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Pathogenetic characteristics and related risk factors of incisional infection after surgery for acute intestinal obstruction and construction of prediction model

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Abstract

Objective To investigate the causative factors, antimicrobial resistance patterns, and associated risk factors of postoperative incisional infections in patients with acute intestinal obstruction and to develop a predictive model.

Methods A retrospective study was conducted on patients with acute intestinal obstruction (n = 329) admitted to the Emergency Surgery Department of the First Affiliated Hospital of Anhui Medical University between January 1, 2020, and December 31, 2022. Patients were included based on specific criteria. Wound drainage samples from patients with postoperative incisional infections were collected for bacterial culture and drug susceptibility testing. Patients were randomly divided into a training set (n = 231) and a validation set (n = 98) at a 7:3 ratio. Least Absolute Shrinkage and Selection Operator (LASSO) regression was employed to screen variables and select predictors. Multivariate logistic regression was utilized to analyze risk factors and develop a predictive model. The area under the curve (AUC) was calculated to assess the model's discriminatory ability, and calibration and decision curve analyses were performed.

Results Among the 329 patients, 37 (11.25%) developed postoperative incisional infections. Bacterial cultures were positive in 32 of 37 infected patients (86.48%). Gram-negative bacteria, primarily *Escherichia coli*, accounted for 65.63% of isolates, while gram-positive bacteria, predominantly *Enterococcus faecium*, comprised 28.12%. Fungi, mainly *Candida albicans*, constituted 6.25%. Gram-negative bacteria exhibited high resistance to ceftriaxone but low resistance to imipenem. Gram-positive bacteria demonstrated higher resistance to erythromycin than ciprofloxacin, with no vancomycin-resistant strains identified. LASSO regression identified seven variables, which were further analyzed using multivariate logistic regression to identify six independent risk factors for incisional infection. A predictive model was developed based on these six factors: age ≥ 60 years, diabetes history, operative time ≥ 3 h, colorectal obstruction, enterostomy, and hemoglobin (HGB). The AUCs for the training and validation sets were 0.952 (95% CI 0.914–0.990) and 0.982 (95% CI 0.959–1.000), respectively. Hosmer–Lemeshow goodness-of-fit tests and calibration curves demonstrated good model fit. Decision curve analysis indicated a significant clinical net benefit of the predictive model.

Conclusion Gram-negative bacteria constitute the primary causative agents of postoperative incisional infections in patients with acute intestinal obstruction. Moreover, these bacteria exhibit significant resistance to commonly used antibiotics. To mitigate the risk of such infections, clinicians should prioritize the monitoring of gram-negative bacterial growth. Prophylactic antibiotic administration can further reduce the incidence of these infections. Additionally,

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a predictive model incorporating six key variables—age ≥ 60 years, diabetes mellitus, operative time ≥ 3 h, colorectal obstruction, enterostomy, and HGB—can aid in identifying high-risk patients. This model enables clinicians to implement targeted early monitoring and preventive strategies, ultimately improving patient outcomes.

Keywords Acute intestinal obstruction, Incision infection, Etiological characteristics, Risk factors, Prediction model

Introduction

Acute intestinal obstruction is a clinical syndrome characterized by acute abdominal pain, distention, vomiting, and cessation of bowel movements, resulting from luminal obstruction by intestinal contents [1]. It is a common cause of acute abdomen with rapid onset, progression, and significant morbidity and mortality [2]. Surgical intervention is often necessary when conservative treatment fails or strangulating obstruction occurs. One of the most common postoperative complications is surgical site infection (SSI) [3, 4]. SSI can prolong hospital stays, increase healthcare costs, and elevate mortality risk [5, 6]. Therefore, identifying risk factors for SSI in patients with acute intestinal obstruction is crucial for targeted preoperative and postoperative management, especially the judicious use of prophylactic antibiotics based on the causative pathogens. However, the specific etiological factors and risk profiles for SSI can vary across different regions and patient populations [7, 8]. While traditional risk factor analyses provide qualitative insights, predictive modeling offers a quantitative approach to identify high-risk patients for targeted prevention and treatment [9]. This study aimed to investigate the etiological characteristics of SSI in patients undergoing surgery for acute intestinal obstruction at the Emergency Department of the First Affiliated Hospital of Anhui Medical University. Additionally, the study developed a clinical prediction model to identify high-risk patients for SSI.

Material and methods

Patient selection

Patients with acute intestinal obstruction who met specific inclusion and exclusion criteria were selected from those admitted to the Department of Emergency Surgery of the First Affiliated Hospital of Anhui Medical University between January 1, 2020, and December 31, 2022. Inclusion criteria included acute abdominal pain, distention, vomiting, and cessation of bowel movements, as well as imaging evidence of intestinal obstruction. Additionally, patients must have undergone surgical treatment and have complete clinical data. Exclusion criteria encompassed preoperative infection, abnormal immune function, incomplete clinical data, and patients who refused treatment or were discharged or transferred. This study was approved by the Ethics Committee of the First Affiliated Hospital of Anhui Medical University.

This study included 369 patients who met the inclusion criteria, and 40 patients were excluded, resulting in a final study population of 329 patients. To ensure a balanced distribution of outcomes, patients were randomly divided into a training set (n = 231) and a validation set (n = 98) in a 7:3 ratio. The training set was used for variable selection and model development, while the validation set was employed to assess the performance of the developed models. The data selection and modeling process are illustrated in Fig. 1.

Data collection

Patient demographics, including hospitalization number, gender, age, diabetes mellitus history, peritoneal irritation signs, time of surgery, blood transfusion status, obstruction site, enterostomy and enterotomy/decompression procedures, body mass index (BMI), and hematological parameters (complete blood count, biochemistry, and coagulation indices) were retrospectively collected.

