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在线全文

•临床研究•

糖尿病足溃疡患者住院时间延长风险预测模型构建及验证*

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【摘要】 **目的** 探究糖尿病足溃疡（diabetic foot ulcers, DFU）患者住院时间延长的危险因素，构建预测模型并进行内部验证。**方法** 回顾性收集2012年1月–2022年12月四川大学华西医院收治的住院DFU患者临床资料，并以7∶3随机拆分数据分配至训练队列与验证队列，将住院时间≥上四分位数确定为住院时间延长，采用训练队列分析其危险因素并建立风险预测模型，应用验证队列对模型进行验证。**结果** 共纳入住院DFU患者967例，其中245例患者住院时间延长。训练队列共676例，验证队列291例。多因素logistic 回归分析显示，吸烟史〔比值比（odds ratio, OR）=1.67，95%置信区间（confidence interval, CI）（1.13, 2.48），*P*=0.010〕、Wagner分级≥3〔OR=7.13，95%CI（3.68, 13.83），*P*<0.001〕、中足溃疡〔OR=1.99，95%CI（1.07, 3.72），*P*=0.030〕、后足溃疡〔OR=3.68，95%CI（1.83, 7.41），*P*<0.001〕、多部位溃疡〔OR=2.91，95%CI（1.80，4.69），*P*<0.001〕、溃疡面积≥3 cm^2〔OR=2.00，95%CI（1.28, 3.11），*P*=0.002〕、白细胞计数〔OR=1.11，95%CI（1.05, 1.18），*P*<0.001〕是DFU患者住院时间延长的危险因素。基于危险因素构建列线图，训练队列和验证队列受试者工作特征曲线的曲线下面积分别为0.782（95%CI 0.745, 0.820）及0.756（95%CI 0.694, 0.818），校准曲线显示预测概率与实际概率具有较高的一致性。**结论** 吸烟史，Wagner分级≥3，中、后足及多部位溃疡，溃疡面积≥3 cm^2，以及白细胞计数升高是DFU患者住院时间延长的危险因素，临床医师应加强对患者全面评估，采取合理诊疗措施以缩短住院时间。

【关键词】 糖尿病足溃疡 住院时间延长 风险预测模型 内部验证

Development and Validation of a Risk Prediction Model for Prolonged Hospitalization in Patients With Diabetic Foot Ulcers

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【**Abstract**】 **Objective** To investigate the risk factors associated with prolonged hospitalization in patients diagnosed with diabetic foot ulcers (DFU), to develop a predictive model, and to conduct internal validation of the model. **Methods** The clinical data of DFU patients admitted to West China Hospital, Sichuan University between January 2012 and December 2022 were retrospectively collected. The subjects were randomly assigned to a training cohort and a validation cohort at a ratio of 7 to 3. Hospital stays longer than 75th percentile were defined as prolonged length-of-stay. A thorough analysis of the risk factors was conducted using the training cohort, which enabled the development of an accurate risk prediction model. To ensure robustness, the model was internally validated using the validation cohort. **Results** A total of 967 inpatients with DFU were included, among whom 245 patients were identified as having an extended length-of-stay. The training cohort consisted of 622 patients, while the validation cohort comprised 291 patients. Multivariate logistic regression analysis revealed that smoking history (odds ratio [OR]=1.67, 95% confidence interval [CI], 1.13 to 2.48, *P*=0.010), Wagner grade 3 or higher (OR=7.13, 95% CI, 3.68 to 13.83, *P*<0.001), midfoot ulcers (OR=1.99, 95% CI, 1.07 to 3.72, *P*=0.030), posterior foot ulcers (OR=3.68, 95% CI, 1.83 to 7.41, *P*<0.001), multisite ulcers (OR=2.91, 95% CI, 1.80 to 4.69, *P*<0.001), wound size≥3 cm^2 (OR=2.00, 95% CI, 1.28-3.11, *P*=0.002), and white blood cell count (OR=1.11, 95% CI, 1.05 to 1.18, *P*<0.001) were associated with an increased risk of prolonged length of stay. Additionally, a nomogram was constructed based on the identified risk factors. The areas under the receiver operating characteristic (ROC) curves for both the training cohort and the validation cohort were 0.782 (95% CI, 0.745 to 0.820) and 0.756 (95% CI, 0.694 to 0.818), respectively, indicating robust predictive performance. Furthermore, the calibration plot

