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## REDUCING AND OPTIMIZING THE CYCLE TIME OF PATIENTS DISCHARGE PROCESS IN A HOSPITAL USING SIX SIGMA DMAIC APPROACH

**Abstract:** A lengthy and in-efficient process of discharging in-patients from the Hospital is an essential quality component that needs to be addressed in order to improve the quality of Health care facility. Even though, several quality methodologies are adopted to improve such services in Hospitals, the implementation of Six Sigma DMAIC methodology to improve the Hospital discharge process is much limited in the Literature. Thus, the objective of this research is to reduce the cycle time of the Patients discharge process using Six Sigma DMAIC Model in a multidisciplinary hospital setting in India. This study had been conducted through the five phases of the Six Sigma DMAIC Model using different Quality tools and techniques. This study suggested various improvement strategies to reduce the cycle time of Patients discharge process and after its implementation; there is a 61% reduction in the cycle time of the Patients discharge process. Also, a control plan check sheet has been developed to sustain the Improvements obtained. This Study would be an eye opener for the Health Care Managers to reduce and optimize the cycle time of Patients discharge process in Hospitals using Six Sigma DMAIC Model.

**Keywords:** Six Sigma, DMAIC Model, Hospital discharge Process, Cycle time

### 1. Introduction

Hospital is the most important service industry. Today, everybody is concerned about the Quality of Health Care facilities and the term “Quality” becomes an essential element to combat competition in the Health care Environment. In the process of attaining Quality, each and every process in the Hospital needs to be optimized to the fullest

satisfaction of the patients. One such process that drives direct attention from the patients is the preparation and the timely availability of discharge summary at the time when they are leaving the hospital. The success of any organization depends on its resource utilization and by ensuring the proper discharge process; we can assure patient satisfaction and also utilizing resources for more patient care.

A lengthy, inefficient process for discharging in-patients is a common concern for the hospitals in India. It not only causes frustration to the patients and family

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members, but also leads to delays for incoming patients from admitting (Udayai and Kumar, 2012). Health care managers have been adopting several strategies to address this issue and one such strategy is Six Sigma. Six-sigma is a business improvement strategy used to improve business profitability to drive out waste, to reduce costs of poor quality and to improve the effectiveness and efficiency of all operations so as to meet or even exceed customer's needs and expectations (Anthony and Banuelas, 2001). In other words, Six Sigma is an organized and systematic method for Strategic process improvements and new product and service development that rely on statistical and the scientific method to make dramatic reductions in customer defined defect rates (Linderman *et al.*, 2003). The name Six Sigma comes from the fact that it is managerial approach designed to create processes that results in no more than 3.4 defects per million (Levine, 2008).

DMAIC (Define, Measure, Analyze, Improve and Control) in Six Sigma is described as an approach for problem solving. DMAIC is applicable to empirical studies ranging from well-structured to semi structured, but not to ill-structured problems or pluralistic messes of subjective problems (Kumar *et al.*, 2013). The advantage of such method is that they are very versatile. Mast and Lokkerbol (2012) have highlighted the characteristics of the DMAIC approach and its limitation, specifically from problem solving perspectives.

For the two decades, many manufacturing companies have implemented six-sigma to improve their processes. But its implementation in service industries like health care is much limited since six-sigma is a journey to reach the target by changing culture of the organization which is a long term process. On reviewing the literature, few studies demonstrated the utility of Six Sigma Models in Health care Industries with specific focus on surgery turnaround time (Adams *et al.*, 2004), clinic appointment

access (Bush *et al.*, 2007), hand hygiene compliance (Eldridge *et al.*, 2006), antibiotic prophylaxis in surgery (Parker *et al.*, 2007), scheduling radiology procedures (Volland, 2005), catheter-related bloodstream infections (Frankel *et al.*, 2005), meeting standards for cardiac medication administration (Elberfeld *et al.*, 2004), nosocomial urinary tract infections (Hansen, 2006), and operating room (OR) throughput (Fairbanks, 2007). More recently, Rosalie Sager and Eric Ling (2007) conducted a study by implementing the six sigma methodology to improve the Hospital bed availability and emphasized that the Leadership support and active participation from employees were key factors in successful implementation of Six Sigma Methodology in Hospitals. Similarly, Heath Rushing and Carolyn Pexton (2006) conducted a study using Six Sigma Model and reduced the admitting delays by improving Bed Management.