Pathogenetic testing and drug sensitivity testing

Postoperatively, patients were monitored for incisional infections using the Diagnostic Criteria for Hospital Infections [10]. Superficial infections were defined by the presence of purulent exudate on the incision surface, positive bacterial culture of the exudate, and local signs of inflammation such as redness, warmth, swelling, or pain. Deep infections were characterized by purulent drainage from the deep incisional tissues, spontaneous wound dehiscence, local tenderness, involvement of the muscular fascia, or deep incisional abscess formation. Wound drainage samples were collected from infected patients and subjected to bacterial identification using the VITEK system (bioMérieux, France) and antimicrobial susceptibility testing using the Kirby-Bauer disk diffusion method.

Statistical analysis

Statistical analyses were performed using SPSS 25.0 and R 4.4.1. The dataset was randomly divided into training and validation cohorts at a 7:3 ratio. The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed variables were compared

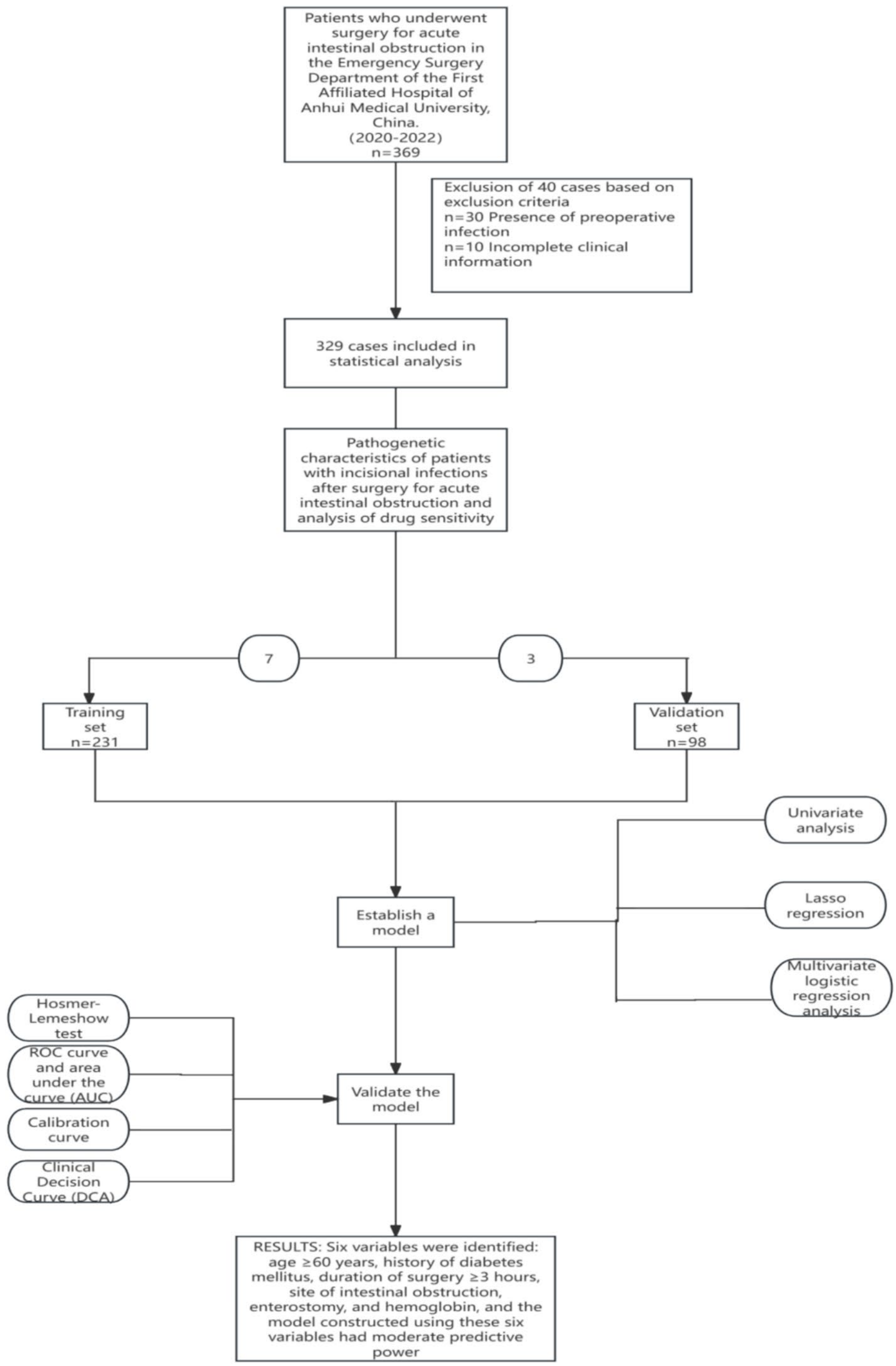

Fig. 1 Workflow of this study

using t-tests, while non-normally distributed variables were compared using Mann–Whitney U tests. Categorical variables were summarized as frequencies and percentages, and compared using chi-square or Fisher's exact tests. Least Absolute Shrinkage and Selection Operator (LASSO) regression was employed for variable selection, and statistically significant variables were included in a multivariate logistic regression model. Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test. The receiver operating characteristic (ROC) curve was plotted, and the area under the curve (AUC) was calculated to assess the model's discriminatory ability. The calibration curve and Consistency index (C-index) were used to evaluate the model's calibration. Decision curve analysis (DCA) was performed to assess the clinical utility of the predictive model.

Results

Incidence of incisional infections, pathogenicity testing, and results of drug sensitivity analysis

Prevalence and microbial etiology of postoperative incisional infections

Of the 329 patients with acute ileus, 37 (11.25%) developed postoperative incisional infections. Bacterial cultures were positive in 32 of 37 infected patients (86.48%). Gram-negative bacteria constituted 65.63% of isolates, with *Escherichia coli* being the predominant species (43.75%). Gram-positive bacteria accounted for 28.12%, primarily *Enterococcus faecium* (21.88%). Fungi comprised 6.25% of isolates, predominantly *Candida albicans* (6.25%), as detailed in Table 1.

Resistance of gram-negative bacteria

Gram-negative bacteria isolated from incisional secretions exhibited high resistance to a range of antibiotics, including ceftriaxone, ceftazidime, ciprofloxacin, levofloxacin, and piperacillin. In contrast, lower resistance rates were observed for cefepime, gentamicin, imipenem, and amikacin, as indicated by drug susceptibility testing (Table 2).

