Six Sigma Approach on Discharge Process Turnaround time in King Khalid Hospital, Hail, Saudi Arabia

1L. Kalyan Viswanath Reddy, 2Fares Al Shammari

1University of Hail, Health Administration department, Faculty of Public Health and Health Informatics, Box. 2440, Hail, Saudi Arabia. 
2University of Hail, Health Administration department, Faculty of Public Health and Health Informatics, Box. 2440, Hail, Saudi Arabia.

ABSTRACT

BACKGROUND: This study is mainly focus to streamline the current discharge process of King Khalid hospital and suggest solution in such a way that maximum output can be attained from minimum input of man power and resources for the best results. This study helps the organization to know the deficiency and more over find out the difficulties facing by the patients at various levels for getting discharge from the hospital. OBJECTIVE: To find, eliminate and control Critical to Quality (CTQs) for a successful Six Sigma implementation and reduce the waiting time and suggest steps to control the turnaround time (TAT) of the discharge process and further apply to other processes of the hospital. RESULTS: In the analysis phase of DMAIC, 32 defects are found in the turnaround time of discharge process and the Defect Per Million Opportunity (DPMO) is calculated as 91428.57 in which defect is 9.14%, yield is 90.86% and Process Sigma level is 2.83. After the improvement phase, the defects reduced from 32 to 2. So, DPMO reduced to 5390.83 in which defect is decreased to 0.54%, yield is increased to 99.46% and Process Sigma level increased to 4.05. CONCLUSION: Six sigma approaches saved the money to organizations, by reducing errors, increased customer service and satisfaction and improved productivity.

INTRODUCTION

Six Sigma can be traced back to the 1980s when Motorola, Inc. developed and implemented a new quality program based on the concept of variation management. Six Sigma approach has predominantly been used to improve manufacturing processes. A defect is anything that could lead to customer dissatisfaction (Fairbanks, 2007). Technically, Six Sigma means 3.4 defects per million opportunities (DPMO), where sigma is a term used to represent the variation around the process mean. However, the Six Sigma term has evolved in the last few years as a more complex approach than a simple way to enumerate defects. Although concepts and templates such as DMAIC have been frequently presented and advocated, there exist a number of different perspectives as to what Six Sigma is fundamentally capable of. (Linderman et al., 2003) define Six Sigma as ‘an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates’.

In order to investigate the effectiveness or usefulness of Six Sigma tools, it is important to recognize other methods used in process improvement. According to the Institute of Medicine (IOM), quality is the degree of desired health care services received by patients (Woodard and Madison, 2005). This declaration is given with the idea that what is expected from hospitals today is nothing less than efficient, cost effective customer service (Longest and Darr, 2000). In the past the Six Sigma approach has predominantly been used to improve manufacturing processes (Does et al., 2002). Among the many processes involving patient flow is the admissions, bed assignment, bed turnaround, giving the care, and timely patient discharges. There are also several points of patient discharges such as the pharmacy, ambulance transportation, scheduled for outpatient clinic, and referrer to other facilities. However, Six Sigma is now increasingly applied to a wide variety of non-manufacturing operations. Not only manufacturing companies, but also service organizations such as hospitals, financial and educational institutions have started to embrace Six Sigma concepts and strategies. The King Khalid Hospital is a medium-sized general hospital with 280 beds located in Hail city, Kingdom of Saudi Arabia. In 2012 the King Khalid Hospital had about 12024 admissions, 819 day-care treatments and 5800 surgeries. The hospital employs 530 full-time equivalent employees. During the past five years management and employees have put a lot of effort into implementing quality management in the hospital. A quality system
was designed and developed by department to implement and support quality assurance. At the end of 2010, an external audit resulted in Central Board for Accreditation of Healthcare Institutions (CBAHI) certification for the entire quality system of the hospital. In addition to quality assurance, the hospital is going for Joint Commission International (JCI).