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demonstrated optimal concordance between the predicted probabilities and the observed outcomes in both the training and the validation cohorts. **Conclusion** Smoking history, Wagner grade≥3, midfoot ulcers, posterior foot ulcers, multisite ulcers, ulcer area≥3 cm^2, and elevated white blood cell count are identified as independent predictors of prolonged hospitalization. Therefore, it is imperative that clinicians conduct a comprehensive patient evaluation and implement appropriate diagnostic and therapeutic strategies to effectively shorten the length of stay for DFU patients.

【Key words】 Diabetic foot ulcers　Prolonged hospitalization　Predictive model　Internal validation

糖尿病足溃疡(diabetic foot ulcers, DFU)是合并下肢周围神经和(或)血管病变的糖尿病患者最常见也最具威胁性的慢性并发症之一[1]。大面积、多发部位、处于重要解剖位置或合并深层组织感染的溃疡通常是导致患者住院、截肢、死亡和预后不良风险升高的重要原因[2-3]。住院时间长短是评估医院医疗资源利用率、医疗质量和技术水平的重要指标之一[4],临床实践提示内分泌代谢科平均住院日最长的通常为糖尿病足病亚专业医疗组。住院时间延长同时伴随DFU患者医疗成本增加[5],给患者本人、家庭及医疗保健系统带来沉重的经济负担[6],同时也将延误等待入院的DFU患者最佳治疗时机,导致其病情加重、治疗难度增加并进一步延长住院时间,进而使DFU管理形成恶性循环。因此本研究分析DFU患者住院时间延长的危险因素,建立风险预测模型并对其进行内部验证,以期为缩短DFU患者平均住院日提供简明有效的理论支持,充分提高DFU综合管理和住院周转能力。

1　资料与方法

1.1　研究对象

本研究纳入2012年1月–2022年12月于四川大学华西医院内分泌代谢科糖尿病诊治中心住院的DFU患者。纳入患者符合国际糖尿病足工作组(The International Working Group on the Diabetic Foot, IWGDF)诊断标准[7]。排除合并非糖尿病性足溃疡(如痛风性溃疡、肿瘤性溃疡、静脉曲张性溃疡等),Wagner 0级溃疡,糖尿病手,入院前4周曾接受类固醇激素及免疫抑制剂治疗,相同溃疡部位重复就诊,自动出院,住院期间出现严重心脑血管事件或死亡,临床基线资料不完整者。本研究经四川大学华西医院临床医学伦理委员会批准(批准号2024年审110号)并通过中国临床试验注册中心审核(ChiCTR2400080747)。

1.2　研究方法

1.2.1　数据收集

通过电子病历系统收集患者临床资料,人口学资料包括性别、年龄、吸烟史、既往溃疡史、糖尿病病程和住院时间;溃疡特征包括溃疡持续时间、Wagner分级、溃疡性质、数目、部位、面积以及是否合并骨髓炎;检查检验指标包括空腹血浆血糖(fasting plasma glucose, FPG)、糖化血红蛋白(glycated hemoglobin, HbA1c)、甘油三酯(triglycerides, TG)、总胆固醇(total cholesterol, TC)、低密度脂蛋白胆固醇(low density lipoprotein cholesterol, LDLC)、高密度脂蛋白胆固醇(high density lipoprotein cholesterol, HDLC)、估算肾小球滤过率(estimated glomerular filtration rate, eGFR)、血清白蛋白(serum albumin, Alb)、血红蛋白(hemoglobin, Hb)、白细胞计数(white blood cell count, WBC)、血小板计数(blood platelet count, PLT)和踝肱指数(ankle brachial index, ABI)。