Analysis of drug resistance in gram-positive bacteria

Gram-positive bacteria isolated from incisional secretions were subjected to drug susceptibility testing. Results indicated a high rate of resistance to penicillin, erythromycin, and tetracycline. In contrast, lower resistance rates were observed for ciprofloxacin, levofloxacin, and gentamicin. Notably, no vancomycin-resistant strains were identified (Table 3).

Table 1 Results of pathogenetic testing of infections

Pathogenic bacteria	Number of plants(n = 32)	Composition ratio (%)
Gram-negative bacteria	21	65.63
Escherichia coli (*E. coli*)	14	43.75
Pseudomonas aeruginosa	3	9.38
Acinetobacter baumannii	2	6.25
Enterobacter cloacae	2	6.25
Gram-positive bacteria	9	28.12
Enterococcus faecium	7	21.88
Corynebacterium striatum	2	6.25
Fungus	2	6.25
Candida alba	2	6.25

Table 2 Analysis of drug resistance in Gram-negative bacteria

Antimicrobial Drug	Incisional infections (n = 21)	
	Number of resistant strains	Drug resistance rate
Ceftriaxone	18	85.71
Ceftazidime	13	61.90
Cefepime	12	57.14
Imipenem	5	23.81
Ciprofloxacin	19	90.48
Levofloxacin	19	90.48
Amikacin	5	23.81
Gentamicin	11	52.38
Piperacillin	18	85.71

Univariate analysis of postoperative incision infection in patients with acute intestinal obstruction

Patients in the training set (n = 231) were categorized into infected and uninfected groups based on the occurrence of incisional infection. Univariate analysis revealed statistically significant differences between the two groups in terms of age, diabetes history, operative time, site of intestinal obstruction, enterostomy, enterotomy decompression, and hemoglobin (HGB) levels ($p < 0.05$, Table 4).

LASSO regression screening model factors

LASSO regression analysis was employed to screen relevant variables, and the variation in coefficient values is depicted in Fig. 2A. Variables that exhibited statistical significance in univariate analysis were included in the LASSO regression model. Ten-fold cross-validation was utilized to determine the optimal lambda value, and the model with the optimal penalty coefficient (lambda.1 se, $\lambda = 0.04123523$) was selected. The final model included seven variables with non-zero regression coefficients: age, diabetes history, operative time, site of intestinal

Table 3 Analysis of drug resistance in Gram-positive bacteria

Antimicrobial Drug	Incisional infections (n = 9)	
	Number of resistant strains	Drug resistance rate
Penicillin	4	44.44
Erythromycin	5	55.56
Ciprofloxacin	3	33.33
Levofloxacin	3	33.33
Vancomycin	0	0.00
Gentamicin	3	33.33
Tetracycline	4	44.44

Table 4 Univariate analysis of postoperative incision infection in patients with acute intestinal obstruction

Relevant factors	Infection group	Uninfected group	*p*
Age			0.013
< 60 years	120 (59.0%)	8 (31.0%)	
≥ 60 years	85 (41.0%)	18 (69.0%)	
Gender			1.000
Male	122 (60.0%)	15 (58.0%)	
Female	83 (40.0%)	11 (42.0%)	
History of diabetes			**< 0.001**
No	193 (94.1%)	12(46.0%)	
Yes	12 (5.9%)	14(54.0%)	
Signs of peritoneal irritation			0.605
No	160 (78.0%)	22 (85.0%)	
Yes	45 (22.0%)	4 (15.0%)	
Surgical time			0.002
< 3 h	146 (71.0%)	10 (38.0%)	
≥ 3 h	59 (29.0%)	16 (62.0%)	
Transfusion			0.097
No	172 (84.0%)	18 (69.0%)	
Yes	33 (16.0%)	8 (31.0%)	
Site of intestinal obstruction			**< 0.001**
Small bowel obstruction	145 (71.0%)	6 (23.0%)	
Colorectal obstruction	60 (29.0%)	20 (77.0%)	
Enterostomy			**< 0.001**
No	153 (75.0&)	9 (35.0%)	
Yes	52 (25.0%)	17 (65.0%)	
Enterotomy and decompression			**< 0.001**
No	152 (74.0%)	7 (27.0%)	
Yes	53 (26.0%)	19 (73.0%)	
BMI	20.8(18.7 ~ 23.0)	21.0(18.5 ~ 24.1)	0.898
HGB (g/L)	126.04 ± 23.34	108.54 ± 23.68	0.001
PLT(× 10^9/L)	216(164 ~ 269)	232(176 ~ 273)	0.606
WBC(× 10^9/L)	8.31(5.93 ~ 12.74)	7.56(4.86 ~ 9.93)	0.274
NEUT%	80.9(71.2 ~ 88.0)	77.6(68.1 ~ 84.3)	0.193
APTT(g/L)	34.9(32.1 ~ 39.4)	36.7(33.6 ~ 40.9)	0.182
PT(g/L)	13.8(13.2 ~ 14.6)	14.4(13.2 ~ 15.1)	0.226
D-D(μg/ml)	2.3(1.1 ~ 3.2)	2.6(1.6 ~ 3.4)	0.352
FIB(g/L)	4.00(3.11 ~ 5.11)	4.06(3.47 ~ 6.15)	0.223
K(mmol/L)	4.12 ± 0.66	4.03 ± 0.63	0.469
ALB(mmol/L)	39.56 ± 6.48	36.95 ± 6.8	0.074

obstruction, enterostomy, enterotomy decompression, and hemoglobin. These variables aligned with the findings from the univariate analysis (Fig. 2B).

