Lean Process Improvement in Presurgical Examination Center at UMass Memorial Hospital

Utilizing lean techniques for improved patient and information flow

A Major Qualifying Project Report Submitted to the Faculty of

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In Partial Fulfillment of the Requirements for the Degree of Bachelor of Science by

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Abstract

Due to the increasing need to operate more efficiently in healthcare, clinics are seeking ways to improve patient flow as effectively as possible. This project, conducted on behalf of UMass Memorial Medical Center, examined and improved the processes used by the Pre-Surgical Examination Center (PSE) to efficiently see their patients while reducing the space they use. In order to recommend improvements for the operations of the PSE, our team utilized lean tools developed specifically for hospital usage. Working alongside UMass' Center for Innovation and Transformational Change, our team examined how these lean tools can eliminate non-value added work, effectively manage resources, and create lean flow. After implementation, the team saw a reduction in patient throughput time, elimination of defects in the chart tracking process, and a decrease in stocked inventory due to the lean transformations.

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Brandon was the main liaison to the CITC staff, coordinating the majority of our communications with UMMHC. He also led the Kaizen team charged with the improvement of the chart preparation process, and worked on the new inventory management system.

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Alyssa was the primary data collector for the team's preliminary metrics. She also assisted the patient flow team during the Kaizen event. Alyssa was responsible for meeting minutes, and participated in the future state mapping event.

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Executive Summary

In this project, we worked alongside the Center for Innovation and Transformational Change (CITC) Staff at the UMass Memorial Health Center (UMMHC) to design and implement a complete lean transformation at their Pre-Surgical Evaluation (PSE) center. To complete this project, we applied techniques we learned in our coursework at WPI, along with lean training provided by UMass, interviews with key personnel, and recommendations based on our own data collection.

Background

CITC is a relatively new department within UMMHC, and is focused on the improvement of hospital processes and operations. Their work within the PSE marks the first time CITC has had the opportunity to conduct a full-scale transformation, complete with a Kaizen event, in any of the areas of interest.

PSE sees patients from three campuses found in Worcester: UMass Memorial Hospital, UMass University Campus, and Hahnemann Hospital. Each of these hospitals performs various procedures for patients, many of whom attend an appointment at PSE prior to their procedure. On average, PSE has to accommodate one hundred and ten patients every day. PSE's facility previously included sixteen exam rooms with an average length of stay around three hours, but it is in the process of being downsized to a space containing only eight exam rooms. PSE management is currently attempting to keep their average length of stay constant despite the reduction, and has enlisted the CITC services to implement their lean transformation to move toward continued process improvement and a decrease in patient times.

Our team, alongside CITC and PSE staff, collected data and implemented a series of lean improvements to PSE's processes in order to accomplish the goals set forth by management in the project charter.

Project Goals

The project goals that were agreed upon over the course of the extensive preliminary planning process are listed on the charter as follows:

- Maximum 75 minute patient throughput time
 - 30 minutes for simple cases
- Assurance of a 100% complete and accurate patient chart
 - No defects (incorrectly ordered paperwork, missing components, etc.)
 - Confirmed delivery of the chart to the appropriate campus (University, Memorial, Hahnemann)
- All necessary patient information available two days prior to surgery
- Minimize delay rate and non-value added work to increase staff efficiency
- Provide a positive patient experience from both provider and patient point of view
- Create a sustainable model for continued process improvement

After these goals were set forth, the team planned out a long term and short term strategy for accomplishing each one. We then collaborated with CITC staff to implement the process improvement recommendations we made.

Methodology

In order for the group to accomplish our goals, as well as the goals set by PSE management and CITC, we followed the schedule planned out at the project's inception. The work that the team did on this project included manual and electronic data collection and analysis, value stream and future state mapping, the Kaizen event, and follow up meetings to gauge the progress that our adjustments have made. Prior to these events, we participated in Six Sigma White Belt lean training by the CITC staff, which gave us background on the applications of lean in healthcare. In order to create a baseline for the project, the group collected data to identify the bottlenecks in the PSE process. The future state mapping event helped the team hone our focus on specific areas of both the information flow and the patient flow. At the future state mapping event, we created an ideal state, and discussed where we had opportunities for improvement in the PSE process.

The Kaizen event was primarily focused on the information flow, which is based on the movement of patients' charts through the PSE. The two main processes that the team made changes to were the Chart Preparation and Chart Compilation work areas. Along with changing the work areas, we trained the PSE staff, and also implemented changes for inventory management. The secondary focus was to improve patient flow, and the team set up signals to inform the PSE staff of which rooms needed attention, and disbanded rigidly assigned nurse teams and rooms. All of the exam rooms in PSE were also standardized to provide each staff member with the necessary equipment to perform every test needed. After completion of the Kaizen event, follow up events were set up for 30, 60, and 90 days.

Results

As a result of our work at the Kaizen event and throughout the project, we were able to see immediate results. We implemented just in time work systems, eliminated batching, and created one piece flow for both Chart Prep and Chart Comp. Secondarily, a "Go-to Work" system was created to increase the efficiency of the staff, and decrease patient lead time. Since the PSE staff was no longer assigned to a partner and certain rooms, and all of the exam rooms were standardized, there has been a noticeable decrease in non-value added work for the RNs and NPs, which goes along with a higher patient turnover.

1) Introduction

"It is not at all certain whether hospitals as they are now managed exist for patients or for doctors"

This quote from production pioneer Henry Ford presents the problem faced by hospitals in 1922, when he began experimenting with production systems in a hospital in Dearborn, Michigan. However, that same question applies to modern day hospitals and the way they conduct their operations. It is often unclear if the incumbent systems that have become entrenched in the processes of many modern hospitals are in place because they add value or are simply 'the way things have always been done'.

Hospitals provide a service essential to our society: prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical and allied health professions (Farlex, 2009). They are also one of the largest employers in the U.S., providing jobs for over 5,000,000 people nationwide (Bureau of Labor, 2008). That number is projected to grow over 14% in the next five years, according to a study conducted by the Bureau of Labor in 2008 (Bureau of Labor, 2008). Within such a large industry, small design flaws and inefficiencies will add up and become costly on a national scale. For this reason, it is important to maximize the abilities of each hospital to create processes that can eliminate waste and maximize not only efficiency and financial standing, but also the ability of each hospital to care for its patients.

Within each hospital, there are a variety of divisions, each specializing in a different function as part of the main organization. These individual units, spanning diverse focuses from neurosurgery to pediatrics, each have separate processes in place to sustain their particular workload, and as such, cannot be supported by 'cookie cutter' solutions. This presents a problem to those whose goal it is to improve efficiency within the hospital, as it makes it very difficult to simply utilize a solution that was successful in one division in another and expect similar results. It requires a significant amount of planning and cooperation, but these transformations can be made with the right commitment from everyone involved.

In this project, our goal was to work alongside the UMass Memorial Hospital Center for Innovation and Transformational Change (CITC) in their reorganization of the Levine Center Presurgical Examination (PSE) wing. Currently, PSE is being downsized from the existing sixteen to eight exam rooms due to the inclusion of a new division in the Levine Center. The problem faced by the PSE personnel and CITC specialists is to continue to service the same number of patients, approximately 111 per day, while decreasing the lead time for each visit (UMass, 2010).

To accomplish this goal, our team partnered with CITC specialists, lean consultants, and a diverse team of employees from PSE to assess the current processes at PSE, identify areas for improvement, brainstorm methods to improve patient flow and information flow, and implement the more efficient systems alongside the other members of the improvement team.

In order to make this project successful, our team had to create a list of goals that we needed to accomplish before working directly on the implementation of a new system. To gain a firm understanding on the scope of the project and identify our function, we first needed to complete the following:

- Research the multiple functions of the PSE
- Observe how patients and information flow through the current system
- Identify bottlenecks in both patient and information flow
- Reexamine the layout of PSE and deployment of resources
- Work with our team to brainstorm lean strategies to optimize improvement
- Implement process improvement modules
- Continue observation for future process sustainability

To achieve these goals, our team had to be trained in Lean technology, UMass policy and operations, and general hospital acumen in order to gain the expertise necessary to begin data collection. The team observed the PSE process, and manually collected detailed data concerning patients' length of stay, including the amount of time spent in each section of PSE. This data was utilized in both current and future state mapping events by the CITC group, and led to the proposals of new layouts and suggestions for improved production modules. The team then

participated in two Kaizen events, implementing the recommendations we had developed through meetings and collaboration with hospital personnel and lean consultants.

