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Review

A systematic review of lean practice in healthcare settings

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Abstract: Purpose: This review mainly aims to identify the lean practice conducted in hospitals, determining what problems lean practice can be helpful to solve in the hospitals. **Data sources:** Four electronic databases (Scopus, Web of science, Medline, and PubMed) were conducted for searching related literature in this review. **Study selection:** These studies in the hospitals that related lean healthcare practice and contained outcome variables were included. Data extraction: Related information such as research design, countries, lean tools, outcome variables, results were extracted. **Results of data synthesis:** 20 eligible articles were identified in this review. There was 20% lean practice being conducted in emergency department of hospitals in this review. Six cases have implemented lean in Brazilian hospitals. There were 12 cases implemented lean practice through Value Stream Mapping. **Conclusion:** Lean practices were highly valued in Brazilian hospitals, and it was frequently implemented in hospital emergency department. Value Stream Mapping and process mapping were the most commonly used lean tool. Waiting time, lead time and Length of Hospital Stay (LOS) were the primary indicators reflecting improvements in this review.

Keywords: lean healthcare; lean practices; lean implementation; lean management; case study

1. Introduction

In response to budget constraints, escalating healthcare costs, and heightened patient expectations, healthcare sectors have increasingly pursued effective management strategies to enhance their organizational performance (Fernandes et al., 2023; Kahm and Ingelsson, 2020; Prado-Prado et al., 2020), thereby guaranteeing optimal utilization of hospital resources. The adoption of lean in healthcare institutions, also known as lean in healthcare, could improve the efficiency of existing processes (Reis et al., 2023) and cost reduction (Almutairi et al., 2021) through lean methods or tools that identified waste. This improvement could contribute significantly to enhancing supply chain performance, reducing cost, eliminating waste and ensuring on-time delivery (Chbaly and Brunet, 2022). Additionally, it also may provide a useful guide for hospital managers and policymakers in the process of administration practices (Prado-Prado et al., 2020). Compared with the application of lean in manufacture, there was scarcity of studies concentrated on lean practice in healthcare sectors (Almutairi et al., 2021). However, it has becoming widely used in the healthcare industry due to its practicability in recent years (Dammand et al., 2020; Vendramini et al., 2016). Numerous academics' perspectives on lean healthcare were shaped by their experience or practical implementation. Almutairi mentioned that lean was one of the most important continuous improvement approaches for attaining operational excellence and service in any organization (Almutairi et al., 2021). Liker

(2004) concluded that lean is a concept and change project that describes a strong culture of improvement built on a strong customer focus and supportive, highly engaged leadership. A growing number of actual implementations need to be conducted in the process of lean practice in real environments (Chbaly and Brunet, 2022).

Lean, originated at Toyota Motor Company in Japan, has been widely applied in the manufacturing landscape (Lukrafka et al., 2020). Based on a multidimensional approach, it has provided an integrated system with a variety of management practices, such as quality systems, work teams, just-in-time, cellular manufacturing, tools, and many more (Shah and Ward, 2003). Actually, lean implementation has encompassed a wide range of administration practices, allowing hospitals practitioners in various counties to select appropriate lean tools in their practice process. Many lean tools, like Value Stream Mapping (Alkher et al., 2019; Astiena et al., 2022; Borges et al., 2020; Cardoso, 2020; Dogan and Unutulmaz, 2014; Lukrafka et al., 2020), 5 why (Martins and Sergio, 2022; Zdeba-Mozola et al., 2022), Ishikawa diagram (Fiorillo et al., 2021), Kaizen (Reis et al., 2023), and so on, were used in the process of lean practice of hospitals. These lean tools mainly were used to identify activities without value. Evidences from research and practical experiences showed that application of lean tools in healthcare institution can be regarded as one of the potential solutions by significantly reducing the cost produced in delivering the care through removing the non-value adding tasks (Ankrum et al., 2019; Cardoso, 2020; Menachemi et al., 2020). Indeed, many researchers reported that the literature in lean healthcare is specifically built on positive cases (Tlapa et al., 2020). Demirli et al. (2021) reported significant improvements a reduction of 86.4% in waiting time during the visit and an increase of clinic capacity after the implementation of lean techniques in healthcare in the Cleveland clinic. Rocha and Vasconcelos (2021) implemented lean in an occupational health clinic in Brazil and attained a reduction of 29.86% in lead time. Reis et al. (2023) provided an example of a lean implementation in Brazilian public hospital and reported 20.75% improvement in the capacity of patient admissions. Astienaet et al. (2022) found that lean could also increase the value-added ratio by 35.7%.

