

## ICASH-PT01

# LEAN METHOD IMPLEMENTATION TO REDUCE OVERCROWDING IN THE EMERGENCY DEPARTMENT: A SYSTEMATIC REVIEW

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### ABSTRACT

**Background:** Throughout the world, emergency departments (ED) are characterized by overcrowding and excessive waiting times. Furthermore, the related delays significantly increase patient mortality and make inefficient use of resources to the detriment of the satisfaction of employees and patients. Lean thinking is a philosophy that focuses on eliminating waste or non-value added elements from the processes so that customers are given greater value. Therefore, many Emergency Departments have begun to apply lean as a way to fight against the problems of crowding, delays and medical incidents.

**Methods:** Eligible studies for this systematic review constitute result summarized that lean method implementation was capable of reducing overcrowding in Emergency Departement. The journal employed in this systematic review sourced from ProQuest, Pubmed, and Google Scholar, whereas the analyzed journals were seven journals.

**Results:** From the total of seven journals reviewed, the studies analyzed the result after implementing the lean method in the Emergency Department. In addition, all of the studies were reported successful in implementing lean intervention. Several studies explained that lean method implementation was capable of reducing waiting time, staying length, and the proportion of patients leaving without being seen in the emergency department. One study suggested that reducing radiography transportation time can reduce turnaround time and can help improve the Emergency Department flow.

**Conclusion:** Lean method implementation can contribute to a decrease in waiting time, stay length, and the proportion of patients leaving without being seen. According to the results of the study, the lean implementation identifies that the lean is capable of decreasing waiting times, stay length, and the proportion of patients leaving without being seen. There must be a policy that governs the lean process. Lean can inspired changes to employee roles, staffing and scheduling, communication and coordination, expertise, workspace layout, and problem-solving.

**Keywords:** Lean, hospital, emergency department, crowds

## INTRODUCTION

Throughout the world, emergency departments (ED) are characterized by overcrowding and excessive waiting times. Furthermore, the related delays significantly increase patient mortality and make inefficient use of resources to the detriment of the satisfaction of employees and patients [1]. The Emergency Room (ER) of AORN Cardarelli is a part of a level II ED that manages 94.000 patients per year, in Sweden 34,870 patients per year, in US 49,000 patients per year [1,2]. Today, the Lean Management Model is one of the most used models in industrial areas and rapidly spreading throughout the healthcare industry. Lean thinking is a philosophy that focuses on eliminating waste or non-value added elements from the processes so that customers are given greater value [3]. It was originated from Toyota Production Systems and has been applied successfully in a wide variety of manufacturing industries and health care settings. Therefore, many Emergency Departments have begun to apply lean as a way to fight against the problems of crowding, delays and medical incidents [3,4].

The prolonged waiting time in the emergency department (ED) has been recognized as a significant barrier to timely and accessible emergency care. Crowding and delays in the Emergency Department have been associated with a higher risk of adverse outcomes for patients, including mortality among admitted patients and both death and subsequent hospital admission for discharged patients [1]. This systematic review aims to provide an exhaustive summary of current literature focused on how Lean principles and tools, applied in an ED, can solve the problem of overcrowding, , improving the processes that contribute to facilitating the flow of patients through the various stages of medical treatment and eliminating waste. Based on the analysis of the article, it was found that that lean method has been successfully applied to a wide range of clinical situations and is capable of contributing to decreasing waiting time, stay length, and the proportion of patients leaving without being seen. Hospitals initiated improvement efforts which were characterized by unstable processes, unclear work methods, and an inadequate appreciation of demand and capacity. Meanwhile, the lean method promoted a process view, yielded more explicit work methods as well as roles and responsibilities, and enhanced stakeholders understanding of capacity and demand. Furthermore, the lean method also brought a structured approach to problem-solving and linked improvement efforts to the hospital's strategy [3-5].

The database search was conducted in five years (2014–2019). The search terms included **“lean”**, **“hospital”**, **“emergency department”**, and **“crowds”**.

