Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2026;15(2):587-92

Nomogram-based prediction of surgical site infection after cervical spondylosis surgery: A retrospective cohort study

Burak Bahadir[1], Fatma Betul Saylak[2]

[1]*Ankara Bilkent Training and Research Hospital, Department of Neurosurgery, Ankara, Türkiye*
[2]*Çankırı State Hospital, Department of Neurosurgery, Çankırı, Türkiye*

Received 05 November 2025; Accepted 08 December 2025
Available online 23 January 2026 with doi: 10.5455/medscience.2025.10.300

Abstract

To develop and internally validate a practical nomogram to predict the risk of surgical site infection (SSI) after cervical spondylosis surgery, using routinely available perioperative parameters. This single-center retrospective cohort study included 204 adult patients who underwent cervical stabilization for degenerative spondylosis at Ankara Bilkent City Hospital between April 2019 and April 2025. Demographic, clinical, and perioperative variables were collected, including age, sex, smoking, operative time, and length of hospital stay (LOS). The diagnosis of SSI was based on clinical documentation and was not determined independently. The primary outcome was SSI, defined as any postoperative wound infection documented during hospitalization or early follow-up. Univariable and multivariable logistic regression analyses were performed to identify independent predictors of SSI. Model discrimination was assessed by the area under the receiver operating characteristic (ROC) curve (AUC), and calibration was evaluated using Hosmer–Lemeshow statistics and a decile-based calibration plot. Among the 204 patients (mean age 51.4 ± 11.2 years; 42.2% male), SSI occurred in 7 patients (3.4%). In multivariable analysis, LOS was independently associated with SSI (adjusted odds ratio (OR) 1.37;95% confidence interval (CI) 1.02–1.83; p=0.039), while age, sex, and operative time were not significant predictors. The model achieved an AUC of 0.65, with good calibration (Hosmer–Lemeshow p=0.84) and internal validity confirmed by bootstrap resampling. Postoperative length of hospital stay (LOS) was identified as an independent and significant risk factor for surgical site infection (SSI) following cervical spondylosis surgery. The developed nomogram demonstrated moderate discriminative ability (AUC=0.65) and, using the Youden index, an optimal probability threshold of 0.053 was determined, corresponding to a sensitivity of 0.43 and specificity of 0.90. This tool provides a simple, reliable, and clinically applicable means to identify high-risk patients and guide infection prevention strategies.

Keywords: Cervical spondylosis surgery, surgical site infection, nomograms, length of hospital stay

Introduction

Cervical spondylosis represents a progressive degenerative condition of the cervical spine characterized by intervertebral disc desiccation, osteophyte formation, and ligamentous hypertrophy, ultimately resulting in spinal canal narrowing and neural compression. It is one of the most common causes of cervical myelopathy and radiculopathy among adults over the age of 40. Epidemiological studies suggest that radiological evidence of cervical degeneration is present in up to 95% of individuals older than 60 years, though only a subset develop symptomatic disease requiring surgery [1,2]. Surgical intervention—most commonly anterior cervical discectomy and fusion (ACDF) or posterior decompression and stabilization—is often indicated in cases of intractable pain, neurological deficit, or myelopathy refractory to conservative therapy.

Although cervical spine surgery has become highly standardized and generally safe, postoperative complications remain a critical concern. Among these, surgical site infection (SSI) is one of the most feared events, associated with prolonged hospitalization, increased reoperation rates, chronic pain, and in severe cases, neurological deterioration or death [1,3,4]. Even superficial wound infections can compromise wound healing and lead to long-term morbidity, while deep infections threaten instrumentation stability and fusion success. Reported

CITATION
Bahadir B, Saylak FB. Nomogram-based prediction of surgical site ınfection after cervical spondylosis surgery: A retrospective cohort study. Med Science. 2026;15(2):587-92.

Corresponding Author: Burak Bahadir, Ankara Bilkent Training and Research Hospital, Department of Neurosurgery, Ankara, Türkiye
Email: md.burakbahadir@gmail.com

DOI: 10.5455/medscience.2025.10.300

SSI rates following spinal surgery vary widely—from 0.7% to 16%—depending on patient comorbidities, surgical approach, and instrumentation type [3,5-7]. Although the incidence after anterior cervical surgery is lower than that seen in posterior or lumbar procedures, its clinical impact is substantial because of the proximity to vital structures such as the trachea and esophagus and the potential for catastrophic complications like mediastinitis.