Despite the increasing number of studies on lean practices in healthcare, most existing reviews have overlooked the comprehensive summarization of lean implementation within the healthcare sector. In this review, we primarily examined lean practices used in hospitals. The purpose of this review was to determine what lean tools have been commonly used in hospitals and what kinds of issues lean practice might help with, hoping it could provide new insight for stimulating the lean application in healthcare.

2. Materials and methods

Data sources:

Four electronic databases including Scopus, Web of science, Medline, and PubMed were utilized to conduct comprehensive search. The keywords “lean healthcare”, “lean methodology”, “lean method”, “lean in healthcare”, “lean practices”, “lean management”, “lean healthcare implementation”, “lean healthcare application”, “lean healthcare practices”, “hospital”, “hospital setting”, “medical institutions”,

"healthcare sector", "public hospital", "lean hospitals", "private hospital", "empirical research", "survey", "case study", "quantitative study" were entered to seek for literature. Search operators like AND, OR were applied to make literature search more comprehensive. The restriction on year of publication was January 2019 up to April 2024. Only articles published in English were chosen in our review.

Study selection:

A Systematic literature review (SLR) method was chosen for this review (Khan, 2020), and acquiring the eligible articles followed the guidance of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Group (Moher et al., 2009). The whole search process has been displayed in **Figure1**. Stringent screening procedures were implemented to select eligible articles. All the articles being included in this review should meet the inclusion and exclusion criteria. Specifically, inclusion criteria: (1) peer-reviewed literature (2) having specific application of lean methods or tools (3) having the outcome variables that provides the positive or negative effects (4) being conducted in hospitals. Exclusion criteria: (1) book or book section (2) conference paper/proceedings (3) study protocol (4) review or meta-analysis (5) not English (6) no related to lean tools (7) theoretical or conceptual articles (8) studies that lacked depth of data field. Besides, considering to avoid any literature with incomplete, distorted or biased, we have excluded grey literature in this review.

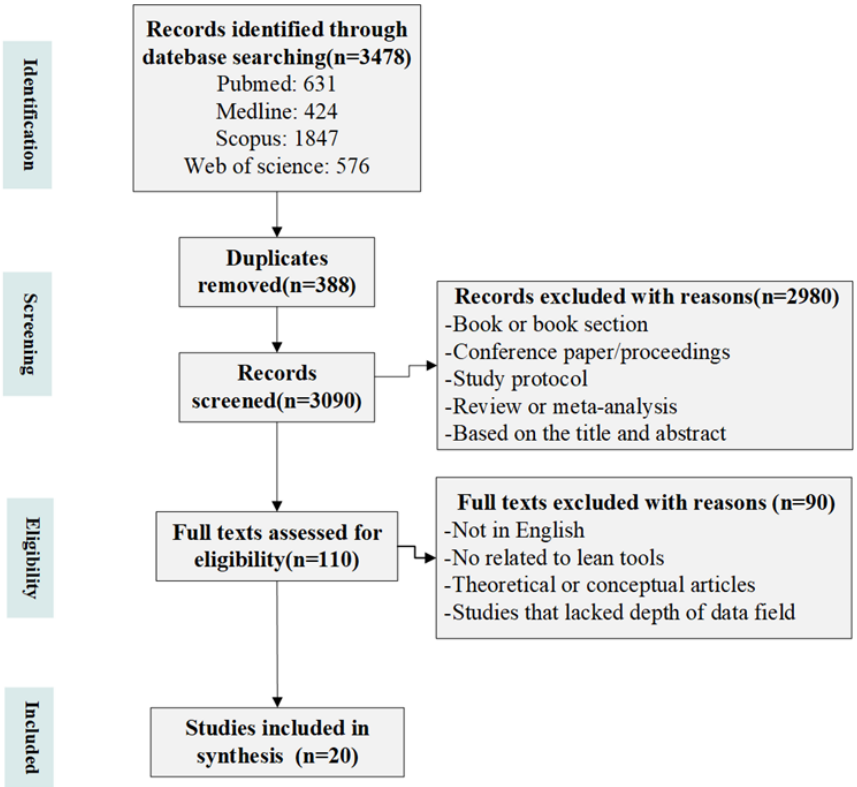

Figure 1. PRISMA flow chart.

