Construction of a Risk Prediction Model for Fever After Painless Bronchoscopy

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Background: The aim of this study was to construct a risk prediction model for fever after painless bronchoscopy.

Material/Methods: A total of 188 patients were included, and a self-designed data collection form was used. By collecting relevant clinical data of patients before, during, and after the painless bronchoscopy, the influencing factors were analyzed through univariate analysis, and multiple logistic regression analysis was performed to construct the prediction equation, which was tested by ROC curve analysis.

Results: Of the 188 patients undergoing painless bronchoscopy, 49 had postoperative fever, and the incidence rate was 26.0%. The prediction probability model was: $P=e^x/1+e^x$, where e is the natural logarithm, $X=-4.337+0.020\times(CRP)+1.014$ (whether the examination time was greater than 30 minutes)$+1.912\times$(whether remifentanil was used during anesthesia)$+1.514\times$(whether nausea or vomiting occurred during surgery or during recovery). The prediction sensitivity and specificity were 78.26% 76.72%, respectively.

Conclusions: Use of this risk prediction model of fever after painless bronchoscopy can improve the recognition of people at high risk of postoperative fever, and it has good ability to guide clinical nursing observation and early screening of fever after painless bronchoscopy.

MeSH Keywords: **Bronchoscopy • Fever • Risk Factors**

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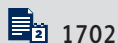
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Background

Bronchoscopy is an important method for the diagnosis, treatment, and rescue of bronchial, lung, and pleural diseases [1], but it needs to enter the tracheobronchial tree through the glottis during the examination. This examination is performed when the patient is awake, which causes violent coughing and feeling of impending death. A small number of patients cannot tolerate the bronchoscopy examination, and instinctively resist or even remove the bronchoscope, leading to termination of the examination [2].

In recent years, painless bronchoscopy could be performed through intravenous general anesthesia, which enables patients to complete the examination smoothly without being aware of it; therefore, it has become more and more widely used in clinical applications [3], which not only greatly increases the comfort of patients during the examination, but also improves the work efficiency of medical staff. Postoperative fever is one of the most common complications of painless bronchoscopy, but there are few reports on fever after painless bronchoscopy. Fever after painless bronchoscopy usually causes varying degrees of headache, fatigue, poor appetite, and general discomfort in patients. Those with high fever need to take non-steroidal anti-inflammatory drugs, hormones, or antibiotics, which not only reduces the patient's postoperative comfort, but also increases the patient's hospitalization costs and length of stay, causing harm to patients and their families. Based on this, the purpose of this study was to analyze the clinical observation indicators of fever after painless bronchoscopy, establish a risk prediction model, and improve the identification of groups at high risk of fever after painless bronchoscopy, so that relevant nursing care and intervention can be carried out early.

Material and Methods

Study subjects

This study retrospectively collected general information of patients undergoing painless bronchoscopy in the Respiratory Department from June 2018 to March 2019. A total of 188 cases were included according to the inclusion and exclusion criteria. Inclusion criteria were: (1) age 18–85 years; (2) diagnosed by a respiratory medicine physician specialist at our hospital, and needing to undergo bronchoscopy to further confirm the diagnosis; (3) preoperative conversations between patients and their families, patients and their families voluntarily chose painless bronchoscopy, and informed consent was signed. Exclusion criteria were: (1) fever before undergoing painless bronchoscopy; (2) other invasive examinations or treatments including surgical treatment within 24 h before and after surgery after undergoing painless bronchoscopy; (3) incomplete medical

records. According to whether the postoperative body temperature (ear temperature) is higher than 37.6°C, all patients were divided into a fever group and a non-fever group. This study was carried out following the rules of the Declaration of Helsinki of 1975 (*https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/*), revised in 2013.

Research tools

A self-designed data collection form was used based on clinical characteristics. The collected information includes: sex, age, preoperative white blood cell count, preoperative neutrophil-lymphocyte count, preoperative C-reactive protein (CRP), history of chronic obstructive pulmonary disease (COPD) or obstructive pneumonia, whether non-steroidal anti-inflammatory drugs/hormones/antibiotics were used before surgery, whether remifentanil was used during anesthesia, whether the examination time was greater than 30 minutes, whether nausea or vomiting occurred during surgery or during recovery, whether severe bleeding occurred during the operation, and whether biopsy was performed during the operation.

Data collection method

A case-control study design was used to collect general clinical information of 188 patients undergoing painless bronchoscopy by consulting the medical records and electronic medical records system.

Criterion for postoperative fever

The criterion for postoperative fever was body temperature (ear temperature) higher than 37.6°C within 48 h after surgery.