After implementation, we collected data on the improvements made, and utilized a survey of employees to compile the results of our modifications. To measure the magnitude of our results, we first ensured that the people who would be using the new systems were comfortable with using them, and actually did improve their processes. Concurrently, we recorded time data for both patients and information in charts, broken down into subsections by function performed, and compared it to the data that we had previously logged before the planning events.

Our report is organized as follows: in Chapter 2, we summarize the background of the project, and a literature review of the materials that helped us to understand lean technology, the ways lean is utilized in hospitals, and information on UMass Memorial, specifically PSE. In Chapter 3, we discuss the methodology we used, beginning with our lean training, progressing through the future state planning and culminating with the Kaizen event. Chapter 4 will detail the results of our implementation, and Chapter 5 will outline our recommendations for future development. Chapter 6 will conclude the report by stating our goals again, and looking into the effectiveness of lean in hospitals going forward. Our appendices will then display the materials we used to complete this project.

2) Background

2.1) Terminology

In order to be successful with this project, it was imperative for our team to familiarize ourselves with health care terminology and common hospital practices through online research and interactions with the PSE staff. The main acronyms and abbreviations we use in this paper are detailed below, and other common terms are defined in our Glossary, found in Appendix H.

Inside of PSE, the most important terms to know are RN, NP, and PCA, the titles of the different varieties of staff that work together to process each patient. An RN is a Registered Nurse, normally the person to retrieve the patient from the waiting room, and is typically the first person to see the patient. RNs perform the majority of vital sign testing, as well as basic tests to assess the readiness of the patient for his/her procedure. NP stands for Nurse Practitioner, whose job it is to review the patient's information and determine whether or not the patient needs to see the anesthesiologist. The PCA is the Patient Care Associate, and they are normally the ones whose responsibility it is to take the necessary blood work from the patient, and take an EKG (Electrocardiogram) if necessary. The PCA can also begin the process by escorting patients from the waiting room, and have the flexibility to do their job whenever is best for the NPs or RNs, as long as it is before they leave to see the anesthesiologist. An EKG measures the electronic activity in the heart over time, and is an important measurement to take for procedures that require general anesthesia. Another term used amongst the RNs, NPs, and PCAs is H&P, which stands for medical history and physical exam. If a patient does not have a physical then the RN or PCA working with the patient can administer one. Before seeing a patient, NPs normally review the H&P to see if there is anything they should be aware of when determining whether or not to send the patient to the anesthesiologist.

2.2) Lean Management Techniques

Lean is a strategy used in businesses and organizations to identify errors in their systems and correct or remove the suggested defects. The use of this management strategy is believed to make processes more effective and efficient, "Six Sigma is a rigorous and a systematic methodology that utilizes information (management by facts) and statistical analysis to measure and improve a company's operational performance, practices and systems by identifying and preventing 'defects' in manufacturing and service-related processes in order to anticipate and exceed expectations of all stakeholders to accomplish effectiveness."(Caldwell, 2009) By limiting variability and eliminating waste and defects while simultaneously catering to the customer to maintain loyalty, Six Sigma has been continuously proven to be successful when executed correctly (Graban, 2008). Sections 2.2a-2.2c will describe the basic lean concepts we used to assess PSE processes and design improvement models.

2.2a) Gap Analysis

There are different designs for Six Sigma. Referred to as DFSS (Design for Six Sigma), the first step in this process is to conduct a Gap Analysis, determining breaches or bottlenecks in the process which negatively affect the performance of the system. While undergoing this analysis it is also important to keep in mind the voice of the customer or patient. From this a five step method can be used:

- Plan: enables the team to succeed with the project by mapping all the vital steps
- Identify: hears the voice of the customer to select the best product concept
- Design: builds a thorough knowledge base about the product and its processes
- Optimize: achieves balance of quality, cost, and time to market
- Validate: demonstrates with data that the voice of the customer has been heard and satisfied

The plan that our team followed for designing our project followed each of these steps, tailored to the specific needs of the PSE. According to lean consultants, when these steps are implemented the process will improve based on a decrease in production gaps and defects, and elimination of bottlenecks that slow down flow (Caldwell, 2009).

2.2b) Cell Design

Cell design is an organizational strategy used to increase productivity while improving flow and the efficiency of a process. This strategy breaks the procedure into multiple increments and creates a sequential flow using these different steps in a way to achieve an optimum layout, "Work-cell layout begins with a detailed sequence of process steps, with careful consideration of opportunities for eliminating unnecessary steps or improving the process. Workstations are arranged in the order of the processing steps. Layout of each workstation in the work cell should be carefully designed so that supplies and any tools are presented to the operator in an optimal manner. Supplies in the work cell should be kept at a minimum; only enough for a shift or a day." (Brue, 2009) There are different variations of the cell design, however, the U-shaped design is the configuration most used, "... a U-shaped form; the operator walks from station to station, until ending the sequence of processes near the beginning step for the next piece or batch. The U-shaped cell is particularly well suited for a variety of activity levels. When volumes are relatively low, a single operator can manage several instruments. When volume is high, a second operator can be added to the cell, such that each operator's walking is kept at a minimum, and the cell layout remains highly efficient."(Brue, 2009) When implemented correctly and successfully, lean work cells bring order to an environment that is poorly organized; reducing lead times, minimizing transportation (handling distances and walking), decreasing necessary space requirements, making things quickly assessable, amongst many other improvements (Caldwell, 2009).



Figure 2.1: Example of U-Shaped Cell Design (Brue, 2009)

2.2c) Value Added Work/Metrics

Takt time is the rate of demand and determines the required rate of production to compensate for the customer demand. To determine takt time, the time available must be determined and then divided by the customer demand, for example, "...the takt time during a peak period in one institution is calculated as the available time divided by customer demand...Operations must complete one sample in that number of seconds to meet customer expectations."(Joseph, 2006) When the takt time is initially being calculated, it is important to

first consider when the levels of customer demand are peaked, ensuring that the process is capable of handling that capacity. Takt time benefits a process in several ways, "Essentially it provides a rhythm...stabilizing the production... it helps work cell designers as in an ideal cell all tasks are balanced... immediate feedback on performance is a powerful motivator..." (Joseph, 2006)

Value added work, "refers to those tasks that cause the product or service to advance to a more complete stage" (Carriera, 2006) and can also be described as anything which the customer would be willing to pay for. Value added processes are those which are involved in producing goods or services and are activities that add value to the product or service. Non-value added work, "includes the activities that do not move the product forward and fall into the seven categories of waste: the moves, inspections, process waste, waiting, excess motion, and so on."(Carriera, 2006) These non-value added activities typically add cost without benefits and should thus be eliminated from the process. The acronym DOWNTIME is often used to describe the most common forms of non-value added work, as described below.

D- DEFECTS O- OVERPRODUCTION W- WAITING N- NOT UTILIZING EMPLOYEE CREATIVITY

T- TRANSPORTATION I- INVENTORY M- MOTION E- EXTRA- PROCESSING

There are some instances in which it is difficult to distinguish between value added and nonvalue added work or activities. Base lining and benchmarking are techniques that can be used to differentiate between the two. Base lining is a standard for comparisons, a reference for measuring progress in improving a process, usually to differentiate between a current state and a future state, while benchmarking is a method for comparing a process using standard or best practices as a basis, and then identifying ways to improve the process.(Brue, 2009) Individuals involved in the system increase the difficulty of the determination of that which is value added and non-value added, as they view most of what they are doing as beneficial to the product or service. Most of what employees do throughout their day falls under the category of non-value added work; however, it is also important to remember that there are some necessary non-value added activities and required non-value added work.

To help eliminate non-value added work and cluttered workspaces, the team utilized a 5s method. 5s is the best way to start off the "leaning" of an area. The five s's stand for sort, straighten, shine, standardize, and sustain. Sorting is the elimination of all unnecessary tools, straightening is when you put everything in its place, shining is cleaning and keeping the work place tidy, standardizing is the act of making work consistent, and finally sustaining is keeping up with the previously listed items (Caldwell, 2009).

