

Effect of six sigma program on the number of surgeries cancellation

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ABSTRACT

Background: Today, the rate of surgeries is increasing, but surgeries are canceled due to various reasons. Unexpected cancellation of surgeries not only results in disorder in the operating room schedule, but also causes stress for patients and their family and increases costs. We determined the number and causes of surgery cancellations and areas for improvement.

Materials and Methods: This outcome evaluation of Six Sigma program was conducted on 850 cases after the implementation of the program and compared to that of 850 cases which received routine care before the program. Cases were selected through easy sampling during the study. Before the implementation, the number of cancellations was recorded daily and their reasons were investigated. Then, Six Sigma program was implemented in accordance with the reasons for each category and necessary steps were taken to prevent the cancellation of surgeries. Data were collected for 3 months using a three-section data collection form. For data analysis, distribution and relative frequency and chi-square test were used.

Results: The three categories of patient, physician, and hospital system were identified as the main causes. The highest rate of cancellation was related to ENT surgeries (74.19%). No cancellations were made in orology surgeries. The implementation of the Six Sigma program caused a significant difference in surgery cancellation ($P = 0.003$); 31 (3.6%) cases of cancellation were reduced to 12 (1.4%) cases.

Conclusions: The results showed that Six Sigma program is a pre-surgery care quality improvement program. Patient education and the implementation of the 6 sigma program can be effective in reducing the rate of cancellation of operations.

Key words: Efficacy, Six Sigma program, surgeries, surgery cancellation

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INTRODUCTION

Every year, tens of millions of people worldwide enter the operating room and undergo surgery. The unique target of surgical interventions is to promote and develop health and well-being of the patient.^[1] Today, where internal medicine is unsuccessful in the treatment of many diseases, surgery is the method used.^[2] Surgery is an intervention that has physiological and psychological stress reactions and had a pronounced impact on patients and their families.^[3-5] Currently, much of the hospitals' capital is spent in the operating rooms; 30.1% of the total healthcare costs is linked to the cost of surgery.^[6]

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On the other hand, improving and increasing productivity is essential for the survival of any medical center.^[7] Surgery cancellation imposes financial cost on the treatment system and financial and psychological burden on the patient.^[8] Cancellation results in stress for the patient and his/her companions, occupation of hospital beds, reduced staff power, wasting of surgeons' and operating room personnel's time, and unused prepared equipments.^[2] Statistical reports showed that at Stanford Medical Center and the University Hospital of Chicago, 13% and 5.3% surgery cancellations were reported, respectively.^[9] These reports also showed 10%, 11.9%, 14%, and 25% cancellations at private institutions in Canada, Australia, England, and Pakistan, respectively.^[9] Surgery cancellation was reported to be 6.61% at Imam Khomeini Hospital (Tehran, Iran) in 2010, 414 cases at Al-Zahra Hospital (Isfahan, Iran) in 2011,^[4] and at Ayatollah Kashani Hospital, Isfahan, it varied between 2% and 13%.^[8] In addition to costs, increased productivity and satisfaction with the operating rooms formed the priority of the efforts taken to increase efficiency and productivity.^[7] Different approaches have been taken to improve the safety and quality of services in health centers worldwide and have been favorably received. For this purpose, the implementation of measures such as total quality improvement of organizational management, ISO standards, and Six Sigma has been suggested. The Six Sigma system, as the latest quality management system, in addition to providing powerful plans, also provides powerful techniques.^[10] The Six Sigma program is fundamentally different from other traditional and modern quality systems in its philosophy and vision. The Six Sigma doctrine holds that the improvement of quality is a factor by which speed is increased and cost reduced, rather than increasing speed and reducing cost to improve quality.^[11]

Six Sigma is a systematic organizational approach that relies on reducing defects and errors.^[12] In simpler terms, Six Sigma is a systematic approach to solving problems and promoting projects and it includes definition, measurement, analysis, improvement, and control.^[13] The implementation of the Six Sigma approach in healthcare organizations causes reduction in percentage of surgery cancellations, improvement of cycle of time and patient turnover in the surgery, emergency, and radiology wards, and reduction in errors in the drafting of bills, coding, and financial reimbursement.^[14]

