degree of success achieved. Research done in other related technologies such as electronic data interchange, indicate that process redesign is required at all stages in the value chain where the technology is applied in order to achieve optimized results. The characteristics of RTLS make data obtained from time and location changes of people and assets intelligent and processes automatic (Tzeng, 2006).

Relevance to Nursing

The challenges faced by nursing in the efficient delivery of patient care have been so long-standing that many nurses cannot imagine work in a different way. Through the development of

a model that provides a blueprint for change, nurses may gain insight into the potentials and opportunities for workflow change as well as the mechanism to make change happen. The transformation process offers nursing a unique opportunity to utilize every process change and all aspects of RTLS functionality to improve care delivery and work efficiently and effectively. Some nurses may voice concerns regarding process change methodologies or technology. They may be hesitant due to time constraints to learn new technologies or a lack of desire to change the work routine they know, however inefficient it might be. Some nurses, in particular, may perceive RTLS technology, as an organizational control strategy. Zuzelo et al. (2008) found that nurses see technology as improving direct care processes, patient safety, patient outcomes, and work environment. However, nurses will attempt to protect resources felt to be scarce if they lack trust in the new technology to support the nurse's work. Also if the technology is perceived as inefficient or adding to the burden of work, nurses are less supportive of adoption (Zuzelo et al.,2008).

Zuzelo et al. (2008) advised nurse leaders to assure the evaluation of the workflow process prior to the implementation of the technology and modify the process to reduce inefficiencies and potential errors. Involvement of a nurse transformation leader is critical to successful process change and adoption of new technologies. The nursing profession will need to embrace and engage in the transformation in order for the organization to achieve success. Lack of engagement of nursing will likely lead to failed process change. Lean methodology offers nurses a means of engagement in the change transformation. Lean relies upon the involvement of those who do the work in the identification of the current state and the desired future state. Nurses are the front line of care delivery and one of a nurse's primary roles is as the coordinator of care for his or her patients. Nurses have an opportunity to personally invest both in the process and the outcome and experience the satisfaction of achieving a higher state of functioning as a transformation leader (Newman, 2008). Standardization of work (Graban, 2012) along with

coaching will be needed initially in order to assist nursing and other staff members to incorporate the new process and technology into their daily work.

CHAPTER 2. LITERATURE REVIEW AND STUDY FRAMEWORK

Healthcare Problem

Healthcare organizations of today face tremendous challenges in balancing the patient and population needs for services, capacity restricted by the rising cost of resources, growing regulatory requirements, escalating disaster preparedness needs, constantly evolving technologies, and government and payer requirements for quality outcomes. Yet according to the Institute of Medicine (IOM) report, *Best Care at Lower Cost: the path to continuously learning health care in America*, American health care falls short on the fundamentals of quality, outcomes, cost and equity (IOM, 2012, p.1). The magnitute of the cost of waste is difficult to grasp. In a study by the University of Maryland Center for Health Information and Decision Systems, U.S. hospitals waste approximately $12 billion annually due to poor communication among care providers (CHIDS, 2008). In 2005, an estimated 75,000 deaths could have been averted if every state had delivered care equal to that of the best performing state.

Federal Initiatives

In order to change the present course and become a health care system that is consistently reliable and improving in a consistant and systematic manner, the IOM recommends healthcare organizations seek the following:

- Real-time access to knowledge for continuous and reliable access and use of the best available evidence and data to improve decision-making, safety and quality.
- Incentives aligned for value to encourage continuous improvement, reduce waste, and reward high-value care.
- Full transparency of processes, costs and outcomes for care improvement and informed decision-making.

- Leadership-instilled culture of learning with full leadership commitment to a culture of teamwork, collaboration, and adaptability.
- Supportive system competencies, ongoing team training, systems analysis and information development to support continuous learning and improvement (IOM, 2012,p.2).

In healthcare, the primary objective is to deliver health services to individuals and patient populations to support and improve health outcomes. The care delivered should be based upon current clinical evidence and provided in a technically and culturally competent manner with good communication and shared decision-making (IOM, 2001). The Institute of Medicine (IOM), in its landmark report, *Crossing the Quality Chasm: A New Health System for the 21st Century*, outlined the six quality aims the patient care experience should be:

- Safe: care delivered without causing harm to the patient.
- Effective: providing evidence-based care to patients to those who could benefit, refraining from providing services unlikely to provide benefit
- Patient-centered: providing personalized care to patients reflective of the patient's values.
- Timely: reducing delays in care.
- Efficient: reducing waste in the care delivery process.
- Equitable: providing care uninfluenced by gender, ethnicity, location or socio-economic status (IOM, 2001, pp.39-40).

Since 2001, the IOM has published several additional reports summarizing the concerns, constraints and challenges of the existing healthcare delivery system and outlining an agenda for change with recommendations directed to Congress, Federal agencies, hospitals and other organizations and professional associations. In *To Err is Human: Building a Safer Health*

System (IOM, 2000, p.156), the IOM recommends health care organizations should establish patient safety programs that: provide visible attention to safety; adopt clear and standardized safety principles regarding equipment, supplies, and processes; and establish effective interdisciplinary team safety training. *In Keeping Patients Safe: Transforming the Work Environment of Nurses*, in addition to addressing issues around management practices, work design, and organizational safety culture, the IOM recommends directly involving workers throughout the redesign of the work process. Active participation is essential in successful organizational change (IOM, 2004, p. 260).

There have been several bills passed by Congress designed to incentivize healthcare organizations to make changes in key areas related to efficiency, technology, care coordination and safety. The Deficit Reduction Act of 2005 created an incentive for acute care hospitals to participate in the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey in which the results are publicly reported for each hospital. Since July 2007, hospitals subject to the Inpatient Prospective Payment System annual payment update provisions must collect and submit HCAHPS data in order to receive their full annual payment update. In addition, the Patient Protection and Affordable Care Act of 2010 includes HCAHPS among measures used to calculate value-based incentive payments in the Hospital Value-Based Purchasing program, beginning in October 2012 (CMS, 2013). In an effort to reduce health care expense related to hospital acquired conditions and incentivise hospitals to prevent them from occurring, the Deficit Reduction Act of 2005 also required the Secretary of Health and Human Services to identify conditions that are high cost or high volume or both, which result in assignment of a case to a DRG that has a higher payment when present as a secondary diagnosis, and could reasonably have been prevented through the application of evidence-based guidelines. As a result, in 2008, the Inpatient Prospective Payment system 2009 Final Rule included 10 categories of conditions that were selected for the Hospital Acquired Condition

(HAC) provision, meaning hospitals were not able to bill for costs related to the 10 categories of conditions. Since 2008, the category list has continued to be expanded (CMS, 2012). And to drive healthcare towards the adoption of information technology, Congress passed in 2009 the American Recovery and Reinvestment Act, incorporated Title XIII, known as the Health Information Technology for Economic and Clinical Health Act (HITECH). The act established incentive payments under Medicare and Medicaid programs for providers and hospitals that demonstrate meaningful use of certified electronic health record technology (ONC, 2013). The development of Accountable Care Organizations (ACO) was supported through the Patient Protection and Affordable Care Act of 2010. In an ACO, a network of physicians and other providers share a financial incentive to control costs and improve quality by closely coordinating care (DHHS, 2012).

Federal initiatives have focused on the accumulated data on the current state of healthcare delivery and identified recommendations for Congress, healthcare organizations, professional organizations and individual providers. The legislation passed has created a means to incentivise healthcare organizations to reduce waste and focus on quality outcomes. Organizations need to identify and implement successful change processes or suffer financial penalties.

Management Solutions

These calls to action for change by the IOM and Congress, have been further supported by research and initiatives by hospitals, other organizations, and industry experts. Mayer and Jensen (2012), describe the importance of the business case for patient flow. They defined patient flow as "the ability to consistently and predictably add value and eliminate waste as patients move through the network of service transitions and sequential queues of healthcare" (Mayer & Jensen, 2012). They further described that the constantly "changing interplay"

between the demand for patient services and the capacity of resources available and ready to meet the demand must be understood if successful flow is to be achieved. In 2012, The Joint Commission (TJC) also issued a report directive, the *R3 Report* (2012*)*, regarding patient flow stating that hospitals must manage the flow of patients throughout the hospital and that the hospital must measure and set goals for the components of the patient flow process. Leaders are required to take action when the goals are not achieved. TJC recognized the boarding of patients in the emergency department, that is the holding of a patient who has been identified as requiring inpatient admission but remains in the emergency department due to capacity constraints, is a risk for patients and that the emergency department is generally not the source of the problem, rather the issue is a hospital-wide patient flow issue (TJC, 2012).

There are numerous transformational strategies promising healthcare organizations improvements. Vest and Gamm (2009) stated three of the most well known are: Six Sigma, Lean/Toyota Production System, and Studer's Hardwiring Excellence. While there are many articles and books referencing all three strategies, few studies have been rigorous enough to ensure the validity of the conclusions and demonstrate stustainablity (Vest & Gamm, 2009). Yet in spite of a lack of rigorous studies, many hospitals world-wide have experienced success by applying such strategies. Probably the most well known case is Virginia Mason (Kenney, 2011). Virginia Mason adapted the Toyota Production System to create the Virginia Mason Production System (VMPS). By utilizing the VMPS, the nursing staff were able to re-organize their work and work environment resulting in increased time spent by staff at the bedside, decreased patient falls, decrease in skin breakdowns, decreased incidence of call-light usage as needs were anticipated before leaving the patient room, and an 85% reduction in amount of distance a nurse walked during the shift thereby decreasing overtime by 2% (Nelson-Peterson & Leppa, 2007). Emergency Departments often struggle with issues around overcrowding and boarding of admitted patients due to hospital capacity contraints, causing significant delays in care and

extended length of stay. Lean has also shown to be effective in reducing hospital length of stay and increasing patient satisfaction in spite of increased patient volumes (Dickson, Singh, et al., 2009; Dickson, Anguelov, et al., 2009).

Several articles in the literature discussed measuring the outcomes achieved by various alterations in patient flow, particularly in the emergency department. Examples of strategies include split flow, fast track, team triage (Oredsson et al., 2011), immediate bedding, and placing a provider at triage (Love et al., 2012). Most studies yielded mixed results with several factors potentially impacting outcomes such as differences inherent in how the strategies were implemented, level of effort and resources applied to implementation, characteristics of the organization and the magnitude of the emergency department crowding (McHugh et al., 2013).

Also noted in the literature were research studies which demonstrated the use of simulation (Raunak et al, 2009) or modeling (Wiler, Griffey & Olsen, 2011) as a decision support tool to predict the outcomes of various proposed process improvement initiatives in order to determine the most effective changes (Montgomery & Davis, 2013). Bellow, Flottemesch and Gillespie (2012), applied a previously developed ED Census Model to analyze census patterns, design efficiency, and operational efficiency. The researchers were trying to determine if a trigger value existed at which throughput time would start to dramatically decrease because of crowding. A limitation of the Bellow et al study was the insufficient patient level data available as well as the reliability of the throughput data (Bellow, Flottemesch & Gillespie, 2012).

A few hospitals have chosen a very comprehensive approach to patient flow with strong top-down leadership support and dedicated resources to the function of flow in a hospital. Resources and strategies may include daily huddles; case management (Enriquez et al., 2009); and centralized transfer center, transport, and bed management (Sweeney, Meisner & Johnston,

2012). Outcomes noted from the studies utilizing dedicated resources included improved care coordination, improved hospital capacity and increased hospital revenue.

Management solutions include a variety of methods for process change, leveraging data and re-structuring of workflows. Success has been varied with an important correlation to leadership and resource commitment by the healthcare organization. One element missing from current management solutions is the availabiliy of real-time data to support efficient process flow.

Technology Solutions

In nearly every process change, technology is used to some degree to support the process, often through the supply and analysis of data. In reviewing the literature specifically around the use of RTLS in healthcare process change, few studies were found. Veterans Health Administration, a leader in cutting-edge approaches to efficiency and effectiveness in healthcare delivery, published a paper on the use of discrete event simulation and real time locating systems as a combined technology solution for process improvement (Day et al., 2012). These two tools were used together for patient flow analysis in an opthamology clinic and operating room setting. The RTLS solution along with disrete event stimulation improved processes and allowed users to identify, evaluate and mitigate barriers in health care delivery. The authors suggested the solution showed promise in assisting systems redesign intiatives across the health care spectrum.

Gap in the Literature

There is very little in the literature that specifically addresses the combined solution of Lean and RTLS in healthcare. However, one study by Chongwatpol and Sharda (2013) demonstrated the use of radio frequency ID (RFID) with Lean strategies in manufacturing. The study

confirmed that implementing Lean and RFID practices reduced some of the waste and improved visibility.