In general, the determination of eligible articles in our review was completed following below stages: (i) Initially, 3478 articles selected from four databases were imported into Endnote, after which 388 duplicate articles were removed. (ii)

Subsequently, 2980 articles were excluded based on their type, title, and abstract. (iii) Next, 110 articles underwent full-text screening for relevance, leading to the selection of the final 20 articles eligible for inclusion. The literature review process involved two reviewers (Jingjing Wang and Wenjie Ren) who independently assessed and synthesized the relevant studies. Each reviewer conducted their assessment based on predefined inclusion and exclusion criteria in this review. In cases of disagreement regarding the literature, the third reviewer (Hui Lv) would provide an impartial assessment and discuss with the other two reviewers until reaching consensus (Kitchenham et al., 2012). All three reviewers have several years of experience in lean healthcare, and each had also previously published related papers in this field, ensuring that they did have qualification to review articles.

Data extraction and analysis:

The primary objective of this review was to investigate the implementation of lean practices in hospitals worldwide, focusing on the common lean tools utilized in these contexts. Articles were selected based on their coverage of practical applications, adaptations, or implementations in real-world scenarios. To facilitate data synthesis, manual coding of the articles was employed to identify predefined thematic nodes, encompassing categories such as authors, countries, lean tools, methodologies, and findings. Concurrently, relevant tables were employed to succinctly present the outcomes derived from the reviewed literature.

3. Results

3.1. The basic characteristics of including articles

A total of 20 articles eligible for inclusion were identified in this review. Articles described lean practices in hospitals across multiple nations, illustrating the multiplicity of applications for lean. Data from the 20 studies showed that the majority of these publications were published in management and business journals, including such as International Journal of Lean Six Sigma (Demirli et al., 2020; Rocha and Vasconcelos, 2021), Journal of Health Organization and Management (Martins-Drei et al., 2022; Reis et al., 2023), International journal of health planning and management (Duong et al., 2022; Verbano and Crema, 2019), as supported by studies detailed in **Figure 2**. The practical setting included clinical/medical center, government/public/teaching hospital, private general medical surgical hospital. It was discovered that there are four studies that related to the implementation of lean practices in emergency departments of hospitals (Cardoso ,2020; Duong et al., 2022; Rollinson et al., 2021; Verbano and Crema, 2019). Lean practices were highly valued in Brazilian hospitals, as evidenced by the six Brazilian publications included in this review. Additionally, we have evidence of lean practices in various parts of the world, including Serbia (Alkher et al., 2019), Indonesia (Astienaet et al., 2022), Abu Dhabi (Demirli et al., 2020), Vietnam (Duong et al., 2022), Italy (Fiorillo et al., 2021; Verbano and Crema, 2019), Spain (Morales-Contreras et al., 2020; Sales-Coll et al., 2024; Sales-Coll et al., 2023), Mexico (Peimbert-García et al., 2021), the United Kingdom (UK) (Rollinson et al., 2021), Indiana (Menachem et al., 2020), USA (Ankrum et al., 2019), Poland (Zdęba-Mozoła et al., 2022), as supported by studies detailed in **Figure 3**.