**Inclusion and Exclusion Criteria.** The first step conducted by the researchers was screening title and abstract, which will be employed as a reference. If the reference searched was irrelevant and incomplete with the material to be submitted, then the researchers did not classify it. The researchers arranged the place studied from a broad place to the narrow place started from all over the world. The language used in this study was limited to English. The researchers also limited the study by examining lean strategy implementation, which was capable of reducing overcrowding in the emergency department. The researchers decided the eligible inclusion studies were peer-reviewed journals or articles published in 2014–2019. The researchers excluded letters, commentaries, note, books, and any studies which were not suitable with the criteria above.

## METHODS

### Searching Strategy

The electronic database was searched for seven days from April 25 to May 1, 2019. The protocol for systematic review referred to PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols). The researchers performed systematic searches in three databases (ProQuest, Pubmed, and Google Scholar) to retrieve peer-reviewed publications of relevant empirical publications.

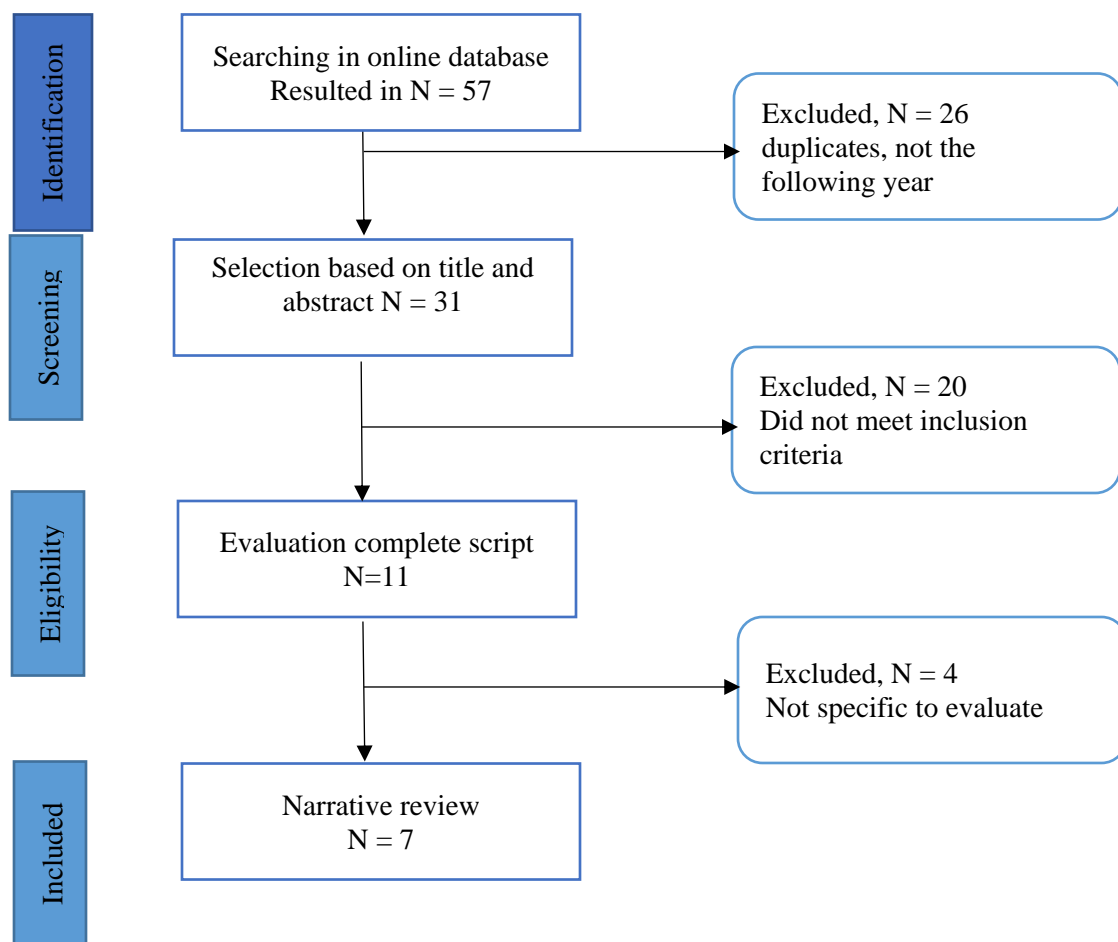


Figure 1. PRISMA-Protocol Search Result

## RESULTS

The keywords employed in the searching were: (1) lean ; (2) hospital; (3) emergency department; and (4) crowded through ProQuest, Pubmed, and Google Scholar. The research obtained 57 papers which were considered suitable with the research objectives. Afterward, the researchers conducted screening whether the title matches the research theme. After screening finished, 31 papers whose titles matched the research theme were achieved. Eleven papers were obtained among the 31 papers which were being screened based on the inclusion and exclusion criteria eligibility. These papers then were subsequently reviewed. An evaluation of the eleven papers was conducted, and it resulted in seven papers as the most suitable papers for this research purpose.

This study analyzed the seven papers after implementing the lean in the Emergency Department. As a result, all of the studies reported success in implementing the lean method. Several studies explained that lean method implementation is capable of reducing the waiting time, the stay length, and the proportion of patients leaving without being seen in the emergency department. One study suggests that reducing radiography transportation time is capable of shortening the turnaround time and improving the Emergency Department flow [9].

Table 1. Critical Assesment

No	Authors	Article Titles	Database, years	Methods	Results