While there is limited research available specifically around the successful adoption of RTLS, there is a body of research regarding the adoption of enterprise resource planning (ERP) systems, electronic health records (EHR), and information technology in healthcare. From reviewing the literature regarding success, or lack of success, in ERP implementations, some important correlations can be made. According to Basoglu, Daimb and Kerimogluo (2007), enterprise resource planning systems are systems that coordinate activities, decisions and knowledge across many different functions, levels and business units. Examples of ERP systems are SAP, PeopleSoft, Oracle, and Microsoft Business Solutions. They are considered key to achieving competitive advantage and are considered an enabling technology to build and support social and intellectual capital within an organization (Basoglua, Daimb & Kerimogluo, 2007). However, implementations of ERP systems have a very high rate of failure and cost overruns. Studying the difference between successful and unsuccessful implementations of ERP systems provides critical insight into factors for success and provides an empirical basis for how best to implement a technology such as RTLS.

The first element to successful implementation of an enterprise solution, such as RTLS, is support from top organizational management (Basoglua, Daimb & Kerimogluo, 2007). The organization must be ready to engage actively in the use of the technology and to support and promote engagement throughout the organization. Communication of this support throughout the organization will send a message to everyone to "get on the bus". A spirit of innovation within the organization also creates an atmosphere of adventure and participation by all staff in creating the end solution. Transformation of process is required for full optimization of a new technology. Organizational transformation involves alterations in practices, process and

culture. Transformation requires the support and leadership from top management for success (Vest & Gamm, 2009).

The second element to success is how good the fit is between the chosen system and the organization. The selected technology system must be in alignment with key organizational strategies and business processes (Basoglua, Daimb & Kerimogluo, 2007). For example, if a key strategy is to improve patient flow, then the system must be able to monitor and report on all patient movement and patient-staff interactions. The new technology must also have the capability to integrate processes across departments and entities within the enterprise.

Thirdly, user adoption and avoidance of user resistance is the final critical element to success. Factors that have been shown to relate directly to user adoption of a new software application are: system quality, information quality, use, user satisfaction, individual impact and organizational impact (Basoglua, Daimb & Kerimogluo, 2007). In addition the usability characteristics of the software interface, its perceived usefulness and ease of use are all related directly to user adoption (Dixon, 1999). The better the fit and overall alignment between the technology, task to complete, user environment, strategy for use and individual characteristics, the better is the system performance, user engagement and satisfaction (Basoglua, Daimb & Kerimogluo, 2007). If there are too many steps for a nurse to go through, or the system is not very intuitive to follow, a user will not bother using a new technology such as RTLS to gain information about the flow of patients through their department, no matter how useful or timesaving it has the potential to be.

Today's environment requires healthcare organizations to align clinical, financial and operational priorities into a unified focus to quality care at lower cost. Strong top-down leadership has been identified as key characteristic of organizations successful at transformation. A common theme in the research to the success of any strategy is engagement of

the workforce and overall commitment of leadership to the transformation (Dickson, Anguelov, et al., 2009). Process change methodologies, such as Lean, which leverage technology, support the delivery of care that is safe, effective, patient-centered, timely, efficient, and equitable.

The gap that exists today, is the need for a model or combined methodology that brings together the essential elements needed for successful transformation. By empowering healthcare organizations with a model outlining the strategies of process change methodology, real time data, leadership and engagement, organizations can move forward with a greater understanding of how to utilize these tools to achieve the desired results.

Theoretical Framework

The primary theoretical framework for this project is Margaret Newman's theory of *Health as Expanding Consciousness* (1994). Newman's theory describes health as the pattern of the whole and views disease not as a separate entity but as a manifestation of the evolving pattern of person-environment interaction. In her model, Newman describes consciousness as the individual's information capability and capacity to interact with the environment. Health is defined as a unitary pattern of the whole and includes both disease and non-disease or health. The health pattern encompasses the evolving human and environment interaction process (Newman, 1994, pp.112-116).

Use of Newman's theory involves a paradigm shift from the traditional treatment of an individual's symptoms to a search for patterns and from viewing disease and crisis as negative to viewing them as a part of the self-organizing process leading to higher consciousness (Newman, 1997). The degree to which an individual interacts with the stressor event determines how disabling it will be. If the individual fights the stressor, he in essence, fight against himself, which increases the occurrence of physically related changes. If however, the individual can be open to the feelings evoked by the stressor, this allows the energies to pass through the

individual. When the individual is able to let go of the need for personal control, his or her life is de-stressed and the person is able to achieve a greater acceptance and response to the event (Newman, 1994, pp.107-109).

The role of the nurse, as suggested by Newman, is to enter into a partnership with the client when he or she is experiencing disruption and uncertainty, such as during a life-altering event or the challenge of chronic disease. The mission of the nurse is to help the client find meaning in the evolving process. Newman states "the nature of nursing practice is the caring, pattern-recognizing relationship between nurse and client relationship that is transforming presence" (Newman, 2008, p.52). A dialogue ensues between the nurse and the client, assisting the client to gain insight into the client's pattern during the period of uncertainty until the client's pattern shifts to a higher order after which the nurse and client move apart (Newman, 1994, pp.112-116). The stage of uncertainty is an important transition from one perspective of life to one at a higher order (Newman, 2008, pp.29-30). Part of the process is the insight a participant gains as patterns of recognition occur, and with pattern recognition the illumination of action possibilities. The nurse through this experience also emerges at a higher level of consciousness by engaging in the relationship (Newman, 2008, pp.71-72).

In this project, rather than the nurse-patient relationship, Newman's theory of *Health as Expanding Consciousness* (1994) is applied to the healthcare system and it's processes for delivery of services to patients. Use of Newman's theory in this manner will assist to acknowledge and incorporate the importance of nursing presence for a successful transformation utilizing the Lean RTLS model. In this project, Newman's theory of presence will be applied to individuals and the healthcare process transformation. At the very essence of Lean, is the critical importance of engaging those who do the work in the process of creating change. The healthcare team is comprised of many professions including nursing, medicine, pharmacology, radiology, lab, respiratory therapy, physical therapy, materials management,

clinical engineering, equipment management, transport, admissions services, medical records and information technology. All members of the team play a role in the delivery of services to the patient. The nurse, utilizing Lean as a transformation tool, will need to be present and engaged with all team members to support the transition from their current state to a higher future state. Similar to a nurse working with a patient during a crisis event, the nurse engaged in the Lean process will support the other staff members to find meaning and insight during the evolving process. For example, consider Lean applied to a process transformation around the triage in the emergency department. The nurse, engaged with the other staff members involved in the process, can assist them in identifying the patterns of responding to the triage workflow the staff have developed over time. Through the course of the dialogue, the other staff members begin to develop an awareness of the existing patterns and how the patterns are affecting the process and how those patterns may be changed to be more effective. The nurse assists the other staff members to achieve a higher state of understanding and response as well as emerging at a higher state of consciousness as an individual. The nurse will continue to come together with the other staff members as they incorporate the new patterns into their daily work.

Background for Proposed Model

Lean methodology is the basis for the design of the Lean RTLS model for nursing in healthcare. The primary resource used in this paper to outline the Lean methodology is Jimmerson. Jimmerson has written several books (2006, 2008, 2010) that provide a very clear, step-by-step description of Lean methodology for healthcare process change leaders. In addition, Jimmerson was the principle investigator for a grant awarded to Montana State University by the National Science Foundation in 2000 to explore the possibility of using concepts and practices of the Toyota Production System in a healthcare setting (Jimmerson, 2010, p.xiii). Jimmerson outlines six steps when utilizing Lean to address an issue in healthcare.

The six steps are:

1. Define the issue or problem: identify the process that is failing to meet the desired outcomes or meet the request with a quality outcome or product. The process must be one of importance or value to the patient, the organization and the worker and therefore worthy of resources dedicated to improvement efforts (Jimmerson, 2010, p.33).
2. Value stream map (VSM) current process: provides a visual drawing of each step of the current process beginning with the initial request. The request is best framed in terms of a need the patient has for a service. Each process step is identified as a box along with all the activities included in the process. Actual processing time, along with delay interval, or wait time, when nothing is happening is indicated for each step. To assure accuracy of the current state VSM, observation of the process activities is often done by measuring the start and stop time of each process step and delay intervals in reaching the next step. The lowest number reflecting the shortest amount of time needed to complete the step is noted on the VSM as well as the highest number reflecting the most time used to complete the process step activities. An average time is then determined for the process step and delay intervals and noted on the VSM (Jimmerson, 2010, pp.34-44). When completed, the average time for all the process steps are totaled and divided by the total average time for all process steps and delay intervals. This percentage calculation is the value quotient, or how much of the total time was actually spent in process time. The value quotient provides a metric for measuring waste in the process. The goal in entering the next Lean step, designing the desired future state, is to eliminate waste, or the non-value added time, and increase the value of the patient's experience (Jimmerson, 2008, p.28). Figure 2 shows a Current State Value Stream Map on the issue of ambulatory care visit delays (Jimmerson, personal communication, 2013).

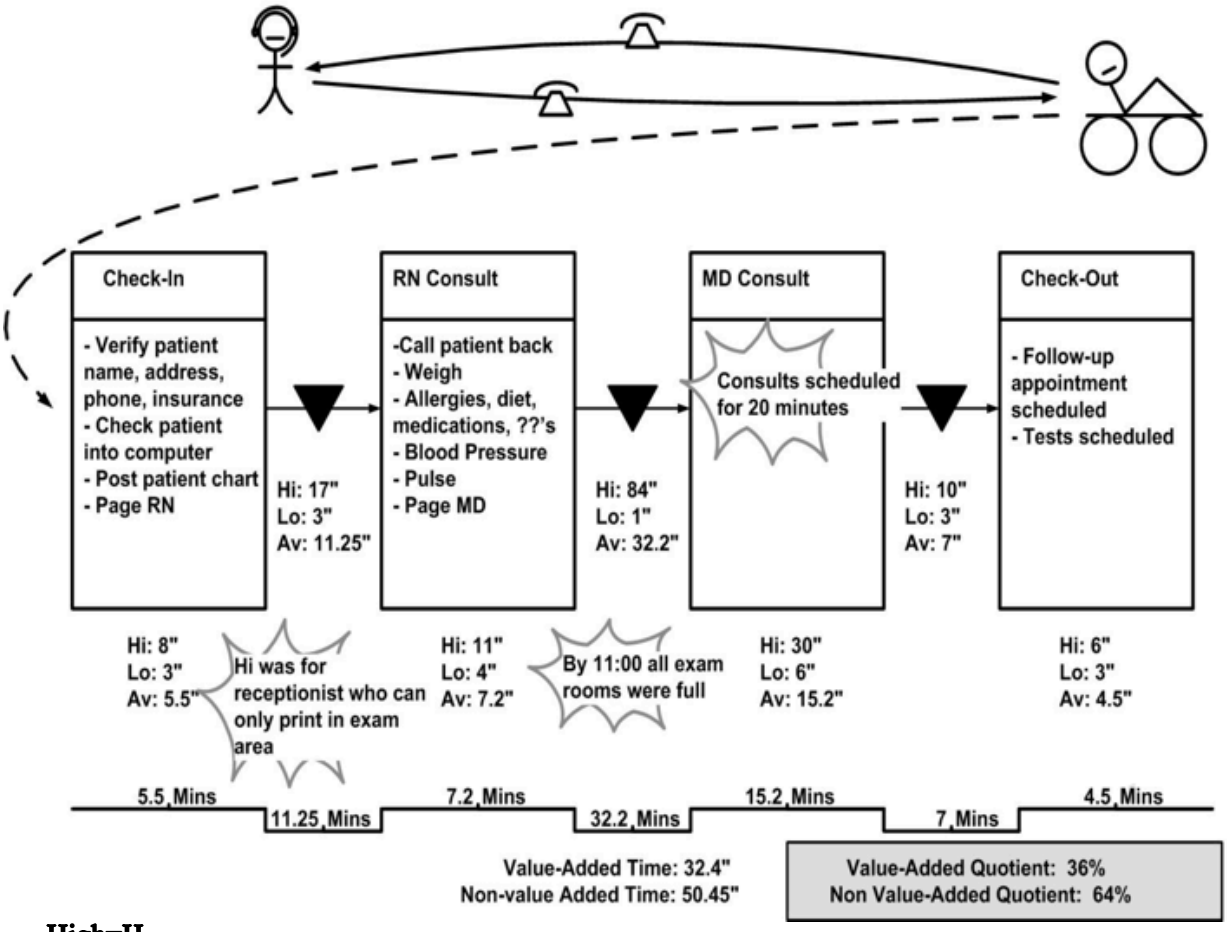


Figure 2. Current State Value Stream Map on Issue of Ambulatory Care Visit Delays

3. Value Stream map of desired future state: provides a visual drawing of each step of the target process beginning with the initial request by the patient. Desired future state must be achievable and move the process closer to an ideal state. The ideal state is not always an achievable goal in the initial transformation of a process but should always be the end objective. In re-designing a process, consideration should be given to which steps and activities can be eliminated, reducing the number of ways a step can be completed, and standardize the activities and time for each process (Jimmerson, 2010, pp.45-58).

Average process and delay interval times are projected and used to calculate a new desired value quotient (Jimmerson, 2008, p.32).