Risk factors for SSI in spine surgery are multifactorial. Host-related variables include diabetes mellitus, malnutrition, smoking, obesity, and immunosuppression [3-5]. Perioperative variables include extended operative time, significant blood loss, multiple-level fusion, prolonged drain use, and delayed wound healing. Hospital-related factors—such as surgical environment, infection control practices, and length of hospital stay (LOS)—further influence infection risk [1,3,7,8]. In particular, LOS has emerged as both a consequence and a predictor of SSI. Prolonged hospitalization increases exposure to hospital-acquired pathogens and may reflect underlying complications or frailty. Identifying patients at risk early in the perioperative course enables implementation of targeted prophylactic measures and optimization of resource utilization.

Despite the recognition of these risk factors, there is a notable lack of procedure-specific predictive models for SSI in cervical spine surgery. Most available risk scores and nomograms were developed for lumbar fusion or mixed spinal cohorts [6,9,10]. For example, Zhang et al. [10] developed a multicenter posterior cervical surgery nomogram integrating body mass index (BMI), operation time, and blood loss, achieving an AUC of 0.68. Similarly, Lian et al. [9] established a predictive tool for transforaminal lumbar interbody fusion, incorporating C-reactive protein (CRP), operative duration, and drain duration. These models, though informative, cannot be directly extrapolated to cervical spondylosis surgery due to differences in anatomical constraints, surgical approach, and postoperative wound dynamics. Nomograms, first introduced into oncological prognostics, have become an increasingly popular means of integrating multivariate risk factors into a single, intuitive clinical tool [11]. By graphically representing logistic regression coefficients as a series of scales, nomograms provide individualized risk probabilities at the bedside without requiring complex computation. They are particularly valuable in perioperative medicine, where a patient's overall risk profile—rather than any single factor—determines complication likelihood. In spinal surgery, nomograms have been used to predict outcomes such as fusion success, adjacent segment disease, and infection risk [6,9,10]. However, as emphasized by Kattan and Marasco [11], a true clinical nomogram must balance statistical robustness with practical interpretability.

In the context of cervical spine surgery, developing an accurate nomogram presents unique challenges. Compared with lumbar procedures, cervical operations are often shorter, involve smaller incisions, and have distinct anatomical risks, such as airway compromise or dysphagia. Furthermore, the risk factors for infection may differ due to tissue vascularity, surgical approach, and instrumentation density. Thus, direct extrapolation from lumbar models may not accurately capture cervical-specific infection dynamics. A dedicated nomogram for cervical spondylosis surgery is therefore needed to enhance personalized infection risk assessment.

The clinical and economic burden of SSI in spine surgery cannot be overstated. Each infection episode is estimated to increase hospital costs by more than 300%, primarily due to prolonged LOS, revision surgeries, and extended antibiotic use [3,8]. Beyond financial impact, SSI delays rehabilitation, worsens functional outcomes, and significantly diminishes quality of life. Lee et al. [4] validated a general spinal infection risk score and demonstrated that targeted preventive strategies based on early risk identification could reduce infection rates by up to 30%. This underscores the importance of predictive analytics in surgical planning and postoperative care pathways.

Against this background, our study aimed to fill an existing gap in the literature by developing and internally validating a cervical-specific SSI nomogram based on routinely available perioperative data. Using a single-center retrospective cohort of 204 patients who underwent cervical stabilization between April 2019 and April 2025, we analyzed demographic, laboratory, and surgical variables to identify independent predictors of SSI. Particular attention was given to the role of hospital length of stay (LOS) as a modifiable perioperative parameter. By translating these findings into a visual nomogram, we sought to create a pragmatic tool that could assist neurosurgeons in stratifying postoperative infection risk, optimizing discharge planning, and improving patient outcomes.

In summary, the present study addresses the unmet need for a simple, evidence-based, and easily interpretable prediction model specifically tailored to cervical spondylosis surgery. This work builds upon previous efforts in lumbar and thoracolumbar surgery [6,9,10] while introducing a refined cervical focus relevant to clinical practice. By combining statistical rigor with bedside applicability, the proposed nomogram represents a step toward personalized, risk-adjusted perioperative management in modern spine surgery.

