·临床研究·

老年全膀胱切除输尿管皮肤造口术患者压力性损伤高危因素分析及预测模型构建

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【摘 要】 **目的** 分析老年全膀胱切除输尿管皮肤造口术患者压力性损伤(PI)高危因素,并构建预测模型。**方法** 回顾性分析2022年1月至2023年11月南京医科大学第一附属医院收治的312例老年泌尿造口患者的临床资料,以2∶1比例分为训练集及验证集,在训练集使用单因素及多因素logistic回归分析筛选老年泌尿造口患者发生PI的危险因素,构建老年泌尿造口患者PI的预测模型。采用受试者工作特征(ROC)曲线评估预测模型的预测效能。采用SPSS 23.0软件进行数据分析。根据数据类型,组间比较分别采用t检验及χ^2检验。**结果** 训练集患者208例,验证集患者104例。训练集中23例(11.06%)患者发生PI,验证集中11例(10.58%)患者发生PI,差异无统计学意义($P=0.898$)。训练集的数据行多因素logistic回归分析,结果显示,年龄、术前老年营养风险指数(GNRI)≤98、术后红外线热成像仪监测温度梯度>2℃、术后Braden评分<13分均为老年泌尿造口患者发生PI的独立危险因素($P<0.05$);以多因素logistic回归分析结果构建预测模型,ln(P/1-P)=-5.306+0.905×年龄+0.952×术前GNRI+1.256×术后红外线热成像仪监测温度梯度+1.124×术后Braden评分。ROC曲线结果显示,在训练集中,预测模型AUC值为0.854(95%*CI* 0.772~0.936;$P<0.05$);在验证集中,预测模型AUC值为0.870(95%*CI* 0.796~0.945;$P<0.05$),提示模型在训练集与验证集中均有良好预测效能。**结论** 老年泌尿造口患者发生PI与年龄、术前营养状态、术后红外线热成像仪监测温度梯度及Braden评分有关,以此建立的预测模型对筛选PI高危患者具有临床指导价值。

【关键词】 老年人;泌尿造口;压力性损伤;危险因素;预测模型
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High risk factors of pressure injury in elderly patients with cutaneous ureterostomy after total cystectomy and construction of a prediction model

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【**Abstract**】 **Objective** To analyze the high risk factors of pressure injury (PI) in elderly patients receiving total cystectomy and cutaneous ureterostomy and construct a prediction model. **Methods** Clinical data of 312 elderly eligible patients in our hospital from January 2022 to November 2023 were collected in this retrospective study. The participants were divided into a training set and a validation set in a ratio of 2∶1. In the training set, univariate and multivariate logistic regression analyses were used to screen the risk factors of PI in the patients. Then a prediction model for PI in elderly patients with ureterostomy was constructed. Receiver operating characteristic (ROC) curve was plotted to evaluate the efficiency of the prediction model. SPSS statistics 23.0 was used for statistical analysis. Data comparison between two groups was performed using t test or χ^2 test depending on data type. **Results** There were 208 cases in the training set and 104 cases in the validation set. PI occurred in 23 cases (11.06%) in the training set and 11 cases (10.58%) in the validation set, and no statistical difference was observed in the PI incidence between the two sets ($P=0.898$). Multivariate logistic regression analysis indicated that in the training set, age, preoperative geriatric nutritional risk index (GNRI) ≤98, postoperative temperature gradient monitored by infrared thermography >2 ℃, and postoperative Braden score <13 points were independent risk factors of PI in elderly patients with ureterostomy ($P<0.05$). The constructed prediction model based on these factors was shown as ln(P/1-P)=-5.306+0.905×age+0.952×preoperative GNRI+1.256×postoperative temperature gradient+1.124×postoperative Braden score. ROC curve analysis revealed that AUC value of the prediction model in the training set was 0.854 (95%*CI* 0.772-0.936; $P<0.05$), and that in

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the verification set was 0.870 (95%*CI* 0.796-0.945; *P*<0.05), suggesting good predictive efficiency in both training set and verification set. **Conclusion** The incidence of PI in elderly patients with ureterostomy is related to age, preoperative nutritional status, postoperative temperature gradient by infrared thermography and Braden score. The prediction model based on these factors has clinical guiding value for screening patients at high risk for PI.