4. Future state plan: outlines what needs to be accomplished in order to achieve the new desired future state. With each task, a projected timeline, accountability and anticipated outcomes are identified. A significant process re-design may contain many components to address. Each component area is identified and pulled out as a unique issue and addressed through the A3 Problem Solving method (Jimmerson, 2010, p.52). A3 is structured problem solving using an 11 inch by 17 inch piece of paper known as "A3" in areas outside of the United States. According to Jimmerson, A3 organizes problem solving into current status and future state components through the following steps (Jimmerson, 2007, pp.35-49):
    - Issue – the issue being addressed utilizing A3.
    - Background – provides information regarding what is the problem being solved and why it has been an issue.
    - Current Conditions – a diagram outlining the current process flow with commentary indicating barriers to process. Barriers are indicated utilizing storm clouds.
    - Problem Analysis – analysis of why things happen as they currently do until you identify the root cause of the problem. In A3, it is often recommended that "why" should be asked five times in order to identify root cause.
    - Target Condition – is the proposed better way to accomplish the work and complete the process step. The new workflow diagram includes commentary describing the new process activities.
    - Countermeasures-are the changes that must occur in order to move from the current state to the target condition. These measures define the tasks

intended to counter the barriers or storm clouds and their root cause identified in the current condition and problem analysis steps.

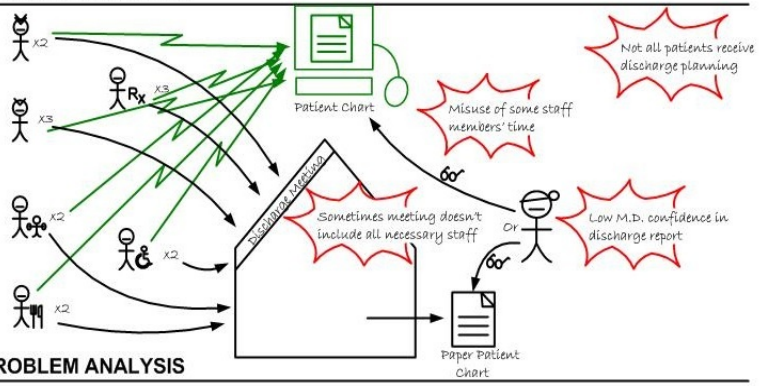
- Implementation plan – establishes the tasks that need to happen, the individual accountable for the task, when it needs to be completed, and the expected outcome of the task. The plan is meant to keep all involved in the project on task to assure successful completion.
- Cost/Benefit/Waste Recognition-summarizes the return-on-investment (ROI) for the process re-design. Costs include any expenses in resources and materials to implement the plan. Cost benefit and waste recognition itemizes the estimated savings in terms of product and staff time through the process re-design. Hours of staff time saved, along with probable salary costs, should be estimated. In addition, estimations for changes in patient satisfaction ratings, clinical outcomes, patient safety, staff turnover, staff injury, throughput and length of stay times along with associated revenues or savings should be included.
- A Test – is performed to determine the success of the new process prior to formal implementation. This provides an opportunity to make any adjustments or refinements to assure success.
- Follow-up - assures someone is accountable for ongoing review and evaluation of the new process in order to document progress as well as opportunity for further improvement. The data collected during follow up defines the new current condition or state.

Figure 3 is a completed A3 tool on the issue of discharge rounding (Jimmerson, personal communication, 2013). The figure is reduced from an 11" x 17" format and is meant to give a general view of A3 problem solving process rather than specific content.

ISSUE Not all patients receive complete discharge planning.

BACKGROUND Discharge rounding is done in meetings with staff from all necessary departments on Mondays and Thursdays. 14 people attend the meetings, with an average wage of $55/hour. Meetings are an average of 1.5 hours long. 14 x $55 x 2 x 52 weeks = $80,080/year spent on discharge rounding meetings.

CURRENT CONDITION

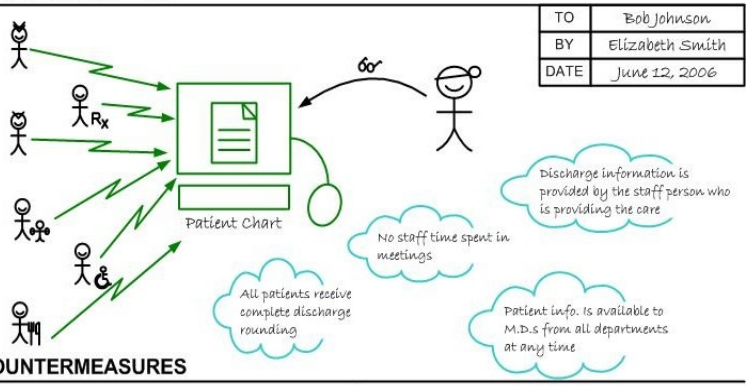


PROBLEM ANALYSIS

1. Sometimes discharge meeting doesn't include all necessary staff.
   - Why? Attendees of meetings are not always the ones who have been treating the patient.
     - Why? Representatives are sent from each department.
       - Why? Everyone from the department are at work and not available at the same time.
2. Not all patients receive discharge planning.
   - Why? Some patients check in and check out before they receive it.
     - Why? Discharge rounding is only done on Mondays and Thursdays.
       - Why? Staff can't be taken away from work every day.
3. Meeting is a misuse of some staff members' time.
   - Why? Staff members have to sit through the review of patients that they have not treated.
     - Why? Not all patients receive care from all departments present at the meeting.
       - Why? It is not always necessary.
4. There is low M.D. confidence in the discharge report.
   - Why? Discharge report is sometimes incomplete.
     - Why? The discharge report was not created by all the people who cared for the patient.
       - Why? Not all the staff was present at the discharge meeting.
         - Why? All the staff is not available to attend meetings.
           - Why? It would take too many people away from direct patient care.

TARGET CONDITION

TO	Bob Johnson
BY	Elizabeth Smith
DATE	June 12, 2006



COUNTERMEASURES

1. Create a discharge screen in computer chart notes for all departments and M.D.s to access.
2. Educate staff on new discharge rounding process.

IMPLEMENTATION PLAN

What	Who	When	Outcome
Meet with staff to determine what info. is necessary on discharge screen	Elizabeth	June 15	Discharge rounding screen criteria created
Meet with IT staff to create new discharge screen	Elizabeth	June 20	Comprehensive screen completed and online
Orient Staff	Elizabeth/ IT	June 30	All staff understands new process and can use the new screen.

COST / BENEFIT

Cost	$$$
In-house development of discharge rounding screens	12 hours x $50 = $600
Benefit	**$$$**
Staff time saved from meeting elimination	$80,080
All patients receive accurate and timely discharge planning	Improved patient care

TEST

Each department uses the new screen in test mode for one week. Staff reviews discharge page and evaluates it for accuracy and quality of patient's discharge plan.

FOLLOW UP

New discharge planning screen has been used successfully for six months with the orthopedic staff. The same discharge rounding system will be implemented hospital-wide over the next two months.

Figure 3. Completed A3 on the Issue of Discharge Rounding

5. Implementation: encompasses the combined series of A3 problem solving projects with a timeline for the duration of each A3 as a progression towards the desired future state (Jimmerson, 2010, p.55).
6. Evaluation: is the ongoing monitoring of project outcomes, metrics related to cost benefit and waste reduction, as well as project success and sustainability. Opportunities for enhancement of the project should be identified and may require additional A3s in order to implement. A new current state map depicts the new process (Jimmerson, 2010, p.55).

Lean methodology also provides some additional guiding principles and concepts for use during transformation. Spear and Bowen (1999) defined four rules fundamental to the success of the Toyota culture of work. These rules illustrate the structure yet fluidness key to the success of Lean. They are:

- Rule 1 addresses how people work: Clearly specify all activities of work including content, sequence, timing and outcome.
- Rule 2 addresses how people connect: All steps in a request for a product or service are simple and direct with clear connection to send requests and receive reponses.
- Rule 3 addresses the work flow: The flow of steps to deliver a request for service or product is simple and direct.
- Rule 4 addresses how to improve: All problems are addressed on a timely basis, in a scientific manner under the guidance of a coach, at the lowest possible level in the organization (Spear & Bowen, 1999).

Value added versus non-value added is another core concept in Lean. The value of a product or service must be defined from the customer or patient's perspective. According to Graban (2012, p.34), to be considered value-added,

- The patient must be willing to pay for the activity or service.
- The activity serves to move the patient from one state to another, in the direction of the desired final state.
- The activity must be performed correctly the first time.

If the activity is not of value, it is considered non-value added. Waste is therefore considered non-value added as it fails to meet the criteria for value-added.

Standardization of work and the work environment is also fundamental for Lean. Standardization serves to assure staff are completing a task in the best way possible with the right high quality outcome, using the fewest resources. It also promotes patient and staff safety and eliminates the opportunity for error (Graban, 2012, pp.67-70). The 5Ss are a set of strategies utilized in the work setting to create an environment that supports the process, the caregiver and the patient (Jimmerson, 2008, p.61). The 5Ss are:

1. Sort. Keep only supplies and equipment that are being used. Remove everything else.
2. Straighten. Identify a place for everything and keep it in its place, making it as visual as possible.
3. Shine. Clean the work area and all equipment, furniture and floors in the space.
4. Standardize. Systems and procedures should be developed to assure conformance of the first three Ss. If there is a consistent work area such as a medication room in multiple departments, each should be standardized in the same manner.
5. Sustain. Make it a habit to review of the workplace routinely (Arthur, 2011, p.36).

Lean provides a clear and structured methodology to use for implementing change in health care yet one that allows for flexibility to address multiple types of scenarios and use cases.

Real time location systems (RTLS) is the technology tool used in the Jagim Lean RTLs Model to provide the real time functionality needed for the model to be an effective

transformation tool. RTLS is a term used to describe an emerging technology that utilizes active wireless tags attached to objects or people to identify and locate them within a building or contained area in real time through a network of fixed reference points. The physical component of an RTLS system generally uses some form of radio frequency, but may also utilize infrared, ultrasound, Wi-Fi, GPS, ZigBee, passive RFID or ultra wideband (Malik, 2009,p.50). Technologies can also be combined to meet multiple objectives around ease of deployment and accuracy, such as combining Wi-Fi and infrared. The RTLS reference points, which can be either transmitters or receivers, are spaced throughout the building or area to provide the desired coverage. Systems that use technologies that do not go through walls, such as infrared or ultrasound, tend to be more accurate in an indoor environment because only tags and receivers that have near or line of site can communicate. The information gathered from the physical network is transmitted to a software user interface where varying levels of logic can be applied to provide meaningful information to a user regarding time and location events (Malik, 2009, pp.52-53). The physical RTLS network and software can be part of an all-in-one system or an integrated system.

There are three primary types of system design: locating using choke points, locating based upon relative coordinates, and room-level locating. Locating at choke points is where short-range ID signals from a moving tag are received by a single fixed reader in a sensory network, indicating the entry of a tag into the same location as the reader. Alternatively, locating at choke points also includes when a moving tag receives a choke point identifier and relays the information to a location processor. Accuracy is dependent upon the range of the choke point transmitter or receiver (Malik, 2009, pp.113-117). Locating based upon relative coordinates is used when a tag's ID signal is received by multiple readers in a sensory network and a position is estimated based upon one or more locating algorithms. Conversely, it can also occur when ID signals from several RTLS reference points are received by the tag and relayed back to a location

processor. Technologies that utilize relative coordinates can be impacted by obstructions in the environment such as walls and furniture (Malik, 2009, pp.189-211). Room-level locating typically utilizes either infrared or ultrasound transmitter unique to each room. The room-level, or sub-room level, device emits the location ID and is received by the tag that in turn transmits its location through radio frequency to a receiver (Malik, 2009, p.138).

The RTLS software user interface receives the tag location updates in real time and provides meaningful association of the information for users. For example, tag #1 is associated with Mary, RN, who has entered Exam Room A at 2:00pm. RTLS software systems have varying capabilities of business logic and are always dependent upon the physical RTLS hardware and level of accuracy. Capabilities may include:

- Search and locate by type or unique item or person. Example: locate Mary, RN or nearby available infusion pump.
- Identify the interaction between two tags. Example: a nurse rounding on a patient or the entry of piece of equipment into a patient room with a patient in it indicating utilization of the equipment.
- Maintain a count of items in a location. Example: a par level of infusion pumps in a clean utility room and alerting when the count drops below par.
- Event alerts. Example: a computer laptop enters a hospital exit or a patient elopes.
- Button press alert. Example: a staff or patient presses a tag button requesting assistance or indicating the patient or staff member is in distress.
- Measure patient throughput times. Example: door to triage, door to room or length of stay in an emergency department.