In order to become fluent in the applications of these lean strategies, it was important for our team to go undergo lean training at the White Belt level, which implies basic knowledge of lean concepts and their uses. However, the majority of our background knowledge of lean systems comes from our WPI classwork, where we learned methods for systems design, layout, and production strategy. Our understanding of lean systems was essential for our success on this project, and these concepts were the most prevalent in the recommendations we made.

2.3) Lean in Healthcare

In the past ten years, hospitals, and the healthcare industry as a whole, have undergone sweeping change, mostly due to rapidly advancing technology, economic turmoil, increased demand, and competition. Since 2000, most hospitals in the United States have experienced growth in competition from other hospitals in their expanding markets (Jones, 2009). The basis of this competition can often be traced to the presence of specialty clinics, which attract the best personnel. Many surgeons have been exploring the lucrative option of working autonomously as a private practice, which can be more easily marketed, and have a tendency to be more "personable and caring" (Parnell, 2004).

In order to compete, many hospitals are embracing the concept of specialized clinics, and offering specific treatment facilities, as well as pre- and post-operative care units. The decision for many hospitals to increase spending on patient care and creation of a more comfortable

setting is a costly one, but can result in an influx of patients. With the growth comes a need for a commitment to self-examination and many hospitals are turning to process analysis for help allocating the new resources in cost effective and efficient ways.

As the need arises to create more specialized and efficient units within hospitals, questions regarding deployment of new resources and the maximization of any spending done also become paramount. As a result, there is a significant opportunity for process improvement and analysis. It is imperative for hospital management to be able to establish a balance between service and efficiency, while keeping costs as low as possible. Another important facet of process analysis is decision making regarding personnel management, usually based on multiple factors such as availability, demand, and room utilization. Using lean techniques as a method to analyze and quantify these action areas is quickly becoming a popular avenue for hospital managers to assess their processes (Graban, 2008).

Lean techniques, detailed earlier, are originally a manufacturing tool, but the crossover is evident as soon as the processes in focus are dissected and compartmentalized. "Whether building a car or providing healthcare for patient, workers must rely on multiple, complex processes to accomplish their tasks and provide value to the customer or patient. Waste — of money, time, supplies, or good will — decreases value" (Womack et al., 2005). This is important to remember when attempting to implement a new, lean system in a hospital environment. Many times, nurses and administrative staff will hear the word 'lean' and contend that they are "…already understaffed (what they think 'lean' means, in everyday language) and already work as hard as they can" (Graban, 2008).

However, when presented to staff in an appropriate manner, lean strategies are easily absorbed into the everyday routine of the hospital. Many times in a hospital setting, lean solutions help to solve the "…everyday, nagging problems that so many committees and teams have already tried fixing" (Graban, 2008). The end result of using lean in healthcare is often the realization of a staff member or nurse that they have just solved an ongoing problem using a common sense solution. In this way, through individual members of the hospital community, lean is accepted one division at a time.

2.3a) Case Studies

In order to fully explore the effectiveness of using lean in hospitals, the team researched multiple cases which had dramatic success stories, and which have similarities to the strategies that would be used at UMass. These cases also illuminated positive and negative aspect of a lean transformation in a hospital, thus allowing our team the opportunity to reverse engineer our process and streamline our brainstorming. The most influential of the cases we examined was a hospital in Houston, Texas that had recently begun a project similar to ours.

St Luke's Episcopal Hospital

When Dr. David Pate took over as CEO of St. Luke's in 2006, he began to receive mixed reviews of the experience different patients had. Eager for a way to improve the quality of his hospital, which we found to be very similar in both layout and function to UMass Memorial, Dr. Pate became interested in the lean principles glorified by the success stories of Toyota, and the efficient way they are able to flow their business. He needed a way to transfer the principals used to manufacture cars to the healthcare sector, so he created a lean task force within the hospital staff to begin the transformation (St. Luke's, 2008).

The task force Dr. Pate created is comparable to UMass' CITC, which provides in-house improvement that works in conjunction with lean consultants to transform selected areas of the hospital. As the St. Luke's team developed, they were able to expand their work into different sections within the hospital, beginning with the Central Sterile Process Dept., which handles, distributes, and sterilizes supplies. This department handles \$4.2 million a year in inventory, and it was a primary concern of the joint task force to make their operations more efficient. After finding areas to improve on, such as the time it took to fill out an order (10 minutes), they set a goal time, in this case 6 minutes, and then used lean techniques such as standardization and visual management to improve layout and production scheduling within the department (St. Luke's, 2008). Our team will utilize these techniques in the Kaizen week improvements.

The St. Luke's team reached their goals for reducing time in sterilizing OR materials (16 minutes down to 12), and reducing costs by \$1.3 million annually by 2009. The team also has worked on the safety of the blood bank system, making it more efficient and mistake-proof to transport blood between different areas of the hospital, by planning out the routes better. Also, by

time-phasing and examining the inventory held by the pharmacy department, they were able to save over \$1 million on inventory and storage costs within six months of implementation.

The way that the St. Luke's team advanced through the hospital one department at a time is very similar to the way CITC is currently progressing through UMass. The next step on the St. Luke's team's revision of the hospital was the emergency department. Dr. Pate's team saw room for improvement on the 459 minute average stay, high diversion rates, and 8% rate at which patients left without being seen by a doctor. (St. Luke's, 2008) After value mapping and studying the methods used by the Emergency Department staff, the team proposed a method called Rapid Assessment and Disposition (RAD) to make the flow of patients more efficient. Under the old system, there were multiple bottlenecks and the waiting room was consistently over capacity as a result.

After only six months of utilizing this new system, patients' total visit time was reduced from 459 minutes to 310 minutes, and RAD patients to a mere 156 minutes. Also, the percentage of patients leaving without being seen by a doctor dropped from 8% to a very low 2%. Currently, the team is working on implementing standardization and centralization of supplies in the ED, including supply carts with designated usage zones to keep the equipment that is necessary for every procedure at close quarters, which eliminates the time that is often taken by staff to go and retrieve it. (St. Luke's, 2008) One of the supply cart docking stations is shown in Figure (2.2).



Figure 2.2: Example of RAD Lean Strategy at St. Luke's

As well as the obvious challenges of creating a feasible system and implementing it in such a fast-paced unit even by hospital standards, Dr. Pate's team encountered resistance from staff. Many of the longer-tenured the individual doctors and nurses, who were reluctant to change the way they had always done things. However, he was able to get them to be on board, saying "Remember, doctors are scientists first. So when you can clearly demonstrate that you'll get a better outcome that's good for everybody, they understand that." (Cook, 2008) After reviewing the improvements that the new lean systems have brought to the hospital, the staff realized that it was a viable way to make their jobs easier, and help the maximum number of people.

The challenges of the modern hospital, and the way that Dr. Pate's team overcame them became starting points for our team. The methods that they were able to use successfully served as a base from which we could expand our suggestions for improvements at UMass. We also investigated other hospital lean transformations such as Seattle's Virginia Mason, Michigan University Hospital, and Nashville Children's Hospital, but the St. Luke's case was most relevant for giving us a framework of the type of problems we would encounter at the PSE, and the ways we could mitigate them, before we became immersed in the project.

2.3b) CITC at UMass

UMass' Center for Innovation and Transformational Change is a relatively new department within UMMHC, and is focused on the improvement of hospital processes and operations. CITC approaches the massive task of implementing a lean transformation throughout the entire UMass Memorial system one unit at a time. At first, it was difficult for them to find sufficient funding or support to enter a unit and provide their brand of flow improvement. However, after two successful transformations, CITC is now in high demand within UMass, and there is a waiting list on departments vying for the opportunity to be the next one to receive CITC's help.

2.4) PSE/ UMass Memorial Background

The PSE area at UMass Memorial is located on the first floor of the Levine Cancer Center building in Worcester, Massachusetts. The Pre-Surgery office sees patients from three campuses found in Worcester: Memorial, University, and Hahnemann. Each of these hospitals performs various surgeries for patients, and patients from all three campuses are often required to attend an appointment at PSE prior to their procedure. Due to the diverse nature of PSE function, based on our research they have to accommodate and average of 110 patients a day.

