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Application of Lean Six Sigma to Improve Turnaround Time for Orthopaedic Patients in Emergency Room of a Public Hospital in Southern Philippines

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ABSTRACT

Background: The Lean Six Sigma Methodology (LSS) is acknowledged for its potential in optimising emergency room (ER) efficiency, particularly turnaround time. **Objectives:** This study explores the impact of LSS on ER turnaround time at Gregorio T. Lluch Memorial Hospital (GTLMH) in Iligan City, Philippines, using a mixed-methods approach. The aim is to fill the research gap by empirically investigating the effects of LSS implementation on the turnaround time for orthopaedic patients in the ER. **Methods:** Analysing data from 50 orthopaedic patients admitted to the ER from September to November 2023, the study employed descriptive statistics, chi-square, and three-way ANOVA. Qualitative interviews with six GTLMH personnel provided nuanced insights. **Results:** The findings revealed a higher prevalence of trauma-related injuries among orthopaedic patients, emphasizing the need for injury prevention. A significant association between lower family income and longer turnaround times suggests socio-economic factors influence timely care. The study underscores the importance of addressing healthcare disparities and improving registration efficiency. Challenges include patients not meeting admission criteria and those with political connections bypassing ER protocols. Strict adherence to admission criteria and protocol enforcement can address these issues. **Conclusion:** Despite challenges, the medical staff perceives the current system as efficient, indicating efforts to provide quality care. In conclusion, LSS is highly applicable for enhancing patient outcomes in GTLMH's ER. Utilising a data-driven approach, LSS can eliminate waste, reduce variation, and optimise processes, addressing inefficiencies in registration, streamlining workflows, and improving resource allocation. It also proves instrumental in addressing root causes of staff scarcity and bed capacity issues, leading to improved patient flow and more timely, efficient care.

Keywords: Disposition Time; Embedded Research; Emergency Room; Lean-Six Sigma; Turnaround Time

INTRODUCTION

The emergency room (ER) plays a crucial role in delivering urgent medical care to patients. However, due to increasing patient volumes, limited resources, and complex operational processes, emergency departments often face significant challenges in providing timely care. To address these challenges, Lean Six Sigma (LSS) principles have been widely implemented across many industries as a proven methodology for process improvement. Lean Six Sigma is a combination of two methodologies: Lean, which aims to eliminate waste and improve flow, and Six Sigma, which focuses on reducing process variation and improving quality. It is a technique for process improvement and is based on ideas of scientific management and continual improvement, drawing from the benefits of previous quality projects (Widiwati, Liman & Nurprihatin, 2024).

This study explores the potential benefits of applying LSS in the context of improving turnaround time for orthopaedic patients in the ER, aiming to enhance both patient satisfaction and clinical outcomes.

Orthopaedic patients, who often present with trauma-related injuries requiring immediate and specialised care, face distinct challenges in the ER. These challenges include the need for timely diagnostic imaging, coordination with orthopaedic specialists, and the management of pain and mobility issues, all of which can contribute to prolonged turnaround times and affect patient outcomes.

Efforts to address these issues in healthcare have led to the adoption of LSS, which has proven successful in various industries, including manufacturing, logistics, and service sectors. LSS offers a systematic approach to identify and eliminate non-value-added activities, variability, and waste in processes (Panayiotou & Stergiou, 2021). Several studies have explored the application of LSS in healthcare settings, primarily focusing on process improvement, patient flow, and reducing waiting times. For instance, Arabelen and Kaya (2021) conducted a study on the impact of LSS on reducing patient waiting times in an emergency department. Their findings indicated a significant reduction in average waiting times and improved patient satisfaction scores following LSS implementation. Another study by Persis *et al*. (2022) investigated the application of LSS in a surgical intensive care unit. They reported a reduction in length of stay, improved discharge processes, and increased patient throughput as a result of Lean Six Sigma interventions. Similarly, Saporito *et al*. (2023) conducted a study on the application of LSS in an Italian emergency department, observing a significant reduction in patient waiting times and improved resource utilisation.

