

Lean Six Sigma methodology application in health care settings: an integrative review

Aplicação da metodologia Lean Seis Sigma nos cenários de assistência à saúde: revisão integrativa

Aplicación de la metodología Lean Seis Sigma en salud: revisión integrativa

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ABSTRACT

Objective: to analyze the scientific production on the results of Lean Six Sigma methodology in health care institutions. **Methods:** an integrative literature review, with the following question: what are the results in health institutions using Lean Six Sigma and Six Sigma methodology? The search was carried out at MEDLINE, LILACS, BDNF, CINAHL, Web of Science, and Scopus, with no time frame. **Results:** thirty-four articles were included, published between 2005 and 2019, of which 52.9% came from the United States of America. The most commonly found improvements were in hospital institutions and from the perspective of customers and internal processes. **Conclusion:** using Lean Six Sigma methodology proved to be effective in the different health care settings, evidencing a gap in its application regarding people engagement and training. **Descriptors:** Total Quality Management; Health Administration; Delivery of Health Care; Quality Improvement; Quality Control.

RESUMO

Objetivo: analisar a produção científica sobre os resultados da metodologia *Lean Six Sigma* nas instituições de assistência à saúde. **Métodos:** revisão integrativa da literatura, com a seguinte pergunta: quais são os resultados nas instituições de saúde com a utilização da metodologia *Lean Six Sigma* e *Six Sigma*? A busca foi realizada nas bases de dados MEDLINE, LILACS, BDNF, CINAHL, *Web of Science* e Scopus, sem recorte temporal. **Resultados:** foram incluídos 34 artigos, publicados entre 2005 e 2019, sendo 52,9% provenientes dos Estados Unidos da América. As melhorias mais comumente encontradas foram em instituições hospitalares e na perspectiva dos clientes e processos internos. **Conclusão:** a utilização da metodologia *Lean Six Sigma* se demonstrou eficaz nos diversos cenários de assistência à saúde, se destacando uma lacuna em sua aplicação quanto ao engajamento e capacitação de pessoas.

Descritores: Gestão da Qualidade Total; Administração em Saúde; Assistência à Saúde; Melhoria de Qualidade; Controle de Qualidade.

RESUMEN

Objetivo: analizar la producción científica sobre los resultados de la metodología *Lean Six Sigma* en instituciones de salud. **Métodos:** revisión integral de la literatura, con la siguiente pregunta: ¿cuáles son los resultados en las instituciones de salud que utilizan la metodología *Lean Six Sigma* y *Six Sigma*? La búsqueda se realizó en las bases de datos MEDLINE, LILACS, BDNF, CINAHL, *Web of Science* y Scopus, sin marco de tiempo. **Resultados:** se incluyeron 34 artículos, publicados entre 2005 y 2019, el 52,9% de los Estados Unidos de América. Las mejoras más comunes se encontraron en las instituciones hospitalarias y desde la perspectiva de los clientes y los procesos internos. **Conclusión:** el uso de la metodología *Lean Six Sigma* demostró ser eficaz en los diferentes escenarios de atención médica, destacando una brecha en su aplicación con respecto al compromiso y la capacitación de las personas.

Descriptorios: Gestión de Calidad Total; Administración en Salud; Prestación de Atención de Salud; Mejoramiento de la Calidad; Control de Calidad.

INTRODUCTION

The increasing complexity of the health system and the increase in life expectancy demand increasingly expensive and complex clinical and surgical treatments, which can increase expenses and put the quality of services at risk⁽¹⁾. Driven by this, health organizations have been thinking about process improvements as a business strategy⁽¹⁾. Process is a set of grouped and sequential activities, in which value is added to inputs (information, materials), resulting in outputs (products, services) to internal or external customers⁽²⁾.

Strategies for mapping and redesigning improvement processes have shown good results in assessing health systems as they enable benefits for institutions such as reduced rework, waste of materials and time and financial gains⁽³⁾.