The present study was conducted with two fold objectives using Six Sigma DMAIC Methodology viz: (i) To reduce the time interval between when a discharge order written by the Physician and when the discharge summary is ready to be handed over to the patient; (ii) To find out which aspect of the current process would be in and out of scope to achieve the timely hand over of discharge summary to the patients. Also, this study addressed the non-value added activities increasing the cycle time of discharge summary preparation process.

## 2. Methodology

### 2.1. Study Settings

This study was conducted at KG Hospital, India during the process of attaining Hospital accreditation in the year 2010-2011. As a measure to improve the Quality of Services, one critical issue consists of delay in handover of discharge summary to the Patients was identified and a cross functional Quality management team was formed to

address the underlying issues that might be causing the delays in discharging the patients. Accordingly, the team members explored various Quality approaches and finally, decided to use DMAIC Model with an objective to optimize the cycle time of Patients discharge process. The study was conducted for the duration of 3 months and necessary process redesign was carried during this period for obtaining optimal results.

## **2.2. DMAIC Model (*Define, Measure, Analyze, Improve and Control Model*)**

The methodological framework adopted in this study is based on DMAIC Model. The Quality tools and techniques and the strategies adopted in each phase of DMAIC to optimize the Patients discharge process is described below:

### **2.2.1. Defining the Problem**

Firstly, the exact critical issue to be investigated was clearly defined in this phase by the Chief Executive Officer (CEO) of the Hospital. The selection of that critical issue is based on the three key parameters viz. (i) Patient centered Hospital Mission; (ii) Past complaints received from the Patients and; (iii) Historical Patient satisfaction Survey results. By analyzing the above three key parameters with particular attention to the voice of customer (Patient feedback form), it was inferred that there is need to reduce patient discharging time, which had been identified as one of the critical factor contributing to dissatisfaction among in-patients. In order to execute this study on a pilot basis, one specific department called, General Medical and Surgical Department was selected. The antique data (for previous 3 months) in the Hospital provides the summary of the total turnaround time taken for discharging the patients in the General Medical and, Surgical departments. However, after due consultation with the

process owners of the Patients discharge process and the concerned HOD of the departments, the Upper specification limit for discharging a patient was fixed as 135 minutes (i.e. 2 hours and Fifteen Minutes).

As a next step, the dash board for the project was created. A Dash board is a tool used by the Hospital management to clarify and assign accountability for the 'Critical Few' key objectives and project tasks needed to steer an organization towards its mission (Basu, 2009). So as to accomplish this project, a Six Sigma team consisted of a Team leader (usually a Health care professional with a Six Sigma Black Belt Certification), Medical Superintendent, Nursing Superintendent, Nursing Manager of the Medical & Surgical wards, One IT specialist (mostly a senior manager from the EDP department) and a technical staff from the billing department were formed by the CEO of the Hospital.

The primary objective of the team is to improve and optimize the patient discharging process and the initial target was fixed to hand over the discharge summary to the patients within two hours and 15 minutes hours (i.e. 135 minutes) of the discharge decision was taken by the attending Physician or Surgeon. The Key process output variable was the average time taken for Patients discharging the Patient in that particular department.

### **2.3. Measure the Current Process**

The measure phase involves documentation and evaluation of the existing Patients' discharge system before implementation of the Improvement strategy that the team might suggest. As an initial step, the process sigma level of the Patient discharging process of the selected specialty department was calculated based on the antique data and it is shown in the table 1.

**Table 1.** Calculation of Process Sigma for the existing Patient discharge process

S.No	Process Sigma Components	Output/Result
1.	Number of Defects opportunities per Unit (O) <i>(Timely handover of Discharge summary to the Patients i.e. on or before the stipulated Upper specification limit of 135 Minutes)</i>	O=1
2.	Number of Patients discharged during the period of 3 months (N)	N=120
3.	Number of Patients not discharged within the Upper Specification limit (i.e.135 minutes) (Defects-D)	D=85
4.	Defects per Opportunity (DPO); $DPO=(D \div O \times N)$	0.70833
5.	Yield $(1-DPO) \times 100$	29.167%
6.	Process Sigma	0.95

The above calculation of the current Sigma Level of error or defects in the discharging process was done with the goal of finding out how close the discharge process is to the target of six sigma standard deviation between the mean 234.35 minutes and the target 135 minutes. The results showed that in the 120 samples data obtained there were 85 discharges that fell above the target of 135 minutes, which is 0.95 or 1 standard deviation from the mean of 234.35 minutes. The ideal sigma level away from the mean of 234.35 minutes would be 6 standard deviations. Therefore, the current discharge process at the Hospital is 5 standard deviations away from the target. This may be because the existing discharge process contains many variables or special cases spread out throughout the process. As a further exploration, the team developed Flow diagram to map a visual representation of all the major steps in the Patients discharge process as shown in Figure-1. This step will help in understanding how the entity (discharge report) flows through the process and what is the role of each stakeholder in the process (Mohamoud and El Banna, 2012).

