

ORIGINAL ARTICLE

Impacts of the implementation of multimodal perioperative care protocols in Brazil in colectomies from 2008 to 2022

Impactos da implementação de protocolos multimodais de cuidados perioperatórios no Brasil em colectomias de 2008 a 2022

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KEYWORDS

Prevalence
Hospitalizations
Length of Hospital Stay
Hospital Lethality

PALAVRAS-CHAVE

Prevalência
Hospitalizações
Tempo de Internação
Letalidade Hospitalar

ABSTRACT

Objective: To identify the epidemiological characteristics of hospitalizations following colectomy procedures recorded in the Hospital Information System (Sistema de Informações Hospitalares) in Brazil, from January 2008 to December 2021. **Method:** This was an epidemiological, observational, and analytical study with a cross-sectional design, based on data obtained from the Hospital Information System (Sistema de Informações Hospitalares). It included hospitalizations of individuals aged 18 years or older who underwent either open or video laparoscopic colectomy procedures. **Results:** A total of 213,132 hospitalizations were analyzed in Brazil, involving patients with a mean age of 60 years and a slight predominance of males. The Southeast region accounted for the majority of hospitalizations. All procedures showed a reduction in average length of stay from 2015 to 2022. Regarding ICU utilization, a significant reduction was observed among patients who underwent video laparoscopic colectomy. A statistically significant reduction in mortality was also observed in this group. **Conclusion:** This study demonstrated a significant increase in the use of video-assisted surgery and a reduction in both hospital stay and associated costs. These findings align with practices promoted by international protocols, which emphasize reduced preoperative fasting, early postoperative feeding, and the use of minimally invasive surgical techniques.

RESUMO

Objetivo: Identificar as características epidemiológicas das internações relacionadas a procedimentos de colectomia registradas no Sistema de Informações Hospitalares (SIH) no Brasil, no período de janeiro de 2008 a dezembro de 2021. **Método:** Estudo epidemiológico, observacional e analítico, com delineamento transversal, baseado em dados do SIH referentes a internações de pessoas com idade mínima de 18 anos submetidas a procedimentos de colectomia aberta ou videolaparoscópica. **Resultado:** Foram analisadas 213.132 internações em todo o território nacional, envolvendo pacientes com média de idade de 60 anos (DP: ±16,49), com discreto predomínio do sexo masculino (50,7%). A região Sudeste concentrou 53,58% das internações. Observou-se redução do tempo médio de internação entre 2015 e 2022 para todos os

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procedimentos analisados, bem como diminuição significativa nas taxas de utilização de UTI e de letalidade entre os pacientes submetidos à colestomia videolaparoscópica.

Conclusão: O estudo evidenciou um aumento expressivo no uso da videocirurgia, acompanhado de redução do tempo de internação e dos custos hospitalares. Esses achados estão alinhados às práticas preconizadas por protocolos internacionais, que incluem a redução do jejum pré-operatório, a introdução precoce da alimentação e o uso de técnicas cirúrgicas minimamente invasivas.

INTRODUCTION

Multimodal care protocols are strategies designed to enhance surgical recovery by applying new approaches to perioperative care, aiming to reduce the risks of mortality, morbidity, and the length of hospital stay. To standardize these care routines, there are international evidence-based protocols, such as ERAS (Enhanced Recovery After Surgery), a pioneering European project from 2001, as well as national ones, like the ACERTO Project (Acceleration of Total Post-Operative Recovery), launched in Brazil in 2005¹. By focusing on patient-centered care through a multidisciplinary team, reducing the endocrine and metabolic response to trauma, alleviating perioperative discomfort, and lowering complication rates, institutions that adopted these protocols have reported satisfactory outcomes^{2,3}.

Several critical steps must be followed and analyzed to achieve surgical success. The first is preoperative preparation; the second is a meticulous surgical technique; followed by postoperative care, including early mobilization, wound management, infection control, intravenous hydration, and the reduction of fasting time⁴. Reducing fasting time is one of the primary goals of multimodal protocols—not only to lower hospital costs, but also to minimize discomfort for patients and their families⁵. In the context of colectomies, it is essential to adopt measures that promote improved recovery and early restoration of physiological bowel function⁶.

The implementation of the ACERTO protocol in Brazil since 2005 has shown differentiated results in optimizing postoperative recovery. Notable outcomes include a reduction in preoperative fasting time, decreased administration of postoperative crystalloids, and consequently, a significant decrease in complication and mortality rates⁷. Many hospitals began adopting the principles of the ACERTO protocol after its initial publications, with growing recognition after 2008, including reductions in perioperative complications, length of hospital stay, and healthcare costs, all contributing to better patient recovery^{1,5,7}.

