

• 临床研究 •

## 相对血糖比值对脓毒症相关 ARDS 患者关系的研究

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**[摘要]** 目的: 研究相对血糖比值(stress hyperglycemia ratio, SHR)与重症监护病房(intensive care unit, ICU)住院的脓毒症相关急性呼吸窘迫综合征(acute respiratory distress syndrome, ARDS)患者的关系。方法: 回顾性纳入2019年10月—2024年2月在同济大学附属东方医院南院中心ICU住院的脓毒症患者375例, 根据患者入院即刻血糖、糖化血红蛋白(glycosylated hemoglobin, HbA1c), 计算SHR值。根据脓毒症患者入院是否发生ARDS分为ARDS组和非ARDS组, 比较两组患者一般临床资料; 应用多因素Logistic回归分析筛选脓毒症发生ARDS的危险因素; 用受试者工作特征(receiver operating characteristic, ROC)曲线分析SHR对脓毒症发生ARDS的预测价值。根据ARDS分级程度不同, 比较SHR在不同ARDS分级中的表现。结果: 发生脓毒症相关ARDS患者293例(78.1%), 其中轻度128例(44.7%)、中度116例(39.6%)、重度49例(16.7%), 与非ARDS组比较, ARDS组患者P/F指数更低, 而SOFA评分、SHR、入院血糖、乳酸水平较高, 呼吸机使用天数、血管活性药物使用天数、ICU住院天数较多, 差异均有统计学意义。多因素Logistic回归分析显示, SOFA评分(OR=1.307, 95%CI: 1.182~1.445)、SHR(OR=4.246, 95%CI: 1.940~9.296)是发生脓毒症相关ARDS的独立危险因素( $P < 0.001$ )。ROC曲线分析显示, SHR预测脓毒症相关ARDS发生的ROC曲线下面积(are under the curve, AUC)为0.682, 敏感度为38.6%, 特异度为91.4%; SHR联合SOFA评分预测脓毒症相关ARDS发生的AUC值为0.791, 敏感度为68.3%, 特异度为80.2%; 随着脓毒症相关ARDS的疾病越严重, SHR数值越高( $P = 0.002$ )。结论: SHR数值高是脓毒症患者并发ARDS的危险因素; SHR水平对脓毒症导致ARDS的发生及其严重程度有一定的关系及预测价值, 可作为快速预警的指标之一。

**[关键词]** 相对血糖比值; 脓毒症; 急性呼吸窘迫综合征

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## A study on the relationship between stress hyperglycemia ratio and sepsis-associated ARDS patients

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**[Abstract]** **Objective:** To study the relationship between the stress hyperglycemia ratio (SHR) and patients with sepsis-related acute respiratory distress syndrome (ARDS) admitted to the intensive care unit (ICU). **Methods:** A total of 375 patients with sepsis admitted to the ICU of the South Hospital of Oriental Hospital from October 2019 to February 2024 were retrospectively included. SHR was calculated based on the blood glucose and glycosylated hemoglobin (HbA1c) upon admission. The patients were divided into the ARDS group and the non-ARDS group according to whether ARDS occurred at the time of admission. The general clinical data of the two groups were compared. Multivariate logistic regression analysis was used to identify risk factors for the development of ARDS in sepsis patients. The predictive value of SHR for ARDS in sepsis was analyzed by receiver operating characteristic (ROC) curve. The performance of SHR was compared across different ARDS severity levels. **Results:** In this study, there were 293 patients with sepsis-related ARDS (78.1%), 128 patients with mild ARDS (44.7%), 116 patients with moderate ARDS (39.6%) and 49 patients with severe ARDS (16.7%). Compared with the non-ARDS group, the ARDS group had lower P/F ratio, higher SOFA scores, SHR, admission blood glucose levels, and lactate levels, as well as longer duration of mechanical ventilation, vasopressor use, and ICU stay, with statistically

