



在线全文

结肠癌全身麻醉患者围手术期神经认知紊乱的影响因素及列线图预测模型构建*

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【摘要】目的 基于列线图构建结肠癌全身麻醉患者围手术期神经认知紊乱(perioperative neurocognitive disorders, PND)的风险预测模型。**方法** 选取2021年8月-2024年12月行全身麻醉下结肠癌手术的患者207例,按照7:3的比例随机分为建模队列($n=145$)和验证队列($n=62$)。根据患者是否发生PND,将建模队列分为PND组($n=42$)和非PND组($n=103$),验证队列分为PND组($n=18$)和非PND组($n=44$)。Logistic回归分析结肠癌全身麻醉患者发生PND的影响因素,并构建列线图预测模型,绘制受试者工作特征(receiver operating characteristic, ROC)曲线和校准曲线,行Hosmer-Lemeshow拟合优度检验。**结果** 单因素分析显示,PND组与非PND组患者年龄、手术时间、麻醉深度、术中出血量、术中平均局部脑氧饱和度(regional brain oxygen saturation, rSO_2)、血小板平均体积(mean platelet volume, MPV)、血小板分布宽度(platelet distribution width, PDW)、疼痛视觉模拟(visual analog scale, VAS)、睡眠质量指数(Pittsburgh Sleep Quality Index, PSQI)差异存在统计学意义($P<0.05$);Logistic多因素分析显示,年龄、麻醉深度、术中平均 rSO_2 、MPV、PDW、VAS、PSQI均是结肠癌全身麻醉患者发生PND的影响因素($P<0.05$);列线图模型ROC曲线下AUC为0.861(95%置信区间:0.786~0.935),在验证队列中AUC为0.827(95%:0.752~0.902);校准曲线分析结果发现,预测患者发生PND的风险和实际发生情况基本吻合,Hosmer-Lemeshow结果显示模型拟合优度较高;临床决策曲线结果显示该模型临床应用价值较高。**结论** 高龄、麻醉深度过浅、术中平均 rSO_2 低、血清MPV与PDW升高、疼痛程度较重及睡眠质量下降是结肠癌全身麻醉患者PND的影响因素;基于上述因素建立的列线图模型具有良好的预测能力。

【关键词】 结肠癌 围手术期神经认知紊乱 列线图 风险预测模型

Perioperative Neurocognitive Disorders in Patients With Colorectal Cancer Undergoing General Anesthesia: Influencing Factors and Development of a Nomogram Prediction Model

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[Abstract] Objective To develop a risk prediction model for perioperative neurocognitive disorders (PND) in patients with colorectal cancer undergoing general anesthesia based on a nomogram. **Methods** A total of 207 patients undergoing colorectal cancer surgery under general anesthesia from August 2021 to December 2024 were enrolled and randomly divided into a modeling cohort ($n=145$) and a validation cohort ($n=62$) at a 7:3 ratio. Based on the occurrence of PND, the modeling cohort was further divided into PND group ($n=42$) and non-PND group ($n=103$), while the validation cohort was divided into PND group ($n=18$) and non-PND group ($n=44$). Logistic regression analysis was performed to identify influencing factors for PND in patients with colorectal cancer undergoing general anesthesia, and a nomogram prediction model was constructed. Receiver operating characteristic (ROC) curves and calibration curves were plotted, and Hosmer-Lemeshow goodness-of-fit test was conducted. **Results** Univariate analysis showed statistically significant differences between PND group and non-PND group in age, operative time, anesthesia depth, intraoperative blood loss, intraoperative mean regional brain oxygen saturation (rSO_2), mean platelet volume (MPV), platelet distribution width (PDW), visual analog scale (VAS) for pain, and Pittsburgh Sleep Quality Index (PSQI) ($P<0.05$). Multivariate Logistic regression analysis revealed that age, anesthesia depth, intraoperative mean rSO_2 , MPV, PDW, VAS, and PSQI were all influencing factors for PND in patients with colorectal cancer undergoing general

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anesthesia ($P < 0.05$). The area under the ROC curve (AUC) of the nomogram model was 0.861 (95% CI: 0.786-0.935) in the modeling cohort and 0.827 (95% CI: 0.752-0.902) in the validation cohort. Calibration curve analysis indicated that the predicted risk of PND was largely consistent with the actual incidence, and the Hosmer-Lemeshow test showed good model fit. Clinical decision curve analysis demonstrated high clinical applicability of the model. **Conclusion** Advanced age, excessively light anesthesia depth, low intraoperative mean rSO_2 , elevated serum MPV and PDW, severe pain, and poor sleep quality are influencing factors for PND in patients with colorectal cancer undergoing general anesthesia. The nomogram model established based on these factors exhibits good predictive performance.