2.4a) PSE Layout

The PSE area is allocated with sixteen exam rooms, six anesthesiologist offices, an area designated for chart preparation for before the patients come in and chart compilation for the folders to go out to their respective campuses after the visits, an initial check in desk, a formal registration area, two waiting rooms, a lab room, and rooms for the RNs and NPs to do the research on the patients. An overhead view of this area is available in Figure (2.3).



Figure 2.3: Pre-Transformation PSE Floor Plan (Red line indicates reduction from 16 to 8 exam rooms)

This layout will be significantly altered because PSE is losing eight of its exam rooms to another group in the hospital. The two most important things that are a concern when changing the layout of an area like PSE are patient and information flow. The team, along with CITC, has made several proposals of ways to alter the layout of PSE in order to accommodate all of the needs of the staff and to still see the 110 patients a day that is required of them. An important factor in the proposals is the goal of 100% patient satisfaction, so each layout must be tailored toward not only nurses and staff, but patients as well. The final layout is shown in Figure (2.4). A number of the other proposed lay out changes have been made available in Appendix A.



Figure 2.4: Approved Future Layout of PSE (UMass CITC)

3.) Methodology

3.1) White Belt Lean Training

To learn applications of lean in healthcare, the group attended a Lean Six Sigma Overview training session held by CITC at UMMHC on September 13th, 2010. During the session, the team also learned about lean processes that were already in progress at UMMHC, and the financial benefits associated with them.

The most important topic covered was value stream mapping, including look at each of the steps, Current State Mapping, Future State Mapping, and Creating an Action Plan. The importance of standard work was also emphasized, with a greater focus on the individual parts. This part of the training constituted the foundation of the Lean Healthcare House Model, which is a variation of the well-known Toyota Model Figure (3.1).



Figure 3.1: Lean Healthcare House Model (Altarum)

The parts of the house model discussed included Just-In-Time, Takt time, Continuous Flow, One-Piece Flow, Pull System, Quick Set-Up, and Total Productive Maintenance (TPM). After learning the basic concepts and their applications in a hospital setting, each of the three meetings that are required for a successful A3 (reporting form for lean improvements) was defined. The final pillar that was included in the Lean Healthcare House Model is the People pillar. At this point in the seminar, there was another discussion on the "Decoding the DNA of the Toyota Production System" and its successful application in healthcare. The group was taught the importance of creating a 'non-blaming' culture, and the questions, that as being leaders in change, one must be able to answer.

3.2) Future State Event

3.2a) Interviews

Participating in the future state mapping event on December 4th, 2010 gave the group an opportunity to speak with many of the people who would be involved in the upcoming Kaizen events and ask them questions about the current process. We were able to immerse ourselves in the issues faced by each of the different groups represented at the meeting, and to see the way the different staff members interacted.

The two lean consultants, Jerry Berlanga and Dean Bliss were helpful to the team when determining what types of techniques they would use in the process of helping to make PSE lean. They were also essential to facilitating the discussion when there was conflict regarding needs and desires of different departments. The two process owners from PSE were Judy Cote, the Director of Perioperative Services, and Nancy DeLuca, Manager of PSE. They both played vital roles in the organization and administration of the meeting, and the project as a whole.

3.2b) Preliminary Data Collection

In order to facilitate the future state planning meeting and provide an accurate view of the current process of PSE, our team collected data from patient visits to the clinic. We recorded the flow of patients through the duration of their visits, segmented by each step of the PSE process from arrival to check out. We also tracked chart flow as it moves through the PSE from the front registration desk to the chart compilation desk at the back end, and analyzed each step. The information that we were able to extract from this data led to our identification of bottlenecks, differentiations between patients, and current utilization of employees (nurses, NPs, and PCAs). An example of this data can be found in Appendix F.

Our main focus was on the flow of the patient from the time of entry to the PSE to the time of departure, known as door to door. In order to collect relevant data, we broke the visit into four distinct segments: entry time to time called for examination, RN examination time, NP examination time, and time in anesthesia. We then added the full length of stay time, for five separate data points for each patient we observed. We were then able to create an entry for each patient, based on the information from the PSE daily schedules, which provided us with details regarding age, type of procedure, campus that surgery will take place in, and any other comments that could affect stay time, such as being in a wheelchair.

The additional details provided by the schedule and the staff were extremely important to our efforts, as we were able to assess the correlation between type of procedure, age, and campus of surgery and the amount of time spent by each respective staff member in the exam room with the patient. We collected patient data for over five weeks, then compiled the data into patient logs, and then analyzed it using graphs to show time sequencing and trends. Figure (3.2) below shows a sample of the team's data collected on the time spent in exam rooms by the RN responsible, over a week of observation time.



Figure 3.2: RN Exam Time Data 12/21/10-12/28/10

We were able to then use this data to identify the causes of such inconsistency, matching specific points to factors in our patient entries to make a connection between type of procedure,

age, and campus and the time it took the RN to examine the patient. We used the data collection methods outlined in this section at multiple phases of our project, as the need for tracking the progress made by our improvements increased.

In addition to the patient flow data, we examined chart flow from its entry to PSE to its eventual departure via couriers that come to pick it up. In mapping chart progression through PSE, we were able to view the information flow from front to back end of the progress. We followed the charts' path on our Gemba Walk, which will be covered more thoroughly in the next section, and determined distance travelled, and minimum and maximum times for each step along the process.

The chart flow was broken down into a different category for each of the three campuses of origin, and then each campus' path was further divided into 11 steps, eight of which are consistent for each campus. We found that the charts originating from all three campuses had the same process time from chart prep to the exam room (18 minutes), but from the exam room to pick up, the times diverged, within a 13 minute range (20 to 33 minutes). The distances traveled by each chart varied as expected, with Memorial charts travelling 101 fewer feet than the other two, farther away campuses. Detail copies of the data collected can be found in Appendices B and F.

3.2c) Gemba Walk

Another precursor to the future state meeting, and a way to get more familiar with the layout and functionality of PSE was the Gemba Walk that our team participated in. A Gemba walk, often referred to by the CITC team as a 'Billy Walk', is a physical recreation of the path taken by the flow of production and information through the entire process. The manager of PSE, Nancy DeLuca, and two of the PSE staff were the process owners for the Gemba Walk, and led us step by step through the progression of each patient and chart, stopping at checkpoints to discuss which function was performed where, and by whom. The Gemba Walk was imperative for our team to get further acquainted with the way things works, current state, at PSE, and was fundamental to our development of process improvement strategies.

To begin, we were introduced to some of the members of the Kaizen team that we would be working with in the coming months. Nancy DeLuca, Judy Cote, and Dave Scottow, head of the Altarum consulting team all became valuable resources for us, and helped us formulate and implement or suggestions for improvement. We were handed copies of the current floor plan, complete with an outline of the areas that would be taken from PSE usability, and then walked to the area that would be eliminated to gain some scope on the problem. PSE's 16 rooms would be reduced to eight, and at the time of the Gemba Walk, the staff was beginning the conversion into a significantly smaller space, and still working out the kinks as best they could.

We first followed the path of each chart, from station to station, showing us the complicated route that each folder had to take before being ready to exit PSE. The current state process was erratic, and there was an inordinate amount of time wasted carrying the chart from one step to the next. We also noticed a few bottlenecks along the way, including storage at both ends of the process, with overflowing containers seemingly the norm. The leaders also informed us of delays caused by the campuses sending the correct medical records to PSE, resulting in confusion and delays for PSE staff.

After tracking the chart through its journey, we were walked through the patients' steps through PSE. In the current system, there was a necessity to move patients from room to room, resulting in a provider-centric process, rather the more efficient and more user friendly patient-centric model. During this walk we learned what functions each different type of provider (RN, NP, PCA, and Anesthesiologist) performed at each step. The common nature of the training of the providers immediately gave us the idea of cross training, a lean concept that we utilized throughout the project.

On the Gemba Walk, we also learned that there were two doctors currently using PSE space for their appointments, taking up resources and floor space to perform a function independent of the PSE. This information was used later, as well as the off-hand mention that staff meetings on Wednesdays formed a bottleneck. Overall, we learned a lot from the interactions that the staff had with each that were not presented to the team on the walk.

After the Gemba Walk was completed and we had had the debrief meeting, we created a spaghetti diagram showing the movements of both patients and charts. This spaghetti chart proved to be extremely useful for us in our reconfiguration of the PSE systems, showing the places we had room to improve and giving us a baseline for times and steps in the process that

we could tinker with along the way. It also enabled us to create a proposal based on our data collected and the layout principles we had learned in our training session for a new layout of PSE, shown in Figure (3.3).



