

# IDENTIFICATION OF RISK FACTORS ASSOCIATED WITH 30-DAY READMISSION OF PATIENTS SUBMITTED TO ANTERIOR OR POSTERIOR ACCESS CERVICAL SPINE SURGERY

*IDENTIFICAÇÃO DOS FATORES DE RISCO ASSOCIADOS À READMISSÃO EM 30 DIAS DE PACIENTES SUBMETIDOS À CIRURGIA DE COLUNA CERVICAL PELAS VIAS ANTERIOR E POSTERIOR*

*IDENTIFICACIÓN DE FACTORES DE RIESGO ASOCIADOS A LA READMISIÓN A LOS 30 DÍAS DE PACIENTES SOMETIDOS A CIRUGÍA DE COLUMNA CERVICAL POR VÍA ANTERIOR Y POSTERIOR*

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## ABSTRACT

**Aim:** To conduct a systematic review of the literature to identify risk factors associated with 30-day readmission of patients submitted to anterior or posterior access cervical spine surgery. **Methods:** The databases used to select the papers were PubMed, Web of Science, and Cochrane, using the following search strategy: patient AND readmission AND (30 day OR “thirty day” OR 30-day OR thirty-day) AND (spine AND cervical). **Results:** Initially, 179 papers that satisfied the established search string were selected. After reading the titles and abstracts, 46 were excluded from the sample for not effectively discussing the theme proposed for this review. Of the 133 remaining papers, 109 were also excluded after a detailed reading of their content, leaving 24 that were included in the sample for the meta-analysis. **Conclusions:** The average readmission rate in the studies evaluated was 4.85%. Only the occurrence of infections, as well as the presence of patients classified by the American Society of Anesthesiology (ASA) assessment system with scores greater than III, were causal factors that influenced the readmission of patients. No significant differences were noted when comparing the anterior and posterior surgical access routes. **Level of evidence II; Systematic Review of Level II or Level I Studies with discrepant results.**

**Keywords:** Surgical procedures, operative; Spine; Neck; Patient readmission.

## RESUMO

**Objetivo:** Realizar uma revisão sistemática da literatura buscando identificar fatores de risco associados à readmissão hospitalar em 30 dias de pacientes submetidos à cirurgia de coluna cervical pelas vias anterior e posterior. **Métodos:** Os bancos de dados usados para a seleção dos trabalhos foram PUBMED, Web of Science e Cochrane, utilizando a seguinte estratégia de pesquisa: patient AND readmission AND (30 day OR “thirty day” OR 30-day OR thirty-day) AND (spine AND cervical). **Resultados:** Inicialmente foram selecionados 179 trabalhos que responderam à string de busca previamente estabelecida. Depois da leitura dos títulos e resumos, 46 trabalhos foram excluídos da amostra por não discutirem efetivamente o tema proposto para esta revisão. Dos 133 trabalhos restantes, 109 também foram excluídos após leitura detalhada do seu conteúdo, restando 24 artigos que foram incluídos na amostra para realização da metanálise. **Conclusões:** A taxa média de readmissões nos estudos avaliados foi de 4,85%. Apenas a ocorrência de infecções, assim como a presença de pacientes classificados pelo sistema de avaliação da American Society of Anesthesiology (ASA) com escores maiores do que III, foram fatores causais que influenciaram a readmissão dos pacientes. Não se verificaram diferenças significativas na comparação das vias de acesso cirúrgico anterior ou posterior. **Nível de evidência II; Revisão Sistemática de Estudos de Nível II ou Nível I com resultados discrepantes.**

**Descritores:** Procedimentos cirúrgicos operatórios; Coluna vertebral; Pescoço; Readmissão do paciente.

## RESUMEN

**Objetivo:** Realizar una revisión sistemática de la literatura buscando identificar los factores de riesgo asociados a la readmisión a los 30 días de pacientes sometidos a cirugía de columna cervical por vía anterior y posterior. **Métodos:** Las bases de datos utilizadas para seleccionar los estudios fueron PUBMED, Web of Science y Cochrane, utilizando la siguiente estrategia de búsqueda: patient AND readmission AND (30 day OR “thirty day” OR 30-day OR thirty-day) AND (spine AND cervical). **Resultados:** Inicialmente se seleccionaron 179 artículos que respondían a la string de búsqueda previamente establecida. Tras la lectura de los títulos y resúmenes, se excluyeron de la muestra 46 trabajos por no ser compatibles con la temática propuesta para esta revisión. De los 133 trabajos restantes, también se excluyeron 109 tras una lectura detallada de su contenido, quedando 24 artículos incluidos en la muestra para el metanálisis. **Conclusiones:**

Study conducted at the Universidade de Campinas – UNICAMP. Faculdade de Ciências Médicas. Department of Orthopedics, Rheumatology, and Traumatology.