Despite these promising findings in various healthcare settings, limited research exists specifically addressing the impact of LSS on orthopaedic patients in the emergency room department. The objective of this study is to investigate the impact of LSS on the turnaround time among orthopaedic patients in the Emergency Room department of Gregorio T. Lluch Memorial Hospital (GTLMH), the main public hospital in Iligan City. At the peak of COVID-19 in 2020, GTLMH formally applied the LSS principles in the ER to improve patient care, reduce wait times, and improve patient satisfaction.

METHODOLOGY

Research Design

This study utilised an embedded mixed methods research design. Embedded design refers to the simultaneous collection of quantitative and qualitative data, with the qualitative data being embedded inside the quantitative data. The inclusion of quantitative methods in this research design allows for the collection of objective data and measurements related to the impact of Lean Six Sigma on turnaround time. This design prioritises quantitative data while also seeking to understand how qualitative data offers additional explanations. The aim is to generate comprehensive findings that can inform evidence-based strategies for enhancing patient care in emergency settings. The embedded mixed methods design was used to investigate the impact of Lean Six Sigma (LSS) on the turnaround time among orthopaedic patients in the Emergency Room GTLMH in Iligan City.

The research questions are divided into quantitative and qualitative categories. The quantitative questions sought to gather information about the demographic composition of orthopaedic patients, their chief complaints, and the turnaround time using a research questionnaire. The qualitative questions aimed to understand the patient flow protocol in the emergency room and identify any issues and proposed solutions related to patient flow through interviews with a multidisciplinary team involved in the patient flow process.

The results of the study were drawn from the inferences made from both the quantitative and qualitative data analysis.

Sample and Setting

The subjects in this research study were the orthopaedic patients who were admitted to Gregorio T. Lluch Memorial Hospital (GTMLH) through the ER between September 1 and October 31, 2023. The study encompassed a total of 50 patients. The eligible subjects consisted of orthopaedic patients, aged 12 to 60 years, regardless of gender, who expressed their willingness to participate in the study.

For the qualitative component, six key personnel were selected for interviews based on their significant roles in the implementation of the LSS methodology at GTLMH. These participants included the hospital chief, the head nurse, and four ER nurses. The selection criteria focused on their leadership positions, direct involvement in ER operations, and their knowledge of LSS processes, ensuring they could provide valuable insights into the implementation and impact of LSS in the ER.

This study, carried out at the emergency department of GTLMH, seeks to provide insights into several facets of orthopaedic emergencies in the context of a local government hospital. The primary objective of this study was to examine the patient demographics, prevalent forms of orthopaedic emergencies, and patient outcomes specifically in relation to the turnaround time.

Instrument

Two research instruments were utilised to collect both quantitative and qualitative data. For the quantitative aspect of the study, the research instrument employed was a research questionnaire designed to gather the demographic profile of the patients as well as their records upon admission to the ER. The questionnaire collected information such as age, gender, ethnicity, and family monthly income of the patients. Additionally, it also aimed to capture the patient's chief complaint upon admission, date of admission, admission time, registration time, and time of disposition. By utilising this research questionnaire, the researcher aimed to gather comprehensive and objective data that could be statistically analysed to gain insights into the patient flow in the ER department of GTLMH.

For the qualitative component of the study, an in-depth interview was conducted. To facilitate the discussion, an interview guide was employed as the research instrument. The interview guide consisted of four questions that were directed to the members of the multidisciplinary team involved in the ER department. The aim of these questions was to gather the perspectives and opinions of the team regarding the structure of the current patient flow in the ER department of GTMLH. The questions focused on identifying potential problems in the patient flow, ways to improve the process, and whether the Residents on Duty (ROD) and ER nurses were perceived as efficient.

Instrument Validity and Reliability

According to Creswell and Creswell (2017), assessment of validity and reliability of research instruments is usually only required for attitudinal or behavioural questions. It can therefore be assumed that demographic items have face validity and are likely to be consistently answered. However, the interview guide for the in-depth interview, which consists of four questions, has been tested in terms of its face validity. The instrument was evaluated by experts and academicians who closely scrutinised the content, format, and overall structure of the instrument. They assessed the alignment of the instrument's items with the research objectives and the appropriateness of the chosen measurement scales. Through their expertise, they ensured that the instrument captured the essential dimensions and variables of the study.