Multivariate analysis of postoperative incision infection in patients with acute intestinal obstruction

LASSO regression identified seven potential risk factors, further analyzed using multivariate logistic regression. This analysis revealed that age ≥ 60 years, diabetes mellitus history, operative time ≥ 3 h, site of intestinal obstruction, and enterostomy were independent risk factors for postoperative incisional infection following acute intestinal obstruction. In contrast, hemoglobin was identified as a protective factor against postoperative incisional infection. Enterostomy decompression was neither a risk nor a protective factor (Table 5)

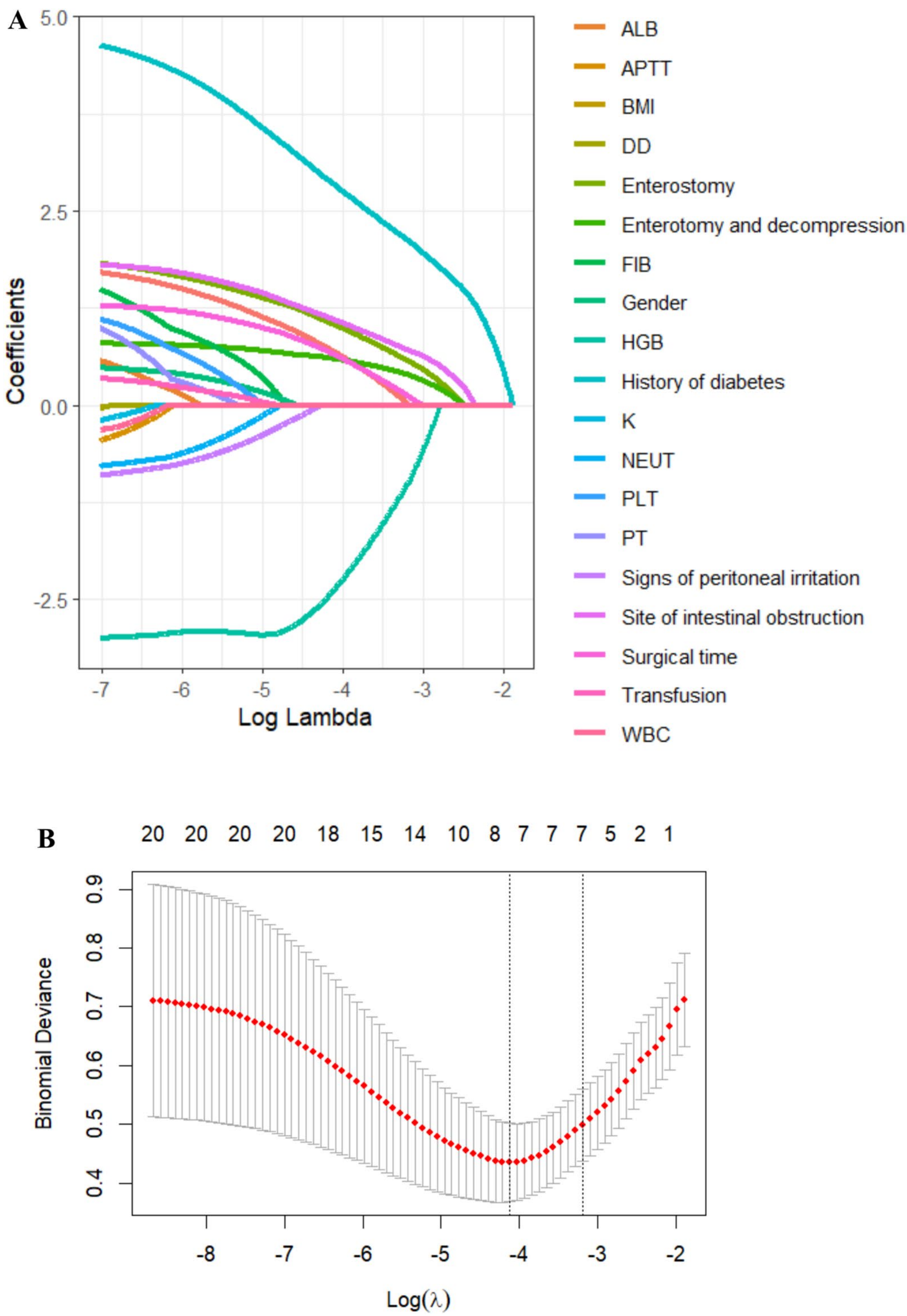

Fig. 2 **A** LASSO regression analysis of screened variables. **B** LASSO regression model cross-validation diagram

Predictive modeling

To construct predictive models, regression equations were established using the following variables: age ≥ 60 years, history of diabetes mellitus, operative duration ≥ 3 h, site of intestinal obstruction, enterostomy status, and hemoglobin level.

Table 5 Multifactorial analysis of postoperative incision infection in patients with acute intestinal obstruction

Variables	B	SE	Wald x^2	p	OR	95%CI
Age ≥ 60 years	1.438	0.559	6.621	0.010	4.219	1.409–12.628
History of diabetes	4.571	0.745	37.619	< 0.001	96.681	22.435–416.644
Surgical time ≥ 3 h	1.586	0.630	6.335	0.012	4.883	1.420–16.784
Site of intestinal obstruction	1.566	0.616	6.450	0.011	4.786	1.430–16.020
Enterostomy	1.913	0.613	9.729	0.002	6.771	2.036–22.524
Hemoglobin	−0.023	0.010	5.054	0.025	0.978	0.959–0.997

Prediction model validation

Hosmer–Lemeshow goodness of fit test

The Hosmer–Lemeshow goodness-of-fit tests for both the training and validation sets indicated adequate model fit. For the training set, the test statistic was $\chi^2 = 7.310$ with 8 degrees of freedom ($p = 0.504$), and for the validation set, the test statistic was $\chi^2 = 3.027$ with 8 degrees of freedom ($p = 0.933$), both exceeding the significance level of 0.05.

Differentiation test

The model demonstrated robust predictive performance, as evidenced by the receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) was 0.952 for the training cohort and 0.982 for the validation cohort, indicating excellent discrimination. The sensitivity was 88.50% and 100%, respectively, while the specificity was 93.20% and 95.40%, respectively. These consistent results across both cohorts highlight the model's ability to accurately identify patients at risk of postoperative incisional infection, as depicted in Figs. 3A and 3B.