[Key words] Colorectal cancer Perioperative neurocognitive disorders Nomogram Risk prediction model

结肠癌是全球发病率与死亡率均居前五的常见消化道恶性肿瘤^[1-2]。国家癌症中心发布的最新数据显示, 2022年我国结肠癌新发病例达51.7万例, 而死亡病例达24万例, 分别居癌症谱第2位和第4位^[3]。近年来, 随着腹腔镜技术的不断进步, 结肠癌腹腔镜手术已成为治疗结肠癌的首选术式。该术式贯彻微创理念, 有助于减轻组织创伤、减低应激反应, 从而有效促进患者术后恢复^[4]。然而, 结肠癌手术通常麻醉时间较长, 全身麻醉是手术过程的关键环节, 对患者的术后恢复及并发症的发生具有重要影响。

围手术期神经认知紊乱(perioperative neurocognitive disorders, PND)是一种常见的手术麻醉并发症^[5-6]。研究显示, 接受全身麻醉的手术患者发生PND的概率较高, 尤其在老年患者中, 其发生率可达65%^[7]。PND不仅影响患者术后恢复, 还可能增加痴呆发生风险及远期死亡率等一系列严重后果, 已成为麻醉医学领域重要研究热点^[8]。然而, 目前关于结肠癌全麻手术患者PND发生情况的研究报道较少, 亦缺乏一种针对该人群、结合其疾病特征与临床指标的PND风险预测模型。

基于此, 本研究将对结肠癌全身麻醉患者PND的影响因素进行深入分析, 通过整合多个影响因素, 构建一个列线图预测模型, 以期能够更准确地预测结肠癌全身麻醉患者发生PND的风险, 为优化围手术期管理、降低PND发生率提供依据, 并为术后认知功能保护与康复探索新思路。

1 资料与方法

1.1 一般资料

回顾性选取2021年8月-2024年12月我院收治的207例结肠癌全麻手术患者, 随后将患者依照7:3的比例分为建模队列($n=145$), 验证队列($n=62$)。根据患者是否发生PND, 将建模队列分为PND组($n=42$)和非PND组($n=103$), 验证队列分为PND组($n=18$)和非PND组($n=44$)。纳入标准: ①符合《2021版NCCN临床实践指南》^[9]中结肠癌诊断标准且经组织病理学确诊; ②年龄 $\geq$

18岁; ③具备手术指征, 无麻醉、手术禁忌症且接受全麻诱导; ④沟通能力正常无语言障碍; ⑤术前无认知功能障碍; ⑥临床资料完整无缺失。排除标准: ①存在五官感知障碍者; ②存在阿尔茨海默病、痴呆等精神疾病; ③病情严重无法配合者; ④存在脑卒中、癫痫等神经系统疾病; ⑤主要器官功能障碍者; ⑤肿瘤出现转移或存在其他恶性肿瘤; ⑦术中输血、心脏骤停等严重不良事件者; ⑧研究期间意外去世; ⑨无法配合完成量表评估者。本研究经安徽医科大学附属巢湖医院医学伦理委员会批准通过(批件号: KYXM-202103-007), 且符合《赫尔辛基宣言》^[10]。

1.2 方法

1.2.1 PND诊断标准

分别于术前1 d、术后7 d及术后30 d, 采用简易智能精神状态检查量表(Mini-Mental State Examination, MMSE)^[11]对患者的认知功能进行评估。该量表总分为30分, 分值越高表示认知功能越好, 其Cronbach's α 系数为0.818。同时, 于上述时间点进行神经心理学测试, 测试内容包括MMSE、颜色轨迹测试、数字广度测试、时钟绘图测试及语言流利度测试。参照ZHOU等^[12]研究方法, 若患者在术后7 d或30 d时, 与术前相比, 至少有两个测试项目的 $|Z|$ 值大于1.96, 则判定为发生PND。

1.2.2 基线资料调查

收集所有患者的基线资料, 包括性别、年龄、体质量、美国麻醉医师协会(ASA)分级、肿瘤位置、肿瘤分化程度、肿瘤组织学类型、手术时间、苏醒时间、麻醉深度、术中输液量、术中出血量、术中平均局部脑氧饱和度(regional brain oxygen saturation, rSO_2)以及术后镇痛方案。