1.	HY Chan [3].	Lean Techniques for the Improvement of Patient Fthe low in the Emergency Department.	World journal of emergency medicine (2014)	Quantitative, pre-and post lean design study	The triage waiting time and end waiting time for consultation were significantly decreased. Waiting time was decreased from 16.85 minutes to 14.28 minutes ( $t=3.218$ , $P<0.05$ ) with similar staff configuration including doctors, nurses, and healthcare assistants The admission waiting time of Emergency Medical Ward (EMW) was significantly decreased from 54.76 minutes to 24.45 minutes after lean management implementation.
2	Giovanni improta, Maria Romano, Maria Vincenza Di Cicco, Anna Ferraro, Anna Borrelli, Maria Verdoliva, Triassi, and Mario Cesarelli [1].	Lean Thinking to Improve Emergency Department throughout AORN Cardarelli	BMC Health Service Research (2018).	Qualitative Analysis and Quantitative Analysis	The average time in emergency department elapsed for the whole process was 4 hour and 18 minutes, of which 80% were due to non-value added activities. The implementation of the Lean methodology reduce waiting times in the ER and improve the patients flow between the emergency room and recovery areas.

No	Authors	Article Titles	Database, years	Methods	Results
3	Richard Miller, Nirisha Chalapati [7].	Utilizing Lean Tools to Improve Value and Reduce Outpatient Wait times in an Indian Hospital	International journal of health care. (2014).	Qualitative case study	Total Patients before Lean were 40 with average waiting time >1 hour, after lean, the total patients reached 120 with an average waiting time of 15 minutes. Creating the value stream map to communicate the key issues facing the hospital leadership. This map helped everyone understand the extent of the problems and the opportunities for improvement.
4	Pamella mozzecat, Richard J Holden, Mats Brommels, Håkan Aronsson, Ulrika Bäckman, Mattias Elg and Johan Thor [2].	How does Lean Work in Emergency Care? A Case Study of a Lean-Inspired Intervention at the Astrid Lindgren Children's Hospital, Stockholm, Sweden	BMC Health Service Research (2014)	Qualitative and Quantitative study	Improvements in waiting and lead times (19-24%) were achieved and sustained in the two years following lean-inspired changes to employee roles, staffing and scheduling, communication and coordination, expertise, workspace layout, and problem-solving. Lean applications identify that lean can contribute to decreases in waiting times, stay length, and the proportion of patients leaving without being seen in the second year post-lean. The percentage of patients completing their visit and leaving the A&E within four hours increased from 67% pre-lean to 80% in the first year post-lean. The average time for physician consultation decreased from 67 minutes to 51 minutes in the first year of post-lean. Meanwhile, the patient volume increased from 24.4 to 26.6.
5	Marian J. Vermeulen, MHSc [9].	Evaluation of an Emergency Department Lean Process Improvement Program to	Annals of Emergency Medicine (2014)	of Before and after study	The differences in outcomes before and after the process improvement program identified that 90th percentile and median Emergency Department length of stay and time to physician assessment were significantly