To this end, specific instruments are used to act in the diagnosis of a problem, in planning or in control. To incorporate a continuous and logical idea of quality assurance, some methodologies were created, among them is Lean Six Sigma (LSS) methodology. This is a business philosophy, idealized by manufacturing, aiming to reduce defects to a level of 3.4 per million opportunities, incorporated with Lean Thinking, which seeks to reduce waste and lean thinking. However, to reduce errors to this proportion, the aim is to reduce the variation of processes to a capacity of \pm six standard deviations (sigma) through a project development model called DMAIC (Define-Measure-Analyze-Improve-Control)⁽⁴⁾.

Applying LSS methodology in institutions is a recent reality, which started in the mid-2000s, although without the Lean philosophy incorporation. However, an international study points to its use in the health field and as a result are cost-cutting, time optimization, material waste reduction and increased patient and family satisfaction⁽⁵⁾. On the other hand, the national literature is still limited as to implementing this methodology to improve management and care practices in health services and to highlight the organizational learning characterized by continuous review of its processes and monitoring of improvements made; the need for a deeper understanding of its application in services is pointed out.

OBJECTIVE

To analyze the scientific production on the results of LSS methodology in health care institutions.

METHODS

This is an integrative review, which aims to synthesize the state of knowledge of a given subject, by searching the available sources of scientific literature in order to identify existing knowledge gaps that need to be filled with new studies⁽⁶⁾.

To carry out the research question, the PICo strategy was used. "P" is equivalent to the population or problem, in this case results of improvements; "I" is equivalent to intervention, i.e., Lean Six Sigma and Six Sigma methodology; and "Co" is equivalent to context, which are health institutions. Therefore, the guiding question was: what are the results in health institutions using Lean Six Sigma and Six Sigma methodology?

Studies that used LSS methodology and that presented tangible results of improvement processes of health care institutions were included. Theses, dissertations, book chapters, letter to editors and editorials, studies that, despite being developed in health institutions, were not developed in settings of direct assistance to patients, as well as studies that did not develop all stages of DMAIC were excluded.

There was no selection of research by time limit, and full texts in Brazilian Portuguese, English, and Spanish were considered.

For the search strategy, the following databases were used: Medical Literature Analysis and Retrieval System Online (MEDLINE), Latin American and Caribbean Health Sciences Literature (LILACS), Nursing Database (BDENF), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science and Scopus. The survey was conducted between January and August 2019.

Descriptors and keywords were selected from Health Sciences Descriptors (*Descritores em Ciências da Saúde*, abbreviated DeCS) and Medical Subject Headings (MeSH), resulting in 784 studies (Chart 1).

Chart 1 - Search strategy for each database and quantity of articles retrieved

Database	Descriptors/keywords	Articles retrieved
MEDLINE	"Total Quality Management" [MesH Terms] AND "Lean Six Sigma" [All Fields]	227
	"Total Quality Management" [MesH Terms] AND Six Sigma" [All Fields]	55
LILACS	"Gestão da Qualidade Total" AND "Seis Sigma" AND (db: ("LILACS"))	7
BDENF	"Gestão da Qualidade Total" AND "Seis Sigma" AND (db: ("BDENF"))	2
CINAHL	"Six Sigma" AND "Quality Improvement"	132
	"Six Sigma" AND "Lean"	89
Web of Science	"Six Sigma" AND "Healthcare"	93
Scopus	"Six Sigma" AND "Healthcare"	179

After selecting articles, the study information was extracted using a collection instrument and stored with the following information: title of study, year, authors, journal, language, objectives, type of institution, intervention performed, and outcomes.

To categorize the studies, the Balance Scorecard (BSC) framework was used. BSC is a performance measurement system that allows you to see improvement processes in four perspectives⁽⁷⁾:

1. Customers: related to the institution's metrics to translate what the customer expects from the organization, it can be exemplified by indicators of customer satisfaction and loyalty.
2. Financial: results related to financial capital, profitability of the organization or working capital.
3. Learning and growth: indicators based on the valorization of human capital, training, and innovation.
4. Internal processes: assessment of the operational process and BackOffice to satisfy customers' needs and add value to service.

RESULTS

Of the studies identified in the selected databases, 48 were duplicated and 608 studies did not meet the inclusion criteria, such as use of DMAIC and presentation of tangible results; 128 studies were selected for reading their abstracts. Of these, 55 were excluded, resulting in 73 articles read in full, and which subsequently resulted in 34 studies included in the review, as presented in PRISMA⁽⁸⁾ (Figure 1).