1.2.3 实验室检查

术前、术后分别抽取患者空腹静脉血5 mL, 以转速3 000 r/min, 离心5 min, 分离血清, 取上清液置于 $-80\text{ }^{\circ}\text{C}$ 条件下保存。使用自动血液分析仪(贝克曼, DxH600)检测患者术前血小板平均体积(mean platelet volume, MPV)、血小板分布宽度(platelet distribution width, PDW)水平。采用血细胞分析仪(深圳迈瑞, BC-5380)检测患者术后血红蛋白(hemoglobin, HB)、红细胞计数(red blood cell

count, RBC)水平。

1.2.4 量表调查

使用疼痛视觉模拟量表(visual analog scale, VAS)^[13]评估患者术后疼痛情况;匹兹堡睡眠质量指数量表(Pittsburgh Sleep Quality Index, PSQI)^[14]评估患者术后睡眠质量。各量表Cronbach's α 分别为0.871、0.912。

1.3 统计学分析

采用SPSS 26.0分析数据,计量资料以 $\bar{x} \pm s$ 表示,行 t 检验,计数资料使用频数描述,组间比较采用卡方检验。对组间具有差异的多个变量进行共线性检验,对于容差 >0.1 及方差膨胀因子(variance inflation factor, VIF) <5 的自变量认为不具有共线性,纳入最终的logistic多因素回归分析。Logistic多因素回归分析结肠癌全身麻醉患者

PND的影响因素,采用R语言、rms程序包建立列线图预测模型,验证集的判别能力和校准图来评估列线图的准确性。绘制受试者工作特征(receiver operating characteristic, ROC)曲线下面积(area under the curve, AUC)评价列线图的分辨能力,Hosmer-Lemeshow检验并十折交叉验证进行模型一致性验证,采用决策曲线分析(decision curve analysis, DCA)评价模型的判别能力。 $P<0.05$ 为差异有统计学意义。

2 结果

2.1 建模队列与验证队列基线资料对比

结果见表1。经单因素分析,两组患者基线资料差异无统计学意义($P>0.05$),提示两组具有良好的可比性,

表 1 建模队列与验证队列基线资料对比
Table 1 Compares the modeling cohort and the validation cohort

Index	Modeling cohort (n = 145)	Validation queue (n = 62)	χ^2/t	P
Sex/case (%)			0.111	0.739
Male	90 (62.07)	40 (64.52)		
Female	55 (37.93)	22 (35.48)		
Age/yr.	65.72 $\pm$ 5.77	66.31 $\pm$ 5.26	0.692	0.490
BMI/(kg/m ²)	21.01 $\pm$ 1.64	21.24 $\pm$ 1.13	1.006	0.316
ASA classify/case (%)			0.194	0.660
< III classify	70 (48.28)	32 (51.61)		
III classify	75 (51.72)	30 (48.39)		
Tumor location/case (%)			4.784	0.188
Colon ascendens	57 (39.31)	24 (38.71)		
Colon transversum	11 (7.59)	3 (4.84)		
Colon descendens	19 (13.10)	5 (8.06)		
Colon sigmoideum	58 (40.00)	30 (48.39)		
Degree of tumor differentiation/case (%)			0.649	0.723
Well-differentiated	8 (5.52)	3 (4.84)		
Moderately differentiated	73 (50.34)	35 (56.45)		
Poorly differentiated	64 (44.14)	24 (38.71)		
Tumor histological type/case (%)			0.634	0.728
Adenocarcinoma	120 (82.76)	54 (87.10)		
Mucinous adenocarcinoma	18 (12.41)	6 (9.68)		
Other	7 (4.83)	2 (3.23)		
Operation time/min	188.24 $\pm$ 50.63	186.79 $\pm$ 51.98	0.187	0.852
Wake up time/min	29.35 $\pm$ 7.18	28.68 $\pm$ 7.25	0.613	0.540
Depth of anesthesia/case (%)			0.144	0.705
40-50	66 (45.52)	30 (48.39)		
50-60	79 (54.48)	32 (51.61)		
Intraoperative infusion volume/mL	830.74 $\pm$ 141.36	829.37 $\pm$ 143.91	0.064	0.949
Intraoperative bleeding/mL	74.63 $\pm$ 15.41	75.21 $\pm$ 14.28	0.253	0.800
Mean intraoperative rSO ₂ /%	64.59 $\pm$ 3.28	65.07 $\pm$ 3.19	0.972	0.332
Postoperative analgesic protocol/case (%)			0.282	0.596
Oral pain medication	76 (52.41)	30 (48.39)		
Analgesic pump	69 (47.59)	32 (51.61)		
MPV/fL	10.98 $\pm$ 0.86	10.94 $\pm$ 0.91	0.301	0.764
PDW/fL	16.23 $\pm$ 0.77	16.31 $\pm$ 0.68	0.708	0.480
HB/(g/L)	112.48 $\pm$ 20.72	111.87 $\pm$ 22.15	0.190	0.850
RBC/ $\times 10^9 L^{-1}$	4.40 $\pm$ 0.47	4.39 $\pm$ 0.51	0.137	0.891
VAS/score	2.98 $\pm$ 1.32	3.01 $\pm$ 1.30	0.151	0.881
PSQI/score	6.34 $\pm$ 2.10	6.37 $\pm$ 1.98	0.096	0.924
Preoperative MMSE/score	28.02 $\pm$ 0.98	27.94 $\pm$ 1.06	0.525	0.600