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La tasa media de readmisión en los estudios evaluados fue del 4,85%. Únicamente la aparición de infecciones, así como la presencia de pacientes clasificados por el sistema de evaluación de la American Society of Anesthesiology (ASA) con puntajes superiores a III, fueron factores causales que influyeron en la readmisión de los pacientes. No se observaron diferencias significativas al comparar las vías de acceso quirúrgico anterior o posterior. **Nivel de evidencia II; Revisión sistemática de estudios de nivel II o nivel I con resultados discrepantes.**

**Descriptor:** Procedimientos quirúrgicos operativos; Columna vertebral; Cuello; Readmisión del paciente.

## INTRODUCTION

In recent years, healthcare costs have increased considerably, becoming an enormous burden for public and private healthcare systems. There are several reasons for this increase, including requests for unnecessary tests, the inefficient use of technology, unnecessary visits to emergency services, the occurrence of side effects and infections after medical treatment, as well as hospital readmissions after surgery, among other causes.<sup>1</sup>

Hospital readmissions after surgery have major clinical and financial implications, especially in rapidly evolving healthcare systems. For example, in the United States, the estimated annual cost of hospital readmissions within 30 days after discharge is approximately USD 17 billion. In these cases, well-designed interventions would successfully reduce the rate of avoidable readmissions by up to 45%.<sup>2</sup>

Several factors are involved in the readmission of patients after cervical spine surgery, among them the existence or not of health insurance, age, ethnicity, length of the hospital stay after the first surgery, and the presence of various comorbidities.<sup>3</sup> Among the comorbidities particularly related to orthopedics, heart and kidney failure, chronic obstructive pulmonary disease, diabetes mellitus, cancer, and infection stand out.<sup>4,5</sup> The objective of this study was to conduct a systematic literature review with meta-analysis, seeking to identify risk factors associated with readmissions of patients submitted to anterior and posterior approach cervical spine surgery within 30 days following the procedure.

## METHODS

The databases used for article selection were PubMed, the Web of Science, and Cochrane, using the following search strategy: patient AND readmission AND (30 day OR "thirty day" OR 30-day OR thirty-day) AND (spine AND cervical). Initially, 149 works were identified in the PubMed database that satisfied the previously established search string and 149 in the Web of Science (121 were duplicates, leaving 28 articles), in addition to 2 articles from the Cochrane database, totaling 179 eligible articles. As inclusion criteria, we only accepted articles that described quantitative or qualitative studies discussing the causes of readmission after cervical spine surgery and which contained more than 100 in patients (who remained hospitalized following surgery), or in patients and out patients (who did not remain hospitalized and were discharged after post-anesthetic recovery), who were over 18 years of age. After reading the titles and abstracts, 46 articles were excluded from the sample because they did not discuss the topic proposed for this review effectively. Of the remaining 133 works, 104 were also excluded after a detailed reading of their content, leaving 24 articles included in the sample for the meta-analysis.

A meta-analytical study was developed that ought to evaluate the interference factors related to readmissions within 30 days following corrective surgery. For this, the Odds Ratio using the Mantel-Haenszel fixed model was considered the main measure of association. This model considers the following components in the calculation:  $Y_j$  (desired effect) =  $\theta M + \epsilon_j$  (where  $\epsilon_j$  is the random error of the study and  $\theta M$  is the effect common to all studies). Cochran's Q test, which presents the statement that all the studies comprising the meta-analysis are homogeneous as the null hypothesis, was also used. All the statistical analyses were conducted using STATA, version 16 (2019) software, using an alpha of 5% (0.05) as the statistical parameter. We tried

to make a distinction between anterior and posterior approach surgeries, including their causal factors and comparing them individually and as groups, considering the works identified in the bibliographic survey.

Because this was a systematic literature review, the study did not require approval by the Institutional Review Board.

## RESULTS

After applying the exclusion criteria, 24 articles were used for statistical analysis. The selected works displayed optimum heterogeneity when grouped, revealing similar agreements between the Odds Ratio and Standard Error analytical models. Multiple causal factors are involved in the readmission process within 30 days after procedures. The total number of patients included in 24 studies selected for the meta-analysis was 726,078, with a minimum of 201<sup>6</sup> and a maximum of 343,068<sup>7</sup>. The mean readmission rate in the studies evaluated was 4.85%. (Table 1)

The data collection, source, and individual readmission characteristics of each article evaluated are described in Table 2. Biological factors such as age, race, and sex did not directly influence the patient's risk of readmission ( $p > 0.05$ ), as seen in Table 2.