Chart 2 presents the studies according to title, year, country of origin, intervention, outcome and type of health institution. A thorough analysis was carried out and it was found that the studies started in 2005, with the majority (61.7%) between 2015 and 2017. In relation to country, 52.9% took place in the United States (USA), and 70% were performed in hospitals (70.5%).

Chart 3 presents the classification of studies from BSC perspectives, in addition to improvements pointed out and the main institutional results. The category “customers” was the most commonly found in the various health care settings (61.7%), indicating improvements in reduction in time and increase in patient satisfaction with the use of LSS.

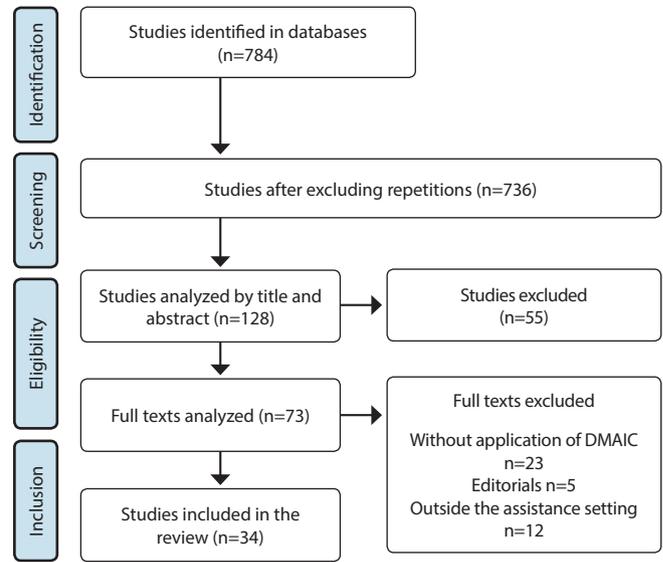


Figure 1 – PRISMA study selection flowchart and inclusion process

Chart 2 - Synthesis of articles included in the integrative review

Title	Year Country	Intervention	Outcomes	Health institution
Use of Lean Six Sigma methodology shows reduction of inpatient waiting time for peripherally inserted central catheter placement ⁽⁹⁾	2019 Ireland	Use of LSS methodology to improve response time for insertion of peripherally inserted central catheter.	Response time reduction from 3.7 to 1.8 days, representing a 35.8% improvement over the previous time.	University hospital
Implementing Lean Six Sigma in a Kuwaiti private hospital ⁽¹⁰⁾	2018 Kuwait	Use of LSS to reduce waiting time in an obstetrics and gynecology unit.	67% reduction in waiting time on weekends and 55% on weekdays.	Private hospital
Applying Lean Six Sigma methods to reduce length of stay in a hospital's emergency department ⁽¹¹⁾	2018 USA	Use of LSS and its instruments in the emergency room of a hospital.	Reduction in length of stay 30% in three months, in the percentage of patients who leave without treatment from 6.5% to 0.3% and improvement of patient satisfaction from 24% to 89.9%.	Private hospital
Lean Six Sigma to reduce Intensive Care Unit length of stay and costs in prolonged mechanical ventilation ⁽¹²⁾	2018 USA	Use of LSS to reduce hospital stay and associated costs in caring for patients with mechanical ventilation.	Reduction in hospital stay by 24% and in the average cost per case of mechanical ventilation by 27%.	University hospital
An Initiative to Optimize Waste Streams in the Operating Room: RECYcling in the Operating Room (RECOR) Project ⁽¹³⁾	2017 USA	Use of LSS to reduce material waste in the operating room environment and improve the low-cost material disposal flow.	Reduction from 12% to 6% of waste per day and increase in recyclable material from 19% to 45%.	Private hospital
Assurance of Myeloid Growth Factor Administration in an Infusion Center: Pilot Quality Improvement Initiative ⁽¹⁴⁾	2017 USA	Use of LSS to reduce the rate of missed doses of myeloid growth factor medications to <0.5%.	Dose omission rate reduction from 3.52 to 0% after the intervention.	Infusion center
Improving performances of the knee replacement surgery process by applying DMAIC principles ⁽¹⁵⁾	2017 Italy	Use of LSS to cut costs related to the process of knee replacement surgery.	Reduction in hospital stay by 42%, from 14.2 to 8.3 days.	University hospital
Lean Six Sigma techniques to improve ophthalmology clinic efficiency ⁽¹⁶⁾	2017 USA	Use of LSS to decrease the patient's flow time at eye clinics.	Reduced patient flow time by 18% as well as improved patient and employee satisfaction rates.	Clinic
Reducing the risk of healthcare-associated infections through Lean Six Sigma: The case of the medicine areas at the Federico II University Hospital in Naples (Italy) ⁽¹⁷⁾	2017 Italy	Use of LSS to reduce the risk of healthcare-related infections.	Reduction in the percentage of colonized patients from 0.37% to 0.21% and reduction in the average number of days of hospitalization from 45 to 36 days in surgical areas and reduction in colonization from 0.36% to 0.19% in clinics.	University hospital

