

老年人群社区获得性肺炎的病原菌分布及发生风险评估模型的构建

王杨中¹, 汤雪斌², 刘道勇³

1. 重庆大学医学院, 重庆大学附属涪陵医院呼吸与危重症医学科, 重庆 408000;

2. 铜仁市人民医院呼吸与危重症医学科; 3. 长寿区中医院医学检验科

摘要:目的 探究老年人群社区获得性肺炎的病原菌分布情况及构建社区获得性肺炎高危人群风险评估模型, 为临床预防和控制肺炎提供依据。方法 纳入 2020 年 1 月至 2025 年 1 月于重庆大学附属涪陵医院进行住院治疗的 163 例老年社区获得性肺炎患者为肺炎组, 另选同期体检正常的 180 例老年人为对照组。对比两组患者基线资料, 使用 logistic 多因素分析影响老年人发生社区获得性肺炎的独立危险因素, 并基于因素分析结果构建列线图预测模型, 以受试者工作特征 (ROC) 曲线、校准曲线、Hosmer - Lemeshow 拟合优度检验评估模型效能。结果 163 例社区获得性肺炎患者中共分离出病原菌 172 株, 以白色念珠菌 (41.10%) 和肺炎克雷伯菌 (31.29%) 占比最高。logistic 分析结果显示, 吸烟史 ($OR = 1.971, 95\% CI: 1.396 \sim 2.783$)、脑血管病 ($OR = 1.300, 95\% CI: 1.013 \sim 1.668$)、贫血 ($OR = 1.281, 95\% CI: 1.014 \sim 1.618$)、肝肾功能不全 ($OR = 2.037, 95\% CI: 1.008 \sim 4.118$)、脓毒性休克 ($OR = 2.299, 95\% CI: 1.074 \sim 4.922$)、意识障碍 ($OR = 1.635, 95\% CI: 1.074 \sim 2.488$)、饲养动物 ($OR = 1.901, 95\% CI: 1.364 \sim 2.648$) 以及粉尘接触 ($OR = 1.478, 95\% CI: 1.048 \sim 2.085$) 均是老年人发生社区获得性肺炎的独立危险因素 ($P < 0.05$)。列线图 ROC 曲线显示, $AUC = 0.877 (95\% CI: 0.844 \sim 0.911)$, 灵敏度为 0.869, 特异度为 0.920。Hosmer - Lemeshow 检验结果显示: $P = 0.38$ ($P > 0.05$)。结论 吸烟史、脑血管病、贫血、肝肾功能不全等均是老年人发生社区获得性肺炎的独立危险因素, 应加强对其危险因素的早期预防和控制, 降低肺炎的发生风险。

关键词:社区获得性肺炎; 老年; 预测; 危险因素; 早期干预

中图分类号: R563.1 文献标志码: A 文章编号: 1003 - 8507(2026)12 - 2220 - 07

DOI: 10.20043/j.cnki.MPM.202601295

Construction of a prediction model for community - acquired pneumonia in the elderly population and analysis of prevention and treatment strategies

WANG Yang - zhong*, TANG Xue - bin, LIU Dao - yong

* School of Medicine, Chongqing University, Department of Respiratory and Critical Care Medicine,

Fuling Hospital Affiliated to Chongqing University, Chongqing 408000, China

Abstract: **Objective** To investigate the distribution of pathogenic bacteria in community - acquired pneumonia among the elderly population, to construct a risk assessment model for high - risk groups of community - acquired pneumonia, and to provide a basis for clinical prevention and control of pneumonia. **Methods** A total of 163 elderly patients with community - acquired pneumonia who were hospitalized in Chongqing Fuling Hospital, School of Medicine, from January 2020 to January 2025 were included as the pneumonia group, and another 180 elderly people with normal physical examinations during the same period were selected as the control group. By comparing the baseline data of the two groups of patients, logistic multivariate analysis was used to identify the independent risk factors for the occurrence of community - acquired pneumonia in the elderly. Based on the results of the factor analysis, a nomogram prediction model was constructed. The model's efficacy was evaluated using the receiver operating characteristic (ROC) curve, calibration curve, and Hosmer - Lemeshow goodness - of - fit test. **Results** A total of 172 pathogenic bacteria were isolated from 163 patients with community - acquired pneumonia, with *Candida albicans* (41.10%) and *Klebsiella pneumoniae* (31.29%) accounting for the highest proportion. The results of the logistic analysis showed that smoking history ($OR = 1.971, 95\% CI: 1.396 - 2.783$), cerebrovascular disease ($OR = 1.300$,