1.2.2　相关定义及分组标准

基于DFU患者住院时间的上四分位距分为住院时间延长组和住院时间非延长组[8]。以7∶3比例将DFU患者随机分配至训练队列和验证队列,训练队列用于探讨DFU患者住院日延长的危险因素及建立风险预测模型,验证队列用于验证预测模型的准确度。基于溃疡在足部的解剖部位分为前足、中足、后足和足踝以上溃疡。溃疡发生于两个部位及以上定义为多部位溃疡[9]。

1.2.3　统计学方法

采用SPSS 27.0软件进行统计学分析,对符合正态分布的计量资料采用$\bar{x}\pm s$进行统计描述,组间比较选择t检验或t'检验;否则采用中位数(四分位距)统计描述,组间比较选择Mann-Whitney U检验。计数资料以频数(百分率)表示,采用χ^2检验、Mann-Whitney U检验。把单因素分析中差异有统计学意义($P<0.05$)的变量进一步纳入多因素logistic回归分析中,采用向后逐步回归法筛选独立预测因素($P<0.05$)。将危险因素引入R软件(R 4.3.1)绘制列线图,采用随机拆分法(7∶3)进行模型内部验证,校准曲线和Hosmer-Lemeshow检验评估模型的准确度与拟合优度,并绘制受试者工作特征(receiver operating characteristic curve, ROC)曲线,使用曲线下面积(area under the curve, AUC)评估模型区分度。AUC>0.70表示模型预测效能良好,$\alpha_{双侧}=0.05$。

2　结果

2.1　基线特征比较

2012年1月–2022年12月共收治DFU患者1 681例,经严格入排标准后,共有967例符合标准的住院DFU患者进

入分析(研究流程见图1),其中位住院时间为35(20, 58) d,其中住院时间延长者245例(25.3%)。按照7∶3经过随机拆分形成训练队列及验证队列,训练队列患者数676例,验证队列患者数291例,两组间基线数据差异无统计学意义。训练队列患者中男性601例(62.2%),中位年龄66(56, 73)岁,中位住院时间为34(19, 57) d,其中167例住院时间延长(24.7%)。与住院时间非延长组相比较,住院时间延长组基线指标如年龄、吸烟史、Wagner分级、溃疡数目、部位、面积以及合并骨髓炎、FPG、HbA1C、TG、TC、HDLC、LDLC、Alb、eGFR、Hb、PLT、WBC等存在差异(P< 0.05),而其他指标差异无统计学意义。见表1。

2.2 DFU患者住院时间延长的独立危险因素

单因素分析结果提示,患者吸烟史、Wagner分级、溃疡数目、溃疡部位、溃疡面积、合并骨髓炎、FPG、HbA1C、TG、TC、HDLC、Alb、eGFR、Hb、PLT及WBC对住院时间延长的影响具有统计学意义(P< 0.05)。将这些因素进行共线性诊断,方差膨胀因子均< 10,表明各因素间无多重共线性。以上述16个因素为自变量进行多因素logistic回归分析,结果显示吸烟、Wagner分级、溃疡部位、溃疡面积和WBC是DFU患者发生住院时间延长的独立预测因素(P< 0.05)(表2)。

2.3 风险预测模型构建与内部验证

根据模型2所得独立危险因素构建DFU患者住院时间延长的预测概率回归方程: $\mathrm{Logit}(P)= -4.825+0.514x_1+1.964x_2+0.690x_3+1.303x_4+1.068x_5+0.693x_6+0.109x_7$。其中,$x_1$: 吸烟史,$x_2$: Wagner分级≥3,$x_3$: 中足溃疡,$x_4$: 后足溃疡,$x_5$: 多部位溃疡,$x_6$: 溃疡面积≥3 cm^2,x_7: WBC。x_1~x_6是= 1,否= 0; x_7取白细胞计数值。基于回归方程绘制DFU患者住院时间延长的列线图(图2)。建模队列的ROC曲线AUC值为0.782(95%CI 0.745, 0.820);验证队列的ROC曲线AUC值为0.756(95%CI 0.694, 0.818)(图3)。采用Bootstrap重抽样法(1 000次)对模型分别在训练队列、验证队列的进行校准度检验(图4),结果显示了预测和观察概率之间良好的一致性。Hosmer-Lemeshow拟合优度检验结果显示预测模型与观察数据的拟合状况良好(Chi-square= 8.283, P=0.406)。

