

6-26-2007

# Implementing Lean Six Sigma Methodologies in the Radiology Department of a Hospital Healthcare System

Jamie Workman-Germann  
*IUPUI*, [jworkma@iupui.edu](mailto:jworkma@iupui.edu)

Heather (Woodward) Hagg  
*Purdue-West Lafayette, RCHE*, [heatherhagg@purdue.edu](mailto:heatherhagg@purdue.edu)

Follow this and additional works at: [http://docs.lib.purdue.edu/rche\\_rp](http://docs.lib.purdue.edu/rche_rp)



Part of the [Health and Medical Administration Commons](#)

---

Workman-Germann, Jamie and Hagg, Heather (Woodward), "Implementing Lean Six Sigma Methodologies in the Radiology Department of a Hospital Healthcare System" (2007). *RCHE Publications*. Paper 27.  
[http://docs.lib.purdue.edu/rche\\_rp/27](http://docs.lib.purdue.edu/rche_rp/27)

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact [epubs@purdue.edu](mailto:epubs@purdue.edu) for additional information.

## **2006-2070: IMPLEMENTING LEAN SIX SIGMA METHODOLOGIES IN THE RADIOLOGY DEPARTMENT OF A HOSPITAL HEALTHCARE SYSTEM**

### **Jamie Workman-Germann, Indiana University-Purdue University Indianapolis**

Jamie Workman-Germann is an Assistant Professor in the Department of Mechanical Engineering Technology. She teaches courses in Materials and Manufacturing Processes.

### **Heather Woodward-Hagg, Indiana University-Purdue University Indianapolis**

Heather Hagg, CQE, CSSBB is an Assistant Professor in the Department of Mechanical Engineering Technology. She teaches courses in Industrial Engineering Technology.

# **Implementing Lean/Six Sigma Methodologies in the Radiology Department of a Hospital Healthcare System**

## **Abstract**

Increased focus is being placed on the quality of care provided by Hospital Healthcare Systems around the country. Caught in the middle between tightening government standards, stricter compliance guidelines for insurance companies, and the basic mission to serve those in need with quality and compassion; hospitals are looking for ways to improve their processes (services) for the benefit of all.

CT (Computed Tomography – CAT Scan) and MRI (Magnetic Resonance Imaging) services in the hospital radiology departments are revenue-generating areas. The reimbursement rates for these services are very high, the scan times (especially in CT) are relatively low, and so the potential for additional revenue to the hospital comes with increasing patient capacity for these services. However, it is also a very competitive time for hospital radiology departments as many outpatient diagnostic centers are being built, drawing patients and physicians to their fast, efficient, no hassles approach to imaging. This brings additional hurdles to the already struggling hospitals.

The Sisters of St. Francis Health Services (SSFHS) group enlisted the aid of faculty at IUPUI to address issues within their organization. The objectives: improve the key performance indicators directly tied to patient and physician satisfaction, improve and streamline CT/MR processes, increase the capacity to perform CT/MR services, and regain a portion of the referral base lost to outpatient diagnostic centers. To address these issues, Lean/Six Sigma methodologies were implemented. Considerable success has been documented in the manufacturing industry using these models, but little has been done in the service-based industry of healthcare so an uncharted area was being entered.

Specially organized teams were created for the project within the hospital organization. Faculty experts provide education and training to these individuals in Lean/Six Sigma methodologies modified to fit healthcare services. The radiology project has been initiated and current results positively support the successful transferability of these manufacturing-originated methodologies into service-based applications. Modeling, simulations, and Cost/ROI of implementation projections for these projects are also being developed. These activities insure transportability of the models between hospitals so the benefit can be felt system-wide.

## **Background**

Hospitals understand where their revenue generating areas are. In most cases, these areas are surgery (especially orthopedic), cardiology/cardiovascular, and radiology. These areas are utilized to offset the losses incurred within other areas in the hospital to meet bottom line revenue goals. For St. Francis, a strong faith-based Catholic organization, meeting the bottom line must happen while fulfilling the mission to serve those in the community unable to pay. Unfortunately, for the mission-driven hospital organizations, the entrepreneurial world has also

caught on to the high paying reimbursement areas within the hospital and started developing specialty centers dedicated to them.

