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ORIGINAL RESEARCH

A Retrospective Study Establishing a Nomogram Predictive Model for Postoperative High-Activity Delirium After Non-Cardiac Surgery

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Background: Postoperative high-activity delirium (PDHA) manifests as a high alertness, restlessness, hallucinations, and delusions. Occurrence of PDHA represents an increased risk of poor prognosis for patients.

Objective: To establish and validate a nomogram prediction model for high-activity delirium after non-cardiac surgery in a post-anesthesia care unit (PACU).

Methods: This study retrospectively enrolled adult patients who underwent non-cardiac surgery and were observed in the PACU as training data. Patients were divided into PDHA (199 patients) and non-PDHA (396 patients) groups. Patients' general data, preoperative indicators, intraoperative conditions, and postoperative PACU conditions were collected. The risk factors for PDHA were identified using univariate and multivariate logistic regression analyses. A predictive column chart was created using R language. Adult patients who underwent non-cardiac surgery and entered the PACU for observation were randomly selected as the validation set data (198 cases) for model performance validation.

Results: The incidence rate of adult PDHA in the PACU was 0.275%. Sex, age, smoking history, low preoperative albumin level, Society of Anesthesiologists (ASA) classification, anesthesia duration, and postoperative PACU pain score were independent risk factors for hyperactive delirium in PACU adults. In this study, an adult PACU PDHA nomogram prediction model was developed. The training dataset verified that the ROC curve (area under the curve) and 95% confidence interval (95% CI) were 0.936 (0.917–0.955). The ROC curve of the validation data row showed that the area under the curve and 95% CI were 0.926 (0.885–0.967).

Conclusion: The nomogram predictive model for PACU adult high-activity delirium constructed in this study showed good predictive performance. This model could enable the visualization and graphical prediction of adult high-activity delirium occurrence after PACU, which has clinical value.

Keywords: post anesthesia care unit, PACU, delirium, risk factor, nomograms

Introduction

The post-anesthesia care unit (PACU) is an important place for anesthesia care, and safety-care management is an important link in perioperative ERAS. Delirium in the PACU, that is, early postoperative delirium, is a strong predictor of subsequent delirium, with a sensitivity of 100% and a specificity of 85%.[1] Among them, postoperative high-activity delirium (PDHA) is mainly manifested as high alertness and restlessness and can produce hallucinations or delusions.[1–3] PDHA is a common and serious complication after major surgery, and such patients are often restless, have low compliance, and are strongly destructive. Improper handling of patients can easily lead to adverse events such as bed fall, unplanned extubation, and trauma,[4] which increases the difficulty of postoperative treatment and nursing, increases the workload of anesthesia nursing, and increases the likelihood of injury to medical teams.[5,6] Early screening of high-risk groups for early intervention can reduce the occurrence of postoperative high-activity delirium, which can reduce the

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workload of anesthesia care and improve postoperative comfort of patients. Furthermore, early postoperative delirium is also a harbinger of development of postoperative cognitive decline (POCD), which has far more significant repercussions on patient health and healthcare system than delirium.[7] Recently, we have established a prediction model for postoperative moderate to severe pain for the PACU in the malignancy patients, demonstrating high accuracy and good predictive ability.[8] This established model would be helpful for PACU medical staff to treat the postoperative pain.

Therefore, this study used a logistic regression model to analyze the incidence and risk factors of early PDHA in adults after surgery and established a predictive model for early PDHA in adults. This study aimed to explore the potential factors of delirium, such as reducing perioperative inflammatory reactions and promoting the reduction of delirium occurrence, providing reference for clinical medical staff to screen and implement intervention measures for high-risk individuals with PDHA in the early stage.

Patients and Methods

Patients

This was a retrospective case-control study. By searching the electronic medical record database of the First Affiliated Hospital of Wenzhou Medical University and the operating room anesthesia electronic record database, adult patients who entered the PACU for postoperative observation from January 1, 2018, to December 31, 2019, were selected for postoperative observation.

The inclusion criteria were as follows: ① Patients who entered the PACU for observation after surgery. ② Patients aged ≥18 years. ③ Patients could communicate normally before surgery and cooperate to complete the various scoring systems. Exclusion criteria were as follows: ① Patients aged <18 years were excluded from this study. ② Patients with brain parenchymal injuries. ③ Patients with Preoperative cognitive dysfunction. ④ Patients with a history of mental illness. ⑤Patients with incomplete data.

For the preoperative cognitive dysfunction, during preoperative evaluation, if it was found that the patient has a history of concurrent cerebrovascular accidents or brain trauma, or if it was discovered during communication that the patient had a tendency towards cognitive impairment, the physician would apply for a psychiatric consultation to make a relevant diagnosis.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Clinical Research (ECCR) of the First Affiliated Hospital of Wenzhou Medical University (Approval No. 2021–102, Approval Date: June, 14th, 2021). All patients provided the written informed consents and approved this study.