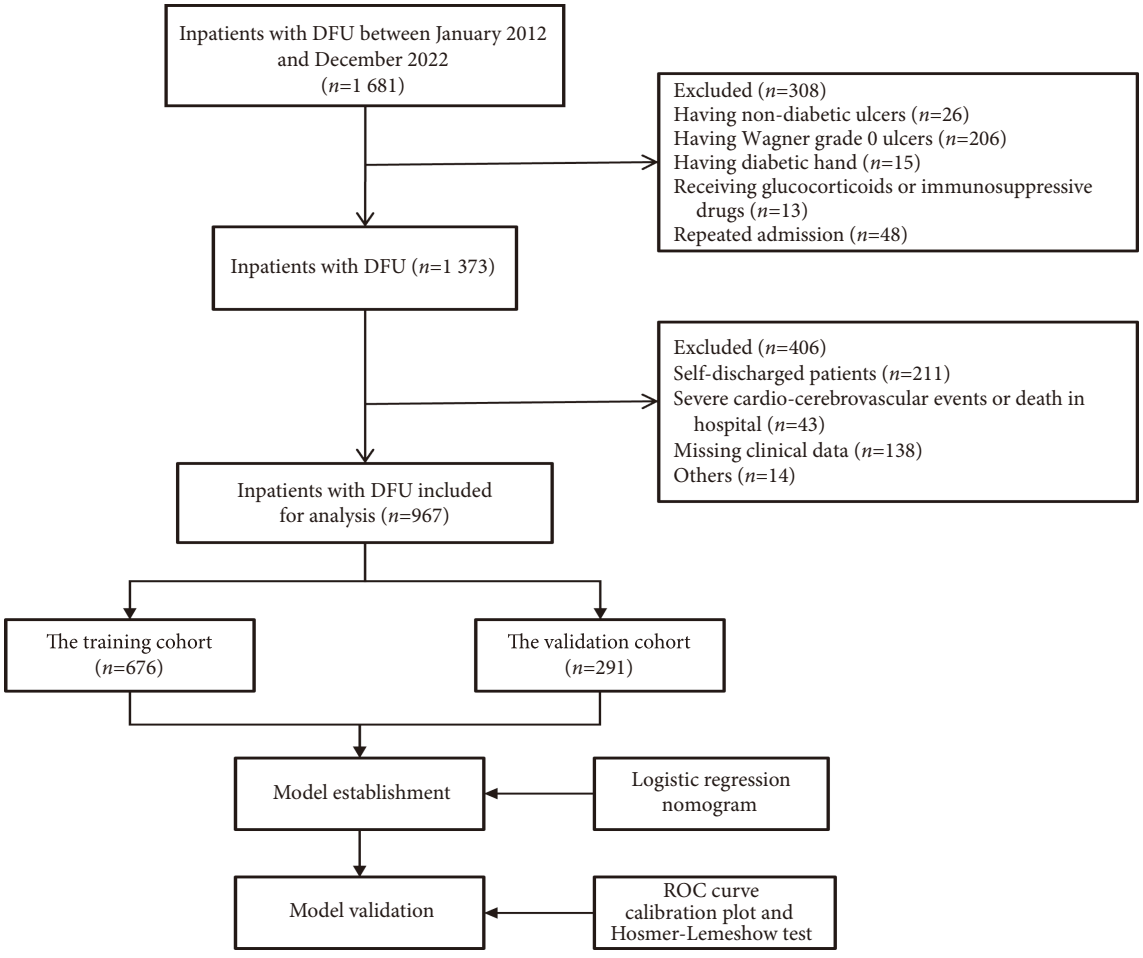

图 1 研究流程图

Fig 1 Study flow chart

表 1　不同住院时间DFU患者基线特征比较

Table 1　Comparison of baseline characteristics among patients with diabetic foot ulcers (DFU) with varying durations of length-of-stay