In general, Six Sigma deals with the fact that process and product variation is usually a strong factor affecting manufacturing lead times, product and process costs, process yields, product quality, and, ultimately, customer satisfaction (Goh T.N et al., 2006). Although many factors likely contributed to the mixed results, one often-ignored factor is the uniqueness of clinical operations (Zelman et al., 2003). The main focus of Six Sigma is to reduce potential variability from processes and products by using a continuous improvement methodology that has the following stages: Define, Measure, Analyze, Improve, and Control (DMAIC). However, both government such as Ministry of Health and accrediting organizations such as the Joint Commission indicate that lack of quality of care is caused by inadequate processes and procedures and lack of training (The Joint Commission, 2009).

**Literature Review:**

Nowadays there are various challenges that hospitals are facing; among them are government regulations, quality issues, accreditation requirements and higher costs. Hospital is a very complex organization where as people visit the hospital not by choice but by force. The process should be like “for too long people have been made to fit the services rather than services being made to fit the people” (Scottish Executive Health Department, 2001). Some hospitals managers believe that the very complexity of the health care system joined with exaggeratedly strict regulations force them to be ineffective (Trusko, Pexton, Harrington and Praveen, 2007). The shortage of a raw material in a factory can delay or stop a manufacturing operation; the lack of a medical supply could mean life or death to a patient (Lin Guo and Selena, 2012). Healthcare organizations also have a group of clinical, therapeutic operations that deliver treatments at the point of service (Roberts et al., 2000). Discharge process begins from the time the consultant doctor orders for discharge of the patient till the time patient leaves the hospital which is the final step in the hospital experience to the patient. In the healthcare industry, the factors that determine the quality and efficiency are usually the flow of information and interaction between people. Six Sigma helps in streamlining the flow of information and achieving strategic business results by initiating cultural shifts all throughout the organization. At such process, to check the quality of service is bit challenging. Healthcare organizations should have little difficulty adapting process improvement to these operations (Schweikhart and Dembe, 2009). So, the six sigma application to process is bit difficulty and very time consuming process.

Today, the concepts and methodologies of Six Sigma are increasingly being used in the healthcare industry for improving the quality of services rendered, increasing efficiency, and eliminating human errors that can often prove fatal. The introduction of general management and the increasing involvement of doctors and nurses in management have placed service quality firmly on the health care agenda, and this has been compounded by increasing patient expectation as consumers become increasingly critical about service experiences (Lam, 1997). Six sigma was utilized in patient flow by Commonwealth Health Corporation in conjunction with General Electric. It implemented Six Sigma in its radiology department, by improving turnaround time and the application of Six Sigma resulted in $800,000 (25%) cost decreasing, and later increased $1.20 million in revenues. In addition, in 2006, its decreasing in costs was estimated to achieve $1.65 million annually; with the enhanced patient turnaround time, the volume also improved by 25%, patient satisfaction was also enhanced (Corn, 2009). An example of using Six Sigma process in patient discharge is Sharp Health Care Hospitals Systems, where a Six Sigma’s DMAIC methodology helped decrease the time it takes for a discharged patient to leave the hospital to a skilled nursing facility, from 2.2 hours to about 1.5 hours, after the physician has given the orders (Atkins, 2008).

A healthcare customer is a consumer but not a payer. As a result, a healthcare organization may not be rewarded financially for its quality and innovative technology (Lin Guo and Selena, 2012). In July 2000, Mount Carmel Health (Columbus, Ohio) became the first healthcare organization to implement Six Sigma (Lin Guo and Selena, 2012). It is a common myth that Six Sigma can only be used in the manufacturing industry. However, this view is simply not true (Bruce, 2002; Pande et al., 2000). The six sigma application to hospitals and health care processes became very common. (Huq and Martin, 2000) reported that only one of the seven hospitals in their study had successfully implemented process improvement programs. New process improvement methods have been introduced over the years and even borrowed from other industries.