Diagnostic Criteria

The monitoring and diagnosis of PDHA were an important part of the postoperative patient evaluation in this study. This study adopted the latest diagnostic criteria of the PACU delirium study by Darren et al and Fields et al in the United States in 2018,[9–11] that is, RASS ≥3 combined with a positive CAM-ICU scale was the standard for diagnosing PDHA. However, a patient with a RASS score higher than zero and a combined high-level pain state would not be regarded as CAM-ICU positive. According to the PDHA diagnostic criteria, the study subjects were divided into two groups: the PDHA group (303 cases) and the non-PDHA group (110056 cases) (Figure 1).

Surgery Types and Perioperative Anesthesia Management

The surgical methods for the patients included in this study mainly include breast surgery, colorectal surgery, gynecological laparoscopic surgery, hepatobiliary and gastrointestinal surgery, and orthopedic surgery. Postoperative patients would enter the recovery room for postoperative observation. Our hospital implements perioperative management based on the concept of promoting rapid postoperative recovery for patients. Anesthesia visits and evaluations are conducted before surgery, and precise management of anesthesia drugs is carried out during surgery. Routine BIS monitoring and airway management are also performed. Individualized selection is made based on the specific surgical situation and

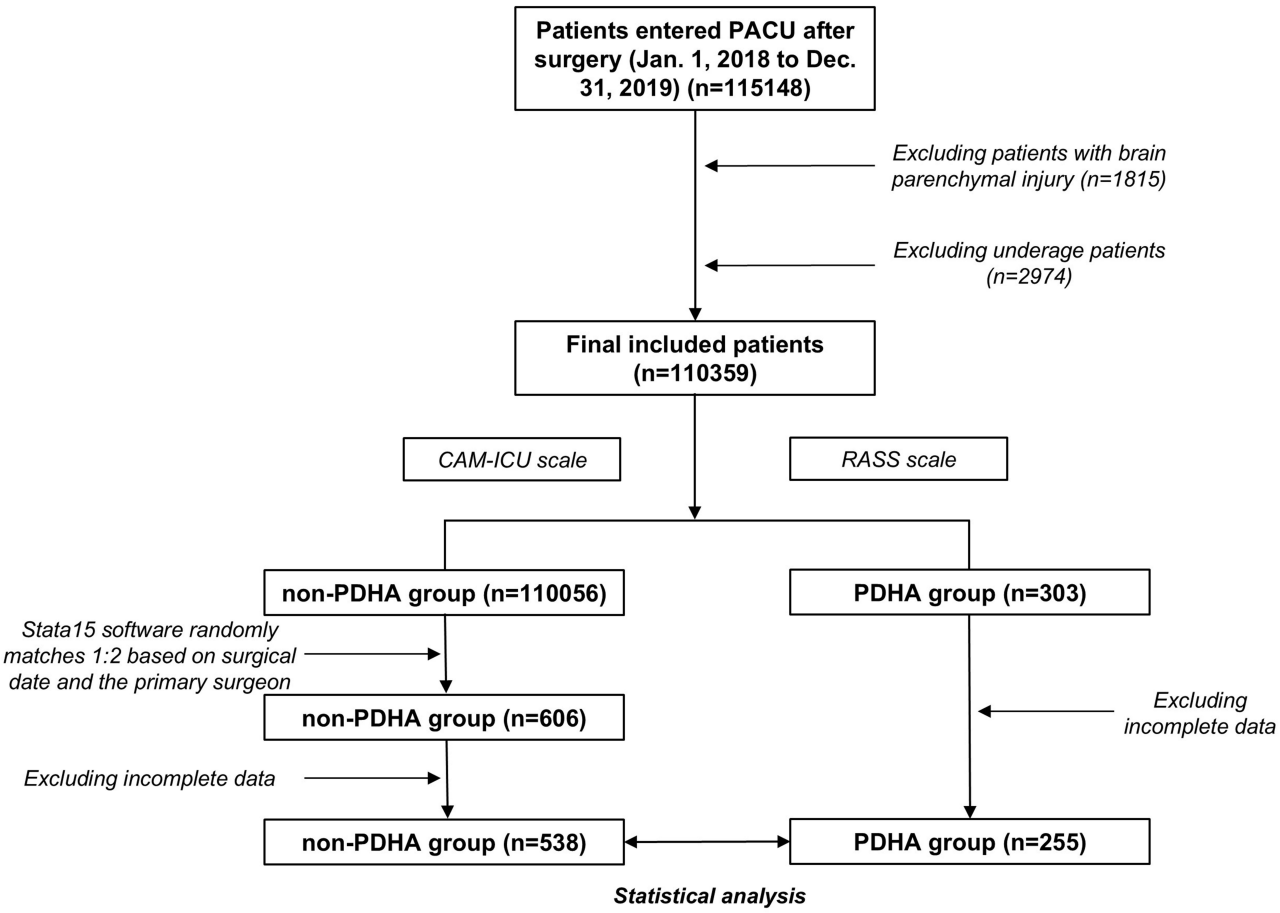

Figure 1 PACU patients screening flowchart.

method of the patient, maximizing the maintenance of stable perioperative vital signs and implementing effective postoperative analgesia.