Item	Total (*n*=676)	The non-prolonged hospitalization group (*n*=509)	The prolonged hospitalization group (*n*=167)	*P*
Sex/case (%)				0.363
Male	413 (61.1)	306 (60.1)	107 (64.1)	
Female	263 (38.9)	203 (39.9)	60 (35.9)	
Age/yr., M (Q1, Q3)	65.0 (56.0, 73.0)	66.0 (56.0, 74.0)	64.0 (55.5, 70.0)	0.038
Smoking history/case (%)				0.049
No	332 (49.1)	261 (51.3)	71 (42.5)	
Yes	344 (50.9)	248 (48.7)	96 (57.5)	
Ulcer history/case (%)				0.650
No	415 (61.4)	310 (60.9)	105 (62.9)	
Yes	261 (38.6)	199 (39.1)	62 (37.1)	
Duration of diabetes/case (%)				0.763
<10 years	282 (41.7)	214 (42.0)	68 (40.7)	
⩾10 years	394 (58.3)	295 (58.0)	99 (59.3)	
Ulcer duration/case (%)				0.721
<1 month	259 (38.3)	196 (38.5)	63 (37.7)	
1-3 month	196 (29.0)	142 (27.9)	54 (32.3)	
>3 month	221 (32.7)	171 (33.6)	50 (29.9)	
Wagner grade/case (%)				<0.001
<3	191 (28.3)	179 (35.2)	12 (7.19)	
⩾3	485 (71.7)	330 (64.8)	155 (92.8)	
Ulcer classification/case (%)				0.208
Neurotic ulcer	198 (29.3)	149 (29.3)	49 (29.3)	
Neuro-ischemic ulcer	365 (54.0)	268 (52.7)	97 (58.1)	
Ischemic ulcer	77 (11.4)	60 (11.8)	17 (10.2)	
Other	36 (5.33)	32 (6.29)	4 (2.40)	
Number of ulcers/case (%)				<0.001
1	352 (52.1)	287 (56.4)	65 (38.9)	
2	147 (21.7)	110 (21.6)	37 (22.2)	
⩾3	177 (26.2)	112 (22.0)	65 (38.9)	
Ulcer site/case (%)				<0.001
Forefoot	359 (53.1)	299 (58.7)	60 (35.9)	
Midfoot	87 (12.9)	65 (12.8)	22 (13.2)	
Hindfoot	55 (8.14)	37 (7.27)	18 (10.80)	
Ankle	31 (4.59)	27 (5.30)	4 (2.40)	
Multisite ulcer	144 (21.3)	81 (15.9)	63 (37.7)	
Ulcer area/case (%)				<0.001
<3 cm^2	272 (40.2)	233 (45.8)	39 (23.4)	
⩾3 cm^2	404 (59.8)	276 (54.2)	128 (76.6)	
With osteomyelitis/case (%)				0.023
No	294 (43.5)	234 (46.0)	60 (35.9)	
Yes	382 (56.5)	275 (54.0)	107 (64.1)	
FPG/(mmol/L), M (Q1, Q3)	7.80 (6.28, 10.30)	7.59 (6.12, 9.95)	8.65 (6.68, 11.20)	0.001
HbA1C/case (%)				0.002
<7%	183 (27.1)	153 (30.1)	30 (18.0)	
⩾7%	493 (72.9)	356 (69.9)	137 (82.0)	
TG/(mmol/L), M (Q1, Q3)	1.43 (1.01, 2.18)	1.47 (1.04, 2.25)	1.36 (0.96, 1.87)	0.050
TC/(mmol/L), M (Q1, Q3)	3.70 (2.91, 4.54)	3.77 (3.01, 4.69)	3.43 (2.70, 4.25)	0.004
HDLC/(mmol/L), M (Q1, Q3)	1.09 (0.86, 1.39)	1.12 (0.88, 1.44)	1.00 (0.77, 1.27)	<0.001
LDLC/(mmol/L), M (Q1, Q3)	2.06 (1.44, 2.72)	2.11 (1.47, 2.77)	1.86 (1.35, 2.61)	0.039