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significant differences. Multivariate logistic regression analysis showed that SOFA score (OR=1.307, 95% CI: 1.182–1.445) and SHR (OR=4.246, 95% CI: 1.940–9.296) were independent risk factors for ARDS ( $P < 0.001$ ). ROC curve analysis showed that the area under the curve (AUC) value of SHR for predicting sepsis-associated ARDS was 0.682, with a sensitivity of 38.6% and a specificity of 91.4%. The combination of SHR and SOFA score had an AUC value of 0.791 for predicting sepsis-associated ARDS, with a sensitivity of 68.3% and a specificity of 80.2%. As the severity of sepsis-associated ARDS increased, SHR values were higher ( $P=0.002$ ). **Conclusion:** High SHR value is a risk factor for ARDS in sepsis patients. The level of SHR is related to the occurrence and severity of ARDS caused by sepsis and has predictive value. SHR can serve as a rapid warning indicator.

**[Key words]** relative blood glucose ratio; sepsis; acute respiratory distress syndrome

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脓毒症是机体对外界各种病原体导致感染而发生反应失调后出现多器官功能障碍的临床综合征<sup>[1]</sup>。常见于各种类型的感染、创伤、老年免疫力低下患者,是急危重症患者严重并发症之一。如今,随着对脓毒症发生发展的不断研究和分析,重症病房的脓毒症患者死亡率有所下降,但罹患脓毒症及脓毒症休克的比例仍较高,是各大重症病房患者死亡的主要原因<sup>[2-3]</sup>。如脓毒症未能得到及时有效的诊断并治疗,可能会进展为多器官功能障碍。其中急性呼吸窘迫综合征(acute respiratory distress syndrome, ARDS)是最常见,也是重症监护室患者发生呼吸衰竭的最主要原因,其病死率接近40%<sup>[4]</sup>。

短暂性高血糖可能是对急性疾病的反应,与不同临床情况下最差的临床结果相关<sup>[5]</sup>。这种血糖水平的变化称为应激性高血糖,可以通过相对血糖比值(stress hyperglycemia ratio, SHR)进行量化。研究表明,脓毒症患者入院血糖升高与预后呈现两面性<sup>[6-7]</sup>,SHR在预测脓毒症不良预后方面有一定价值。近年来,有研究报告指出,死亡的糖尿病合并COVID-19感染的患者在住院期间血糖水平较高。此外,另一项研究显示,住院期间的高血糖水平[而非糖化血红蛋白(glycosylated hemoglobin, HbA1c)]与COVID-19相关ARDS患者的较差预后有关,如30 d死亡率、机械通气时间、气管插管率等<sup>[8-9]</sup>。COVID-19相关高血糖可能是由于感染后大量使用皮质类固醇引起的<sup>[10]</sup>,也可能是脂肪组织功能障碍和胰岛素抵抗的结果,且未能有效发挥快速预警作用。此外,脓毒症相关ARDS与COVID-19感染相关ARDS在病理生理上存在显著差异,发病机制更为复杂。一些研究明确指出,血糖水平的相对升高可能与重症患者的不良预后相关<sup>[11-16]</sup>,考虑到血糖与ARDS之间存在多种混杂因素,目前相关研究较少,故本研究通过SHR分析探讨血糖水平与重症监护病

房(intensive care unit, ICU)住院的脓毒症相关ARDS患者的关系。

## 1 对象和方法

### 1.1 对象

选取2019年10月—2024年2月在同济大学附属东方医院南院中心ICU住院的脓毒症患者375例。脓毒症临床诊断标准:①确诊感染或疑似感染;②序贯性器官功能衰竭评分(sequential organ failure assessment, SOFA)较基线增加 $\geq 2$ 分<sup>[1]</sup>。纳入标准:①年龄18~80岁;②满足脓毒症临床诊断;③ARDS患者及ARDS严重程度分级(轻、中、重)需符合2012年柏林定义的诊断<sup>[17]</sup>。排除标准:①终末期肿瘤者;②肺终末期患者(严重肺纤维化、尘肺);③原发或继发性免疫缺陷者;④孕产妇、哺乳期女性;⑤入院当天死亡及未留取HbA1c者。本研究经过同济大学附属东方医院医学伦理委员会批准(2024YS-222)。