Figure 3.3: Proposed Layout for PSE After Gemba Walk and Future State Meeting

3.3) Ideal State

The ideal state of PSE was addressed immediately during the future state mapping event. A UMass employee whose mother was a patient at the clinic, and had experienced for herself the process at the PSE was invited as a guest to share her experience and offer any advice that she thought might be helpful to our improvement. She was mostly critical of the PSE's accessibility and the way she and her mother were left in a room for an extended period of time due to a scheduling mistake caused by the soon to be replaced nurse accountability system. The issues brought forth by the employee were the basis of the project goals regarding patient satisfaction.

The general layout of the waiting room was an initial problem affecting patients, especially those arriving to the clinic on stretchers, those requiring the use of walking aids, or individuals being maneuvered by wheelchair. Chairs and tables were positioned in a way that made it difficult for many people to move around or wait comfortably, especially at times when the office was crowded with people waiting to be seen. The guest at this mapping event felt staff should have noticed the struggle with her mother's wheelchair. Aside from modifying the physical layout of the waiting area, it was suggested that the employees at the desk start greeting patients to show hospitality and also to direct them to the appropriate place.

After the patient informed the front desk that they had arrived for their appointment they were sent to registration and gave the information to be recorded and filed into their chart. As a remedy for this time consuming step, many at the mapping event advocated for online preparation or questionnaires that can be filled out while the patient is in the waiting room to reduce the time taken to ask and answer questions at a later point by personnel. Our team, along with a member of the CITC staff, also devised an algorithm that detailed a phone screening process that can be used for preliminary patient assessment. The algorithm is a standardized work order for any personnel that would be making a screening call, and was approved by the Head of Registration for use after the Kaizen event. A diagram of the process is shown in Figure (3.4).



Figure 3.4: Preliminary Phone Screening Algorithm

When the patient had completed their registration, that information was printed and their chart was compiled and prepared for the RNs and NPs. Those working at the front desk found

the chart compilation process to be more time consuming than necessary and suggested that the system be reworked to make the process more efficient.

It was brought to everyone's attention at the meeting that a scheduled itinerary for the patient would be helpful for them to understand the process that they would be going through throughout the duration of their pre-surgery appointment. A schedule of the care to be given to the patient would allow for time estimation for their visit, an estimated length of their scheduled surgery, and a checklist to ensure that they went through the necessary requirements. This would help to eliminate the instances where patients do not receive a certain test or lab before surgery, and are forced to come back to the PSE for an additional appointment.

After the patient has completed the registration and their compiled chart is taken by the nurse, they are called into an exam room where they are seen by a registered nurse and a nurse practitioner. The guest at the future state mapping event was extremely dissatisfied with the quality of care given to her mother throughout this visit. She felt as though the staff was unmotivated and not attentive to the needs of the patients. There were several occasions where questions were asked by her or her mother regarding their appointment, the surgery, the aftercare necessary, instructions for before surgery, etc., and they were left unanswered. She had calculated that a majority of their time at the PSE was spent waiting to be seen by someone. This was disheartening to the staff that was present at the mapping event. The ideal state was quite obviously to improve each of the addressed issues. Timely responses to questions being asked and tangible instructions for pre-surgery and post-surgery care were objectives for the speculative state. Improved attitude and moral among staff members was considered a necessity for the future of the Levine Center. Utilizing time and reducing the overall wait time for patients was expected by the staff. Most important was the quality of care given to patients being improved, making them the priority and being more attentive to their needs was a change that was inevitable.

After being examined by a registered nurse and nurse practitioner, the patient is brought from their exam room to another waiting room to see the anesthesiologist, creating a bottleneck in the process. Potential explanations for the anesthesia bottleneck include understaffing, defects in the scheduling process, and anesthesiologists' inefficiency. The unpleasant experience of the guest continued with the anesthesia review, as they were required to wait for over an hour before being seen for a brief anesthesia evaluation. The patient was then required to return to anesthesia at a later date to retrieve her care instructions, showing a need for more personal attention for each individual patient

The time spent at the PSE for this particular pre-surgery appointment was approximately three hours five minutes, with the time spent with specialists amounting to approximately 45 minutes. This is an outlier, as the average time for a patient's stay at the PSE was two hours twenty minutes. However, it was obvious that such outliers must be prevented by the new system, and reducing waste time, standardizing of certain aspects of the process, eliminating rework, utilizing time properly, and better preparation, among other things, are all areas for improvement to reduce the length of appointments.

3.4) Design of Improvement Transformations

After collecting our data on the flow of both patients and charts through the PSE and analyzing the results to frame our main problems, the team had an understanding of the main needs for improvement and the lean tools that we would implement to improve upon those problem areas. The team held a meeting along with Dave Scottow from Altarum and Nick Comeau from CITC to divide the PSE processes and identify the lean techniques that we would use during the Kaizen event on each problem area.

After analysis of the chart preparation area, the group decided to create a standard work system to decrease the time for registration, as well as the time used for training new employees. We also implemented a new schedule distribution process to expedite the process by which each nurse received a copy of the day's schedule and the appropriate patient charts for each section of the day's work.

The team also recognized the backlogging of resources in the chart compilation area, and decided to try to implement a pull system, including a 5s reorganization of the workspace to eliminate redundant work and create a smoother transition from front end to back end of the process. After diagramming the chart comp workspace, the team designed a new layout that would maximize the limited space available and create a new inventory management system using kanbans. The diagram in its approved state is shown in Figure (4.3). The completion of the design process marked the end of the preliminary planning stage and the beginning of the

implementation stage, in which the changes our team proposed and CITC approved would be made in the PSE. The team was able to enact these transformations during the Kaizen event, and we also found that there were other improvements that we did not anticipate, but had to adjust to during the event. The combination of planning, design, and on-the-fly improvements was a major contributing factor to the success of our project.

3.5) Kaizen Event

The first Kaizen Event was held from January 3rd till January 8th at the PSE. The two main topics for this Kaizen event were creating a more efficient information flow, and implementing the changes that had been approved for the new layout. Prior to our participation in the event, we spent two additional weeks collecting data inside of PSE to provide a baseline for any changes we made. This data can be found in Appendix B. The first day of the event was spent refreshing the lean tools and reviewing the plan for the week, then our team, worked with the CITC team, various members of the PSE staff, including RNs, NPs, and PCAs, and lean consultant, Dave Scottow to implement the changes.

3.5a) Goals

The process of the lean transformation of the PSE has multiple goals as laid out by the Process Improvement Charter, shown in Appendix C. Each of these goals are important in each segment of the Kaizen event, but in the first Kaizen event the focuses were 100% complete and accurate patient chart, maximum 75 minute throughput, and positive patient experience/safe for surgery (from both the provider and patient point of view). For the Kaizen event, the large team split up into smaller groups, with one group focusing on the Chart Preparation process, another group concentrating their effort on making the Chart Comp process, and yet another focused on the patient to exam room process. However, all team members participated in every facet of the transformation, and there was significant overlap of responsibilities. Each of the groups will measure the errors/inconsistencies in the patients' charts before they are sent to Hahnemann, Memorial, or University Campus as well as the percentage of surgeries that are delayed due to PSE errors.

Each member of our team was assigned to a different group to act as a lean coach and process specialist for that area. We used the lean tools we had learned in classes as well as the White Belt training to implement the changes agreed upon in the preliminary meetings. Each

member assumed a greater leadership role as the event progressed, and responsibilities included creating lean workspaces, designing just in time production systems for charts, using kanbans for inventory management, and training staff to utilize the new methods.

4) Results

4.1) Chart Preparation

One of the groups was presented with the challenge of leaning the Chart Prep process and area. The way the system was set up upon the groups' arrival to PSE on January 5th was that all of the charts would be made the night before by some of the PSE staff, and would then be pulled from two large metal crates as the patient was called from the waiting room. All of the forms for the Chart Prep were located in the back hallway across from the PSE's Manager's office, with the extras scattered throughout various filing locations inside of PSE. The majority of the surplus forms were located in closet, with no labels or sorting.