BMI: body mass index; ASA: American Society of Anesthesiologists; rSO₂: regional brain oxygen saturation; MPV: mean platelet volume; PDW: platelet distribution width; HB: hemoglobin; RBC: red blood cell count; VAS: visual analog scale; PSQI: Pittsburgh Sleep Quality Index; MMSE: Mini-Mental State Examination.

具备后续研究基础。

2.2 建模队列的PND组和非PND组基线资料对比

经对比, 两组患者年龄、手术时间、术中麻醉深度、术中出血量、术中平均 rSO_2 、术后镇痛方案、MPV、PDW、VAS、PSQI差异有统计学意义($P<0.05$), 其余资料差异均无统计学意义($P>0.05$), 见表2。

2.3 多重共线性检验

为排除单因素分析结果中8个差异指标间的多重共线性, 进行共线性检验。结果显示, 年龄、手术时间、麻

醉深度、术中出血量、术中平均 rSO_2 、术后镇痛方案、MPV、PDW、VAS、PSQI的容差均 >0.1 、VIF均 <5 。因此, 变量间无共线性, 可纳入下一步研究, 见表3。

2.4 多因素回归分析结肠癌全身麻醉患者PND的影响因素

以结肠癌全身麻醉患者发生PND作为因变量(非PND组=0, PND组=1), 以年龄、手术时间、麻醉深度(40~50=1, 50~60=0)、术中出血量、术中平均 rSO_2 、术后镇痛方案(口服止痛药=1, 镇痛泵=0)、MPV、PDW、VAS、PSQI为自变量, 纳入logistic多因素分析。结果显

表 2 建模队列的PND组和非PND组基线资料对比

Table 2 Comparison of baseline data between the PND and non-PND groups for the modeled cohort