The mapping of the Patients discharge process was carried out using Process flow chart to analyze all the steps starting from the preparation of the discharge summary by

the physician and continued with sequential activities until it is handed over to the patient.

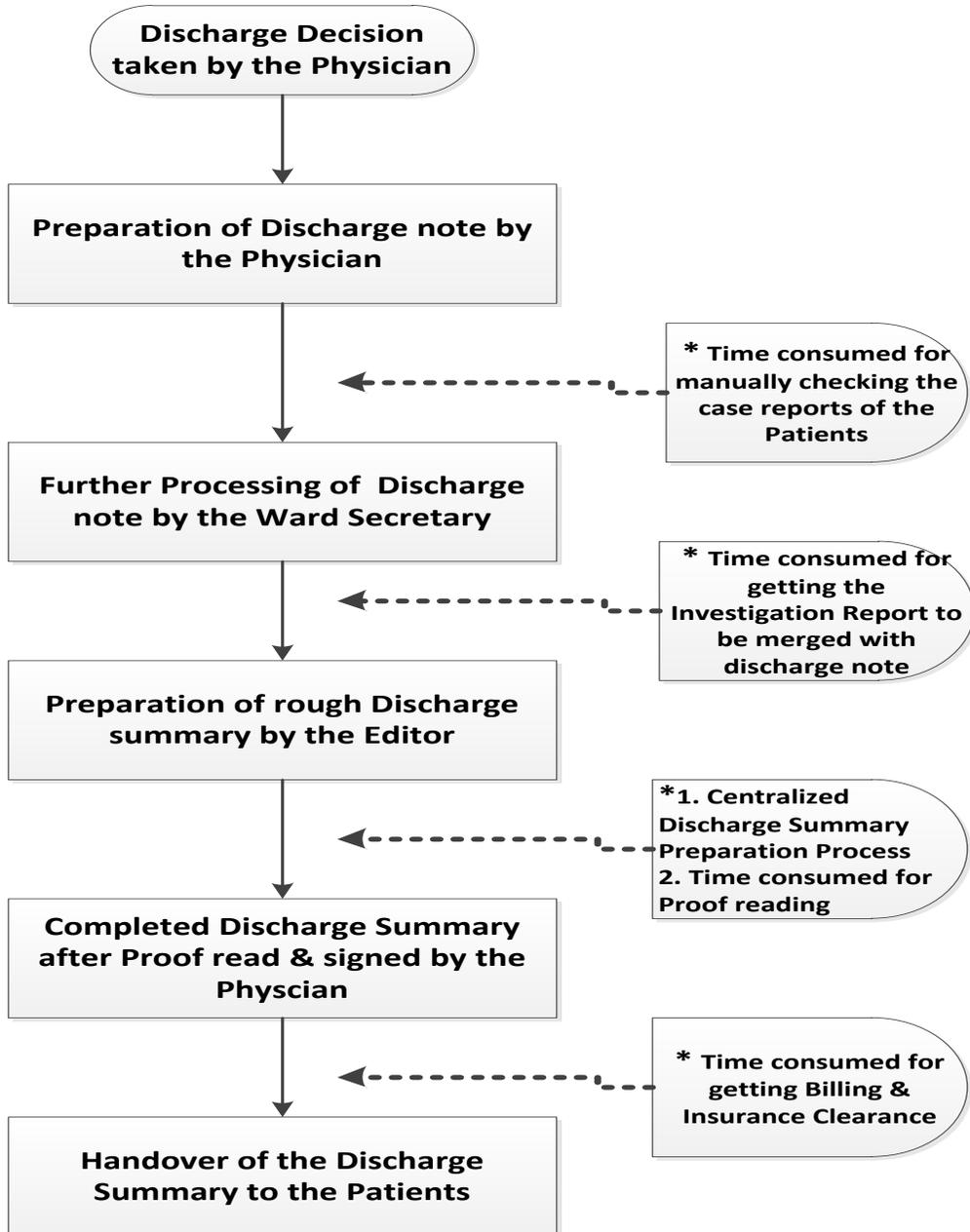
The process comprising of a sequential steps starting from the discharge decision taken by the Physician and ends with the timely handover of discharge summary to the patient. It was broken down into five logical sub processes viz:

- 1) Preparation of discharge notes by the attending Physician or Surgeon
- 2) Processing of discharge notes by the ward secretary by appending the necessary laboratory reports.
- 3) Processing and typesetting of the discharge summary by the Editor
- 4) Completion of final discharge summary by the Editor after proof read by the Physician or Surgeon
- 5) Discharge summary ready to be handed over to the Patient after signed by the Physician or Surgeon.

A time study was used to measure each step in the process to determine the time consumed by each of the five sub processes towards the preparation of the discharge summary. Time study is a direct and continuous observation of a task, using a timekeeping device (e.g., decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera) to record

the time taken to accomplish a task. The observed mean time for each of the sub processes of the Patients discharge process

against the upper specification limit fixed during the define phase is given in the table.2.



\* Process location where the delay occurs due to input is waiting to proceed to the next activity in the Patient discharging process.

**Figure 1.** Flow Chart showing major steps in the Patients Discharge Process

**Table 2.** Time study showing the description of Patients Discharge Process along with the observed mean time and the upper specification limit fixed by the Process Owners

Process Steps	Description of the Discharge Process	Description of the Process in terms of time intervals	Observed Mean time	Upper Specification Limit
I	Confirmation of discharge, preparation of the discharge notes by the primary physician	Time elapsed from the Physician visiting time to the time until the rough discharge report completed by the Physician.	53.42	30
II	Processing of discharge notes by the ward secretary by appending the necessary laboratory reports.	Time elapsed from the receipt of discharge notes by the ward secretary until the rough discharge report made ready.	51.96	30
III	Processing and typesetting of the discharge summary by the Editor	The time elapsed from the receipt of rough discharge report by the Editor until the time where the typesetting of the rough discharge summary is completed.	52.14	30
IV	Completion of final discharge summary by the Editor after proof read by the Physician or Surgeon	The time elapsed from dispatch of the rough typed discharge summary by the editor until the receipt of the same after proof corrected by the Physician.	25.86	15
V	Discharge summary ready to be handed over to the patient after signed by the physician or Surgeon	The time elapsed from the completion of the final and proof corrected discharge summary by the editor to the time where final discharge summary is signed by the Physician.	25.51	15
VI	Actual receipt of the Discharge summary by the Patient	The time elapsed from the time where the discharge summary is signed by the Physician and the actual time of handover of the same to the Patient.	25.44	15
<b>Total time</b>		234.35 minutes	142.86 minutes	

From the process mapping and the time study of each sub processes, it is found that six areas were identified as critical areas that

may delay the timely handover of discharge summary to the Patients. Firstly, a delay might occur at the Physician or Surgeon's

end in the rough preparation of discharge notes. Secondly, a delay might occur at the processing of the discharge notes by the ward secretary due to interruptions in getting the investigation reports. Thirdly, due to interruption in getting the completed discharge notes by the ward secretaries, there is a potential source of delay in sending the rough draft of discharge notes to the editor. The next source of delay may occur at the editor's desk due to the centralized discharge summary preparation process. Even after the rough draft of discharge summary prepared by the editor, there might be a chance that the discharge report may hold up at the doctors' desk for getting his final approval and signature. Finally, even when the discharge summary is ready to be handed over to the patients, there might be a chance for delay in the process of getting clearance from the Insurance or billing department.

#### 2.4. Analysis of the Data

In the analyze Phase, a list of Key process Input variables (KPIs) were analyzed. The Key process input variables include 'Time factors' that are controlling the Opportunities of the Patients Discharge process. The time consumed for each of the six process steps of the Patients discharge process is shown in the table 2. Based on the homogeneity of activities related to preparation of discharge summary, it is found that four critical areas consumed more time with respect to the upper specification limit (i.e. 135 minutes) fixed by the process owners viz:

- 1) Preparation of rough discharge note by the Physician;
- 2) Further processing and issuance of discharge note by the Ward secretary;

- 3) Processing time for typesetting the discharge summary by the Editor (combines the process steps III, IV & V);
- 4) Processing time to handover the discharge summary to the patient after getting clearance from the billing and the Insurance department.