Material and Methods

This retrospective cohort study was conducted at the Department of Neurosurgery, Ankara Bilkent City Hospital, and included adult patients (≥18 years) who underwent cervical stabilization for degenerative spondylosis between April 2019 and April

 DOI: 10.5455/medscience.2025.10.300

2025. Patients with trauma, tumor, or congenital pathology were excluded. Demographic characteristics (age, sex), smoking status, laboratory values (CRP, albumin, hemoglobin, platelets), radiological parameters (Torg–Pavlov ratio, paraspinal muscle–fat ratio), operative details (approach, operative time, number of levels, instrumentation), and postoperative variables such as length of hospital stay (LOS) were recorded. The primary outcome was defined as surgical site infection (SSI), characterized by clinically documented wound discharge, purulent exudate, erythema, or abscess formation during the postoperative period. "All data were retrieved from electronic medical records, and the study was approved by the Scientific and Ethical Committee for Medical Research of Ankara Bilkent City Hospital, affiliated with the University of Health Sciences." (Protocol No: TABED-1-25-1263,07.05.2025).

Continuous variables were summarized as mean ± standard deviation or median (IQR), and categorical data as frequencies and percentages. Univariable logistic regression was used to screen potential predictors of SSI, and variables with p<0.20 were included in a multivariable logistic regression model. Results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). The model's performance was assessed by the area under the ROCcurve (AUC) for discrimination and by Hosmer–Lemeshow testing and a calibration plot for goodness of fit. Internal validation was performed with bootstrap resampling (1.000 iterations). A p<0.05 was considered statistically significant.

Result

A total of 204 patients met the inclusion criteria. The mean age was 51.4 ± 11.2 years, and 85 patients (42.2%) were male. The median length of stay (LOS) was 2 (2–3) days, and the median operative time was 2 (2–3) hours. Surgical site infection (SSI) occurred in 7 patients (3.4%). Given the limited number of events in our cohort, the statistical power of the nomogram analyses is reduced, confidence intervals for the odds ratios are widened, and the generalizability of the model is constrained. Consequently, external validation using larger, multicenter cohorts is necessary to improve the robustness and reliability of the predictive model. The demographic and perioperative characteristics of the cohort are summarized in Table 1.

Table 1. Descriptive statistics of the study population (n = 204)

Variable	Mean ± SD or n (%)	Minimum	Maximum
Age (years)	51.4 ± 11.2	28	83
Male sex (%)	85 (42.2)	-	-
Length of stay (days)	2.9 ± 1.7	1	12
Operative time (hours)	2.3 ± 0.5	1	4
Surgical site infection (%)	7 (3.4)	-	-

Values are presented as mean ± standard deviation (SD) for continuous variables and as numbers (percentages) for categorical variables

On univariable logistic regression analysis, LOS showed a significant association with SSI (OR=1.36, 95% CI 1.03–1.79, p=0.03), indicating that each additional hospital day increased infection risk by approximately 36%. Age (OR=1.00, p=0.92), sex (male vs female, OR=1.03, p=0.97), and operative time (OR=1.44, p=0.59) were not significant predictors. Details of the univariable analysis are presented in Table 2.

Table 2. Univariable logistic regression for surgical site infection

Variable	Odds Ratio (OR)	95% CI (Lower–Upper)	p-value
Age (years)	1.00	0.93–1.07	0.92
Male sex	1.03	0.22–4.73	0.97
Length of stay (days)	1.36	1.03–1.79	0.03
Operative time (hours)	1.44	0.38–5.39	0.59

Significant results are shown in bold

A multivariate logistic regression model including age, sex, LOS, and operative time identified LOS as the only independent predictor of SSI (adjusted OR=1.37, 95% CI 1.02–1.83, p=0.039), while the other covariates were non-significant (all p>0.80). The results of the multivariable analysis are shown in Table 3.

DOI: 10.5455/medscience.2025.10.300

Table 3. Multivariable logistic regression for surgical site infection

Variable	Adjusted OR	95% CI (Lower–Upper)	p-value
Age (years)	0.99	0.92–1.07	0.84
Male sex	0.95	0.20–4.57	0.95
Length of stay (days)	1.37	1.02–1.83	0.04
Operative time (hours)	0.95	0.23–4.01	0.95
Model performance: AUC=0.65, Hosmer–Lemeshow p=0.84			

The final model achieved an area under the ROC curve (AUC) of 0.65, reflecting moderate discriminatory power. The optimal probability threshold determined by the Youden index was 0.053, corresponding to a sensitivity of 0.43 and specificity of 0.90. The ROC curve is depicted in Figure 1. Model calibration demonstrated good agreement between predicted and observed probabilities. The Hosmer–Lemeshow goodness-of-fit test was non-significant (*χ^2=4.20, df=8, p=0.84*), and the decile-based calibration plot showed alignment along the 45° reference line (Figure 1), indicating excellent internal calibration.