续表 1

Item	Total (n=676)	The non-prolonged hospitalization group (n=509)	The prolonged hospitalization group (n=167)	P
Alb/case (%)				<0.001
⩾30 g/L	562 (83.1)	441 (86.6)	121(72.5)	
<30 g/L	114 (16.9)	68 (13.4)	46 (27.5)	
eGFR/case (%)				0.006
⩾60 mL/(min·1.73 m^2)	504 (74.6)	366 (71.9)	138 (82.6)	
15-<60 mL/(min·1.73 m^2)	147 (21.7)	122 (24.0)	25 (15.0)	
<15 mL/(min·1.73 m^2)	25 (3.70)	21 (4.13)	4 (2.40)	
Hb/(g/L), $\bar{x} \pm s$	116.0±21.9	118.0±20.9	111.0±24.3	0.002
PLT/($\times 10^9 L^{-1}$), M (Q1, Q3)	212 (159, 276)	204 (154, 266)	236 (175, 310)	<0.001
WBC/($\times 10^9 L^{-1}$), M (Q1, Q3)	6.94 (5.56, 8.72)	6.59 (5.40, 8.28)	7.72 (6.07, 10.60)	<0.001
ABI/case (%)				0.464
<0.4	435 (64.3)	332 (65.2)	103 (61.7)	
0.4-<0.9	52 (7.7)	38 (7.5)	14 (8.4)	
0.9-1.3	165 (24.4)	120 (23.6)	45 (26.9)	
>1.3	24 (3.6)	19 (3.7)	5 (3.0)	

FPG: fasting plasma glucose; HbA1C: glycosylated hemoglobin; TG: triglyceride; TC: total cholesterol; HDLC: high-density lipoprotein cholesterol; LDLC: low-density lipoprotein cholesterol; Alb: serum albumin; eGFR: estimated glomerular filtration rate; Hb: hemoglobin; PLT: platelets; WBC: white blood cell; ABI: ankle-brachial index.

表 2 DFU患者住院时间延长的单因素和多因素logistic回归分析

Table 2 Univariate and multivariate logistic regression analyses of prolonged length-of-stay in patients with DFU

Variable	Univariate regression		Multivariate regression model 1		Multivariate regression model 2	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Smoking history	1.42 (1.00, 2.02)	0.05	1.69 (1.14, 2.53)	0.010	1.67 (1.13, 2.48)	0.010
Wagner grade⩾3	7.01 (3.79, 12.96)		7.00 (3.59, 13.64)	<0.001	7.13 (3.68, 13.83)	<0.001
Number of ulcers						
2	1.49 (0.94, 2.35)	0.092				
⩾3	2.56 (1.71, 3.85)	<0.001				
Ulcer site						
Forefoot						
Midfoot	1.69 (0.97, 2.94)	0.066	1.76 (0.93, 3.33)	0.084	1.99 (1.07, 3.72)	0.030
Hindfoot	2.42 (1.29, 4.54)	0.006	3.47 (1.71, 7.06)	<0.001	3.68 (1.83, 7.41)	<0.001
Ankle	0.74 (0.25, 2.19)	0.584	1.53 (0.45, 5.17)	0.494	1.55 (0.46, 5.23)	0.484
Multisite ulcers	3.88 (2.52, 5.96)	<0.001	2.83(1.74, 4.60)	<0.001	2.91 (1.80, 4.69)	<0.001
Ulcer area⩾3 cm^2	2.77 (1.86, 4.13)	<0.001	1.93 (1.23, 3.02)	0.004	2.00 (1.28, 3.11)	0.002
Having osteomyelitis	1.52 (1.06, 2.18)	0.024				
FPG	1.06 (1.01, 1.11)	0.01	1.04 (0.99, 1.10)	0.135		
HbA1C⩾7%	1.96 (1.27, 3.04)	0.003				
TG	0.84 (0.72, 0.98)	0.025				
TC	0.85 (0.75, 0.97)	0.016				
HDLC	0.53 (0.35, 0.79)	0.002				
Alb⩾30 g/L	2.47 (1.61, 3.77)	<0.001	1.59 (0.98, 2.59)	0.060		
eGFR/(mL/[min·1.73 m^2])						
⩾60						
15-<60	0.54 (0.34, 0.87)	0.011	0.62 (0.37, 1.04)	0.072		
<15	0.51 (0.17, 1.50)	0.218	0.37 (0.11, 1.22)	0.102		
Hb	0.99 (0.98, 0.99)	0.001				
PLT	1.00 (1.00, 1.00)	<0.001				
WBC	1.16 (1.10, 1.23)	<0.001	1.10 (1.03, 1.16)	0.002	1.11 (1.05, 1.18)	<0.001
AIC			637.76		641.62	

Model 1 was fitted with variables selected directly by stepwise regression; model 2 was fitted with significant variables (P<0.05) in model 1. AIC: Akaike's information criterion. The other abbreviations are explained in the note to Table 1.