基金项目: 重庆市涪陵区科学技术局项目 (FLKJ2025AAN2078)

作者简介: 王杨中 (1986—), 男, 本科, 主治医师, 研究方向: 肺病感染与耐药

通信作者: 刘道勇, E-mail: 453400257@qq.com

95% *CI*: 1.013 - 1.668), anemia (*OR* = 1.281, 95% *CI*: 1.014 - 1.618), liver and kidney dysfunction (*OR* = 2.037, 95% *CI*: 1.008 - 4.118), septic shock (*OR* = 2.299, 95% *CI*: 1.074 - 4.922), consciousness disorder (*OR* = 1.635, 95% *CI*: 1.074 - 2.488), animal breeding (*OR* = 1.901, 95% *CI*: 1.364 - 2.648), and dust exposure (*OR* = 1.478, 95% *CI*: 1.048 - 2.085) were all independent risk factors for community-acquired pneumonia in the elderly ($P < 0.05$). The ROC curve of the nomogram showed that the AUC = 0.710 (95% *CI*: 0.661 - 0.759), the sensitivity was 0.702, and the specificity was 0.813. The Hosmer-Lemeshow test result showed: $P = 0.36$ ($P > 0.05$). **Conclusion** Smoking history, cerebrovascular disease, anemia, liver and kidney dysfunction, etc. are all independent risk factors for community-acquired pneumonia in the elderly. Early prevention and control of these risk factors should be strengthened to reduce the risk of pneumonia occurrence.

Keywords: Community-acquired pneumonia; Elderly; Prediction; Risk factors; Early intervention

社区获得性肺炎作为全球范围内感染性疾病中的主要致死病因,临床症状主要表现为发热,并伴有咳嗽、咳痰,同时可能出现胸痛及呼吸困难等情况,其病原体多为细菌、病毒或真菌,与医院等医疗机构内感染无关联^[1-2]。值得注意的是,当前该疾病的重症病例占比及患者年龄分布特征正呈现动态变化趋势。既往研究表明^[3],老年群体属于社区获得性肺炎的易感高危人群,尤其 60 岁及以上年龄段人群的发病率呈现显著增高态势。数据显示,2012 年我国肺炎死亡率平均值为 17.46 例/10 万人口,而在 85 岁及以上的高龄群体中,这一指标攀升至 864.17 例/10 万人口,显著高于整体平均水平^[4]。虽然经验性抗生素治疗能显著降低社区获得性肺炎的死亡风险,但该疾病的治疗失败情况仍较为常见,特别是在老年社区获得性肺炎患者中表现更为突出^[5]。因此,实行早期康复干预对降低老年人群社区获得性肺炎的发生率和病情严重程度具有重要意义。对老年社区获得性肺炎患者实施早期肺康复干预,不仅有助于有效清除其呼吸道分泌物、湿化气道,还能明显降低肺不张等并发症的发生几率^[6-7]。基于此,本研究旨在通过构建社区获得性肺炎高危人群预测模型,同时,设计早期干预方案,有望为社区获得性肺炎的个体化防控提供科学依据,最终改善患者预后并降低社会经济负担。

1 对象与方法

1.1 研究的对象 回顾性纳入 2020 年 1 月至 2025 年 1 月于重庆大学附属涪陵医院进行住院治疗的 163 例老年社区获得性肺炎患者为肺炎组,另选同期无肺炎疾病的 180 例老年人为对照组。本研究经重庆大学附属涪陵医院医学伦理委员会批准(审批号:K20252310.1),研究对象均知情同意。本研究涉及 13 个自变量,通常要求发生事件数至少是自变量的 5~10 倍,本研究肺炎组患者数量为 163,符合样本量要求。

