Effectiveness and Best Practices of Lean and Six Sigma Methodologies in Hospitals

The Honors Program
Senior Capstone Project
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INTRODUCTION

Healthcare quality and costs are a growing problem in the United States. Healthcare organizations are facing increasing costs combined with declining quality (Schoenbaum). This unsustainable trend is putting a great burden on the health care system as a whole. The improvement of quality within the healthcare system would increase the value of the care (Schoenbaum).Improving healthcare quality, and thereby lowering the costs, is critical for the sustainability of healthcare organizations.

There are many different ways that organizations can use quality to reduce costs and increase the quality of service to their patients. There are also various ways an organization can implement quality. The processes can lead to different results and focuses. The potential processes include lean based A3 Report, Kaizen events, and Six Sigma. These processes focus on continuous improvement of quality within a process. The ideal situation would utilize these processes to create a high quality environment while lowering costs.

This report will investigate the impact of projects utilizing the A3, Kaizen, and Six Sigmamethodologies in order to improve processes efficiency,increase quality, and reduce costs of care.These methods can be applied in many different organizations, including the health care industry. The impact of these process improvement projects should be substantial and essential to the health care industry. The impact of the methodologies will be analyzed to see if they substantially reduce the costs and increase the quality. The focus of this research is on hospitals and will compare hospitals in a quality position, as defined by the 100 Top hospitals list and the MalcolmBaldrigeQuality Award recipients nationwide, and other regional hospitals in the Northeast not currently on the 100 Top lists or a Baldrige award winner. The goal of any organization should be to increase the quality of their service.

An ACPE Quality of Care Surveyfound that 18.5% of respondents utilized Six Sigma to improve quality, 13.3% utilized Lean processes, 12.2% used vendor-provided systems, 26.7% used other methods including homegrown, and 29.2% did not utilize any programs (Martin). This project looks to identify if there are trends between those that utilize the programs and positioning as a top quality performance hospital and if so what quality management programs had the biggest impact at the different types of hospitals. While this project focused

on hospitals as the health care organization to be surveyed and examined, similar principals would be expected to hold true for any patient facing organization.

LITERATURE REVIEW

This literature review will cover background information on the health care industry, Medicaid, the Baldrige program's health care award, 100 Tophospitals, Magnet Nursing Hospitals, lean, Six Sigma, and A3. Following this will the research methodology outlining the steps my research will follow.

Health Care Industry

Average household expenditure on services in the health care industry was $2,976 in 2008. American households spent 5.9% of their budgets on health care services (Increasing Cost of Health Care). According to the Bureau of Labor and Statistics the industry provided 14.3 million jobs in 2008. The industry is also one of the fastest growing, expected to increase by 3.2 million jobs from 2008 to 2018 (Healthcare). The industry has been the focus of much government attention and regulation in recent years and is a huge component of the United States economy. The health care sector comprised of nearly 8% of US GDP in 2010 (2012 Statistical Abstract).

Government's Impact on Health Care Industry

The Federal Government spends billions of dollars a year on Medicare and Medicaid programs. However, these programs do not look at the quality of care. With the exception of the Baldrige program's heath care award, the Federal Government has not focused on improving the quality of health care as a solution to the growing costs of care. The focus has been on cutting or minimizing the costs of health care. A stronger government influence to push for quality as a solution to increasing costs could be needed in the future (Schoenbaum).

The Patient Protection and Affordable Care Act of 2010 and Health Care and Education Reconciliation Act of 2010 were the most significant and sweeping law changes ever in the health care industry. The two bills overhauled many health care regulations. The goals of the bills were to reduce the number of uninsured and to reduce the cost of health care not only for

individuals but also for the federal government (Jackson). The focus of the bills were very heavy on reducing the costs, but not on the improvement of the quality of health care.

The Federal Government could take a more active role in the improvement of health care. Many of the potential suggested solutions consist of improving or investing in research, infrastructure, or public reporting (Schoenbaum). None of these solutions involve improving the processes that can sometimes lead to redundancies, mistakes, or lost information. However, these processes can be improved through quality improvement processes such as Kaizen or A3.

Medicaid

Medicaid has its roots from during the great depression in the 1930's. During that time period federal and state governments began to take on the medical expenses of children, the elderly, and the poor. In 1965, the Nineteenth Amendment of the Social Security Act created the Medicaid program to extend health care to the poor. The program has quickly grown and in 2005 covered approximately 50 million people for a total cost of $300 billion (Quinlan-Colwell). Through other laws the scope of the program has been expanded to include drug rebates and complete coverage for certain cancers (Quinlan-Colwell).

Over the past 40 years there have been several attempts to lower the cost of Medicaid. In 1977, the Department of Health, Education, and Welfare attempted to merge Medicaid and Medicare in order to control health care costs (Quinlan-Colwell). The merge was ultimately unsuccessful but certain administrative areas were combined. The Deficit Reduction Act of 2005 attempted to reduce the federal costs of Medicaid by increasing co-pays and reducing certain services (Quinlan-Colwell). This attempt was supposed to reduce spending on Medicaid by approximately $1 billion per year over ten years (Quinlan-Colwell).

Errors in the implementation of the program are a significant issue that is leading to increasing costs. As more private sector approaches are being implemented in Medicaid, efficiency is improving. When Medicaid in Pennsylvania worked with Health Risk Management the result was an improved, more efficient billing system. Fraudulent claims and improper payments add on to the errors in the system. While fraudulent claims are being

countered by technology that identifies trends in the fraud and abuse to identify those claims, nothing is being done to analyze improper payments (Quinlan-Colwell).