Colectomy was chosen as the focus of this study because it is one of the most widely evaluated procedures in early ERAS studies, which demonstrated significant improvements following the application of multimodal protocols⁸. Furthermore, colectomy is a major surgery with a considerable impact on patient prognosis, reinforcing its relevance in assessing perioperative interventions.

Therefore, the aim of this study was to identify the epidemiological characteristics of hospitalizations following colectomy procedures in the Hospital Information System (SIH-DATASUS) in Brazil from January 2008 to December 2021.

METHODS

This was an epidemiological, observational, and analytical study with a cross-sectional design, based on data obtained from the Hospital Admission System (SIH-DATASUS)⁹. The study included hospitalizations of individuals aged 18 years or older who underwent procedures recorded with the following descriptions: partial colectomy in oncology, total colectomy in oncology, total proctocolectomy in oncology, partial colectomy, total colectomy, video laparoscopic colectomy, total proctocolectomy with ileal reservoir, abdominal rectosigmoidectomy, abdominoperineal rectosigmoidectomy, and abdominal rectosigmoidectomy in oncology. Only patients undergoing elective procedures were included, while urgent and emergency cases were excluded, as they are not typically subjected to optimized preoperative preparation protocols. The dataset referred to patients who remained hospitalized for up to 30 days in any of the 27 Brazilian federation units between January 2008 and December 2022.

The microdata from approved hospital admission authorizations (SIH-RD) are stored monthly for each federation unit and year. To retrieve this information, 4,536 datasets were downloaded. This automated process was performed using the microdatasus package (version 2.1.0)¹⁰ in R programming language.

The variables included in the analysis were: sex, age group, state and region of residence, year of hospitalization, length of hospital stay, procedure performed, main diagnosis, clinical outcome, and total cost associated with the Hospital Admission Authorization (AIH). It is important to note that the analyzed costs refer to the standardized amount paid per AIH, based on fixed reimbursement tables for each procedure performed. If the patient developed complications during hospitalization—such as pneumonia or the need for reoperation—a new AIH would be generated with a corresponding cost. Therefore, the total cost of the entire hospitalization was not captured; rather, individual AIH entries were considered, reflecting the per-procedure payment system used by SIH-DATASUS.

Categorical variables were summarized using absolute (n) and relative frequencies (%), while numerical variables were presented as means with standard deviation (SD) or 95% confidence intervals (95% CI). Comparisons of means across hospitalization periods were performed using one-way ANOVA. Pearson's chi-square test was used to compare proportions across groups. All analyses were conducted using R software (version 4.2.3) within the RStudio environment (version 2023.03.0), with a significance level set at 0.05.

As this study used publicly available and previously anonymized data from DATASUS, submission to an Ethics Committee was not required.

RESULTS

A total of 213,132 hospitalizations were recorded in Brazil, involving patients with an average age of 60.16 years (SD $\pm$ 16.49 years; 95% CI: 60.09–60.23). Most patients were male (50.7%), hospitalized between 2008 and 2014, residing in the Southeast region. The average hospital stay was 8.72 ± 5.53 days, with most patients being discharged without requiring ICU care. The average hospitalization cost was R\$ 4,438.15 $\pm$ 2,740.99, and average lethality was approximately 1 in every 10 patients (Table 1).

Patients who underwent partial colectomy had the highest proportion of male individuals, with hospitalizations concentrated between 2020 and 2022, and predominantly residing in the Southern region of Brazil. Patients who underwent total colectomy had a higher proportion of hospitalizations between 2008 and 2014 and also showed a higher mortality rate. Those who underwent video laparoscopic colectomy had the highest proportion of individuals from the Northeast and Southeast regions, along with a lower mortality rate. Individuals who underwent total proctocolectomy were predominantly female and aged between 18 and 59 years. Most hospitalizations in

this group occurred between 2015 and 2019, with patients mainly residing in the Midwest and North regions. These cases had a higher average hospitalization cost, a longer average hospital stay, and greater lethality. Finally, patients who underwent rectosigmoidectomy were mostly aged 60 years or older.

All procedures demonstrated a reduction in the average length of hospital stay over the years (Figure 1). When comparing the most recent to the earliest study periods, the percentage reduction in length of stay was as follows: –15.38% in partial colectomy, –11.83% in total colectomy, –26.37% in video laparoscopic colectomy, –12.62% in total proctocolectomy, and –17.02% in rectosigmoidectomy.