Data Collection

The observation period was from the patient's postoperative admission to the PACU to the period from the PACU. The electronic medical records, operating room anesthesia and postoperative recovery room records, and nursing records of the two groups of patients included in the statistical analysis were reviewed. Meanwhile, the access database was used to retrospectively collect the following data from the two groups of patients: ① General information, including the patient's age, sex, body mass index (BMI), education level, smoking history, drinking history, combined history of other diseases, and combined history of previous surgery, etc. ② Preoperative indicators, including preoperative sleep, preoperative hemoglobin value, preoperative albumin level, history of sedative and analgesic use, preoperative pain, and American Society of Anesthesiologists (ASA) grade, etc. ③ Intraoperative conditions, including surgical site, method of anesthesia, use of inhaled anesthetics, duration of anesthesia, duration of operation, intraoperative medication, intraoperative events, and intraoperative bleeding, etc. ④ Postoperative PACU situation, including postoperative pain score, postoperative hypothermia, indwelling catheterization, and indwelling drainage tube.

Statistical Methods

The PDHA group (303 cases) and the non-PDHA control group (606 cases) were randomly matched using Stata 15 software according to the operation date and the surgeon's 1:2 ratio, and imperfect data records were excluded (Figure 1). The final PDHA group (255 cases) and non-PDHA control group (538 cases) were included in the statistical analysis

(Figure 1). According to a ratio of 2:1, the collected research data were randomly divided into training and validation sets. With PDHA as the dependent variable, binomial logistic regression analysis was used, R language was used for statistics and analysis, stepwise logistic regression was used to screen for risk factors, and statistical significance was set at $P<0.05$. Normally distributed continuous variables were represented by the mean (standard deviation, SD), and non-normally distributed continuous variables were represented by the median (interquartile range, Q). For comparisons between groups, the *t*-test was used to compare normally distributed data, and the Mann–Whitney *U*-test was used to compare non-normally distributed data. The classification data were expressed as numbers and percentages (%), and the Fisher test or Pearson chi-square test was used for accurate comparison. A nomogram was established based on the results of the multifactor logistic regression analysis, and its performance was verified in the validation set, including its recognition ability, calibration, and clinical application.

Results

General Situation of the Case

According to the clinical records, the incidence of PDHA in PACU adults in the hospital from January 1, 2018, to December 31, 2019, was 0.275%, with an average age of 68.64 years old. Among the adults with PDHA above the PACU, 209 were male patients (81.96%) (Tables 1 and 2). All patients in the PDHA group had limb restlessness and a lack of cooperation. Among the PDHA patients, 30.20% had intense speech and were unable to communicate, 22.75% had an extubation tendency, and 6% had aggressive behaviors and medical injuries (Tables 1 and 2). In addition, this study included 538 patients in the non-PDHA group (202 males, 336 females.

Comparison of Observation Indicators Between Patients in PDHA Group and Non-PDHA Group

The two sets of collected research data were analyzed using the Stata 15 software and randomly divided into training set data and validation set data in a 2:1 ratio. Owing to the severe multicollinearity between surgical duration and anesthesia duration, and considering the characteristics of the department and clinical experience, it was decided to retain the variable of anesthesia duration and exclude the variable of surgical duration. The training set data of patients in the non-PDHA and PDHA groups were analyzed using logistic regression. According to the logistic regression results, all 23 observation indices, including age, sex, degree of education, drinking history, smoking history, history of coronary heart disease, history of diabetes, history of hypertension, history of stroke, sleep condition, preoperative pain, preoperative low hemoglobin level, preoperative low albumin level, operation site, ASA grade, anesthesia mode, duration of anesthesia, intraoperative use of inhaled drugs, intraoperative bleeding, postoperative hypothermia, postoperative drainage tube, postoperative catheterization, and postoperative PACU pain score, were significantly differences between the two groups (Table 3). However, there were no statistically significant differences in factors such as BMI, combined history of previous surgery, and preoperative use of sedatives between the PDHA and non-PDHA groups.