To further enhance credibility, pilot testing was conducted with a small group of participants representative of the study population. Feedback from this pilot testing led to minor revisions in wording and question order to improve clarity and relevance. Additionally, inter-rater reliability was assessed by having multiple researchers independently code and analyse the interview responses. The consistency in their coding results indicated a high level of agreement, further supporting the reliability of the instrument.

Based on the evaluations, the research instrument demonstrated a high level of face validity. The evaluations indicated that the instrument appeared to measure the intended constructs and variables effectively.

Data Collection

Once the necessary permissions from the GTLMH administration and ethical clearance were obtained, the data collection process was initiated. The data gathering procedure was designed to capture relevant

information on orthopaedic patients' turnaround time in the emergency room department. Data on the demographic profile (including age, gender, ethnicity, and family income) and historical data on patient turnaround time were collected from hospital records for a predefined period after the implementation of Lean Six Sigma methodology. Specifically, two types of turnaround time were measured: (i) turnaround time from registration to disposition, and (ii) turnaround time from admission time to disposition time. These measurements provided valuable insights into the overall time spent by patients in the ER and the time spent after the decision for admission has been made. The study adhered to rigorous ethical considerations, beginning with the acquisition of permission in accordance with GTLMH regulations and approval from the University Research Ethics Committee of the proponents university. The protocol encompassed details such as the primary investigator's information, research title, review type, and subject specifics. Informed consent was implemented, ensuring adherence to the Philippines' Data Privacy Act of 2012. Respondents' confidentiality was prioritised through numerical codes, fictitious identities, and secure storage of data.

Furthermore, comprehensive interviews were carried out utilising a structured interview guide containing open-ended questions to obtain valuable input from the members of the multidisciplinary team who possess the potential to make substantial contributions to the adoption of the Lean Six Sigma methodology at GTMLH. The interviews were conducted concurrently with the collection of quantitative data from the patients. The data collected from the interviews were embedded into the quantitative component of this study, which is the primary focus of this study. Questions allowed participants to articulate their views and discoveries using their own language. A total of six individuals, comprising the hospital chief, the head nurse, and four ER nurses, were selected for the interviews. The comprehensive interview sought to comprehend the current procedures and protocols implemented in the emergency room. This study facilitated the identification of areas for enhancement and probable causes of delay in the turnaround time in the ER.

Given the confidential nature of the data collected, strict measures were taken to ensure the privacy and anonymity of the participants. The information obtained from the participants was treated with the utmost confidentiality, and all data were stored securely to safeguard their identities.

Methods of Data Analysis

The data analysis involves a combination of quantitative and qualitative approaches to provide a comprehensive understanding of the research problem.

The raw quantitative data gathered throughout the investigation were imported into IBM SPSS software version 28 using suitable codes. Descriptive statistics were used to analyse all the variables.

Quantitative data is analysed using descriptive statistics, chi-square analysis, and ANOVA. Thematic analysis was utilised to uncover major themes and patterns in the patient flow and provide solutions. The study's findings were based on inferences obtained from both quantitative and qualitative data analyses.

Ethical Consideration

The present study received ethical approval from the Research Ethics Committee of Mindanao State University, College of Health Sciences (MSU-CREC) with reference number CREC 2023-01 on 12th November, 2023.

RESULTS

Analysis and Interpretation of Quantitative Data

Demographic Profile of Population

In Part I of the study, the presentation, analysis, and interpretation of quantitative data focused on the demographic profile of the study population, consisting of fifty orthopaedic patients. The mean age was 35.28 years, with a standard deviation of 15.06, indicating a wide age distribution ranging from 12 to 59 years. The gender distribution showed a significant male majority (76.0%) compared to females (24.0%), with a male to

female ratio of approximately 3.18:1. Notably, the study's sample predominantly comprised non-Maranao individuals (96.0%) compared to a minority of Maranao participants (4.0%). Regarding family income, 64.0% had an income below PHP 10,000, and 36.0% fell within the range of PHP 10,000 to PHP 30,000. These findings highlight a higher prevalence of economic disadvantage within the orthopaedic patient population and understanding these demographic and socioeconomic factors is crucial for contextualising the study's outcomes and assessing potential implications for healthcare access and disparities.