These specialty centers are run like businesses rather than hospitals. They have taken a serious look at the **W**eaknesses of the hospital model, turned them into **O**pportunities for their business, and focused efforts into making them the **S**trengths within their business model (SWOT/TOWS analysis). In radiology specifically, the outpatient diagnostic centers have listened to the Voice of the Customer (VOC) and made dramatic improvements in the areas Critical to Quality (CTQ). They also understand that their customers (physicians and patients) have choices for where they receive service and so they have a strong marketing presence to promote their facilities, services, and improvements over traditional hospital processes. The result: hospitals are losing revenue and their referral base to outpatient diagnostic centers.

Knowing that something must be done to reverse some of the negative performance indicators, streamline processes and regain patient and physician satisfaction to be competitive with the outpatient diagnostic centers, the hospital began looking for potential solutions. A physician and hospital board member mentioned that he had taken some Industrial Engineering Technology courses at IUPUI focused on Quality Improvement Processes and Six Sigma Methodologies and that the instructor was working on projects within hospitals to bring these tools into the healthcare profession. Extremely interested, meetings were set-up, proposals were written, and a new Lean Six Sigma for Healthcare program was initiated.

### **Structure of the Program**

Professor Hagg developed a program, utilizing IUPUI faculty expertise, for the entire SSFHS hospital system to progressively train Six Sigma Green Belts and Black Belts and then assist them through initial rounds of project planning and implementation based on a model created by GE.<sup>1,2</sup> While the Certified Six Sigma Green Belt (CSSGB) and Black Belt (CSSBB) Body of Knowledge is encompassed within the training, IUPUI does not certify individuals as Green Belts or Black Belts. Participants understand that these official certifications must come by passing the examinations given by the American Society for Quality.

Within the Lean Six Sigma for Healthcare program, training at the Green Belt level is 12 weeks (8 hrs/wk) plus work on a pilot project. The Black Belt level training consists of 16 weeks (8 hrs/wk) of material plus work on a pilot project. Training is also done at the Executive and Champion levels so top level administration can help the Black Belt teams identify potential projects and select projects in line with the business goals. Project team training at the Green Belt and Black Belt levels is limited to 12-15 individuals so that a close relationship can be formed between the IUPUI faculty and the project implementation teams. As indicated by the program title, Lean Concepts are also taught throughout the course and participants are trained to notice areas where Lean techniques can be beneficial in streamlining processes and work areas, and identifying and eliminating sources of waste. The teaming of Lean and Six Sigma are complimentary and provide a model for quality improvement and streamlining operations.<sup>3,4</sup>

The program uses a mid-level approach to implementation. Top-level administration and executives are given Executive and Champion training as mentioned, but Mid-level managers are

identified as the primary source for Black Belts. Department managers, nursing staff, and technical staff are preferred choices for Green Belts as they are most familiar with the processes being addressed. The primary disadvantage to this approach is that these individuals, while highly specialized in their care areas, are not likely to have any knowledge of Six Sigma, Quality Improvement, or Statistical Process Control concepts so the training must take this into account. On the other hand, faculty without direct healthcare experience are disadvantaged by the learning curve associated with understanding healthcare terminology, equipment, practices, protocols, reporting requirements, and insurance dealings.

## **Radiology Project - DMAIC**

### Define Phase

The radiology project began by establishing a project charter to identify why the project needed to be done, why the project needed to be done now, and what were the costs of doing nothing. A SIPOC<sup>5</sup> (Suppliers, Inputs, Process, Outputs, Customers) diagram was generated, factors Critical to Quality (CTQ) were established by examining the Voice of the Customer (VOC). Results of this phase are summarized below. As expected, the outcomes of this exercise paralleled the improvements implemented by the outpatient diagnostic centers.

Business Case: Radiology is a major source of revenue generation within healthcare. Insuring the referral base for a specific radiology department and service area is an important component to providing a consistent revenue stream for a healthcare facility. The important components to maintaining the referral base include 1) timely patient scheduling, 2) timely reporting of results to physicians, and 3) providing an expected level of technology.

The purpose of this project is to utilize Lean and Six Sigma Methodologies to understand the characteristics of the current radiology processes that are limiting the ability of the radiology department to appropriately insure the referral base for the CT and MR service areas. The consequences for not doing this project are a continued loss of market share for the CT and MR departments, loss of referral base, decreased patient satisfaction, and loss of revenue.

Problem Statement: Lack of availability of CT and MR procedures, and untimely reporting of results is negatively impacting the hospital referral base, resulting in decreased customer satisfaction, limiting revenue opportunities, and generating patient loss to outpatient diagnostic centers.