Statistical analysis

All statistical analyses were performed using SPSS version 22.0 statistical software. Normally distributed measurement data are expressed as the mean and standard deviation ($\bar{\chi}\pm s$). For data that were not normally distributed, comparisons between groups were performed using the independent-samples t test. Measurement data are expressed as median and quartile [M (P_{25}, P_{75})], and comparisons between groups were performed using the Kolmogorov-Smirnov Z test. Count data are represented by numbers, comparisons between groups were performed using the χ^2 test, and risk analysis of fever after painless bronchoscopy was analyzed by binary logistics regression. The prediction model was established based on the risk factors, the receiver operating characteristic (ROC) curve was used to evaluate the predictive ability of the prediction model, and we calculated the area under the curve (AUC) and the sensitivity and specificity corresponding to the optimal threshold. A P value of <0.05 was considered statistically significant.

Table 1. Univariate analysis of risk factors for fever after painless bronchoscopy.

Groups	n	Gender		Age (years old)	Preoperative white blood cell count (10^9/L)
		Male	Female		
Fever group	49	28	21	58.80±12.02	7.70±4.18
Non-fever group	139	79	60	58.12±12.60	6.34±2.35
χ^2/Z/t		0.001		0.328	2.780
P		0.970		0.185	0.006

Groups	n	Preoperative neutrophil-lymphocyte count (10^9/L)	Preoperative C-reactive protein (mg/l)	Smoking history (Yes/No)	History of COPD or obstructive pneumonia (Yes/No)	Whether non-steroidal anti-inflammatory drugs/hormones/antibiotics were used before surgery (Yes/No)	Whether the examination time was greater than 30 minutes (No/Yes)
Fever group	49	4.15 (3.40, 5.93)	20.7 (4.48, 68.59)	24/25	26/23	27/22	23/26
Non-fever group	139	3.70 (2.80, 4.92)	5.50 (1.32, 13.75)	74/65	78/61	86/53	105/34
χ^2/Z/t		1.027	1.906	0.263	0.137	0.692	13.638
P		0.242	<0.001	0.608	0.712	0.405	<0.001

Groups	n	Whether remifentanil was used during anesthesia (No/Yes)	Whether nausea or vomiting occurred during surgery or during recovery (No/Yes)	Whether severe bleeding occurred during the operation (No/Yes)	Whether biopsy was performed during the operation (No/Yes)
Fever group	49	5/44	19/30	43/6	11/38
Non-fever group	139	57/82	103/36	135/4	62/77
χ^2/Z/t		15.552	19.844	6.312	7.847
P		<0.001	<0.001	0.012	0.006

Results

Univariate analysis of risk factors for fever after painless bronchoscopy

Independent-samples t test analysis showed that there was a statistically significant difference in the preoperative white blood cell count between the fever group and the non-fever group. The Kolmogorov-Smirnov Z test showed that the preoperative CRP levels were significantly different between the 2 groups. The chi-square test was performed to determine the significance of differences between groups in whether the examination time was longer than 30 minutes, whether remifentanil was used during anesthesia, whether nausea or vomiting occurred during surgery or during recovery, whether severe bleeding occurred during the operation, and whether biopsy was performed during the operation (Table 1).

Multivariate analysis of risk factors for fever after painless bronchoscopy

All statistically significant variables observed in the univariate analysis for fever after painless bronchoscopy were used as independent variables. Numerical values were assigned to variables; the preoperative CRP were continuous variables and no assignment was required. All other assignments were 0: none or 1: yes. Based on the number of cases and clinical characteristics of fever after painless bronchoscopy included in the study, we assessed the effect of 5 risk factors: the preoperative CRP level, whether the examination time was longer than 30 min, whether remifentanil was used during anesthesia, whether nausea or vomiting occurred during surgery or during recovery, and whether biopsy was performed during the operation. We found that fever after painless bronchoscopy was correlated with preoperative (CRP) level, whether

Table 2. Multivariate analysis of risk factors for fever after painless bronchoscopy.

Indexes	β	SE	Wald χ^2	P	OR (95% CI)
Preoperative CRP	0.020	0.007	9.102	0.003	1.020 (1.007~1.034)
Whether the examination time was greater than 30 minutes	1.014	0.449	5.100	0.024	2.757 (1.143~6.648)
Whether remifentanil was used during anesthesia	1.912	0.561	11.608	0.001	6.765 (2.252~20.320)
Whether nausea or vomiting occurred during surgery or during recovery	1.514	0.438	11.943	0.001	4.543 (1.926~10.721)
Whether biopsy was performed during the operation	0.695	0.467	2.213	0.137	2.004 (0.082~5.005)
Intercept	−4.337	.713	37.048	0.000	

the examination time was longer than 30 min, whether remifentanil was used during anesthesia, and whether nausea or vomiting occurred during surgery or during recovery. The results are shown in Table 2.

ROC curve analysis

The prediction probability model based on multivariate regression was: prediction probability $P=\frac{e^x}{1+e^x}$, where e is the natural logarithm, X=−4.337+0.020×(CRP)+1.014 (whether the examination time was longer than 30 min)+1.912×(whether remifentanil was used during anesthesia)+1.514×(whether nausea or vomiting occurred during surgery or during recovery). ROC curve analysis was used to test the fitting effect between the predicted probability and fever after painless bronchoscopy, as shown in Figure 1. The AUC=0.841 (95% *CI*: 0.776~0.894), *Z*=9.757, *P*<0.0001, the best cut-off value was 0.298. At this point, the predictive sensitivity was 78.26% and the specificity was 76.72%.