Regarding ICU utilization rates by period, a statistically significant increase was observed among patients who underwent partial colectomy, total colectomy, total proctocolectomy, and rectosigmoidectomy. However, for those who underwent video laparoscopic colectomy, ICU utilization remained statistically unchanged (Figure 2). A statistically significant reduction in mortality was observed only among patients who underwent partial colectomy. In contrast, a significant increase in mortality was seen in total colectomy, while mortality remained statistically unchanged in video laparoscopic colectomy, total proctocolectomy, and rectosigmoidectomy (Figure 3).

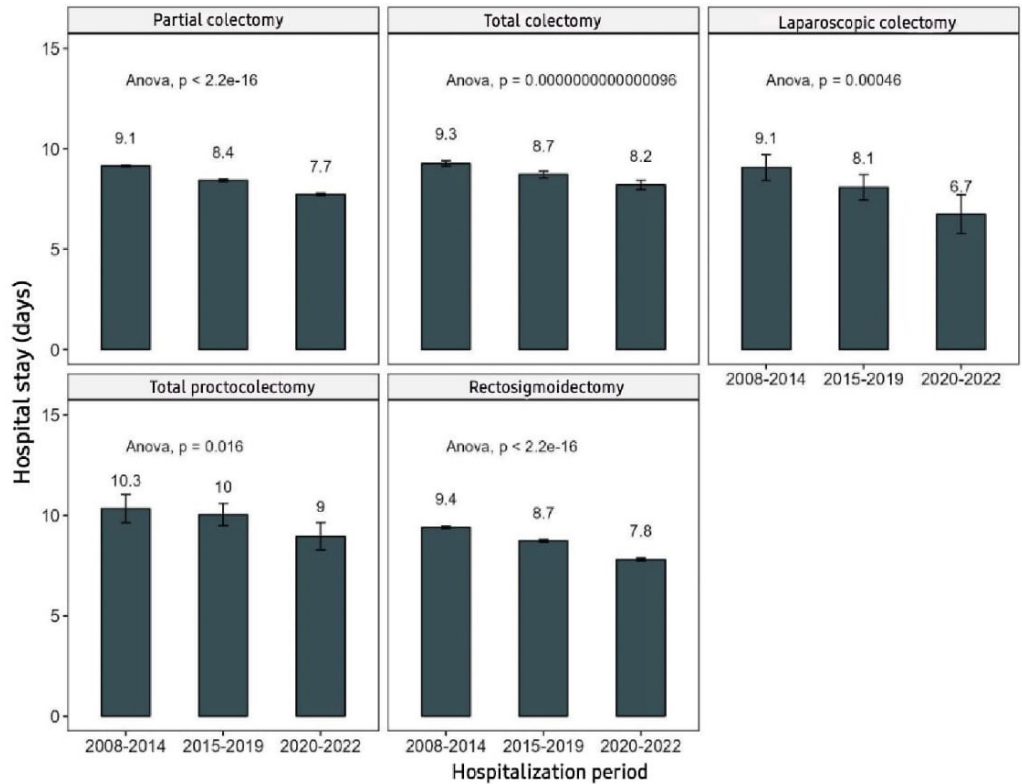


Figure 1 – Comparison of the average length of hospitalization according to year of hospitalization and procedure performed among individuals who underwent colon resection in Brazil between January/2008 and December/2022. Additional observations: first board, partial colectomy; the second, total colectomy; the third, video laparoscopic colectomy; the fourth board, total proctocolectomy; and the last, rectosigmoidectomy.

Table 1 – Epidemiological profile of hospitalized patients who underwent colon resections in Brazil: 2008 to 2022.