Adding to cost problems is a lack of primary care providers. When a person with Medicaid does not have a primary care provider,he or she can find it nearly impossible to schedule an appointment with other physicians leading to nonemergency visits to the emergency department. This brings with it higher cost of care and can overload emergency departments with nonemergency patients (Quinlan-Colwell).

Baldrige Program and the Health Care Industry

The Malcolm Baldrige National Quality Award program was created by the Public Law 100-107. The law was signed in 1987 with the goal of recognizing the achievements of organizations that have high standards of quality and providing guidance and guidelines for other organizations (Malcolm). The award focuses on a number of different sectors including health care. The health care sector has a set of criteria for organizations to understand their performance processes. The criteria includes leadership, strategic planning, customer focus, measurement, analysis, performance management, workforce focus, operations focus, and results. These criteria form the model for how organizations should look at their processes and take steps to improve their quality (Health Care Criteria).

Studying the characteristics of Baldrige winners provides valuable information about the success of their quality improvement programs. These organizations saw great improvements in areas such as patient satisfaction, employee turnover, employee satisfaction, and an increase in diversity among management. At Baptist Hospital, Inc. in Pensacola, Florida, inpatient and outpatient satisfaction has improved up to the 99th percentile. In addition ambulatory surgery satisfaction has also been in the 99th percentile (Institute). SSM Health Care in St. Louis, Missouri experienced lower turnover rates. These cases showed that improvement processes at these organizations culminated with the winning of the Baldrige award.

100 Top Hospitals

Being listed as a "100 Top Hospital" is one of the key criteria that will be used to identify if a hospital is in a quality position or not. 100 TopHospitals is a list of hospitals that Thompson

Reuters has put together in order to identify the top performing hospitals in patient care quality and as a business. The prestigious annual award evaluates hospitals on patient care, operational efficiency, and financial stability. The hospitals are compared only to others of the same size and teaching status. According to the 100 Top Hospitals website, "If all Hospitalsperformed at the same level as the 100 Top Hospitals award winners: Nearly 116,000 additional patients would survive each year" (100 Top Hospitals). This highlights the importance of increasing the quality of care for patients and this report will look to identify if Lean and Six Sigma methodologies are a potential solution to increasing the quality of care.

The 100 Top Hospitals list, however, does not look into the underlying reasons for why these hospitals perform in this way. The list simply analyzes the quality of the hospitals and ranks them. This project will look to identify some of the underlying reasons for the high performing hospitals, namely the impact of Lean and Six Sigma methodologies on their performance. 100 Top Hospitals forms the comparison point for this research.These hospitals are high quality performers and this report compares them to other hospitals to identify any methodologies that are used significantly more by the high quality performers.

Magnet Nursing Hospitals

The Magnet Nursing Recognition program looks to bring recognition to hospitals who have achieved quality patient care, excellent nursing, and innovations in nursing. The credential is a symbol of high quality levels of care. Less than 7% of hospitals nationwide have achieved this level of quality (ANCC). In this researchMagnet Nursing Hospitals are considered to have superior levels of quality.Along with 100 Top Hospitals and Baldrige winners, they comprise the quality group for the survey.

Lean Methodologies

A well-known quality improvement tool is the Kaizen process. Kaizen is a Japanese word that translates to "continuous improvement". The focus is on constantly evolving and improving to ideally reach a state of zero defects. The system was pioneered by Toyota as a constant focus on improving efficiency and innovation. This method was one of the reasons that Toyota achieved such a high standard of quality with their products (Kissoon).

However, recently Toyota has suffered a slew of recalls that have compromised the success of Toyota's Kaizen process. NiranjanKissoon attributes Toyota's failures to their inability to accept their mistakes, address the complaints of their customers, and the effects of Toyota's rapid growth on their Kaizen process. Toyota neglected to do these things as they rapidly grew leading to their breakdown (Kissoon).

Toyota's constant improvement processes have been put into practice in a variety of health care organizations with proven success. Allegheny General Hospital has worked to implement Toyota's production techniques to improve the care of patients. Within three months of the new procedures infections dropped 90%. The hospital also estimates the new procedures have saved $500,000 per year. These processes are beginning to show their incredible value to hospitals as a push comes from manufacturing and service businesses to reduce employee health care costs (Bernard).

Lean methodologies work to redefine workflow processes. Health care facilities have utilized lean to empower front line workers to improve quality and workflow. The results of the process have helped to significantly reduce times for monitoring patients or deliveringmedications. Different organizations have sought to target idle time, inventories, confusion, and processing through different lean tools. These can be improved through the empowering of workers and improvement of their processes (Cases).

Lean methodology seeks to remove non-value-added activities from the processes. These non-value-added activities are considered to be waste. The seven types of waste are: overproduction/underproduction, wasted inventory, rework, wasted motion, waste from transport, and waste from processing. These wastes can be identified during the value stream mapping of the processes and highlighted for improvement (Varkey).