In order to locate the reasons for the delay in each of the sub processes of the Patients discharge process, a root cause analysis (Five Whys) was carried out and it is depicted in the table 3. It is a systematic technique of asking five questions successively in order to probe the causes of a Problem to get to heart of the problem. It is a very effective tool and can be used to identify the root causes of a problem.

The table 3 depicts four critical issues that might be causing delays in timely handover of the discharge summary to the patients at the time when are leaving the Hospital. All the issues identified were further explored and subjected to the root cause analysis using brain storming techniques. The first issue explored was to the find out the reasons for the delay in the preparation of discharge note by the Physician. After discussion with each of the Physician in charge of preparing the discharge note, it was found that the physician have to prepare the discharge note manually by verifying all the relevant records of the Patients. Such activity consumes a little long time and this happened because the Information technology was noted fully utilized to generate and verify the required patient records needed for preparation of the discharge note.

**Table 3.** Analysis of Root causes contributing to delay in the Patients Discharge Process.

S.No	Problem under investigation	Analysis of the Problem (by asking five Whys to reach the Root cause)				Root Cause of the problem
		Why?	Why?	Why?	Why?	
1.	Delay in the Preparation of rough discharge note by the Physician	The attending Physician manually prepares the discharge note by checking all the relevant case reports of the patients. (e.g. drugs consumed before and during stay in the hospital; Physical activity & dietary schedule adapted during the stay in the Hospital)				Failure to utilize Information Technology system to generate and verify the required patient Information.
2.	Delay in further processing & issuance of discharge note by the ward secretary	Frequent Clarifications in the discharge report delays the process.	Physician Hand writing difficult to understand	Different Ward Secretary to process Discharge Summary Report	Shift timings are different requires different ward secretary to process discharge report.	Failure to use same & trained ward secretaries to process the discharge report.  Failure to develop a proper channels of communication or mechanism to get the Investigation Reports
		Delay in getting Investigation report that is to be merged with the discharge summary.				
3.	Delay in typesetting the rough Discharge summary by the editor	Centralized Discharge Summary preparation Process	Lack of Manpower to setup discharge unit for each Specialty Department			Lack of decentralized Discharge summary preparation Process
		Non availability of Physician /Surgeon to proof read the rough discharge Summary	Engagement of the attending Physician or Surgeon in the Ward rounds or surgery			Failure to empower the Assistant Physician/Surgeon to proof read the rough Discharge Summary.
4.	Delay in handover of the discharge summary to the patient after signed by the Physician	Delay in getting Insurance or billing clearance for the Patients	Consumes more time to get clearance from the source using paper based methods.			Lack of Facilities like Intranet or ERP packages installed in the Computer terminals located at the selected departments to access necessary patient records for confirming the bills clearance when the need arises.

The second issue explored was to find out the reason for the delay in further processing & issuance of discharge note by the ward secretaries and it was subjected to the root cause analysis. The analysis yields four possible sequence of events that leads to the occurrence of this problem as perceived by the Ward Secretaries viz. (i) more time consumed for clarifying certain critical issues such as drugs and its dosage, follow-up details etc. which are generally incorporated in the discharge note; (ii) The hand written discharge note by the Physician is difficult to understand that requires further clarification; (iii) Different ward secretaries were used to process the same discharge note due to change in their shift timings. The eventual solution to overcome this specific critical issue is to use same and trained ward secretaries to process the discharge note so that they can be familiar with the Physicians handwritings and the whole process will be finished within optimal time.

Further the root cause for the delay in typesetting the rough discharge summary by the editor was explored. Two specific reasons were traced from the feedback of the process owners. The first one is the Centralized discharge summary preparation process adopted by the Hospital administration. As result of this, all the discharge summaries were prepared at a centralized unit and there was a long queue that leads to a long waiting time to complete the process. This could be avoided by making the discharge summary preparation process decentralized to each department level. The second issue was related to the process where the delay was occurring due to the non-availability of Physicians to proof read and correct the rough discharge summary prepared by the editors. This could be attributed to the fact that the attending physician might be involved in Ward rounds or attending surgeries. The appropriate solution would be to involve or empower Assistant Surgeon or Physician to proof read the rough discharge summary and to make necessary changes if required.