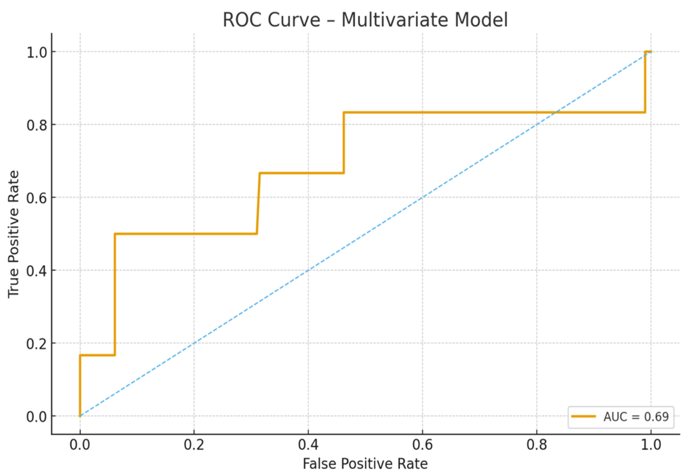

Figure 1. Receiver operating characteristic (ROC) curve of the final predictive model

Overall, the results suggest that postoperative length of hospital stay remains the strongest indicator of infection risk following cervical spondylosis surgery, while demographic factors and operative duration had limited predictive value in this cohort.

Discussion

LOS independently predicted SSI, consistent with prior studies highlighting hospitalization duration as a surrogate for perioperative complexity [3,4,7]. The discriminatory performance of the model was evaluated using ROC analysis. The optimal probability threshold, determined according to the Youden index, was 0.053, which provided the highest combined accuracy between sensitivity and specificity (sensitivity=0.43; specificity=0.90). The area under the ROC curve (AUC=0.65) indicated a moderate discriminative capacity, demonstrating that the model distinguished patients with and without SSI better than chance alone. These findings suggest that although the model's predictive performance is limited, it nonetheless offers clinically meaningful discriminatory ability.

Model discrimination (AUC=0.65) was comparable to lumbar fusion nomograms [9,10]. Calibration (HL p=0.84) supports reliability. The nomogram may guide risk stratification and perioperative infection prevention [7,8]. Strengths: practical variables, internal validation. Limitations: retrospective design, single-center data, low event count [12]. Future multicenter validation is warranted.

The present study identified postoperative length of hospital stay (LOS) as the most significant and independent predictor of surgical site infection (SSI) after cervical spondylosis surgery. Although our model demonstrated only moderate discrimination (AUC=0.65), its calibration was excellent (Hosmer–Lemeshow p=0.84), suggesting that it provides reliable and interpretable probability estimates within the observed data range. Importantly, this is among the first cervical spine–specific nomograms developed using a Turkish population and one of the few globally that focus exclusively on degenerative cervical procedures rather than heterogeneous spinal cohorts [6,9,10].

Our findings are consistent with the existing body of literature emphasizing the relationship between prolonged hospitalization and postoperative infection risk. LOS is a complex variable that integrates patient frailty, intraoperative complexity, and postoperative course. It may reflect underlying complications, wound drainage duration, unrecognized microleaks, or comorbid conditions delaying discharge. Numerous studies in spine and orthopedic surgery have demonstrated that longer hospitalization correlates with increased infection rates [3,4,7]. This is likely due to greater exposure to nosocomial flora, immune suppression from prolonged stress, and more frequent invasive interventions such as indwelling catheters, suction drains, and repeated dressing changes [1,8]. Therefore, LOS functions not only as a temporal measure but also as a surrogate marker for systemic vulnerability and procedural burden.

Interestingly, neither operative time nor patient demographics such as age and sex were significant in our cohort. This diverges slightly from prior large-scale analyses where extended operative duration—typically exceeding 4 hours—was a major determinant of SSI, particularly in multi-level posterior fusions [3,6,7,10].

In our population, the operative time distribution was narrow (median 2 hours, IQR 2–3 hours), likely limiting its discriminative power. Moreover, the predominance of anterior approaches, which generally involve shorter exposure and reduced dead space compared to posterior cervical operations, may explain the minimal effect of surgical duration on infection development [2,6]. The uniformity of technique and instrumentation—most surgeries being single- or two-level anterior cervical discectomy and fusion (ACDF)—further reduced heterogeneity, focusing the model's predictive capacity primarily on perioperative rather than technical variables.