Variables	Total	Partial Colectomy	Total Colectomy	Vido laparoscopic colectomy	Total Proctocolectomy	Rectosigmoidectomy
	N = 213.132 ¹	N = 116.310 ¹	N = 14.429 ¹	N = 766 ¹	N = 1.085 ¹	N = 80.542 ¹
Gender						
Female	105566 (49.53)	57039 (49.04)	7196 (49.87)	481 (62.79)	790 (72.81)	40060 (49.74)
Male	107566 (50.47)	59271 (50.96)	7233 (50.13)	285 (37.21)	295 (27.19)	40482 (50.26)
Age Range (years)						
18-30	9684 (4.54)	6846 (5.89)	1125 (7.80)	66 (8.62)	129 (11.89)	1518 (1.88)
31-45 years	25006 (11.73)	14491 (12.46)	2135 (14.80)	130 (16.97)	233 (21.47)	8017 (9.95)
46-59 years	55534 (26.06)	28982 (24.92)	3589 (24.87)	196 (25.59)	318 (29.31)	22449 (27.87)
60 or more	122908 (57.67)	65991 (56.74)	7580 (52.53)	374 (48.83)	405 (37.33)	48558 (60.29)
Year of Hospitalization						
2008-2014	96711 (45.38)	51847 (44.58)	7619 (52.80)	337 (43.99)	357 (32.90)	36551 (45.38)
2015-2019	73178 (34.33)	40499 (34.82)	4488 (31.10)	304 (39.69)	452 (41.66)	27435 (34.06)
2020-2022	43243 (20.29)	23964 (20.60)	2322 (16.09)	125 (16.32)	276 (25.44)	16556 (20.56)
Region of Residence						
Midwest	17677 (8.29)	10044 (8.64)	1133 (7.85)	58 (7.57)	107 (9.86)	6335 (7.87)
Northeast	27613 (12.96)	15912 (13.68)	2008 (13.92)	109 (14.23)	130 (11.98)	9454 (11.74)
North	6457 (3.03)	3638 (3.13)	442 (3.06)	16 (2.09)	117 (10.78)	2244 (2.79)
Southeast	114195 (53.58)	60003 (51.59)	7901 (54.76)	474 (61.88)	521 (48.02)	45296 (56.24)
South	47190 (22.14)	26713 (22.97)	2945 (20.41)	109 (14.23)	210 (19.35)	17213 (21.37)
Length of Stay (days)	8.72 (5.53)	8.60 (5.60)	8.93 (5.97)	8.30 (5.81)	9.87 (6.23)	8.85 (5.32)
Progress						
Medical Release	192522 (90.33)	102849 (88.43)	12051 (83.52)	761 (99.35)	1036 (95.48)	75825 (94.14)
Death	20610 (9.67)	13461 (11.57)	2378 (16.48)	5 (0.65)	49 (4.52)	4717 (5.86)
Cost of Hospitalization (R\$)	4438.15 (2740.99)	3702.93 (2134.38)	5043.67 (3529.06)	1792.41 (1074.03)	6202.26 (3582.54)	5392.81 (3003.62)
ICU Utilization						
No	144006 (67.64)	78671 (67.71)	8993 (62.40)	617 (80.65)	603 (55.73)	55122 (68.51)
Yes	68898 (32.36)	37515 (32.29)	5420 (37.60)	148 (19.35)	479 (44.27)	25336 (31.49)
Not informed	228	124	16	1	3	84

¹n (%); Means (Standard Deviation).