Lastly, the root cause for the delay in handover of the discharge summary to the patient after it was signed by the corresponding Physician or Surgeon was explored. One specific reason was pointed out by the process owners involved in that activity. There was a potential delay in getting the Patients bills to be cleared either from the Insurance companies or from the Patients itself. While exploring the reasons for this delay, it was found that it took long time to get the bills clearance manually using pen and paper based approach. Also, there was no Enterprise Resource Planning (ERP) software or Intranet facility to connect all the departments for confirming the bills clearance of the patients, when the need arise. The suitable solution would be to install an appropriate ERP package to link all the computers via intranet so that this problem could be resolved in short run.

## 2.5. Improve Phase

In this Phase, the results of the analyze phase were carefully implemented to make appropriate change in the design of Patients discharge process by removing the non-value added activities contributing to the delay in discharging the patients and following recommendations were implemented viz:

- 1) Generate up-to-date information about the drugs and therapies utilized by the patients before and during the stay in the hospital using Information technology system. Ensure all the information about the patients is available in a computer generated printed form and be inserted in to the medical record of the patient on the day prior to the expected discharge. This form provides an opportunity for the Physician to review the medications taken by the patients prior to admission and also the drugs and therapies prescribed during the hospital stay. Check boxes are given that help the Physician with

- an opportunity to indicate or modify the medications and dietary schedule to be consumed by the Patients after discharge.
- 2) Efforts have been taken to train and utilize same Ward secretary/technical staff at each department so that the delay in processing of discharge summary could be reduced. The task of carrying out the preparation of discharge summary was assigned to specific staff at each department so that the task would be completed at appropriate time. Moreover, a Process Design Program Chart (PDPC) was prepared depicting the patient discharging process customized to each department and made readily available to facilitate the process. Also, the Patients discharge process flow have been developed and displayed in the inpatient room so that the discharge expectations are communicated to the patients during their hospital stay (Ajami and Ketabi 2007).
  - 3) Decentralize the Hospital discharge process where the preparation of discharge summary is done at each individual department itself. Adequate facilities and man power were developed at each department to prepare discharge summary. This will reduce the delay in the typesetting the discharge summary by the Editor at a Centralized discharge Unit.
  - 4) Purchase and install suitable ERP software in all the Computers through the Electronic Data Processing (EDP) Department and electronically link all the specialty departments so that the delay in getting the clearance from the Billing department would be reduced. Responsibility was assigned to the billing personnel to update all the inpatient bills clearance to till time, every day and upload the information in the Computer.

After implementation of the above suggestions for the period of 2 months, the data was collected to study the turnaround time for discharging the Patients. Overall, the average time for discharging a Patient was reduced from 234 minutes to 143 minutes, demonstrating a 61% decrease.

### 2.6. Control Phase

The recommendations which are piloted, and implemented during the improve phase were standardized, confirmed and institutionalized in the Control Phase. The Process improvements obtained during the improve phase will only work if it leads to long term changes in Performance. A control plan and a check list (table 4) was made and circulated among the process owners of the Patients discharge process in each department to track results and to ensure the improved process remains improved over long run.

**Table 4.** The Process check list to sustain and control Improvement for long run

Process /Activity Steps	Processing time		Target Time	Task completion status (C-Completed; P*-Pending)	Signature of the Employee
	Start time	End Time			
Processing & Completion of the discharge notes by the primary physician					
Processing & completion of discharge notes by the ward secretary					
Processing and typesetting of the discharge summary by the Editor					
Completion of final discharge summary by the Editor after proof read by the Physician or Surgeon					
Time of handover of discharge summary to the Patient					

\*If a Process is Pending and needs clarifications from other department for its completion, the breakup time and the reasons for such clarifications needs to be mentioned in the remarks section to find out any assignable cause for such activity.

### 3. Discussion of findings

This study is the documentation of the effectiveness of implementing Six Sigma DMAIC methods to reduce and optimize the Patients discharging process at KG Hospital, Coimbatore, India. In order to execute this study on a pilot basis, one specific department namely General Medical and Surgical department was selected based on the homogeneity of services offered and the complexity of the patients handled in the department.

During the define phase, the problem was defined based on the inputs captured through the Patient feedback forms. Accordingly, a Project charter was prepared and roles and responsibilities of the team were fixed. Also, the team fixed the Upper Specification Limit (USL) to handover the discharge summary to the patients and it had been fixed as 135 minutes. This USL (target) is fixed based on consultation with the process owners who are in charge for preparing the discharge

summary and also on the basis of benchmarking practice adopted by similar tertiary care hospitals in the Country.