4.1a) Staff and Lean Techniques

There were several people from different sects of the hospital in the group that focused on Chart Prep. The primary people involved were Nick Comeau and Jennifer Groves (CITC), Brandon Cooney (WPI), and Maria Rodriguez (Registration Staff), and Kelly Peterson (PCA), both from the PSE staff. Everyone involved participated in the lean training, and would be essential to the success of the project.

There were several different lean techniques in order to make the changing of the Chart Preparation. The first technique the group used was 5s, followed by Pull Systems, Flow, Standard Work, and at the end they were able to set up a Kanban system. All of these processes together were able to help the group make the Chart Prep process significantly improved.

4.1b) Changes Made

The first change made by the Chart Prep group was to move Registration to left most part of the waiting room. In order to do so, the whole back area had to be 5s'd. Another change made along with the moving of Registration was the process. Registration was now happening once the patient arrived to PSE. An andon signal will be set up to notify the people at Registration upon a patient's arrival; the Registration staff will then call the patient over and begin the patient registration process.

The next change to be made was the relocation of the actual Chart Prep. Chart Prep used to be located all around PSE. The group centralized its location in the small space in between the Registration group and the Greeting Desk. This area was 5s'd also before anymore of the

changes occurred. Since the group was trying to instill lean methods into PSE, they set up a pull system for the Chart Prep. The PSE staff would no longer make the charts the day before, but instead as the patients arrived. After Registration had finished their job, they will utilize another andon signal to the staff at Chart Prep who will then create the patients folder. Once the chart was completed, the staff would then place it in a location behind the Greeting Desk, where RNs, NPs, and PCAs could pull the folders and call the patients. In addition to the creating of the folders, the forms used to be put in a random order on a back wall. The order of the forms was standardized and labeled as to which goes when. A Standard Work list was created in order to help people to be able to quickly learn the process. Since the three different hospitals that PSE serves require different forms to be filled out prior to surgery, a different colored indicator was created for each of the hospitals. Also, if there is a patient under the age of twelve, they are considered a Pedi, and also require different forms, so the group had to account for labeling these forms as such. Since it was not possible for all of the supply to be held in the Chart Prep area, a Kanban system had to be implemented. Figure (4.1) shows a before and after comparison of the chart prep. area after the team implemented its layout changes



Figure 4.1: Before and After Chart Prep

A two part Kanban system was created, one at the Chart Prep area, and another in the storage closet. When the group first visited the storage closet, it was in complete disarray. All of the forms were scattered throughout the closet, with no labels on which was where. It was basically luck of the draw when a staff member would pull a stack of papers. The forms inside of the closet were organized and set up in the same order as they were in the Chart Prep area.

Each of the stacks was labeled with what form they were, and equipped with a Kanban card to be taken to the PSE Manager who is in charge of ordering the forms.

4.1c) Results

As a result of the work the group did the Chart Prep process and area went through vigorous leaning. A Standard Work list was created for Chart Prep; a Pull System was set up; from Greeter to Registration, Registration to Chart Prep, and Chart Prep to the RNs, NPs, and PCAs. This change led to a 16.7% reduction in registration time (14.3 minutes), lowering the average time from entering the PSE to completion of registration to 31 minutes. Also the standard work was made straightforward enough that a new PSE staff member was able to learn the process in two days after training from one of our team members. Most importantly, the registration staff has all given positive reviews to the new system, and have 100% adopted the methods as of the 30 day follow-up meeting.



Figure 4.2: Registration Time Data (1/6/11)

4.2) Chart Compilation

Another focus of the Kaizen Event's analysis was the area in the back of PSE designated for chart compilation. This area is the endpoint for charts after the patient has gone through the presurgical process. The employees assigned to this area are a combination of PCAs and administrative personnel. Their job consists of taking completed charts from the end of the examination process, then processing, collating, and adding the relevant paperwork to complete the chart binder. The finished binders are then placed in bins to be collected by couriers and taken to the appropriate campus.

4.2a) Goal

Our goal was to reduce the amount of time spent on the chart compilation, in order to free up personnel for utilization elsewhere. To accomplish these goals, the team of Dave Scottow (Lean Consultant), Diane Alves (RN), and Zach Roche (WPI) documented the space needed, time spent and information flow used by the employees in chart compilation. Additionally, the team explored, and ultimately decided to implement a change in layout of entire area, as detailed earlier. After creating a scale drawing of the chart comp. area (Figure (4.3)), we were able to use scale diagrams of the available organizational materials (desks, shelves, etc.) to create different iterations of the area.



Figure 4.3: Scale Floor Plan for Chart Comp

We then mapped our process from start to finish, and using the results, found a way to lay out the area so as to add the most value while also increasing the efficiency of the employees. Our team utilized a pull method for completing the charts, and created a Kanban system to maximize the use of resources and minimize the superfluous storage space. After deciding on a system that satisfied all of the goals that the team established at the beginning of the process, and consulting with the chart compilation employees, we removed the massive, redundant storage shelves that encumbered the desks, and replaced them with our revamped Kanban system. Before and after pictures are shown below in Figure (4.4).



Figure 4.4: Before and After Chart Comp

After completing the transformation, the team then talked with the affected personnel and trained them on the ways in which to use the new setup. After a brief period of resistance, they were widely accepting of the system, and actually found it to be easier than the original. The remainder of the Kaizen event, for the chart comp. area, was dedicated to tweaking the design and working alongside the staff to idealize the work area.

4.2b) Results

By changing from a batching approach to a just in time system, the team was able to reduce the time from backlogged stocking to 4 minutes 44 seconds on the first day, to 3 minutes 31 seconds on the final day of the Kaizen event. This exceeded the goal time of 4 minutes 30 seconds that was originally stated in the future state meeting. The team was also able to completely eliminate the large (60"x45") storage shelves shown in Figure (4.4) that took up the majority of the workspace and create a completely 5s'd workspace with a much more efficient kanban system.

4.3) Patient Flow Improvements

In order to improve the efficiency of the PSE process, the team implemented some of the same lean tools employed by Toyota in their renowned manufacturing plants. We based each change on data collected, value stream mapping, and results of the future state meeting. However, one of the major influences on both our team and the CITC team was the input that we received from interviews, formal and informal, with the PSE staff. By familiarizing ourselves with the everyday issues faced by the RNs, NPs, and PCAs, we were able to work on a system that was both efficient for patient flow and convenient for the PSE staff.

4.3a) Standardized Exam Rooms

One of the issues facing the improvement team was the inefficient deployment of resources throughout the PSE. Materials that are required for every patient that enters the system were interspersed seemingly at random throughout the wing. In order for each NP and RN to do their job in a timely manner so as to fit the goals laid out by management, it was important for the nurses to have an easy way to access their equipment. We decided to implement standardized exam rooms, which is used primarily in manufacturing settings. To do this, we interviewed the PSE staff, and compiled a comprehensive list of all the equipment necessary for the majority of the procedures done at PSE. The input from the nurses, along with guidance from our lean consulting team, allowed PSE management to put in an order for the equipment needed to create these standardized rooms. An example of what our standard rooms will look like when implemented is shown in Figure (4.5).



Figure 4.5: Example Standardized Exam Room

4.3b) Andon System for Coordination

To address the problem of non-value added work and downtime for the staff, we decided to test out a simple andon system, which is a method of visual management invented by Toyota, and informs employees of the current status of a given exam room based on clearly visible cues. The beginnings of the andon system were already in place, but had not been utilized by the staff. The improvement team was able to devise an easily recognizable system to inform the nurses of who was with a patient currently, what stage of the PSE process the patient was going through, and what the next steps in care were. The andon signals were difficult to implement at first, mostly due to omission of their use by busy nurses, but as they began to adopt, they became a useful tool and led to the creation of a more effective go to work system. A picture of the andon signal used in the PSE is shown in Figure (4.6).



Figure 4.6: Andon Flags Used in PSE

5) Future Recommendations

An important aspect of the work we did is continuous improvement on the processes we implemented. The best way to judge how well the implemented changes are going is by having following up meetings with PSE staff members and CITC. Though the ideal state has not been met at the time of this report, the processes are moving closer to the ideal, but can always be improved upon and tweaked to help make the overall process as streamlined as possible.