Intermountain Health Care (IHC) in Salt Lake City, Utah underwent a project to apply lean techniques to their processes. The project addressed a variety of issues and made a wide range of improvements. The processes that were improved significantly reduced amounts of wasted time by the workers. The reduction of hours required by employees can be translated into real savings almost immediately. Other savings could include reduced numbers of errors or increased patient satisfaction. Some examples of savings or benefits from the project included

decreases in treatment delays and an immediate savings of nearly $1 million through the implementation of an electronic payment system (Jimmerson et al, 2005).

There were three key factors in the success of the projects at IHC. The first key factor was that the participants in the project were able to identify the waste in their daily activities and the significance of the waste on the bottom line. The second key factor was the participant's and other staff's willingness to change. There was not a lot of resistance to change within the organization for the project. Finally, the third factor identified at IHC was the use of A3 as a tool to clearly identify problems in a process and communicate those problems to those who can make the change happen (Jimmerson et al, 2005).

Park Nicollet Medical Center in Minneapolis, MN utilized the Toyota Production System and lean methodology to attempt to decrease wait times. They used a continuous flow system to check in patientswithin 10 minute intervals. They scheduled appointments for the various staff in sequence in order to achieve a continuous flow with minimal wait times. The medical center also standardized instruments for surgical procedures allowing them to reduce instrument inventory by 60%. The report estimates the Medical Center saved $7.5 million in 2004 (Varkey).

A3 Reports

One of the many different quality tools that can be used to increase quality and lower costs are A3 reports. A3 reports were created by Toyota Motor Corporation through an evolution of continuous improvement activity. The A3 Reports look at the current condition of processes. The process is examined by direct observation and how exactly it is performed, instead ofhow it should be or how someone else explains it. Through the diagramming of the current condition problems with the processes can be identified easily and more objectively. The A3 report then looks at how the process could be improved. The improvements counter any problems within the system and create a target condition for the process. Implementation and follow up plans are then created in order to put into practice the target condition and monitor the results of the new process (Sobek, Jimmerson, 2004).

The A3 report is useful because it looks at one process at a time. Through the breakdown of the problems into smaller, more manageable pieces workers can make improvements more

rapidly. An effective coach is also critical to the success of an A3 project. An effective coach can help make sure the root of the problem is found and guide the problem solving to help create the target condition. Many of the problems encountered can be addressed by the A3 report, especially since many have roots in, "poorlyspecified activity, a vague unreliable connection, or a complex pathway" (Jimmerson et al, 2005).

The A3 report is set up into two halves of an 11" x 17" piece of paper. Drawn on the left side is a diagram of the current process and on the right side a diagram of the target condition or ideal process. The diagrams need to be very detailed and are visually oriented including the use of storm clouds to show problems in the current process. The current process on the left side is analyzed and asked *Why?*for every problem in order to identify the core cause of the problems (Jimmerson, 2007) (Visich, et al, 2010).

The right side of the A3 report had the target condition drawn with improvements highlighted by fluffy clouds. The necessary changes that must be made to reach the target condition are identified as the countermeasures in the process. The next step in the process is to create an implementation plan of the countermeasures in order to change the process to the ideal condition and a cost/benefit analysis of the implementation plan in order to determine if the changes are financially beneficial. Finally, a sample of how to test the implementation plan is listed, and how and when a follow-up should be conducted on the process (Jimmerson, 2007).

Value Stream Mapping is another important piece of the A3 Method and it is used to help identify where value is added or not added throughout a process. Through the minimization of pieces of the process where value is not added the processis improved. In health care these improved processes can help improve patient outcomes and satisfaction (Visich, et al, 2010).

Six Sigma

Six Sigma is quality philosophy pioneered by Motorola in order to greatly reduce the number of defects in processes. Six Sigma looks to minimize the defects that occur in a process,by using a Define, Measure, Analyze, Improve, and Control cycle (DMAIC), to improve quality of the processes (Jacobs).Six Sigma can be utilized in a number of health care industry applications. Looking at measurable processes the number of defects could be compared to the Six Sigma standard of 3.4 defects per million opportunities. The defects could then be

analyzed to see how to improve the process and minimize the number of defects ideally to below 3.4 defects per million opportunities. One defect area that has been improved close to the 3.4 defect per million opportunities rate was surgical anesthesia deaths. Once numbering around 20 to 50 per million opportunities is estimated to be around 5 per million opportunities nationwide (Chassin).

Applications of Six Sigma include combining innovation with Six Sigma to create a better, higher quality, lean process that can also lower costs. This could be achieved by streamlining the processes to reduce waste and mistakes. Combining the new innovations with the lean processes would allow health care organizations to continue to bring together innovative new technologies with lower process defect levels (Polk).

Using the measurement of defects within Six Sigma is a critical step to understanding the current defect rates and the ideal goal defect rates within a given process. The number of defects within a given observed process divided by the number of potential opportunities (the number of potential failures within a single process times the total number of observations) gives the rate of defect. Finding the total number of defects within a million potential opportunities allows the observer to calculate how often the process will succeed. These observations can be plotted on a chart to determine if the process is within a set criteria range for the failure rates (Varkey).

One example of Six Sigma being applied to a health care process can be seen in the Charleston Area Medical Center. Six Sigma was used to evaluate the rate of infections in colon and vascular surgical sites. They followed the DMAIC method to develop a case study, measure the results, analyze the results to create a new pre-operation checklist, usedreport cards, and promptedsurgeons to identify potential improvements. The result of the process was an infection reduction to a sigma of 2.86. The report promoted a potential annual savings in excess of $1 million (Varkey).