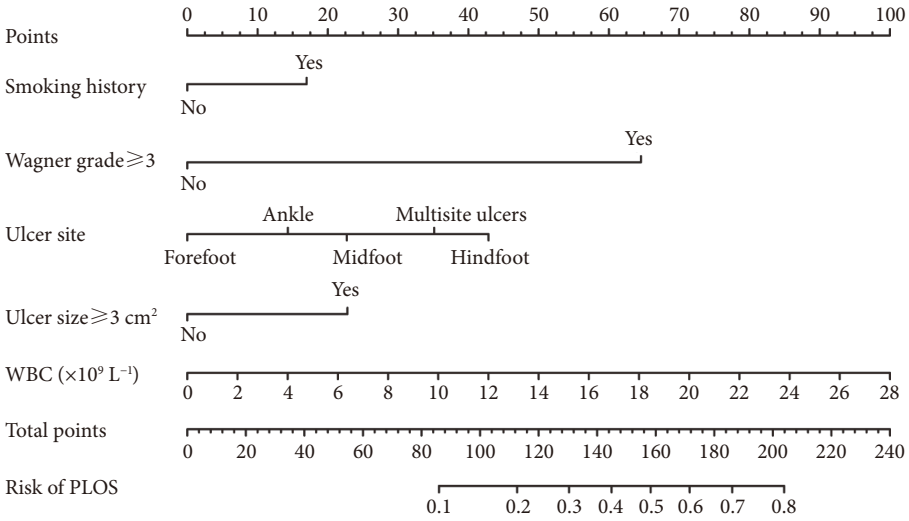

图 2 DFU患者住院时间延长的列线图预测模型

Fig 2 The nomogram prediction model for DFU patients who experience an extended duration of hospitalization

PLOS: prolonged length-of-stay.

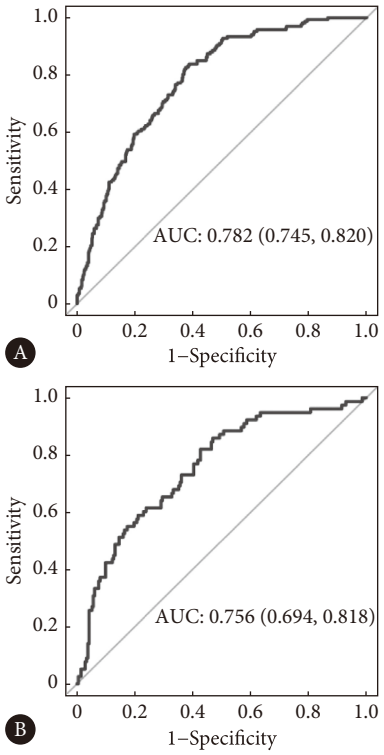

图 3 DFU患者住院时间延长的ROC曲线

Fig 3 ROC curve of DFU patients with prolonged length-of-stay

A, Training cohort; B, validation cohort.

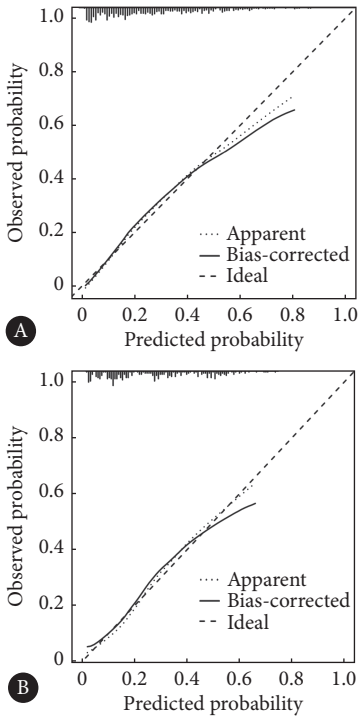

图 4 DFU患者住院时间延长的校准曲线

Fig 4 Calibration plots of DFU patients with prolonged length-of-stay

A, Training cohort; B, validation cohort.