【Key words】 aged; urostomy; pressure injury; risk factors; prediction model

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输尿管皮肤造口是中晚期膀胱癌常用治疗手段,也是泌尿外科最常见的泌尿造口之一,泌尿造口不仅改变患者排尿方式,也导致患者活动受限,术后需长期卧床[1]。压力性损伤(pressure injury,PI)既往称为压疮,是长期卧床者的主要并发症之一,发生机制为压力及(或)剪切力刺激,以骨突处、医疗器械形成压力或剪切力的接触处为好发部位,可引起患者住院时间延长、感染风险升高[2]。老年人群皮肤脆弱、恢复能力差,故老年泌尿造口患者较青中年患者更易发生 PI[3]。然而,目前老年泌尿造口患者发生 PI 高危因素的报道主要为个案分析、综述等[4],缺乏临床试验证据。基于此,本研究旨在分析老年泌尿造口患者发生 PI 的危险因素,并构建预测模型,以辅助临床筛选 PI 高危人群,为临床治疗提供指导意见,报道如下。

1 对象与方法

1.1 研究对象

回顾性分析 2022 年 1 月至 2023 年 11 月南京医科大学第一附属医院收治的 312 例老年泌尿造口患者的临床资料。纳入标准:(1)经病理检查确诊为膀胱癌;(2)行择期全膀胱切除输尿管皮肤造口术治疗;(3)年龄≥60 岁;(4)首次行泌尿外科手术;(5)视听功能、认知功能正常,沟通能力良好;(6)术后均遵医嘱治疗,未自行出院或失访;(7)实验室检查、体格检查等资料完整。排除标准:(1)术前造口周围皮肤破损;(2)合并严重感染;(3)合并血液系统疾病或免疫系统疾病;(4)凝血功能障碍;(5)术后 24 h 死亡。

1.2 方法

1.2.1 术后干预方法 所有老年泌尿造口患者术后给予体位管理、皮肤清洁、营养支持等常规干预措施,其中术后体位需 2 h 更换 1 次,保持皮肤清洁、干燥,并维持床位整洁,患者衣物需清洁、无碎屑,饮食需以高蛋白、维生素充足食物为主,以补充营养。且术后 1 次/12 h 监测皮肤温度及 Braden 评分,其中皮肤温度使用红外线热成像仪监测,检测区域需在室温下暴露 3~5 min,测量时仪器距检测区域 30~50 cm,以局部皮肤较邻近正常组织的温度梯度>2℃ 提示存在显著温度差;Braden 评分包含感知觉、潮湿度、活动能力、移动能力、营养摄入、摩擦力/剪切力共 6 个项目,总分 6~23 分,得分<13 分为高度 PI 风险[5]。

1.2.2 PI 诊断方法 参考 2019 年版《压疮的预防和治疗:临床实践指南》[6],以局部受压部位中心点按压 5 s 红斑不褪色而皮肤完整,或存在皮肤表层缺损、真皮层暴露、伤口湿润且呈粉红色或伴浆液性水泡为 PI,以此分为 PI 组与非 PI 组。

1.2.3 资料收集方法 所有患者在术前 1 d 常规采集清晨空腹外周肘静脉血 3~4 ml,使用全自动生化分析仪(日本日立公司,型号:7600-220)检测血清白蛋白,计算 GNRI 值[7],GNRI = 1.489×血清白蛋白(g/L)+41.7×实际体质量(kg)/理想体质量(kg),男性理想体质量=身高(cm)-100-[(身高-150)/4],女性理想体质量=身高(cm)-100-[(身高-150)/2.5],GNRI≤98 提示老年患者存在营养状况不良。年龄、性别及既往史等资料查阅电子病历获得。

