

Pediatric Spine Arthrodesis Care Line: reducing SUS ICU daily costs

Linha de Cuidado de Artrodese de Coluna Pediátrica: reduzindo custos de diárias de UTI SUS

Harli Pasquini-Netto¹, Kharol Neves², Lucas Miyake Okumura³, Allana Roseira⁴, Roseli Ferreira Matos⁵, Luiz Muller Avilla⁶, Luca Erdmann Bini Cordeiro⁷, Leonardo Cavadas da Costa Soares⁸, Marinei Campos Ricieri⁹, Fabio de Araújo Motta¹⁰

¹ Pharmacist, Master in Pharmaceutical Sciences, Health Economics and Outcomes Research (HEOR), Value Management Office, Pequeno Príncipe Hospital, Curitiba, Paraná, Brazil.

² Pharmacist Resident at the Value Management Office of Pequeno Príncipe Hospital through the Multidisciplinary Residency Program in Child and Adolescent Health. Curitiba, Paraná, Brazil.

³ Pharmacist, Master in Health Economics applied to Health Technology Assessment, Consultant at the Value Management Office, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

⁴ Bachelor of Nursing, Nurse at the Quality Care Center, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

⁵ Bachelor of Psychology, Coordinator of the Quality Care Center, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

⁶ Physician, Orthopedist and Traumatologist, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

⁷ Physician, Orthopedist and Traumatologist, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil. <https://orcid.org/0009-0008-5369-4479>.

⁸ Physician, Master in Child and Adolescent Health, Quality Care Center, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

⁹ Pharmacist, Master in Applied Biotechnology in Child and Adolescent Health, Coordinator of the Clinical Research Center, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

¹⁰ Physician, Doctor in Applied Biotechnology in Child and Adolescent Health, Director of the Clinical Research Center, Pequeno Príncipe Hospital. Curitiba, Paraná, Brazil.

Corresponding Author:
netto_pasquini@hotmail.com

How to cite this article:
Pasquini-Netto H, Neves K, Okumura LM, Roseira A, Matos RM, Avilla LM, et al. Pediatric Spinal Arthrodesis Care Pathway: reducing SUS ICU daily costs. JAFF [Internet]; 9(1). 2024.
doi: 10.22563/2525-7323.2024.v.9.n.1. p. 36-43e

Received on 30/09/2023.

Accepted for publication on 26/01/2024.

ABSTRACT

Objective: To assess the minimization of costs associated with Intensive Care Unit (ICU) length of stay, after implementing a Spinal Arthrodesis Care Pathway (CP).

Method: Cost-minimization analysis of administrative CP data from a public pediatric hospital. Two periods of analysis were considered: pre (2019) and post-complete implementation of the CP (2022). The study considered SUS as payer. The ICU daily cost considered SIGTAP table. A budget impact analysis was conducted considering a 5-year time horizon to estimate a savings associated with more patients receiving CP over the years. **Results:** 64 patients were followed by PC in 2019 (ICU average time; 3.8 days) and 62 patients (ICU average time: 0.8 days) in 2022, suggesting a 3-day ICU stay reduction, and resulting in minimization of cumulative costs of R\$ 189k for 60 patients. In addition, shorter total hospital stay was identified with 2022 CP. **Conclusion:** The implementation of the Spine Arthrodesis Care Pathway was a strategy considered effective as it provided equal rates as it helped to discharge patients from hospital and reduced ICU stay. The new CP optimized ICU-beds, providing an efficient allocation of resources in a hospital from SUS.

Keywords: cost-minimization; spine arthrodesis; care pathway.