Table 1 General Characteristics of Patients in PDHA Group and Non-PDHA Group (Mean±standard Deviation)

	Non-PDHA Group (n=538)	PDHA Group (n=255)
BMI (kg/m^2)	24.36±12.74	23.14±3.34
Operation duration (min)	73.17±51.89	153.25±81.02
Anesthesia duration (min)	99.04±57.87	190.55±86.84
Age (year)	50.65±14.81	68.64±12.11
Postoperative PACU pain score (n)	0.53±1.01	1.81±1.82

Table 2 The General Situation of Counting Data for Two Groups of Patients

Risk Factors		Non-PDHA Group (n=538)	PDHA Group (n=255)
Gender, n (%)	Male	202 (37.55)	209 (81.96)
	Female	336 (62.45)	46 (18.04)
Degree of education, n (%)	Primary school or lower	260 (48.33)	174 (68.24)
	Junior middle school	154 (28.62)	65 (25.49)
	Senior middle/higher school	124 (23.05)	16 (6.27)
Sleep condition, n (%)	Normal	456 (84.76)	182 (71.37)
	Relatively poor	57 (10.59)	49 (19.22)
	Considerably poor	25 (4.65)	24 (9.41)
Preoperative pain, n (%)	Negative	410 (76.21)	133 (52.16)
	Positive	128 (23.79)	122 (47.84)
Use sedatives before operation, n (%)	Negative	500 (92.94)	234 (91.76)
	Positive	38 (7.06)	21 (8.24)
History of previous operations, n (%)	Negative	276 (51.30)	132 (51.76)
History of hypertension, n (%)	Positive	262 (48.70)	123 (48.24)
	Negative	403 (74.91)	148 (58.04)
	Positive	135 (41.96)	107 (41.96)
History of diabetes, n (%)	Negative	495 (92.01)	211 (82.75)
	Positive	43 (7.99)	44 (17.25)
History of stroke, n (%)	Negative	535 (99.44)	232 (90.98)
	Positive	3 (0.56)	23 (9.02)
History of coronary heart disease, n (%)	Negative	532 (98.88)	244 (95.69)
	Positive	6 (1.12)	11 (4.31)
History of smoking, n (%)	Negative	459 (85.32)	157 (61.57)
	Positive	79 (14.68)	98 (38.43)
History of drinking, n (%)	Negative	404 (75.09)	174 (68.24)
	Positive	134 (24.91)	81 (31.76)
Preoperative low albumin, n (%)	Negative	412 (76.58)	85 (33.33)
	Positive	126 (23.42)	170 (66.67)
Preoperative low hemoglobin, n (%)	Negative	435 (80.86)	148 (58.04)
	Positive	103 (19.14)	107 (41.96)
Operation site, n (%)	Superficial tissue	191 (35.50)	25 (9.80)
	Deep tissue	347 (64.50)	230 (90.20)
ASA classification, n (%)	1–2	518 (96.28)	190 (74.51)
	3–4	20 (3.72)	65 (25.49)
Anesthesia mode, n (%)	General anesthesia	37 (6.88)	4 (1.57)
	Intraspinal anesthesia	61 (11.34)	10 (3.92)
	Combined anesthesia	10 (1.86)	31 (12.16)
	Other	430 (79.93)	210 (82.35)
Inhaled drug, n (%)	Negative	101 (18.77)	28 (10.98)
	Positive	437 (81.23)	227 (89.02)
Intraoperative hemorrhage, n (%)	Below 200mL	529 (98.33)	243 (95.29)
	Above 200mL	9 (1.67)	12 (4.71)
Postoperative indwelling catheterization, n (%)	Negative	282 (52.42)	26 (10.20)
	Positive	256 (47.58)	229 (89.80)
Postoperative indwelling drainage tube	Negative	308 (57.25)	44 (17.25)
	Positive	230 (42.75)	211 (82.75)
Postoperative hypothermia, n (%)	Negative	522 (97.03)	219 (85.88)
	Positive	16 (2.97)	36 (14.12)

Table 3 Comparison of Two Groups of Observation Indicators in the Training Set Data