5.1) Follow Up Meetings

Follow up meetings are important to the success of implementing any new processes, which is why the group set up meetings at thirty, sixty, and ninety days after the Kaizen event. We have already had our first follow up meeting, in which we were able to conclude some very important metrics including a 100% adoption rate. This was one of our very early struggles that we were very happy to see. With the staff subscribing to the changes, they have also worked on the some of the processes and made some adaptations they came up with themselves.

The data from the follow up meetings since the Kaizen is still being processed by the CITC staff. But we have been informed that the metrics, thus far, have shown a substantial improvement in comparisons to the times from before the event and are approaching the original goals set by the charter.

5.2) Continuous Improvement

As a part of any improvements, it is important that they do not stop after the original implementation. The staff must embrace the changes, and make them their own in order to ensure continued success. One of the big changes that the staff made was to the andon flags. The staff decided to tweak the meanings of each of the colors so it was easier for them to see where in the process each exam room was.

Another area where the staff decided to change the process to better fit the needs of the PSE staff was at Chart Preparation. There were points in time when the Chart Prep staff would have completed their work, and already completed everything on the "Go-to Work". As a staff they decided to add a task to that list, and it was to utilize the newly implemented inventory management system and replenish their stock.

Both of these are important for us and CITC to witness because, not only did it show us that everyone had supported our changes, but they were looking to make the process better and adjusting it to fit their needs. This process is the essence of continuous improvement, and the best way for PSE to surpass its goals.

6) Conclusions

6.1) Effectiveness of Lean in Healthcare

Though lean techniques began as a way to improve manufacturing processes, we have learned that many of the most effective methods can be transferred to other industries, including healthcare. Our team was able to tailor techniques such as 5s, visual management, just in time, one piece flow, and standard work to fit the needs of the PSE. Our customization of those common lean techniques for the hospital setting was the driving force behind this project, and directly led to our success. This project has given our team the confidence that lean healthcare is in fact an attainable goal, and when implemented, can lead to success for production metrics and also financial gains.

6.2) Training PSE Staff in Lean Methods

One of the challenges about going into a work environment and trying to implement a change is getting people to be behind the changes that are being executed. When implementing all of our new processes, we were fortunate to have at least one staff member who supported the change. They were able to persuade some of their fellow PSE staff members to give the new processes a chance. There were staff members who still resisted the change though, and it was forced upon them. The staff most affected by the changes, began to adopt the new methods once they were able to witness how effective the new process was in comparison. An example of one of these such people worked in Chart Comp, and didn't fully accept the change until he saw how much more efficient the new process was.

Through this we were able to learn how resistant people actually are to change. It took us showing one of the staff members how the new process will make his job easier and less stressful in order for him to try the new process. As a group, we all assumed that things would change with no real resistance from the staff, so when we actually encountered a lot of it, at first we were a bit shocked. Thanks to a few people in the staff who were completely behind the change, it made the transition easier. We were also able to learn the importance of inside help when attempting to make changes in a work environment.

We were also able to finish the Kaizen event with the confidence that the staff had begun to create a streamlined work environment, and that they would work to improve what we were able to accomplish throughout the event. At our follow up meetings, we were able to see how effective our changes actually were, and how well the staff had adopted the new, lean methods. Their ability to take some of the processes we had implemented and adapt them to be a better fit at PSE is an integral part of the transformation process, and the basis for continued improvement.

Appendix A: Proposed PSE Layouts











Appendix C: Project Charter

| Project Information | | Process Purpose | Problems/Case for Change | | |
|--|---|--|--|--|--|
| Leadership | Participant/Process Representatives | Pre-surgical evaluation for | Number of rooms/ space available to clinic is being | | |
| Executive Steering <u>Committee:</u> Peter Foley · Richard Perugini; Surgeon | Team members and Dept : • Peter Foley • Richard Perugini; Surgeon | patients having surgery at the Hahnemann, Memorial or University campus | reduced • Patients can wait up to 6 hours before they even get to an exam room • Charte are inaccurate missing or aren't available | | |
| • Barbara Wilson | Shubyeetkaui Sudershan Singh Jery Piley, Sheile Maranelo: Bocking | | Charts are inaccurate, missing, or aren't available Patient complexity is not known ahead of time Miscommunication between campuses and within PSE | | |
| ProcessOwner: Judy Cote Nancy Deluca | • Donna; Scheduling • Dr. Preuss | acretary Project Goals Donna; Scheduling Dr. Preuss | | | |
| Embedded/Central Coaches: | Linda Anderson; SACU PACURN Manager Kelly Peterson; PCA Martha Boyd, Mike Kelly; Facilities | Goals/Key Measures: • Positive patient experience / safe for surgery (provider and | Large amount of waste in process dealing with visits the can be done over the phone Patient education inadequate or unnecessary | | |
| Lean Coach/facilitator: • Dave Scottow | Diane, Nancy, SACU Jill Machamara; University NP Chris Russo: Memorial RN | patient point of view) • Maximum 75 minute throughput, 30 min for simple | Patient cancellation/delays of surgery because of non- healthrelated issues Provider dissatisfaction with process | | |
| Victoria Diamond | Mary Abraham; University RN Diane Alves; Hahnemann RN Micki Kother; CRNA | cases • 100% complete and accurate patient chart | | | |
| - <u>CITC Support:</u> | Maria: Billing | Minimize cancellation/delay rate | | | |
| Nick Comeau | 2 Patients or families IT Systems | All necessary information available 2 days prior to day of | Project Time Frame | | |
| • <u>Observers</u> • Brandon Cooney | | surgery | Milestone/Date | | |
| Zachary Roche | | Metrics: | • GembaWak – 11/04/2010 | | |
| Alyssa Xarras | | Length of Stay Errors/inconsistency in Chart | Planning Meeting #2 – 11/22/2010 | | |
| | | preparation | FSM Event - 12/04/2010 Kainan Event - 01/02/2010 Kainan Event - 01/02/2010 | | |
| | | % of surgeries that are started on time | • Kalzen Event – 01/03/2010 – 01/07/2010 | | |
| Process Scope: Start/Stop | Process Scope: In/Out | Cancellation rate(s) | ~30 day follow-up/Audit (25% of Action Plan done) | | |
| Start: | In Scope: | Delays in surgery | ~60 Day follow-up/Audit(50% of Action Plan done) 00 Day follow-up (Audit (75% of Action Plan done) | | |
| Decision made for surgery | Preparation work before PSE visit, PSE visit, and review work up to the day of surgery | Morbidity / mortality related to pre-op Number of Cases handled over | • ~ 90 Day to low-up/Audit(/ 5% of Action Plan done) | | |
| Chart review in SACU, day before or morning of surgery | Out: • Patients who are delayed prior to initial PSE visit | the phone • Patient/provider satisfaction surveys | | | |
| | Patients who have complications that prohibit initial PSE visit | | | | |

Process Improvement Charter: Pre-Surgical Evaluation

Last Update: 11/23/2010

Charter Owner: Barbara Wilson

Appendix D: Kaizen Event Patient Times

| In Clinic to Registration Complete | | In Clinic to Exam Room | |
|---------------------------------------|----|---------------------------|-----|
| Mean 20 | | Mean | 56 |
| Median 18 | | Median | 53 |
| Max | 90 | Max | 123 |
| Min 1 | | Min | 10 |

| Without Anesthesia | | | | | | | | |
|---------------------|-----|-----|-----|----|--|--|--|--|
| Mean Median Max Min | | | | | | | | |
| RN Exam Time | 18 | 17 | 40 | 2 | | | | |
| NP Exam Time | 13 | 12 | 37 | 2 | | | | |
| PCA Exam | | | | | | | | |
| Time | 4 | 4 | 7 | 2 | | | | |
| | | | | | | | | |
| Waiting Time | 15 | 15 | 43 | 0 | | | | |
| Dwell Time | 103 | 100 | 185 | 64 | | | | |

| With Anesthesia | | | | | | | | |
|---------------------|-----|-----|-----|----|--|--|--|--|
| Mean Median Max Min | | | | | | | | |
| RN Exam Time | 19 | 20 | 42 | 1 | | | | |
| NP Exam Time | 15 | 15 | 57 | 2 | | | | |
| PCA Exam | | | | | | | | |
| Time | 8 | 7 | 25 | 2 | | | | |
| Anes. Exam | | | | | | | | |
| Tim | 16 | 15 | 55 | 4 | | | | |
| | | | | | | | | |
| Waiting Time | 37 | 37 | 95 | 5 | | | | |
| Dwell Time | 152 | 150 | 237 | 73 | | | | |