1.3 统计学处理

采用 SPSS 23.0 统计软件进行数据分析。符合正态分布的计量资料用均数±标准差($\bar{x}\pm s$)表示,采用 t 检验;计数资料用例数(百分率)表示,采用 χ^2 检验。训练集采用单因素及多因素 logistic 回归分析筛选老年泌尿造口患者发生 PI 的危险因素,构建老年泌尿造口患者发生 PI 的预测模型;在验证集中,采用 Hosmer-Lemeshow 检验评估预测模型的拟合度,采用受试者工作特征(receiver operating characteristic, ROC)曲线评估预测模型的预测效能。P<0.05 为差异有统计学意义。

2 结 果

2.1 研究对象的一般资料

将 312 例老年泌尿造口患者采用随机数生成器随机生成随机数作为病例编号,以该病例编号按升序排序,前三分之二为训练集(208 例),分析 PI 发生的危险因素并构建预测模型,后三分之一为验证集(104 例),评估预测模型的预测效能。训练集中

有23例(11.06%)患者发生PI,验证集中有11例(10.58%)患者发生PI,两组差异无统计学意义($\chi^2=0.017$,$P=0.898$)。

2.2 训练集两组患者一般资料

训练集PI组与非PI组患者年龄、术前GNRI、术后红外线热成像仪监测温度梯度、术后Braden评分比较,差异均有统计学意义(均$P<0.05$;表1)。

2.3 老年泌尿造口患者发生PI的单因素回归分析

单因素logistic回归分析显示,年龄、术前GNRI≤98、术后红外线热成像仪监测温度梯度>2℃、术后Braden评分<13分均为老年泌尿造口患者发生PI的危险因素($P<0.05$;表2)。

2.4 老年泌尿造口患者发生PI的多因素回归分析及预测模型构建

多因素logistic回归分析结果显示,年龄、术前GNRI≤98、术后红外线热成像仪监测温度梯度>2℃、术后Braden评分<13分均为老年泌尿造口患者发生PI的独立危险因素($P<0.05$;表3)。以多因素logistic回归分析结果各因素的β系数构建预测模型:In(P/1-P)=-5.306+0.905×年龄+0.952×术前GNRI+1.256×术后红外线热成像仪监测温度梯度+1.124×术后Braden评分。

2.5 预测模型预测效能分析

上述预测模型可基于4种因素计算PI的预测概率,以实际是否发生PI为基础,使用ROC评估预测模型计算的预测概率的检验效能,在训练集中,预测模型AUC值为0.854($P<0.001$),95% *CI* 0.772~0.936;在验证集中,预测模型AUC值为0.870($P<0.001$),95%*CI* 0.796~0.945(图1);提示模型在训练集与验证集中均有良好预测效能。

表1 两组患者一般资料比较

Table 1 Comparison of general data between two groups

Item	PI group($n=23$)	Non-PI group($n=185$)	χ^2/t	P value
Gender[n(%)]			0.018	0.893
Male	15(65.22)	118(63.78)		
Female	8(34.78)	67(36.22)		
Age(years, $\bar{x}\pm s$)	71.56±5.42	68.12±4.98	3.094	0.002
Body mass index(kg/m^2, $\bar{x}\pm s$)	21.76±2.04	22.49±2.13	1.557	0.121
Hypertension[n(%)]	13(56.52)	92(49.73)	0.378	0.539
Diabetes mellitus[n(%)]	4(17.39)	16(8.65)	0.934	0.334
History of smoking[n(%)]	7(30.43)	62(33.51)	0.088	0.767
Preoperative GNRI[n(%)]			6.026	0.014
≤98	14(60.87)	64(34.59)		
>98	9(39.13)	121(65.41)		
Pathological types of bladder cancer[n(%)]			4.702	0.095
Transitional cell papillary carcinoma	21(91.30)	182(98.38)		
Squamous cell carcinoma	1(4.35)	2(1.08)		
Adenocarcinoma	1(4.35)	1(0.54)		
Wound area(cm^3, $\bar{x}\pm s$)	5.29±0.98	5.15±0.93	0.677	0.499
Time of stoma bag replacement[n(%)]			1.119	0.290
<7 d	10(43.48)	102(55.14)		
≥7 d	13(56.52)	83(44.86)		
Postoperative infrared thermography monitoring temperature gradient >2℃ [n(%)]	17(73.91)	62(33.51)	14.174	<0.001
Postoperative Braden score<13 points[n(%)]	16(69.57)	65(35.14)	10.199	0.001

