Quality Improvement in Critical Care Areas using the Lean Six Sigma approach

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Abstract

Background: An intensive care unit provides critical lifesaving care and as such, this study is done to understand the compliance of the nursing staffs working in the ICUs of a 350 bedded urban tertiary care hospital in India, towards the quality indicators functional in its critical area areas using the Lean Six Sigma approach and studying the deviation between the knowledge and practice.

Materials and Methods: An observational cross-sectional study was done among the nursing staffs of different ICUs, using google form questionnaire and checklists. Lean Six Sigma was used as a study tool. A sample size of 164 was considered using Convenience Sampling. And data analysis was done using the SPSS version 28.0.0.0.

Results: An increase in the bed occupancy, ALOS and HAIs among the ICU patients was markedly observed. The chi-square analysis revealed significant difference (3) = 18.0231, $p < 0.05$) and ((3) = 11.48, $p < 0.05$) in practice, among the nursing staffs with respect to the quality indicators based on different variables.

Conclusion: Hospital quality indicators and the correct way to follow them, is necessary to deliver a quality healthcare service experience to the patients admitted in the critical care areas of the hospital.

Keywords: Critical care, infection control, quality indicators, Lean Six Sigma, Fish bone analysis, Pareto chart

Introduction

The differences in ICU outcomes between hospitals are likely related to differences in ICU design and treatment routes. Understanding these variables can aid in the reduction of variability and the improvement of patient care[1]. As such, this study is done to understand the compliance of the nursing staffs working in the ICUs of a 350 bedded urban tertiary care hospital in India, towards the quality indicators functional in its critical area areas, and Lean and Six Sigma (DMAIC) concepts are combined to increase a process' overall efficiency, providing a complete process performance improvement[2].

Material and Methods

***Study design*:** Analytical Observational Cross-Sectional Study

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***Study population*:** Patients and Nursing staffs in the critical care areas of a 350 bedded urban tertiary care hospital in India

***Study period*:** April 2021 – June 2021

***Period of data analysed*:** December 2020 – May 2021 (6 months)

***Study tools*:** Structured Closed-ended Questionnaires and Checklists

***Six Sigma tools*:** Lean Six Sigma tools – Chi square test

***Data Collection Methods*:**

Primary data: Direct Questionnaires to nursing staffs in the ICUs using google forms and Collection of data from quality indicators checklists

Secondary Data: ICU Records - Patient files and registers

Sampling Method: Convenience Sampling

Sample Size: 164 (out of total 225 nursing staffs in the critical care units)

***Ethical Considerations*:**

- Data confidentiality has been maintained throughout the study.
- E-Consent was taken from every respondent.

***Data Analysis*:** Descriptive statistical tools like chi square analysis, using the SPSS version 28.0.0.0

Findings

Define Phase

Project Charter for the Proposed Research

Problem Statement

A decrease compliance to quality indicators among the medical staffs of the critical care areas in a 350 bedded urban tertiary care hospital in India.

Project Title

Analysing the compliance to quality indicators among the medical staffs of the critical care areas in a tertiary care hospital in Durgapur - a DMAIC approach

Stakeholder Needs

Increase in the hospital revenue.

Availability of hospital resources and its optimum utilization.

Project Goals

Increased Revenue and availability of hospital resources.

Decreased incidences of HAIs

Decreased ALOS for the ICU patients

Increased compliance to quality guidelines.

Estimated Cost Saving

To increase the bed availability by 20%, and reducing their ALOS to increase hospital revenue by 35%

Key Action Tools

Fish bone diagram

Data collection plan

Pareto analysis

Barriers

Non-compliance by the medical staffs.

Improper record keeping.

Inadequate knowledge

Scope of the project

Identifying the key improvement areas for increasing the compliance level of the medical staffs towards quality indicators in the ICUs of the hospital, in order to increase the quality of services being delivered to the patients.