The occurrence of infections, as well as the presence of patients classified by the American Society of Anesthesiology (ASA) evaluation system with scores greater than III, were the causal factors that most influenced patient readmission. These results can be observed in Figures 1, 2, and 3, which show the results of the Odds Ratio calculations based on the statistic I.<sup>2</sup>

Continuing the evaluation, the measures of association related to factors like patient age, the presence of dysphagia, associated comorbidities, habits such as smoking, age above 60 years, and sex of the patients are presented in Figure 4. It is noteworthy that these factors showed no association with readmissions, as low Odds Ratio values and p-values greater than 0.05 were observed. Also, there was no mean difference between the Odds Ratios observed when comparing the different access routes, or for the morbidity factors (OR = 1.8 -0.4- 2.3). Once again, the differentiated and grouped relationships, considering ASA classifications greater than III, as well as infections, stood out as being the most responsible for readmissions in the short term, regardless of the surgical approach.

**Table 1.** Readmission frequency by type of surgery and analysis period.

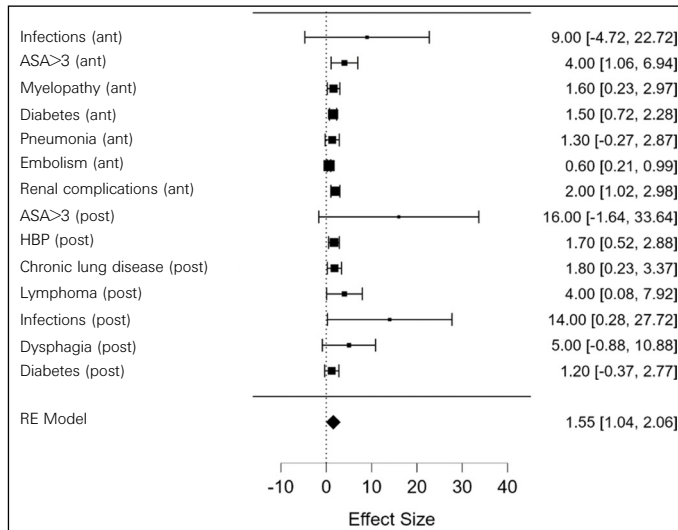
Parameters	Number of studies	Number of patients	Mean readmissions (%)	Lower CI	Upper CI
Grouped results	24	726,078	4,85	3,45	6,85
<b>Analysis period</b>					
Between 2010 and 2015	2 (8%)	36,628	5,6	2,1	7,8
Between 2015 and 2019	12 (50%)	303,425	4,8	1,3	8,2
Between 2020 and 2021	10 (42%)	386,025	4,1	2,8	6,1
<b>Type of surgery</b>					
Anterior	10	596,905	6,8	3,9	9,7
Posterior	7	102,179	4,5	1,5	6,3
Both	5	26,994	3,2	0,7	5,2

CC = Confidence interval. Source: Data collected by the authors.