To be continued

Chart 2

Title	Year Country	Intervention	Outcomes	Health institution
Supply and demand: application of Lean Six Sigma methods to improve drug round efficiency and release nursing time ⁽¹⁸⁾	2017 Ireland	Use of LSS to reduce interruptions and time in oral medication administration rounds.	Oral medication administration time reduced from 151 to 51 minutes and interruptions from 12 to 11 times on average.	University hospital
Improving operating room efficiency in academic children's hospital using Lean Six Sigma methodology ⁽¹⁹⁾	2017 USA	Using LSS to improve efficiency in the operating rooms of a children's hospital.	The interval between patient departure from the operating room and the arrival of the next one decreased from a median of 41 minutes to 32 minutes, and the interval between dressing and the subsequent surgical incision decreased from 81.5 minutes to 71 minutes.	Hospital
Reducing patients' falls rate in an Academic Medical Center (AMC) using Six Sigma "DMAIC" approach ⁽²⁰⁾	2017 Saudi Arabia	Use of LSS to reduce the rates of falling patients.	Reduction in the fall rate from 6.57 to 1.91 per thousand patients/day, showing an improvement of 71%.	University hospital
Using Lean Six Sigma Methodology to improve a mass immunizations process at the United States Naval Academy ⁽²¹⁾	2016 USA	Application of LSS methodology to improve the mass immunization process.	79% reduction in average vaccination time and 10% need for human resources	Naval health clinic
Use of Six Sigma Methodology to reduce appointment lead-time in obstetrics outpatient department ⁽²²⁾	2016 Colombia	Use of LSS to reduce the time required to make an appointment at the obstetrics clinic.	Reduction in the average of the consultation process (Lead Time) from 6.89 days to 4.08 days.	Obstetric outpatient clinic
Application of Six Sigma Methodology to reduce medication errors in the outpatient pharmacy unit: a case study from the King Fahd University Hospital, Saudi Arabia ⁽²³⁾	2016 Saudi Arabia	Use of LSS to reduce medication errors in the outpatient clinic of a University Hospital.		Outpatient clinic
Decreasing turnaround time and increasing patient satisfaction in a safety net Hospital-Based pediatrics clinic using Lean Six Sigma Methodologies ⁽²⁴⁾	2016 USA	Using LSS to reduce waiting time and improve patient and employee satisfaction.	Defect reduction and improvement in sigma capacity from 3.09 to 4.08 sigma.	Pediatric medical center
Improvement in patient transfer process from the operating room to the PICU using a Lean and Six Sigma-Based quality improvement project ⁽²⁵⁾	2016 USA	Use of LSS to improve the process of transferring patients from the operating room to the pediatric ICU.	Errors in the shift from the surgical center to the pediatric ICU decreased from 1.9 to 0.3 errors per patient and waiting time decreased from 90 to 32 minutes. Moreover, team satisfaction improved after the intervention.	Hospital
The application of Lean Six Sigma methodology to reduce the risk of healthcare-associated infections in surgery departments ⁽²⁶⁾	2016 Italy	Use of LSS to implement actions to improve the colonization of sentinel bacteria in hospitalized patients.	Reduction in hospital stay by 20% and in the number of patients affected by infection related to care from 0.37% to 0.21%.	Hospital
Applying Lean Six Sigma methodology to reduce cesarean section rate ⁽²⁷⁾	2016 China	Use of LSS to reduce the rate of cesarean section in the hospital.	Reduction in the cesarean section rate from 41.8% to 32% and the sigma capacity increased from 1.70 to 1.96.	Hospital
Lean Six Sigma: a new approach to the management of patients undergoing prosthetic hip replacement surgery ⁽²⁸⁾	2015 Italy	Use of LSS in the development of a care plan in hip prosthesis surgery.	Reduction in the average stay time from 18.9 to 10.6 days, representing a 44% time reduction and savings of 260 thousand euros.	University hospital
Decreasing the dispatch time of medical reports sent from hospital to primary care with Lean Six Sigma ⁽²⁹⁾	2015 Netherlands	Using LSS to increase the proportion of cancer staging reports sent on the day of patients' visit to the oncology center.	90.6% of medical reports sent on the day of patient visits, compared to an index prior to the intervention of 12.3%.	Oncology center
How to reduce head CT orders in children with Hydrocephalus using the Lean Six Sigma Methodology: Experience at a major quaternary care Academic Children's Center ⁽³⁰⁾	2015 USA	Use of LSS to reduce the relative use of pediatric cranial tomography in children with hydrocephalus by 50% within six months.	75% reduction in cranial tomography exams in three months.	Hospital