RESEARCH METHODOLOGY

This research will examine the effectiveness of quality initiatives in improving cost and/or the quality of care, and how institutions can be effective in improving the quality of care. This

will be achieved by looking at the different methodologies used by healthcare institutions and determining if there are statistically significant differences in methodologies. Improving the quality of care will be judged as lowering wait times, lowering the number of hospital errors (misdiagnoses, wrong medicines, infections, etc.), and improving patient satisfaction. Lowering cost will be elvaluated as lowering cost of care to the hospital, lowering the cost of care to the patient, or requiring fewer inventories for the hospital. These will be identified through the subject's beliefs of the initiative's impact on these metrics.

After the initial research and literature review were completed, a hypothesis was developed that was used to test the results of the survey data.The hypothesis developed was that the hospitals in the quality group would utilize the methodologies more than those in the non-quality group.Those organizations were then contacted to gather the necessary data. This data was obtained from the surveys of Baldrige winners,100 Top hospitals, and Magnet Nursing hospitals as hospitals in a quality position and other hospitals in the Northeast that will be defined as the non-quality group.The survey was administered online using Google Docs and analyzed with Microsoft Excel and statistical tests from MiniTab.

The survey that was administered began with a question regarding informed consent. If the subject gave their consent the survey continued, if they did not give their consent the survey ended. After the subject gave their consent the survey began by asking the subject about the categorization of their hospital, the candidate's position at the hospital, the size of the hospital, and the performance status of the hospitals. These questions helped define the different variables for comparing the responses. See Appendix I for the survey instrument and appendices II-IV for definitions of the survey item.

Following these questions the survey asked, "What Lean or Six Sigma Methodologies have you utilized at your hospital? What Kaizen or Lean Tools have you utilized? What problem ID tools have you utilized?" Following these questions the respondentwas asked what kind of an impact they believed quality improvement initiatives have had on patient satisfaction, patient outcomes, and financial measures. These questions were measured on a Likert Scale with a 1 being a great negative impact, a 7 being a great positive impact, and a 4 being no impact. Finally, there was an open-ended question asking the subjects to provide any

additional information that they would like to disclose relating to quality improvement initiatives at their hospitals.

The data was then analyzed to determine if there was difference between the usage and beliefs of the impact of quality process improvement projects between those hospitals in quality positions and those that are not.2-sample t-tests were conducted to determine the level of statistical significance of the findings. These 2-sample t-tests utilized pooled variances if the variances were found to not be statistically significant based upon the values of Levene's test and the F-Test. The statistically significant methodologies or tools will be identified and form the foundation for the identification of the best practices. Then a framework will be developed for future applications of these methodologies to raise the quality of hospitals.

DATA ANALYSIS

The following section will stratify and analyze the data compiled from the surveys. It will look at the summary of the data, the usage of methodologies and tools in the quality group and non-quality group. It will then look at the significance tests conducted on the data in order to determine which methodologies and tools were used statistically more frequently by the quality group.

Summary of Data and Hospital Characteristics

A total of 280 hospitals were surveyed including 88 that were identified as 100 Top Hospitals, Baldrige winners, and Magnet Nursing Hospitals located nationwide. The remaining 192 were hospitals that were located in the northeast of the United States (NY, CT, MA, RI, VT, NH, and ME). Out of these 280 hospitals, 32 responses were received through the GoogleDocs survey giving a good response rate of 11.4%. The data set was then analyzed and separated into 16 "Quality" hospitals (those that were identified as being a 100 Top Hospital, Baldrige winner, or Magnet Nursing hospital) and 16 "Non-Quality" hospitals (all others). Of the 16 quality hospitals, 37.5% were Baldrige winners, 62.5% 100 Top Hospital winners, and 56.25% Magnet Nursing Hospitals. Seven of the quality hospitals won two awards while one had won all three. From these two groups I looked at what quality methodologies and processes were the most commonly used, identified the statistical significance of their usages.

The hospital type and hospital size varied greatly in both the quality and non-quality groups. Fifty percent of the quality group identified themselves as being urban hospitals and 62.5% identified themselves as being a large hospital (>250 beds). In the non-quality group, 50% identified themselves as rural hospitals and 43.75% identified themselves as small hospitals (<100 beds). In addition,37.5% of the quality hospitals identified themselves as non-teaching hospitals.See Table 1below for a more detailed look at the hospital characteristics.

Table 1 - Hospital Characteristics

	Hospital Type				Hospital Size		
	Urban	Rural	Teaching	Non-Teaching	Small	Medium	Large
Non-Quality	18.75%	50.00%	18.75%	6.25%	43.75%	25.00%	31.25%
Quality	50.00%	12.50%	18.75%	37.50%	6.25%	31.25%	62.50%

Six Sigma and Lean Methodology Usage

Of the 16 respondents in the quality group, 93.75% said they utilized Six Sigma or lean methodologies for process and quality improvement. One hospital in the quality group responded as not utilizing any quality methodology in order to improve their processes. The Rapid Cycle Improvement Process methodology was the most widely used with 81.25% of the respondents utilizing them. 56.25% of hospitals used Kaizen Events and 43.75% of respondents said they utilized A3 problem solving. Six Sigma and lean methodologies appear to be another significant resource for the quality group hospitals.