3　讨论

本研究结果显示, 吸烟、Wagner分级、溃疡部位、溃疡面积、WBC是DFU患者住院时间延长的危险因素。基于危险因素构建了DFU患者住院时间延长风险的列线图, 其模型 ROC曲线、校准曲线及拟合优度检验结果表明其具有良好的预测能力及准确度。

本研究显示吸烟是DFU患者住院时间延长的危险因素。研究表明吸烟增加DFU发生、不愈合及截肢(趾)风险[10]。其可能的机制是吸烟导致下肢动脉粥样硬化、微

循环受损、氧化应激增强等,引起足部血供减少,促进创面形成、延迟创面愈合[11]。

研究发现Wagner分级≥3是DFU患者住院时间延长的危险因素,与EREN等[12]研究结论类似。Wagner分级常用于评估DFU患者溃疡严重程度,其等级越高预示着截肢风险越大[13],研究表明Wagner 分级≥4是住院期间不良结局(大截肢及院内死亡)的独立危险因素[14]。另外Wagner等级与创面感染存在相关性,队列研究显示Wagner分级≥3组别中患者感染率明显增加,且约43.7%感染DFU患者Wagner分级为5级[15]。中国西南地区DFU患者伤口分泌物培养研究发现随Wagner级别增加,创面由单一病原体感染转变为多病原体感染,且真菌感染比例增加[16]。因此,临床上强调早期发现并积极处理低Wagner级别患者,对改善DFU患者预后、减少住院时间均具有重要意义。

DFU多合并不同程度缺血,相较于前足丰富的侧支循环,后足血运供应相对单一。同时,足底不同部位皮肤组织学形态差异可能影响局部生物力学负荷及愈合能力[17]。Eurodiale研究表明随溃疡位置后移,溃疡愈合率下降,愈合时间延长[18]。此外,当DFU患者合并骨髓炎时,相较于前足,中足及后足溃疡无法通过小截肢改善病情[19],大截肢风险增加[20]。

溃疡面积是评估创面大小的重要指标,本研究发现溃疡面积≥3 cm^2是住院时间延长的危险因素,与MARQUES等[21]研究一致。这是由于溃疡面积增大,溃疡愈合可能性降低,愈合时间延长[22],且增加血运重建、大截肢及死亡风险[20]。

研究显示WBC升高是DFU患者住院时间延长的危险因素。WBC是临床评估急性感染的炎症标志物,研究表明WBC与DFU预后相关。与治疗痊愈组相比,治疗无效组基线WBC水平更高[23],且WBC升高增加截肢风险[24]。

本研究存在以下局限性。首先,本研究为单中心研究,结果无法推广于其他医疗单位;其次,研究时间跨度大,住院时间受这期间地区经济水平、医保政策、诊疗技术以及患者医疗意识等变化的影响。今后需进行多中心前瞻性大样本研究,以进一步评估模型效能。

综上所述,吸烟史,Wagner分级≥3,中、后足溃疡,多部位溃疡,溃疡面积≥3 cm^2及WBC升高是DFU患者住院时间延长的危险因素。临床医师需对DFU患者进行综合评估,采取合理诊疗方案,以达到缩短住院时间的目的。

* * *

作者贡献声明 王冰雪负责论文构思、数据审编、正式分析、研究方法和初稿写作,林婷负责数据审编,吴静负责研究方法和审读与编辑写作,龚洪平、任妍、查盼盼和陈利鸿负责调查研究,刘关键负责正式分析和研究方法,陈大伟和王椿负责提供资源,冉兴无负责论文构思、经费获取、提供资源、监督指导和审读与编辑写作。所有作者已经同意将文章提交给本刊,且对将要发表的版本进行最终定稿,并同意对工作的所有方面负责。

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