RESUMO

Objetivo: Avaliar a minimização de custos relacionados ao tempo de internação em Unidade de Terapia Intensiva (UTI), após implementação de uma Linha de Cuidado (LC) de Artrodese de Coluna. **Método:** Análise de minimização de custos que considerou dados administrativos da LC de um hospital pediátrico. Foram considerados dois períodos de análise: pré (2019) e pós-implementação completa da LC (2022), na perspectiva do SUS como fonte pagadora. O custo da diária em UTI foi baseado em tabela SIGTAP. Análise de impacto orçamentário com horizonte temporal de 5 anos foi realizada para estimar a economia gerada pelo maior número de pacientes que recebem a LC ao longo dos anos. **Resultados:** 64 pacientes foram acompanhados pela LC em 2019 (tempo médio; T_{UTI} : 3,8 dias) e 62 pacientes (tempo médio; T_{UTI} : 0,8 dias) em 2022, sugerindo uma redução média de 3 dias de UTI, e acarretando em uma minimização de custos de R\$189 mil, para 60 pacientes acumulados em 5 anos. Além disso, foi observado menor tempo de hospitalização total. **Conclusão:** A implementação da estratégia de Linha de Cuidado de Artrodese de Coluna é considerada efetiva sob o ponto de vista de promover alta hospitalar aos pacientes. Otimiza o tempo de UTI, sugerindo uma melhor capacidade de alocação eficiente de recursos no SUS.

Palavras-chave: custo-minimização; artrodese de coluna; linha de cuidado.

Introduction

In Brazil, approximately 6 million people present with scoliosis. In youth, this condition has a prevalence of 1.4 to 4% among individuals aged 10 to 18 years, with 85% of the cases occurring in females in late-onset forms.

Scoliosis can be secondary to neuromuscular diseases, congenital issues, tumors, or various syndromes. It is defined as a deformity of the spine in the coronal plane greater than 10° on radiographic examination, accompanied by vertebral rotation. Commonly, the etiology is not identified, meaning it is often idiopathic.

The progression and severity of scoliosis are related to the etiology and the growth of the patient; that is, scoliosis may worsen during periods of growth spurts. Treatment, likewise, is indicated according to etiology, degree of curvature, and potential remaining growth. Generally, in the pediatric population, scoliosis does not lead to significant symptoms and is not prevalent, not being a determining factor for modifying medical conduct.

The evolution of surgical materials and techniques, along with intraoperative care, has transformed the routine of the surgical specialty in pediatric hospitals in recent decades, accounting for a significant portion of healthcare funding.

It is known that a patient's stay in the hospital, especially in the ICU, leads to worse clinical outcomes due to a higher risk of infection, as well as increased hospital costs. Standardizing patient care during preoperative, intraoperative, and postoperative periods has become increasingly relevant to optimize the care of patients with scoliosis. In this context, Care Pathways have gained prominence as a significant strategy to enhance the effectiveness and efficiency of care for patients with scoliosis.

A Care Pathway (CP) can be defined as a multidisciplinary effort aimed at developing a care plan for a defined group of patients, incorporating guidelines, evidence, and expert consensus opinions on local care. The Care Pathways (CPs) aim to reduce variability in care and enhance its systematization, positively impacting the improvement of care quality, patient experience, reduction of hospital costs, and better clinical outcomes. By

translating the best evidence into systematized and multidisciplinary care—through algorithms and treatment protocols that manage processes and outcomes—along with patient involvement in the clinical decision-making process, clinical management becomes more comprehensive, integrating management needs, improving clinical outcomes, and enhancing user satisfaction within the health-care system.

Objective

To analyze the costs of ICU stays for pediatric patients undergoing spinal arthrodesis before and after the implementation of the Care Pathway for Idiopathic Spinal Arthrodesis, from the perspective of the Unified Health System (SUS).

Methods

Study Location and Cost Analysis Perspective

The study was conducted in a large (361 beds) and high-complexity pediatric hospital in southern Brazil, which has a nationally recognized orthopedic surgery service. This hospital also has a Health Value Management Office responsible for the institution's economic analyses. The study was developed from the perspective of SUS as the payer.

Study Design

This is a comparative analysis (pre vs. post-implementation of CP) of costs, based on administrative data collected from a CP specialized in caring for patients undergoing spinal arthrodesis. Patients attended at the pediatric reference hospital of SUS have their data systematically collected, analyzed, and made available in a Dashboard (WeKnow®) for the managers of the CP.

Through real-time analysis, the Care Pathway (CP) is monitored daily by medical professionals (managers and surgeons) and a multidisciplinary team to identify opportunities for improving care.