Goal Statement: The goal of the project is to develop a standardized methodology to:

1. Improve availability of CT and MR procedures
2. Improve timeliness of procedure reporting to physicians
3. Improve physician and patient satisfaction
4. Grow revenue from CT/MR areas

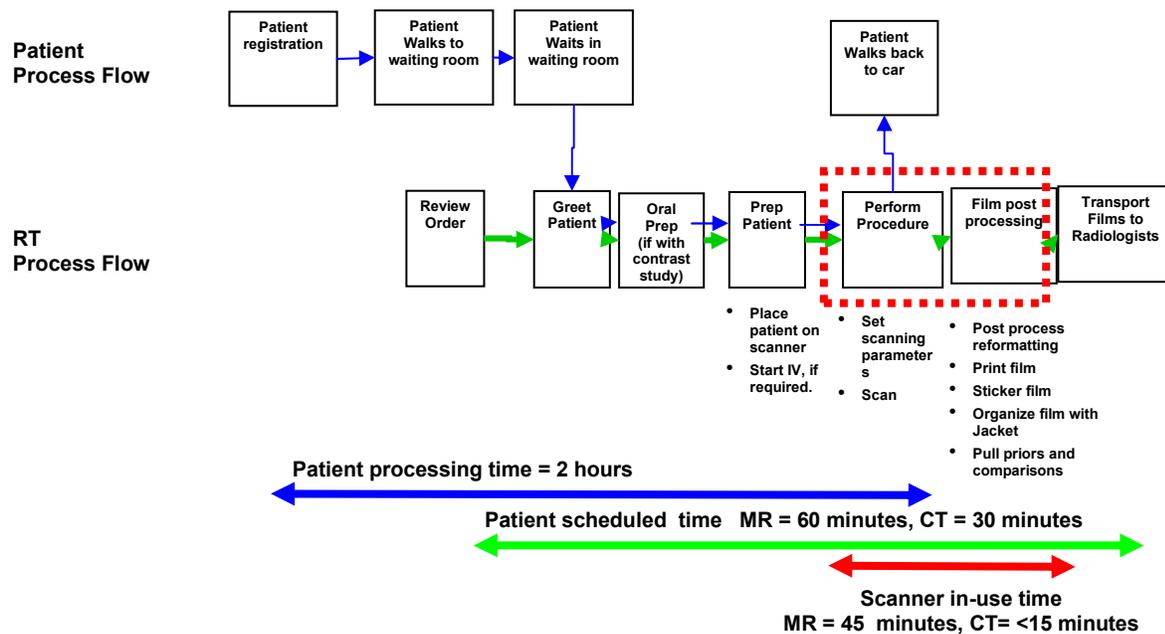
Project Scope: Understanding that radiology is a large department within the hospital, the boundaries of the project are limited to CT and MR only with analysis of current technology only.

Obstacles: As with any project, there are obstacles that must be identified and overcome. For this project, major obstacles identified are: change within radiology, change outside radiology (scheduling, registration, corporate culture, physicians), and system thinking.

Project Objective(s): Objectives for this project are to:

1. Identify and reduce the impact of the radiology process constraints limiting the ability of the MR and CT areas to maintain their referral base.
2. Provide a project roadmap to maximize the number of procedures available on a daily basis in the MR and CT areas, resulting in increased revenue.
3. Provide a project roadmap to increase patient and physician customer satisfaction
4. Create standardized methodology for transfer of project learnings to other radiology areas within the hospital system.