**Table 2.**Data sources and information capture periods.

Authors and year	No. of patients	Observation period	Data source	Readmission rate as a %
Wang et al. <sup>7</sup>	343,068	2003-2007	Institutional review board	7.9
Lovecchio et al. <sup>8</sup>	2,320	January to December 2011	American College of Surgeons National Surgical Quality Improvement	2.5
Joseph et al. <sup>9</sup>	49,300	2013-2015	University Health System Consortium	6.4
Samuel et al. <sup>10</sup>	17,088	2012-2014	American College of Surgeons National Surgical Quality Improvement	3.2
Bhashyam et al. <sup>11</sup>	6,077	2013-2014	American College of Surgeons National Surgical Quality Improvement	2.6
Derman et al. <sup>12</sup>	87,045	1997-2012	The New York State All-Payer Health-Care Database	4.2
Rumalla et al. <sup>13</sup>	29,990	January to September 2013	Multicenter Database	5.4
Rumalla et al. <sup>14</sup>	72,688	January to September 2013	Multicenter Database	6.0
Choy et al. <sup>15</sup>	3,401	2006-2013	American College of Surgeons National Surgical Quality Improvement	6.0
Zaki et al. <sup>16</sup>	549	2013-2014	American College of Surgeons National Surgical Quality Improvement	5.1
Shin et al. <sup>17</sup>	2,667	2011-2014	American College of Surgeons National Surgical Quality Improvement	3.9
Ansari et al. <sup>18</sup>	12,578	2011-2018	American College of Surgeons National Surgical Quality Improvement	5.1
Malik et al. <sup>19</sup>	1,140	2012-2016	American College of Surgeons National Surgical Quality Improvement	3.5
Sheha et al. <sup>3</sup>	2,019	2005-2012	Statewide planning and research cooperative system database	6.0
Sing et al. <sup>20</sup>	18,883	2012-2016	American College of Surgeons National Surgical Quality Improvement	4.4
Elsamadicy et al. <sup>5</sup>	13,093	2013-2015	National surgical quality improvement program	4.0
Lee et al. <sup>21</sup>	546	2016-2017	American College of Surgeons National Surgical Quality Improvement	3.0
Mesfin et al. <sup>6</sup>	210	2014-2017	American College of Surgeons National Surgical Quality Improvement	6.3
Schafer et al. <sup>22</sup>	3,762	2014-2018	Michigan Spine Surgery Improvement Collaborative	5.4
Villavicencio et al. <sup>23</sup>	1,077	2013-2017	American College of Surgeons National Surgical Quality Improvement	7.3
Taylor et al. <sup>24</sup>	50,126	January to September 2014	National surgical quality improvement program	4.8
Mauler et al. <sup>25</sup>	1,273	2013-2016	The St. Joseph's Hospital and Medical Center Institutional Review Board for Human Research	7.6
Tsai et al. <sup>26</sup>	3,957	2005-2018	National surgical quality improvement program	4.6
Zeidan et al. <sup>27</sup>	3,221	2012-2017	National surgical quality improvement program	1.1

Source: Data collected by the authors.

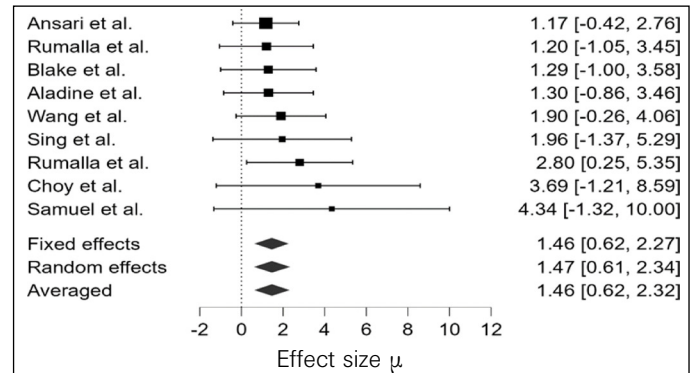


**Figure 1.** Odds Ratios adjusted by the Standard Error for Confidence Intervals, considering the risk factors observed between the anterior and posterior accesses. I2: 76%(excellent heterogeneity). Q (p-value<0.05).

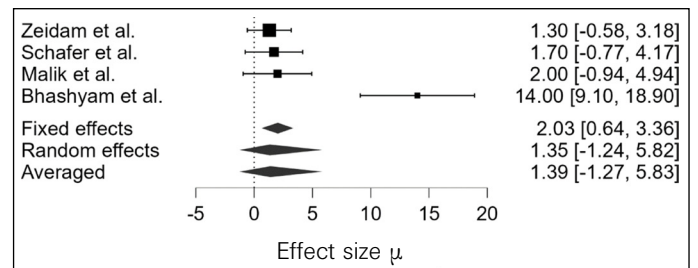
**DISCUSSION**

In recent decades, the growing number of spine surgeries has increased the costs of healthcare considerably. Even more worrisome is the fact that non-planned readmissions following procedures negatively affect both healthcare costs and the quality of the care provided. In many services, 30-day readmission rates are used as a measure of the quality of care, and in some centers, in order to reduce healthcare costs and improve the quality of care, hospitals with excessive rehospitalization numbers face reductions in the payment of their fees.<sup>23</sup>

In our study, factors like the age, race, and sex of the operated patient did not influence the readmission risk. Also, the presence of comorbidities did not account for any statistically significant correlation with the increase in readmissions. Never the less, one of the factors that most influenced increasing readmissions in the works we evaluated was the occurrence of surgical wound infections. Similarly,