Further details of the data and assumptions of the cost-minimization analysis can be seen in chart 1.

Population Characteristics

Eligible patients for the study should possess the following characteristics: they must be undergoing treatment according to the institutional guidelines of the Care Pathway for Spinal Arthrodesis, which included children and adolescents (up to 18 years old) diagnosed with any comorbidity that requires surgical intervention, particularly due to idiopathic scoliosis.

Patients admitted specifically for idiopathic scoliosis in 2019 and 2022 were included in this study, as the pre- and post-implementation groups of the CP for Arthrodesis due to Idiopathic Scoliosis, respectively. The years 2020 and 2021 were considered a “wash-out” period due to the pandemic and the interval for the implementation of the CP. Administrative data (length of stay, ICU time, hospital discharge, and mortality) were defined as study objects, thus not requiring approval from the Ethics and Research Committee. Economic data related to the payer source (daily rates) were obtained from the Management System of Procedures, Medications, and OPMEs (SIGTAP).

Administrative and cost data were extracted from the hospital's computerized database and SIGTAP, respectively.

Costs

Expenses related to pediatric ICU daily rates (code: 08.02.01.015-6 - daily rate for pediatric intensive care unit - ICU II) were calculated, summing the total costs.

Medical fees or other rates or therapy costs that could add to the total treatment cost were not considered. Costs associated with adverse drug events and procedures or other costs related to quality of life were not estimated.

Control Scenario: Pre-Implementation of the Care Pathway

Before the implementation of the care pathway, spinal arthrodesis was managed according to the directives given by the operating surgeon, without a systematic monitoring of results, either regarding care processes or patient outcomes. The team's actions occurred based on the patient's needs, without, however, a directed approach towards daily goals to be achieved.

Chart 1. Assumptions of the Cost Analysis

Scientific question	What is the economic impact of implementing a spinal arthrodesis care pathway?
Study population	Pediatric patients undergoing corrective spinal arthrodesis surgery
Intervention	With Care Pathway (2022)
Comparator	Without Care Pathway (2019)
Outcomes	Hospital discharge (primary), ICU length of stay (secondary)
Perspective	Payer, SUS (Brazilian Unified Health System)
Time horizon	Hospitalization period
Cost	Direct medical costs (Pediatric ICU daily cost: R\$ 700.00. Source: SIGTAP 2022)
Currency	Brazilian Real (R\$)
Relevant model assumptions	1) Hospital discharge suggests successful surgical recovery. Therefore, the CP is considered effective when patients are discharged, which occurred in 100% of cases (both pre and post-implementation), validating cost-minimization as the analysis method.
	2) Only ICU daily costs were considered, as they are the most relevant economic data for the chosen perspective.
	3) Mortality definition within the CP is limited to observation during hospital stay.

Source: Authors (2023)

Post-Implementation Scenario of the Care Pathway

In October 2020, the monitoring of the Care Pathway for spinal arthrodesis began, initially directed towards patients with Idiopathic Scoliosis. The care protocol was monitored by a multidisciplinary team (surgeons, physiotherapists, nursing staff, pharmacy, psychology, nutrition, social services, and quality nurse) with the goal of applying it individually to each patient undergoing the procedure, identifying their vulnerabilities, opportunities for improvement, and adjusting the protocol according to the observed needs.

Daily therapeutic goals were established in the therapeutic plan, associated with reducing the average length of stay while maintaining adequate pain control to facilitate early mobilization of the patient and conditions for hospital discharge.

The following actions were developed to assist the professionals involved in monitoring the care pathway (Chart 2):

Budget Impact Analysis (BIA): Pre vs. Post-Implementation

The population of the economic model is based on the assumption that the number of patients will remain constant, i.e., 60 per year, which can be

allocated to both the “pre” and “post-implementation” strategies, depending on the dynamics of the adoption of the Care Pathway (CP) within the institution. The costs derived from the economic analysis described earlier, with average costs per patient in the pre and post periods being R\$ 2660 and R\$ 560, respectively. As the budget impact analysis requires an annual adoption rate of the intervention, a hypothetical increase of 10% per year was assumed (reaching 50% in the fifth year) for patients receiving the new model of the CP for spinal arthrodesis.