To be continued

Chart 2 (concluded)

Title	Year Country	Intervention	Outcomes	Health institution
Impact of Lean on surgical instrument reduction: less is more ⁽⁵⁾	2015 USA	Use of LSS to reduce surgical field processing time, operating time, surgical field assembly time and processing cost.	Surgical material assembly time reduction 8.4 to 4.7 minutes with a 44% joint assembly cost reduction. Reduction in average surgical field processing times from 97.6 to 76.1 seconds and reduction in processing costs.	Hospital
Impact of Lean Six Sigma process improvement methodology on cardiac catheterization laboratory efficiency ⁽³¹⁾	2015 USA	Use of LSS to improve patient efficiency and performance in the catheterization laboratory.	Improvement in room turnover from 43.6% to 56.6%, in addition to the percentage of cases attended on time, from 41.7% to 62.8%.	Catheterization laboratory
Use of Six Sigma strategies to pull the line on central line-associated bloodstream infections in a neurotrauma intensive care unit ⁽³²⁾	2015 USA	Use of LSS to improve the quality of the results of central catheter-related bloodstream infection in a neurological trauma ICU.	Reduction from 1.46 to 1.2 infections per 1,000 catheters.	Hospital
Six Sigma applied to reduce patients' waiting time in a cancer pharmacy ⁽³³⁾	2014 Jordan	Use of LSS to reduce the waiting time of patients at the oncology pharmacy.	Waiting time was reduced by 50%.	Oncology outpatient clinic
Redesigning an inpatient pediatric service using Lean to improve throughput efficiency ⁽³⁴⁾	2014 USA	Use of LSS in determining the time of discharge request and patient discharge compared to the control group.	Reduction in the time for requesting discharge to before 11 a.m., with a median reduction in 200 minutes and hospital discharge decreased by an average of 93 minutes.	Pediatric hospital
Patient discharge time improvement by using the Six Sigma approach: a case study ⁽³⁵⁾	2013 Jordan	Use of LSS to reduce discharge time without adding expenses.	57% improvement in patients discharged within 50 minutes.	Hospital
The usefulness of lean six sigma to the development of a clinical pathway for hip fractures ⁽³⁶⁾	2013 Netherlands	Use of LSS in the development of a multidisciplinary clinical pathway.	Reduction in hospital stay in 4.2 days (-31%) and an average duration of surgery in 57 minutes (-36%), in addition to savings of approximately 120 thousand euros.	Private hospital
Application of Six Sigma methodology to a cataract surgery unit ⁽³⁷⁾	2012 Turkey	Use of Six Sigma in a cataract unit in a public hospital.	The project team recorded all cataract surgeries that did not improve acuity and also classified intra and postoperative complications, showing an increase in sigma capacity from 2.60 to 3.75.	Hospital
Use of lean and six sigma methodology to improve operating room efficiency in a high-volume tertiary-care academic medical center ⁽³⁸⁾	2011 USA	Use of LSS to improve the efficiency of operating rooms.	Punctuality on admission to the operating room increased from 52% to 81%, waiting time for surgery in up to 10 minutes reduced from 42% to 12% and improved operating room turnover.	Medical center
Using Six Sigma methodology to reduce patient transfer times from floor to critical-care beds ⁽³⁹⁾	2011 USA	Use of Six Sigma to reduce the transfer time from the hospitalization unit to the ICU.	Improvement of the average transfer time from 214 minutes to 84 minutes, with a 6 sigma capacity after 8 months.	University hospital
Using the six sigma process to implement the Centers for Disease Control and Prevention Guideline for Hand Hygiene in 4 intensive care units ⁽⁴⁰⁾	2006 USA	Use of Six Sigma to assess hand hygiene practices and increase compliance with CDC recommendations.	Increased adherence to the hygiene rate from 47% to 80%.	Hospital
Use of corporate Six Sigma performance-improvement strategies to reduce incidence of catheter-related bloodstream infections in a surgical ICU ⁽³⁾	2005 USA	Use of LSS to reduce the rate of central catheter-related bloodstream infection.	Reduction in the infection rate from 11/1000 days to 1.7/1,000 days of catheter, with an improvement of 650%.	Hospital