	Project Timeline	
Define	Identification of the problem area in the ICUs	1 week
	Developing tools for data collection	
Measure	Collection of data through patient checklist, registers and patient files and from Infection Control Department	8 weeks
	Conducting ICU staff questionnaire	
	Graphical representation of the collected data	
Analyse	Analysis of data from survey and that collected through checklist from the ICUs for the past 6 months	2 weeks
Improve	Data Interpretation and Representations	1 week
	Designing solutions and proposals	
Control	Approval of Proposed Solutions (Tentative)	1 week

Following this, study tools were developed. A questionnaire was prepared to understand the compliance level of the medical staffs to the quality indicators in the ICU and checklists were formed for doing the trend analysis for different quality parameters over the past 6 months from the study.

According to the Australian Critical Care Journal, the optimal bed occupancy in the ICUs is 82-85%. The below graph, shows a less than optimal bed occupancy in the months of Dec 2020 and March 2021. The same has been seen above optimal value in May 2021.

Measure Phase:

Bed Occupancy in the critical care areas for last 6 months

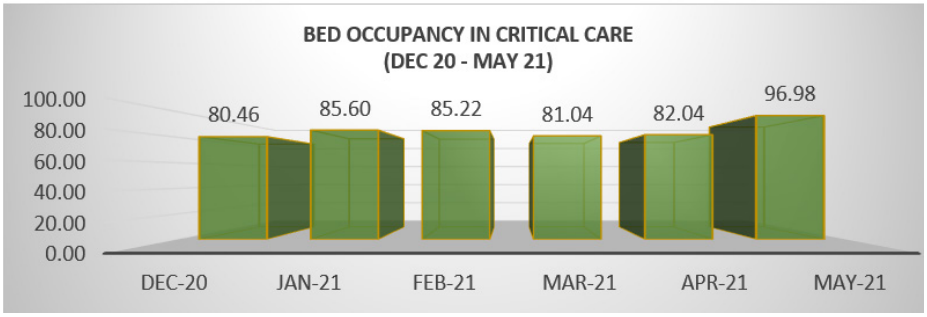

Figure 1 Bed Occupancy Rate in the Critical Care Areas from December 2020 to May 2021. Source. The 350 bedded urban tertiary care hospital, India. Credit. Self

Average Length of Stay for patients for the last 6 months.

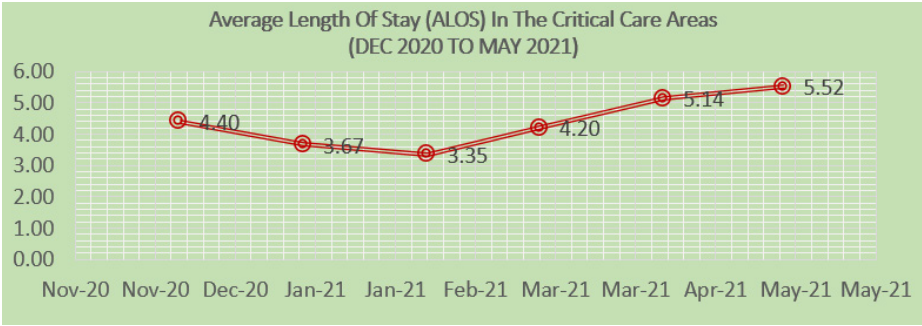

Figure 2 Average Length of Stay (ALOS) in the critical care areas from December 2020 to May 2021. Source. The 350 bedded urban tertiary care hospital, India. Credit. Self

There has been a steady increase in the ALOS from March 2021 to May 2021. The reason attributing to the same could possibly be the delay in discharge of Govt. Insurance patients and increased need for critical care for COVID patients admitted in the ICUs (April – May 2021).