Of the 16 respondents in the quality group, 18.75% of these respondents said they did not utilize any Six Sigma or lean methodology. Of the 81.25% that did utilize Six Sigma or lean methodology, Rapid Cycle Improvement Process was utilized by 50%, the most of any methodology. The non-quality group also widely utilized Six Sigma with 37.5% of respondents reporting its use in those hospitals. Every other methodology was utilized by less than 20% of the non-quality group. See Table 2 on the next page for a complete breakdown of the usage of six sigma and lean methodologies across the two groups.

Table 2 – Six Sigma and Lean Methodology Usage

Six Sigma and Lean Methodologies		
	Quality Mean	Non-Quality Mean
A3	43.75%	12.50%
Kaizen Event	56.25%	18.75%
Kaizen Blitz	12.50%	12.50%
Kaizen Burst	6.25%	12.50%
Rapid Cycle Improvement	81.25%	50.00%
Six Sigma	37.50%	37.50%
None	6.25%	18.75%
CQI	0.00%	6.25%
DMAIC	6.25%	0.00%
Workout	0.00%	12.50%
TPS	6.25%	0.00%
Lean	6.25%	6.25%

Lean and Kaizen Tool Usage

Lean and Kaizen tools were also widely used among the quality group. A total of 93.75% of the quality group used some kind of Lean or Kaizen tools. Every one of those respondents utilized Value Stream Mapping as a process improvement tool. 75.0% of the quality group utilized Observation forms and 75.0% used 5S/Visual Controls in their process improvements. Standardized Processes were used by 68.75% of the hospitals in the quality group.

Value Stream Mapping was the most utilized Kaizen or lean tool by the hospitals in the non-quality group, with 62.50% of the respondents reporting the utilization of Value Stream Mapping. No other Kaizen or lean tools were utilized by more than one-third of the respondents. However, 81.25% of the respondents utilized some kind of Kaizen or lean tools which shows its importance to the organizations in the non-quality group. See Table 3 on the next page for a complete breakdown of the usage of Kaizen and Lean Tools across the two groups.

Table 3 – Kaizen and Lean Tool Usage

Kaizen and Lean Tools		
	Quality Mean	Non-Quality Mean
Observation Forms	75.00%	25.00%
Value Stream Mapping	93.75%	62.50%
5S	75.00%	31.25%
Standardized Processes	68.75%	31.25%
Poke-Yoke	31.25%	12.50%
Pull Systems	37.50%	12.50%
Cause & Effects Matrix	0.00%	6.25%
Waste/ Gemba Walks	0.00%	12.50%
Just-In-Time	0.00%	6.25%
None	6.25%	18.75%

Problem Identification Tool Usage

Every hospital in the quality group reported using root cause analysis as a problem identification tool. 81.25% of the respondents in the quality group also reported using Fishbone Diagrams in problem identification. A total of 56.25% the hospitals in the quality group also responded as using Why-Why diagrams. Problem identification tools were clearly a significant resource for these hospitals in the quality group.

The majority of respondents of the non-quality hospital group utilized some kind of problem identification tools. Almost 44% of respondents utilized Why-Why diagrams, root cause analysis and fishbone diagrams in order to identify problems at their hospitals. Nearly, 82% utilized fishbone diagrams and root cause analysis. Finally, 12.50% of respondents only used root cause analysis in order to identify problem areas at the hospital. A total of 93.75% of respondents utilized root cause analysis. The utilization of these problem identification tools appears to be an important tool for non-quality group hospitals.See Table 4 on the next page for a complete breakdown of the usage of Problem Identification Tools across the two groups.

Table 4 – Problem Identification Tool Usage

Problem Identification Tools		
	Quality Mean	Non-Quality Mean
Root Cause	100.00%	93.75%
Fishbone	81.25%	81.25%
Why-Why	56.25%	43.75%
None	0.00%	6.25%
TapRoot	0.00%	0.00%
FMEA	6.25%	6.25%

Significance Tests

Three significance tests were utilized in MiniTabin order to determine differences between the two groups in the usage of methodologies and tools. First, an F-Test and Levene's test were run to determine if the variances for the two groups could be pooled. If the results of both tests showed statistical significance the variances would be assumed to be different and could not be pooled. The only methodology or tool that did not allow for pooled variances was Value Stream Mapping. All of the other variances were pooled for the 2-sample t-test.The 2-sample t-tests were then run in order to identify a p-value. If this p-value was less than 0.05 the process was assumed to be used statistically more by the quality group than the non-quality group.

When comparing the quality group of hospitals to the non-quality group of hospitals the usage of several methodologies, tools, and problem identification tools appear to be statistically significant. That is, the usage of some of these tools by the hospitals in the quality group is significantly higherthan the usage by hospitals in the non-quality group.

The usage of three lean or Six Sigma methodologies by those hospitals in the quality group were statistically significant when compared to the usage by hospitals in the non-quality group. A3 problem solving, Kaizen Events, and Rapid Cycle Improvement Process were all used statistically more by the quality group compared to the non-quality group. A3 problem solving was used by 43.75% of the quality group compared to 13.33% of the non-quality group the difference between these groups resulted in a p-value of 0.026 meaning the usage of A3 problem solving by the quality group was statistically significant at the 95% confidence

level. Kaizen events were used by 56.25% of the quality group while 20.0% of non-quality group utilized them.This resulted in a p-value of 0.014 meaning the usage of Kaizen events by the quality group was statistically significant 95% confidence level compared to the non-quality group. Finally, Rapid Cycle Improvement Process was used by 81.25% of the quality group compared to 46.67% of the non-quality group with a p-value of 0.033. See Table 5 below for a detailed look at the means, standard deviations and resulting p-values of the significance tests.