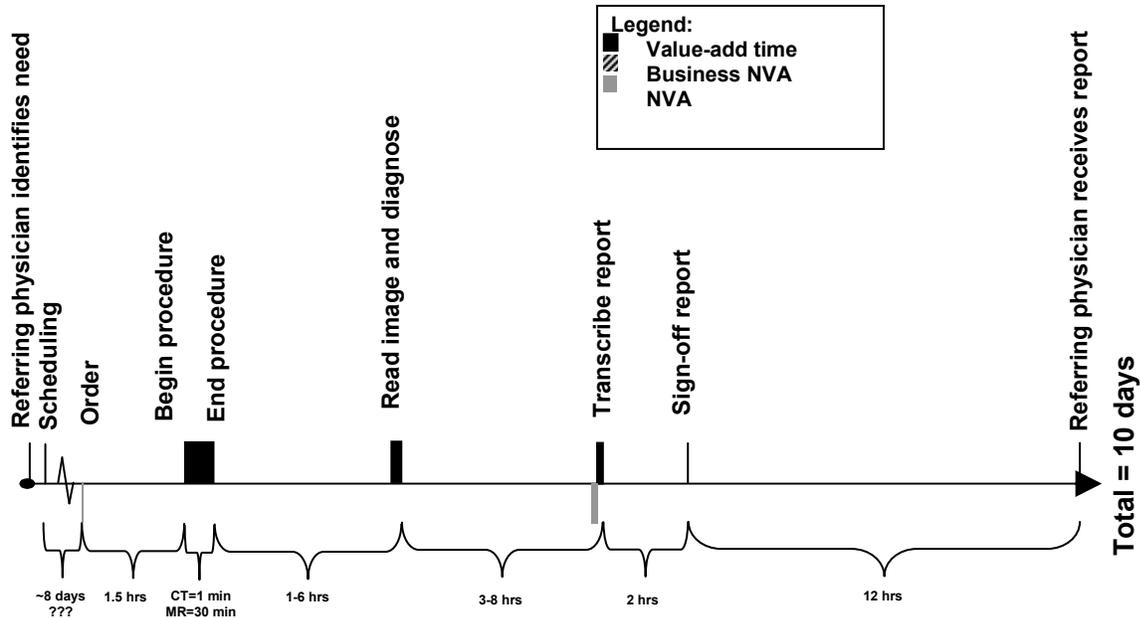
Process Map: The basic process was also mapped and a diagram is included here.



### Measure Phase

From the SIPOC done during the Define Phase, KPIVs and KPOVs (Key Process Input/Output Variables) were listed to generate a preliminary understanding of their relationships. Also, an initial look into the VOP (Voice of the Process) told the group how the process was performing with respect to the CTQs that had been identified. From the VOC and CTQ exercises, the two factors that became the primary performance indicators needed to evaluate patient and physician satisfaction were: 1) procedures being scheduled in a timely manner (< 48 hours) and 2) timely reporting of results (< 24 hours). An additional factor identified for patient satisfaction was wait time within the service area. Analysis of the current process showed that the average time from

physician referral to patient date of service was 8 days. In total, the overall process time from physician referral to physician receiving the report could take more than two weeks on average. Outpatient diagnostic centers have numbers closer to 3 days for the entire process. A sample timeline is given below:



After looking again at the process map and the project charter, it also became apparent that the first performance indicator was outside the scope of the project. The hospital utilizes a central scheduling department that fills in the schedules for all areas of the hospital. So unfortunately, this would not be addressed in the current project. However, reporting this information to the Champion and Executive teams led to the development of another Six Sigma project specifically geared to address this need. Ultimately, the two indicators that would be measured and analyzed were 1) patient wait time and 2) report turn around time (TAT). The next several weeks were spent observing the sub-processes within the process, doing time studies, looking at historical data, making modifications to the process map, and creating data collection and analysis plans for the next phase.

### Analyze Phase

During the analyze phase, several key discoveries were made about the process that led the team to focus on a couple of critical sub-processes. From the timeline and historical data, key areas of delay seemed to be the End Process – Read step and the Read – Transcribe step. Taking a closer look at these processes showed 2 things: 1) the availability of film jackets with “priors and comparisons” was causing delays in getting the films read and 2) the primary group of radiologists left at 5p, leaving only 1 scheduled radiologists until 11p and one on-call radiologist. This caused a significant backlog for images needing to be read.

The first finding was related to the film library, the storage capability of the facility, and the staffing available for pulling jackets, filing reports, and locating priors and comparisons. The major issue: reports from almost 2 months previous were still waiting to be matched with their jackets and filed. With each day, new reports were being generated and the backlog was increasing. Immediate attention was needed. For the second finding, the evening and on-call radiologists could not handle the volume build up from 5p – 7a. Radiologists on-call are utilized primarily for STAT cases, however, CT is staffed 24 hours/day, and CT and MR outpatients are scheduled late into the evening. This workload was too much for the one scheduled radiologist which essentially meant that images not read before 5p essentially had an automatic 14 hour delay added to their report TAT.

Compounding these delays, it was discovered that the process for delivering films to the radiologists ended up placing them in First In – Last Out order. In other words, a film from 5p the previous night was on the bottom of the pile with all subsequent films placed on top. As radiologists entered in the morning, they began reading films from the top of the stack. The effect on report TAT was severe and this step of the process became the initial area to streamline and improve using Lean Techniques.