No	Authors	Article Titles	Database, years	Methods	Results
		Reduce Length of Stay			lower after the program. Emergency Department length of stay significantly decrease, short-term admission, mortality, and readmission; overall, fewer patients left without being seen and 72-hour ED revisit rates were lower after the program.
6	Eveline A Hitti et al. [6].	Emergency Department Radiology Transportation time: Successful Implementation Lean Methodology	BMC Health Service Research (2017)	Quantitative	Implementing lean management technique can be effective in reducing transportation time radiography in Emergency Departement. From the post-intervention, it identified a statistically significant decrease in the mean transportation TAT (mean±SD:9.87 min ± 15.05 versus 22.89 min ± 22.05, respectively, <i>p</i> -value <0.0001). In addition, the lean methodology was effective in reducing transportation time of patients to plain radiography, reducing the turnaround time, and improving the Emergency Department flow.
7.	Teng-Kuan Wang, Taho Yang, Chih-Yao Yang , Felix T.S. Chan [8].	Lean Principle and Simulation Optimization for Emergency Department Layout Design	Emerald Publishing International Journal. (2015)	Before and after study	The patients' average waiting time decreases from 78 to 38 minutes. The service level increases from 54.86 to 88.55 percent. Moreover, the number of nurses reduces from nine to six..
8	Marian J. Vermeulen, MHSc [9].	Evaluation of an Emergency Department Lean Process Improvement Program to Reduce Length of Stay	Annals of Emergency Medicine (2014)	Before and after study	The differences in outcomes before and after the process improvement program identified that 90th percentile and median Emergency Department length of stay and time to physician assessment were significantly lower after the program. Emergency Department length of stay significantly decrease, short-term admission, mortality, and readmission; overall, fewer patients left without being seen and 72-hour ED revisit rates were lower after the program.

The several studies shows that the triage waiting time and end waiting time for consultation were significantly decreased. Waiting time was decreased from 16.85 minutes to 14.28 minutes with similar staff configuration including doctors, nurses, and healthcare assistants. The admission waiting time of Emergency Medical Ward (EMW) was significantly decreased from 54.76 minutes to 24.45 minutes after lean management implementation [2,6,7]. The average time in emergency department elapsed for the whole process was 4 hour and 18 minutes, of which 80% were due to non-value added activities [3]. The differences in outcomes before and after the process improvement program identified that Emergency Department length of stay and time to physician assessment were significantly lower after the program. Emergency Department length of stay significantly decrease, short-term admission, mortality, and readmission; overall, fewer patients left without being seen and 72-hour ED revisit rates were lower after the program [5]. Improvements in waiting and lead times (19-24%) were achieved and sustained in the two years following lean-inspired changes to employee roles, staffing and scheduling, communication and coordination, expertise, workspace layout, and problem-solving. Lean applications identify that lean can contribute to decreases in waiting times, stay length, and the proportion of patients leaving without being seen in the second year post-lean.

The percentage of patients completing their visit and leaving the A&E within four hours increased from 67% pre-lean to 80% in the first year post-lean. The average time for physician consultation decreased from 67 minutes to 51 minutes in the first year of post-lean [5].

## **DISCUSSION**

The number of people attending the emergency department (ED) is increasing in recent years. Patients always spend at least half to two hours before discharging or admission. Most of them have to take several steps: registration, triage by the nurse, examine by physicians, blood tests, radiographs, consultations from specialists, discharge instructions, and other procedures. From the patient's perspective, the processes are time-consuming, and the visit is unpleasant. Therefore, understanding what patients want and improving patient flow in ED is a significant factor in affecting patient satisfaction and healthcare quality [1]. The prolonged waiting time in the Emergency Department (ED) has been recognized as a major barrier to timely and accessible emergency care. Crowding and delays in the Emergency Department have been associated with a higher risk of adverse outcomes for patients, including mortality among admitted patients, and both death as well as subsequent hospital admission for discharged patients [1].

Based on the article analysis, it was identified that that lean has been successfully applied in a wide range of clinical situations and is capable of decreasing waiting time, stay length, and the proportion of patients leaving without being seen. Before the hospitals initiated improvement, the hospitals were characterized by unstable processes, unclear work methods, and an inadequate appreciation of demand and capacity. On the other hand, lean promoted a process view, yielded more explicit work methods, generated roles and responsibilities, and enhanced stakeholders understanding of capacity and demand.