### 1.2 方法

根据入院首个静脉血糖及HbA1c,运用Nathan等<sup>[18]</sup>公式计算平均血糖:平均血糖=1.59×HbA1c-2.59。进一步计算SHR首次静脉血糖除以平均血糖所得值<sup>[11]</sup>,SHR=入院即刻血糖/1.59×HbA1c-2.59。

根据脓毒症患者合并ARDS与不合并ARDS分为两组,观察两组患者的临床一般资料,包括患者一般情况(性别、年龄等);血清实验室检查指标(炎症指标、生化、循环灌注指标等),器官支持情况(呼吸机、升压药等),入院血糖及SHR;ARDS患者根据氧合指数分为轻、中、重3组,同时记录3组的各项实验室指标、ICU住院天数、器官支持治疗情况、疾病严重程度各评分等。

### 1.3 统计学方法

采用SPSS25.0和Graphad5.0进行统计分析,连续性正态分布资料使用均数 $\pm$ 标准差( $\bar{x} \pm s$ )表示,非

正态分布资料使用中位数(四分位数)[ $M(P_{25}, P_{75})$ ]表示。组间差异分析使用独立 $t$ 检验、单因素方差分析(事后两组间检验使用LSD- $t$ )、Mann-Whitney  $U$ 和Kruskal-Wallis检验(事后两组间检验使用Bonferroni矫正),事后检验分类资料使用频数(百分率)[ $n(\%)$ ]描述,使用卡方检验(事后两组间检验使用Bonferroni矫正)。多因素分析使用二元Logistic回归分析。再将具有统计学意义的检验指标绘制成受试者工作特征(receiver operating characteristic, ROC)曲线,计算曲线下面积(area under curve, AUC),确定该指标的最佳诊断界值。相关性分析使用斯皮尔曼相关性分析。 $P < 0.05$ 为差异有统计学意义。

## 2 结果

### 2.1 患者特征

本研究纳入419例符合诊断标准者(图1),有44例满足排除标准,肺部疾病终末期9例,哺乳期2例,免疫缺陷病3例,终末期肿瘤21例,入院放弃治疗及入院死亡9例。最终375例患者入选。

在375例脓毒症患者中,有293例发生ARDS,则脓毒症相关ARDS的发生率为78.1%。与非ARDS组比较,ARDS组患者的入院血糖、SHR、乳酸、血红蛋白、SOFA评分、呼吸机使用天数、血管活性药物使用天数、ICU住院天数、28 d死亡率均显著升高, $P/F$ 值

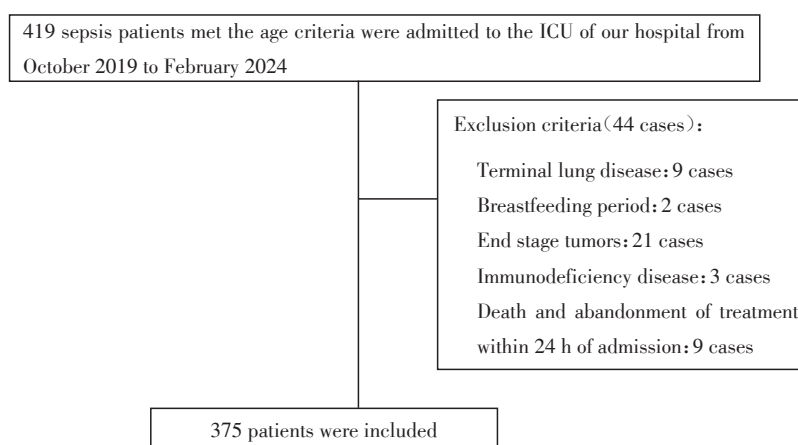


图1 脓毒症入选患者流程

Figure 1 Flowchart of sepsis patient selection

降低,差异均有统计学意义( $P < 0.05$ ,表1)。

### 2.2 脓毒症患者发生ARDS的危险因素的Logistic回归分析

多因素Logistic回归分析脓毒症相关ARDS发生的危险因素,结果显示,SHR、SOFA评分是脓毒症相关ARDS发生的独立危险因素( $P$ 均 $< 0.05$ ),入院血糖、乳酸水平非脓毒症相关ARDS发生的危险因素( $P > 0.05$ ,表2)。