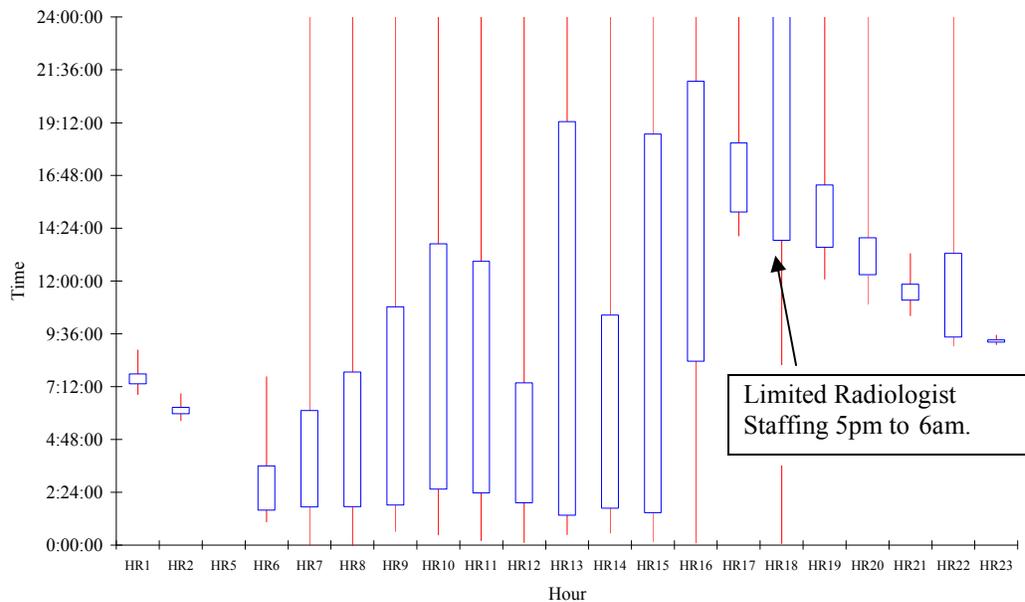
The delays and backlog coming from the radiologist staffing also caused delays downstream in the Read-Transcribe step of the process. There are 5 transcriptionists shared between two hospital campuses. These transcriptionists are responsible for typing all radiology reports generated by both campuses. Data showed that the length of the Read-Transcribe step averaged 1.5 hours before 2p and jumped to almost 6 hours after 2p. Noticing that this increase happened before the radiologists left at 5p was curious. As it turns out, transcription day shift ends at 3p, the evening shift begins at 2:30p and the staffing level in the evening is lower. So even though transcriptionists are able to process 1 report every 2-4 minutes, the input queue was driving up the overall process time for that step.

Simulations were used to statistically validate the processes, identify potential staffing constraints, and predict process improvements made by adding additional staffing in key areas. Simulations also presented a visual tool for helping executive and champion team members understand the process better and actually visualize the limitations being incurred with inadequate staffing levels. These simulations were also used to develop initial cost/ROI (Return on Investment) calculations for the project. With an initial investment of approximately \$120K and a 15:1 ROI goal from the regional CEO – the expectations were set very high to reflect the importance of the project.

### Sample Data

	<b>BG before 2p</b>	<b>BG after 2p</b>	<b>IN before 2p</b>	<b>IN after 2p</b>
Order to Begin	1.5 hr	1.5 hr	1.5 hr	1.5 hr
Begin to End	30 min MR, 7 min CT			
End to Read	1 hr	1 hr	1 hr	1 hr
Read to Transcribe	3 hrs	8 hrs	7 hrs	14 hrs
Trascribe to Signoff	2 hrs	2 hrs	2 hrs	2 hrs
<b>Total Time</b>	8 hrs	14 hrs	17 hrs	24 hrs

### Indy Out Patient CT End to Read Time by End Hour - M-F Only



### Improve and Control Phases

Several improvements have been made to the process, but additional improvements are ready to be implemented before the Control phase will be initiated. For the film library, the backlog of reports has been eliminated and additional FTEs (Full Time Equivalents) have been added to reduce the possibility for this type of backlog in the future. The hand-off process for films has been streamlined and now functions as First In – First Out for reading by radiologists. Also, film jacket configuration has been standardized to assist radiologists in their ability to consistently locate important information. The radiologists are discussing shift options to help cover the evening and weekend hours better. Transcription has been able to add another person on the evening shift to help reduce the read-transcribe step time. TATs are being tracked on a regular basis to examine performance trends and identify additional areas for improvement.