肺炎组纳入排除标准:(1)纳入标准:①符合社区获得性肺炎的相关诊断标准^[8],且经临床检测具有发

热症状轻重不一,伴随呼吸功能异常如呼吸困难,呼吸道症状包括咳嗽并伴有痰液生成,肺部听诊时可闻及湿性啰音等体征;②年龄 ≥ 60 岁;③具有完整的临床资料;④该病症由细菌感染引发,且已通过病原学检查获得明确诊断依据。(2)排除标准:①合并免疫系统疾病;②存在其它呼吸道疾病;③合并肾功能障碍且需透析治疗;④长期使用糖皮质激素。

对照组纳入排除标准:(1)纳入标准:①年龄 ≥ 60 岁;②体格检查、血常规、胸部影像学检查无明显异常,无呼吸道感染症状;③体检资料完整,知情同意参与研究。(2)排除标准:①近 3 个月内有呼吸道感染、肺炎病史者;②合并慢性呼吸系统疾病;③胸部影像学检查显示陈旧性病灶、肺间质改变等异常者。

1.2 研究方法 临床资料调查:收集所有患者性别、吸烟史、饮酒史、冠心病、糖尿病、脑血管病、贫血、英国胸科协会改良肺炎评分(CURB) > 2 分、低蛋白血症、急性呼吸衰竭、肝肾功能不全、营养状态、衰弱、合并脓毒性休克、意识障碍、饲养宠物、长期粉尘接触以及病原菌检测结果。

1.3 疾病诊断标准 吸烟史:既往吸烟史 5 年以上,并且目前仍然吸烟者。饮酒史:既往饮酒史 5 年以上,并且目前仍然饮酒者。冠心病:《2019 年欧洲心脏病学会(ESC)慢性冠状动脉综合征诊断和管理指南》^[9],至少 1 支主要冠状动脉血管存在 $\geq 50\%$ 管腔狭窄(含临界病变)。糖尿病:《中国糖尿病防治指南(2024 版)》^[10],糖化血红蛋白 A1c $\geq 6.5\%$,或静脉空腹血糖 ≥ 7.0 mmol/L,或口服糖耐量试验时 2 h 血糖 ≥ 11.1 mmol/L。贫血:男血红蛋白 < 130 g/L,女血红蛋白 < 120 g/L。低蛋白血症:血清白蛋白 < 35 g/L。急性呼吸衰竭:《呼吸内科学》^[11],出现低氧饱和度($SaO_2 < 92\%$),经过清理气道、加大吸氧流量后仍不能改善,复测血气分析出现 $P(O_2) < 60$ mm Hg。肝肾功能不全:肝脏 B 超肝脏脂肪含量 $> 20\%$,天冬氨酸氨基转移酶(AST)升高 > 2.5 倍;白蛋白肌酐比值 ≥ 300 mg/g,满足其一即可判定肝功能异常。营养状态:采用营养风险筛查 2002 量表评估营养风险,分

值越高表明营养风险越高。衰弱:采用 FRAIL 量表评估。脓毒性休克:根据第三次脓毒症和脓毒性休克国际共识定义脓毒性休克。

1.4 统计学方法 采用 SPSS 27.0 软件处理数据。计量资料用($\bar{x} \pm s$)描述, t 检验;计数资料以[$n(\%)$]表示, χ^2 检验。应用 logistic 进行单因素和多因素回归分析筛选社区获得性肺炎的独立危险因素,后采用受试者工作特征(ROC)曲线分析其预测价值。检验水准 $\alpha = 0.05$ 。