### 2.3 SHR、SOFA评分、SHR联合SOFA评分对脓毒症相关ARDS患者发生的预测价值

ROC曲线分析SHR、SOFA评分、SHR联合SOFA评分对脓毒症相关ARDS发生的预测价值,结果显示,SHR预测AUC值为0.682,敏感度为38.6%,特异度为91.4%;SOFA评分预测AUC值为0.714,敏感度为47.4%,特异度为97.5%。SHR联合SOFA评分预测AUC值为0.791,敏感度为68.3%,特异度为80.2%(图2、表3)。

### 2.4 脓毒症相关ARDS疾病严重程度(轻、中、重)各临床资料比较

按照柏林标准将ARDS分级为轻、中、重,其中轻度128例、中度116例、重度49例,并分为3组进行比较,发现随着ARDS疾病严重程度的增加,SHR、乳酸、入院血糖、SOFA评分、胆红素水平逐渐升高,差异均有统计学意义( $P < 0.05$ )。3组患者其他资料比较差异均无统计学意义( $P > 0.05$ ,表4)。

脓毒症相关ARDS患者中,随ARDS疾病严重程度增加,SHR、乳酸、入院血糖、SOFA评分、胆红素成显著正相关,相关系数分别为0.170、0.288、0.159、0.161、0.158, $P$ 均 $< 0.01$ (表5)。

## 3 讨论

脓毒症是目前引起ICU患者死亡的主要病因之一<sup>[19]</sup>,每年全球有超过3 000万患者罹患此病,约530万人因此死亡,并且这一数字近年呈上升趋势<sup>[20]</sup>。