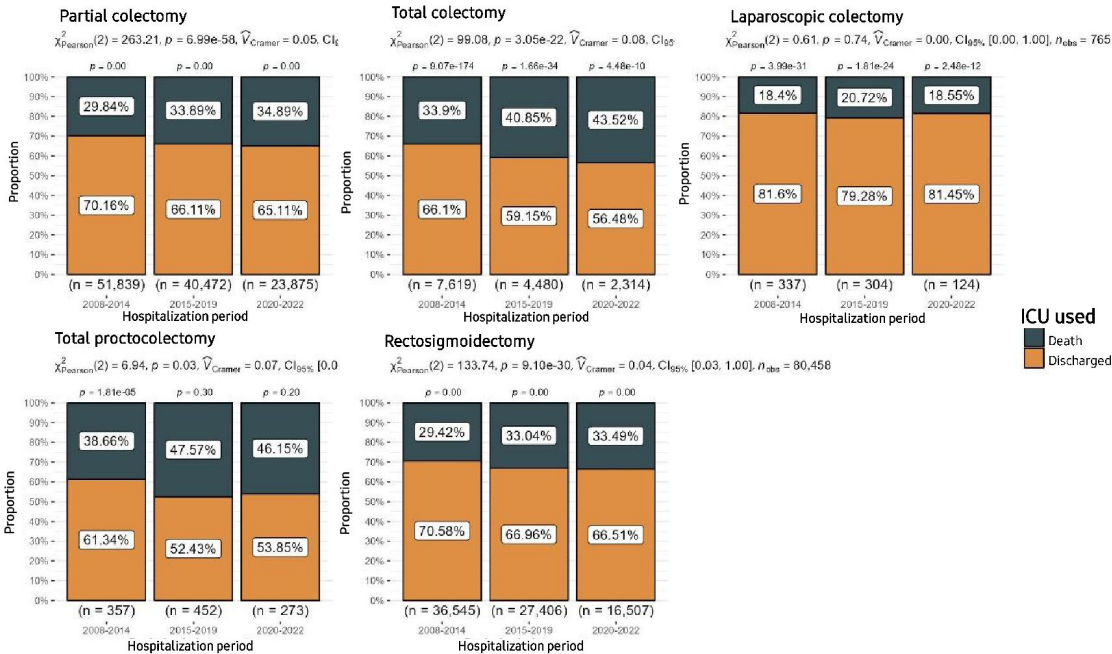


Figure 2 – Comparison of the rate of ICU use according to year of hospitalization and procedure performed among individuals who underwent colon resection in Brazil between January/2008 and December/2022. Additional observations: first board, partial colectomy; the second, total colectomy; the third, video laparoscopic colectomy; the fourth board, total proctocolectomy; and the last, rectosigmoidectomy.

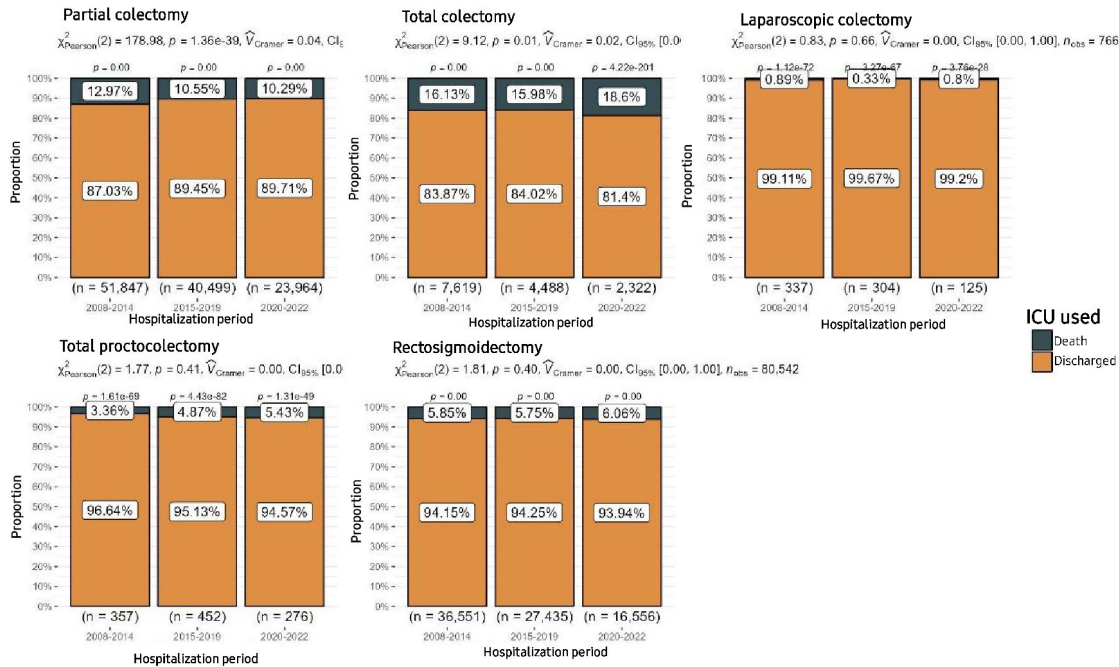


Figure 3 – Comparison of lethality according to year of hospitalization and procedure performed among individuals who underwent colon resection in Brazil between January/2008 and December/2022. Additional observations: first board, partial colectomy; the second, total colectomy; the third, video laparoscopic colectomy; the fourth board, total proctocolectomy; and the last, rectosigmoidectomy.

DISCUSSION

The analysis of the epidemiological characteristics of hospitalizations after colectomy surgery in Brazil, from January 2008 to December 2021, reveals a scenario consisting of 213,132 hospitalizations. Most hospitalizations occurred between 2008 and 2014 and were observed mainly in the Southeast region of the country. The observed sample demonstrates a slightly higher prevalence in males (50.13%) than in females (49.87%). The study highlights an average age of 60 years, with an average length of stay exceeding one week, although most of them were discharged without the need for ICU admission. It is worth mentioning that the average cost of hospitalization exceeded four thousand reais, and the average lethality occurred in 1 in every 10 patients.