2 结 果

2.1 社区获得性肺炎的病原菌分布情况 163 例社区获得性肺炎患者中以白色念珠菌占比最高。见表 1。

2.2 社区获得性肺炎因素的单因素分析 单因素分

析显示,吸烟史、脑血管病、贫血、CURB > 2 分以及肝肾功能不全是社区获得性肺炎的影响因素($P < 0.05$)。见表 2。

表 1 社区获得性肺炎的病原菌分布情况

Table 1 Distribution of pathogenic bacteria in community – acquired pneumonia

病原菌	例数(占比,%)
肺炎克雷伯菌	51(31.29)
白色念珠菌	67(41.10)
铜绿假单胞菌	3(1.84)
热带念珠菌	2(1.23)
金黄色葡萄球菌	2(1.23)
鲍曼不动杆菌	21(12.88)
产气肠杆菌	5(3.07)
大肠埃希菌	20(12.27)
阴沟肠杆菌复合菌	1(0.61)

表 2 社区获得性肺炎因素的单因素分析

Table 2 Univariate analysis of factors of community – acquired pneumonia

特征	肺炎组($n = 163$)	对照组($n = 180$)	χ^2 值	P 值
性别			0.219	0.640
男	82(50.31)	86(47.78)		
女	81(49.69)	94(52.22)		
吸烟史			15.679	<0.001
有	39(23.93)	15(8.33)		
无	124(76.07)	165(91.67)		
饮酒史			1.972	0.160
有	12(7.36)	7(3.89)		
无	151(92.64)	173(96.11)		
冠心病			5.989	0.014
有	16(9.82)	6(3.33)		
无	147(90.18)	174(96.67)		
糖尿病			2.554	0.110
有	9(5.52)	4(2.22)		
无	154(94.48)	176(97.78)		
脑血管病			24.691	<0.001
有	43(26.38)	12(6.67)		
无	120(73.62)	168(93.33)		
贫血			14.753	<0.001
有	83(50.92)	55(30.56)		
无	80(49.08)	125(69.44)		
CURB > 2 分			8.052	0.005
有	24(14.72)	10(5.56)		
无	139(85.28)	170(94.44)		
低蛋白血症			0.217	0.641
有	49(30.06)	50(27.78)		
无	114(69.94)	130(72.22)		
急性呼吸衰竭			0.696	0.404
有	52(31.90)	50(27.78)		
无	111(68.10)	130(72.22)		
肝肾功能不全			36.498	<0.001
是	99(60.74)	51(28.33)		
否	64(39.26)	129(71.67)		
营养状态			106.196	<0.001
营养风险评分 < 3 分	36(22.09)	140(77.78)		

(续表)

特征	肺炎组 (n = 163)	对照组 (n = 180)	χ^2 值	P 值
营养风险评分 ≥ 3 分	127 (77.91)	40 (22.22)	26.348	<0.001
衰弱				
是	62 (38.04)	25 (13.89)	37.598	<0.001
否	101 (61.96)	155 (86.11)		
脓毒性休克			6.244	0.013
有	62 (38.04)	18 (10.00)		
无	101 (61.96)	162 (90.00)	22.669	<0.001
意识障碍				
有	33 (20.25)	19 (10.56)	18.056	<0.001
无	130 (79.75)	161 (89.44)		
饲养动物				
有	67 (41.10)	32 (17.78)		
无	96 (58.90)	148 (82.22)		
粉尘接触				
有	26 (15.95)	5 (2.78)		
无	137 (84.05)	175 (97.22)		

2.3 社区获得性肺炎因素的多因素分析 除衰弱外,其余无共线性干扰。以是否发生肺炎为因变量(否=0,是=1),同时将吸烟史(有=0,无=1)、冠心病(有=0,无=1)、脑血管病(有=0,无=1)、贫血(否=0,是=1)、CURB>2分(有=0,无=1)、肾功能不全(否=0,是=1)、营养状态(营养风险评分<3分=0,营养风险评分 ≥ 3 分=1)、脓毒性休克(无=0,有=1)、意识障碍(无=0,有=1)、饲养动物(无=