表1 发生ARDS组与非ARDS组患者临床资料比较

Table 1 Comparison of clinical data between the ARDS group and the non-ARDS group patients					
Variable	Total(n=375)	Non-ARDS group(n=82)	ARDS group(n=293)	Z/ $\chi^2$	P
Age[years, $M(P_{25}, P_{75})$ ]	73(64, 84)	72.50(63.75, 84.00)	74(64, 84)	-0.520	0.603
Sex[n(%)]				0.971	0.324
Male	219(58.4)	44(53.7)	175(59.7)		
Female	156(41.6)	38(46.3)	118(40.3)		
P/F[mmHg, $M(P_{25}, P_{75})$ ]	210(156, 290)	358(331, 397)	189(125, 239)	-13.751	<0.001
SOFA score[ $M(P_{25}, P_{75})$ ]	8(6, 11)	7(5, 9)	9(7, 12)	-5.860	<0.001
APACHE II score[ $M(P_{25}, P_{75})$ ]	17(12, 22)	16(11, 24)	17(13, 22)	-0.517	0.605
Lactic acid[mmol/L, $M(P_{25}, P_{75})$ ]	2.3(1.7, 4.2)	2.2(1.5, 2.9)	2.3(1.8, 4.2)	-2.446	0.014
WBC[ $10^9/L, M(P_{25}, P_{75})$ ]	13.87(9.25, 18.44)	13.57(9.92, 18.21)	13.96(9.09, 18.82)	-0.035	0.972
RBC[ $10^{12}/L, M(P_{25}, P_{75})$ ]	3.45(2.98, 3.98)	3.42(3.06, 3.89)	3.48(2.98, 3.99)	-0.327	0.743
PLT[ $10^9/L, M(P_{25}, P_{75})$ ]	94(74, 119)	94(73, 116)	94(75, 122)	-0.120	0.904
HB[g/L, $M(P_{25}, P_{75})$ ]	102(89, 116)	98(78, 113)	105(91, 118)	-2.785	0.005
N%[ $M(P_{25}, P_{75})$ ]	89.90(85.50, 92.60)	89.65(84.68, 92.30)	90.00(85.90, 92.60)	-0.958	0.338
L%[ $M(P_{25}, P_{75})$ ]	5.60(3.60, 9.50)	6.30(4.00, 9.75)	5.55(3.50, 9.43)	-0.919	0.358
PCT[ng/mL, $M(P_{25}, P_{75})$ ]	3.86(0.90, 17.68)	3.27(0.95, 15.10)	3.86(0.90, 17.89)	-0.507	0.612
Admission glucose [mmol/L, $M(P_{25}, P_{75})$ ]	9.80(8.30, 12.10)	9.00(7.55, 10.60)	10.00(8.60, 12.70)	-3.844	<0.001
SHR[ $M(P_{25}, P_{75})$ ]	1.35(1.08, 1.74)	1.22(0.92, 1.44)	1.40(1.15, 1.84)	-5.010	<0.001
Cr[ $\mu\text{mmol/L}, M(P_{25}, P_{75})$ ]	115(68, 189)	104(69, 167)	118(68, 190)	-1.011	0.312
TBIL[ $\mu\text{mol/L}, M(P_{25}, P_{75})$ ]	15.00(9.20, 30.00)	15.00(9.90, 25.35)	15.90(9.00, 32.20)	-0.152	0.880
TC[mmol/L, $M(P_{25}, P_{75})$ ]	3.35(2.63, 4.20)	3.12(2.56, 4.10)	3.45(2.68, 4.20)	-1.637	0.102
TG[mmol/L, $M(P_{25}, P_{75})$ ]	1.31(0.88, 1.98)	1.40(0.85, 2.15)	1.28(0.89, 1.86)	-0.390	0.697
ALB[g/L, $M(P_{25}, P_{75})$ ]	28.80(25.00, 32.00)	28.00(24.07, 32.00)	29.00(25.00, 32.50)	-1.036	0.300
HbA1c[% , $M(P_{25}, P_{75})$ ]	6.10(5.40, 7.00)	6.10(5.60, 7.20)	6.00(5.30, 7.00)	-1.737	0.082
CRP(mg/L)	100.33(52.80, 148.17)	111.36(56.20, 153.76)	96.52(48.23, 144.87)	-1.470	0.142
PT[s, $M(P_{25}, P_{75})$ ]	17.60(15.90, 19.80)	17.90(15.90, 19.90)	17.60(16.00, 19.80)	-0.166	0.869
D-dimer[ $\mu\text{g/mL}, M(P_{25}, P_{75})$ ]	11.30(6.45, 17.68)	11.30(6.44, 18.34)	10.50(6.52, 17.46)	-0.141	0.888
BNP[ng/L, $M(P_{25}, P_{75})$ ]	2 168.00(896.00, 6 218.02)	2 215.06(863.95, 6 341.00)	2 138.14(929.00, 6 638.51)	-0.399	0.690
MVP[mmHg, $M(P_{25}, P_{75})$ ]	85.00(68.00, 92.30)	86.10(71.50, 92.48)	84.10(67.00, 92.30)	-0.530	0.596
IL-6[pg/mL, $M(P_{25}, P_{75})$ ]	192.38(85.56, 340.03)	184.14(98.41, 331.53)	194.88(82.54, 354.19)	-0.035	0.972
ALT[U/L, $M(P_{25}, P_{75})$ ]	48.00(25.34, 99.00)	49.95(27.93, 108.00)	48.00(25.00, 99.00)	-0.441	0.659
28 born or not[n(%)]				5.682	0.023
Survival	167(44.50)	46(56.10)	121(41.30)		
Death	208(55.50)	36(43.90)	172(58.70)		
Ventilator[n(%)]				23.158	<0.001
No	127(33.90)	46(56.10)	81(27.60)		
Yes	248(66.10)	36(43.90)	212(72.40)		
ICU length of stay[d, $M(P_{25}, P_{75})$ ]	11(6, 18)	8(4, 15)	12(7, 18)	-3.172	0.002
Vasoactive drug duration [d, $M(P_{25}, P_{75})$ ]	5(2, 10)	2(0, 8)	5(2, 10)	-3.257	0.001
Number of days of ventilator use [d, $M(P_{25}, P_{75})$ ]	4(0, 10)	0(0, 5)	5(0, 12)	-4.791	<0.001
Hospitalization expenses [yuan, $M(P_{25}, P_{75})$ ]	71 052.53 (34 260.55, 150 213.39)	45 811.71 (27 057.52, 145 712.93)	74 171.86 (34 923.03, 153 372.85)	-1.464	0.143