Our study reveals a significant reduction in the average length of hospital stay in recent years, with emphasis on the period from 2015 to 2022. It is important to note that this interval coincides with the dissemination of the ACERTO project in Brazil¹. This correlation strongly suggests that the implementation of multimodal protocols had a substantial impact on this outcome. One of the main changes proposed by the ACERTO project during this period was the reduction of fasting time and early refeeding^{7,11}. A study on the impacts of nutritional status and fasting time on gastrointestinal complications and length of hospitalization in surgical patients showed that prolonged postoperative fasting time increased hospital stay, compared to patients who were fed again in less than 24 hours after the end of surgery¹². And, in shortening the fasting time, a case study that included patients treated in colorectal surgeries, exposed or not to clinical and demographic risk factors and submitted or not to interventions proposed by the ACERTO project, showed that preoperative fasting longer than 4 hours and refeeding after 24 hours of the procedure were associated with a length of stay longer than 7 days.

It is worth highlighting that the interventions from the ACERTO project gained national repercussion after the works published from 2008 onwards, a period in which our results showed an increase in the use of video surgery, as well as a reduction in hospitalization time and hospital costs. Such evidence can be corroborated with the practices adopted, such as reducing pre-operative fasting to less than 4 hours, also contributing to shorter hospitalization times, reduced risks of infection at the surgical site, anastomotic fistula, and pulmonary complications⁷. Furthermore, fasting with clear liquids enriched in carbohydrates was related to a decreased risk of mortality after surgery. Similarly, the administration of intravenous fluid therapy with crystalloids in volumes less than or equal to 30 mL/kg/day in the first 48 hours after surgery also reduced the risk of prolonged hospitalization, also demonstrating a protective effect against pulmonary complications⁷. However, the data in this study are limited to the period from 2008 to 2021, without including information prior to 2008. This makes it impossible to compare with the period prior to the dissemination of the ACERTO project, questioning whether the improvements observed are exclusive to the implementation of the protocol or whether similar trends

were already occurring before 2008. Additional studies covering the period prior to 2008 would be necessary to confirm whether the observed impact is effectively attributable to the interventions proposed by ACERTO or if other factors, such as technological advances and changes in care standards, also contributed to these results.

Between 2008 and 2014, the highest rate of hospitalizations was recorded, totaling 45.38% of the group. In this interval, total colectomy stood out as the surgery with the highest number of hospitalizations, contrasting with proctocolectomy, which had the lowest prevalence. In the subsequent period, from 2015 to 2019, the scenario proved to be the second highest in terms of hospitalizations, with a total share of 34.33%. During this period, video laparoscopic colectomy emerged as the surgery most frequently related to hospitalizations, and a notable increase in the adoption of this surgical technique was observed⁵. It is important to highlight that the ACERTO protocol encourages minimally invasive surgical practice, in line with the use of video laparoscopy, which provides less surgical impact for patients and reduces complications and enables early discharge⁵.

The period between 2020 and 2022 was marked by a sharp drop in hospitalizations, possibly due to the outbreak of the COVID-19 pandemic. During this interval, only 20.29% of total hospitalizations occurred, representing a significant decrease compared to previous years. Although the authors initially attributed the reduction in the absolute number of hospitalizations to the COVID-19 pandemic, it is necessary to consider that the observed drop may not be significant in proportional terms, given the smaller number of years evaluated. However, it is undeniable that the pandemic has had an impact on health systems, prioritizing care for victims of the virus and postponing elective surgeries that were not urgent in that context^{12,13}. Colectomies are necessary procedures, but they can often be scheduled, and therefore, many were postponed due to restrictions imposed by the pandemic, such as the redirection of hospital resources to the management of patients with COVID-19. The need to reduce the circulation of people in hospital environments, the increase in bed occupancy by severe cases of the infection, and the shortage of supplies, such as personal protective equipment (PPE), also contributed to the postponement of these procedures¹³. This scenario explains the reduction in the number of hospitalizations for colectomies during the period, even considering their relevance in the surgical context. Despite this observation, the proportional comparison between the periods requires caution, since the smaller number of years in the 2020–2022 interval limits a conclusive analysis regarding the direct impact of the pandemic on hospitalization rates for elective procedures.

The financial costs of admissions to colectomy surgeries in Brazil are a factor of considerable importance in the healthcare scenario. Our study does not make a comparison between hospital costs before and after the implementation of multimodal protocols, but rather between the averages of the total values of the procedures analyzed in the periods 2008–2014, 2015–2019, and 2020–2022. Besides, a study¹¹ showed that hospitalizations for major surgeries, including colon resection, resulted in a 20% reduction in hospital costs.