Nurses have an important role in reducing surgery cancellation and the resulting wasting of energy, time, and cost by assessing, reviewing, and understanding the patient, triage, and communicating with all members of the surgical team.^[15] In this regard, they can also provide care quality improvement programs. In large hospitals of Isfahan, Iran, such as Al-Zahra and Ayatollah Kashani, there are still

concerns regarding surgery cancellations, and the rate of cancellations remains high. Thus, researchers have tried to eliminate this problem by highlighting the nurses' role and illustrating that nurses can have a major role in reducing surgery cancellations. However, shortcomings in this regard and the specific causes and interventions on surgery cancellations still remain. Moreover, hospital evaluation has recently been substituted with accreditation, and its implementation by hospitals has been made mandatory. Surgery cancellation is one of the most important criteria of accreditation; rates closer to zero indicate the higher quality of a center. Therefore, due to the problems caused by surgery cancellations (organizational, insurance, and patient costs, stress imposed on the patients and their families, and the wasting of time and energy), the researcher studied the implementation and impact of the Six Sigma program on surgery cancellation. This study was conducted with the hope to reduce these costs.

MATERIALS AND METHODS

This study was an outcome evaluation conducted to improve the quality of care. After obtaining permission from the School of Nursing and Midwifery of Isfahan University of Medical Sciences, Iran, this program was conducted on 850 surgeries in Ayatollah Kashani Hospital from April to June 2014. The results were then compared to 850 surgeries in which this program was not applied, but received usual care. Simple sampling was performed. Before performing the program, the operating room list was reviewed and daily tracking was performed to obtain the number of surgery cancellations. Investigations on the causes of cancellation were then conducted. The Six Sigma program was implemented in accordance with the reasons for each category and measures were taken to prevent cancellation. The data collected from the two groups were analyzed. The Six Sigma program included five stages. In the definition stage, surgery cancellation was defined. In the measurement stage, the number of canceled operations was evaluated. In the analysis stage, factors were identified and planning took place. In the improvement stage, measures to improve the process were carried out. In the control stage, the frequency of surgery cancellations after applying the program was compared with before applying the program. The study population included patients who had been referred to these centers for surgery through clinics or hospitals. The inclusion criteria consisted of surgeries which were in elective list 1 (orthopedics and neurology operating room) and elective list 2 [ear, nose, and throat (ENT), and general surgery operating rooms]. Surgeries whose cause of cancellation was not specified were not calculated in the analysis. The data collection form was used to collect data. The first part of data consists of records about the ward, type of surgery, operating room, and surgeon's name.

The second part of the information regarding the surgery cancellation included the cancellation form, evaluation form before the improved surgery, admission checklist, surgery room anesthesia equipment checklist, and surgery room equipment checklist (the storage room was sterilized). Data were gathered by the researcher in two stages, one before the implementation of the Six Sigma program and again after the implementation of the Six Sigma program. The Six Sigma program was implemented after obtaining permission from the authorities of Ayatollah Kashani Hospital and completing the data collection forms. In the first stage (defining the problem), the related figures and statistics, and the cost of surgery cancellation or its postponement were explained to the authorities and the problem was defined. The consent and cooperation of the authorities for the consecutive sessions and follow-up was obtained. In the second stage (measurement), the initial sampling was performed. Data were collected before performing the program in the operating rooms and hospital statistics units. In the third stage (analysis), 850 surgeries were selected and the number of canceled surgeries was determined. The reasons were divided and recorded in three groups of patient, medical reasons, and hospital system.