Discussion

Fever is a common complication after bronchoscopy, and the related literature reports that the incidence is about 10–20% [4–6]. Further studies showed that fever incidence rates after bronchoscopy in elderly people over 80 years old and those under 80 years old were 7.6% and 4.1%, respectively, and there was no statistically significant difference between them [7]. Short-term fever is common among outpatients and inpatients undergoing fiber bronchoscopy, and studies have shown no correlation with age, tooth decay, smoking, systemic disease, presence of lesions, or endoscopic techniques [8]. Other studies have reported that fever caused by bacterial infection accounts for 25% of fevers after bronchoscopy [8]. The results of this study showed that the incidence of fever after painless bronchoscopy was 26%. Preoperative CRP levels, whether the examination time was longer than 30 min,
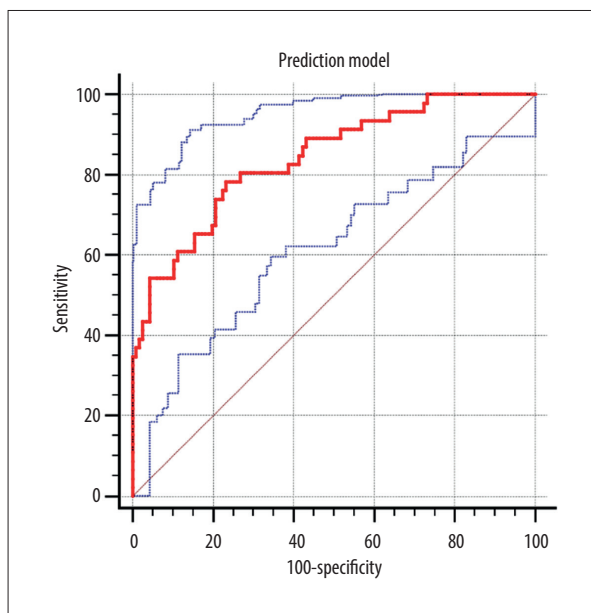

Figure 1. ROC curve analysis to test the prediction probability model of fever after painless bronchoscopy. The AUC=0.841 (95% *CI*: 0.776~0.894), *Z*=9.757, *P*<0.0001, the best cut-off value was 0.298. Moreover, the predictive sensitivity was 78.26% and the specificity was 76.72%.

whether remifentanil was used during anesthesia, and whether nausea or vomiting occurred during surgery or during recovery were risk factors for fever after painless bronchoscopy.

Abnormal preoperative CRP levels indicated the presence of pre-existing infections in the patient. In a study of fever after percutaneous nephrolithotomy, it was found that there was a significant difference in CRP levels between the fever group and the non-fever group [9]. This study found that the levels of CRP in the fever group and non-fever group after bronchoscopy were 20.7 mg/L and 5.5 mg/L, respectively, and there were statistically significant differences between the 2

groups. Similarly, in the study of predictive factors for fever after percutaneous nephrolithotomy, it was found that operation time longer than 95 min was a significant factor, and the longer the operation time, the higher the risk of postoperative fever [10]. During painless bronchoscopy, the longer the examination time, the longer the exposure and invasive procedures during the examination; therefore, there is greater risk of postoperative fever. The results of this study showed that 26 patients (53.06%) in the fever group had an examination time of longer than 30 min.

The instructions for remifentanil use clearly state that adverse reactions such as chills and fever have been found in clinical studies [11]. The retrospective analysis in this study showed that 44 patients (89.79%) in the fever group received remifentanil hydrochloride injection. Nausea and vomiting during surgery or during recovery is an important cause of fever after painless bronchoscopy. Although patients have been fasting for 8 h or more and liquid fasting for 6 h or more before surgery, some patients have nausea and vomiting during the surgery and during recovery due to the use of anesthesia and the change of posture after bronchoscopy. In addition, due to the use of anesthetics, the patient's reflex function is reduced.

Oropharyngeal secretions and vomitus easily enter the respiratory tract at the end of the examination, which undoubtedly increases the risk of aspiration and greatly increases the risk of postoperative fever [12].

Conclusions

In this study, retrospective analysis showed that the occurrence of fever after painless bronchoscopy was related to the preoperative CRP level, whether the examination time was longer than 30 min, whether remifentanil was used during anesthesia, and whether nausea or vomiting occurred during surgery or during recovery. Based on this, a risk prediction model for fever after painless bronchoscopy was established, which has good prediction ability. This model suggests the clinical characteristics of fever that may occur after painless bronchoscopy, and aims to achieve early detection and early intervention through standardized and reasonable preoperative plans and clear and well-organized postoperative care monitoring. This study only included a clinical sample data from a single center. The sample size was limited, and the prediction ability of the risk model needs to be verified in a larger sample.

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