When comparing the data between the techniques used, it is possible to see how the minimally invasive ones offer a hospitalization cost (AIH) much lower than the others—approximately more than 50%. However, it is important to highlight that the costs presented in the study correspond only to the main AIH, without including the additional costs of OPMEs (Orthoses, Prostheses, and Special Materials), such as surgical staplers and other devices frequently used in minimally invasive procedures. Therefore, the total cost of hospitalization may be significantly higher than reported, especially in techniques that make extensive use of these materials. Even so, the benefits of laparoscopic techniques remain evident, including less invasiveness, shorter hospital stays, and reduced perioperative complications—factors that contribute to a positive impact on patients' recovery¹⁴. Future studies that analyze total costs, including OPMEs linked to procedures, would be necessary for a more comprehensive assessment of the economic impact of different surgical techniques. When comparing these data with the rates of laparoscopic colectomy procedures, it is possible to observe that this remained stable throughout the studied period, maintaining 18% to 20% of cases requiring ICU after surgery. It is known that laparoscopy is associated with fewer complications and shorter hospital stays, consequently lower costs for the healthcare system and low mortality rates¹⁵⁻¹⁷.

In this context, randomized research comparing open and laparoscopic colectomy techniques concludes that the latter is associated with a significant reduction in hospital stay, improved comfort, and reduced need for analgesia compared to open surgery^{18,19}. The ACERTO project has played a significant role in improving outcomes for patients undergoing major colorectal surgery¹. The relevance of the ACERTO protocol in improving surgical processes in favor of better postoperative recovery of the patient is inferred, as it acts directly in enhancing the multimodal approach to the surgical patient^{1,7}.

CONCLUSION

The analysis of the epidemiological characteristics of hospitalizations related to colectomy procedures in Brazil, between 2008 and 2021, allowed us to identify important patterns regarding the impact of different surgical approaches. The results showed that video laparoscopic colectomy was associated with a shorter mean hospital stay, a lower rate of ICU use, and a significant reduction in mortality compared to open techniques. These findings reflect the evolution of surgical practices and corroborate the benefits of minimally invasive techniques, aligned with the objectives of multimodal perioperative care protocols.

However, the limitations inherent in the use of secondary data from SIH-DATASUS, including the lack of detailed information on individual risk factors, pre-existing conditions, and total costs associated with procedures, reinforce the need for caution in interpreting the results. Despite these limitations, the study achieved its objective by describing the epidemiological characteristics of hospitalizations and the outcomes associated with different types of colectomies, highlighting the relevance of optimized approaches in the national surgical context.