The age distribution across a broad range and the observed gender imbalance underscore the need for a nuanced understanding of orthopaedic conditions across different age groups and genders. The economic data further emphasise the socioeconomic challenges faced by a significant portion of the orthopaedic patient population, suggesting potential implications for healthcare accessibility and outcomes. The study's comprehensive examination of these demographic and socioeconomic factors lays a foundation for a more nuanced interpretation of the subsequent findings (Table 1).

Table 1: Demographic Profile of the Study Population

		Mean ± SD	Frequency	Percentage (%)
Age*		35.28 ± 15.06		
Gender				
	Male		38	76.0%
	Female		12	24.0%
Ethnicity				
	Maranao		2	4.0%
	Non-Maranao		48	96.0%
Family Income				
	<10, 000		32	64.0%
	10,000 − 30,000		18	36.0%

Age range: 12 to 59 years old, n=50

Respondents' Orthopaedic Chief Complaints

Table 2 provides a snapshot of orthopaedic chief complaints from patients admitted to the emergency room during the study period. The majority of chief complaints are trauma-related (92%), while a small percentage (8%) are non-traumatic. The most prevalent orthopaedic complaint was fractures, constituting 40.0% of cases, followed by wounds (18.0%), other issues like arthritis and post-surgery infections (14.0%), motor vehicle accidents (12.0%), falls (10.0%), deformities (6.0%), and dislocations (4.0%). Beyond fractures, dislocations, deformities, and wounds were also identified as significant concerns, with each requiring distinct treatment approaches. Timely intervention, especially for elective orthopaedic procedures like open reduction and internal fixation (ORIF), emerged as crucial for successful outcomes, emphasizing the importance of prompt and appropriate management to prevent complications and ensure patient satisfaction, as supported by existing literature.

Table 2: Frequency and Percentage Distribution of the Respondents' Orthopedic Chief Complaints

Variables	Frequency	Percentage (%)
Fractures	20	40.0
Falls	5	10.0
Dislocations	2	4.0
MVA	6	12.0
Deformity	3	6.0
Wounds	9	18.0
Others	7	14.0

n = 50

Patient Outcome After LSS Implementation as Quantified by Turnaround Time

Two key measurements were analysed were turnaround time from registration to disposition and

turnaround time from admission time to disposition time. Descriptive statistics revealed a mean turnaround time of 2.75 hours for registration to disposition and 2.76 hours for admission to disposition, with minimums and maximums identical in both measurements. The data displayed variations and potential inefficiencies, indicated by relatively high standard deviations (1.56 and 1.58 hours, respectively) (Table 3). These variations suggest room for improvement through LSS methodologies, including the identification and elimination of waste, process standardisation, and improved communication among healthcare professionals.

Table 3: Descriptive Statistics for the Respondents' Turnaround Time

Variables	Minimum (Hours)	Maximum (Hours)	Mean	SD (Hours)
Registration to Disposition	0.58	6	2.75	1.56
Admission to Disposition	0.58	6	2.76	1.58

n = 50

Correlation between Demographic Characteristics and Turnaround Time

This section provides an interpretation and analysis of the information regarding the turnaround time from registration to disposition, capturing the total time spent by the patient in the emergency room (ER).

The three-way ANOVA results reveal that gender and ethnicity did not significantly impact the turnaround time, while family income showed a significant association. Participants with family incomes below Php 10,000 experienced longer turnaround times (mean 3.13 hours) compared to those with incomes between Php 10,000 and Php 30,000 (mean 2.08 hours) (table 4). These findings align with existing research on the influence of socioeconomic status on healthcare access and wait times.