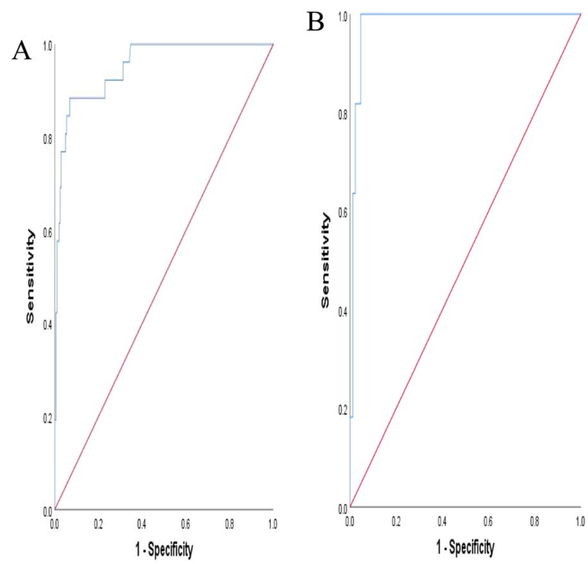

Fig. 3 ROC curves of the nomogram prediction model in the training

Calibration

The initial concordance index (C-index) of the training set was 0.952, which decreased to 0.904 after calibration, as depicted in Fig. 4A. Similarly, the initial C-index of the validation set was 0.982, declining to 0.964 post-calibration (Fig. 4B). These findings suggest that the model exhibits robust discriminatory ability.

Clinical effectiveness test

The DCA curve showed a good net clinical benefit for the predictive model, as seen in Fig. 5.

Discussion

Acute intestinal obstruction, a serious surgical condition characterized by the blockage of intestinal contents, accounts for approximately 20% of emergency surgical admissions [3]. While conservative treatment is often attempted, surgical intervention is typically indicated for failed conservative treatment or strangulated obstruction. Acute intestinal obstruction triggers an inflammatory response and immune imbalance, alongside shifts in intestinal flora. These factors contribute to the increased risk of postoperative incisional infections, a common complication [3, 4, 11]. Such infections prolong hospital stays [12] and elevate healthcare costs [13]. Consequently, understanding the pathogenesis of postoperative incisional infections in patients with acute intestinal obstruction and developing predictive models is crucial.

The outcomes of this investigation revealed that 37 out of 329 patients undergoing surgery for acute intestinal obstruction developed postoperative incisional infections, yielding an infection rate of 11.25%. This figure aligned closely with the findings reported in previous studies [14, 15]. Furthermore, the analysis indicated a predominance of Gram-negative bacterial strains (65.63%) among the isolated pathogens, surpassing the prevalence of Gram-positive bacteria (28.12%) and fungi (6.25%). Notably, *Escherichia coli* emerged as the most prevalent Gram-negative bacterium (43.75%), while *Enterococcus faecalis* constituted the majority

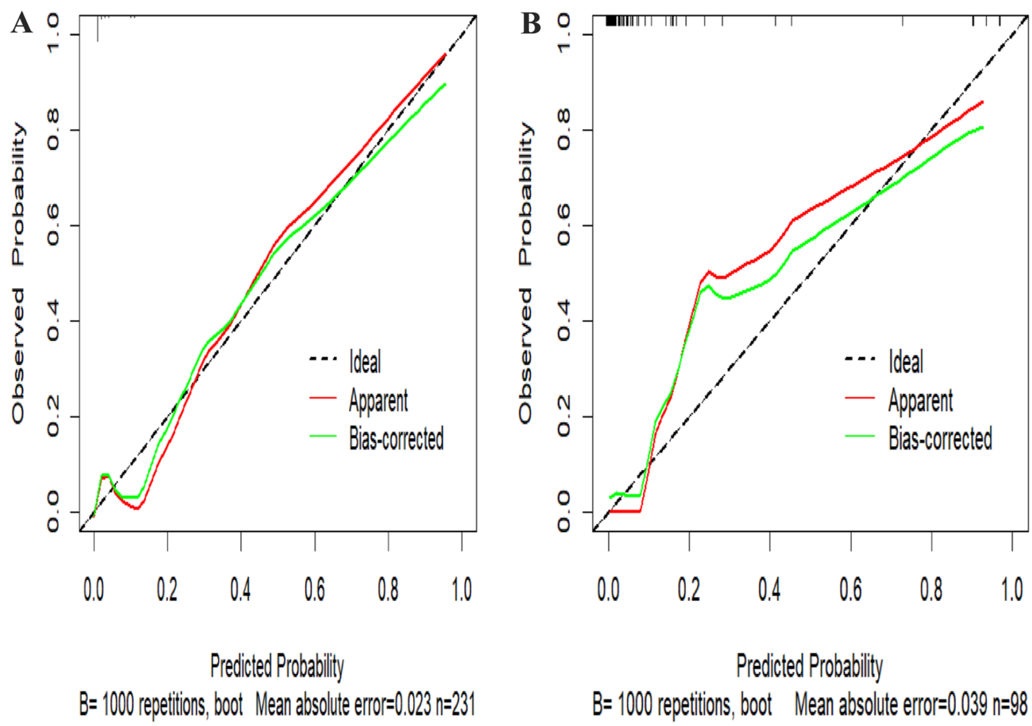

Fig. 4 Calibration curves of the nomogram prediction model in the training cohort (4 A) and validation cohort (4B)