Table 5 – Six Sigma and Lean Methodologies Means, Standard Deviations, and P-Values

Six Sigma and Lean Methodologies Means, Standard Deviations and P-Values								
	Quality Mean	Quality Std Dev	Non-Quality Mean	Non-Quality Std Dev	F-Test	Levene's Test	P-Value of T-Test	Degrees of Freedom
A3	0.438	0.512	0.125	0.342	0.127	0.051	**0.026**	30
Kaizen Event	0.563	0.512	0.188	0.403	0.363	0.136	**0.014**	30
Kaizen Blitz	0.125	0.342	0.125	0.342	1.000	1.000	0.500	30
Kaizen Burst	0.063	0.250	0.125	0.342	0.238	0.559	0.720	30
Rapid Cycle Improvement	0.813	0.403	0.500	0.516	0.348	0.004	**0.033**	30
Six Sigma	0.375	0.500	0.375	0.500	1.000	1.000	0.500	30
None	0.063	0.250	0.188	0.403	0.074	0.300	0.850	30
CQI	-	-	0.063	0.250	-	-	**-**	-
DMAIC	0.063	0.250	-	-	-	-	**-**	-
Workout	-	-	0.125	0.342	-	-	**-**	-
TPS	0.063	0.250	-	-	-	-	**-**	-
Lean	0.063	0.250	0.063	0.250	1.000	1.000	0.500	30

(Bold Values are Statistically Significant at 95% Confidence Level)

Four of the Kaizen or Lean tools were used statistically more by the quality group compared to the non-quality group. Observation Forms, Value Stream Mapping/Process Flow Charts, 5S/Visual Controls, and Standardized Processes were all used significantly more by the quality group. Observation forms were used by 75% of the quality group compared to the 26.67% of the non-quality group. This resulted in a p-value of 0.002. Value Stream Mapping/Process Flow Charts were utilized by 93.75% of the quality group while only 66.67% of the non-quality group used them. This was statistically significant with a p-value of 0.018. 5S/Visual Controls were used by 75.0% of the quality group compared to 33.33% of the non-quality group.The p-value for this tool was 0.006 showing its statistical significance at the 95% confidence level.Finally, Standardized Processes were also a significant tool with 68.75% of the quality group utilizing them and 33.33% of the non-quality group. The

difference was statistically significant with a p-value of 0.017.See Table 6 below for a detailed look at the means, standard deviations, and p-values of the significance tests.

Table 6 – Kaizen and Lean Tools Means, Standard Deviations, and P-Values

Kaizen and Lean Tools Means, Standard Deviations and P-Values								
	Quality Mean	Quality Std Dev	Non-Quality Mean	Non-Quality Std Dev	F-Test	Levene's Test	P-Value of T-Test	Degrees of Freedom
Observation Forms	0.750	0.447	0.250	0.447	1.000	1.000	**0.002**	30
Value Stream Mapping	0.938	0.250	0.625	0.500	0.011	0.033	**0.018**	22
5S	0.750	0.447	0.313	0.479	0.796	0.705	**0.006**	30
Standardized Processes	0.688	0.479	0.313	0.479	1.000	1.000	**0.017**	30
Poke-Yoke	0.313	0.479	0.125	0.342	0.203	0.212	0.106	30
Pull Systems	0.375	0.500	0.125	0.342	0.151	0.109	0.055	30
Cause & Effects Matrix	-	-	0.063	0.250	-	-	**-**	-
Waste/ Gemba Walks	-	-	0.125	0.342	-	-	**-**	-
Just-In-Time	-	-	0.063	0.250	-	-	**-**	-
None	0.063	0.250	0.188	0.403	0.074	0.300	0.850	30

(Bold Values are Statistically Significant at 95% Confidence Level)

None of Problem identification tools were used significantly more by the quality group compared to the non-quality group. Root Cause Analysis and Fishbone diagrams were widely used by both groups. Root Cause Analysis was used by 100% of the quality group and 93.8% of the non-quality group.Fishbone diagrams are used by 81.25% of the quality group and 80.0% of the non-quality group. The p-value for this tool was 0.500 showing the lack of statistical significance. See Table 7on the next page for a detailed look at the means, standard deviations, and p-values of these significance tests.

Table 7 – Problem Identification Tools Means, Standard Deviations, and P-Values

Problem Identification Tools Means, Standard Deviations and P-Values								
	Quality Mean	Quality Std Dev	Non-Quality Mean	Non-Quality Std Dev	F-Test	Levene's Test	P-Value of T-Test	Degrees of Freedom
Root Cause	1.000	-	0.938	0.242	-	-	**-**	-
Fishbone	0.813	0.390	0.813	0.390	1.000	1.000	0.500	30
Why-Why	0.563	0.496	0.438	0.496	1.000	1.000	0.248	30
None	-	-	0.063	0.242	-	-	**-**	-
TapRoot	-	-	-	-	-	-	**-**	-
FMEA	0.063	0.242	0.063	0.242	1.000	1.000	0.500	30

(Bold Values are Statistically Significant at 95% Confidence Level)

Opinions of the quality improvement initiatives varied greatly between the different outcomes and the two groups.Respondents were asked of their opinion of how have quality improvement initiatives impacted patient satisfaction, patient outcomes, and financial measures. In response to how have they impacted patient satisfaction the quality group had an average response of 5.875 out of 7. This means they believed patient satisfaction was positively improved by the quality improvement initiatives. The non-quality group had an average response of 5.2 out of 7. The non-quality group also believed that patient satisfaction was improved by the quality improvement initiatives but not as greatly as the quality group believed. The quality group also believed financial measures were improved with an average response of 5.875 out of 7. The non-quality group believed the quality improvement measures improved financial measures with an average response of 5.2667 out of 7. Patient outcomes saw the highest ratings with an average score of 6.375 from the quality group and 5.667 from the non-quality group.