Table 4: ANOVA Table Regarding Registration to Disposition

Variables	Mean $\pm$ SD (Hours)	F Value	Analysis of F Value	p-value	Remarks
Gender		0.093	No Association	0.762	NS
Male	2.79 $\pm$ 1.44				
Female	2.63 $\pm$ 1.96				
Ethnicity		0.045	No Association	0.834	NS
Maranao	2.98 $\pm$ 0.02				
Non-Maranao	2.74 $\pm$ 1.59				
Family Income		5.793	Moderate Correlation	0.020*	S
<10, 000	3.13 $\pm$ 1.72				
10,000 – 30,000	2.08 $\pm$ 0.93				

*NS=Not significant, S=Significant, Correlation is significant at the *$p \leq .0.05$, (N=50)*

Table 5 presents the results of chi-square correlation between demographic factors (gender, ethnicity, and family income) and the time duration from registration to disposition for orthopaedic patients in the ER at GTLMH. The p-values indicate the significance of these associations. Regarding gender, the analysis reveals no significant association between gender and turnaround time, aligning with previous studies that found gender to be an insignificant predictor of turnaround time in emergency departments. Similarly, ethnicity, specifically Maranao ethnicity, shows no significant association with turnaround time, consistent with prior research indicating no significant differences based on ethnicity in emergency room waiting times. However, family income demonstrates a significant association with turnaround time, indicating that patients with a family income below Php 10,000 experience longer turnaround times compared to those with higher incomes. This aligns with previous studies highlighting the influence of lower family income on prolonged turnaround times among orthopaedic patients in emergency rooms.

Overall, the findings underscore the potential impact of socioeconomic factors, particularly family income, on the time duration from registration to disposition for orthopaedic patients in the emergency room setting.

Table 5: Chi-square Correlation between Demographic Profile and Time Duration from Registration to Disposition

	Registration to Disposition			x^2	*p-value*	Remarks
	< 1 hour	2 – 4 hours	> 4 hours			
Gender				3.665	0.160	NS
Male	11 (28.9%)	18 (47.4%)	9 (23.7%)			
Female	6 (50.0%)	2 (16.7%)	4 (33.3%)			
Ethnicity				3.125	0.210	NS
Maranao	0 (0.0%)	2 (100.0%)	0 (0.0%)			
Non-Maranao	17 (35.4%)	20 (40.0%)	13 (26.0%)			
Family Income				6.127	0.047*	S
<10, 000	9 (28.1%)	11 (34.4%)	12 (37.5%)			
10,000 – 30,000	8 (44.4%)	9 (50.0%)	1 (5.6%)			

Correlation is significant at the *p ≤ 0..05, NS = Not significant, S = Significant, (N=50)

Qualitative Data Analysis

Patient Flow in the Emergency Room

The patient flow in the ER at GTLMH is critical for ensuring efficient and timely patient care. A multidisciplinary team, including the hospital's chief, was consulted to gather information about the current patient flow in the ER. The team's cumulative data was used to create a flowchart (Figure 1) outlining the stages of patient flow in the GTLMH ER, aiming to identify issues related to turnaround time from registration or admission to disposition and propose solutions.

The GTLMH ER comprises two main areas: triage and the main ER. The triage area, staffed by a doctor, assesses patients to determine their need for admission or outpatient care. The ER nurses play a crucial role in facilitating patient flow, handling registration, providing ongoing care, and coordinating with the laboratory for necessary tests. Challenges include a nurse-to-patient ratio of 1:40 and potential delays in patient transfer due to bed capacity constraints.
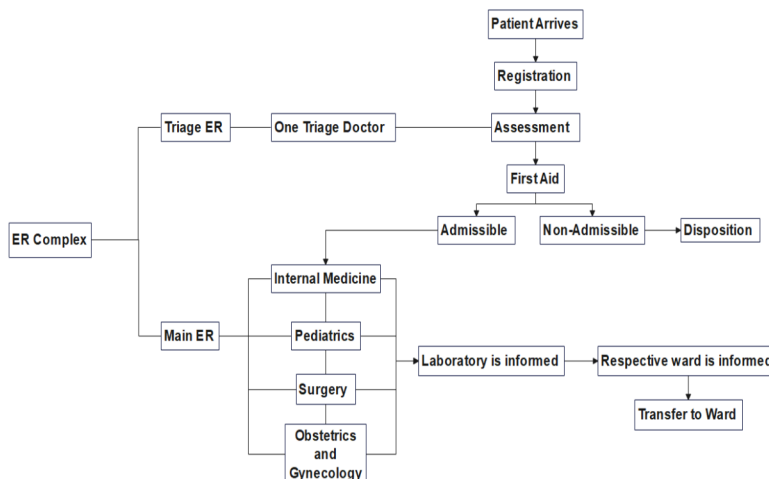