RTLS systems may also offer additional functionality such as temperature monitoring of refrigerators, freezers, warmers and locations; hand-washing compliance through proximity to

dispenser; messaging features; reporting tools; and integrations to mobile devices, nurse call systems, bed management systems, and electronic health records. Most systems provide data in a text form and also a map view for a more visual display of information. In addition, RTLS can be used in combination with RFID technology. RFID technology in healthcare is primarily used to support supply chain automation and real-time inventory of vital expensive consumables such as heart stents, implants, bone and tissue. Potential use cases for RTLS are:

- Asset management to include locating, utilization, distribution, clean processing time, maintenance time, loss prevention, rental usage and purchase avoidance.
- Staff safety including locating and personal alert activation.
- Patient safety including locating, personal alert activation, fall reduction and hand hygiene.
- Emergency response including the locating of staff, patients and critical resources as well as monitoring numbers of patients by acuity in all treatment areas.
- Throughput management including measurement of times patients reach specific milestones, length of time a patient is in a milestone or waiting for care, capacity monitoring, measuring operating room occupancy, and measuring patient room cleaning times.
- Automated communications based upon time and location events including notifications regarding patients waiting, capacity alerts, need for cleaning or bed available status, abandoned equipment in hallways, out of compliance temperature readings, and patients needing transport.
- Auto-recognition of staff when entering a patient room with corresponding display of staff name and photo on patient's television screen or auto-login the staff member into a bedside computer.

- Patient rounding documentation and notification when a patient is not seen within specified time frame.
- Infectious disease exposure identification of all staff and patients in the same location as someone diagnosed with an infectious disease.
- Home activity monitoring corresponding with vital signs monitoring allowing patients to remain in their home yet still be continuously monitored for clinical events.
- Elopement and infant abduction prevention.

CHAPTER 3. MODEL DEVELOPMENT

Project Design

The Lean RTLS project involves the development of a new healthcare model that combines the management methodology of Lean with the visibility, data and tools of real time location systems. The new model will support the attainment of improved, standardized and sustainable outcomes. The Jagim Lean RTLS Model for Healthcare will serve to further the elimination of waste and improve the timely delivery of important pieces of information to staff who have been empowered to take action based on the information at hand.

During the development phase of the project, the Jagim Lean RTLS model was designed and evaluated. Subject matter experts were recruited to perform an evaluation of the model using a tool developed to address the accuracy, effectiveness and value of the model. Included with the evaluation tool was a sample scenario illustrating how the new model could be applied. The resulting sample design demonstrated the use of the model in a healthcare setting to optimize the benefits for an overall stronger solution and improved outcomes.

Strength of Visibility

Many of the potential uses and capabilities of RTLS align well with process issues Lean methodologies address. Envisioning the expanded capacity for efficiency by eliminating waste that can be accomplished by incorporating the data and tools of RTLS into Lean methodology, leads one to realize how powerful the union of the two strategies becomes. Table 1 provides examples of some of the ways RTLS could be utilized during the different steps of the Lean process. This table also incorporates the role of nursing in each phase. The table is not meant to be all encompassing, but rather to provide some of the primary examples.

Table 1. Lean methodology steps aligned with supporting RTLS functions and nurse presence

Lean Methodology	Supporting RTLS Functions	Nurse Presence
Define the Issue or Problem	Provides real time data to more accurately define the scope of an issue. Examples: key milestone times/measures; how often capacity is exceeded; minutes of time patients wait for care: how long it takes infusion pumps to be cleaned; and utilization of resources.	Engaging with others on healthcare care team involved in doing the work to determine the issue and pertinent background information. Utilize data sources to determine baseline metrics data related to issue. Identify impact on patient service.
Value Stream Map of Current Process	Measure process time as well as delay time. May be used in combination with direct observation Replay on a screen map of a staff and/or patient scenario to show process steps and process delays.	Engaging with others on healthcare care team involved in doing the work to map current state. Define the value stream from perspective of a patient request. Participate in observation studies. Analyze data provided from both observation and RTLS. Ask additional questions of staff to understand cause of waste in process.
Value Stream Map of Desired Future Process	Provides visibility into what is occurring 24/7 regarding locations, process and capacity in real time. Eliminates staff time spent searching for items/people. Reduces/eliminates overproduction due to visibility of product availability and utilization. Identifies approaching limits and trigger alerts. Automates communications to drive actions to the next step in the process based upon location/time events as they occur in order to reduce wait/delay in process.	Engaging with others on healthcare care team involved in doing the work to determine ideal process. Utilize RTLS and related technologies to bridge gaps in data, communication, and awareness of key events – create visibility into the process and determine what key information needs to get to the right person at the right time to delivery service to patient and move forward in process.

Table 1. Lean methodology steps aligned with supporting RTLS functions and nurse presence (continued)

Lean Methodology	Supporting RTLS Functions	Nurse Presence
Future State Plan & Metrics	Standardize workflow by automating communications based upon objective monitoring of location/time events. Integrations with other systems to support documentation, patient safety, process flow. Continuous collection of real time data metrics to monitoring of events and processes.	Engaging with others on healthcare care team involved in doing the work to determine what systems and data need to connect in order to achieve future state.
Implementation	Incorporate access to data/tools in RTLS system into workflow steps. Utilize alerts and messages to notify staff when delays are occurring or impending. Notify staff when par levels of critical assets drop below or above the desired level. Utilize alert features to maintain a safe and uncluttered work environment. Automation of elements of the process reduce variability and support sustainability and standardization.	Engaging with others on healthcare care team involved in doing the work to break down the future state process into actionable A3 workflows. Utilize RTLS and related technologies to bridge gaps in data, communication, and awareness of key events – create visibility into the process and determine what key information needs to get to the right person at the right time to delivery service to patient and move forward in process.
Evaluation	Utilize data to evaluate process times, process delays, deviation from standardized workflow, and opportunities for workflow improvement.	Engaging with others on healthcare care team involved in doing the work to evaluate the new current process and success in meeting desired outcomes. Analyze the data and start to trend process times and key metrics. Identify impact on meeting patient need for service.Determine additional steps needed to meet desired future state.

The interaction of Lean and RTLS data can be bi-directional and continuous throughout all stages of Lean supporting nursing and other healthcare staff with the structure of Lean foundations along with the visibility and automation of RTLS.

The New Model

The purpose of the Jagim Lean RTLS Model is to create a framework for nursing that combines Lean methodologies with the tools of RTLS to transform care delivery. The opportunities are limitless. Yet without guidance, it is often difficult to see how the tools can be used to provide insight, data, automation, standardization and efficiency. This model is meant to contribute to the core knowledge of nursing regarding both Lean and RTLS and assists nurses to envisioning how to leverage these tools as powerful drivers of change to care delivery processes. The presence of nursing, both in transformational leadership, as well as in the day-to-day engagement in changing workflow and the patient experience, is critical to success.

There are three core concepts of the model (Figure 4). The concepts are Lean as a transformational methodology, RTLS as a visible and automatic tool to support Lean, and the presence of the nurse in the transformation process based upon Newman's theory of Health as Expanding Consciousness (Newman, 1994, p.115). Each of these concepts is strengthened by its relationship to the other two and all three concepts are interwoven at every stage of the model.

In the Jagim Lean RTLS Model, Lean provides the foundation for the transformation process. Lean incorporates a structured methodology for identifying the root cause of a current issue, understanding how it impacts the current process flow, determining the ideal process, the cost to implement the change/new process, and the benefit that will be gained when the new process is implemented. It also includes an implementation plan to move from current state to the desired future state which includes A3 problem solving, and evaluation of the plan's successes (Jimmerson, 2010). Lean focuses on keeping the flow of work and communications

simple and direct and on providing a consistent, quality delivery of a service (Jimmerson, 2010, p.13-17).

A critical component of the success of Lean is the engagement of the people who do the work. Nursing plays a critical role in many processes within the healthcare setting, and primarily those processes involving patients. Use of the Jagim Lean RTLS Model illuminates opportunities for nurses to play to a key role in healthcare delivery transformation. The model defines the role of the nurse as a central figure in transforming and engaging in a relationship with the other staff also involved in doing the work. Newman's theory states that through the engagement of the nurse, he or she can assist others to gain insight into the current patterns occurring and shift to a higher ordered state and an improved workflow. Through this experience, the nurse emerges with a higher level of consciousness and understanding and as a more knowledgeable and effective healthcare transformational leader (Newman, 2008, p.54-59).

RTLS offers the ability to visualize and gather information about time and location events in real time. Rather than the more typical snapshots of data gathered using manual methods or review of electronic health records, RTLS (a continuous flow of real time data) can be used in every phase of the Lean methodology. RTLS benefits include preventing waste, reducing costs, and optimizing operations (Maurno & Sirico, 2010, p.77). In addition, RTLS data, either alone or through integration with other technologies, can be used to trigger the automation of communications regarding the occurrence or absence of events in real time. The availability of this type of data can impact changes in healthcare in a major and significant way. Nursing leaders could then use this data to leverage its power to affect outcomes and to facilitate change.

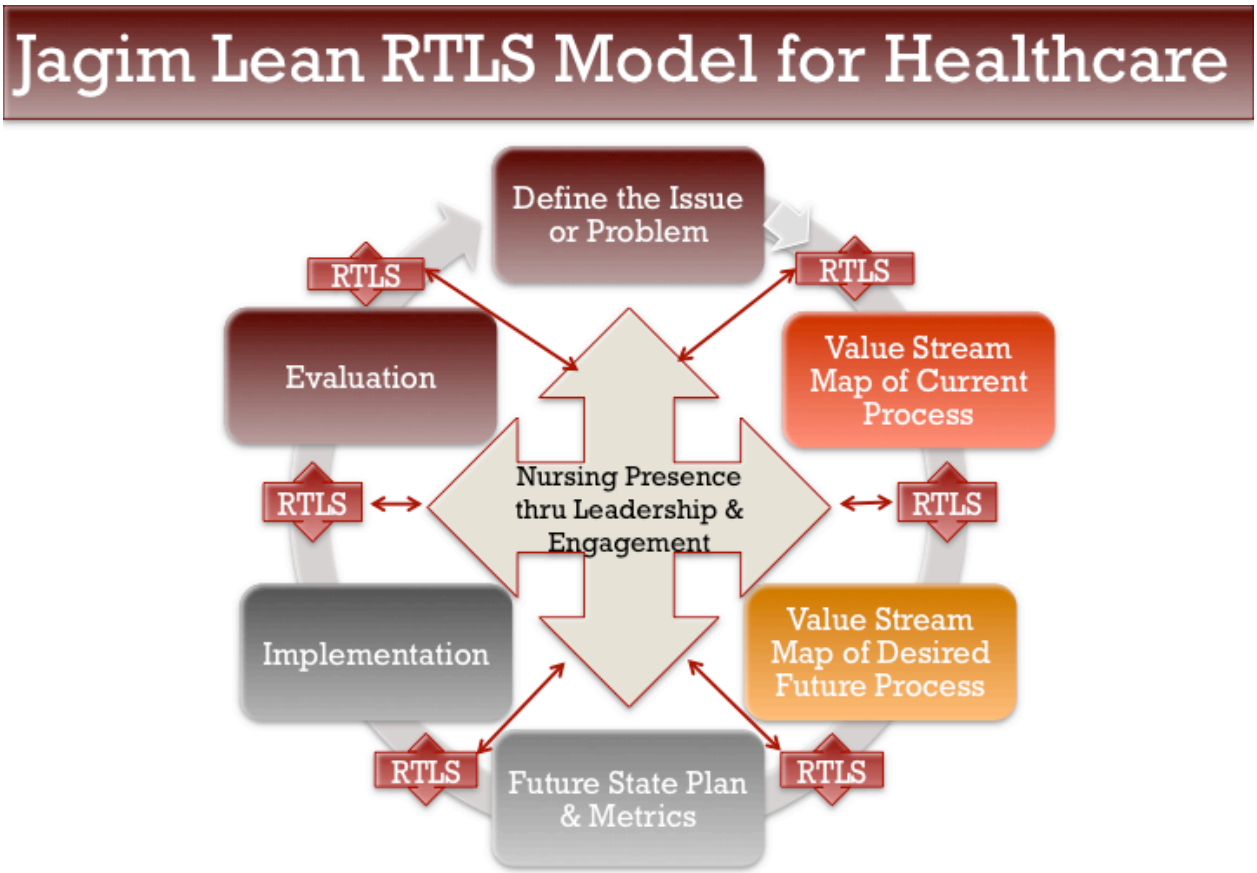


Figure 4. Jagim Lean RTLS Model

CHAPTER 4. METHODS

Evaluation of the Model

The Jagim Lean RTLS Model for Healthcare was evaluated by a group of subject matter experts in the areas of RTLS, Lean and hospital transformation leadership. The panel included the following:

- Cindy Jimmerson, President and Founder of Lean Healthcare West. Ms. Jimmerson initiated her Lean work with a grant from the National Science Foundation in 2001 and has been a long time leader in lean for healthcare.
- Susan Sheehy, PhD, RN, FAAN, FAEN, Associate Professor, Graduate School of Nursing and Family Nurse Practitioner Program, Uniformed Services University, Bethesda, MD. Dr. Sheehy is a nationally and internationally expert in emergency nursing and lean implementation.
- Mark Rheault, President of Infinite Leap. Mr. Rheault is an expert and entrepreneur in the area of enterprise visibility in healthcare through the use of RTLS.
- Clint Abernathy, Professional Services Officer, Texas Health Harris Methodist Hospital Alliance in Ft. Worth, TX. Mr. Abernathy is a Lean Six Sigma Black Belt with several years experience in the implementation of real time location systems in hospitals to improve efficiency and patient flow, reduce waste, reduce costs and support staff workflow.