Results

General Data

In the following table (Table 1), we present data from 64 patients during the pre-implementation period (2019), compared to 62 patients in the post-implementation period (2022). There were no losses in follow-up.

Outcomes

All patients from both groups (pre and post-implementation) were discharged from the hospital (considered as the resolution of spinal arthrodesis). There were no fatalities.

Chart 2. Actions developed for monitoring the idiopathic scoliosis spinal arthrodesis care pathway

- Structuring a goal-oriented Therapeutic Plan shared with the team and family.
- Establishing Daily Therapeutic Goals for the patient, including 5 care categories:
 1. Clinical care (wound care, devices, and pain scale monitoring),
 2. Pain control (analgesia),
 3. Early mobilization,
 4. Nutrition (gastrointestinal symptoms),
 5. Social care – all customized by day of hospitalization (D0, D1, D2...).
- Measuring Average Length of Stay from the day of surgery (D0) to the discharge day, considered the primary outcome.
- Creating a Spinal Arthrodesis CP Diary with information on goals, pain scale, and a space for patients and families to log entries during hospitalization. This encourages patient-centered care and enables daily progress tracking based on the therapeutic plan.
- Defining the FLACC scale as the standard for pain measurement by the nursing team.
- Creating a standard prescription template including routine items used by the medical team, incorporating objective criteria (FACES) for additional analgesia.
- Managing the transition from intravenous to oral medication and early mobilization

Source: Authors (2023)

Table 1. Data obtained from the Dashboard on pre- and post-implementation of the care pathway

		SUS n (%)	Private Insurance n (%)	Out-of-pocket n (%)	Total n (%)
Pre (2019)	N°. of patients	64 (36.57%)	108 (61.71%)	3 (1.71%)	175 (100%)
	Hospital discharge	64 (100%)	108 (100%)	3 (100%)	175 (100%)
	In-hospital death	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Post (2022)	N°. of patients	62 (37.80%)	96 (58.54%)	6 (3.66%)	164 (100%)
	Hospital discharge	62 (100%)	96 (100%)	6 (100%)	164 (100%)
	In-hospital death	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Source: Authors (2023)

Costs

Before the implementation of the Care Pathway (CP) in 2019, the average cost for ICU daily rates was R\$ 2,660.00, with an average length of stay of 3.8 days per patient. After the implementation of the CP in 2022, the average cost for ICU daily rates decreased to R\$ 560.00, with an average length of stay of 0.8 days per patient.

Thus, we can observe that the reduction of 3 ICU days (Pre: 3.8 days vs. Post: 0.8 days) generated an average savings of R\$ 2,100.00 per patient (Figure 1).

Additionally, early mobilization of patients, reduced postoperative opioid use, and shorter hospitalization times were reported; however, these costs were not accounted for in this study.

Budget Impact Analysis (BIA)