Hospital Acquired Infection Rates for the last 6 months

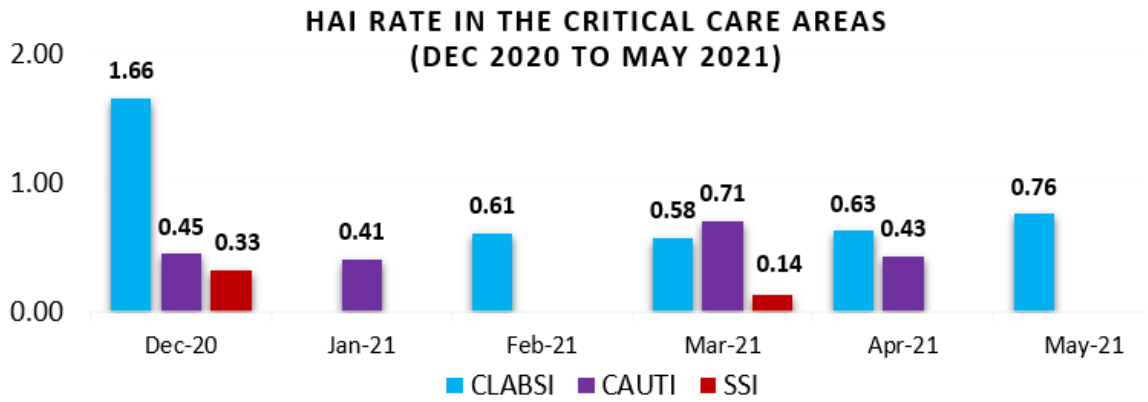

Figure 3 Hospital Acquired Infection Rates in the Critical Care areas from December 2020 to May 2021. Source. The 350 bedded urban tertiary care hospital, India. Credit. Self

The Hospital Acquired infections that were most commonly seen in the ICUs were, Central Line Associated Blood Stream Infections (CLABSI), Catheter Associated Urinary Tract Infections (CAUTI) and Surgical Site Infection (SSI).

Incidence of Adverse events for the last 6 months

From Dec 2020 to May 2021, there were 45 incidents of Accidental removal of lines. 40 pressure sore incidents, 3 incidents of patient fall, 20 incidents of re-intubation within 48 hours and 6 incidents of Return to ICU within 48 hours, that had occurred in the ICUs.

Analyse Phase:

A sum total of 164 responses (73% of total staffs) were collected from the different critical areas of the hospital.

Chi square analysis

The responses recorded were grouped into four types of variables, i.e., based on the type of ICU ward, experience in the healthcare sector, number of nursing trainings attended and according to the seniority of post held in the hospital. These numbers were then divided into two groups based on their scores in the survey in the knowledge and practice section,

and categorised further as, good or poor. Responses that scored more than 60% were considered as good and the rest were grouped as poor. Furthermore, the chi square analysis was done to understand the significant difference in the knowledge and practice among different groups of nursing staffs working in the critical care areas.

Chi square for wards and knowledge:

The value of chi-square statistic is 2.762. The *p*-value is .838.

The result was found non-significant at $p < .05$.

The result showed no significant difference between the knowledge level of the nursing staffs about the quality indicators in different types of ICU wards.

Chi square for wards and practice:

The value of chi-square statistic is 8.514. The *p*-value is 0.203.

The result was found non-significant at $p < .05$.

The result showed no significant difference between the practice level of the nursing staffs about the quality indicators in different types of ICU wards.

Chi square for experience and knowledge:

The value of chi-square statistic is 0.053. The *p*-value is 0.997.

The result was found non-significant at $p < .05$.

The result showed no significant difference between the experience and the knowledge level of the nursing staffs about the quality indicators in different types of ICU wards.

Chi square for experience and practice:

The value of chi-square statistic is 5.409. The *p*-value is 0.144.

The result was found non-significant at $p < .05$.

The result showed no significant difference between the experience and the practice level of the nursing staffs about the quality indicators in different types of ICU wards.

Chi square for training attended and knowledge:

The value of chi-square statistic is 3.0818. The *p*-value is .214191.

The result was found non-significant at $p < .05$.