Each expert reviewer was asked to evaluate the model based upon a set of criteria. The evaluation criteria were designed to evaluate the model's origin and underlying principles, meaning, logic, usefulness, generalizability and testability. The evaluation criteria were based upon suggested evaluation strategies of nursing theories (McEwen & Wills, 2011, p.95-113).

Evaluation Tool Criteria

1. Origins of the model

- What is the origin of the problem with which the model is concerned?
- What methods were used in the model development (induction, deduction, synthesis)?

2. Meaning of the model

- What is the character of the subject matter dealt with by the model?
- Does the model provide a blueprint for use in addressing healthcare issues?
- Does the title of the model reflect its purpose and content?

3. Logical analysis of the model

- Is the model logical?
- Is the model complete in terms of subject matter and perspective?
- Are the relationships among the model components made explicit?

4. Determination of model usefulness

- How would the model be practical and useful to nursing?
- How would the model be practical and useful to healthcare?
- Does the model contribute to understanding and predicting outcomes?
- Is the model appropriately applied to the described use case? Is the application logical?

5. Generalizability of the model

- Does the model guide healthcare practice?

- Does the model contribute to the body of healthcare knowledge?

6. Testability of the model

- What further testing opportunities are generated by the model?
- Can the model be supported by test data?

Applied Scenario

To demonstrate how the model would work, it was applied to a case study of a patient who presents to the emergency department (ED) and is then admitted to the operating room (OR) for a surgical procedure prior to transfer to an inpatient bed. The ED-OR patient flow example is a common scenario in an emergency department setting and involves many interfacing steps between different departments and processes, providers, and systems. The case study is formatted using the defined steps of Lean methodology. The examples below are not meant to be all-inclusive, but to give examples of how the model components could be applied.

Defining the Issue: patient delays in care

- Lean-provides the structre to identify the underlying cause of the issue and any process delays in patient care.
- RTLS-allows for real time data collection of all patients, staff, and equipment in the issue.
- Nurse – engaged in defining the issue and underlying cause.

Value Stream Map of Current State

- Lean-provides the structure to create a “map” of the current state, steps in the request for a product or service, steps in the delivery of the service, and the identification of non-value added process steps or time.

- RTLS-allows for real time data collection of all patients, staff, and equipment involved in the issue. It can be combined with direct observation of specific processes, such as the patient door-to-triage-to-room process for a given patient, in order to further define process delays.
- The Nurse-who is fully engaged in the process and provides input regarding identified patterns.

Figure 5 Shows the patient process steps and interface of the three model components during the Current State Mapping phase of Lean.

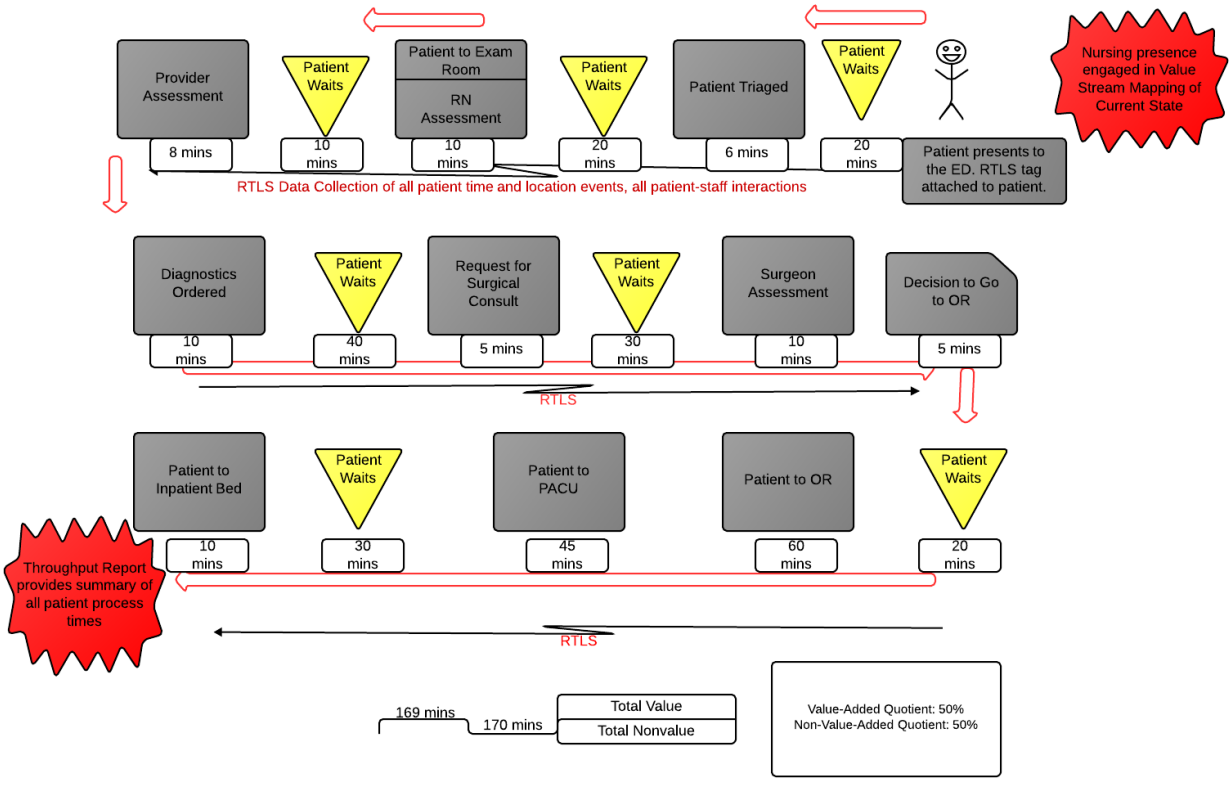


Figure 5. Model Applied to Current State Mapping Phase of Lean

Value Stream Map of Future State

- Lean-provides the structure for mapping future state and identifying non-value added time.
- RTLS-provides real time location and automation to streamline process steps and reduce non-value added time; RTLS leverages the data into actionable events to drive process steps and reduces non-value added time.
- Nurse-fully engaged in the process and provides input regarding opportunity for a higher ordered process.

Figure 6 shows the patient process steps and interface of the three model components during the Future State Mapping phase of Lean.

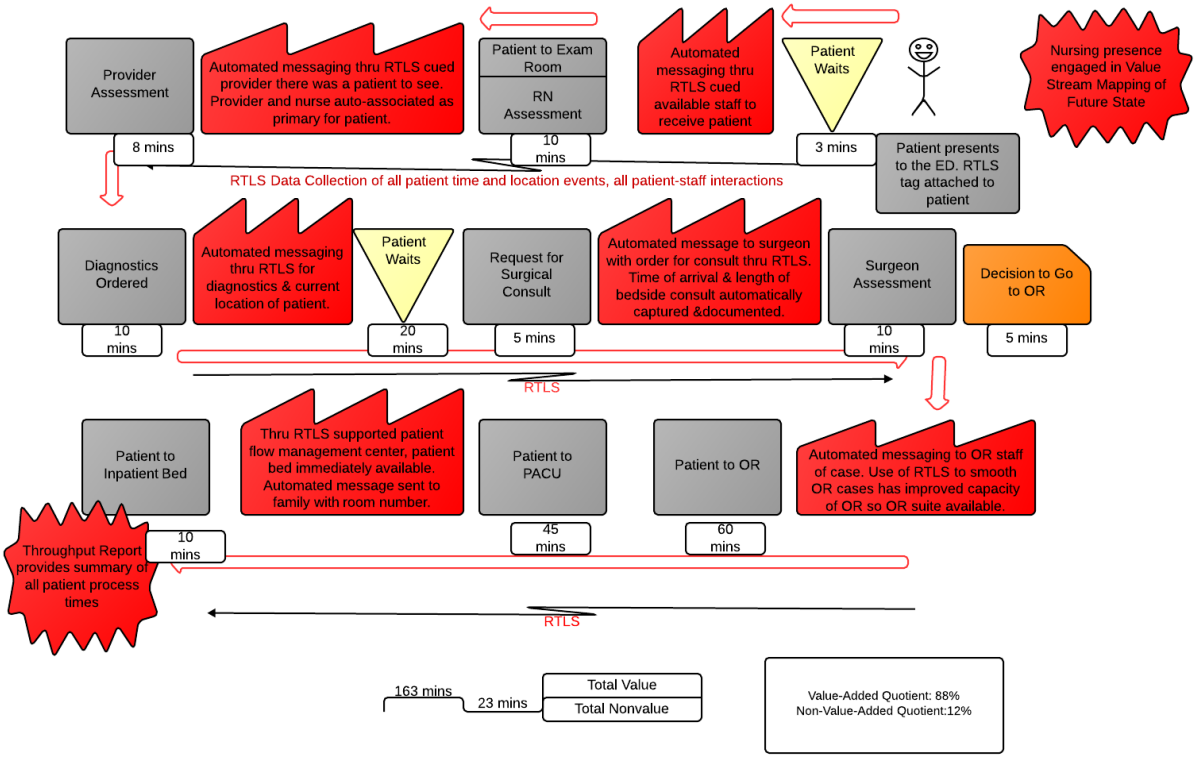


Figure 6. Model Applied to the Future State

Implementation

- Lean-provides the structure for implementation of steps and determination of cost-benefit analysis.
- RTLS-provides real time location and automation to streamline process steps and communications. RTLS data can be a supportive tool for A3 problem solving. RTLS data provides visibilty into events occurring in all locations simulataneously and cues staff regarding actionable events. Data can be interfaced with electronic health records eliminating the need for staff to enter data. RTLS may be interfaced with other technologies providing additional opportunities for efficiency and data integration.
- The Nurse-leads and engages in implementation. The nurse utilizes data to improve experience for patient and assist staff to learn to work more efficiently.

Evaluation

- Lean-provides the structure for ongoing evaluation of implementation steps.
- RTLS-provides real time location data to evaluate outcomes of the implementation steps in comparison to the current state.
- The Nurse-is highly engaged in successful evaluation of implementation steps and the analysis of data to identify additional changes in process to improve patient experience and staff efficiency.

Application of the Jagim Lean RTLS Model to a patient flow process issue provides endless new opportunities for transforming the process into one that will be value added for the patient. The model integrates Lean methodology, RTLS technology and presence of the nurse to provide nursing and healthcare with a blueprint for a powerful, integrated, efficient solution to patient flow and workflow issues.

CHAPTER 5. MODEL EVALUATION RESULTS

Comments from subject matter experts regarding the model were reviewed as part of the model development process. The complete evaluation forms are provided in Appendix A. Suggestions for enhancing the model, case study and supporting material were incorporated into the final version of the Jagim Lean RTLS Model described in Chapter 4. Overall, the evaluators were highly supportive of the model and it's core concepts. Summary of evaluator's comments are described below.

1. Origins of the Model

- There was general consensus among the evaluators regarding the inefficiencies and waste in healthcare.
- Deduction and synthesis were identified as the primary methods used in the model's development.
- Evaluators were in consensus regarding the synthesis of the 3 models/methodologies: Lean, RTLS, and Newman's theory.

2. Meaning of the Model

- Model's character of subject matter is healthcare delivery improvement.
- Model articulates the binary value of the process data based methodology of Lean with the data from RTLS.
- Suggest additional reference to Newman's theory regarding nursing presence throughout the content of the model– keeping all core elements of the model on an equal level of importance.
- Title reflects purpose and content. Suggests incorporating "nurse" component in title.
- Suggest adding Six Sigma to title to draw in the "effectiveness" content needed for the overall goal of streamlining healthcare.

3. Logical Analysis of the Model

- Model is logical and demonstrates the synergy between RTLS and Lean methods. Real time data collection reduces the risk of subjective influence in Lean problem solving. Model is not overly complex.
- Suggest adding Six Sigma as part of the process improvement cycle as well as utilization of statistical techniques.
- Suggest adding some expanded use cases for RTLS as well as associated use cases for RFID.
- Suggest assuring that all members of the healthcare team involved in transformation are recognized.
- The relationships among the model components are made explicit and clear. Some enhancements and examples regarding Newman's theory would be helpful to understanding how the theory is applied in the model construct.

4. Determination of Model Usefulness

- Model is useful but will require multi-disciplinary expertise in order to initially implement. Once the model is understood, in particular by nurse leaders, it can be expanded and taught in a healthcare setting, becoming an effective and powerful model.
- Model is practical and useful to healthcare. Individually, each component has been proven effective. Coupled together, a more effective model is created than the power of the separate parts.
- Model demonstrates how the inclusion of dependable real time data in the Lean process will likely expedite problem solving.

- Model appropriately suggests the steps required to use both Lean and RTLS in harmony to improve work processes. It includes a development and evaluation phase to help predict unnecessary variation in processes.
- Model describes how outcomes can be better predicted.
- The described scenario is an excellent illustration of the model in use to accurately measure the time and activities within each step and using Lean thinking to analyze and re-create the process with fewer variances in practice, RTLS will accurately reflect both the pre-improvement times and the post effort changes in time. Suggest adding time components to illustrate the improvement potential.