In the fourth stage (improvement phase), the implementation of programs and interventions began. Cases were analyzed and the hospital management and administration were informed of the results. Then, to improve them, measures were applied which included medical, hospital system, and patient issues. Medical measures consisted of: a) Setting up anesthesia visiting room at the clinic; b) the presence of an on-call heart specialist in their programs; and c) issuing an internal circular on the admission of the elderly, diabetics, and cardiac patients 1 day before the surgery. The hospital system measures consisted of: a) Controlling the operating room equipment at the beginning of the morning shift, which, if found to malfunction, the operating room staff should be notified and b) making necessary arrangements with the hospital pharmacy for the preparation of the equipment required for patients during surgery, such as screws, plaques, and other required props that were previously written in the patient record. Actions including blood bank checking, providing blood products for patients, checking x-ray, laser, endoscopy, and other equipment in the operating room should also be performed. Moreover, the availability of beds for patients in need of the intensive care unit (ICU) should also be checked and coordination made with the related supervisors and residents. The patient measures consisted of: a) Preparing educational pamphlets to educate the patients and distributing them at doctors' offices or clinics and b) providing face-to-face trainings on measures before the surgery. All of these steps were continued until the samples at the second stage reached 850 operations. In the fifth stage (control), until the end of

the research, every stage of recovery was under supervision and followed, and cancellation cases were recorded in the cancellation form. Finally, the number of cancellation cases before the intervention were compared with those after it. To analyze the data, SPSS software (version 18; SPSS Inc., Chicago, IL, USA) and relative distribution statistics, percentage, and chi-square test were used.

RESULTS

The findings showed that before the implementation of the program, 61.3% of the patients were over 40 years of age and after the program, 58.3% were over 40 years of age. In addition, before the program and after the program, 38.7% and 41.7% of the patients, respectively, were younger than 40 years of age. Chi-square test showed that the relative frequency of patients' age whose surgery was canceled had no significant difference before and after the Six Sigma program ($P < 0.860$). In terms of gender of the subjects, before the program, 64.5% of the subjects were men and 35.5% were women. After the program, 75% of surgeries of the men and 25% of surgeries of the women were canceled. Fisher's exact test showed that the relative frequency of gender of the patients whose surgery was canceled before and after the program was not significantly different [Table 1]. Results of the first stage showed that the reasons for cancellations can be categorized into three groups of a) patient, b) medical problems, and c) hospital system. In this study, 19.4% of cancellations were related to the patient, 58.1% to medical problems, and 22.6% to the hospital system. Chi-square test showed that the frequency distribution of cancellation reasons before and after the program showed a significant difference ($P < 0.050$) [Table 2].

The chi-square test showed significant differences in the frequency distribution of the number of canceled surgeries before and after the implementation of Six Sigma in different surgical services. The number of canceled ENT surgeries had reduced from 23 cases (11.79%) to 3 cases (1.55%). However, no difference was observed in other surgical services. Chi-square test showed that the frequency distribution of the number of canceled surgeries, depending on the type of surgery, significantly differed before and after the implementation of Six Sigma ($P = 0.040$) [Table 2]. Before the implementation of the Six Sigma program, of the 850 surgeries, 31 cases (3.6%) and after the program, 12 cases (1.4%) were canceled ($P = 0.003$, $\chi^2 = 8.16$) [Figure 1].

DISCUSSION

The results showed that the implementation of the Six Sigma program reduced the rate of cancellation of surgeries from 3.6% to 1.4% ($P = 0.003$). Exline and Martin stated that

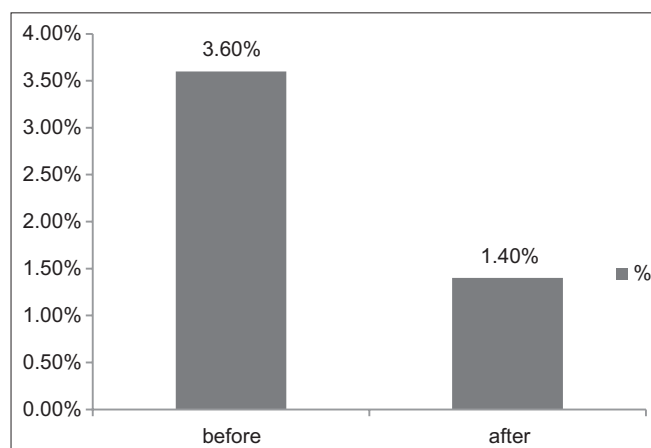
Table 1: Distribution of the number of operations canceled based on the kind of surgery before and after the implementation of the six sigma program