The difference between quality groups and non-quality groups was statistically significant in two of the three opinion categories. The difference in patient satisfaction was significant with a p-value of 0.027. The other category where the quality group had a significantly higher response was in patient outcomes with a p-value of 0.008. Finally, the difference in financial measures between the quality group and non-quality group was not statistically significant with a p-value of 0.051.However, this was very close to the significance level and may be a significant difference in a larger sample. See Table 8on the next page for a detailed look at the means, standard deviations, and p-values of the significance tests.

Table 8 – Impact of Quality Initiatives Means, Standard Deviations, and P-Values

Impact of Quality Initiatives Means, Standard Deviations and P-Values								
	Quality Mean	Quality Std Dev	Non-Quality Mean	Non-Quality Std Dev	F-Test	Levene's Test	P-Value of T-Test	Degrees of Freedom
Patient Satisfaction	5.875	1.147	5.200	0.941	0.492	0.207	**0.027**	30
Patient Outcomes	6.375	0.719	5.667	0.816	0.708	0.729	**0.008**	30
Financial Measures	5.875	1.088	5.267	1.033	0.749	1.000	0.051	30

(Bold Values are Statistically Significant at 95% Confidence Level)

RECOMMENDATIONS

The surveys show that the hospitals in the quality group utilize different methodologies and tools more frequently than the hospitals in the non-quality group. The best practices of the hospitals in the quality group can be considered the different methodologies and tools that they used. In order to improve the quality of care the hospitals in the non-quality group should utilize these best practices.

There are seven critical methodologies and tools that the quality hospitals use more versus the non-quality hospitals. The three methodologies that the quality hospitals used statistically more than the non-quality group areA3, Kaizen Events, and Rapid Cycle Improvement Process.These three methodologies can be assumed to be critical to improving the quality of care within hospitals. While not every hospital in the quality group utilizes these methodologies more use them than do not use them. The assumption is that it is more beneficial to use these methodologies than to not use them.

Four Kaizen or Lean tools were used statistically more by the quality hospitals compared to the non-quality hospitals. Observation Forms, Value Stream Mapping/Process Flow Charts, 5S/Visual Controls, and Standardized Processes were all used more frequently by the quality hospitals compared to the non-quality hospitals. Using these tools can be considered critical to the improvement of the quality in hospitals. The utilization of these tools will put non-quality hospitals in a better position than they would be otherwise.

Through the utilization of these tools and methodologies non-quality hospitals can help improve their quality initiatives in order to positively impact patient satisfaction and outcomes. While using these tools donot guarantee success, the proper use of them in critical areas could greatly improve the quality of care. It must be said that in order to obtain a higher quality of care a hospital does not need to utilize these tools and methodologies. One Urban, non-teaching hospital did manage to obtain 100 Top Hospitals and Magnet Nursing Hospital status using only Root Cause Analysis out of the surveyed items. However, it was the only hospital surveyed that was able to achieve this status without using any of the tools or methodologies. It is possible that this hospital used a homegrown quality program.

Many of the hospitals surveyed both in the quality group and non-quality group utilized some methodologies or tools. However, this survey has shown that the quality hospitals utilize different methodologies or tools more than the non-quality group.The assumption is that the discrepancy can be accounted for the in the quality position of the hospitals. However, because some of the non-quality hospitals do utilize the same methodologies that the quality group do the assumption becomes that either they have not been adapted properly (utilized in wrong areas, not completely open, staff not knowledgeable enough about the processes) or they are in the early stages of use and development.

Limitations of Research

There were a few limitations to the scope of this research. The small sample size made it difficult to see how widespread the discrepancy between some of the methodologies and tools used by the quality hospitals compared to the non-quality. The small sample was also further diluted when I split the respondents into two groups to be compared.The survey was limited in that it did not define each individual item which could have led to people not selecting things they were using, just under a different name. The survey and research is also limited because it was difficult to identify how well each methodology or tool was implemented. This could have an impact on why certain hospitals performed better than others or how the quality hospitals were able to distinguish themselves. Finally, the non-quality hospitals surveyed were all located in the New England region which may not be the best representation of hospitals nationwide.

<u>Further Research</u>

Further research would have to be done to confirm or deny these assumptions. A larger sample size would add more power to the statistical tests done. This would add more validity to our results. Consolidating certain categories and containing more explicit definitions would make the survey more user friendly and limit the potential error of choosing a methodology or tool the hospital might have used under a different or even incorrect name. Finally, more reliance on actual case studies would have been beneficial to see the actual application of the methodologies or tools. This would allow us to identify how well the hospitals implemented the methodologies and how dedicated they were to making them successful. This could have an impact as it may have been that using the methodologies was advantageous but utilizing them and implementing them successfully was the true point of differentiation between the quality and non-quality groups.