Note: USA - United States of America; LSS - Lean Six Sigma; CDC - Centers for Disease Control and Prevention; ICU - Intensive Care Unit.

Chart 3 - Distribution of studies according to Balance Scorecard perspectives, improvements and results in health institutions

BSC perspective	Improvement	Result for health institutions
Customers	Time reduction	Reduction in waiting time for patients and families, time for carrying out assistance and administrative activities, hospital discharge, hospitalization time and flow improvements ^(5,9-12,15-18, 21-22, 24-26,29, 33-36, 38-39) .
	Patient satisfaction	Improvement of patient and family satisfaction with assistance team and organization ^(11,24-25) .

To be continued

Chart 3 (concluded)

BSC perspective	Improvement	Result for health institutions
Internal processes	Clinical indicators	Reduction in the rate of mechanical ventilation use, in the rate of care-related infection, in surgical complications, in the fall rate, in the number of cesareans, and improvement in the rate of hand hygiene ^(3,12,20,26-28,31-32,37,40) .
	Error reduction	Reduction in diagnostic errors, medication errors, and errors in shift passage ^(11,14,23,25) .
Financial	Cost-cutting	Cost-cutting of surgical procedures, processing hospital waste, and surgical materials ^(5,12-13,36) .
	Productivity	Improvement in bed turnover, surgical room turnover, and optimization of hospital resources ^(19,30-31,38) .
Learning and knowledge	Human Resources	Optimization of human resources and care team training ^(5,21,40) .

Note: BSC - Balance Scorecard.

DISCUSSION

In recent years, health care institutions have been seeking management methods and instruments to improve their processes as a strategy to ensure their sustainability, demonstrating a professionalization of management in the health field. This fact is highlighted by this research, in which there is a greater number of studies in the last five years⁽¹⁾.

Most studies were conducted in the USA and in several assistance settings, pointing to a concern regarding the optimization of flows, cost-cutting and process improvements^(12,14,21). It was found that no Brazilian study was found regarding the methodology use in its completeness. This fact can be explained by the complexity itself and its applicability in the context of health confirming a gap in the production of knowledge.

The BSC performance measurement system is used in organizations as a way to support development by its ability to generate simple access reports allowing information exchanges. The benefits of this instrument are related to the translation of indicators, which are sometimes not clear for operation. Moreover, other gains can be measured as facilitation of communication between areas and favoring feedback⁽⁷⁾. Thus, the option to use the BSC structure can show that LSS methodology proved to be versatile in the most diverse perspectives of applicability in health institutions.