The relationship identified between the above variables was found to be non - significant, (3, N = 164) = 5.409, p = 0.144. Therefore, the result showed no significant difference between the experience and the practice level of the nursing staffs about the quality indicators in different types of ICU wards**.**

Chi square for training attended and practice:

The value of chi-square statistic is 18.0231. The *p*-value is .000122.

The result was found significant at $p < .05$.

The result showed a highly significant difference between the number of trainings attended and the practice level of the nursing staffs about the quality indicators in different types of ICU wards**.**

Chi square for position held and knowledge:

The value of chi-square statistic is 5.9372. The *p*-value is .051376.

The result was found non-significant at $p < .05$.

The result showed no significant difference between the position held and the knowledge level of the nursing staffs about the quality indicators in different types of ICU wards.

Chi square for position held and practice:

The value of chi-square statistic is 11.48. The *p*-value is .003215.

The result was found significant at $p < .05$.

The result showed a highly significant difference between the number of trainings attended and the practice level of the nursing staffs about the quality indicators in the critical care areas.

Root Cause Analysis

Problem 1.: Cause and Effect Analysis – High incidence of CLABSI

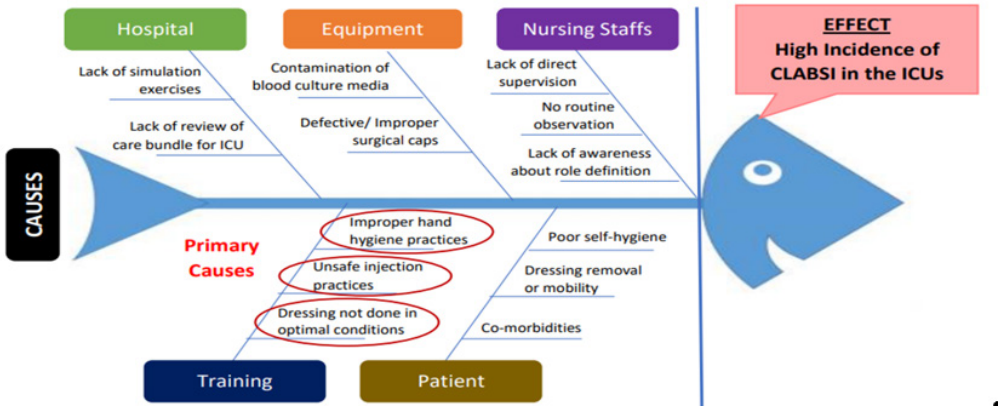

Figure 4 Fish bone diagram for the Root Cause Analysis of the increased incidence of Central Line Associated Blood Stream Infection (CLABSI) in different Critical Care areas of a 350 bedded urban tertiary care hospital, India.