Index	PND group (n = 42)	Non-PND group (n = 103)	χ^2/t	P
Sex/case (%)			0.163	0.687
Male	25 (59.52)	65 (63.11)		
Female	17 (40.48)	38 (36.89)		
Age/yr.	69.27 ± 6.54	62.36 ± 4.93	6.937	< 0.001
BMI/(kg/m ²)	21.05 ± 1.63	20.98 ± 1.48	0.251	0.802
ASA classify/case (%)			0.695	0.404
< III classify	18 (42.86)	52 (50.49)		
III classify	24 (57.14)	51 (49.51)		
Tumor location/case (%)			0.394	0.942
Colon ascendens	15 (35.71)	42 (40.78)		
Colon transversum	3 (7.14)	8 (7.77)		
Colon descendens	6 (14.29)	13 (12.62)		
Colon sigmoideum	18 (42.86)	40 (38.83)		
Degree of tumor differentiation/case (%)			0.118	0.906
Well-differentiated	2 (4.76)	6 (5.83)		
Moderately differentiated	22 (52.38)	51 (49.51)		
Poorly differentiated	18 (42.86)	46 (44.66)		
Tumor histological type/case (%)			0.571	0.568
Adenocarcinoma	36 (85.71)	84 (81.55)		
Mucinous adenocarcinoma	4 (9.52)	14 (13.59)		
Other	2 (4.76)	5 (4.85)		
Operation time/min	198.37 ± 54.79	180.21 ± 47.61	1.993	0.048
Wake up time/min	28.69 ± 7.25	29.31 ± 7.18	0.470	0.639
Depth of anesthesia/case (%)			6.403	0.011
40-50	26 (61.90)	40 (38.83)		
50-60	16 (38.10)	63 (61.17)		
Intraoperative infusion volume/mL	833.62 ± 136.01	827.96 ± 151.32	0.210	0.834
Intraoperative bleeding/mL	77.95 ± 16.97	72.21 ± 13.24	2.176	0.031
Mean intraoperative rSO_2 /%	62.24 ± 2.98	66.98 ± 3.61	7.524	< 0.001
Postoperative analgesic protocol/case (%)			10.852	< 0.001
Oral pain medication	31 (73.81)	45 (43.69)		
Analgesic pump	11 (26.19)	58 (46.31)		
MPV/fL	11.59 ± 0.74	10.32 ± 0.96	7.687	< 0.001
PDW/fL	17.67 ± 0.82	15.54 ± 0.59	17.518	< 0.001
HB/(g/L)	113.65 ± 19.87	110.97 ± 21.63	0.692	0.490
RBC/ $\times 10^9 L^{-1}$	4.42 ± 0.41	4.36 ± 0.52	0.668	0.506
VAS/score	3.39 ± 1.37	2.14 ± 1.29	5.198	< 0.001
PSQI/score	7.25 ± 2.60	5.26 ± 1.31	6.112	< 0.001
Preoperative MMSE/score	28.02 ± 0.98	27.94 ± 1.06	0.421	0.674

The abbreviations in the table are the same as those in Table 1.

表 3 多重共线性检验

Table 3 Multiple collinearity test

Index	Tolerance	VIF
Age	0.799	1.252
Operation time	0.645	1.543
Depth of anesthesia	0.565	1.770
Intraoperative bleeding	0.953	1.049
Postoperative analgesic protocol	0.647	1.546
MPV	0.782	1.278
PDW	0.486	2.058
VAS	0.811	1.234
Mean intraoperative rSO ₂	0.788	1.269
PSQI	0.749	1.335

VIF: variance inflation factor. All other abbreviations in the table are the same as those in Table 1.

示,年龄[比值比(odds ratio, OR)=1.191, 95%置信区间(confidence interval, CI): 1.093 ~ 1.299]、麻醉深度(OR=4.276, 95%CI: 1.292 ~ 14.153)、术中平均rSO₂(OR=0.600, 95%CI: 0.372 ~ 0.968)、MPV(OR=4.592, 95%CI:

2.413 ~ 8.736)、PDW(OR=62.575, 95%CI: 2.620 ~ 94.220)、VAS(OR=1.835, 95%CI: 1.272 ~ 2.647)、PSQI(OR=1.634, 95%CI: 1.259 ~ 2.119)均是结肠癌全身麻醉患者发生PND的影响因素, P 均<0.05, 见表4。

2.5 结肠癌全身麻醉患者PND的列线图预测模型

将所得的7项影响因素建立列线图预测模型方程:
 $\text{Log}(P)=0.175 \times \text{年龄} + 1.453 \times \text{麻醉深度} - 0.510 \times \text{术中平均 rSO}_2 + 1.524 \times \text{MPV} + 4.136 \times \text{PDW} + 0.607 \times \text{VAS} + 0.491 \times \text{PSQI} - 42.467$ 。各预测因子评分相加为模型总分, 根据总分对应结肠癌全身麻醉患者发生PND的风险, 见图1。

2.6 列线图模型区分度

结果见图2A、2B。绘制列线图模型在建模队列和验证队列中的ROC曲线, 建模队列AUC(95%CI)为0.861(0.786 ~ 0.935), 灵敏度0.778、特异度0.833、阳性预测值0.870、阴性预测值0.529; 在验证队列中AUC(95%CI)为0.827(0.752 ~ 0.902), 灵敏度0.764、特异度0.788、阳性预测值0.857、阴性预测值0.604。均提示该模型具有较好的区分度和判别能力。

表 4 多因素回归分析结肠癌全身麻醉患者PND的影响因素

Table 4 Multivariate regression analysis of factors affecting PND in patients under general anesthesia for colon cancer