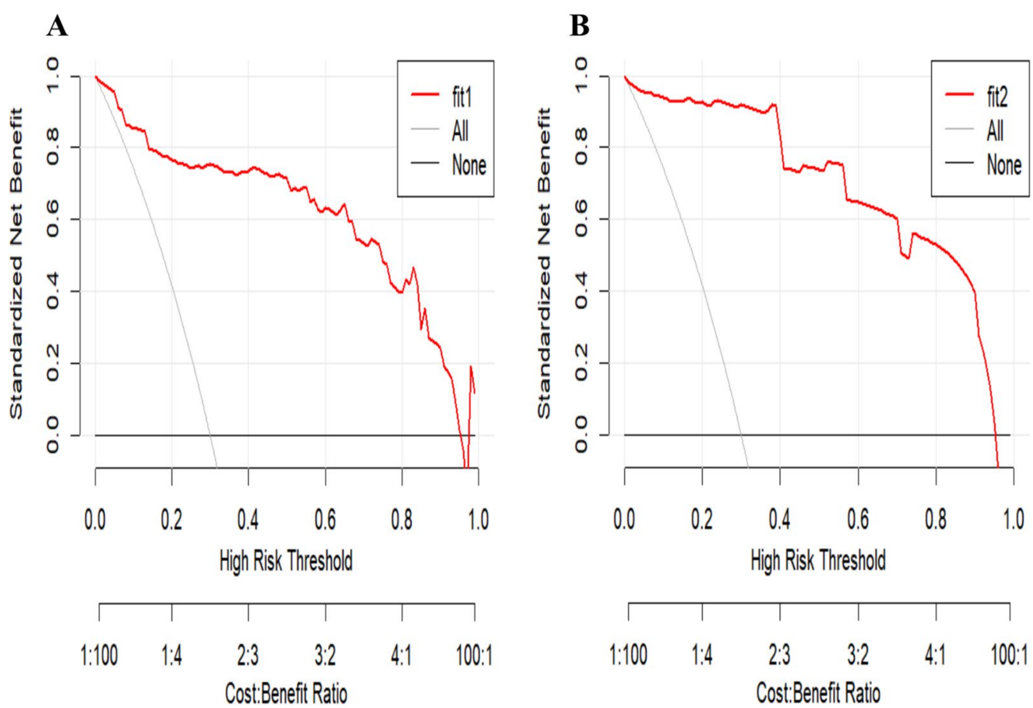

Fig. 5 DCA curves of the nomogram prediction model in the training

of Gram-positive isolates (21.88%). This trend can be attributed to the potential for bacterial translocation of the normal intestinal flora in the context of intestinal obstruction [16, 17]. Moreover, the altered distribution of the normal flora in post-surgical patients with intestinal obstruction may contribute to an increased risk of incisional infections [18]. Concurrently, the susceptibility testing of Gram-negative bacterial isolates revealed elevated resistance rates to ceftriaxone, ceftazidime, ciprofloxacin, levofloxacin, and piperacillin, contrasting with relatively lower resistance to cefepime, gentamicin, imipenem, and amikacin. In light of these findings, rigorous surveillance of Gram-negative bacteria is imperative in clinical settings, and the judicious use of prophylactic antimicrobial therapy may prove beneficial in mitigating the incidence of postoperative incisional infections.

Advanced age is frequently identified as a significant risk factor for healthcare-associated infections, particularly those affecting surgical incisions [19]. Older patients undergoing surgical procedures are more susceptible to adverse outcomes, including infection, when compared to middle-aged individuals. This heightened vulnerability is attributed to a combination of factors, such as diminished immune function, malnutrition, and various age-related physiological and anatomical changes [20]. As individuals age, their bodily organs experience a decline in function, making them more prone to complications from other medical conditions. Consequently, these patients often endure prolonged illness and treatment durations, further increasing their susceptibility to incisional infections [21]. Therefore, it is imperative to prioritize the enhanced monitoring of elderly patients within clinical settings, and to consider the judicious use of medications designed to bolster immune function.

Preclinical research utilizing animal models has revealed a strong correlation between diabetes mellitus and impaired wound healing, characterized by diminished collagen density, reduced tensile strength, and heightened susceptibility to wound dehiscence and infection [22]. These detrimental effects are further exacerbated by the microangiopathy inherent to diabetes, which compromises blood flow and hinders the body's natural regenerative processes [23]. From a clinical perspective, diabetic patients exhibit a weakened immune system, rendering them more vulnerable to infection. Concurrently, hyperglycemia inhibits fibroblast production, a crucial component of wound healing, further increasing the risk of incisional infections [24, 25]. Additionally, elevated blood sugar levels create an environment conducive to bacterial colonization and proliferation [26]. Consequently, individuals with a history of diabetes mellitus who undergo surgery for acute intestinal obstruction are particularly susceptible to postoperative incisional infections due to the interplay of these multiple factors and should be closely monitored by healthcare professionals.

Surgical incisions for acute intestinal obstruction are inherently contaminated or potentially contaminated, rendering them susceptible to pathogenic bacterial exposure. Prolonged surgical duration exacerbates this risk, as evidenced by our study, which identified a significant correlation between extended operative time (180 min) and postoperative incisional infections, aligning with previous research [27]. Numerous studies have established a linear relationship between operative time and incisional infection risk [28, 29]. Extended operative time not only compromises the surgical site's microenvironment but also significantly increases the likelihood of bacterial colonization due to prolonged exposure of the incision to the air [30]. To mitigate the incidence of postoperative incisional infections, it is imperative to minimize operative time while ensuring surgical success.

Patients presenting with colorectal obstruction, as opposed to small intestinal obstruction, exhibited a significantly heightened risk of postoperative incisional infection, as evidenced by a 77.0% incidence rate, aligning with the observations of Du et al. [31]. Furthermore, a substantial 7.017-fold increase in incisional infection risk has been documented among individuals undergoing emergency colorectal surgery compared to those undergoing other emergency gastrointestinal procedures [30]. This elevated risk can be attributed to several factors, including the inherently high bacterial load within the colorectum, characterized by a diverse array of Gram-negative and anaerobic bacteria. Additionally, the emergent nature of most colorectal obstruction surgeries often precludes adequate bowel preparation, rendering the intestinal contents susceptible to spillage and contamination of the surgical site. Consequently, patients undergoing emergency colorectal obstruction surgery are more prone to postoperative incisional infections than those with small bowel obstruction [14]. In light of these findings, meticulous postoperative incision site care should be prioritized when preoperative imaging indicates colorectal obstruction as the underlying cause.