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APPENDECIES

Appendix I: Survey

Question #1: Informed Consent
1. Statement of purpose: You are invited to participate in a study of the effectiveness and best practices of Lean and Six Sigma in health care. We hope to learn what practices contribute to the success of a Lean or Six Sigma program and how effective the programs are at increasing quality of care. You were selected as a possible participant in this study because of your position as a quality manager at a hospital.
2. Description, Including Risks and Benefits If you decide to participate, you will complete a survey questionnaire to provide data for our research. Completing the questionnaire will not require any personally identifying information and should not cause any risk or harm to the respondent.
3. Confidentiality Any information obtained in connection with this study will remain confidential and will not be disclosed to the general public in a way that can be traced to you. For any written reports or publications, no participant other than the researchers will be identified, and only anonymous data will be presented This consent form, with your signature, will be stored separately and independently from the data collected so that your responses will not be identifiable.
4. Statement that Participation Is Voluntary Your participation is totally voluntary, and your decision whether or not to participate will not affect your future relations with Bryant University or its employees in any way. If you decide to participate, you are also free to discontinue participation at any time without affecting such relationships.
5. Persons to Contact If you have any questions, please contact Daniel Branco (dbranco@bryant.edu). If you have any additional questions later, we will be happy to answer them. You can have a copy of this form to keep.
6. Informed Consent Clicking the button below to complete the survey indicates that you have read and understand the information provided above.

o   Yes I give my consent
o   No I do not give my consent

Question #2: What category best describes your hospital?
o   Urban
o   Rural
o   Teaching
o   Non-Teaching
o   Other

Question #3: What is your position at the hospital?
▪   (Open ended)

Question #4: What is the size of your hospital?
o   Small (<100 beds)
o   Medium (100-250 beds)
o   Large (>250 beds)

Question #5: Is your Hospital Recognized as one of these High Performers?
o   Baldrige Award Recipients
o   100 Top Hospitals
o   Magnet Nursing Hospital

o Other

Question #6: What Lean or Six Sigma methodologies have you utilized at your hospital?
o A3 Problem Solving
o Kaizen Events
o Kaizen Blitzes
o Rapid Cycle Improvement Process
o Six Sigma
o None
o Other

Question #7: What Kaizen or Lean Tools have you utilized at your hospital?
o Observation Forms
o Value Stream Mapping/Process Flow Charts
o 5S/Visual Controls
o Standardized Processes
o Poka-Yoke
o Pull Systems
o None
o Other

Question #8: What Problem Identification Tools have you utilized at your Hospital?
o Root Cause Analysis
o Fishbone Diagrams
o Why-Why Diagrams
o None
o Other

Question #9: What else can you tell me about quality improvement initiatives at your Hospital?
▪ (Open ended)

Question #10: How have quality improvement initiatives impacted patient satisfaction?
o 1 (Great Negative Impact)
o 2
o 3
o 4 (Neutral)
o 5
o 6
o 7 (Great Positive Impact)

Question #11: In your opinion, How have quality improvement initiatives impacted patient outcomes?
o 1 (Great Negative Impact)
o 2
o 3

- o 4 (Neutral)
- o 5
- o 6
- o 7 (Great Positive Impact)

Question #12: In your opinion, How have quality improvement initiatives impacted financial measures?
- o 1 (Great Negative Impact)
- o 2
- o 3
- o 4 (Neutral)
- o 5
- o 6
- o 7 (Great Positive Impact)

Appendix II: Six Sigma and Lean Methodologies Definitions

Six Sigma and Lean Methodologies	
	Definition
A3	Identify how a process is completed and what the ideal situation would be, looks to change process to ideal in order to minimize waste
Kaizen Event	Week long event based on Kaizen Methodology
Kaizen Blitz	2-3 day event based on Kaizen Methodology, also known as Rapid Cycle Improvement Process
Kaizen Burst	Shorter term event based on Kaizen Methodology
Rapid Cycle Improvement Process	See Kaizen Blitz
Six Sigma	Methodology based on limiting a process to 3.4 defects per million opportunities
None	No Six Sigma or Lean Methodology were used

Appendix III: Kaizen and Lean Tools Definitions

Kaizen and Lean Tools	
	Definition
Observation Forms	Processes are observed and every action written down to identify steps in process
Value Stream Mapping	Processes are mapped and areas where value is added or waste is created are identified
5S	Sort, Straighten, Sweep, Standardize, Sustain, looks to make processes and
Standardized Processes	Processes are standarized and made uniform
Poka-Yoke	Aims to anticipate and eliminate potential defects before they arise or as early as possible
Pull Systems	Customer orders drive demand for production, looks to minimize inventory
None	No Kaizen or Lean tools used

Appendix IV: Problem Identification Tools Definitions

Problem Identification Tools	
	Definition
Root Cause	Looks to identify the base cause of a problem, the underlying reason for why something is occuring
Fishbone	Fishbone Diagrams explore the main causes for a problem that is occuring and breaks down each of those main problems into the underlying cause of the problem
Why-Why	Looks to identify the underlying cause of a problem by asking a series of Why questions, each why digs deeper into the underlying cause of the problem
None	No Problem Identification Tools Used