5. Generalizability of the Model

- Model changes the mind process from reactive measures that focus on outputs to systematic measures that focus on inputs. It would enhance the effectiveness, timeliness and accuracy in the practice of nursing if applied by the people who do the work, in the course of the work.
- Model offers an opportunity for further development of a step-by-step approach with templates for different case studies as well as training materials.
- Model provides a basis for evidence-based practice, identifying root causes and ways to address them logically and systematically.
- Model contributes to healthcare knowledge by providing data on how we deliver care, creating a foundation for iterative improvement.
- Model lays a foundation for process and performance improvement.
- Model provides a new and innovative way of combining proven methods, tools and people management/leadership together to make a transformational impact in a healthcare organization.

6. Testability of the Model

Endless testing options available with the model, as the data provides accurate measure of improvement from the baseline to the implemented future state and careful analysis of results.

- Model would require training and evaluation of competency of team before implementing.
- Model is focused on responsive and preventative data that could be evaluated in a test case.
- Model would require a solid baseline to demonstrate success following implementation.

7. Additional Comments

- Innovative and smart model/concept.
- Brilliant adaptation of a method and technology that could have gone on for a very long time independently, missing the opportunities apparent in the model.
- Nice way to combine two methodologies with a nursing theoretical model to improve patient outcomes, and increase patient and staff satisfaction.

CHAPTER 6. MODEL OUTCOME EFFECTIVENESS

When implementing the Jagim RTLS Lean Model as part of a healthcare process improvement transformation, specific metrics should be considered to determine the model's implementation success. Metrics are a critical part of transformation and serve as the concrete measurement of the success of the project. Metrics can vary depending upon the scope of the project and the project's intended goals.

Recommendations for Project Metrics

The key metrics may be used to measure outcomes, system performance data, strategic and organizational impacts of the implementation of RTLS technology in conjunction with organizational process change (Tzeng,Chen&Pai, 2006). Metrics fall into four primary categories: efficiency metrics/communication, strategic initiatives/balanced scorecard, regulatory compliance metrics, and user adoption metrics.

In a systematic review of health care efficiency measures, Hussey et al (2009), identified three types of measures. These included perspective, which defines the evaluator; outputs, which can be further divided into health services and health outcomes; and the inputs used to produce the outputs (Hussey et al., 2009). In their review of the literature, Hussey et al. found a dichotomy between measures developed through research and those developed by vendors. There was no overlap of measures. The vendor-developed measures tended to be more financially based. However, it was also identified that hospitals tended to use the vendor-based measures rather than those developed through vigorous research. Efficiency measures have also not undergone significant rigorous evaluation (Hussey et al., 2009).

When evaluating efficiency, it is very important to consider the entity evaluating the efficiency. Different entities have different objectives for considering efficiency (Hussey et al., 2009). Outputs can be challenging as a measurement. Therefore it is important to assure they

are comparable in nature, such as efficiency measurement for the same type of patient or service. Typical outputs include hospital discharges, procedures and physician visits (Hussey et al., 2009). Inputs can be measured as data counts by type including physical inputs such as length of stay and financial inputs such as cost per patient visit (Hussey et al., 2009).

A balanced scorecard is a customized performance measurement system based upon organizational strategy. The scorecard becomes a common framework linking vision and strategy with performance and action in a very tangible way for all members of the organization. It is considered "balanced" because performance measures are grouped into several perspectives, generally four, that are critical for success. The health system then strikes a balance between financial operating measure and strategy and vision (Voelker, Rakich & French, 2001). The scorecard then becomes the basis for decision-making regarding capital investments. The scorecard provides a common tool for both clinicians and business managers to put the focus on the patient and a shared path by which to maintain that focus when making strategic decisions (Lyons, Gumbus & Bellhouse, 2003).

Metrics around user adoption of the technology may be based upon the Technology Acceptance Model (TAM). The TAM is the theoretical model constructed to explain the relationship between user attitudes, perceptions, beliefs, and eventual system use. The perceived usefulness and perceived ease of use of technology applications, such as RTLS, are major drivers of its usage. Perceived usefulness is defined as the degree to which a user believes an application will enhance his or her job performance. Perceived ease of use is how effort-free the application is for the user (Basoglua,Daimb & Kerimoglua, 2007, Amoako-Gyampah, 2007). Users also benefit from intrinsic and situational involvement. Use of the application is enhanced when a user feels the application has personal relevance and psychological significance. Also, users engaged in decision-making and system development tend to feel a greater commitment, acceptance and satisfaction with the system. A person's beliefs can also be

influenced by persons important to him or her, such as top management. Therefore, a clear vision articulated by leadership endorsing the application is essential and critical (Amoako-Gyampah, 2007). Table 2 provides a summary of potential model outcome metrics.

Table 2. Summary of potential model outcome metrics

Metric Focus Area	**Metric Outcomes**
Efficiency /Enhanced Communications	1. Inpatient length of stay (LOS) 2. Emergency Department (ED) LOS 3. Emergency Department hours of holding admissions 4. ED volume 5. Inpatient admissions 6. Inpatient bed turns (cleaning time) 7. Operating Room on time starts 8. Nurse call response times 9. Equipment utilization 10. Nurse time with patient 11. Physician time with patient 12. Wait times
Strategic Initiatives/Balanced Scorecard	1. Organizational health a. Employee learning b. Innovation c. Growth d. Staff Satisfaction Survey Results 2. Quality improvement a. Patient satisfaction survey scores b. Patient safety c. Patient falls d. Infection rates 3. Process improvement a. Time of admit b. Length of stay 4. Volume and market share growth a. Expanded volumes 5. Financial health a. Maximizing revenues b. Managing costs
Regulatory Compliance	1. Joint Commission Accreditation a. Biomed preventative maintenance compliance rate b. Temperature monitoring of vaccine, medication and nourishment refrigerators 2. Meaningful use with EHR

Table 2. Summary of potential model outcome metrics (continued)

Metric Focus Area	Metric Outcomes
User Adoption	1. Process transformation 2. Users accessing application 3. Staff post-implementation surveys

Baseline Analysis

A baseline measurement of metrics is recommended prior to implementation of the Jagim Lean RTLS Model. This will allow evaluators to establish current state prior to any influence or change in work process facilitated by Lean or the RTLS software or hardware. A thirty-day timeframe of data is required for an adequate baseline. Balanced scorecard information and regulatory compliance data would need to be obtained from the organization.

Data Collection and Analysis

The RTLS system will provide ongoing data collection of many of the efficiency measures and should be reviewed at a minimum of monthly in order to utilize the data to drive additional change. Balanced scorecard data will be obtained and reviewed quarterly. Monitoring of compliance with regulatory bodies is also an ongoing process utilizing the RTLS application. User adoption will be the most challenging metric to measure and analyze. A combination of methods will need to be used such as observation of user engagement with the application, monitoring the software for user access, successful transition of RTLS related process changes and administering staff post-implementation surveys. RTLS program administrators will meet with senior administration to review data and analysis and evaluate modifications to the program or opportunities for expansion.

Action research is another method of data collection and analysis, which could be used as a qualitative method of evaluating the program outcomes. Action research is a research style in

which researchers work explicitly with and for people rather than undertake research on them. Action research is known for its ability to focus on generating solutions to practical problems and its ability to empower practitioners (Meyer, 2000). The method of action research likely would work very well with the Jagim Lean RTLS Model approach.

CHAPTER 7. CONCLUSION AND NEXT STEPS

The Jagim Lean RTLS Model integrates the methodology of Lean and the real time data opportunities of RTLS together with nursing as a central figure in the healthcare delivery transformation process. The Jagim Lean RTLS Model will require testing in a healthcare setting as an important next step. Testing will provide for an opportunity to evaluate the model concepts and effectiveness. Application in a healthcare setting will also test the receptiveness and support of the model concepts by hospital leadership, process change leaders and nursing. The strength of Jagim Lean RTLS Model is in it's interfacing of the core concepts of Lean, RTLS and the role of the nurse in the transformation process and therefor inherently requires nursing leadership for successful application.

It is worth noting that the implementation of significant process change requires the collaboration of the entire healthcare team. Every team member must be committed to providing the highest quality service to the patient and engaged in the transformation. The nurse, by establishing relationships and being present with others involved in the care delivery process, will gain insight, trust and priceless opportunities to assist other team members in reaching a higher order of response to patient service issues.

The ultimate success of an enterprise transformation is dependent upon the value, resources and commitment placed upon the transformation. Many good intentions towards transformation have gone unfulfilled primarily due to being under supported and under resourced. The process change and supporting technology implementations must have the ongoing knowledgeable resources to continuously drive and support the change process and support the new processes and systems. Without adequate resourcing, projects are destined for failure.

There are some additional considerations to strengthen a Lean-RTLS implementation. Process change leaders, such as nurses and hospital leadership, should consider Lean training to prepare them for their role in the change management process. Training provides a strong foundation in Lean methodology and process re-design. There are a variety of programs available to select. Some Lean experts will contract with a hospital to come onsite and train a group of process change leaders and assist in launching initial projects. Utilizing a RTLS expert to assist in the business case development followed by selection and implementation of a technology solution is also recommended. The ideal resource would be expert resources with both Lean and RTLS knowledge to assist in the development and ongoing management of an enterprise transformation.

Incorporating Six Sigma into the ongoing process change will also support reduction in process defects. Six Sigma is a systematic and organized methodology that relies on statistical and scientific methods to make reductions in process defect rates (Vest & Gamm, 2009). Six Sigma is a concept originated in 1985 by Motorola as a change strategy to compete more effectively against the Japanese strength in the electronics marketplace. A structured method is used in Six Sigma to achieve a new process that meets the targeted defect rate (Linderman et al., 2003). Different process improvement methods may be used with DMAIC being one of the most well known. DMAIC stands for define, measure, analyze, improve and control (Arthur, 2011, p.83-84). In order to implement Six Sigma, accurate data is essential in order to measure process defects (Arthur, 2011, pp.84-85). RTLS will make the collection of accurate and ongoing data more possible. Six Sigma can be blended with Lean methodology as a way to help reduce variations in service delivery (Meisel et al., 2007, pp.21-22).

In summary, the Jagim Lean RTLS Model connects two tools for change, Lean and RTLS. Each strong in its own right, but neither has the ability to meet all aspects of the change process. Lean can drive a new and efficient process but lacks the ability to utilize real time data to

measure change or drive process steps through automation. RTLS can provide the real time data and automation, but technology will never fix a bad process, only automate it. Joining the two parts, makes the combined methodology far more powerful than each separately. The Jagim RTLS Model is intended as a guide to nursing and healthcare change process leaders for transforming healthcare delivery utilizing the structured process of Lean, the real time data tools and automations of RTLS and the presense of a key stakeholder in the care delivery process, the nurse. Newman's theory of health as expanding consciousness speaks to the evolving relationship between a nurse and a patient. Through interactions between the nurse and the patient, patterns are identified regarding how the patient is responding to the current health event. The Jagim Lean RTLS Model is reflective of the health of the healthcare delivery system itself. Healthcare processes are essentially patterns of delivery of services to the patient. By placing the nurse in the role of interactng and engaging with the other healthcare team members, similar to how the nurse would interact with a patient, patterns of response can be identified in the current process and support the evolvement to a higher state of functioning, the new future state process. The nurse becomes a transformation leader through this process and utilizes the Jagim Lean RTLS Model to create an exceptional patient experience.

REFERENCES

Agency for Healthcare Research and Quality (AHRQ). (2010). *Team triage reduces emergency department walkouts, improves aptient care*. Retrieved from AHRQ Healthcare Innovations Exchange: http://www.innovations.ahrq.gov/content.aspx?id=1735&tab=1.

Agency for Healthcare Research and Quality (AHRQ). (2012). *Two-track ED process flow reduces the number of untreated patients, lengths of stay, and waiting times*. Retrieved from AHRQ Health Innovations Exchange: http://www.innovations.ahrq.gov/content.aspx?id=1754

Amoako-Gyampah, K. (2007). Perceived usefulness, user involvement and behavioral intention: An empirical study of ERP implementation. *Computers in Human Behavior, 23* (3), 1232-1248.

Arthur, J. (2011). *Lean Six Sigma for Hospitals*. New York: McGraw-Hill.

Basoglua, N., Daimb, T., Kerimoglua, O. (2007). Organizational adoption of enterprise resource planning systems: A conceptual framework. *The Journal of High Technology Management Resource, 18* (1), 73-97.

Bellow, A.A., Flottemesch,T.J., & Gillespie, G. L. (2012). Application of the emergency department census model. *Advanced Emergency Nursing Journal, 34* (1), 55-64.

Bush, R. (2007). Reducing waste in U.S. healthcare systems. *JAMA, 297* (8), 871-874.

Center for Health Information and Decision Systems (CHIDS), (2008). *Quantifying the Economic Impact of Communication Inefficiencies in US Hospitals*. University of Maryland Robert H. Smith School of Business. Retrieved from

http://www.rhsmith.umd.edu/chids/pdfs_docs/ResearchBriefings/CHIDS-ResearchBriefing-Vol3Issue1a.pdf.