表2 多因素Logistic回归分析脓毒症相关ARDS发生的危险因素

Table 2 Multivariate logistic regression analysis of risk factors for sepsis related ARDS

Indicator	B	SE	Wald	P	OR(95%CI)
Lactic acid	0.009	0.036	0.064	0.800	1.009(0.940-1.084)
SOFA score	0.268	0.051	27.368	<0.001	1.307(1.182-1.445)
SHR	1.446	0.400	13.086	<0.001	4.246(1.940-9.296)
Admission glucose level	0.080	0.059	1.843	0.175	1.083(0.965-1.215)

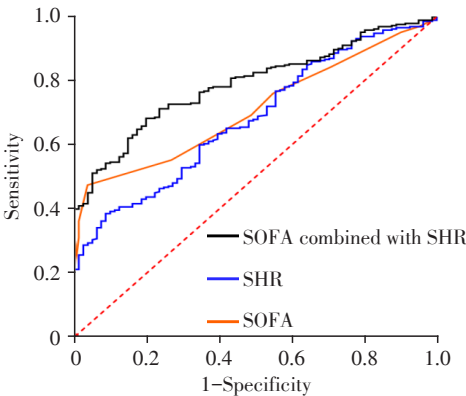


图2 SHR、SOFA评分、SHR联合SOFA评分对脓毒症相关ARDS发生的预测价值

Figure 2 The predictive value of SHR, SOFA score, and SHR combined SOFA score for sepsis related ARDS occurrence

ARDS是一种严重的肺衰竭形式,治疗选择有限,死亡率为35%~50%<sup>[21]</sup>。ARDS也常见于脓毒症住院患者中,突显出开发易于临床使用的预后生物标志物的必要性。生物标志物可以帮助检测疾病进展并指导治疗。尽管在ARDS亚型研究方面有所进展,早期预后生物标志物的开发仍然非常紧迫<sup>[22]</sup>。已有研究表明,单独依赖血糖指标在评价危重患者预后时,往往忽略了患者基础血糖水平的影响<sup>[16]</sup>。应激状态下的血糖水平升高是一种短暂的、与应激相关的生理反应,通常不直接与糖尿病相关,对于患者来说基础血糖水平的不同、每个人对于应激反应的差异及糖尿病的诊断未明等,单用入院血糖难以真正反映其疾病状态。为此,研究引入了一个新的指标SHR,它能够对应激引起的血糖变化与患者的基

表3 SHR、SOFA评分、SHR联合SOFA评分对脓毒症相关ARDS发生的预测价值

Table 3 The predictive value of SHR, SOFA score, and SHR combined SOFA score for sepsis related ARDS occurrence

Indicator	AUC	SE	P	95%CI	Sensitivity	Specificity	Cut-off value
SHR	0.682	0.031	<0.001	(0.622-0.742)	0.386	0.914	1.63
SOFA score	0.714	0.027	<0.001	(0.661-0.767)	0.474	0.975	9.50
SOFA combined with SHR	0.791	0.024	<0.001	(0.744-0.837)	0.683	0.802	0.78

础血糖水平进行比较和校正,突出了应激条件下血糖水平的相对变化情况。这类似于休克指数或体重指数的使用,SHR能反映重症患者在应激状态下血糖的变化。脓毒症相关ARDS的发生也涉及复杂的炎症和应激反应<sup>[21]</sup>。因此,本研究讨论了SHR升高与脓毒症相关ARDS之间的关系。