Stages of the study Kind of surgery	Before implementation				After implementation				Test	
	Number of canceled operations per ward	Number of operations per ward	Frequency per ward (%)	Total frequency (%)	Number of canceled operations per ward	Number of operations per ward	Frequency per ward (%)	Total frequency (%)	χ^2	P
ENT	23	195	11.79	2.7	3	193	1.55	0.35	9.92	0.04
Orthopedic	4	405	0.98	0.47	4	414	0.96	0.47		
Neurosurgery	2	87	2.29	0.23	2	62	3.22	0.23		
General surgery	2	140	1.42	0.23	2	153	1.3	0.23		
Urology	0	23	0	0	1	28	3.57	0.11		
Total	31	850	-	3.63	12	850	-	1.39		

ENT: Ear, nose, and throat

Table 2: Distribution of causes of cancellation of surgeries before and after the implementation of the six sigma program

Stages of the study Causes of cancellation	Before implementation		After implementation		Total	χ^2	P
	Number	Frequency (%)	Number	Frequency (%)			
Patient	6	19.4	1	8.3	7	1.8	0.03
Medical issue	18	58.1	6	50	24		
Hospital system	7	22.6	5	41.7	12		
Total	31	100	12	100			

**Figure 1: Percentage of surgical cancellation before and after implementation of the Six Sigma program**

using the Six Sigma program can prevent the cancellation of surgeries.^[16] Haufler and Harrington believed that telephone calls from nurses to the patient before the surgery and reporting the call to the anesthesiologist and surgeon were effective in reducing surgery cancellations ($P = 0.006$).^[17]

Marla *et al.* also showed that the anesthesiologist's visit before surgery had a significant impact in reducing the rate of canceled surgeries. Their results revealed that the number of surgery cancellations of the patients who were visited by the anesthesiologist before surgery was much less than of those who were not visited by the anesthesiologist.^[18] Moreover, Nagah *et al.* noted that launching an anesthesia clinic

reduced the delaying of surgery to zero.^[19] In addition, the study by Ferschl *et al.* showed that anesthesia preoperative assessment of patients at the clinic had a significant effect on reducing the delaying and cancellation of surgeries.^[20] Other studies that have used a part of the intervention in this research were also able to reduce the number of canceled surgeries. No standard has been declared for the number of cancellations, but improvement and reduction compared to the starting point was promising. Quality improvement is a factor in increasing speed and reducing costs and this signifies approaching the target.^[21-25] In this study, the Six Sigma program had an impact on reducing surgery cancellations. This program also showed its effects in studies of other researchers such as Nasiri pour *et al.*^[21] and Mahmoudirad and Esteki.^[22] The Six Sigma program intervention reduced the waiting time in emergency departments, reduced the length of hospitalization, and increased the and improved patients education.

The chi-square test showed that the frequency distribution of the reasons for surgery cancellations differed significantly before and after the implementation of the program. Cancellation reasons were categorized into three groups of a) patient, b) medical problems, and c) hospital system. Sung *et al.* showed that surgery cancellations for outpatients were repeated more than for inpatients.^[9] Changes in clinical conditions of the patients were the most common cause of cancellation; 47 cases were canceled due to cardiovascular problems. Fever, upper respiratory tract infection, asthma,