0,有=1)、粉尘接触(无=0,有=1)作为自变量,进行多因素 logistic 分析。

结果显示,吸烟史、脑血管病、贫血、肾功能不全、脓毒性休克、意识障碍($OR = 1.635, 95\% CI: 1.074 \sim 2.488$)、饲养动物以及粉尘接触均是老年人发生社区获得性肺炎的独立危险因素($P < 0.05$)。见表 3。

表 3 社区获得性肺炎因素的多因素分析

Table 3 Multivariate analysis of factors of community-acquired pneumonia

自变量	β	SE	Wald χ^2	P	OR(95% CI)
吸烟史	0.678	0.176	14.823	<0.001	1.971(1.396~2.783)
冠心病	0.465	0.582	0.639	0.424	1.593(0.509~4.986)
脑血管病	0.262	0.127	4.260	0.039	1.300(1.013~1.668)
贫血	0.248	0.119	4.347	0.037	1.281(1.014~1.618)
CURB>2 分	0.406	0.555	0.535	0.465	1.500(0.506~4.448)
肾功能不全	0.712	0.359	3.297	0.048	2.037(1.008~4.118)
营养状态	0.049	0.182	0.072	0.788	1.050(0.735~1.499)
脓毒性休克	0.833	0.388	4.596	0.032	2.299(1.074~4.922)
意识障碍	0.492	0.214	5.281	0.002	1.635(1.074~2.488)
饲养动物	0.642	0.169	14.425	<0.001	1.901(1.364~2.648)
粉尘接触	0.391	0.175	4.983	0.026	1.478(1.048~2.085)

2.4 列线图预测模型的构建与验证 基于本研究中多因素 logistic 回归分析筛选出的独立危险因素结果,使用 R 4.5.0 语言软件开发老年人群发生社区获得性肺炎的列线图风险预测模型,结果见图 1。

通过绘制 ROC 曲线,计算 AUC 值,进一步检验该列线图模型的区分度,结果发现 $AUC = 0.877(95\% CI: 0.844 \sim 0.911)$,灵敏度为 0.869,特异度为 0.920,提示该风险预测模型具有良好的区分度。Hosmer-Lemeshow 检验结果显示: $P = 0.38(P >$

$0.05)$,说明该列线图风险预测模型校准度较好。见图 2、图 3。

3 讨论

在老年人群中,一旦感染社区获得性肺炎,很可能会使原本的疾病状况恶化,给患者的生命安全带来极大风险。由于年龄的不同,会通过抗生素使用史、身体免疫功能状况等多种因素对社区获得性肺炎的感染特点产生影响^[12],所以不同的患者在感染后

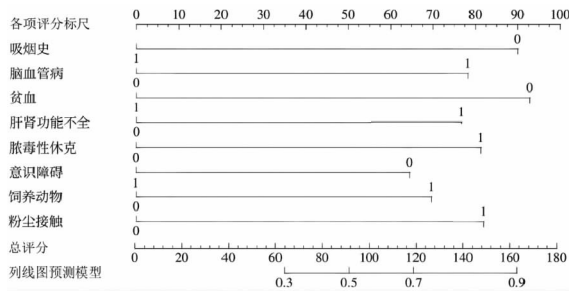
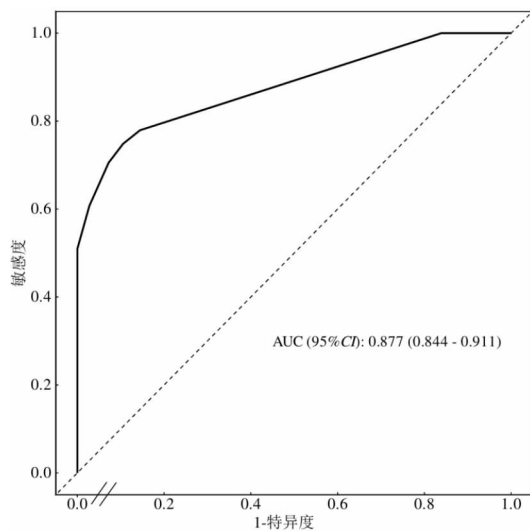