Literature review search was conducted with various key areas; the challenges and driving forces for discharge process improvement in hospitals, the Six Sigma model and its use in healthcare sectors with emphasis on patient discharge and flow, and the factors required for a successful Six Sigma method. A healthcare organization primarily operates on a pull system, in which patients pull services out of the system (Kilpatrick, 2003). Management of discharges is essential to enhance the quality of patient care across all sectors of hospital. Team work with proper coordination and cooperation at all levels of hospital service delivery
must be encouraged to ensure that health care is planned, managed and delivered based on a patient centered approach which ensures quality and fairness for all. Up to date, managers are realizing that the problem is a process flow problem with variations in quality. For example, studies were conducted by the Institute for Healthcare Improvement (IHI) in which 60 hospitals participated in 2004. The aim was to find a best practice that other hospitals could use to find a smooth flow of patients. The results found that patient flow and bottlenecks were improved when all departments involved interdependently rather than independently. The study concluded that part of the solution in patient flow was finding ways to reduce variability (Haraden and Resar, 2004). It requires that patients needing medical attention can only be discharged after they have been stabilized, left on their own will, or were transferred to another hospital with better equipment.

Six Sigma concepts and methods enable a healthcare organization to offer improved healthcare services to patients by streamlining business processes. In the healthcare industry, the quality of services rendered depends a lot on human skills, which is often very difficult to measure and control. Six Sigma is effective as it is based on a comprehensive approach that focuses on improving both human as well as transactional aspects of a process. Although implementing Six Sigma concepts in the healthcare industry is a challenging task, it does help in getting results. A manufacturing company is a provider of products, whereas a healthcare organization is a provider of services (Velma et al., 2000). Hence, proper discharge cycle times will help to reduce the Average length of stay (ALOS) of the hospital and hence lead to higher revenue generation for hospital and lead to high patient satisfaction. Process improvement has a principle for inventory management known as Just-In-Time, that is to keep “only what is needed, only in the amounts needed, and only when it is needed” (Jackson, 2009). Delivering an error-free service is thus more critical for a healthcare organization than delivering a defect-free product is for a manufacturing company (Lazarus and Neely, 2003; Sherman, 2006). Six sigma is a powerful approach to process improvement, reduced costs and increased business profitability and revenue growth. (Jiju Antony and Craig Fergusson, 2004).

Most significantly, the results of the review showed that Six Sigma tools offer great details in its output to assist in pinpointing the root causes for the delays in patient flow. Based on the literature review, it emerges that Six Sigma is a very successful method. This is not because only Six Sigma is a proven model to reduce waste and variation but because it is one of the minorities, if not the only method, that comes closest to reach the high quality standards the Joint Commission demand from healthcare organization. Additionally, evidence confirms that many more hospitals and other healthcare sectors are joining in the attempts to give perfect care to increase profits, decrease costs and to sustain compliance.

Research Methodology:
Research methodology can be viewed as the process taken to accomplish the key objectives of the research undertaken.

Purpose of study:
Six Sigma was not used in healthcare sectors until 2001; after Commonwealth Health Corporation of Kentucky (CHC) partnered with General Electric’s medical products division, following a successful reduction of its radiology equipment cycle time by 33% (James, 2005). This study is mainly focus to streamline the current discharge process of King Khalid hospital and suggest solution in such a way that maximum output can be attained from minimum input of man power and resources for the best results. This study helps the organization to know the deficiency and more over find out the difficulties facing by the patients at various levels for getting discharge from the hospital.

Objectives of study:
1. To study, review and understand the existing discharge procedure followed by the King Khalid Hospital and the status of Six Sigma application in the hospital;
2. To identify and analyze the data with the help of Six sigma quality tool DMAIC and find out value added time and non value added time within hospital discharge processes; and
3. To find, eliminate and control Critical to Quality (CTQs) for a successful Six Sigma implementation and reduce the waiting time and suggest steps to control the turnaround time (TAT) of the discharge process in King Khalid Hospital, Hail, Kingdom of Saudi Arabia and further apply to other processes of the hospital.