Index	β	SE	Wald χ^2	P	OR	95% CI
Age	0.175	0.044	3.966	< 0.001	1.191	1.093-1.299
Operation time	-0.017	0.018	-0.935	0.350	0.983	0.948-1.019
Depth of anesthesia	1.453	0.611	2.379	0.017	4.276	1.292-14.153
Intraoperative bleeding	0.014	0.086	0.167	0.867	1.015	0.857-1.201
Mean intraoperative rSO ₂	-0.510	0.244	-2.091	0.037	0.600	0.372-0.968
Postoperative analgesic protocol	1.635	0.796	0.244	0.624	0.675	0.142-3.211
MPV	1.524	0.328	4.645	< 0.001	4.592	2.413-8.736
PDW	4.136	1.619	2.555	0.011	62.575	2.620-94.220
VAS	0.607	0.187	3.245	0.001	1.835	1.272-2.647
PSQI	0.491	0.133	3.696	< 0.001	1.634	1.259-2.119
Constant	-42.467	8.013	-5.300	< 0.001	-	-

SE: standard error; OR: odds ratio. All other abbreviations in the table are the same as those in Table 1.

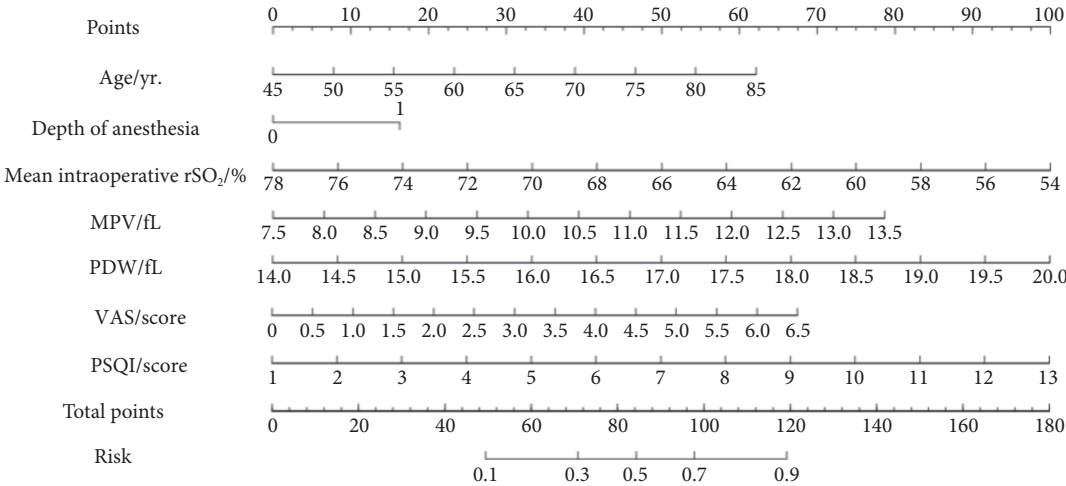


图 1 预测结肠癌全身麻醉发生PND的列线图模型

Fig 1 A nomogram model for predicting the occurrence of PND in general anesthesia in colon cancer

