

Reducing Waiting Time in Patients Undergone Spinal Surgeries at Operation's room of Shohada-ye-Tajrish Hospital using Six Sigma Model

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Abstract: Background and Aim: Since reducing the waiting time is one of the effective factors in patient's satisfaction on quality of services, eliminating of additional process could contribute more to increase utilization of operating room and satisfaction of patients. This research was conducted in order to evaluate the effect of Six Sigma on decreasing of waiting time for starting operation surgery for patient of spine surgery in operating room of Shohada-ye- Tajrish Hospital in Tehran. **Material and Methods:** This study was conducted with the benefit of Six Sigma model in four stages, with qualitative and quantitative methods. The study sample comprised all patients who have spine surgery in Shohadaye Tajrish hospital in three kind of operation: Lumbar fusion, Lumbar laminectomy, Cage implant, in six month duration before and after implementation of six sigma. The sample size was 198 persons. Data collection tools were: Chronometer clock, time measurement forms, and surgery operation registration notebooks. After entering raw data into the software (Minitab) has been calculated by descriptive statistics and central measures, scissoring (average, standard deviation). **Results:** Average waiting time for surgery reduction for patient with lumber laminectomy 51.4 minutes with standard deviation of 21.2, in Cage implant 62.6 with standard deviation of 18.3, and in Lumbar fusion surgery 51.6 with standard deviation of 20.7 has been reached after implementation of Six-Sigma. **Conclusions:** postponement of personnel attendance in recovery room in order to transfer the patient to operating room, transferring the patient to the operating room until changing the nursing shift, nursing resource shortage, prematurely attendance of second and third patient at recovery and lack of physical space of recovery were main factors of increasing patient waiting time. Improvement were taken in order to reduce the average of waiting time for start of the operation surgery by cooperating the attendance of patient after changing the nursing shift, estimating the completion time of the first operation and calling the next patient to the operating room then, and preparing sufficient manpower and enlarging recovery physical space.

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1-Introduction

Six Sigma is a regular strategy to understand the needs of the clients, eliminate the errors, wastes, and quality problems in order to improve processes. This approach was initially applied in manufacturing industries, consequently led to successful results. Following this success, the approach also entered the service units slowly. Because of the special nature of medicine and expectations of the clients and patients, the health care centers attempted to implement these techniques with the goal of reducing errors and improving the quality, safety as well as financial improvements. Implementing this approach in various centers and different countries has provided beneficial results including the increased satisfaction and reduced "waiting time" for the patients (at the

health care centers), more satisfaction of physicians and staffs, cost savings, increased rate of return on investment, the improved scheduling of the surgeries, faster and safer services offerings, and the reduction of mortality (Asadi, 2007). On the other hand, due to the special nature of medical services, impractical services evaluation by customers, as well as increased expectations of the patients, the institutes are forced to apply management's approaches and techniques. In recent decade, Six Sigma has been proposed as a powerful systematic approach to improve health care quality and costs controls focused on identifying shortcomings of the processes' performances and reducing the errors of those clinical and operational processes conducted by eliminating much time consuming, high costs and

poor outcomes. Six Sigma is an improving strategy based on measurement focuses on process improvement and reducing variations. One of the methods used in implementing Six Sigma methodology is DMAIC. In this method, thorough standard procedures, the improvement process will be completed systematically, eventually improves the domain of the considered project (Pourhossein, 2005). It can be mentioned that Six Sigma offers a systematic procedure to improve business processes based on customer needs and to analyze the actual processes occurring at every institutes, which shows the difference of Six Sigma to other methods and the main reason for applying it at health care institutions. Health and other service organizations require efficient cost, systematic and innovative efforts to compete with each other, and being up to date and according to this, Six Sigma can be useful to prepare an efficient framework for the production of the systematic innovative efforts in Health Services (Koning, 2006). Mandahawi investigated that the waiting time in the emergency ward using a design for Six Sigma and discrete event simulation could reduce residence time 34% and waiting time 64% after implementing a triage system without any additional staff (Mandahawi, 2010). According to Dupree and colleagues investigation in the research entitled "Improving the patient satisfaction with pain management using Six Sigma tool" it can be concluded that SIX SIGMA approach can lead to improved patients satisfaction and measurable improvements in the process of recovery and patients satisfaction with pain control and allows the recovery and unit capabilities of the control phase to be included in the daily operations (DuPree, 2010). Harders in 2006 conducted research about the delay in operating room in a hospital, and announced that most prolonged delays in surgeries are due to venipuncture, airway intubation, changing the patient's position in the operation room, unavailability of surgical equipment and the experimental results, patient delays for attending the operating room, the delays of the technological affairs, anesthesiologist and the surgeon delays. Then the researcher was able to analyze and redesign processes to reduce the amount of delays in surgery (Harders, 2006). Moreover, Taner by investigating the applications of Six Sigma in the health care industry associated with affecting factors on increasing the length of hospitalization, has mentioned items such as long histopathological and radiography experiments, poor planning in patients' release, catheter-related infections and postoperative complications and specialized counseling services, as the reasons of the patient's prolonged residence time (Taner, 2009). Maleki also examined "the impact of