Each of the five DMAIC phases involves detailed plans that help to guide project leaders through the execution of the QI project (De Koning and De Mast, 2006). These key stages are defined as follows:

Define. Define the problem to be solved, including customer impact and potential benefits.
Measure. Identify the critical-to-quality characteristics (CTQs) of the product or service. Verify measurement capability, designate the current defect rate as baseline, and set goals for improvement.
Analyze. Understand the root causes of defects; identify key process input variables (KPIVs) that cause defects.
Improve. Quantify the influences of the KPIVs on the CTQs, and identify acceptable limits of these variables; modify the process to stay within these limits, thereby reducing defect levels in the CTQs.

Control. Ensure that the modified process now keeps the key process output variables (KPOVs) within acceptable limits, in order to maintain the gains in the long term.

Six Sigma can be defined as a statistical data analysis approach used to reduce errors. This means in statistical terms, driving towards six standard deviations between the mean and the nearest specification limit in a process (IsixSigma, 2009). A statistical concept that measures a process in terms of defects – at the six sigma level, there 3.4 defects per million opportunities. Moreover, it is used with the purpose of producing deficiency free processes, and to decrease the variations or inconsistencies in business and clinical processes that cause long cycle times and increased costs (Lazarus and Neely, 2003). Furthermore, Six Sigma is considered to propose proven quality techniques aiming to achieve a standard 3.4 errors per million opportunities, that is 0.0003% error rate (Pyzdek, 2003), and 99.99% of the time. In healthcare sectors, a defect is anything such as medication errors including death or misdiagnosis, delays in admissions or discharges and patient dissatisfaction (Corn, 2009). In US service industry which include health care, has an average sigma level between 2.0 and 2.5 (Belmont, 2001). That is between 158,700 and 208,500 defects or errors per million.

<table>
<thead>
<tr>
<th>Sigma Level (Process Capability)</th>
<th>Defects per Million Opportunities (DPMO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>308,537</td>
</tr>
<tr>
<td>3</td>
<td>66,807</td>
</tr>
<tr>
<td>4</td>
<td>6,210</td>
</tr>
<tr>
<td>5</td>
<td>233</td>
</tr>
<tr>
<td>6</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Define Phase:
Statement of Problem:
To reduce and consistently maintain turn around time (TAT) of discharge process ie; the patient waiting time from doctor order for discharge and to the exact time the patient leave the hospital ward.

Project charter:
Discharge process begins from the time the consultant doctor orders for discharge of the patient till the time patient leaves the hospital which is the final step in the hospital experience to the patient. The discharge process is a critical bottleneck for efficient patient flow. Slow or unpredictable discharge translates into a reduction in effective bed capacity, admission process delays and unsatisfied patients.

Voice of the Customer (VOC):
From the staff, treating physician, resident doctor and personal observation survey indicated that the structure and processes relative to Quality of care, communication, patient’s perception of caring and compassion, and coordination of care offered several opportunities for improvement. Also VOC indicated the discharge process took too long and negatively impacted throughout initiatives. Coordination of care during discharge was identified as another area for opportunity for improvement. However, there are many opportunities to minimize unnecessary changes by improving the communication process among the hospital staff, patient and his family and among the internal “Hospital discharge care team.”

The discharge process turnaround time set by King Khalid Hospital is 120 minutes but with the increase of patient flow and decrease of sufficient man power in hospital led to the delay in the discharge process than the bench marked time set by the hospital. So, the researcher undertook the project to apply Lean six sigma approaches to the hospital discharge process by totally focusing on reducing the discharge time using effective Lean Six Sigma tools.