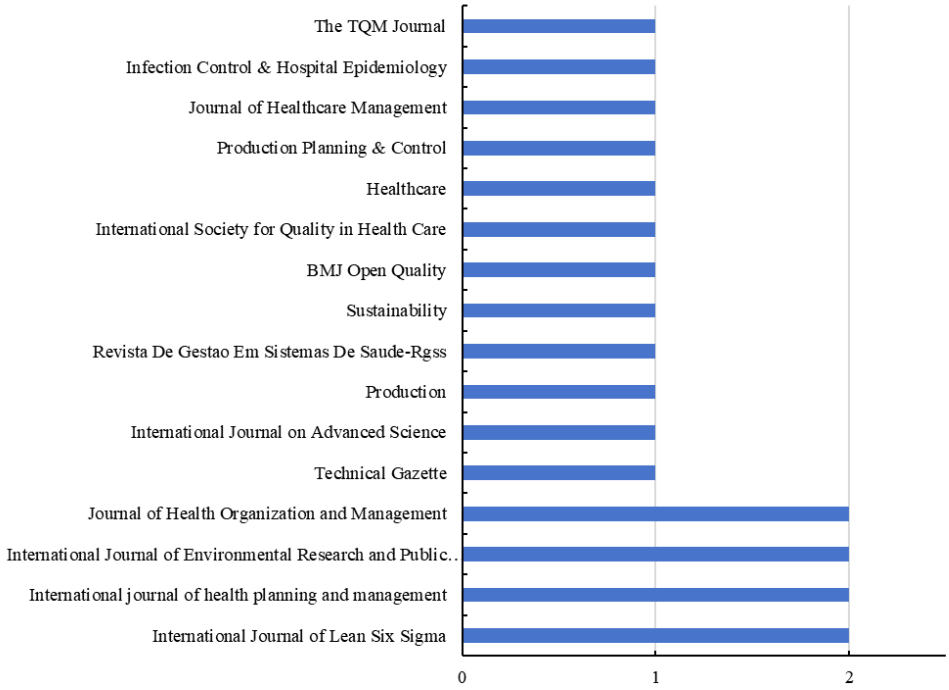

Figure 2. The journals of including articles.

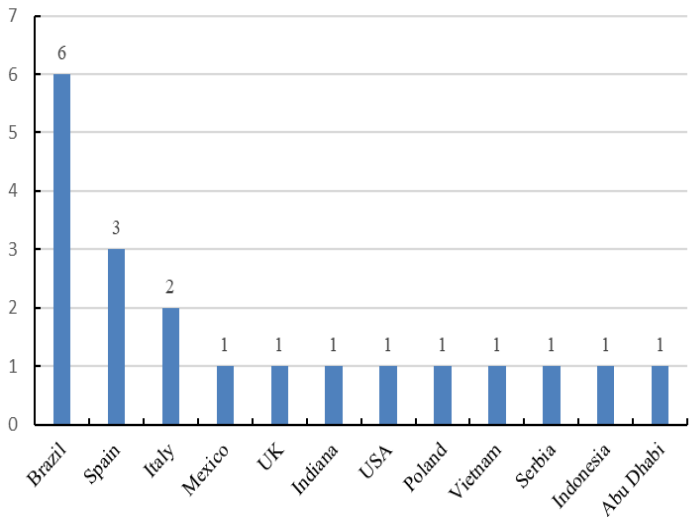

Figure 3. The countries of lean practice in hospitals.

3.2. Tools of lean practice

Hospitals implemented lean practices with varying emphasis, which led to the selection of distinct lean tools for identifying waste or no-value activities. The elimination of waste was the primary goal of lean practices in hospitals. The analysis of the selected articles showed that Value Stream Mapping (12 cases) was the most widely utilized lean technique due to its immediate benefits and easy implementation. Lean practitioners, meanwhile, intended to apply VSM either exclusively or in conjunction with the fishbone diagram technique (Rollinson et al., 2021), Kaizen (Luciana et al., 2023), Ishikawa diagram (Fiorillo et al., 2021), 5Why (Agnieszka et al., 2022), and A3 reports (Agnieszka et al., 2022), as supported by studies detailed in **Table 1**.

Table 1. The outcomes of including articles.