The observed SSI rate of 3.4% aligns with prior cervical series reporting rates between 0.2% and 4.3% depending on approach and patient mix [3,6,7]. Oprea et al. [3] in their systematic review underscored that anterior procedures exhibit the lowest SSI rates, whereas posterior cervical decompression and fusion carry a markedly higher risk due to extensive muscle dissection, hardware bulk, and prolonged exposure. Our relatively low infection incidence likely reflects standardized anterior protocols, prophylactic antibiotic adherence, and stringent intraoperative sterility practices. Nonetheless, even a 3% SSI rate in cervical surgery can have significant clinical and financial implications given the potential for reoperation, neurological deterioration, and implant loss.

Our nomogram translates these statistical findings into a pragmatic bedside tool. By assigning proportional risk points to each variable, clinicians can quickly estimate individualized infection probabilities. For example, a 60-year-old male patient with a LOS>3 days following ACDF would cross the 5% predicted risk threshold—our model's optimal cutoff—indicating the need for intensified postoperative surveillance and possibly extended antibiotic prophylaxis. Such simple visual tools can promote risk communication, facilitate shared decision-making, and help stratify patients for resource allocation in busy surgical units [9-11].

The implications of LOS as a modifiable factor are particularly relevant in the context of Enhanced Recovery After Surgery (ERAS) pathways. ERAS principles—early mobilization, optimized pain control, early drain removal, and standardized discharge criteria—have proven effective in shortening LOS without increasing readmission or complication rates. Applying ERAS-like protocols in cervical spine surgery could thus serve a dual purpose: improving recovery metrics while indirectly mitigating infection risk. Furthermore, our results highlight the need for post-discharge wound monitoring, as some infections manifest after hospital release; telemedicine-based wound checks or scheduled early outpatient visits may be valuable adjuncts.

From a pathophysiological perspective, several mechanisms may link prolonged hospitalization with infection susceptibility. Prolonged immobilization impairs tissue oxygenation and local perfusion, reducing immune cell recruitment at the wound site. Delays in ambulation or inadequate nutritional intake during extended stays may also compromise host defense. Additionally, exposure to multidrug-resistant hospital flora increases with each inpatient day, particularly in large tertiary centers where spine wards coexist with other high-dependency units. Collectively, these factors position LOS as both a marker and a mediator of infection risk. Considering the possibility of reverse causation, it should not be overlooked that, in our study, prolonged length of stay (LOS) may sometimes be not only a cause but also a consequence of early postoperative complications.

Our moderate AUC (0.65) mirrors other pragmatic clinical prediction models that prioritize simplicity and generalizability over maximal statistical discrimination. Zhang et al. [6] reported an AUC of 0.68 for their multicenter posterior cervical nomogram using variables such as BMI, operation duration, and blood loss. Similarly, Wang et al. [6] achieved an AUC of 0.70 in a 10-year Chinese cohort incorporating serum albumin and CRP levels. The modest performance of such models reflects the multifactorial nature of SSI and the difficulty of capturing unmeasured perioperative nuances. Nevertheless, good calibration, as seen here, remains crucial for clinical utility; an interpretable, well-calibrated model often outperforms a highly discriminative but poorly calibrated one in real-world decision-making [11].

Our study reinforces the necessity of incorporating biochemical markers into future predictive models. Previous research has shown that hypoalbuminemia and elevated CRP are associated with poor wound healing and increased infection rates [5,12]. The limited availability of these laboratory parameters in our dataset, due to retrospective data recording, precluded their inclusion in the final model. Prospective data collection including nutritional indices, inflammatory markers, and microbiological surveillance could enhance predictive accuracy. Integration with machine-learning algorithms—gradient boosting or random forests—may further improve discrimination while maintaining interpretability through feature importance and SHapley Additive exPlanations (SHAP) analysis.

The clinical utility of the present nomogram lies in its simplicity. It can be applied during postoperative ward rounds using readily available information (age, sex, operative time, LOS). For institutions without sophisticated electronic risk calculators, a printed nomogram or scoring chart offers a practical alternative. High-risk patients identified by this tool can benefit from reinforced wound protocols: double-layer dressing, frequent inspection, extended prophylactic antibiotics, and nutritional optimization. In resource-limited settings, where routine microbiological screening is costly, such targeted approaches can meaningfully reduce SSI incidence.

Strengths of this study include the well-defined cervical degenerative cohort, standardized surgical techniques, and rigorous validation metrics (AUC, calibration, HL test). Using LOS as a core predictor aligns with pragmatic hospital-based risk assessment. Moreover, the use of open-source statistical tools (SPSS and Python) ensures reproducibility. Importantly, this model may serve as a foundation for a national registry-based risk calculator, integrating multicenter data to refine weightings and generate externally validated predictions.