It is widely acknowledged that the primary source of pathogens responsible for incisional infections stems from the patient's own skin, mucosal surfaces, or internal organs. Nevertheless, beyond these direct sources, numerous potential avenues for infection exist, including the environmental air. [32]. Notably, patients undergoing ostomy surgery exhibit a heightened risk of exposure to bacteria compared to those undergoing primary anastomosis procedures, thereby increasing the likelihood of developing incisional infections [33]. Concurrently, research has indicated that ostomy closure itself constitutes an independent risk factor for incisional infections in abdominal surgery, with wound infection rates reaching as high as 41% during this procedure [34]. Consequently, our findings, coupled with previous research, underscore the importance of meticulous consideration during ostomy surgery for acute intestinal obstruction. Such procedures should be reserved for high-risk patients who are unsuitable candidates for primary anastomosis. To minimize unnecessary ostomies, clinicians must exercise judicious control over the indications for this surgical intervention.

Preoperative anemia can significantly compromise patient outcomes by exacerbating malnutrition, hindering immune protein synthesis, and impairing wound healing, thereby increasing the risk of postoperative infection [35]. Research conducted by Weber et al. underscores the strong association between anemia and incisional infections [36]. The underlying mechanism involves reduced oxygen delivery to the surgical site, which compromises antibacterial defenses and delays wound healing [37]. To mitigate these risks, clinicians should prioritize the correction of anemia in patients with acute intestinal obstruction prior to surgery, thereby establishing a favorable foundation for reducing the incidence of postoperative infection.

This investigation employed a one-way analysis to contrast the incision infection group following acute intestinal obstruction surgery with the uninfected cohort. Statistically significant disparities were observed in age, diabetes mellitus history, operative duration, obstruction site, enterostomy, enterotomy, decompression, and hemoglobin levels between the two groups ($p < 0.05$). To further delineate the risk factors for incisional infection post-acute intestinal obstruction, LASSO regression and multifactorial logistic regression analyses were conducted. The findings revealed that age ≥ 60 years, diabetes mellitus history, operative duration ≥ 3 h, colorectal obstruction, and colostomy constituted risk factors, while hemoglobin emerged as a protective factor against incisional infection. A predictive model was developed based on multifactorial logistic regression analysis, incorporating six indicators: age ≥ 60 years, diabetes history, operative duration ≥ 3 h, colorectal obstruction, enterostomy, and hemoglobin. This model offers clinicians a straightforward predictive tool to identify high-risk patients and implement targeted preventive measures, thereby reducing incisional infection rates, hospitalization duration, and associated costs. The study's potential to mitigate incisional infection incidence, shorten hospitalization, and lower costs is substantial. Nevertheless, certain limitations exist: (1) the retrospective nature of the study introduces potential selection bias during data collection and quality control, necessitating prospective studies to validate the model's reliability; (2) the relatively small sample size precludes the inclusion of additional potential predictors; and (3) while the model has undergone validation within a randomized division validation set, the data originates from a single center, warranting external validation through data from multiple centers.

In conclusion, this study examined the pathophysiological characteristics of postoperative incisional infections in individuals with acute intestinal obstruction and developed a predictive model incorporating six key variables: age ≥ 60 years, history of diabetes, operative duration ≥ 3 h, colorectal obstruction, enterostomy, and hemoglobin. This model enhances the assessment of infection risk and offers valuable guidance to clinicians in preventing incisional infections among patients undergoing surgery for acute intestinal obstruction. Future research should prioritize interdisciplinary collaboration with other institutions to refine the model through multicenter validation and optimize its predictive capabilities.

Abbreviations

ROC	Receiver operating characteristic
AUC	Area under the curve
DCA	Decision curve analysis
BMI	Body mass index
HGB	Hemoglobin
PLT	Platelet
WBC	White blood cell count
NEUT%	Neutrophil percentage
APTT	Activated partial thromboplastin time
PT	Prothrombin time
D-D	D-dimer
FIB	Fibrinogen
K	Potassium
ALB	Albumin