Patient Registration to Nurse Interview/H&P Complete 1st Day Data



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Appendix F: Preliminary Data for Patient Flow at PSE

Inpatient

| # | Process Step | P/T (minutes) | Max | Notes | Distance traveled by Patient (ft) |
|----|--|------------------|-------|-------|---|
| 1 | Patient called from waiting roon station | and brought | to RN | | 30 |
| 2 | Weight, height, vitals taken | 1 | | | |
| 3 | Brought into exam room and wait for RN | | | | 47.3 |
| 4 | Flow Sheet, Lab Sheet, Testing Orders | 2 | | | |
| 5 | RN does Medication Reconciliation | 8 | 20 | | |
| 6 | Surgical history, Health Care Proxy. Review allergies. Asks if patient has MRSA or VRE | 2 | | | |
| 7 | Perianesthesia Inpatient Record | 2 | 2 | | |
| 8 | Initial Patient Assessment | 15 | 25 | | |
| 9 | Patient instruction sheet | 5 | 7 | | |
| 10 | Pre-op Teach sheet | 5 | | | |
| 11 | Surgery Specific Sheets - Doctors orders, Labs, N Blood Products, Abortions, ESWL | 2 | | | |
| 12 | Ortho Specific Sheet | 15 | | | |
| 13 | Vascular Specific Sheet | 5 | | | |
| 14 | EKG, Bloodwork? | 2 | 10 | | |
| 16 | NP Reviews patient informataion before entering room | 8 | 20 | | |
| 17 | Review activity level, neurological info, urinary and abdominal, bleeding, muscular, skin, endocrine, diabetes, sex specific info, Social history, Family history | 5 | | | |

| 18 | Review special information (cardiac, respiratory, vascular, orthopedic, Pedi) | 7 | 10 | |
|----|---|-----|----|-------|
| 19 | Review Vitals | 0.5 | | |
| 20 | Physical | 12 | | |
| 21 | Write Notes | 5 | | |
| 22 | NP Reports Out to Anes special concerns, extra qeustions, etc. | 1.5 | | |
| 23 | Patient Leaves Exam room and checks out at front desk | | | 87.3 |
| | | | OR | |
| 24 | Patient Brought to Anes Waiting room | | | 122.3 |
| 25 | Anesthesiologist reviews chart | 2 | 15 | |
| 26 | Patient brought into Anes. Office | | | 24 |
| 27 | Anesthesiologist reviews info with patient | 20 | 45 | |
| 28 | Patient leaves Anes. office and checks out at Front Desk | | | 65 |

| | Avg P/T (minutes) | Max P/T (minutes) | | |
|----------------------------------|----------------------|----------------------|----------------------|-------|
| Time Spent with RN | 39 | 54 | | |
| Time w/ PCA for blood/EKG | 2 | 10 | | |
| NP review/report-out w/o Patient | 9.5 | 20 | | |
| Time Spent with NP | 29.5 | 10 | | |
| Time with Anesthesiologist | 20 | 45 | | |
| LOS w/o Anesthesia | 80 | 94 | Distance traveled | 164.6 |
| VA Exam Time | 68.5 | 64 | | |
| NVA Exam Time | 11.5 | 30 | | |
| LOS w/ Anesthesia | 100 | 139 | Distance traveled | 375.9 |
| VA Exam Time | 88.5 | 109 | | |
| NVA Exam Time | 11.5 | 30 | | |

Appendix G: Value Stream Map From Planning meeting



Appendix H: Glossary

RN – Registered Nurse. Normally the person to retrieve the patient from the waiting room, and is normally the first person to see the patient

NP – Nurse Practitioner. Normally the person whose job it is to review the patient's information and determine whether or not the patient needs to see the anesthesiologist.

PCA – Patient Care Associate. They are normally the ones whose responsibility it is to take the necessary blood work from the patient, and take an EKG if necessary. They also have the flexibility to do their job whenever is best for the NPs or RNs, as long as it is before they leave to see the anesthesiologist.

EKG – Electrocardiogram. A device which measures the electronic activity in the heart over time.

Value Stream Mapping – Diagramming and identifying the current flow of information and patients through PSE. We used this to understand how the process worked inside of PSE, and what non value added work could be eliminated.

Pull Systems – Demand based inventory management system, dependent on specific need.

Standard Work – A step by step process detailing what an employee should be doing at a certain work station. We utilized this technique at Chart Prep.

One Piece Flow – One piece flow was implemented because it eliminates wasted time and non-value added non-required work that would result from a patient not attending their scheduled appointment.

Standardized Rooms – A technique in which all of the work stations are set up identically so everyone who uses it knows where the necessary items to complete the tasks are located. We standardized the exam rooms so any NP or RN could use them at any given time.

5S –Sorting, Straightening, Sweeping, Standardizing, Sustaining. We used this to clean and set up the Chart Prep and Chart Comp.

Just In Time – Use of Kanbans and Andon Signals so that the staff knows what they need to do next by visual signals.

Kanbans – An inventory ordering system that helps to create a Just In Time work environment. This was used for ordering forms for Chart Prep and supplies in Chart Comp.

Andon Signals – A signal that informs the staff of who is needed in what room, and who has already been to which rooms

References

- Aveta Solutions LLC. "Six Sigma Yellow Belt Training & Online Certification." Six Sigma Training and 6 Sigma Certification with Six Sigma Online. Aveta Solutions LLC. Web. 25 Apr. 2011.
- Brue, Greg. Six Sigma for Managers. New York: McGraw-Hill Education Europe, 2002. 28. Print.
- Caldwell, Chip. "Lean Six Sigma for Healthcare: A Senior Leader Guide to Improving Cost and Throughput". (2009) Quality Press, NY, NY
- Carreira, Bill, and Bill Trudell. "15; Project: Increasing Throughput on an Assembly Line." Lean Six Sigma That Works: a Powerful Action Plan for Dramatically Improving Quality, Increasing Speed, and Reducing Waste. New York: American Management Association, 2006. 175. Print.
- Cocolicchio, Brian. "Lean Hospitals" (2009). Quality Printing
- Deal Media LLC. "Glossary." ISixSigma. Http://www.isixsigma.com/, 2000. Web. 25 Apr. 2011.
- Driving Hospital Performance to the next Level.(2010, July 1). Express Healthcare,
- George, Michael L., David Rowlands, Mark Price, and John Maxey. The Lean Six Sigma Pocket Toolbook: a Quick Reference Guide to Nearly 100 Tools for Improving Process Quality, Speed, and Complexity. New York: McGraw-Hill, 2005.
- Graban, Mark. "Lean in Hospitals", 2008. Productivity Press, NY, NY
- Gressel, Steven. (2008, September). New Hospital Designs Focus On Reducing Cost, Improving Health and Flexibility. Retrieved September 28, 2010, from Facilitiesnet: Http://www.facilitiesnet.com/healthcarefacilities/article/New-Hospital-Designs-Focuson-Reducing-Cost-Improving-Health-and-Flexibility--9680
- Jacobs, Francis; R..B. Chase, & N.J. Aquilano (2009). Operations and Supply Management. New York: McGraw-Hill Irwin.

- Jimmerson, C. (2010). Value Stream Mapping for Healthcare Made Easy. New York: Productivity Press.
- Jones, David. (2009, September 10). Hospital CEOs Manage Staff Time, Inventory to Cut Costs. Retrieved October 1, 2010, from USA Today: Http://www.usatoday.com/news/health/2009-09-09-saving-money-hospitals_N.htm
- Joseph, Thomas P. "Design of Lean Work Cells: a Lean Lab Layout (part II)." Nelson Publishing, 2006. Web. 13 Jan. 2011.
- Lash, S. (2009). Lean Hospitals: Improving Quality, Patient Safety, and Employee Satisfaction
- Mand, C. (2009). Using The Lean Model for Performance Improvement. Health Care Perfromance Improvement Education Series . Milwaukee, WI, USA: Wisconsin Office of Rural Health.
- Oklahoma Medical Center, "PATIENT CARE ASSISTANT." Oklahoma Medical Center. Web. 28 Dec. 2010. .
- SW MAS Staff, "Takt Time." South West MAS, 2010.