Figure 1: Patient Flow in the Emergency Room

Identified Problems and Proposed Solutions in the Emergency Room

To provide a comprehensive overview, the participants were posed with two inquiries: (1) Do you believe that there are issues with the efficiency of patient flow in the emergency room? (2) What modifications might be implemented to enhance the efficiency of the patient flow procedure?

The responses provide details regarding the issues detected in the emergency room process and the suggested remedies. Thematic analysis of responses from a multidisciplinary team revealed three primary issues: shortage of personnel, limited bed capacity, and patient-related challenges.

Problem 1: Shortage of Personnel

The ER at GTLMH faces a nurse-to-patient ratio of 1:40, far below the standard set by the Philippine Department of Health (Alibudbud, 2023). The lack of manpower leads to increased waiting times, compromised patient safety, and stress for medical staff. The low salary, burnout, and job insecurity prevalent in the country contribute to the understaffed healthcare system. Proposed solutions include conducting staffing analysis, implementing recruitment and retention strategies, providing training, and considering shift rotations to reduce burnout.

Problem 2: Bed Availability

GTLMH's ER has an 11-bed capacity, insufficient to meet the increasing patient inflow. Solutions involve conducting a capacity analysis to determine the ideal number of beds, implementing a bed management system, encouraging collaboration with other departments, and considering the possibility of expanding bed capacity.

Problem 3: Patients

Patients contribute to ER challenges, with some expressing a desire for admission without meeting criteria and others seeking preferential treatment due to political connections. Mitigation strategies include patient education programs, clear protocols and consequences for bypassing ER processes, establishing a patient advocacy committee, implementing a medical needs-based triage system, and raising awareness among legislators for adherence to protocols.

Efficiency of the Doctors and Nurses in the Emergency Room

The efficient performance of doctors and nurses in the ER is crucial for providing timely and effective healthcare services to patients. In this analysis, the focus is on the efficiency of doctors and nurses in the ER of GTLMH as reported by the multidisciplinary team. Additionally, the analysis considers the turnaround time as an indicator of efficiency and explores the impact of nurse-to-patient ratios on the healthcare staff's ability to meet the demands of their workload.

The feedback provided by the multidisciplinary team is a valuable source of information on the efficiency of doctors and nurses in the ER. The response of the multidisciplinary team at GTLMH regarding the efficiency of doctors and nurses in the ER is unanimous; they all stated that the doctors and nurses were efficient. This positive response suggests that the healthcare professionals at GTLMH are competent in delivering timely and effective care to patients in the ER. However, it is important to critically analyse this response and explore the factors contributing to this perceived efficiency.

To further support the claim of efficiency, the analysis considers the turnaround time in the ER. Turnaround time refers to the period from a patient's registration or admission at the ER to their disposition. A shorter turnaround time indicates that the doctors and nurses are providing timely care, efficiently managing resources, and optimising patient flow in the ER. In the current study, the institution's turnaround time was found to meet the mandate of the Philippine Society of Emergency Care Physicians and Philippine College of Emergency Medicine. This is consistent with the current findings of the mean duration of turnaround time, which is almost 3 hours from registration to disposition (mean = 2.75 + 1.56 hours) and from admission to disposition (mean = 2.76 + 1.59). This finding demonstrates that the doctors and nurses at GTLMH are efficiently handling the influx of ER patients and delivering care within acceptable timeframes. This suggests that the institution has implemented protocols and measures to ensure prompt and efficient delivery of care in the ER. It is worth noting that compliance with such mandates indicates a commitment to quality and patient safety.