本研究发现,SHR对于预测脓毒症患者发生ARDS具有重要价值。ARDS患者的SHR明显升高,且随着ARDS病情的加重,SHR也逐渐升高。与入院血糖以及HbA1c相比,SHR在预测脓毒症相关ARDS的发生方面更具优势。尽管在脓毒症是否合并发生ARDS两组临床资料对比时,显示ARDS组与非ARDS组患者入院血糖差异有统计学意义,但多因素回归分析结果显示,入院血糖水平并非预测ARDS发生的独立危险因素,这提示由于患者基础

血糖水平不同、存在糖耐量受损或新发糖尿病诊断未明确等情况,脓毒症患者入院血糖绝对数值的高低无法真正反映患者的应激状态及病情危重程度。本研究还发现,炎症指标(如白细胞、降钙素原等)在ARDS组与非ARDS组之间差异无统计学意义,提示常规指标在某些疾病中可能会表现出不同的价值,而对于感染加重的情况以及不同病原体或感染部位的反应可能更为强烈,与既往报道一致<sup>[23-25]</sup>。此外,尽管ARDS组患者乳酸水平显著高于非ARDS组,但多因素分析显示乳酸水平非预测发生ARDS的独立危险因素,这可能是因为乳酸更能反映微循环灌注的情况,对于休克患者价值更大<sup>[26]</sup>。本研究结果显示,SHR、SOFA评分是脓毒症患者发生ARDS的独立危险因素,且二者与ARDS严重程度呈线性关系。SHR、SOFA评分联合用于预

表4 脓毒症相关ARDS疾病严重程度(轻、中、重)各临床资料比较

Table 4 Comparison of clinical data on the severity of sepsis related ARDS(mild, moderate, severe)