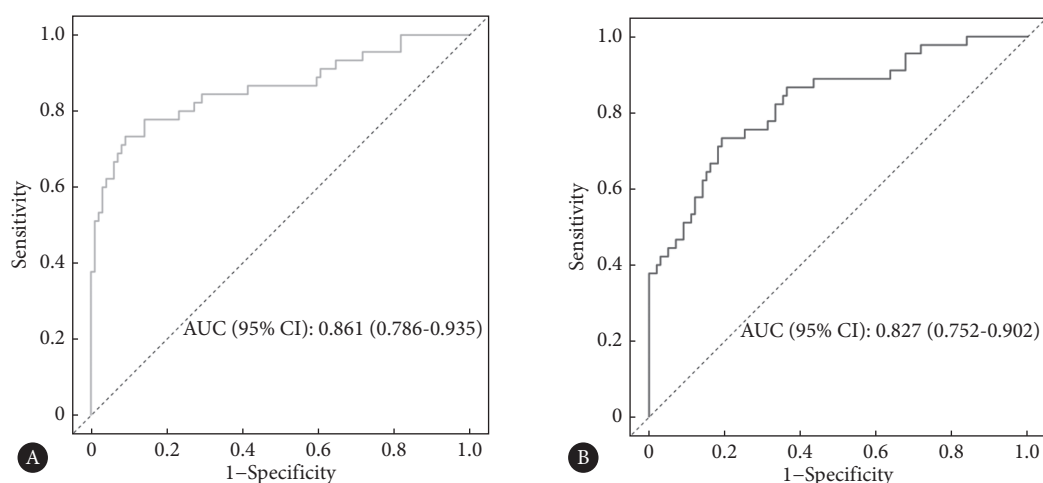


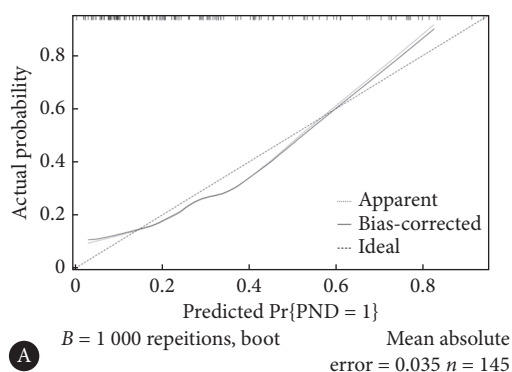
图2 预测结肠癌全身麻醉发生PND列线图模型的ROC曲线

Fig 2 ROC curve of the prediction model for PND in colon cancer patients undergoing general anesthesia

A, Modeling cohort; B, validation cohort.

2.7 列线图模型校准度

绘制列线图模型在建模队列和验证队列中的校准曲线, Hosmer-Lemeshow检验结果显示, 预测结果与实际结果一致性较好(χ^2 分别为5.728、7.464, 均 $P>0.05$), 模型校准能力良好, 见图3A、3B。



2.8 决策分析曲线

绘制列线图模型在建模队列和验证队列中的决策分析曲线, 结果显示, 列线图模型的净收益曲线整体趋势是随着阈值增加而下降, 预测概率在“0.05 ~ 0.95”、“0.1 ~ 0.8”时对患者进行干预, 则有更高的净获益, 见图4A、4B。

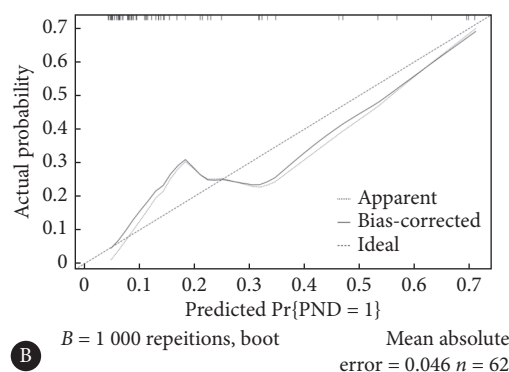


图3 预测结肠癌全身麻醉发生PND列线图模型的校准曲线

Fig 3 Calibration curve of PND line diagram model for prediction of general anesthesia in patients with colon cancer

A, Modeling cohort; B, validation cohort.

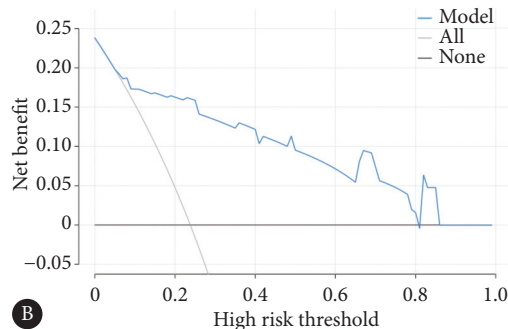
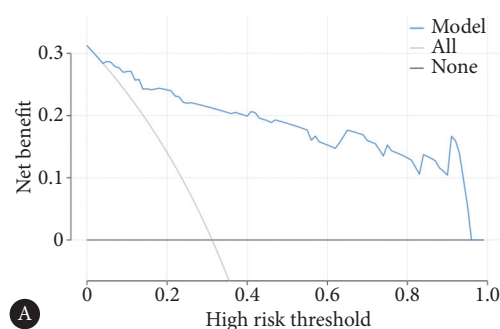


图4 预测结肠癌全身麻醉发生PND列线图模型决策曲线

Fig 4 Decision curve of PND line diagram model for prediction of general anesthesia in patients with colon cancer

A, Modeling cohort; B, validation cohort.