Risk Factors		Non-PDHA Group (n=396)	PDHA Group (n=199)	Statistics	P
Age (year)	≤40	105 (26.5)	9 (4.5)	140.556[a]	<0.001
	>40 and ≤60	188 (47.5)	28 (14.1)		
	>60 and ≤80	91 (23.0)	134 (67.3)		
	>80	12 (3.0)	28 (14.1)		
BMI (kg/m^2)		24.01±10.71	23.22±3.26	1.017[b]	0.31
Gender, n (%)	Male	252 (63.6)	36 (18.1)	110.010[c]	<0.001
	Female	144 (36.4)	163 (81.9)		
Degree of education, n (%)	Primary school or lower	194 (49.0)	114 (72.4)	37.007[a]	<0.001
	Junior middle school	110 (27.9)	43 (21.6)		
	Senior middle school or higher	92 (23.2)	12 (6.0)		
History of drinking, n (%)	Positive	95 (24.0)	68 (34.2)	6.902[c]	0.009
	Negative	301 (76.0)	131 (65.8)		
History of smoking, n (%)	Positive	54 (13.6)	80 (40.2)	53.563[c]	<0.001
	Negative	342 (86.4)	119 (59.8)		
History of coronary heart disease, n (%)	Positive	4 (1.0)	9 (4.5)	6.091[d]	0.014
	Negative	392 (99.0)	190 (95.5)		
History of stroke, n (%)	Positive	3 (0.8)	16 (8.0)	22.723[c]	<0.001
	Negative	393 (99.2)	183 (92.0)		
History of diabetes, n (%)	Positive	30 (7.6)	33 (16.6)	11.350[c]	0.001
	Negative	366 (92.4)	166 (83.4)		
History of hypertension, n (%)	Positive	98 (24.7)	84 (42.2)	19.024[c]	<0.001
	Negative	298 (75.3)	115 (57.8)		
History of previous operations, n (%)	Positive	197 (49.7)	98 (49.2)	0.013[c]	0.908
	Negative	199 (50.3)	101 (50.8)		
Sleep condition, n (%)	Considerably poor	21 (5.3)	20 (10.1)	11.398[a]	0.001
	Relatively poor	42 (10.6)	36 (18.1)		
	Normal	333 (84.1)	143 (71.9)		
Preoperative pain, n (%)	Positive	98 (24.7)	97 (48.7)	34.614[c]	<0.001
	Negative	128 (23.79)	122 (47.84)		
Preoperative low hemoglobin, n (%)	Positive	75 (18.9)	85 (42.7)	38.077[c]	<0.001
	Negative	321 (81.1)	114 (57.3)		
Preoperative low albumin, n (%)	Positive	98 (24.7)	134 (67.3)	100.988[c]	<0.001
	Negative	298 (75.3)	65 (32.7)		
Operation site, n (%)	Superficial tissue	139 (35.1)	18 (9.0)	44.960[c]	<0.001
	Deep tissue	257 (64.9)	181 (91.0)		
ASA classification, n (%)	1–2	379 (95.7)	150 (75.4)	52.203[a]	<0.001
	3–4	17 (4.3)	49 (24.6)		
Anesthesia mode, n (%)	General anesthesia	318 (80.3)	163 (81.9)	37.904[c]	<0.001
	Combined anesthesia	8 (2.0)	24 (12.1)		
	Intraspinal anesthesia	46 (11.6)	8 (4.0)		
	Other	24 (6.1)	4 (2.0)		
Anesthesia duration (min)		85 (37.0)	181 (58.0)	−13.264[e]	<0.001
Inhaled drug, n (%)	Positive	321 (18.1)	176 (88.4)	5.245[c]	0.022
	Negative	75 (18.9)	23 (11.6)		
Intraoperative hemorrhage, n (%)	Above 200mL	6 (1.5)	9 (4.5)	4.875[c]	0.027
	Below 200mL	390 (98.5)	190 (95.5)		

(*Continued*)

Table 3 (Continued).

Risk Factors		Non-PDHA Group (n=396)	PDHA Group (n=199)	Statistics	P
Postoperative hypothermia, n (%)	Positive	10 (2.5)	23 (11.6)	20.627[c]	<0.001
	Negative	386 (97.5)	176 (88.4)		
Postoperative indwelling drainage tube	Positive	164 (41.4)	164 (82.4)	89.992[c]	<0.001
	Negative	232 (58.6)	35 (17.6)		
Postoperative indwelling catheterization, n (%)	Positive	187 (47.2)	178 (89.4)	99.583[c]	<0.001
	Negative	209 (52.8)	21 (10.6)		
Use sedatives before operation, n (%)	Positive	28 (7.1)	13 (6.5)	0.060[c]	0.807
	Negative	368 (92.9)	186 (93.5)		
Postoperative PACU pain score (n)	0	262 (66.2)	74 (37.2)	89.740[a]	<0.001
	1	106 (26.8)	38 (19.1)		
	2	5 (1.3)	21 (10.6)		
	3	7 (1.8)	21 (10.6)		
	4	3 (0.8)	18 (9.0)		
	5	13 (3.3)	27 (13.6)		

Notes: Data are expressed as n (%) or median (interquartile range, Q); a: linear trend chi-square test statistic; b: *t*-test statistic; c: Pearson chi-square test statistic; d: Continuous corrected chi-square test statistic; e: Rank sum test statistic; P<0.05, indicated significant differences.