However, several limitations must be acknowledged. First, the retrospective design inherently introduces potential bias and limits causal inference. Second, the event rate was low (7 infections), restricting model complexity and potentially underpowering detection of smaller effects. Third, certain known risk factors—body mass index, diabetes, nutritional status—were incompletely recorded in the retrospective database. Fourth, SSI ascertainment relied on clinical documentation rather than systematic culture-based confirmation, which might underestimate superficial infections. Finally, external validation in independent cohorts is essential before routine clinical implementation.

Despite these limitations, the present work contributes valuable insight into postoperative infection risk in cervical spine surgery. By highlighting the dominant influence of LOS and validating a user-friendly nomogram, we provide a foundation for personalized perioperative infection prevention. The model underscores the importance of minimizing unnecessary hospitalization days and implementing structured ERAS protocols—an intervention that not only optimizes recovery but may also reduce hospital-acquired infection risk.

Future research should focus on prospective multicenter validation, incorporation of biochemical and microbiological markers, and assessment of the model's clinical impact through implementation trials. Integration with hospital electronic medical record systems could allow real-time automated risk computation, prompting alerts for patients exceeding predefined thresholds. Such tools could transform infection control from reactive to proactive, ultimately improving outcomes and reducing costs in spinal surgery.

In summary, our study demonstrates that even a simple model incorporating routine clinical parameters can yield actionable insights. Postoperative LOS emerges as a powerful predictor of SSI after cervical spondylosis surgery. By translating this association into a calibrated nomogram, we move closer to achieving the goals of precision medicine in spine surgery—individualized risk estimation, targeted intervention, and enhanced patient safety [1-12].

Conclusion

An internally validated nomogram for SSI prediction after cervical spondylosis surgery identified LOS as an independent predictor. The model demonstrated moderate discrimination and strong calibration, supporting its role in personalized infection prevention.

Ethical Approval

The study was approved by the Scientific and Ethical Committee for Medical Research of Ankara Bilkent City Hospital (No: TABED-1-25-1263; Date: 07 May 2025).

Patient Consent

Informed consent was waived by the ethics committee due to the retrospective design.

Conflict of Interests

The authors declare no conflict of interest.

Funding

No financial support was received.

References

1. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg. 2017;152:784-91.
2. Aleem IS, Tan LA, Nassr A, Riew KD. Surgical Site Infection Prevention Following Spine Surgery. Global Spine J. 2020;10:92S-8S.
3. Lu K, Tu Y, Su S, et al. Machine learning application for prediction of surgical site infection after posterior cervical surgery. Int Wound J. 2024;21:e14607.
4. Yuan K, Chen HL. Obesity and surgical site infections risk in orthopedics: a meta-analysis. Int J Surg. 2013;11:383-8.
5. Lian J, Wang Y, Yan X, et al. Development and validation of a nomogram to predict the risk of surgical site infection within 1 month after transforaminal lumbar interbody fusion. J Orthop Surg Res. 2023;18:105.
6. Sebastian A, Huddleston P 3rd, Kakar S, et al. Risk factors for surgical site infection after posterior cervical spine surgery: an analysis of 5,441 patients from the ACS NSQIP 2005-2012. Spine J. 2016;16:504-9.
7. Saifi C, Fein AW, Cazzulino A, et al. Trends in resource utilization and rate of cervical disc arthroplasty and anterior cervical discectomy and fusion throughout the United States from 2006 to 2013. Spine J. 2018;18:1022-9.
8. Wang J, Chang Y, Suo M, et al. Incidence and risk factors of surgical site infection following cervical laminoplasty: A retrospective clinical study. Int Wound J. 2023;21:e14450.
9. An Y, Cui X, Wang H, et al. Nomogram for predicting surgical site infections in elderly patients after open lumbar spine surgery: A retrospective study. Int Wound J. 2024;21:e14734.
10. Lee MJ, Cizik AM, Hamilton D, Chapman JR. Predicting surgical site infection after spine surgery: a validated model using a prospective surgical registry. Spine J. 2014;14:2112-7.
11. Kattan MW, Marasco J. What is a real nomogram?. Semin Oncol. 2010;37:23-6.
12. Dowdell J, Brochin R, Kim J, et al. Postoperative Spine Infection: Diagnosis and Management. Global Spine J. 2018;8:37S-43S.