Variable	ARDS			$\chi^2/F$	P
	Light(n=128)	Moderate(n=116)	Severe(n=49)		
Age[years, $M(P_{25}, P_{75})$ ]	72(63, 85)	75(65, 83)	74(66, 83)	0.344	0.846
Sex[n(%)]				1.994	0.369
Male	73(57.00)	75(64.70)	27(55.10)		
Female	55(43.00)	41(35.30)	22(44.90)		
SOFA score[ $M(P_{25}, P_{75})$ ]	8.00(6.00, 12.00)	9.50(7.00, 12.75)	10.00(8.00, 12.00)	7.666	0.022
Lactic acid [mmol/L, $M(P_{25}, P_{75})$ ]	2.1(1.5, 3.0)	2.9(2.1, 5.1)	3.1(2.1, 7.5)	25.695	<0.001
WBC[ $10^9/L, M(P_{25}, P_{75})$ ]	14.35(9.33, 18.13)	13.96(9.08, 19.61)	13.12(8.97, 18.85)	0.288	0.866
N%[ $M(P_{25}, P_{75})$ ]	89.85(86.00, 92.48)	90.25(85.45, 92.60)	90.20(85.90, 92.90)	0.590	0.745
L%[ $M(P_{25}, P_{75})$ ]	5.60(3.60, 8.90)	5.50(3.20, 9.60)	5.30(3.35, 8.60)	0.231	0.891
PCT[ng/mL, $M(P_{25}, P_{75})$ ]	3.10(0.80, 20.36)	4.29(0.80, 15.30)	4.10(1.31, 16.32)	0.739	0.691
Admission glucose [mmol/L, $M(P_{25}, P_{75})$ ]	9.63(8.33, 12.10)	10.00(7.93, 12.75)	12.00(9.75, 13.50)	11.129	0.004
SHR[ $M(P_{25}, P_{75})$ ]	1.35(1.13, 1.73)	1.41(1.11, 1.83)	1.74(1.29, 2.23)	12.259	0.002
Cr[ $\mu\text{mmol/L}, M(P_{25}, P_{75})$ ]	117.50(66.50, 194.25)	119.50(68.25, 196.00)	100.00(67.00, 183.50)	2.471	0.291
TBIL[ $\mu\text{mol/L}, M(P_{25}, P_{75})$ ]	12.00(7.25, 24.80)	16.40(10.00, 32.50)	20.00(9.60, 36.80)	7.352	0.025
TC[mmol/L, $M(P_{25}, P_{75})$ ]	3.45(2.63, 4.21)	3.49(2.67, 4.21)	3.36(2.90, 4.14)	0.309	0.857
TG[mmol/L, $M(P_{25}, P_{75})$ ]	1.28(0.89, 1.98)	1.31(0.89, 1.84)	1.28(0.92, 1.82)	0.012	0.994
HbA1c[% , $M(P_{25}, P_{75})$ ]	6.00(5.30, 6.98)	6.10(5.10, 7.38)	5.90(5.10, 6.80)	5.055	0.080
CRP[mg/L, $M(P_{25}, P_{75})$ ]	90.14(44.84, 143.81)	97.58(59.55, 143.79)	104.85(29.59, 150.00)	1.454	0.483
PT[s, $M(P_{25}, P_{75})$ ]	18.00(15.90, 19.80)	17.60(16.00, 19.80)	17.40(16.00, 19.60)	0.145	0.930
D-dimer[ $\mu\text{g/mL}, M(P_{25}, P_{75})$ ]	9.55(6.21, 16.17)	11.97(6.60, 16.57)	12.41(6.67, 24.75)	2.112	0.348
BNP[ng/L, $M(P_{25}, P_{75})$ ]	2 215.06(1 080.18, 10 866.83)	2 153.07(895.26, 10 866.83)	1 906(833, 4 263.39)	0.424	0.809
MVP[mmHg, $M(P_{25}, P_{75})$ ]	85.30(69.15, 92.18)	83.00(65.00, 90.83)	85.00(73.00, 92.70)	2.037	0.361
IL-6[pg/mL, $M(P_{25}, P_{75})$ ]	205.79(86.97, 328.70)	194.88(82.49, 384.83)	172.13(80.47, 355.13)	0.288	0.866
ALT[U/L, $M(P_{25}, P_{75})$ ]	44.75(25.76, 100.50)	48.05(21.03, 96.00)	67.90(27.00, 100.50)	0.241	0.887
Hospitalization expenses [yuan, $M(P_{25}, P_{75})$ ]	61 624.13 (34 489.62, 148 489.42)	91 148.45 (35 882.05, 167 850.74)	71 880.49 (34 591.79, 138 176.6)	0.832	0.660

表5 脓毒症相关ARDS严重程度(轻、中、重)与各指标的相关性分析

Table 5 Correlation analysis between severity(mild, moderate, severe) of sepsis related ARDS and various indicators

Indicator	r	P
SHR	0.170	0.003
Lactic acid	0.288	<0.001
Admission glucose	0.159	0.006
SOFA score	0.161	0.006
TBIL	0.158	0.007

测脓毒症发生ARDS的敏感度为68.3%,特异度达80.2%,两者独立预测的能力相当,但SHR的优势在于其简便、快速,而SOFA评分则需要对多器官功能

进行全面评估后才能得出结论。如果能对SHR进行动态监测,可能更有助于疾病的发生和进展的评估,这也是今后研究的一个方向。另外,有研究表明,疾病较差预后与血糖呈J形关系<sup>[27-28]</sup>,提示还可以进一步比较在某一低血糖值范围内重症患者SHR变化对预后的影响。从本研究来看,SHR合并SOFA评分预测脓毒症发生ARDS方面效果良好,今后还可以通过进一步的前瞻性研究和动态监测来减少感染因素,并通过多中心研究结果确定SHR的最佳阈值,从而为后续研究提供更多参考。

本研究的优势在于仍在持续收集该疾病不同时间点的SHR数据,这为预测重症患者的预后提供了可操作性及可持续性。而局限性在于病例数较少且为单中心研究,患者的疾病严重程度差异较

大,这可能会对结果产生一定影响。

总之,SHR与脓毒症相关ARDS的发生密切相关,是预测ARDS的危险因素之一,且可用于评估脓毒症相关ARDS的严重程度,具有重要的临床应用价值。

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