Six Sigma approach reduce the length of stay in orthopedic surgery ward patients of educational and medical center of Firoozgar which reduced mean hospitalization period from 7.915 days to 6.375 days after training DMAIC cycle and concluded that using Six Sigma to improve the quality of hospital services, teaching how to use this tool is so important (Maleki, 2008). Generally, there are four parameters, which specify performance level of health care organization, separately or in combination, including how to give service to patients, the price level, customer satisfaction and clinically appropriate services. Although these parameters are extremely practical in health care organizations, but their correct application in a system is very difficult. Despite the challenges of using Six Sigma in the healthcare industry, many hospitals have started using Six Sigma methodology to satisfy patients (Bandyopadhyay, 2005). Health care organizations and other service organizations require the efficient costs, innovative systematic efforts to compete each other, and being up to date and according to this Six Sigma can be used to prepare an efficient framework for the innovative systematic production of the health care services (Heuvel, 2006) For example, the article of the American physician, Pentecost, entitled "Improving the quality of health care," pointed out that Six Sigma is the best known tool for quality control and improvement of the performance (Pentecost, 2007). It also indicates that patient waiting time denotes the availability of the hospital services and is measurable as a hospital performance index (Benson, 2001), it is also possible to reduce patient waiting times using Six Sigma model. However, the use of Six Sigma methodology materializes many ways to improve the quality of health services employing this method and identifying its custodians can be highly profitable for health care organizations. Simmons in his research concluded that identifying the custodians of the process and design of management process system is one of the key factors in the process improvement by Six Sigma in long term (Simmons, 2004). On the other hand, in healthcare provider organizations, long waiting times and canceled surgeries for those who try to satisfy patients in the operating room are too undesirable. Furthermore, unnecessary long waiting times for emergency surgeries may lead to adverse health effects of delayed onset, which must be considered to achieve the desired results. Hospitals should seriously seek efficiency and the care quality in operating room not being mono-parameter relying on the surgery room performance. For example, one indicator of operating room utilization is the ratio of the time spent per patient in the operating room during a surgical procedure to the time determined for the surgery (Hong, 2011). Therefore, the aim of

this study is to improve spine surgery waiting period using Six Sigma model in the operating room of the Shohada-ye-Tajrish hospital of Tehran.

2-Materials and Methods

The purpose of this research study was conducting an interventional analytical study that is classified in the group of the applied researches in terms of the results. The model applying the advantage of Six Sigma model in a four-stage model with quantitative and qualitative methods in a 7 month period from early August to mid February 2012, has been implemented in Shohada-ye-Tajrish hospital operation room. This study was conducted based on four steps DMAIC. The first stage called the definition phase of the cycle was allocated to fill the Six Sigma Project Charter, drawing the overall diagram of the process and analyzing the outputs with the greatest effect on the process (SIPOC) collecting and displaying the data confirming customer needs and his/her desires (Sager, 2005). The first step was to determine what is important; the expectations that should improve the process and its impact on beneficiaries were identified. Data of the patient waiting time were collected before surgery through timing, clocks with chronometer and clinical medical records. In this research, the waiting times patients are expected to spend at the time of their arrivals in operation room during surgery to begin operation in three different spinal surgeries were measured, in the first three months of the study. At the third stage which is data analysis stage, data were analyzed in brainstorming sessions and longer waiting times as well as different reasons to waste time were identified and agreed upon by all members. The meetings held with the presence of the (surgical) team, and the main reasons of increased patient waiting time for the surgery operations start are as follows: delay of surgical team personnel in order to transfer the patient to recovery hall, transferring the patient to the operating room before nursing shift change at the early hours of the day, the inaccurate estimation of the operation time and thereby calling for the next patient by physician in an improper time, insufficient empty stretcher to transport patients underwent surgery, insufficient recovery beds, and lack of physical space for recovery and the patient's underlying problems. Strategies and recommendations were proposed to eliminate the identified factors and reduce patient waiting time at the group discussion meeting. Improving programs after investigating the main problems, giving weight to them and their practicality were described as follows:

1. The patients' presence after the nursing shift changed shortly before the surgery.

2. Calling for patients who are not intended to be operated at the initial surgeries considering the end time of the previous operation.

3. Extending the recovery space

4. Supply workforce for the timely transfer of patients.

In the second 3month, after implementation of Six Sigma methodology, waiting times in a number of patients using timing sheets were collected and the time data obtained from 198 samples were investigated using the software MINITAB. Samples were randomly and classically selected from all those visited Shohada-ye-Tajrish Hospital operating room; the members of the sample community were selected from Department of Spinal Surgery, with three groups of inserting Disc in cervical spine, and spine vertebrae laminectomy. Then, the data were analyzed, through T-TEST, to find a significant relationship between implementation of Six Sigma using the independent T-TEST.

3-Results

Based on the results, the mean waiting time of surgery in patients with spinal vertebrae laminectomy was 65.8 minutes with a standard deviation of 27.4 prior to the implementation of Six Sigma. The operation of inserting Disk in spinal vertebrae lasted 62.7 minutes with a standard deviation of 26.1. In cervical cage surgery), the mean waiting time was obtained 74.9 minutes with a standard deviation of 22.1. Applying the Six Sigma methodology and implementing the recovery phase using T-test and analyzing the data, revealed significant differences before and after applying Six Sigma methodology to reduce the waiting time. Statistical findings of this study showed that the t statistic of the test of disc insertion in spinal vertebrae, in practice, was 2.94 with a 144-degree of freedom and P-Value of less than 0.004. Therefore, the hypothesis mentioned that Six Sigma is effective in reducing the waiting time which is significant in this regard (Table 1). In other operations, including spinal vertebrae laminectomy surgery (Table 2) and cervical cage surgery (Table 3), the obtained P-Values were 0.001 and 0.007, respectively, accompany with statistic t, 3.17 and 2.77 which represent the significance of the Six Sigma hypothesis on reducing the average waiting time. The most important, responsible factors in these processes identified in the previous step leading to longer waiting times were investigated after recognizing the identified processes in the previous step. In the overall process, the presence of patients during preoperative nursing shift, early calling of the second and third patients, lack of space and the recovery beds were the most effective factors of prolonged waiting time. Factors such as workforce,

planning, operation facilities, surgical equipment and space, as well as informing the patient played a significant role in wasting patients' time in all steps of operating room before surgery.

4-Discussion

In the present study, the mean waiting time for the start of surgery in the operating room of Shohada-ye-Tajrish Hospital before applying Six Sigma was determined 62.7 minutes, based on measurements performed in spinal vertebrae disc insertion operation, lasted 65.8 minutes in laminectomy surgery and cervical cage operation duration was determined 74.9 minutes. Implementing Six Sigma decreased aforementioned times to, 11.1 min, 14.4 and 12.3 min, respectively. In a study conducted by Mossadegh RAD on outpatient sector of Razi hospital, Qazvin, the referrers waiting time was measured 168 minutes. According to a research conducted by Aeenparast in orthopedic clinics of medical centers affiliated to Medical Sciences University of Tehran, patients wait 4.1 min on average in admission section, 2.9 min in settlement section, 78.4 minutes for examination and 26.3 minutes in radiology (Mosadegh, 2004). Based on the findings of the existing processes, from the stage of admission at operating room to the beginning of the operation, there are barriers affecting the overall time spent in releasing the patient which makes the waiting time more longer for the patients receiving services; applying Six Sigma model tools enables to eliminate these barriers and decrease the waiting time of surgery. In the research of Maleki et al. (2008) after investigating the presence time of the patients attended the orthopedic surgery in Tehran Medical center of Firoozgar, it was found that patients waiting time in this center is much and by training the Six Sigma, it is possible to reduce patient residence time in the hospital and by defining Six Sigma and training it to professionals, residents and the staff of the orthopedic ward, the waiting time may decrease from 7.915 to 6.365 days Maleki, Khoshkam, & Gohari nezhad, 2008). In other research, carried out by Nassir poor et al. patients waiting times referring to Shahid Dastani clinical complex on the day of visiting the physician decreased from 121 minutes with standard deviation of 33.73 by applying Six Sigma due to the large number of patients, delay of the physician, and lack of doctors (Nasiripour, 2011). Heuvel in Red Cross hospital of Amsterdam in the Netherland managed to reduce patients waiting time through applying Six Sigma methodology after hip surgery from 14 days to 8 days (Heuvel, 2006). The results of Karen and colleagues study after implementing Six Sigma project to reduce the duration of hospitalization for pneumonia patients,