Author(year)	Lean tool	Methods	Results
Alkher (2019)	Value Stream Mapping	Questionnaire survey:312 patients; analysis of routine data: 140 patients about their blood draw process; interviews.	Increase of 15% on an observed sample of 400 patients per day; the total process time was also improved by 15%.
Astienaet (2022)	Value Stream Mapping	Observation:71 patients by systematic random sampling; mapping the flow of patient service time by using the time stamp. Simulation of the Lean-based digitalization model.	Reducing service steps from 10 to 4 steps, waste waiting from 5 to 2 steps, and Lead Time from 336 to 39 min (−88.4%), increasing the VAR from 5.1% to 20.5%.
Borges (2020)	Value Stream Mapping	A case study, current state map: guided on-site visits; observation; focused groups with the cross-functional team (16 hospital members); Semi-structured interviews (four researchers with lean practices experience); Quantitative data: historical data; computational simulation modelling.	Delivery service level remained at 100% for all three simulated scenarios; lead time was 20.4% lower than the average value observed during the 30-day data
Cardoso (2020)	Value Stream Mapping	Applied research: the collection of data from the hospital's database, or through observations and informal conversations. Content analysis: based on studies of transcriptions in the form of text of the obtained data.	Reducing the lead time of total production from 5.31 h to 5.12 h, with a reduction of 3.7%. Invest in receptionist training; Reducing the size of the reception queue and consequently the screening.
Demirli (2020)	Aligning processes	A five-step procedure: (1) Gather data and draw the current patient value stream. (2) Analyze patient and resource interactions and identify waste and sources of waste. (3) Eliminate sources of waste to improve patient flow and resource utilization. (4) Assess the performance under dynamic conditions and plan patient arrivals using DES. (5) Extend the analysis to the entire clinic.	Clinic capacity from the current 176 patients up to 479 (without violating the 30 min waiting time policy)； Reducing the patient waiting time during the visit from the current 33 min to 4.5 min (without violating the capacity goal of 333 patients); "Before Kaizen" case from 16 to 11 and decreased average patient waiting time from 77.8 to 32.3 min.
Duong (2022)	Value Stream Mapping; Five-phase DMAIC problem-solving approach	A quantitative study with pre- and post-lean design: questionnaire survey (pre-design with 96 patients, post-lean design with 51 patients), related information being recorded from reception desk nurses.	Pre-operative test results (for patients requiring medical procedures/operations) by 33.3% (134.4 to 89.4 min) vascular interventions by 10.4% (54.6 to 48.9 min); and (3) admission to other hospital departments by 49.5% (118.3 to 59.8 min). Patients' satisfaction (22.9% to 76.5%); applying lean strategy and tools can improve patient flow in public/ general hospital Eds.
Fiorillo (2021)	Value Stream Mapping; Ishikawa diagram	Personal observations, patient interviews, brainstorming with nurses and doctors and from printed medical records (151 patients, including pre-improvement 65 patients and post-improvement 86 patients), qualitative analysis of the hospitalization process.	The average preoperative LOS decreased from 4.90 to 3.80 days (22.40%) with a *p*-value of 0.001. variable age the presence of cardiovascular disease and diabetes in patients significantly influence
Morales-Contreras (2020)	Process innovation based on Kaizen	A case study and action research (collaboration of researchers with hospital management and professionals): (1) process selection and understanding the process, (2) mapping the process, (3) process measurement, (4) process analysis, (5) process redesign.	Presurgical time reduced from 4 days to 3.15 days. Total hospitalization time from 15.9 days to 9.41 days; in-hospital mortality from 6.77% to 3.7%; the average post-surgical time was reduced to 5.25 days, a reduction of approximately 50%.
Martins-Drei (2022)	A3 tool, Pareto diagram, 5 whys	Three distinct stages: Planning (to integrate employees and others involved in the processes): Observations, questionnaires; interview, Systematic Proposal (A3 tool, VSM, Pareto diagram,5 whys) and Systematic Confirmation (observation, comparing the time and displacement values existing before and after the application of the proposed system,), 27 employees of the medical clinic.	Reducing waiting time for patients, at approximately 53.8%, with a decrease in the standard deviation of the times—of approximately 79.14%, and displacement of those involved, of 72%, in addition to eliminating unnecessary activities for the process.

Table 1. (*Continued*).