Centers for Medicare & Medicaid Services (CMS). (2013). *Linking quality to payment*. Retrieved from Medicare.gov: http://www.medicare.gov/hospitalcompare/linking-quality-to-payment.aspx

Centers for Medicare & Medicaid Services (CMS). (2013). *HCAHPS: Patients' Perspectives of Care Survey*. Retrieved from CMS.gov: http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/HospitalHCAHPS.html

Centers for Medicare & Medicaid Services. (2012). *Hospital-Acquired Conditions*. Retrieved from CMS.gov: http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/Hospital-Acquired_Conditions.html

Chongwatpol, J., Sharda, R. (2013). Achieving lean objectives through RFID: A simulation-based assessment. *Decision Sciences Journal , 44* (2), 239-266.

Day, T. E., Babu, A.N., Kymes, S.M., Ravi, N. (2012). Discrete event simulation and real time locating systems: technology integration for process improvement. *International Journal of E-Adoption, 4* (4), 16-28.

Department of Health and Human Services. (2012). *Accountable Care Organizations: Improving care coordination for people with medicare*. Retrieved from HealthCare.gov: http://www.healthcare.gov/news/factsheets/2011/03/accountablecare03312011a.html

Dickson, E. W., Anguelov, Z., Vetterick, D., Eller, A., Singh, S. (2009). Use of lean in the emergency department: A case series of 4 hospitals. *Annals of Emergency Medicine, 54* (4), 504-510.

Dickson, E. W., Singh, S., Cheung, D.S., Wyatt, C.C., Nugent, A.S. (2009). Application of lean manufacturing techniques in the emergency department. *Journal of Emergency Medicine, 37* (2), 177-182.

Dixon, D. (1999). The behavioral side of information technology. *International Journal of Medical Informatics, 56* (1-3), 117-123.

Eitel, D. R. (2010). Improving service quality by understanding emergency department flow: A white paper and position statement prepared for the American Academy of Emergency Medicine. *Journal of Emergency Medicine, 38* (1), 70-79.

Enriquez, M., Sisson, M., Kirby, A., Gupta, N. (2009). Increasing hospital capacity using existing resources to improve patient flow management. *Nurse Leader*, 7(1), 26-31.

Found, P. A., Van Dun, D. H., & Fei, F. (2009, May). Multi-level management and leadership skills in lean organizations. In *Proceedings of the 20 th Annual Production and Operations Management Society Conference*. Retrieved from http://www.pomsmeetings.org/ConfPapers/011/011-0035.pdf.

Gamm, L. K. (2007). Organizational technologies for transforming care, measures and strategies for pursuit of IOM quality aims. *Journal of Ambulatory Care Management, 30* (4), 291-301.

Graban, M. (2012). *Lean Hospitals* (2nd ed.). Boca Raton: CRC Press.

Hussey, P., deVries, H., Romley, J., Wang, M., Chen, S., Shekelle, P., McGlynn, E. (2009). A systematic review of health care efficiency measures. *Health Services Research, 44* (3), 784-805.

Institute of Medicine (IOM). (2012). *Best care at lower cost: The path to conintuously learning health care in America*. Report Brief. Washington, DC: National Academy Press.

Institute of Medicine (IOM). (2001). *Crossing the quality chasm: A new health system for the 21st century*. Washington, DC: National Academy Press.

Institute of Medicine (IOM). (2004). *Keeping patients safe: Transforming the work environment of nurses*. Washington, DC: The National Academies Press.

Institute of Medicine (IOM). (2000). *To err is human: Building a safer health system*. Washington, DC: Institute of Medicine.

Institute of Medicine (IOM). (November 2011). *Health IT and patient safety: Building safer systems for better care* .

Jimmerson, C. (2007). *A3 problem solving for healthcare*. Boca Raton: CRC Press.

Jimmerson, C. (2008). *reView: Realizing exceptional value in every day work* (2nd ed.). Bozeman, MT: Cartel.

Jimmerson, C. (2010). *Value stream mapping for healthcare made easy*. Boca Raton: CRC Press.

Kenney, C. (2011). *Transforming health care: Virginia Mason Medical Center's pursuit of the perfect patient experience*. Boca Raton: CRC Press.

KLAS. (2011, December 27). *KLAS Press Room*. Retrieved from KLAS: http://www.klasresearch.com/News/PressRoom/2011/RTLS

Linderman, K., Schroeder, R.G., Zaheer, S., Choo, A.S. (2003). Six Sigma: A goal-theoretical perspective. *Journal of Operations Management*, 21(2), 193-203.

Love, R. A., Murphy, J.A., Lietz, T.E., Jordan, K.S. (2012). The effectiveness of a provider at triage in the emergency department: a quality improvement initiative to improve patient flow. *Advanced Journal of Emergency Nursing, 34* (1), 65-74.

Lyons, B., Gumbus, A., Bellhouse, D. (2003). Aligning capital investment decisions with the balanced scorecard. *Cost Management, 17* (2), 34-40.

Malik, A. (2009). *RTLS for Dummies*. Hoboken, NJ: Wiley Publishing.

Maurno, D., Sirico, L. (2010). *Thin air: How wireless technology supports lean initiatives*. New York: Taylor & Francis Group.

Mayer, T. &. (2012). The business case for patient flow. *Healthcare Executive, 27* (4), 50-53.

Meisel, R.M., Babb, S.J., Marsh, S.F., Schlicting, J.P. (2007). *The executive guide to understanding and implementing Lean Six Sigma: The financial impact*. Milwaukee: ASQ Quality Press.

McEwen, M., Wills, E.M. (2010). *Theoretical basis for nursing* (3rd ed). Philadelphia: Lippincott Williams & Wilkins.

McHugh, M., VanDyke, K.J., Howell, E., Adams, F., Moss, D., Yonek, J. (2013). Changes in patient flow among five hospitals participating in a learning collaborative. *Journal for Healthcare Quality, 35* (1), 21-29.

Meyer, J. (2000). Using qualitative methods in health related action research. *British Medical Journal, 320* (7228), 178-181.

Montgomery, J. B., Davis, K. (2013). The hospital patient flow model: a simulation decision support tool. *2013 Society for Health Systems: Healthcare systems process improvement conference* (pp. 1-6). Society for Health Systems.

National Health System (NHS) Confederation (2006). *Lean thinking for the NHS*. Retrieved from http://www.leanuk.org/downloads/health/lean_thinking_for_the_nhs_leaflet.pdf

Nelson-Peterson, D. L., Leppa, C.J. (2007). Creating an Environment for Caring Using Lean Principles of the Virginia Mason Production System. *Journal of Nursing Administration , 37* (6), 287-294.

Newman, M. (1994). *Health as expanding consciousness* (2nd ed). Sudbury: Jones & Bartlett.

Newman, M. (1995). *A developing discipline*. New York: National League for Nursing Press.

Newman, M. (1997). Evolution of the theory of health as expanding consciousness. *Nursing Science Quarterly*, 10(22), 22-25.

Newman, M. (2008). *Transforming Presence: The difference that nursing makes*. Philadelphia: F.A. Davis Company.

Office of National Coordinator of Health IT (ONC). (2013). *Certification and EHR Incentives*. Retrieved from www.healthit.gov: http://www.healthit.gov/policy-researchers-implementers/hitech-act-0

Oredsson, S., Jonson, H., Rognes, J., Lind, L., Goransson, K.E., Ehrenberg, A., Asplund, K., Casten, M., Farrohknia, N. (2011). A systematic review of triage-related interventions to improve patient flow in emergency departments. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 19* (43).

Raunak, M., Osterweil, L., Wise, A., Clarke, L., Henneman, P. (2009). *Simulating patient flow through an emergency department using process-driven discrete event simulation.* Retrieved from Loyola University: http://evergreen.loyola.edu/raunak/www/papers/sehc2009.pdf

Sirio, C.A., Segel, K.T., Keyser, D.J., Harrison, E.I., Lloyd, J.C., Weber, R.J., Muto, C.A., Webster, D.G., Pisowicz, V., Feinstein, K.W. (2003). Pittsburg Regional Healthcare initiative: A systems approach for achieving perfect patient care. *Health Affairs*, 22 (5), 157-165.

Spear, S., Bowen, H.K. (1999). Decoding the DNA of the toyota production system. *Harvard Business Review, 77* (5), 97-106.

Sweeney, B., Meisner, H., Johnston, M. (2012). *The journey to building a patient flow management center.* Retrieved from http://www.modernhealthcare.com/assets/pdf/CH79573516.PDF.

Teich, S.T., Faddoul, F.F. (2013). Lean management-The journey from Toyota to healthcare. *Rambam Maimonides Medical Journal*, 4 (2), 1-9.

The Joint Commission. (2012). *R3 Report. Issue 4.* The Joint Commission. Retrieved from http://www.jointcommission.org/standards_information/r3_report.aspx

Tzeng, S. F., Chen, W.H., Pai, F.Y. (2006). Evaluating the business value of RFID: evidence from five case studies. *International Journal of Production Economics, 112*, 601-613.

Vest, J. R., Gamm, L.D. (2009). A critical review of the research literature on Six Sigma, Lean and StuderGroup's Hardwiring Excellence in the United States; the need to demonstrate and communicate the effectiveness of transformation strategies in healthcare. *Implementation Science , 4* (35).

Voelker, K. E., Rakich, J.S., French, G.R. (2001). The balanced scorecard in healthcare organizations: a performance measurement and strategic planning methodology. *Hospital Topics, 79* (3), 13-24.

Wiler, J., Griffey, R.T., Olsen, T. (2011). Review of modeling approaches for emergency department patient flow and crowding research. *Academic Emergency Medicine, 18*, 1371-1379.

Womack, J.P., Jones, D.T., Roods, D. (1990). *The machine that changed the world*. New York: Rawson Associates Scribner.

Zuzelo, P.R., Gettis, C., Hansell, A.W., Thomas, L. (2008). Describing the influence of technologies on registered nurses' work. *Clinical Nurse Specialist*, 22 (3), 132-140.

APPENDIX. MODEL EVALUATION TOOL RESPONSES

Jagim Lean RTLS Model Evaluation Form
Mark Rheault

1. Origins of the model
What is the origin of the problem with which the model is concerned? Healthcare is incredibly inefficient and has continued to lag other industries in utilizing sensory network and intelligent workflow software to automate processes and communications. There are many opportunities to improve efficiency, patient safety, staff workflow, communications, etc. using the Lean methodology couple with RTLS technology and engaged nurses/staff.
What methods were used in the model development (induction, deduction, or synthesis)? Because a logical methodology is used (Lean) in conjunction with technology that can measure activities (RTLS system), all three methods were exemplified in the paper. Examples include - Induction: utilization rates and patient flow rates can be reasonably predicted based on past measured performance. Deduction: If a piece of equipment is moved into a patient's room, it is assumed it is in use. Synthesis: By establishing baseline equipment use in a particular zone using RTLS data, one can use that to set par levels for each hospital department and reduce equipment purchasing costs for that type of equipment. This requires synthesizing data from many sources to determine optimal utilization levels that then impact financial performance.

2. Meaning of the model
What is the character of the subject matter dealt with by the model? I'm not sure what is meant by this question. I'm sorry.
Describe how the model provides a blueprint for use in addressing healthcare issues? It addresses the keys to a successful solution: people (importance of engagement using

Newman's theory), processes (Lean), and tools/technology (RTLS) and effectively illustrates how the three components tie together to create the blueprint. I think it was particularly well done with regards to Lean and RTLS. I think the references to the Newman model could be enhanced to include more practical examples, and further, the practical integration of the theory to the other two components. The table at the beginning of the chapter has a column for Lean and one for RTLS, but not one for the Newman theory (which I am referencing as engagement, in general), which seems to be missing when the overall model references all three. I could envision the table with a column for it that reference how staff are engaged, behavior modified, and/or performance improved. Just an idea.

Does the title of the model reflect its purpose and content? Explain.

Yes - it does. However, the Newman model seems to at points have equal billing to Lean and RTLS, and sometimes it is at a "second level" to Lean and RTLS, such as in the title.

3. Logical Analysis of the Model

Is the model logical? Explain why.

Yes, the model is very logical in that it clearly identifies the problem of "visibility" and how RTLS addresses that issue. The model then also couples that with each step of the Lean process nicely. I really liked seeing the before and after process diagrams to illustrate one concrete example of a process flow change.

Is the model complete in terms of subject matter and perspective? Explain why.

It is very good as it is, but I thought there might be a few somewhat significant omissions, or at least the lack of acknowledgement:

1.) The focus on RTLS technology specifically, rather than expanding or acknowledging related technologies that can be utilized in a similar fashion. For example, the use of passive RFID for healthcare supply chain automation, real-time inventory of vital expensive consumables (heart stents, implants, bone/tissue, etc.) and so forth. Also, related technologies for elopement prevention, infant abduction, etc. that use low frequency technology to alert when a tag goes through a portal (elopement) or when two tags come in/out of proximity (wrong baby in a mother's room), or even when a surgical sponge is left inside a patient during surgery. Another related "automation technology" that is up and coming is real-time vitals and activity monitoring using similar devices, but

in a different way - to allow patients to be monitored at home or at a lower skilled care facility to enhance patient independence and overall cost of care while still providing a higher level of care for the patient.