DISCUSSION

The application of Lean Six Sigma (LSS) to the turnaround time of orthopaedic patients in the emergency room can significantly improve efficiency and patient satisfaction. LSS, which combines Lean Manufacturing and Six Sigma, focuses on waste reduction and process optimisation (Yadav & Desai, 2016). While it originally started in a production environment, it has proven to be highly effective in-service industries as well, including healthcare (Rathi, Vakharia & Shadab, 2022). Lean Six Sigma methodology offers several benefits when applied to improve turnaround time in the emergency room. The primary objective is to identify and eliminate waste or non-value-added activities in the patient flow process. By streamlining processes and eliminating unnecessary steps, LSS can enhance the overall efficiency of the orthopaedic department (Tretiak, 2024). The analysis of fractures highlights their common occurrence, with literature suggesting that the type (open or closed) provides valuable insights into injury severity. Lower limb fractures, particularly the tibia and fibula, were noted as most frequent in a study by Zhang *et al*. (2024), aligning with the distribution observed in the chief complaints. The study suggests further exploration of factors like illness severity and staffing levels that may contribute to ER turnaround times (Jucal & Tacay, 2022; Bhattacharyya *et al*., 2008; De Mast, 2006)

The findings of this study suggest that while gender and ethnicity do not significantly influence the turnaround time for orthopaedic patients, family income does have a significant association. Patients with a lower family income are more likely to experience longer turnaround times in the emergency room. This highlights the potential disparities in access to timely healthcare services based on socioeconomic factors. One study that supports these findings is a study by Martin, Siciliani and Smith (2020), which analysed the impact of socioeconomic factors on emergency department wait times. They found that lower-income patients had longer wait times compared to those with higher incomes. This could be attributed to various factors, such as limited access to healthcare resources and higher demand for emergency services among lower-income populations.

Another study by Klein *et al*. (2024) explored the relationship between patient socioeconomic status and emergency department utilization. They found that patients with lower incomes were more likely to use emergency services for non-urgent conditions, which can contribute to longer wait times for patients with more urgent needs. A case study conducted by Furterer (2018) demonstrates the effectiveness of LSS in healthcare settings. In just three months, the implementation of the Lean Six Sigma DMAIC (Define, Measure, Analyse, Improve, Control) methodology resulted in a decline in the percentage of departing patients by 6.5% to a remarkable 0.3%. Additionally, patient stay time decreased by a significant 30%. These improvements directly translate into enhanced patient experience, reduced waiting times, and ultimately, increased patient satisfaction.

Alibudbud (2023) also pointed out that the understaffed Philippine healthcare system has been a well-documented issue in the country. The main reasons for this lack of manpower were low salary, burnout (the nurse-to-patient ratio can escalate to 1:50), and job insecurity, which is very prevalent in the country, not just in the context of nurses. In fact, Beltran (2023) reported that because of these, especially the lower pay of nurses, this drives these healthcare professionals to go abroad for better pay. Consequently, the government proposed to hire unlicensed graduates to help fill the 4,500 urgently needed positions in government hospitals. Even though the multidisciplinary team in this current study proposed to hire more nurses as a solution for the high nurse-to-patient ratio, the low salary coupled with burnout and job insecurity being rampant in the country may not attract the nurses and, worse, may change to another profession (Alibudbud, 2023).

Another challenge faced by the GTLMH is the limited number of beds available to accommodate new patients. The current 11-bed capacity in the ER falls short of meeting the demands of the consistently increasing patient inflow, resulting in prolonged waiting times and compromised patient care. In the report by Cagula (2023), it is said that the entire GTLMH currently has a bed capacity of 119, 11 of which are in the ER. However, the interdisciplinary team involved in this study has shown that this number is insufficient to accommodate the increasing number of new patients arriving at the hospital on a daily basis. The findings align with previous research demonstrate the effectiveness of LSS in reducing turnaround time in healthcare settings, particularly in emergency departments (Persis *et al*., 2022). Various studies have highlighted the benefits of LSS in improving patient flow, reducing unnecessary tests, decreasing length of stay, and enhancing overall efficiency in emergency room and surgical settings. (Rahul, Samanta & Varaprasad, 2020; Sayeed *et al*., 2018; Elamir, 2018).