Consequently, can the Six Sigma model, a system used mostly in manufacturing, be the answer to hospitals’ discharge process improvement issues? Could this model reduce delays in patient discharge? There is no doubt that Six Sigma can be used by healthcare organizations and to improve their patient flow. This study provide analytic and valuable information to the hospital management in turn help them in taking certain managerial decisions which can reduce and control Turn Around Time (TAT) for the discharge process and help for higher patient satisfaction and revenue generation in the form of increased admissions and decreased average length of stay (ALOS) of patient in hospital.

Defining customers and their requirements (CTQs):
Voice of the Customer is the main part of the Six Sigma DMAIC process. After selecting the key external and internal customers – patients, family and family caregivers, and Medicare service givers as the most important external customers, and consultants or resident doctors, staff nurses, and outcomes management as the vital internal customers – the study team conducted personal observational and interviews with members of each
customer group. Following the collection of the customer “voice,” responses then were translated to the underlying key issues that the customers were communicating. Once key issues were identified, the study team translated the key issues to “critical-to-quality” (CTQ) needs. Critical-to-quality needs then were translated into measurable project Ys. The project Y for this CTQ was “compliance to a standardized discharge process.” Table 2 shows a snapshot of the CTQ matrix.

<table>
<thead>
<tr>
<th>Customer</th>
<th>Voice of Customer</th>
<th>Key Issues</th>
<th>CTQ</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>Not aware of proper Discharge instructions.</td>
<td>Variability of discharge instructions</td>
<td>Making aware of a defined Discharge process for all concerned nurses</td>
<td>Compliance to a standardized discharge process</td>
</tr>
<tr>
<td>Patient</td>
<td>Informs me that I am discharged by treating doctor during the morning rounds around 8 am but I couldn’t get the discharge paperwork until afternoon up to 12:00 pm.</td>
<td>Adequate ancillary support</td>
<td>1. Inadequate continuum of care 2. Unmatched demand of Labor 3. Lack of Communication among caregivers</td>
<td>Adequate staffing levels</td>
</tr>
<tr>
<td>Ancillary Support</td>
<td>There is adequate work in the ward and less number of workers and delay by nurse to inform us.</td>
<td>Variability of discharge instructions and inadequate staff</td>
<td>Lack of Communication among caregivers</td>
<td>Compliance to a standardized discharge process</td>
</tr>
<tr>
<td>Treating doctor/ Resident doctor</td>
<td>Too many number of patients cause delay in preparing discharge summary</td>
<td>Inadequate staff cause variability of discharge summary sheet</td>
<td>1. Discharge planning 2. Accuracy of discharge summary sheet typing</td>
<td>Compliance to a standardized discharge process</td>
</tr>
</tbody>
</table>

**Goal Statement:**

To find, eliminate and control Critical to Quality (CTQs) for a successful Six Sigma implementation and reduce the waiting time and suggest steps to control the turnaround time (TAT) of the discharge process in King Khalid Hospital, Hail, Kingdom of Saudi Arabia and further apply to other processes of the hospital.

**Scope / Boundaries of the project:**

The discharge process is a critical bottleneck for efficient patient flow. Slow or unpredictable discharge translates into a reduction in effective bed capacity, admission process delays and unsatisfied patients. This study is limited to the discharge process of only male patients including Saudi nationals and Expatriates.

**Constraints:**

Some of the patients leave the ward without informing the nurse and even without collecting the discharge summary.

**Resources Needed:**

The team members of this six sigma study follow the patient file of each and every individual discharge to note the Turnaround time (TAT) of discharge process. So, a template is prepared to note the Turnaround time of the discharge process as per the hospital discharge process.

**Team guideline and composition:**

The team selected for this study includes Assistant professor as senior Green belt. He acts as the team leader, and was responsible for the overall success of the project. In this particular project, the green belt himself was the process owner. The primary responsibility of team members was to support Green belt in executing the project-related actions. Another Assistant professor was identified as junior Green belt for this study. The team along with two Green belts developed a project charter with all necessary details of the project. This has helped the team members to clearly understand the project objective, project duration, resources available, roles and responsibilities of team members, project scope and boundaries, expected results from the project, etc. This creates a common vision and sense of ownership for the study, so that the entire team is focused on the objectives of the project. The team had several meetings with the team leader to discuss various aspects of the problem, including the internal (hospital staff issue) and individual patient-related and patient centred issues arising because of the delay in the discharge problem.
Expected results from the project:
To find, eliminate Critical to Quality (CTQs) and reduce the waiting time and control the discharge time within the benchmark time of the hospital discharge process.