Problem 2.: Cause and Effect Analysis – High incidence of CAUTI

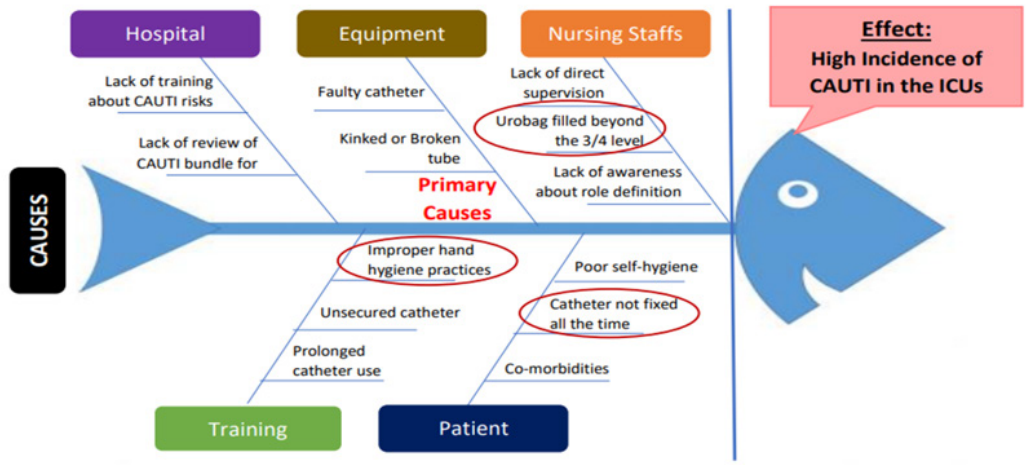

Figure 5 Fish bone diagram for the Root Cause Analysis of the increased incidence of Catheter Associated Urinary Tract Infection (CAUTI) in different Critical Care areas of A 350 bedded urban tertiary care hospital in India.

Problem 3: Primary Reasons for Increased Incidence of Pressure Sores:

As per the hospital incidents' record, the main reasons documented for the increased occurrence of Pressure Sores in patients are –

- Prolonged bed ridden patients having a longer length of stay
- Under supervision of patient positioning.
- Prolonged wearing of diapers by patients

Problem 4: Primary Reasons for Increased Incidence of Accidental removal of lines:

As per the hospital incidents record, the main reasons documented for the increased occurrence of Accidental Removal of Lines in patients are –

- A restless or irritable patient or unaccompanied while moving.
- Lack of awareness during shifting of patients
- Self-removal by patients

Pareto Analysis

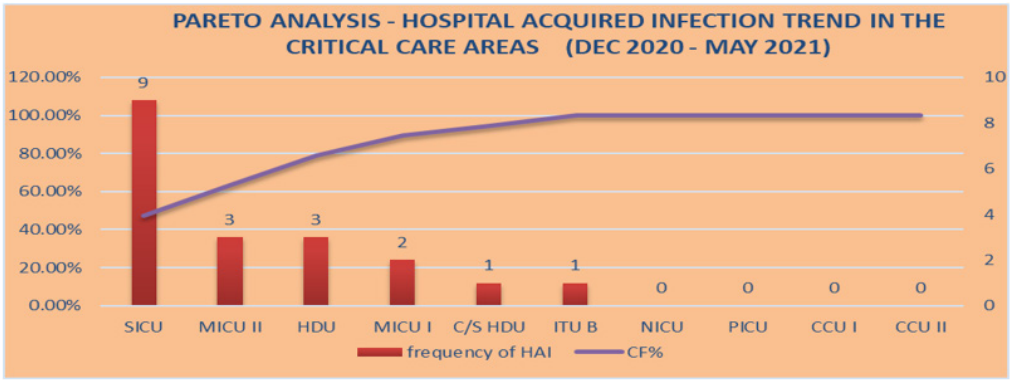

Figure 6 Pareto Chart for the Hospital Acquired Infections in the different ICU wards

Interpretation: The above Pareto analysis reveals that 70-80% of the Hospital Acquired Infections are reported from the SICU, MICU II and HDU. So, focussing on reducing the HAI rates in these 3 ICUs can significantly reduce the majority of HAIs in the critical care areas of the hospital.

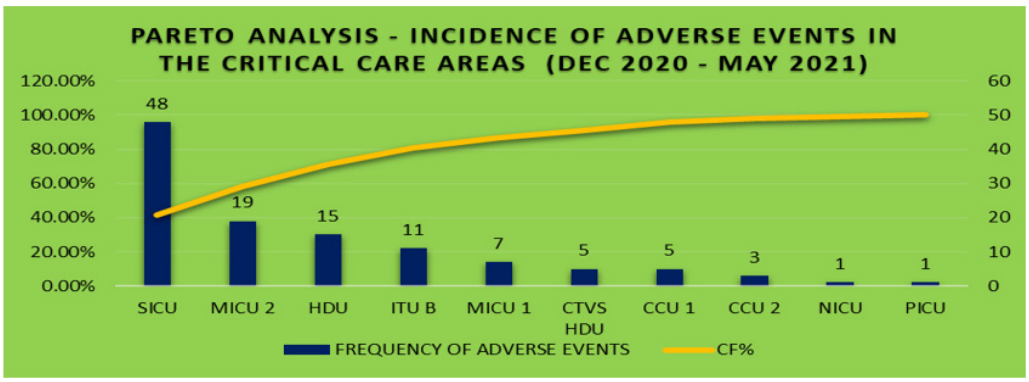

Figure 7 Pareto chart for the Incidence of Adverse events in different ICU wards of the hospital.