表2 老年泌尿造口患者发生PI的单因素logistic回归分析

Table 2 Univariate logistic regression analysis of PI in elderly patients with urinary stoma

Factor	β	*SE*	*Wald* χ^2	P value	*OR*	95%*CI*
Age	0.788	0.289	7.435	0.006	2.199	1.052-4.595
Intraoperative GNRI≤98	0.856	0.293	8.535	0.003	2.354	1.186-4.671
Postoperative infrared thermography monitoring temperature gradient> 2℃	1.123	0.307	13.381	<0.001	3.074	1.827-5.173
Postoperative Braden score<13 points	0.931	0.287	10.523	0.001	2.537	1.374-4.684

PI: pressure injury; GNRI: geriatric nutritional risk index.

表 3 老年泌尿造口患者发生 PI 的多因素 logistic 回归分析

Table 3 Multivariate logistic regression analysis of PI in elderly patients with urinary stoma

Factor	β	*SE*	*Wald* χ^2	*P* value	*OR*	95%*CI*
Age	0.905	0.304	8.862	0.003	2.472	1.268-4.817
Intraoperative GNRI≤98	0.952	0.311	9.370	0.002	2.591	1.360-4.937
Postoperative infrared thermography monitoring temperature gradient> 2℃	1.256	0.332	14.312	<0.001	3.511	2.150-5.736
Postoperative Braden score<13 points	1.124	0.319	12.415	<0.001	3.077	1.788-5.294
Constant	-5.306	1.598	11.025	0.001	0.005	-

PI: pressure injury; GNRI: geriatric nutritional risk index. -: no datum.

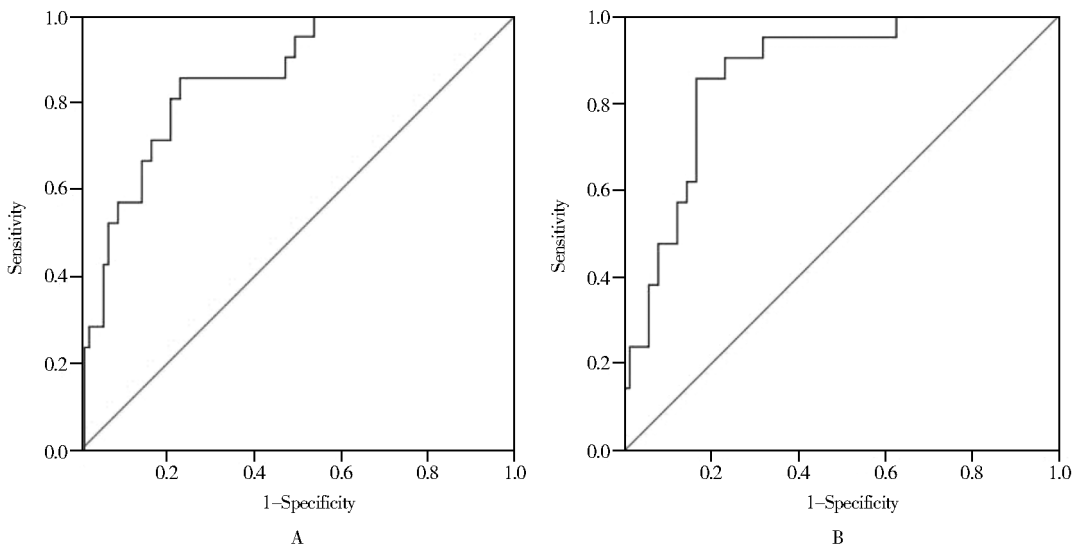


图 1 预测模型的预测效能分析曲线

Figure 1 Predictive efficiency analysis curve of the prediction model

A: ROC curve of prediction model in the training set for PI prediction; B: ROC curve of prediction model in the validation set for PI prediction. PI: pressure injury; ROC: receiver operating characteristic.