cardiovascular problems, severe hypertension, and abnormal electrocardiogram, respectively, resulted in the highest rate of cancellation for this group. Furthermore, congestive heart failure, chest pain, and myocardial infarction were the other causes of surgery cancellation.^[9] Susan *et al.* stated that the main reason for surgery cancellation was acute illnesses which included 97 patients (49%).^[23] Not fasting, lack of beds in the ICU, delay in the operating room, the need for consultation, abnormal laboratory tests, not having a companion on the day of surgery, having no insurance, pregnancy, and use of nonsteroidal anti-inflammatory agents were the reasons for surgery cancellation.^[24] Haufler and Harrington found that the most common reason for surgery cancellation was the absence of the patient, lack of Not per Oral (NPO), and not having any companion at the hospital.^[24] The abovementioned studies only focused on patient-related factors, but the present study evaluated the three categories of patient, medical reasons, and hospital systems. It should be noted that depending on the circumstances in each medical center, such as facilities and different surgical services, the number of cancellations also differs. In 2011, Ezike *et al.* divided the causes of cancellation into five groups.^[3] The most common cause was unavailability and lack of preparation of the surgeon (35.8%). In addition, 25.3% of reasons were related to the patient, 41% to the physician, 10.2% to the medical issues of the patient, 17.5% to hospital admission, and 6% to other reasons.^[3] Zafar *et al.* generally divided the cancellation reasons into three categories and showed that 43% were due to problems with anesthesia, 39% to the surgeon, and 18% to hospital and organizational problems.^[25]

Susan *et al.* also listed the factors related to the patient and medical problems as surgery cancellation reasons.^[23] Therefore, most of these reasons can be prevented through appropriate training of the patients, tracking their problems, and timely follow-up consultation and testing. However, Zare and Amrollahi,^[2] Zafar *et al.*,^[25] and Ezike *et al.*^[3] considered problems related to anesthesia and the surgeon as the most important factors for surgery cancellation. With appropriate management and planning, these cases can also be reduced.

Regarding the relative frequency of patients' gender before and after the program, the results showed that prior to and after the implementation of the program, the surgeries of 64.5% and 75% of the men were canceled, respectively. Moreover, before and after the implementation of the program, the surgeries of 35.5% and 25% of the women were canceled, respectively. Fisher's exact test showed that the frequency distribution of gender of those patients whose surgery was canceled before and after the program was not significantly different. Fisher's exact test showed no

significant relationship between the gender of the patients and surgery cancellation after the program. Sung *et al.* showed that gender was not an important factor in surgery cancellation.^[9] This finding supported the findings of the present study. Contrary to this study, Zare and Amrollahi showed that the number of surgery cancellations in women (0.1%) was higher than in men.^[2] Zamani Kiasari *et al.* also showed that among the patients whose surgeries were canceled, 2387 (50.9%) were women and 2299 (49.1%) were men. They believed that female gender was an influencing factor in surgery cancellation.^[26]

Chi-square test showed that the frequency distribution of the type of canceled surgery significantly differed before and after the implementation of Six Sigma. The number of ENT surgeries reduced from 23 cases (11.79%) to 3 cases (1.55%), but no difference was observed in the other surgery services. Ramezankhani *et al.* demonstrated that 18% of surgeries were canceled and the highest percentages of cancellation of surgeries were, respectively, related to vascular, orthopedics, general, and ENT surgeries.^[27] In one of the referral hospitals of Australia, 11.9% of all surgeries were canceled.^[28] The highest percentage of cancellation was related to ENT surgeries (19.6%) and the lowest percentage of cancellation was related to gynecological surgeries, neurosurgery, and organ transplantation.^[28] The study by Susan *et al.* showed that ENT surgeries had the highest number of cancellations.^[23] ENT surgical services had the highest rate of cancellation in most of the studies. This difference may be due to this group of patients having flu before the surgery, or it may be related to the type of surgery, special preparations, and tools and equipment used in the surgery.

CONCLUSION

Results of the present study showed that implementation of the Six Sigma model can reduce the number of surgery cancellations and can be used to improve the quality of services at hospitals. Quality improvement is an ongoing process that must be performed in collaboration with the working groups. Investment in the training and implementation of the Six Sigma philosophy in the health and treatment organizations results in the improvement of the process and reduction of costs. Each medical center, depending on its circumstances, such as facilities and different surgical services, can reduce the number of and prevent surgery cancellations. However, with the implementation of the Six Sigma program, the number of surgery cancellations came close to that of developed countries.

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Conflicts of interest

There are no conflicts of interest.

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