decreased from the 5.9 days to 5.1 days. Financial savings due to the reduced duration of the hospitalization reached over 300 million \$ and the mortality from the acquired pneumonia patients of the community reduced from 6.7% to 5.3 % (Karen, 2007). Lofond considered that the waiting time before surgery is influenced by cases such as economic and social factors and hospital type (training, state), the health level of patients etc (Lofvendahl, 2005). All of the above researches confirm the findings of the present study about using Six Sigma model to reduce patients waiting time; indicated that there is a relation between waiting time and Six Sigma model. In the analysis phase, factors including the delay of the surgical team in attending the operation room, inappropriate informing by operation room secretary, patients transfer to operating room until the change of nursing shift, inaccurate estimates of the operation duration and calling for the next patient (to be operated) before proper time, limited physical space and recovery beds, the presence of underlying problems of the patient, and the shortage of nursing power, change of nursing shifts are known as the reasons to increase waiting time in surgical operation. Nasiri Pour described factors such as planning to visit many patients simultaneously, physician untimely attendance, insufficient physicians, lack of proper planning, skills deficiencies, experience and training of the executive staff, poor informing to the patient about operation's exact time, lack of executive staff and treatment facilities, the causes of the prolonged waiting time for patients (Nasiripour, 2011). Dexter conducted a comprehensive study (2005) to reduce the time of the delays and wasted time in the recovery section of the operating room; some interventions preventing time waste are as follows: Having a scheduled planning, related to recovery section based on predictions about the amount of the activities all the time and updating it during the day; scheduling and coordinating the operation room plans; coordinating the recovery section personnel based on the scheduled planning of the surgery if facing with the surgical risks or delayed recovery programs (Dexter, 2005).

5-Conclusions

Findings of calculated times in the operating room of the educational and medical hospital of Shohada-ye-Tajrish showed that using the Six Sigma model it is possible to reduce the waiting time for beginning the surgery, this model as the newest philosophy, approach, application and tool in order to improve the quality of the business success, has been applied during the past year in companies and various health organizations around the world with

remarkable and valuable results which can be applied to improve the quality of the services in other sectors of the hospital. Considering the noteworthy results obtained from the reduction of waiting times, full implementation of this methodology in the healthcare system is proposed, which was the reason that, during the last years, using Six Sigma in service centers and companies around the world has led to impressive and valuable results. Therefore, investment in training and applying Six Sigma can provide a suitable context for high quality services and create a competitive environment for health care centers

(Aeeinparast, 2006). Considering the above results, the transfer of the patient to the operating room after nursing shift change, secretary proper information about the patient's timely attendance and timing the beginning and the end of the operation, supplying equipment and recovery beds, creating the physical space for recovery, providing nursing power and workforce to transfer the patients, adequate and timely participation of personnel in the operating room in all stages of admission till the patient leaves the operating room are recommended as strategies to reduce waiting times for patients.

Table 1. waiting time of CD implementation

Status	Number of sample	Average	Standard deviation	Test result
Before Six Sigma	77	62.7	26.1	T=2.94 DF=144 P=.004
After Six Sigma	77	51.6	20.7	

Table 2. Waiting time of laminectomy implementation

Status	Number of sample	Average	Standard deviation	Test result
Before Six Sigma	79	65.8	27.4	T=3.71 DF=146 P=.001
After Six Sigma	79	51.4	21.2	

Table 3. Waiting time of Cage

Status	Number of sample	Average	Standard deviation	Test result
Before Six Sigma	42	74.9	22.1	T=2.77 DF=79 P=.007
After Six Sigma	42	62.6	18.3	

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