Independent Risk Factors of Occurrence of High Activity Delirium in PACU Adults

The observation indicators (P<0.01 in the univariate analysis were included in the logistic multivariate regression model. Multivariate regression results showed that seven observation indicators (sex, age, combined smoking history, low preoperative albumin level, ASA grade, duration of anesthesia, and postoperative PACU pain score) were directly correlated with the occurrence of PDHA (Table 4). Therefore, the above 7 indicators were independent risk factors for the occurrence of high-activity delirium in adults with PACU.

Predictive Model for Occurrence of Hyperactive delirium in PACU Adults

According to the independent risk factors in Table 4, the prediction value was 1.499×gender+0.955×age+1×smoking history +1.042×preoperative low albumin+1.211×ASA classification+0.0.15×duration of anesthesia+0.367×postoperative PACU pain score. The prediction model constructed in this study, based on multivariate regression analysis of the training dataset, is shown by a nomogram (Figure 2). The total risk of the prediction model was 0–200 points, and the risk rate was 0.1–0.9. The higher the total score, the higher is the risk of postoperative PDHA.

Table 4 Multivariate Regression Analysis of PDHA Risk Factors

Factors	B	SE	Z	P	OR	95% CI	
						Lower	Upper
Gender	1.499	0.293	26.212	<0.001	4.477	2.522	7.946
Age	0.955	0.191	24.925	<0.001	2.600	1.787	3.783
Smoking history	1.000	0.292	11.749	0.001	2.717	1.534	4.813
Preoperative low albumin	1.042	0.280	13.867	<0.001	2.834	1.638	4.903
ASA classification	1.211	0.409	8.789	0.003	3.357	1.507	7.476
Anesthesia duration	0.015	0.002	51.065	<0.001	1.015	1.011	1.019
Postoperative PACU pain score	0.367	0.090	16.649	<0.001	1.443	1.210	1.722

Abbreviations: B, regression coefficient; SE, standard error for regression coefficient; OR, odds ratio; CI, confidence interval; ASA, American society of anesthesiologists; PACU, post anesthesia care unit.

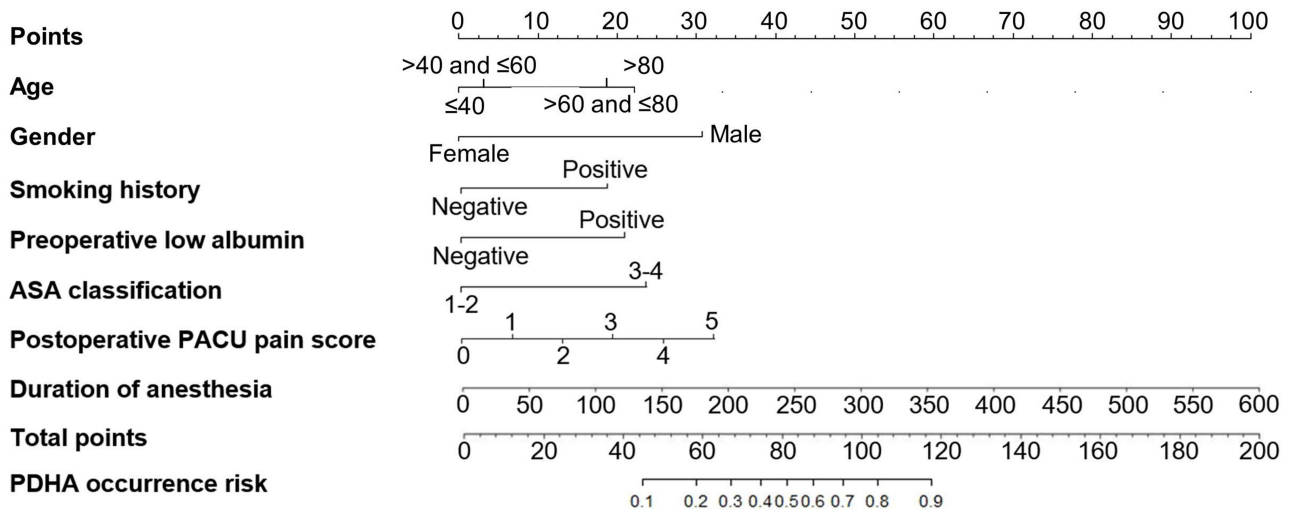

Figure 2 Postoperative PDHA risk prediction model nomogram.