Author(year)	Lean tool	Methods	Results
Peimbert-García (2021)	Quick changeover (the single-minute exchange of die (SMED))	A non-experimental intervention study including three stages: (1) discharge process diagnosis (2) time studies and data collection, and (3) implementing quick changeover.	Lean implementation allowed reducing the time to discharge patients from 6 to 3 h by eliminating 57% of non-value-added activities and 70% of errors found in discharge orders, representing a 2% annual capacity increase and a 6.423 bed made available without investment
Reis (2023)	VSM; Kaizen event: plan-do-check-act (PDCA) cycle	Action research relied on five stages: (1) diagnosis, (2) planning, (3) action, (4) evaluation and (5) learning. Semi-structured interview (coordinator, Manager); Document analysis (ERP System); Meetings (Workers from the areas involved).	The time the bed waited for hygiene, decreased from 13.45 h to 1.61 h; the total cycle time decreased from 26.43 h to 5.52 h; 88% reduce in the waiting time for inpatient bed hygiene; 20.75% increase in the capacity of patient admissions.
Rocha and Vasconcelo (2021)	Value stream mapping	A case study: including qualitative and quantitative approach, interviews with the managers of the health unit and direct observation of the clinic's operational routine and the secondary data were provided from management reports on the care provided.	A reduction in the average total waiting time of 37.92%, a reduction in lead time to 29.86%. Increase in queues for patients in a 05:30 min work shift.
Rollinson (2021)	Value stream mapping (VSM); PDSA cycles; fishbone diagram	A case study: Through the improvement practice process adopted through Vital Signs, a suite of measures was identified across different areas associated with discharge including process, outcome and balancing measures.	Prenoon discharge measure from baseline of 8% to 24% on ward X and from 9% to 19% on ward Y.
Saavedra (2023)	Kamishibai board (K-board); Plan-do-study-act cycles.	A descriptive case study describing the continuous process implementation of an adapted Kamishibai board (K-board) during a large BTS collaborative.	After 17 months of this initiative, 177 (93.7%) participating ICUs had included this visual management tool in their daily care routines. When more than 94 (>50%) ICUs posted K-board data, the mean compliance for the bundles for each HAI was sustained above 85%.
Sales-Coll (2024)	Reducing changeover time (SMED), pull, and continuous flow	Action Research: work team participation and analysing secondary data (data from the period 2015–2018 and through implementing continuous improvement tools).	Annual savings amounted to 7.4% of the total cost of a high-complexity surgical block, Process improvements have led to annual operational savings of over EUR 8.5 million.
Sales-Coll (2021)	Process Value Flow Map	Action Research (AR): improvement teams involved 368 healthcare professionals, process improvement teams of between 6 and 14 people.	(1) reduced waiting times for operations and (2) increased efficiency of operating rooms stemming from a cultural change in surgical resources management, particularly activity planning.
Menachem (2020)	Rapid Improvement Events (RIE)	A pooled cross-sectional study：Data from enterprise information systems;	45% (1144 rapid improvement events (RIEs) over a 5-year period) were associated with some organizational benefit in several categories, including cost reductions, time savings, a reduction in clinical and nonclinical defects, and a reduction in workflow steps.
Verbano and Crema (2019)	Value Stream Mapping	Case study: Direct observations on site, participating in meetings, and collecting internal documentation; Unstructured interviews and informal conversations with the employees of the ED and radiology.	Reporting report turnaround time (RTAT) approach the 60-minute goal.
Ankrum (2019)	Value Stream Mapping	Data collection: using paper forms, noting the time in min for each wait and process time.	Median room turnover decreased from 130 min to 65 min; decreased median time between room breakdown to cleaning start time (from 10 to 3 min), room cleaning complete to UV disinfection start (from 36 to 8 min), and the duration of room cleaning and curtain changing (from 57 to 37 min).
Zdęba-Mozoła (2022)	Value-stream mapping, 5Why; A3 reports	Direct observations, Interviews with persons responsible for project implementation, working groups.	The most important waste: paper medical documentation. The use of electronic form saved included 2.3 nursing positions and 1.09 medical staff positions.