To achieve these outcomes, the first step in implementing LSS in the emergency department would involve defining the problem. In this case, the issue would be the extended turnaround time for orthopaedic patients. Next, the current process would be measured and analysed to identify bottlenecks, unnecessary steps, and areas of improvement. This analysis might involve mapping the patient flow process and gathering data on each step. Once the problem areas have been identified, the Lean Six Sigma team can proceed to improve the process. This could involve redesigning workflows, implementing standardised work procedures, and ensuring the availability of necessary resources. Continuous improvement efforts should also focus on staff training and involvement to create a culture of accountability and ownership in delivering efficient care.

Finally, to sustain the improvements achieved through LSS, control measures need to be put in place. These measures can include regular monitoring of the turnaround time, ongoing data collection, and feedback loops to ensure that the process remains optimised and any deviations or issues can be addressed promptly. Therefore, the application of LSS in the emergency room for orthopaedic patients can significantly improve efficiency and turnaround times. By streamlining processes, eliminating waste, and continuously monitoring and improving workflows, hospitals can enhance patient experience and satisfaction. The successful implementation of LSS in other healthcare organisations serves as evidence of its effectiveness in reducing patient stay time and increasing overall throughout (Chugani *et al.*, 2017).

Limitations

The scope of this study focuses on investigating the application of Lean Six Sigma principles on the turnaround time among orthopaedic patients in the emergency room department. Focusing on patients admitted between September 1 and November 27, 2023, the study incorporated interviews with multidisciplinary team members and analysed demographic data alongside two key metrics: registration to disposition and admission time to disposition. The study employed Lean Six Sigma principles (Define, Measure, Analyse, Improve, and Control) for a comprehensive evaluation and improvement of ER turnaround times.

The study's findings are based on a small sample of orthopaedic patients, which may constrain the generalisability of the results. Additionally, the qualitative interview data could be susceptible to bias, potentially influencing the interpretation of findings. Furthermore, the study's scope was limited to orthopaedic patients in the emergency department, excluding other clinical areas or patient populations. External factors, such as hospital policies or referral systems, were not addressed, thereby confining the investigation to the specific context of the GTLMH emergency department and the application of Lean Six Sigma principles to improve orthopaedic patient flow.

CONCLUSION

This study underscores the critical need to reduce turnaround times for orthopaedic patients in the ER department at Gregorio T. Lluch Memorial Hospital (GTLMH). The analysis reveals current turnaround time metrics and their variations, emphasizing the potential for improvement through Lean Six Sigma principles. By optimising processes and minimising waste, GTLMH can enhance patient outcomes and operational efficiency.

To strengthen these efforts, it is recommended that specific strategies such as implementing streamlined triage protocols, enhancing staff training in Lean methodologies, and investing in technology to support real-time patient tracking. These initiatives not only address current challenges in manpower and bed availability but also promise broader implications for healthcare delivery efficiency. Furthermore, evidence suggests that integrating Lean Six Sigma principles into ER workflows can yield tangible benefits, including reduced wait times and improved resource allocation. These improvements not only enhance patient care but also contribute to the sustainability of healthcare services at GTLMH.

Building on the findings of this study, future research could explore the application of Lean Six Sigma in other departments of GTLMH, such as outpatient services or surgical units, to comprehensively enhance hospital-wide efficiency. Additionally, longitudinal studies could assess the long-term impact of Lean Six Sigma implementation on patient satisfaction and cost savings, providing a broader perspective on its benefits in a healthcare setting. Investigating the integration of advanced technologies like AI and machine learning into Lean Six Sigma processes could also offer innovative solutions for further reducing turnaround times and enhancing

patient care quality. Prioritising these recommendations and fostering a culture of continuous improvement are essential for GTLMH to achieve its goal of delivering timely, effective, and equitable emergency care. By leveraging Lean Six Sigma principles and committing to ongoing evaluation and adaptation, GTLMH can ensure sustained improvements in patient outcomes and operational effectiveness.

Conflict of Interest

The authors declare that they have no competing interests.

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