3 讨论

PND是手术患者常见的并发症,其临床多表现记忆、精神、情绪方面的错乱异常,且高发于老年、全麻手术患者^[15-16]。结肠癌是典型的消化道恶性肿瘤,手术是治疗该疾病的主要方法,而麻醉是手术过程中不可或缺的一环^[17]。本次研究发现,207例结肠癌全麻手术患者有60例发生PND,发生率较高,严重影响患者预后恢复。然而,目前临床对于PND的发病机制尚不明确,且缺乏有效的诊断手段,因此,分析PND相关影响因素,尽早识别出处于高风险状态、易于发生PND的结肠癌全麻手术患者,并密切监测与及时有效地干预,对于改善患者预后状况,减轻疾病负担具有重要意义。

多项研究指出^[18-19]高龄是PND发生的危险因素之一,且在老年患者中发生率较高。本次研究同样发现,高龄是结肠癌全身麻醉患者发生PND的危险因素($P<0.05$)。分析原因为,随着年龄的增长,机体各项生理机能都会逐渐下降,大脑出现一定程度的萎缩现象,导致神经元数量与神经递质减少,神经元之间的连接变得稀疏,从而影响大脑认知功能状态,促进PND的发生。同时,XU等^[20]认为,超过70岁的老年人群出现认知能力下降的现象很常见,且容易伴随多种合并症,多重因素共同作用下,使得老年结肠癌患者术后更容易出现PND。本次研究还发现,麻醉深度与术中平均 rSO_2 低均是结肠癌全身麻醉患者发生PND的危险因素(P 均 <0.05)。分析原因为,较浅的麻醉深度会导致患者术中出现应激反应,增加脑组织氧耗量, rSO_2 是反映脑组织氧合情况的重要指标,当该水平下降时多提示患者脑灌注不足,脑组织或处于缺氧状态,导致脑细胞代谢障碍,使神经递质失衡,进而影响术后认知功能恢复。ZHANG等^[21]发现,术中 rSO_2 变化与术后认知功能障碍呈明显相关性,监测该指标可保护患者认知功能,减少围手术期的不良后果。且DING等^[22]研究指出,术中监测 rSO_2 可降低术后神经认知障碍的发生率。同时,苏崇玉等^[23]认为,深度麻醉可减少因脑灌注不足导致的基底节神经与海马神经造成损伤,从而降低全身麻醉后认知功能障碍的风险。

本次研究发现,血清MPV与PDW水平高以及疼痛、睡眠质量不佳均是结肠癌全身麻醉患者发生PND的危险因素(P 均 <0.05)。分析原因为,MPV与PDW是血小板功能的重要参数,二者水平升高增加了血小板活化程度,促进血栓形成,导致脑血管阻塞,影响脑血流,从而对神经系统造成损害,增加PND的发生风险。有研究表明^[24],MPV与心脏手术患者术后认知功能的下降高度相关。祁

思忆等^[25]认为,PDW升高反映了血小板功能紊乱,进而影响神经递质的合成、释放和再摄取过程,增加神经系统的损伤风险,促进术后认知功能障碍的发生。同时,多项研究指出^[26-27],术后疼痛水平过高能够触发患者大脑炎症通路,激活下丘脑-垂体-肾上腺轴,诱导患者发生应激反应,促进细胞因子、趋化因子大量释放,使中枢神经过度活跃,导致神经元及其突触被损害,进而引发大脑神经系统失衡,使PND发。此外,术后疼痛还会促进患者术后发生睡眠紊乱,影响大脑主观认知功能,继而增加的PND的发生概率^[28]。WANG等^[29]研究指出,围手术期睡眠障碍,特别是急性睡眠剥夺,会诱发小胶质细胞和星形胶质细胞过度激活,从而导致术后认知障碍,改善患者围手术期睡眠质量可降低术后谵妄和术后认知功能障碍的发生率。

综上所述,高龄、麻醉深度与术中平均 rSO_2 低、血清MPV与PDW高以及疼痛、睡眠质量不佳是结肠癌全身麻醉患者PND的影响因素,通过上述因素本研究初步构建了一个PND预测模型,且进一步验证,但其应用需严格限定于相似临床场景。鉴于研究的单中心、小样本及回顾性设计,建议临床推广时需谨慎,在应用前应在多中心、多样化人群中进行外部验证,并补充纳入更多潜在影响因素以优化模型,避免过度依赖现有结果导致临床决策偏差。并在既往研究中发现,机体衰弱、ASA分级、高血压等因素也与PND有一定关联,后续可参考相关研究,借鉴影响因素,进一步防止PND发生,保障手术患者的预后恢复。

* * *

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