Evaluation for Discrimination of Predictive Model of PACU Adult Hyperactive Delirium

The prediction model used the training set data to perform an ROC curve analysis of the total risk score for PDHA occurrence. The results showed that the area under the curve (AUC) and 95% confidence interval were 0.936 (0.917–0.955), respectively (Figure 3A). We randomly selected adult patients who underwent non-cardiac surgery and entered the PACU for observation from January 2020 to December 2020 as the validation set data (198 cases) to validate the effectiveness of the model. ROC curve analysis showed that the AUC and 95% confidence interval were 0.926 (0.885–0.967), respectively (Figure 3B). The AUC of both sets of data showed that the prediction model had good accuracy.

Evaluation for Calibration and Validity of Predictive Model of PACU Adult Hyperactive Delirium

The calibration and validity of the PACU for adult hyperactive delirium were also verified to determine the effectiveness of the predictive model. In this study, an accuracy curve of the risk prediction model for the occurrence of PDHA in adults after PACU was constructed. The results showed good consistency between the predicted and observed values (Figure 4A). Therefore, the model demonstrated a good prediction accuracy. This study also developed a postoperative

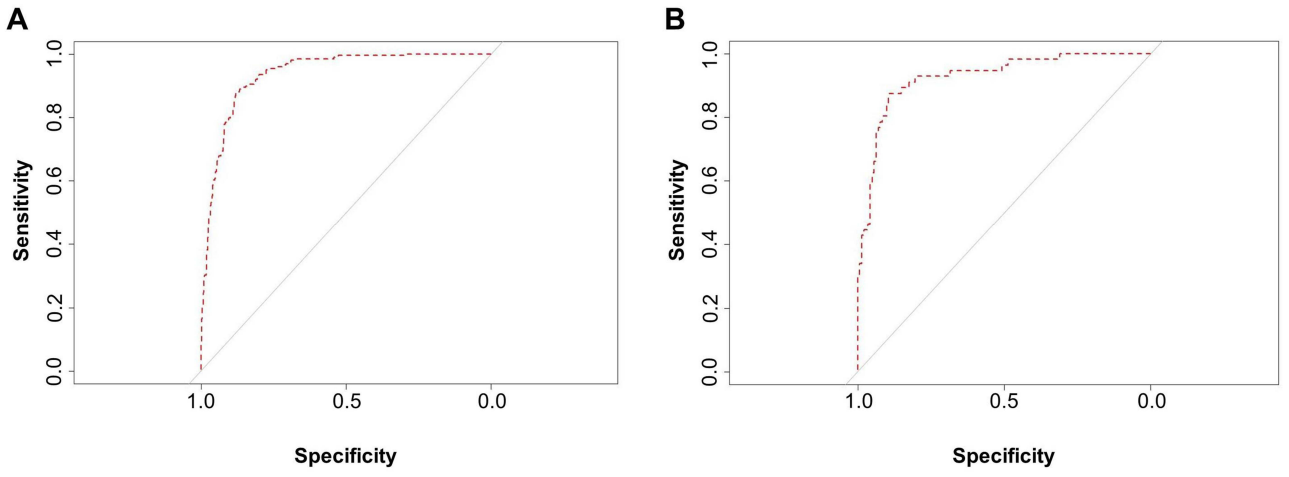

Figure 3 ROC curves for training datasets (**A**) and dataset datasets (**B**).

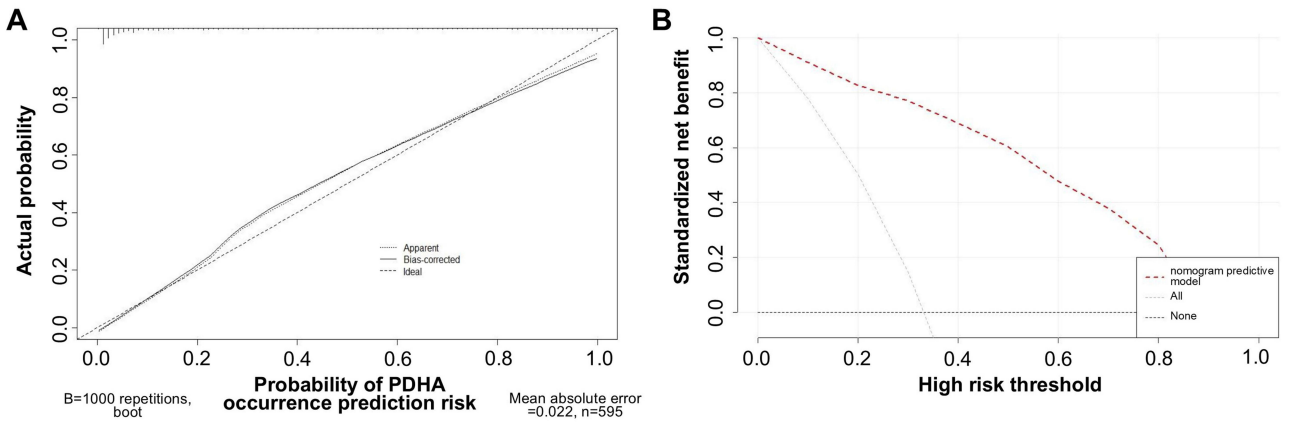

Figure 4 The accuracy curve (**A**) and decision curve (**B**) of the risk prediction model for postoperative PDHA occurrence.

delirium prediction model clinical decision curve to verify its clinical value. This curve showed a higher net benefit value and demonstrated that this model had good clinical application value (Figure 4B).