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Author contributions
Q.W.,Y.Z. and X.W. conceived the project and developed the methodology.Q.W.,Y.Z.. and L.C. are responsible for data acquisition. Q.W. and Y.Z. performed the statistical analysis and interpreted the data.Q.W. and Y.Z.wrote the manuscript. L.C., T.Z., J.C., X.W. aided in interpreting the results and reviewed the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was performed in accordance with the latest version of the Declaration of Helsinki and was approved by the ethics committee of the First Affiliated Hospital of Anhui Medical University. Due to the retrospective nature of the study, the need for a written informed consent was waived by the ethics committee.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Kowalski G, Żądło D, Gawrychowski J. Diverticulosis of the proximal part of the jejunum causing intestinal obstruction—case report. Wiad Lek. 2017;70(6 pt 1):1146–50.
2. Yang Q, Zhao F, Qi J, et al. The comparison of accuracy and practicability between ultrasound and spiral CT in the diagnosis of intestinal obstruction: a protocol for systematic review and meta-analysis. Medicine. 2021;100(4): e23631.
3. Bankole AO, Osinowo AO, Adesanya AA. Predictive factors of management outcome in adult patients with mechanical intestinal obstruction. Niger Postgrad Med J. 2017;24(4):217–23.
4. Chen Q, Wang Z, Wu BX. Promoting wound recovery through stable intestinal flora: reducing post-operative complications in colorectal cancer surgery patients. Int Wound J. 2023;21(3): e14501.
5. Cheong Chung JN, ALI O, Hawthornthwaite E, et al. Closed incision negative pressure wound therapy is associated with reduced surgical site infection after emergency laparotomy: a propensity matched-cohort analysis. Surgery. 2021;170(5):1568–73.
6. Cohen NS, Bock JM, May AK. Sepsis and postoperative surgical site infections. Surgery. 2023;174(2):403–5.
7. Utsumi M, Yamada T, Yamabe K, et al. Differences in risk factors for surgical site infection between laparotomy and laparoscopy in gastrointestinal surgery. PLoS ONE. 2022;17(9): e0274887.
8. Carvalho RLR, Campos CC, Franco LMC, et al. Incidence and risk factors for surgical site infection in general surgeries. Rev Lat Am Enfermagem. 2017;25: e2848.
9. Lin WP, Xing KL, Fu JC, et al. Development and validation of a model including distinct vascular patterns to estimate survival in hepatocellular carcinoma. JAMA Netw Open. 2021;4(9): e2125055.
10. Diagnostic criteria for Nosocomial infection (Trial). Chinese Medical Journal. 2001, 81(5). 10
11. Soressa U, Mamo A, Hiko D, et al. Prevalence, causes and management outcome of intestinal obstruction in Adama Hospital, Ethiopia. BMC Surg. 2016;16(1):38.
12. Ejaz A, Schmidt C, Johnston FM, et al. Risk factors and prediction model for inpatient surgical site infection after major abdominal surgery. J Surg Res. 2017;217:153–9.
13. Zhou J, Ma X. Cost-benefit analysis of craniocerebral surgical site infection control in tertiary hospitals in China. J Infect Dev Ctries. 2015;9(2):182–9.
14. Li Z, Gao JR, Song L, et al. Risk factors for surgical site infection after emergency abdominal surgery: a multicenter cross-sectional study in China. Zhonghua Wei Chang Wai Ke Za Zhi. 2020;23(11):1043–50.
15. Guo YC, Sun R, Wu B, et al. Risk factors of postoperative surgical site infection in colon cancer based on a single center database. Zhonghua Wei Chang Wai Ke Za Zhi. 2022;25(3):242–9.
16. Costa R, Rasslan R, Koike MK, et al. Bacterial translocation and mortality on rat model of intestinal ischemia and obstruction. Acta Cir Bras. 2017;32(8):641–7.
17. Costa R, Fischer J, Rasslan R, et al. Effects of N-acetylcysteine on the inflammatory response and bacterial translocation in a model of intestinal obstruction and ischemia in rats. Acta Cir Bras. 2023;37(12): e371204.
18. Lin SS, Zhang RQ, Shen L, et al. Alterations in the gut barrier and involvement of toll-like receptor 4 in murine postoperative ileus. Neurogastroenterol Motil. 2018;30(6): e13286.
19. Bischoff P, Kramer TS, Schröder C, et al. Age as a risk factor for surgical site infections: German surveillance data on total hip replacement and total knee replacement procedures to 2018. Euro Surveill. 2009. https://doi.org/10.2807/1560-7917.ES.2023.28.9.2200535.
20. Ansari S, Hassan M, Barry HD, et al. Risk factors associated with surgical site infections: a retrospective report from a developing country. Cureus. 2019;11(6): e4801.
21. Langit MB, Miwa S, Yamamoto N, et al. Risk factors for postoperative deep infection after malignant bone tumor surgery of the extremities. Anticancer Res. 2020;40(6):3551–7.
22. Minossi JG, Lima Fde O, Caramori CA, et al. Alloxan diabetes alters the tensile strength, morphological and morphometric parameters of abdominal wall healing in rats. Acta Cir Bras. 2014;29(2):118–24.
23. Okonkwo UA, Dipietro LA. Diabetes and wound angiogenesis. Int J Mol Sci. 2017;18(7):1419.
24. Aravindhan V, Anand G. Cell type-specific immunomodulation induced by helminthes: effect on metainflammation, insulin resistance and type-2 diabetes. Am J Trop Med Hyg. 2017;97(6):1650–61.
25. Huang X, Liang P, Jiang B, et al. Hyperbaric oxygen potentiates diabetic wound healing by promoting fibroblast cell proliferation and endothelial cell angiogenesis. Life Sci. 2020;259: 118246.
26. Rosell-Mases E, Santiago A, Corral-Pujol M, et al. Mutual modulation of gut microbiota and the immune system in type 1 diabetes models. Nat Commun. 2023;14(1):7770.
27. Bislenghi G, Vanhaverbeke A, Fieuws S, et al. Risk factors for surgical site infection after colorectal resection: a prospective single centre study an analysis on 287 consecutive elective and urgent procedures within an institutional quality improvement project. Acta Chir Belg. 2021;121(2):86–93.
28. Kurmann A, Vorburger SA, Candinas D, et al. Operation time and body mass index are significant risk factors for surgical site infection in laparoscopic sigmoid resection: a multicenter study. Surg Endosc. 2011;25(11):3531–4.
29. Gowd AK, Bohl DD, Hamid KS, et al. Longer operative time is independently associated with surgical site infection and wound dehiscence following open reduction and internal fixation of the ankle. Foot Ankle Spec. 2020;13(2):104–11.
30. Li Z, Li H, Lv P, et al. Prospective multicenter study on the incidence of surgical site infection after emergency abdominal surgery in China. Sci Rep. 2021;11(1):7794.
31. Du M, Liu B, Li M, et al. Multicenter surveillance study of surgical site infection and its risk factors in radical resection of colon or rectal carcinoma. BMC Infect Dis. 2019;19(1):411.
32. Ricciardi R, Roberts PL, Hall JF, et al. What is the effect of stoma construction on surgical site infection after colorectal surgery? J Gastrointest Surg. 2014;18(4):789–95.
33. Furukawa K, Onda S, Taniai T, et al. Risk factors and overcoming strategies of surgical site infection after hepatectomy for colorectal liver metastases. Anticancer Res. 2021;41(11):5651–6.
34. Konishi T, Watanabe T, Kishimoto J, et al. Elective colon and rectal surgery differ in risk factors for wound infection: results of prospective surveillance. Ann Surg. 2006;244(5):758–63.
35. Chen M, Liang H, Chen M, et al. Risk factors for surgical site infection in patients with gastric cancer: a meta-analysis. Int Wound J. 2023;20(9):3884–97.
36. Weber WP, Zwahlen M, Reck S, et al. The association of preoperative anemia and perioperative allogeneic blood transfusion with the risk of surgical site infection. Transfusion. 2009;49(9):1964–70.
37. Itani KMF, Dellinger EP, Mazuski J, et al. Surgical site infection research opportunities. Surg Infect. 2017;18(4):401–8.

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