The lean also brought a structured approach to problem-solving and linked improvement efforts to the hospital's strategy. The total Patient before Lean was 40 patients, with average waiting time more than 1 hour. After lean, the total patients amounted to 120 patients with the average waiting time of 15 minutes. Creating the value stream map helps communicate the critical issues encountered by hospital management. This map helps everyone understand the problems and opportunities for improvement. From this research



result, it identified that the stay length and waiting time had the highest frequency. Improvements in waiting and lead times (19-24%) were achieved and sustained in the two years following lean-inspired changes to employee roles, staffing and scheduling, communication and coordination, expertise, workspace layout, and problem-solving. The lean implementation demonstrates that the lean can contribute to decreases in waiting time, stay length, and the proportion of patients leaving without being seen in the second year of post-lean. The percentage of patients completing their visit and leaving the Emergency Department within four hours increased from 67% pre-lean to 80% in the first year of post-lean. The average time for physician consultation decreased from 67 minutes to 51 minutes in the first year of post-lean.

Meanwhile, the patient volume increased from 24.4 to 26.6 [7]. The lean management technique can be effective in reducing transportation time radiography in the Emergency Department. Furthermore, the reduction of stay length from 4.57 to 3.65 hour of post-intervention is beyond the 13-minute improvement in transportation time. This condition could be explained by operational changes that were directed at reducing waiting time, decreasing turnaround time, and improving the Emergency Department flow [9]. As a result, policies concerning on waiting time in the Emergency Department have been pursued in many jurisdictions

## CONCLUSION

According to the results of the study, the lean implementation identifies that the lean is capable of decreasing waiting times, stay length, and the proportion of patients leaving without being seen. There must be a policy that governs the lean process. Lean can inspired changes to employee roles, staffing and scheduling, communication and coordination, expertise, workspace layout, and problem-solving.

## REFERENCES

1. Improta, Giovanni. Lean Thinking to Improve Emergency Department throughout at AORN Cardarelli. *BMC Health Service Research*. 2018; 18:914.
2. Mozzecat, Pamela, Richard J Holden, Mats Brommels, Håkan Aronsson, Ulrika Bäckman, Mattias Elg and Johan Thor. How Does Lean Work in Emergency care? A Case Study of a Lean-Inspired Intervention at The Astrid Lindgren Children's Hospital, Stockholm, Sweden. *BMC Health Service Research*. 2014.
3. Chan, HY. Lean Techniques for the Improvement of Patient Flow in Emergency Department. *World Journal of Emergency Medicine*. 2014; 5 (1) : 24-28.
4. W. Decker, Wyatt & Latha G. Stead. Application of Lean Thinking in Health Care: A Role in Emergency Departments Globally. *International Journal of Emergency Medicine*. 2008; 1:161-162
5. David Ng, MD; Gord Vail, MD, MSc; Sophia Thomas, MD; Nicki Schmidt, RN. Applying the Lean Principles of the Toyota Production System to Reduce Wait Times in the Emergency Department. *CJEM*. 2010;12(1):50-7.
6. Eveline A Hitti et al. Emergency Department Radiology Transportation Time: Successful Implementation Lean Methodology. *BMC Health Service Research*, 2017.
7. Miller, Richard, and Nirisha Chalapati. Utilizing Lean Tools to Improve Value and Reduce Outpatient Wait times in an Indian Hospital. *International Journal of Health Care*.2014.
8. Teng-Kuan Wang, Taho Yang, Chih-Yao Yang, Felix T.S. Chan. Lean Principle and Simulation Optimization for Emergency Department Layout Design. *Emerald Publishing International Journal*. 2015.
9. J. Vermeulen, Marian. Evaluation of an Emergency Department Lean Process Improvement Program to Reduce Length of Stay. *Annals of Emergency Medicine*. 2014.
10. F. Bruno. Lean Thinking in Emergency Departments: Concepts and Tools for Quality Improvement. *Emergency Nurse Journal*. 2017.