REFERENCES

1. DE-Aguilar-Nascimento JE, Salomão AB, Caporossi C, Dock-Nascimento DB, Eder Portari-Filho P, Campos ACL, et al. ACERTO Project - 15 years changing perioperative care in Brazil. *Rev Col Bras Cir* 2021;48:e20202832. <http://doi.org/10.1590/0100-6991e-20202832>. PMID:33503143.
2. Kaye AD, Urman RD, Cornett EM, Hart BM, Chami A, Gayle JA, et al. Enhanced recovery pathways in orthopedic surgery. *J Anaesthesiol Clin Pharmacol* 2019;35(5, Suppl 1):S35-9. http://doi.org/10.4103/joacp.JOACP_35_18. PMID:31142957.
3. Singh SM, Liverpool A, Romeiser JL, Miller JD, Thacker J, Gan TJ, et al. A U.S. survey of pre-operative carbohydrate-containing beverage use in colorectal enhanced recovery after surgery (ERAS) programs. *Perioper Med (Lond)* 2021;10(1):19. <http://doi.org/10.1186/s13741-021-00187-3>. PMID:34044894.
4. Hadaya J, Sanaiha Y, Juillard C, Benharash P. Impact of frailty on clinical outcomes and resource use following emergency general surgery in the United States. *PLoS One* 2021;16(7):e0255122. <http://doi.org/10.1371/journal.pone.0255122>. PMID:34297772.
5. Coelho JCU, Pinho RV, de Macedo JJM, Andriguetto PC, Campos ACL. Colectomia laparoscópica: revisão retrospectiva de 120 casos. *Rev Col Bras Cir* 2009;36(2):144-7. <http://doi.org/10.1590/S0100-69912009000200010>. PMID:20076886.
6. Vu JV, Li J, Likosky DS, Norton EC, Campbell DA Jr, Regenbogen SE. Achieving the high-value colectomy: preventing complications or improving efficiency. *Dis Colon Rectum*. 2020;63(1):84-92. <http://doi.org/10.1097/DCR.0000000000001523>. PMID:31633600.
7. Bicudo-Salomão A, Salomão RF, Cuerva MP, Martins MS, Dock-Nascimento DB, Aguilar-Nascimento JE. Factors related to the reduction of the risk of complications in colorectal surgery within perioperative care recommended by The ACERTO Protocol. *Arq Bras Cir Dig*. 2019;32(4):e1477. <http://doi.org/10.1590/0102-672020190001e1477>. PMID:31859930.
8. Turchini M, Del Naja C, Tancredi A. Enhanced Recovery After Surgery: a patient centered process. *J Vis Surg*. 2018;4:40. <http://doi.org/10.21037/jovs.2018.01.20>.
9. Brasil. Ministério da Saúde. Orientações técnicas para operacionalização do SIH durante o estado de emergência de saúde pública por coronavírus [Internet]. Brasília: Ministério da Saúde; 2020 [cited 2006 Nov 2]. Available from: <http://sihd.datasus.gov.br>.
10. Saldanha RF, Bastos RR, Barcellos C. Microdatasus: pacote para download e pré-processamento de microdados do Departamento de Informática do SUS (DATASUS). *Cad Saude Publica*. 2019;35(9):e00032419. <http://doi.org/10.1590/0102-311x00032419>. PMID:31531513.
11. de Aguilar-Nascimento JE, Bicudo-Salomão A, Ribeiro MRR, Dock-Nascimento DB, Caporossi C. Cost-effectiveness of the use of acerto protocol in major digestive surgery. *Arq Bras Cir Dig*. 2022;35:e1660. <http://doi.org/10.1590/0102-672020210002e1660>. PMID:35766605.
12. McLean RC, Young J, Musbahi A, Lee JX, Hidayat H, Abdalla N, et al. A single-centre observational cohort study to evaluate volume and severity of emergency general surgery admissions during the COVID-19 pandemic: Is there a "lockdown" effect? *Int J Surg*. 2020;83:259-66. <http://doi.org/10.1016/j.ijsu.2020.09.011>. PMID:32931980.
13. Ali AB, Shaikh A, Maghami N, Zia M, Wolf DA, Bonville DJ. Impact of Covid-19 pandemic on volume and surgeon professional fees generated by emergency general surgery procedures. *Surg Endosc*. 2022;36(12):9297-303. <http://doi.org/10.1007/s00464-022-09168-z>. PMID:35296948.

14. Ahmad G, Baker J, Finnerty J, Phillips K, Watson A. Laparoscopic entry techniques. *Cochrane Database Syst Rev*. 2019;1(1):CD006583. <http://doi.org/10.1002/14651858.CD006583.pub5>. PMID:30657163.
15. Senagore AJ, Erwin-Toth P. Care of the laparoscopic colectomy patient. *Adv Skin Wound Care*. 2002;15(6):277-83, quiz 284-5. <http://doi.org/10.1097/00129334-200211000-00009>. PMID:12477980.
16. Sheetz KH, Norton EC, Regenbogen SE, Dimick JB. An instrumental variable analysis comparing medicare expenditures for laparoscopic vs open colectomy. *JAMA Surg*. 2017;152(10):921-9. <http://doi.org/10.1001/jamasurg.2017.1578>. PMID:28614579.
17. Anderson C, Uman G, Pigazzi A. Oncologic outcomes of laparoscopic surgery for rectal cancer: a systematic review and meta-analysis of the literature. *Eur J Surg Oncol*. 2008;34(10):1135-42. <http://doi.org/10.1016/j.ejso.2007.11.015>. PMID:18191529.
18. Veldkamp R, Kuhry E, Hop WCJ, Jeekel J, Kazemier G, Bonjer HJ, et al. Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol*. 2005;6(7):477-84. [http://doi.org/10.1016/S1470-2045\(05\)70221-7](http://doi.org/10.1016/S1470-2045(05)70221-7). PMID:15992696.
19. Nelson H, Sargent DJ, Wieand HS, Fleshman J, Anvari M, Stryker SJ, et al. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med*. 2004;350(20):2050-9. <http://doi.org/10.1056/NEJMoa032651>. PMID:15141043.

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