3.3. Experimental designs

The majority of these cases, based on the actual methodologies employed, planned to identify waste through a combination of methods, such as a quantitative and qualitative survey (Agnieszka et al., 2022; Alkher et al., 2019; Borges et al., 2020; Cardoso, 2020; Fiorillo et al., 2021; Rocha and Vasconcelo, 2021; Samuel et al., 2022; Verbano and Crema, 2019). Three cases identified non-value activities using a questionnaire survey (Alkher et al., 2019; Duong et al.,2022; Samuel et al., 2022). Prior to the implementation of lean practice in hospitals, routine or historical data extraction was regarded to be a fantastic way to know about the current situation. 10 cases have been linked to this technique. Furthermore, techniques like observation and interviewing were designed to be used in the lean practice process. The analysis of all the articles showed that 10 cases identified the process procedure or waste using this method. A study by Borges et al., for example, mentioned using semi-structured interviews with four researchers who had expertise with lean practice (Borges et al., 2020), and the study conducted by Rocha et al. (2021) applied the method that interviews with the managers of the health unit and direct observation of the clinic's operational routine.

3.4. The outcomes of lean practice in hospitals

All these cases analyzed explore improvements concerning hospitals, which aimed at identifying waste or non-value activities, addressing waste elimination in hospitals, and providing the quantitative outcome for showing the effect of lean practice. Hospitals most frequently discovered waiting time waste, which was evidently reduced after lean implementation. Examples of this included 86.4% reduction in waiting time during the visit (Demirli et al., 2021), approximately 53.8% reduction in waiting time for patients (Martins-Drei and Arruda-Ignacio, 2022), 88% reduction in the waiting time for inpatient bed hygiene (Reis et al., 2023), 37.92% reduction in the average total waiting time (Rocha et al., 2021), a reduction in operating room waiting times, and 57% reduction in in patient discharge time (Morales-Contreras et al., 2020).

One further measure used to determine the impact of lean practices was lead time reduction, such as lead time from 336 to 39 min (−88.4%) (Astiena et al., 2022), the lead time of total production reduced from 5.31h to 5.12h (Cardoso, 2020), and a reduction in lead time to 29.86% (Rocha et al., 2021). Additionally, we discovered that lean practices might raise staff productivity by 15% on an observed sample of 400 patients per day in a case (Alkher et al., 2019) and clinic capacity could be increased from its present 176 patients to 479 patients without going against the 30-minute waiting time limit (Demirli et al., 2021). A study also represented that a 6.423 bed was made available without investment, which means that there was a 2% yearly capacity gain (Peimbert-García et al., 2021). According to a research, 20.75% improvement in the capacity of patient admissions (Reis et al., 2023). A study reported that median room turnover dropped from 130 min to 65 min (Ankrum et al., 2019), and it get a similar result from Verbano and Crema (Verbano and Crema, 2019). Simultaneously, we discovered that the time of related test of patients reduced, like pre-operative test results reduced from 134.4 to 89.4 min, vascular interventions from 54.6 to 48.9 min

(Duong et al., 2022). Also, 2 articles had got the similar result about the reduction of hospitalization time (Fiorillo et al., 2021; Morales-Contreras et al., 2020). Only 1 article showed patients' satisfaction increased from 22.9% to 76.5% (Duong et al., 2022). Besides, other benefits were identified in the implementation of lean in hospitals, such as prenoon discharge measure (Rollinson et al., 2021), cost reductions (Menachemi et al., 2020), turnaround time reductions (Verbano and Crema, 2019), positions saved in staffs (Zdeba-Mozola et al.,2022).

4. Discussion

Since the lean management was initially developed and implemented in healthcare sector, a large number of hospital managers in different countries have taken the initiative to implement lean techniques and tools in hospital management in an effort to increase productivity and save costs (Fournier et al., 2023). We found that lean practices were highly valued in Brazilian hospitals, with the six Brazilian publications included in this review (Borges et al., 2020; Cardoso, 2020; Martins-Drei et al., 2022; Reis et al., 2023; Rocha and Vasconcelos, 2021; Saavedra et al., 2023). According to the study of Santos et al. (2020), lean practice was frequently implemented in hospital emergency department, while there was 20% lean practice being conducted in emergency department of hospitals in this review (Cardoso, 2020; Duong et al., 2022; Verbano and Crema, 2019; Rollinson et al., 2021).