During the measure phase, the antique data (i.e. previous 3 months) of the patients discharge process was measured to drive the average cycle time required to handover the discharge summary to the patients after the discharge decision taken by the Physician or Surgeon. The result indicated that it took 234 minutes to handover the discharge summary to the Patients. As a further exploration, a process flow chart was made to find out the time consumed for each activity in the preparation of discharge summary with respect to the target fixed by the team members. It consists of six process steps and the time consumed for completing each of the processes is depicted in the table 2.

During the Analyze phase of DMAIC, a root cause analysis was carried out with each process owners in charge for the preparation of various components of the discharge summary report. The root cause analysis

yielded five critical issues contributing to the delay in the handover of discharge summary to the Patients (table 3). These include: (i) Failure to utilize Information technology to generate and verify the patient information. All the required information for discharging the patients such as Lab reports and Bill clearance had been done through manual methods instead of using Information technology (i.e. checking via intranet); (ii) Failure to utilize same & trained ward secretaries to process the discharge report. The applicability of Job rotation technique exposes different ward secretaries to process the discharge summary and it impedes the employees to be specialized in that Job; (iii) Lack of decentralized discharge summary preparation process. The responsibility for preparing the discharge summaries had been undertaken by a centralized Unit at the Hospital that also contributing for the delay; (iv) Failure to empower the Assistant Physician or Surgeon to proof read the rough discharge note prepared by the editor for review. There was a potential delay noted for this activity due to the engagement of the attending Physician or Surgeon either in ward rounds or in Surgery and; (v) Failure to link all the computers located in all the departments with ERP software so that accurate and up-to-date information about the Patients can be gathered without delay.

All the critical issues identified in the Analyze phase was carefully evaluated and appropriate solutions were implemented in the Improve phase of DMAIC. Following recommendations were implemented viz. (i) All the process owners of Patient discharge process were given training to utilize the Information Technology to generate up-to-date information about the Patients to be discharged. (ii) Job Specialization technique was adopted to train specific ward secretaries in each department to process the discharge summary of the Patients. Also, a Process Design Program Chart (PDPC) was prepared depicting the patient discharging process customized to each department and made readily available to the ward secretary

to facilitate the process. (iii) The Discharge summary preparation process has been decentralized and the reports are generated in each department itself. Necessary manpower has been recruited for this purpose.

After implementation of the improvement strategies for the period of 2 months, the data on Patients discharging time was again collected in the specific departments. It was found that the average time to discharge the patients was measured as 143 minutes against the target of 135 minutes. When compared with Pre-intervention phase of DMAIC, there was a significant reduction in the average discharge time from 234 minutes to 143 minutes demonstrating 61% decrease. Such improvement is comparable with the findings of previous study done by Theodore *et al.* (2010) who demonstrated a decrease of 62% in the discharge timing after the implementation of the Six Sigma Methods.

#### 4. Conclusion

This study validated the application of Six Sigma DMAIC methods to reduce and optimize the patients discharge process with specific focus on a Medical and Surgical Department. Even though the average discharge time reduced from 234 minutes to 143 minutes demonstrating 61% decrease, but it is higher than the upper specification limit (135 Minutes) as fixed by the Process owners. However, the results demonstrated a positive impact on reducing the patient discharge time due to the application of suggested recommendations for the period of two months. As result of this breakthrough improvement, more patients will be managed in the particular department which indirectly increase the number of admissions, turnover of the rooms, increase hospital profitability and will also enhance Patient satisfaction. This study also demonstrated the contribution of the multidisciplinary team members of the hospital in reducing Patients discharge time.

## 5. Limitations

The Coverage of this study and improvements obtained was limited to only to the General Medical and Surgical Department of Study Setting. So, an appropriate precaution needs to be taken while generalizing the results. This study will help the Hospital administrators and policy planners in expediting decision about the implementation of six sigma Methods to improve the Quality of care in Hospitals.