3 讨 论

手术患者是院内 PI 损伤的高危人群,老年泌尿造口患者术后卧床时间长,身体素质差,极易发生 PI,不仅增加住院时间及住院费用,也导致患者生活质量严重下降,增加感染等并发症发生风险[8]。目前报道的老年住院患者 PI 发生率在 10%~36%[9]。本研究中,训练集及验证集中 PI 发生率分别为 11.06%、10.58%,与上述报道一致。

营养状态不良被认为是成人住院患者发生 PI 的高危因素之一[10]。本研究也发现,术前 GNRI≤98 为老年泌尿造口患者发生 PI 的危险因素,提示术前营养状况欠佳者泌尿造口术后 PI 风险高。分析该结果的原因为营养不良者血液循环慢,血液白蛋白水平低下,血管内胶体渗透压下降,术后易发生组织水肿,增加 PI 发生风险[11]。因此,对于术前营养状态较差者可积极予以营养支持,尽早纠正营养状态,以降低老年泌尿造口患者术后 PI 发生率。本研究还发现,年龄也是老年泌尿造口患者发生 PI 的危险因素,考虑与年龄越大者器官组织衰老越明显,结缔组织更疏松,受到挤压、剪切力刺激时更易发生 PI 有关[12]。故对于年龄较大者可在术后借助空气流化床等工具,减轻局部皮肤压力与剪切力,降低 PI 发生风险。

另据文献报道,受压界面皮肤温度升高是 PI 发生的重要前期表现,压力或剪切力刺激导致缺血、细胞变形、间质液体流动障碍,该区域的血流供应变化也可以反映到皮肤温度变化[13]。既往缺乏皮肤温度监测的客观工具,难以通过皮肤温度预测 PI 的发生,近年随着红外线热成像技术在临床的广泛应用,通过便携式红外线热成像仪实时监测术后皮肤温度变化,可评估术后切口愈合、PI 发生情况[14]。本研究中,术后红外线热成像仪监测温度梯度>2℃是老年泌尿造口患者发生 PI 的危险因素,提示红外线热成像仪可为局部皮肤温度变化提供客观数据支持,有望成为老年泌尿造口患者术后 PI 预测的重要评估工具。

Braden 评分是以 PI 病因学角度制定的风险评估工具,已在临床广泛应用[15,16]。本研究结果显

示,术后 Braden 评分<13 分为老年泌尿造口患者发生 PI 的危险因素,提示 Braden 评分可综合感知、活动力、摩擦力等 6 方面因素预测 PI 的发生,在老年泌尿造口患者中也适用。然而,Braden 评分也存在缺陷,近年有报道认为,Braden 评分的评估内容主要为主观性指标,缺乏局部微循环等客观指标,难以准确预测 PI[17]。还有研究指出,不应单独使用 Braden 评分预测患者 PI 发生风险[18,19]。因此,综合多项指标能更准确预测 PI 风险。本研究基于多因素 logistic 回归分析结果构建 PI 预测模型 $\ln(P/1-P)=-5.306+0.905\times$年龄$+0.952\times$术前 GNRI$+1.256\times$术后红外线热成像仪监测温度梯度$+1.124\times$术后 Braden 评分,综合 4 项高危因素共同预测 PI,训练集与验证集 ROC 曲线分析结果显示,该预测模型的预测效能具有统计学意义,即根据 4 种因素能判断发生 PI 的风险数值,对于高风险者应予以重点防控及尽早临床干预,可为临床诊疗提供指导意见。然而,本研究作为单中心回顾性研究,存在代表性欠缺等缺点,还需后续联合其他医疗机构开展大样本量多中心研究,对本研究结论加以验证。

综上,术前营养状态较差、年龄较高的老年泌尿造口患者发生 PI 风险更高,通过术前积极营养支持、术后借助空气流化床等干预措施可能对降低 PI 发生风险有利。另外,术后评估 Braden 评分、利用红外线热成像仪监测温度梯度可辅助预测 PI 风险,指导临床治疗,综合 4 项指标构建的 PI 预测模型也具有良好应用价值。

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