The application of lean tools primarily aids in the transformation of lean initiatives by identifying procedures and activities that do not add value, making it simple to eliminate these invalid activities (Al-Saa'Da et al., 2013; Gadolin, 2019; Vidal-Carreras et al., 2022). It is obvious that the sustainability of lean in the hospitals under study has depended heavily on its appropriate use at the right times (Henrique et al., 2021). Additionally, divergent perceptions of lean management could impact on the lean being perceived to have within hospitals, thereby meaning that the same lean tool was probably not suitable to implement in different hospitals. Value Stream Mapping (VSM) is the lean tool applications with the highest percentage in this review (Agnieszka et al., 2022; Alkher et al., 2019; Ankrum et al., 2019; Astienaet et al., 2022; Borges et al., 2020; Cardoso, 2020; Demirli et al., 2020; Duong et al., 2022; Fiorillo et al., 2021; Rocha and Vasconcelo, 2021; Rollinson et al., 2021; Verbano and Crema, 2019), which was line with a previous review (Lukrafka et al., 2020). Perhaps the main reason for its popularity is that it draws attention to a variety of issues that arise in day-to-day operations and processes from the viewpoint of the patients, picturing wastes that need to be eliminated and opportunities for more improvement. Furthermore, some academics contended that VSM can be seen of as a communication tool for lessening fear and anxiety regarding the changes that will occur during the lean implementation process (Henrique et al., 2021). With regard to the experimental design, many cases have applied a combination of methods (Agnieszka et al., 2022; Alkher et al., 2019; Borges et al., 2020; Cardoso, 2020; Fiorillo et al., 2021; Rocha and Samuel et al., 2022; Vasconcelo, 2021; Verbano and Crema, 2019), such as a quantitative and qualitative survey. This method could be helpful for identifying systematically problems. For example, semi-structured interviews have been conducted with experienced employees who had qualifications or participated in

continuous improvement projects (Duong et al., 2022).

Lean methods or tool have generally been used in hospitals as a potential approach to increase efficiency by cutting out nonvalue-added activities (Almutairi et al., 2020; Fernandes et al., 2023). Optimizing the value of the patient could be achieved by removing inefficient processes from the service process (Al-Hakim and Sevdalis, 2021). Lean management was praised as a fantastic technique to identify waste or nonvalue-added activities representing workflow waste (Alowad et al., 2021; Ankrum et al., 2019; Duong et al., 2022). Those hospitals that appropriately implemented lean have demonstrated noteworthy and beneficial outcomes (Shortell et al., 2018), which are mostly reflected via indicators. Waiting time, lead time and Length of Hospital Stay (LOS) were the primary indicators reflecting improvements in this review. Additionally, we discovered that lean implementation led to increased patient satisfaction by reducing the times for pre-operative test results, vascular interventions and the admission to other hospital departments (Duong et al., 2022). Astienaet et al. (2022) assured that lean implementation in hospitals led to the identification of the wasteful steps, a reduction in the service steps. Besides, such indicators like room turnover (Ankrum et al., 2019), pre-operative test results (Duong et al., 2022), patients' satisfaction (Duong et al., 2022), cost (Peimbert-García et al., 2021; Sales-Coll et al., 2024) has proved to get improvement.

This review exclusively examines healthcare organizations globally, conducting a systematic analysis of lean practice implementation within hospitals and exploring its practical implications. The findings aim to offer guidance and reference points for hospital managers navigating lean implementation. Still, some limitations exist. Firstly, the predominant focus of the studies reviewed is on case studies, where lean practices are implemented selectively within specific hospital departments, rather than across entire hospital settings. This narrow scope may limit the generalizability of findings to broader hospital contexts. Secondly, there is a notable gap in attention towards the adoption of lean approaches by healthcare providers in developing countries, reflecting a bias towards experiences in more developed healthcare systems. while the studies reviewed contribute evidence on the efficiency of lean practices, there is a scarcity of articles that rigorously test the statistical significance of outcome variables, thereby potentially compromising the robustness of the reported results.

5. Conclusion

The increasing pressure on hospitals due to limited financial constrains has driven more attention towards the continuous improvement of hospitals. Lean management is praised as a fantastic technique to identify waste or nonvalue-added activities representing workflow waste. This study has found that lean practices are highly valued in Brazilian hospitals, accounting with the highest percentage in this review. Lean practice was frequently implemented in hospital emergency department. Value Stream Mapping (VSM) is the most commonly used lean tool. Waiting time, lead time and LOS are the primary indicators reflecting improvements in this review.

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