Discussion

In this study, seven observational variables, including sex, age, combined smoking history, preoperative low albumin level, ASA grade, duration of anesthesia, and postoperative PACU pain score, were found to be independent risk factors for the occurrence of hyperactive delirium in PACU adults. Age, ASA grade, duration of anesthesia, and postoperative PACU pain score were positively correlated with PACU adult postoperative PDHA risk. At advanced age, it is a comprehensive state that covers the degeneration and abnormalities of multiple organs throughout the body.[12] As the age increases, the brain tissue will progressively degenerate and the cerebral blood flow will decrease, leading to abnormal central neurotransmitter function and damage to the blood-brain barrier. After surgery, acetylcholine activity decreases and the brain's tolerance to external stimuli decreases in elderly patients. This causes tolerance to surgery and other stimuli to reduce and induce PDHA. A high ASA grade indicates a high vulnerability of the patient. At present, foreign studies have shown a significant correlation between vulnerability and postoperative delirium.[13–16] A high ASA grade indicates a higher risk of PDHA in the patient. The patient was anesthetized for a long time, indicating that the patient had a larger operation and more trauma, and was more likely to cause internal environmental disorders, resulting in insufficient blood supply to the brain. Postoperative pain can promote an increase in sympathetic nerve excitability, oxygen consumption, and neuroendocrine stress response[17] to induce postoperative PDHA. Therefore, we believe that relieving postoperative pain could reduce the incidence of postoperative PDHA. Therefore, the alleviation of postoperative pain can reduce the incidence of postoperative PDHA. A total of 255 patients in the PDHA group were included in this study, 209 of whom were male. The total number of men with PDHA was high as 81.96%. Compared with women, men are more likely to undergo PDHA after surgery. This verifies that the Tabet et al Research supports the susceptibility of male patients.[18] In terms of smoking, the proportion of domestic males is higher than that of females. It damages endothelial cells and promotes an inflammatory response mechanism, which is a potential factor in the occurrence of delirium. Poor systemic nutrition and poor liver function in patients with low albumin levels can affect the metabolism of toxic substances in the human body and induce delirium.

Traditional delirium risk assessment mainly uses logistic stepwise regression analysis, which has a good predictive effect. However, the calculation of fortune is cumbersome. This study constructed a nomogram chart of the risk prediction model for PDHA in adults after PACU, which can simply find the corresponding scores of each factor and then total the total. The calculation method is simple, intuitive, and visual, and the visual operation of the risk assessment model can be realized.

Due to the limitations of the research conditions, many risk factors were not included in this study for evaluation, such as the mental status of patients before surgery, intraoperative anesthesia medication, and intraoperative blood

pressure fluctuations. It was a retrospective study. Although the data were from a single-center sample, the sample size was large and the verification prediction model was good. Therefore, these results are clinically significant. However, if large-scale clinical promotion is required, a large sample size of multicenter research is needed for verification. Improve the forecasting model. Meanwhile, this study only investigated the high-activity delirium which is significantly less common that hypoactive and mixed delirium. In the following study, we would investigate the hypoactive and mixed delirium. Moreover, in clinical practice during the perioperative period, low-activity delirium is often difficult to distinguish from postoperative drowsiness caused by residual anesthetic drugs. High-activity delirium is easier to identify and can cause safety adverse events during the anesthesia period. Therefore, this study only studied the high-activity delirium, which is a limitation of this study, and further investigation of low-activity delirium would be conducted in the future.

Conclusions

Clinical medical staff should identify high-risk PDHA groups as soon as possible, correct these potential risk factors, and implement effective nursing interventions to reduce the incidence of PDHA, reduce the workload of anesthesia care, and reduce the incidence of PACU adverse events. This can improve the quality of anesthesia nursing safety management and enhance the effectiveness and safety of clinical treatments.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Clinical Research (ECCR) of the First Affiliated Hospital of Wenzhou Medical University (Approval No. 2021-102, Approval Date: June, 14th, 2021). All patients provided the written informed consents and approved this study. This study was performed in accordance with the 1964 declaration of Helsinki and later amendments.

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Disclosure

The authors have no competing interests to declare relevant to the content of this article.

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