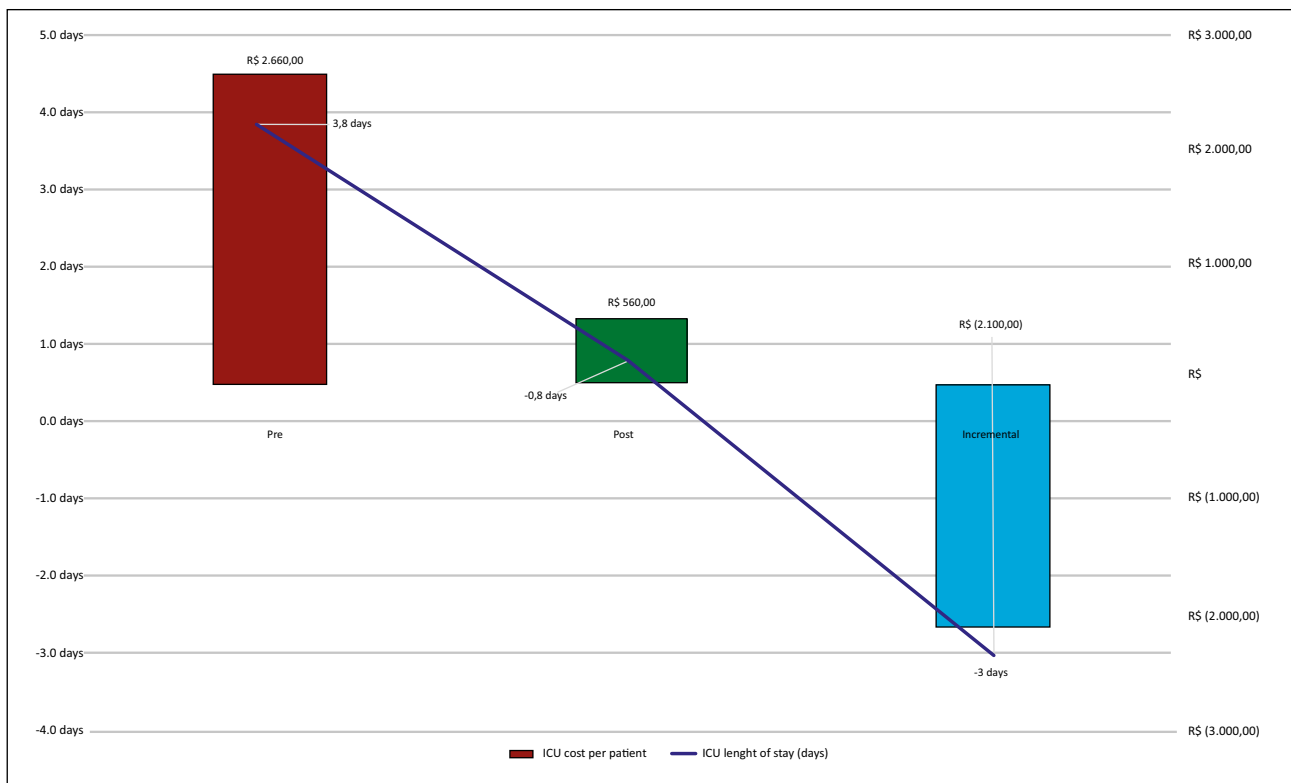
Based on the assumptions adopted for the budget impact analysis, it was possible to observe that annually, in a scenario without CP, the costs related to the treatment of 60 patients would reach R\$ 159,600. Over 5 years, the total costs would amount to R\$ 798,000. In the scenario where the CP (post-implementation strategy) is gradually adopted in the institution, the total costs in Year 1 would be R\$ 147,000, while in Year 5, the total costs would be R\$ 96,600.