SIPOC analysis:

<table>
<thead>
<tr>
<th>S</th>
<th>SUPPLIERS</th>
<th>I</th>
<th>INPUT</th>
<th>P</th>
<th>PROCESS</th>
<th>O</th>
<th>OUTPUT</th>
<th>C</th>
<th>CUSTOMER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consultant</td>
<td>Discharge instruction</td>
<td>Refer to table 4.</td>
<td>Decrease in Average length of stay (ALOS)</td>
<td>Patient</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resident doctor</td>
<td>Discharge summary writing</td>
<td>Decrease the waiting time of discharge</td>
<td>Patient, his family members and relatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nurse</td>
<td>Educating the patient about home remedy and diet</td>
<td>Educating patient</td>
<td>Patient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ancillary support</td>
<td>Transferring the patient by wheel chair</td>
<td>Help for the patient satisfaction</td>
<td>Patient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pharmacy</td>
<td>Drug supply</td>
<td>Early recovery</td>
<td>Patient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: SIPOC analysis.

Table 4: Simplified Discharge process for the study.

Measure Phase:
The measure phase has the purpose of mapping the discharge process and establishing methodology that describe the study in order to narrow the problem to its major factors (Pande et.al., 2000)

Define defects:
The defect is defined as delay of the discharge process at any stage of discharge process leading to the increase in the benchmark discharge time of the hospital.

Defect Per Million Opportunity (DPMO): \( \frac{\text{Total No. of Defects} \times 1,000,000}{\text{Total No. of Patients} \times \text{Opportunities}} \)

Table 5: Data collection plan.

Table 6: Discharge process map (Format of Data Collection).

With the data collection format, defects ie; the reasons for the delay of discharge process are noted as below in the form of Pareto chart.

Table 7: Defects measurement ie; Reasons for delay of discharge process.
Analysis Phase:

In measure phase, data is collected through carefully designed discharge process steps by identifying few vital steps of complete and complex discharge process. These vital steps are usually refereed as vital “X” which is used to analyze the outcome of the study. After mapping the discharge process, cause and effect diagram was prepared that increase the identification of potential factors causing an overall outcome—in this study ie; delay in the discharge process.

In the above Cause and Effect diagram, the statement of the effect ie; problem is represented in square and the causes are represented in the form of arrows.

Graph 1: Histogram showing the number of delays.

Graph 2: Pareto chart showing the delay in discharge process as per cause.

Table 8: Data Sheet of turnaround time (TAT- FORM).

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>Total TAT(Min.)</th>
<th>Average TAT(Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>7610</td>
<td>152.2</td>
</tr>
</tbody>
</table>

Table 9: Discharge patients average time.

<table>
<thead>
<tr>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient ideal discharge time as per hospital</td>
</tr>
<tr>
<td>Patient average discharged time as per study</td>
</tr>
<tr>
<td>Time gap</td>
</tr>
</tbody>
</table>
Fig. 1: Cause and Effect Diagram (Fishbone Diagram).

Graph 3: Patient Discharge Time.

Table 10: Analyzing the patients discharged with in hospital benchmarked time.

<table>
<thead>
<tr>
<th></th>
<th>No. of patients discharged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within the hospital benchmarked time i.e., 120min.</td>
<td>18</td>
</tr>
<tr>
<td>Above 120 min.</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>
Graph 4: Analyzing the patients discharged with in hospital benchmarked time.