Interpretation: The above pareto analysis reveals that 70-80% of the incidents are reported from the SICU, MICU II and HDU. So, careful monitoring strategies in these 3 ICUs can significantly reduce the rate of adverse events in the critical care areas of the hospital.

Discussion

Improve Phase:

Problems Identified	CA/PA suggested
1. Increase in the nosocomial infection rate	• Spot training of nursing staffs • Patients monitoring on a daily basis, and dressing change as needed. • Physical restraints used in case of restless/irritable patient.

Continue.....

2. Increase in incidence of few adverse events	• Bed alarms for patients who are required to be handled with extra care. • Hourly monitoring of high-risk patients on Morse Fall Scale. • Allocation of GDA staff to accompany patients while moving out of bed for any reason.
3. Decreased compliance with infection control guidelines	• Use of PPE as and when required by the care provider. • Medical waste handled and disposed of properly. • Hand washing following any contact with the patient.
4. Gaps in the knowledge and practice regarding quality and policy guidelines	• Training of the medical staffs regarding the quality guidelines. • Continuous surveillance of the nursing staff's activities for spot identification of gaps and training. • Multidisciplinary rounds to enhance patient care.

Conclusion

Most of the ICUs in India are facing the shortage of skilled workers like trained intensivists and critical care nurses, that is leading to a shortage of ICU beds across the country, especially during the pandemic and increased incidence of COVID pneumonia. In patients admitted to ICUs, a 24-hour trained intensivist presence has been found to improve outcomes[3]. Also, an increase in staffing in the ICU is associated with reduced mortality of patients in the critical care areas[4]. The prevention approach for reducing disease spread within ICUs has been identified by isolation of infected patients, that was followed by 54 percent of respondents in the survey. Furthermore, the survey witnesses an increased percentage of CLABSI and CAUTI rates and a net increase in the ALOS by 7 - 8 days. As a result, better infection prevention techniques are needed in the ICU, so as to lower the morbidity and mortality for the admitted patients.

This study found gaps in specific aspects of knowledge and practice among the nursing staffs working in the ICUs regarding their compliance towards different quality and policy indicators. The attitude was seen to be better in senior level staffs and/or staffs with more training regarding the same. Hence, this gap should be focused on in future awareness and training programs conducted for the nursing staffs in the hospital.

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Conflicts of interest: There are no conflicts of interest

Abbreviations

ALOS	Average Length of Stay	IV	Intra Venous
CAPA	Corrective Action and Preventive Action	KPI	Key Performance Indicators
CAUTI	Catheter Associated Urinary Tract Infection	MICU	Medical ICU
CCU	Critical Care Unit	MO	Medical Officers
CDC	Centre For Communicable Diseases	NABH	National Accreditation Board for Hospitals
CLABSI	Central Line Associated Blood Stream Infections	NICU	Neonatal ICU
COVID-19	Coronavirus Disease Of 2019	OT	Operation Theatre

DMAIC	Define, Measure, Analyse, Improve, Control	PICU	Paediatric ICU
EOL	End of Life	PPE	Personal Protective Equipment
HAI	Hospital Acquired Infection	RTI	Respiratory Tract Infection
HDU	High Dependency Unit	SICU	Surgical ICU
HMIS	Hospital Management Information System	SIPOC	Suppliers, Inputs, Process, Outputs, Consumers
ICU	Intensive Care Unit	SSI	Surgical Site Infection
IEC	Information Education Communication	VAP	Ventilator Associated Pneumonia
ITU	Intensive Thoracic Unit	WHO	World Health Organization

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