Discussion

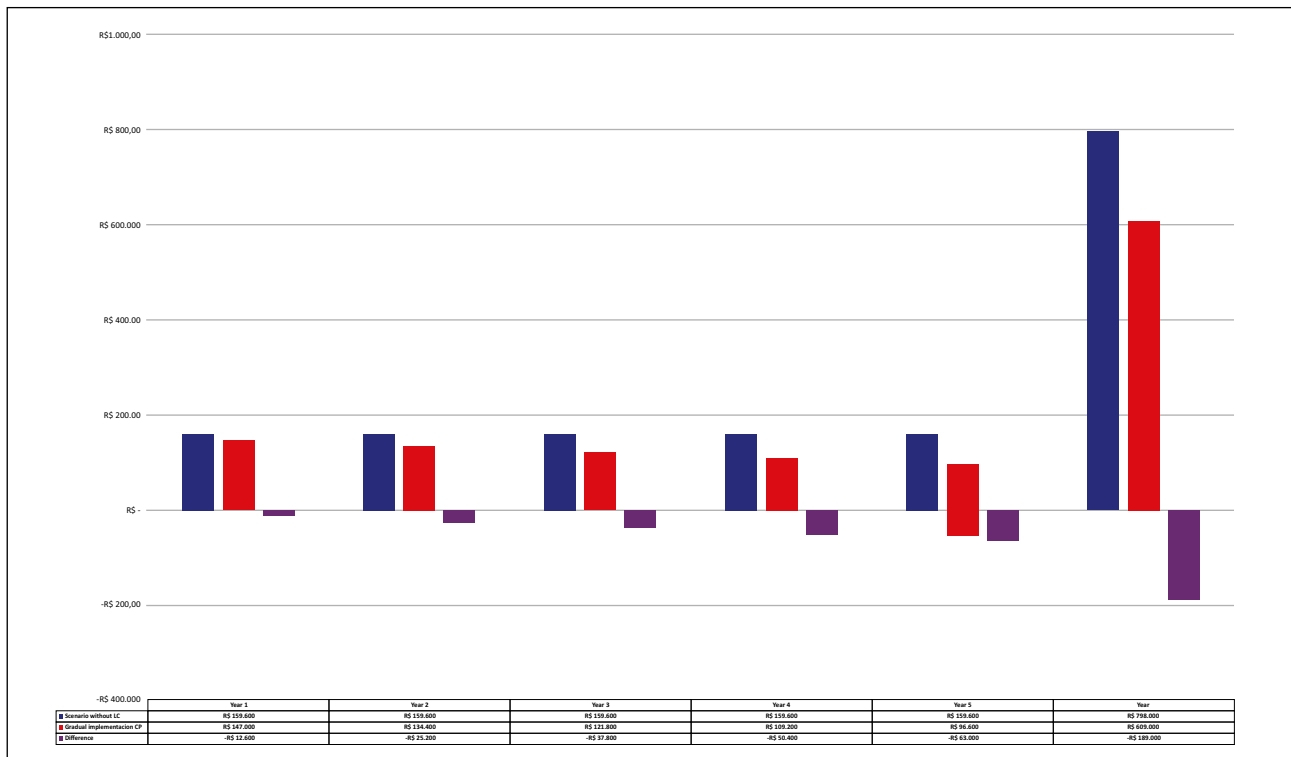
This is the first study in the literature regarding the reduction of costs related to the length of stay in the ICU, measured by the cost of hospital daily rates, resulting from the implementation of a care pathway in clinical practice for pediatric patients undergoing spinal arthrodesis surgery, admitted to a SUS hospital. We demonstrated the capacity to better allocate resources within a healthcare system, particularly in relation to the scarcity of ICU beds.

The inclusion of Care Pathways for Spinal Arthrodesis as presented suggests an important role for systematized assistance, with the potential for better outcomes than reported in the international literature. An American cohort study with 10 years of follow-up of patients with spinal deformities suggested that, of the 1,310 patients monitored, the length of stay after the first surgical procedure corresponds to a median time of 8 days (interquartile range of 7 to 9 days). In the present study, the ICU length of stay was less than 1 day, and the total length of stay averaged 11 days, which can be considered close to the American study. Additionally, findings from the Scandinavian Registry of patients with spinal-related diseases support these results. It is important to note that the etiology of scoliosis is critical for estimating prognosis and complications that may extend the hospital length of stay, which was not the focus of this initial research.

The low mortality rate found in this Brazilian cohort (zero) reflects other studies, which reported a risk of 0.1% to 1.7% after 90 days of hospital discharge.

Figure 1. Reduction in ICU stay and daily costs per patient

Legend: Pre (pre-implementation period, 2019); Post (post-implementation period, 2022); ICU (Intensive Care Unit) Source: Authors (2023)

Figure 2. Budget Impact

Legend: ICU (Intensive Care Unit). Source: Authors (2023)

Regarding the limitations of this study, it is important to highlight that the analyzed period differs from previous publications, as it is common to evaluate outcomes such as readmission, mortality, and other complications over a 90-day time horizon. The Care Pathway of the referred hospital, still under development, aims to monitor beyond the hospitalization period, collecting data to track outcomes and the outpatient environment.

Additionally, the retrospective collection of data introduces potential biases related to loss or inaccuracy of information, as well established in the literature. Finally, the cost of pediatric ICU daily rates was the only variable considered for the economic analysis, along with the length of stay in the ICU. Thus, the extrapolation of these data to other contexts should be carried out cautiously, especially concerning private hospitals. The absence of an economic model in the analysis may lead to limitations related to the lack of cost variables and clinical parameters that could impact the final patient cost, such as infections and even the risk of readmission.