2.) It seemed to be overly nurse centric to the extent that the other staff types were not even acknowledged - doctors, techs, support staff, etc. that are also vital to the patient flow and patient experience. I think it is fine that it is centrally focused on the nurse's ROLE in the process improvements using the model, it would be good to acknowledge that ALL staff will work together in a more efficient and cohesive manner (perhaps orchestrated by the nurses, largely), that ultimately leads to greater efficiency in all parts of the organization and enhances the patient experience, as a result.

Are the relationships among the model components made explicit?

It is very well done with respect to Lean and RTLS, but as mentioned, there could be some enhancement to the description and examples around the Newman model.

4**. Determination of Model Usefulness**

How would the model be practical and useful to nursing?

I think it could be very useful, but will require multi-disciplinary expertise (Lean process, RTLS/auto-id technology, engagement/leadership models) in order to initially implement. I think this is a unique experience set that many hospitals will lack until it is developed over time or through the use of those specifically trained in this model. Once certain nurse champions really understand it, it can be expanded to all nurse managers, and perhaps to all nurses in an organization. With proper training and implementation assistance, I believe this can be a tremendously effective and powerful model.

How would the model be practical and useful to healthcare?
Each of the three components are already proven to be effective individually within the healthcare environment. I think you have effectively explained how these components, when coupled together, can create a much more effective model than when applied and used individually.

Does the model contribute to understanding and predicting outcomes? Explain.
Yes. I think the use of examples was well done, particularly when describing each Lean

step, and then identifying one or more corresponding RTLS enabled processes and metrics. The model also describes how outcomes can be better predicted using the vast amount of real-time visibility data and compiled information that can be derived from the RTLS system.

Is the model appropriately applied to the described scenario? Is the application logical? Explain.

For the most part, yes. The two flow diagrams were good, but I think they could be enhanced a bit. It was explained earlier in the paper that waste (wait times) as percentage of the total time (i.e. length of stay) was a key metric to be targeted. It would be great to show the (hypothetical) times and durations for each stage in the example, and then calculate the waste for each, and thus demonstrate how RTLS reduces waste through the illustration of the calculation. For example wasted minutes over total minutes in the non-RTLS example could be 150 waste minutes over 300 total minutes = 50% waste, while in the RTLS enabled example it might be 50 minutes over 200 total minutes = 25% waste and a concurrent reduction of total LOS of 33% (from 300 minutes down 33% to 200 minutes). I think the illustration would seem more reasonable if wait periods are still shown (there are none in the "RTLS enabled version" which is not realistically the case), but simply show them as greatly reduced rather than eliminated.

Again, just a thought. Overall very good though.

5. Generalizability of the Model

Does the model guide practice? Explain

Yes, at a high level. I think to make it truly practical, it would simply need to be further developed so that it included more of a "step by step how-to" approach, various templates for each use case type (i.e. patient flow in the OR, reduction of capital asset purchases, etc.), and training materials. As the high-level model, it is very good. Just needs more fleshing out to put into full practice in a repeatable fashion, which would come the first time it is truly implemented (which I hope is very soon!)

Does the model contribute to the body of healthcare knowledge? Explain

I believe it does. This is a new and innovative way of combining proven methods, tools, and people management/leadership together to make a transformational impact in a hospital organization.

6. **Testability of the model**
What further testing opportunities are generated by the model? I think this can be practically applied to literally dozens if not more than a hundred specific use cases with a large healthcare system. The approach can be used in a wide variety of use cases from asset management to temperature monitoring to patient/staff workflow, to supply chain to remote patient monitoring and so forth and so forth. The opportunities seem almost limitless.
Can the model be supported by test data? I think so. I think the greatest challenge will be getting a solid "before" baseline to test the "after" results. For example, if you are trying to improve the patient wait times for a particular department, you would have to do, essentially, manual measurements via observation prior to deploying the technology and implementing the new processes. Because the baselines would still likely be based on incomplete data (not all activities full tracked and measured), biased data (people's behavior changes if they know they are being measured/monitored), and "dirty" data (you can't be sure there are not other factors causing the variances in the before and after data), getting firm "results" will always be a bit of a challenge. However, that said, once implemented, the "results" will be extremely easy to capture, review, and assess to determine the success level of the model because of the use of RTLS.

Additional Comments
Overall, an incredibly innovative and smart model/concept. With further refinement and development of supporting tools and methodologies, I can envision widespread adoption the of Jagim Model. Great job on this Mary - I am very proud of you!!

Jagim Lean RTLS Model Evaluation Form

Clint Abernathy

1. Origins of the model
What is the origin of the problem with which the model is concerned? The ability to combine Lean with RTLS to help increase the effectiveness and efficiency of care delivery.
What methods were used in the model development (induction, deduction, or synthesis)? NA

2. Meaning of the model
What is the character of the subject matter dealt with by the model? The character of the subject matter is robust in that is utilizes two systems for a common good. Lean Six Six Sigma is a tool set focused on data based decision making and RTLS gives the data sets needed to make critical decisions. .
Describe how the model provides a blueprint for use in addressing healthcare issues? The model gets to the crux of healthcare reform. We (the healthcare industry) have to find a way to produce excellent results in a more efficient and cost effective way. This model gives the framework necessary to make a large dent.
Does the title of the model reflect its purpose and content? Explain. It does address the purpose behind the tool. Lean and RTLS are both associated with making processes more efficient. I do think adding Six Sigma to the title would help draw in the "effectiveness" content needed for the overall goal streamlining healthcare.

3. Logical Analysis of the Model
Is the model logical? Explain why. Yes, it is very logical. Lean Six Sigma is a tool set that focuses on data. RTLS supplemented at the automated data source gives a logical approach to all "gemba walks," or data needs.
Is the model complete in terms of subject matter and perspective? Explain why. I do think Six Sigma can be intertwined into the equation as part of the DMAIC cycle and utilization of statistical techniques. The implementation and evaluation phase could be analyzed and verified to help reduce non-regression X-variables.
Are the relationships among the model components made explicit? Yes

4**. Determination of Model Usefulness**
How would the model be practical and useful to nursing? The model could be absorbed as a practice model. Currently models such as PDCA, PDSA, and Team Stepps all focus on practical improvement of nursing processes. The Jagim Lean Model does the same but identifies a way to capture critical data in a streamlined way.
How would the model be practical and useful to healthcare? See Above
Does the model contribute to understanding and predicting outcomes? Explain. Yes, the model has a develop and evaluation phase that helps predict unnecessary variation in processes.

Is the model appropriately applied to the described scenario? Is the application logical? Explain.

Yes, the model is logical in that it starts with a problem and utilizes key tools to help scrub and find critical variable that control desired outputs.

5. **Generalizability of the Model**
Does the model guide practice? Explain Yes, it changes the mind process from reactive measures that focus on outputs to systematic measures that focus on inputs.
Does the model contribute to the body of healthcare knowledge? Explain Yes, it lays a foundation for process and performance improvement.

6. **Testability of the model**
What further testing opportunities are generated by the model? The value stream tools are fairly complicated. Testing the level of competency and understanding of the team would be necessary before implemented.
Can the model be supported by test data? Yes, the model is focused on responsive and preventative data. A test case could easily be created that showed the value of the approach.

Additional Comments

Jagim Lean RTLS Model Evaluation Form

Cindy Jimmerson

1. **Origins of the model**
What is the origin of the problem with which the model is concerned? Recognition of processes of work in nursing that do not offer complete value to patients, creating wasted time, increased risk, cost and misuse of nurse time.
What methods were used in the model development (induction, deduction, or synthesis)? Deduction and synthesis

2. Meaning of the model
What is the character of the subject matter dealt with by the model? The subject matter is both powerful and pertinent to the challenges, threats and pressures of the current healthcare system. It engages two instruments that are intuitive and complimentary to nursing practice.
Describe how the model provides a blueprint for use in addressing healthcare issues? The model creates a clearly articulated binary value, using Lean methods to identify and solve issues in patient care delivery and RTLS-collected data to inform the initial understanding and significance of the problem. The RTLS data is not only used retrospectively, but can be used to project improvement value.
Does the title of the model reflect its purpose and content? Explain. The title does reflect the purpose and content if the reader is familiar with both Lean methods and RTLS technology and function.

3. Logical Analysis of the Model
Is the model logical? Explain why. Because the success of Lean improvement/problem solving relies on direct observation and collected data, the model demonstrates the synergy between RTLS and Lean methods. In general, Lean methods (value stream mapping and A3 problem solving) are at risk of being populated with opinion if data collection is not meaningful and achievable in the course of work. The demonstration of RTLS as a tool for real time data collection is very logical.
Is the model complete in terms of subject matter and perspective? Explain why. The subject matter is accurate; it could always be enhanced with years of experience, but it is adequate to initiate immediate use.
Are the relationships among the model components made explicit? Yes

4**. Determination of Model Usefulness**
How would the model be practical and useful to nursing? As explained in the text, nurses could use RTLS with alerts to signify when a Lean problem solving (A3) could be initiated to identify an opportunity and method of improvement. When a problem is identified in the course of work, RTLS could provide the essential data to deeply understand the problem in the A3 process. Evaluation of the dependable data would likely expedite the problem solving by providing a foundational understanding for the way the work happens now which would be a perfect springboard for creating a future state map and plan for that achievement.
How would the model be practical and useful to healthcare? To alert nursing and allied personnel to opportunities to do timely and quick process problem solving with substantial data, in the course of work.

Does the model contribute to understanding and predicting outcomes? Explain.

Yes, with the deep understanding of any problematic work (using Lean thinking), the next logical step is using that information to create a better way to work. The model suggests the steps required to use both Lean and RTLS in harmony to improve work processes.

Is the model appropriately applied to the described scenario? Is the application logical? Explain.

There are many steps in the scenario described and if each of those steps is done differently by the people performing them, there can be a huge variance in practice and outcomes. Using this model to accurately measure the time and activities within each step and using Lean thinking to analyze and re-create the process with fewer variances in practice, RTLS will accurately reflect both the pre-improvement times and the post effort changes in time. The described scenario is an excellent illustration of the model in use.

5. Generalizability of the Model

Does the model guide practice? Explain

Use of the model would enhance effectiveness, timeliness and accuracy in the practice of nursing if applied by the people who do the work, in the course of work.

Does the model contribute to the body of healthcare knowledge? Explain

Yes, the model can increase the knowledge of how we deliver care, creating an foundation for iterative improvement.

6. Testability of the model

What further testing opportunities are generated by the model?

Endless testing is possible with small to very broad issues of care delivery, as the data provides accurate measure of improvement from the baseline to the implemented future state, which should always be considered a test, with careful analysis of the results.

Can the model be supported by test data?

Yes. Good data doesn't lie.

Additional Comments

This is a brilliant adaptation of a method and a technology that could have gone on independently for a very long time, missing the opportunities that are apparent in this model. Ms Jagim should be commended for developing a model that creates the enhanced use of each.

Jagim Lean RTLS Model Evaluation Form

Susan Sheehy

1. Origins of the model
What is the origin of the problem with which the model is concerned? Efficiency and eliminating waste in healthcare to improve patient and staff satisfaction and patient outcomes.
What methods were used in the model development (induction, deduction, or synthesis)? Synthesis of three models/methodologies: Lean, RTLS, and a nursing model.

2. Meaning of the model
What is the character of the subject matter dealt with by the model? Healthcare delivery improvement .
Describe how the model provides a blueprint for use in addressing healthcare issues? Addresses a current state issue and assists with the development of a future state map to direct an implementation plan.
Does the title of the model reflect its purpose and content? Explain. Yes, it incorporates the essential components of the model.

3. Logical Analysis of the Model
Is the model logical? Explain why. Yes – easy to follow and not over-complex.

Is the model complete in terms of subject matter and perspective? Explain why. Yes, contains all essential components.
Are the relationships among the model components made explicit? Yes, very clear.

4**. Determination of Model Usefulness**
How would the model be practical and useful to nursing? Can be used to address everyday, common issues.
How would the model be practical and useful to healthcare? Again, can be used to identify and work on issues that prevent the delivery of the highest quality of healthcare.
Does the model contribute to understanding and predicting outcomes? Explain. Yes, because the lean methodologies provide a clear and concise way to evaluate the current state and define what the future state should look like, along with all supporting documents to take the appropriate steps to get to the future state.
Is the model appropriately applied to the described scenario? Is the application logical? Explain. Yes, very easy to follow and easy to understand.

5. **Generalizability of the Model**
Does the model guide practice? Explain It can be the basis of evidence-based practice, identifying root causes and ways to address them logically and systematically.
Does the model contribute to the body of healthcare knowledge? Explain Yes, combines two methodologies with a well-known nursing theoretical model.

6. **Testability of the model**
What further testing opportunities are generated by the model? Can be used with almost any issue that may arise in healthcare.
Can the model be supported by test data? Yes.

Additional Comments
A nice way to combine two methodologies with a nursing theoretical model to improve patient outcomes, and increase patient and staff satisfaction. Thank you for the opportunity to provide input. Susan Sheehy, PhD, RN, FAEN, FAAN