The results pointed to a greater application aimed at customers, corroborating the recent trends of valuing it within assessing the quality of services. Value-based health takes into account patient assessment and their experience within health services regarding aspects of care, cost and impact on health. The patients' experience brings their looks and voices as team members and can be exemplified by participating in organizations' advisory boards and monitoring the improvement processes implemented⁽⁴¹⁾.

The research findings demonstrate as the main improvement, in relation to the patient's perspective, time reduction, whether related to waiting in care or performing activities and increasing satisfaction with care. Reduction in assistance time is crucial and directly impacts patient satisfaction, especially in emergency services. A review study that highlighted a greater number of improvements related to reduction in length of hospital stay, waiting time, volume of care and increased satisfaction, corroborates the statement⁽⁴²⁾.

Another review study, in which the management of Lean and LSS techniques in acute care environments was analyzed, demonstrated favorable results regarding reduction in process time and waiting time⁽⁴³⁾.

Studies point to LSS methodology regarding its effectiveness from the perspective of internal processes. When looking from the point of view of health, internal processes are related to optimization of clinical indicators, reduction in errors and adverse events^(23,28).

The literature attaches importance to these findings highlighting the need for improvements in care and administrative processes through implementing methodologies that reduce incidence of errors and adverse events in the various health care settings, especially those related to medication system and reduction in fall⁽⁴³⁻⁴⁵⁾.

The World Health Organization highlights the importance of using instruments to assess the risk of reducing errors, especially medication. Notably LSS methodology has not yet been encouraged by the agency for application in health organizations, which allows suggesting a path for the learning of institutions in this sense⁽⁴⁶⁾.

Furthermore, the Brazilian National Patient Safety Program (*Programa Nacional para Segurança do Paciente*) highlights the process improvement strategy as a way to ensure patient safety and reduce adverse events. This gives importance to the results of this research in which findings regarding reduction in events, such as falls, and errors were reduced with the use of the methodology^(11,14,23,25,47).

The results also positively impacted indicators of care, such as reduced use of mechanical ventilation and infection related to care. This corroborates other studies that indicate improvements in reduction in infection rates, hospital mortality, stay in critical units, readmissions, and rationalization of antibiotic use^(12,26,28,32,43,48).

From the point of view of the financial dimension, the research brought findings regarding reduction in financial and material waste and increased productivity, such as increased bed turnover and operating room turnover^(19,30-31,38). A study conducted at a university hospital in France aimed at assessing costs and waste of surgical material revealed that up to 20% of the total cost of surgical supplies are wasted, which would represent savings of 100,000 euros if they did not occur⁽⁴⁹⁾. At a time of current fragility in the remuneration and financing of the health system, studies of process improvements can contribute to improving the sustainability of health organizations.

Despite less frequency, studies on institutional learning deserve to be highlighted in the current health setting, mainly because they contribute to gains in optimization of human resources and training of teams^(5,21,40). Studies that demonstrate that professionals more engaged and committed to their work offer health care

with better performance converge with this finding, in addition to placing patients at the center of care⁽⁵⁰⁾. Therefore, it is important and necessary developing more studies applying LSS methodology to optimize work processes and to value the people directly involved in assistance.

Study limitations

A limitation of this research is related to the methodological option in assessing studies directly related to assistance, making it impossible to verify the use of the instrument in other assistance settings.

Contributions to nursing and health

It is known that instruments for process improvement have a wide potential in health institutions and nursing leaders must be trained to use it with authority to make the necessary changes in the health system. Using LSS methodology demonstrated numerous benefits for customer satisfaction and experience, in

addition to improving processes to guarantee safety of care and organizational efficiency. This research did not bring the levels of scientific evidence used in the studies found; this can be the object of new research to expand the discussions related to qualification of interventions in management and, with this, bring contributions for its application in the Brazilian health system.

CONCLUSION

This study demonstrated the applicability of LSS methodology in several health care settings, however more frequently in the hospital environment.

The main improvement processes were related to customers, such as reduced waiting times and increased satisfaction, followed by internal processes, with optimization of assistance indicators and reduction in errors. From the financial perspective, it was possible to verify a reduction in operating and assistance costs and an increase in productivity. However, from the perspective of learning, there was a smaller number of studies, which confers a knowledge gap to be explored for people engagement and training.

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