Conclusions

The implementation of the strategy for the Care Pathway for Spinal Arthrodesis is considered effective in promoting hospital discharge for patients. It optimizes ICU time, suggesting a better capacity for efficient resource allocation within the Unified Health System (SUS).

Acknowledgments

The authors thank Pequeno Príncipe Hospital for encouraging the practice of research and innovation based on Value in Health.

1. Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. *Methods for the Economic Evaluation of Health Care Programmes*. (3o ed.) Vol. 1: 1–396 p. Oxford University Press; 2005. 1–396 p.
2. Konieczny MR, Senyurt H, Krauspe R. Epidemiology of adolescent idiopathic scoliosis. *J Child Orthop*. 2013;7(1):3–9.
3. Souza FI de, Ferreira RB Di, Labres D, Elias R, Sousa APM de, Pereira RE. Epidemiologia da escoliose idiopática do adolescente em alunos da rede pública de Goiânia-GO. *Acta Ortop Bras*. 2013;21(4):223–5.
4. Addai D, Zarkos J, Bowey AJ. Current concepts in the diagnosis and management of adolescent idiopathic scoliosis. *Child's Nervous System* 2020;36(6):1111–9.
5. Lavelle J, Schast A, Keren R. Standardizing Care Processes and Improving Quality Using Pathways and Continuous Quality Improvement. *Curr Treat Options Pediatr*. 2015;1(4):347–58.
6. Seilhamer C, Miller K, Holstine J. Reducing Postoperative Length of Stay for Idiopathic Scoliosis Patients using Quality Improvement Methodology. *Pediatr Qual Saf*. 2023;8(4):e672.
7. Spisak K, Thomas MD, Sirois ZJ, Jones A, Brown L, Froehle AW, et al. Novel Enhanced Recovery After Surgery Pathway Reduces Length of Stay and Postoperative Opioid Usage in Adolescent Idiopathic Scoliosis Patients Undergoing Posterior Spinal Fusion. *Cureus* 2023; 15(8).
8. Fruergaard S, Ohrt-Nissen S, Pitter FT, Høy K, Lindberg-Larsen M, Eiskjær S, et al. Length of stay, readmission, and mortality after primary surgery for pediatric spinal deformities: a 10-year nationwide cohort study. *The Spine Journal* 2021;21(4):653–63.
9. Von Heideken J, Iversen MD, Gerdhem P. Rapidly increasing incidence in scoliosis surgery over 14 years in a nationwide sample. *European Spine Journal* 2018;27(2):286–92.
10. Cognetti D, Keeny HM, Samdani AF, Pahys JM, Hanson DS, Blanke K, et al. Neuromuscular scoliosis complication rates from 2004 to 2015: a report from the Scoliosis Research Society Morbidity and Mortality database. *Neurosurg Focus* 2017;43(4):E10.
11. Fu KMG, Smith JS, Polly DW, Ames CP, Berven SH, Perra JH, et al. Morbidity and mortality associated with spinal surgery in children: a review of the Scoliosis Research Society morbidity and mortality database. *J Neurosurg Pediatr*. 2011;7(1):37–41.
12. Camargo LMA, Silva RPM, Meneguetti DUDO. Research methodology topics: Cohort studies or prospective and retrospective cohort studies.

Journal of Human Growth and Development
2019;29(3):433–6.

13. Garcia LP, Sant'Anna AC, Magalhães LCG de, Freitas LRS de, Aurea AP. Gastos das famílias brasileiras com medicamentos segundo a renda familiar: análise da Pesquisa de Orçamentos Familiares de 2002-2003 e de 2008-2009. *Cad Saude Publica*. 2013;29(8):1605–16.
14. DataSUS [homepage na internet]. Sistema de Gerenciamento da Tabela de Procedimentos, Medicamentos e OPM do SUS (SIGTAP). Available from: <http://sigtap.datasus.gov.br/tabela--unificada/app/sec/inicio.jsp>.
15. Camargo LMA, Silva RPM, Meneguetti DUDO. Research methodology topics: Cohort studies or prospective and retrospective cohort studies. *Journal of Human Growth and Development* 2019;29(3):433–6.