**Defect Analysis:** DEFECT PER MILLION OPPORTUNITY (DPMO)

\[
\text{Total No. of Defects X 1,000,000} = 32 \times 1,000,000 = 91428.57
\]

\[
\text{Total No. of Patients X Opportunities} = 50 \times 7
\]

Therefore, DPMO is calculated as 91428.57 that suggest defect is 9.14%, yield is 90.86 % and Sigma level (Process Capability) of 2.83.

**Improvement Phase:**

The following critical elements were recognized and improved: (1) poor process flow; (2) inconsistent communication; (3) no standardized order writing process; (4) under utilization of human resource; and (5) lack of understanding at the staff level of the importance of this issue. Then, specific solutions were developed individually.

All the staff involved in the patient discharge were educated about the defects in the discharge process and were brainstormed regarding the improvement of the process. Later on the defects were made to correct in the following ways:

a) **People:** a) The patient relatives or family members were informed regarding the discharge of patient one day before so that there won’t be any delay in receiving the patient as soon as he get discharged. b) The consultant were given enough time and advised to write down the progress notes as early as possible without any delay. c) As there was lack of resident doctors, more resident doctors were appointed and involved in the avoiding the delay in discharge process.

b) **Environment:** a) All the documents of the patients were secured and placed in order as per inpatient record file. This is the responsibility of the concerned nurse. b) Any discharges should be done at least 30 minutes before the prayer timings.

c) **Process:** a) The staff is advised to improve the communication for the timely output and quality performance of hospital staff.

d) **Materials:** a) Three wheel chairs and stretchers were dedicatedly allotted for the discharge patients.

After the above corrections, again data is collected for the period of 3 months and defect analysis was done after the post improvement phase.

**Defect Analysis:** DEFECT PER MILLION OPPORTUNITY (DPMO)

\[
\text{Total No. of Defects X 1,000,000} = 2 \times 1,000,000 = 5390.83
\]

\[
\text{Total No. of Patients X Opportunities} = 53 \times 7
\]

Therefore, DPMO is calculated as 5390.83 that suggest defect is 0.54%, yield is 99.46 % and Sigma level (Process Capability) of 4.05.

**Control Phase:**

In this phase, Constant data tracking and documentation to improve and come to the level of Zero defects and the process to be kept well within the benchmarked time of 120 minutes by the hospital authorities. But this
is not achieved even after 3 more months of data analysis after the post improvement phase and the sigma level is 4.05 only with defect percentage of 0.54. The Green belt team members measure any improvements and ensured that they would be sustained.

RESULTS AND DISCUSSION

Six sigma continuous quality strategy blend in utilization in many sectors especially it is growing popularity in the health sector. The main reason is the hospital quality is patient centric and continuous process so it calls for zero defect processes. Six sigma approaches saved the money to organizations, by reducing errors, increased customer service and satisfaction and improved productivity. In this study, in the pre improvement phase, 32 defects are found in the turnaround time of discharge process and the DEFECT PER MILLION OPPORTUNITY (DPMO) is calculated as 91428.57 in which defect (%) is 9.14, yield (%) is 90.86 and Process Sigma level is 2.83. But in the post improvement phase, the defects reduced from 32 to 2. So, DPMO reduced to 5390.83 in which defect (%) is decreased to 0.54, yield (%) is increased to 99.46 and Process Sigma level increased to 4.05.

The Six Sigma with the tools, road maps, and management processes is essentially a carefully managed process for systematically scheduling and carrying out innovation projects that can be taught, learned, and performed with a high degree of success. The application at the King Khalid Hospital provides an illustration of the significant benefits of the Six Sigma approach. In Six Sigma approach process there were inherent difficulties faced in executing this study. Mainly the availability of people for attending training and getting the support of the people at the lower levels in the organization because of coping with day to day activities, training and for participating in the implementation of the solutions. The six sigma team achieved the results with proper coordination and help from the hospital authorities. Lastly, this study will help the fellow researchers to do further study on many more processes in hospital and health care.

REFERENCES