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## References:

- Adams, R., Warner, P., Hubbard, B., & Goulding, T. (2004). "Decreasing turnaround time between General Surgery Cases: a six sigma Initiative. *Journal of Nursing Administration*, 34, 140-148.
- Ajami, S., & Ketabi, S. (2007). An Analysis of the average waiting time during the patient discharge process at Kashani Hospital in Esfahan, Iran: A case study. *Health Information Management Journal*, 36(2), 37-42.
- Anthony, J., & Banueles, R. (2001). A Strategy for Survival. *Manufacturing Engineer*, 80(3), 119-121.
- Basu, R. (2009). *Implementing Six Sigma and Lean. A Practical Guide to Tools and Technique*. Butterworth-Heinemann: Oxford, United Kingdom.
- Bush, S.H., Lao, M.R., Simmons, K.L., Goode, J.H., Cunningham, S.A., & Calhoun, B.C. (2007). Patient access and clinical efficiency improvement in a resident hospital-based women's medicine center clinic. *American Journal of Managed care*, 13, 686-690.
- El. Banna, M.A. (2012). Improving Patients Discharge Process in Hospitals by using Six Sigma Approach. *World Academy of Science, Engineering and Technology*, 68, 112-120.
- Elberfeld, A., Goodman, K., & Van Kooy, M. (2004). Using the Six Sigma approach to meet quality standards for cardiac medication administration. *Journal of Clinical Outcomes Management*, 11, 510-516.
- Eldridge, N.E., Woods, S.S., Bonello, R.S., Clutter, K., Ellingson, L., Harris, M.A., Livingston, B.K., et al. (2006). Using the six sigma process to implement the Centers for Disease Control and Prevention Guideline for Hand Hygiene in four intensive care units. *Journal of General Internal Medicine*, 21(2), 35-42.
- Fairbanks, C.B. (2007). Using six sigma and lean methodologies to improve or throughput *AORN Journal*, 86, 73-82.
- Frankel, H.L., Crede, W.B., Topal, J.E., Roumanis, S.A., Devlin, M.W., Foley, A.B. (2005). Use of corporate Six Sigma performance-improvement strategies to reduce incidence of

- catheter-related bloodstream infections in a surgical ICU. *Journal of American College of Surgeons*, 201, 349-358.
- Hansen, B.G., (2006). Reducing nosocomial urinary tract infections through process improvement. *Journal for Healthcare Quality: Promoting Excellence in Healthcare*, 28, W2-2.
- Kumar, R.K., Kumar, T.B., Ahmed, I. (2013). Reducing Process variability by using DMAIC model: a case study in Bangladesh. *International Journal for Quality Research*, 7(1), 127-140.
- Levine, D.M. (2008). *Statistics for Six Sigma Green Belts with Minitab and JMP*. Pearson Education: Dorling Kindersley (India).
- Linderman, K., Schroeder, R.G., Zaheer, S., & Choo, A.S. (2003). Six Sigma: a goal-theoretic perspective. *Journal of Operations Management*, 21, 193-203.
- Mast, J.D., & Lokkerbol, J. (2012). An analysis of the six sigma DMAIC method from the perspective of problem solving. *International Journal of Production Economics*, 132, 134-154.
- Parker, B.M., Henderson, J.M., Vitagliano, S., Nair, B.G., Petre, J., Maurer, W.G., Roizen, MF., et al. (2007). Six sigma methodology can be used to improve adherence for antibiotic prophylaxis in patients undergoing non-cardiac surgery. *Anesthesia & Analgesia*, 104, 140-146.
- Rushing, H., & Paxton, C. (2006). Reducing admitting delays by improving bed management using six-sigma methodology. Retrieved from: <http://www.isixsigma.com/new-to-six-sigma/dmaic/reducing-admitting-delays-improving-bed-management>. Accessed February 25, 2014.
- Sager, R., & Ling, E. (2007). Leveraging Six Sigma to Improve Hospital Bed Availability. Retrieved from: <http://www.isixsigma.com/new-to-six-sigma/dmaic/leveraging-six-sigma-improve-hospital-bed-availability>. Accessed February 25, 2014.
- Theodore T.A., Shih-Hsien, T., Swanson, K., & AcClay, M.A. (2010). Improving the Hospital Discharge Process with Six Sigma Methods. *Quality Engineering*, 22, 13-20.
- Udayai, K., & Kumar, P. (2012). Implementing Six Sigma to Improve Hospital Discharge Process. *International Journal of Pharmaceutical Sciences and Research*, 3(11), 4528-4532.
- Volland, J. (2005). Quality Intervenes At a Hospital. *Quality Progress*, 38, 57.

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