On the patient wait times, the CT team leader has implemented several improvements that have enabled her team to process patients now every 15 minutes rather than every 30 minutes. While downstream issues are still being resolved, this throughput improvement is very positive. To understand the impact of adding capacity to the process, based on reimbursement numbers provided by the hospital, the addition of 1 CT scan per day every day of the year will generate an additional \$400K per year of reimbursements. For the actual scanning, this means increasing efficiency enough that only 15 additional scan minutes are worked into the day. While scan times are considerably longer in MR, adding 1 scan per day for the entire year will add more than \$800K per year. Utilizing these numbers even conservatively, it's not difficult to see how 15:1 ROI can be achieved and why outpatient diagnostic centers have been developed.

### **Impact on IE/IET Education**

IE/IET education has long promoted the use of quality-driven tools, programs and analyses for the benefit of the product, process, customer, and company. Unfortunately, the program name “Industrial Engineering” and “Industrial Engineering Technology” has been primarily tied to manufacturing. Recently, much of the manufacturing base of the United States has moved offshore. This leaves a considerable amount of the U.S. workforce focused on service-based industries. While Lean Six Sigma has matured in the manufacturing industries, its application in the service areas is not as mature. This presents an exciting opportunity for IE/IET programs and curricula to broaden their scopes, show that the tools developed for manufacturing have applications outside of manufacturing, and open new doors for students graduating from these programs.

Within the undergraduate curriculum, implementing a series of courses that encompass the Six Sigma Body of Knowledge introduces students to one of the most predominant quality programs being utilized in industry today. Lean Six Sigma also takes concepts already being taught in the IE/IET undergraduate curriculum (statistical tools, SQC, SPC, TQM, DOE) and provides a specific platform that ties them together while providing a structured approach for their implementation.

Also, by establishing relationships or utilizing existing ones, students can work on projects (all or in part) for companies as part of their educational requirements. Students for the St. Francis projects have been utilized everywhere from collecting and analyzing data, to driving a “quick hit” type of projects as a team on their own. These opportunities are mutually beneficial for the students and the sponsoring company. The students benefit from the experience of implementing or being involved in a Six Sigma project for their certification, and the company benefits from the improvements of the project and the low cost of utilizing students to drive the project.

## **Summary**

Implementing Lean Six Sigma in healthcare is interesting, challenging, and rewarding. For individuals used to manufacturing-based processes, service-based applications present new perspectives and challenges to the same problems. The most challenging and rewarding aspect of these projects is the human-factor. Everyone in healthcare feels that what they do is different (case by case) and cannot be described as a process. With that being said, how can someone from outside the healthcare profession come in and make these dramatic improvements?

It is often difficult for non-manufacturing individuals to grasp concepts and terminology related to processes (inputs, outputs, variables, etc). The key is finding a way to show people that what they are doing is a process and an integral part of a much larger process all together. And, by not being consistent in their tasks or protocols, they are actually introducing more variation into the system than needed. This variation is what the customers end up seeing and remembering and so applying Lean Six Sigma methodologies is actually the best way to make dramatic improvements. The techniques are based on real and relevant data, identified by those most familiar with the process. The data is generated by the process and analyzed to identify inconsistencies and variation. The inputs and outputs of the process are identified and examined

to see which inputs have the largest impact on the outputs through testing or DOE (Design of Experiments).

Ultimately, business and process decisions can be made using data, not instinct and getting everyone to recognize this concept is an extremely rewarding experience. This is in addition to all the improvements made to the process for the patients and the other customers of the process including the hospital, its employees, and the physicians.

## **Bibliography**

1. Snee, R. (2003). *Leading Six Sigma: A Step by Step Guide Based on Experience with GE and Other Six Sigma Companies*. Prentice Hall, Upper Saddle River, NJ.
2. Pande P., Neuman R., Cavanagh R. (2002). *The Six Sigma Way Team Fieldbook: An Implementation Guide for Process Improvement Teams*. McGraw-Hill, New York, NY.
3. George M., Rowlands D., Kastle B. (2004). *What is Lean Six Sigma?*. George Group (McGraw-Hill), New York, NY.
4. George M., (2003). *Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions*, McGraw-Hill, New York, NY.
5. George M., Maxey J., Rowlands D., Upton M., (2005). *The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to 70 Tools for Improving Quality*. McGraw-Hill, New York, NY.
6. Pyzdek T., (2001) *The Complete Guide to Six Sigma*. Quality Publishing, Tuscon, AZ