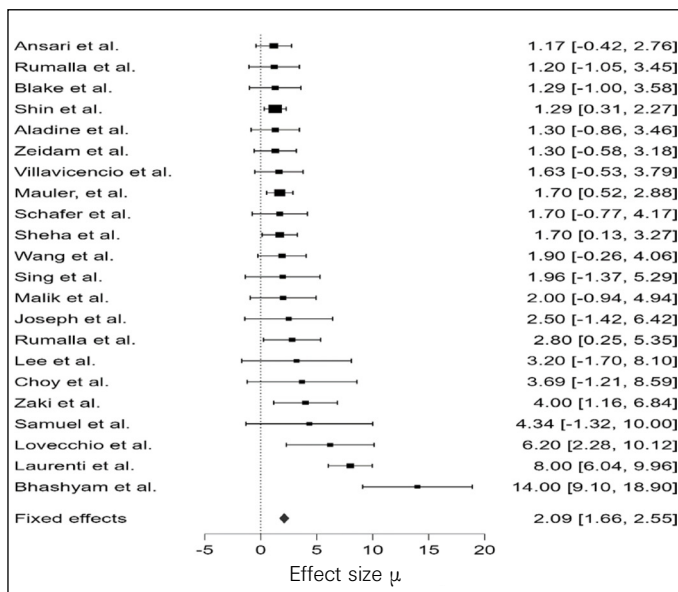


**Figure 2.** Odds Ratios adjusted by the Standard Error for Confidence Intervals, considering infections as a factor for readmission within an interval of up to 30 days. I2: 58% (good heterogeneity). Q (p-value<0.05).



**Figure 3.** Odds Ratio adjusted by the Standard Error for Confidence Intervals, considering an ASA score greater than III as a factor for readmission within an interval of up to 30 days. I2: 51% (good heterogeneity). Q (p-value<0.05).

Bernatz and Anderson<sup>28</sup> verified that the presence of infections was the most reported factor related to readmissions within a 30-day period following cervical spine surgery. Among these infections, those occurring at the surgical site stand out, follow by deep neck space infections and bacteremia. Infections were cited as the main cause of hospital readmissions following cervical spine surgery in several series.<sup>23,29,30</sup>



**Figure 3.** Odds Ratios adjusted by the Standard Error for the Confidence Intervals for all risk factors observed. I<sup>2</sup>: 76% (excellent heterogeneity). Q (p-value<0.05).

Various strategies aimed at reducing postoperative infections have been studied, including the creation of screening programs for methicillin-resistant *Staphylococcus aureus*, decolonization, optimization of operating room air quality, and adherence to the correct use of antibiotics by the patient.<sup>28</sup> According to Tan et al.,<sup>31</sup> there are three phases to be considered in the prophylaxis of the surgical site, specifically the preoperative, the intraoperative, and the postoperative. They also state that, despite the postoperative phase being fundamental in the prophylaxis of infections, there is still no consensus regarding the best way to prevent infections in spine surgery. Some measures taken in the postoperative period, including the use of specific types of dressings, the duration of post surgical dressing use, and specific protocols for the treatment of infection, have proved to be some what

effective. Furthermore, silver-impregnated dressings, in addition to negative pressure incisional wound therapy have had positive results in reducing infections following spine surgery.<sup>31</sup>

Another factor that influenced readmissions was the classification of the patient with an ASA score greater than III. According to Schupper et al.,<sup>32</sup> this ASA classification is directly correlated with a more complicated postoperative hospital protocol, including a longer hospital stay and, consequently, an increase in treatment-related costs. Moreover, patients in ASA classes III and IV usually require more Intensive Care Unit admissions compared to patients without systemic disease.

For Bernatz and Anderson,<sup>28</sup> in patients with high ASA scores, mainly ASA IV, but not discounting ASA III, comprehensive programs of prior treatment and reduction of medical comorbidities have been shown to reduce postoperative complications, including rehospitalizations. Therefore, the authors suggest that an indication of cervical surgery for a patient with an elevated ASA score should be reconsidered, given the high risks of complications and rehospitalizations inherent in these patients.

Finally, we did not observe any differences in relation to the need for readmission when we compared anterior and posterior surgical accesses. This result was likethat observed in the study conducted by Kuris et al.,<sup>33</sup> who also reported similar readmission rates when comparing both approaches. Also in that study, the only variable that had a positive correlation with readmissions was the presence of an ASA score above II.

## CONCLUSIONS

The risk factors directly associated with readmission to the hospital in patients who had undergone cervical spine surgery were the occurrence of infections and an ASA classification higher than III. No significant differences were noted when comparing the anterior and posterior surgical access routes.

All authors declare no potential conflict of interest related to this article.

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