图1 老年人群发生社区获得性肺炎的列线图风险评估模型
Fig. 1 Risk assessment model for community - acquired pneumonia in the elderly population using a nomogram



注:实线为预测模型,虚线为参考线

图2 老年人群发生社区获得性肺炎的 ROC 曲线
Fig. 2 ROC curve for community - acquired pneumonia in the elderly population

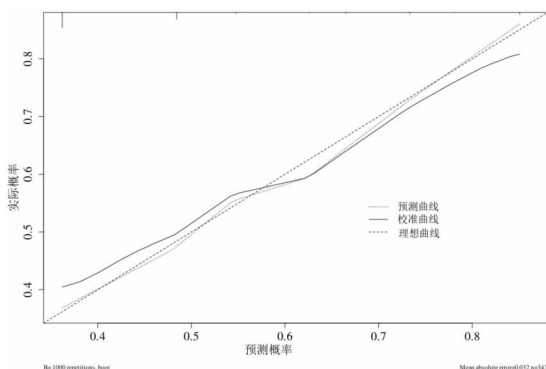


图3 老年人群发生社区获得性肺炎的校准曲线
Fig. 3 Calibration curve for community - acquired pneumonia in the elderly population

的症状表现以及抗生素治疗方案的选择上都有着明显的不同。163 例社区获得性肺炎患者中共分离出病原菌 172 株,其中以白色念珠菌(41.10%)和肺炎

克雷伯菌(31.29%)占比最高。

本次研究显示,吸烟史、脑血管病、贫血、肝肾功能不全、脓毒性休克、意识障碍、饲养动物及粉尘接触均为老年人发生社区获得性肺炎的独立危险因素($P < 0.05$),与既往研究^[13-14]结果一致。分析原因主要是,吸烟的损伤效应源于烟草燃烧释放的四千余种化合物,有害成分经肺泡入血后可触发免疫应答、生成炎性介质,长期吸烟会诱发呼吸道低度慢性炎症^[15-16],同时尼古丁的免疫调节作用会干扰免疫监视功能,显著提升病原体侵袭概率^[17-18]。合并基础疾病的老年人免疫功能普遍降低,更易发生致病菌定植繁殖,缺血性脑卒中后机体进入免疫抑制状态以保护中枢神经系统,会直接升高感染风险^[19-20];老年脑血管病患者长期卧床、免疫力弱,不仅反复感染风险升高,反复使用抗生素还会加剧肠道菌群紊乱^[21-23],适当补充益生菌可增强抗感染能力^[24]。贫血会降低中性粒细胞、红细胞免疫功能,提升感染易感性^[25],铁缺乏会直接抑制核酸与蛋白质合成,干扰 T 淋巴细胞增殖分化,导致细胞免疫功能失调;肺部感染引发的消耗又会进一步加重贫血,形成恶性循环,临床需积极纠正贫血,必要时输血阻断感染进展^[26-27]。肝肾功能不全者免疫防御受损更显著。肝脏作为免疫器官,合成补体、细胞因子及清除病原体的能力下降;肾功能不全时尿素氮、肌酐等毒素蓄积,会抑制淋巴细胞增殖、巨噬细胞吞噬功能,同时肝肾功能减退会消耗脏器储备,肝脏代谢药物、清除炎症介质能力下降,肾脏排泄、水电解质调节功能紊乱,感染后易引发炎症扩散、肺部水肿,加重病情^[28]。老年人本身存在免疫生理性衰退,感染后全身炎症反应易诱发基础疾病急性加重,更易进展为脓毒性休克,休克后又会诱发多脏器功能衰竭,延长肺炎病程^[29]。与张艳艳等^[30]研究的结果相近(AUC = 0.765, 敏感度 = 75.00%, 特异度 = 78.00%)。合并意识障碍的患者吞咽、咳嗽反射迟钝,气道保护能力下降,口咽部分泌物误吸风险高,加上自主排痰能力丧失、长期卧床诱发肺底部淤血,多重机制共同为病原菌定植创造条件^[31]。饲养宠物的风险源于浮毛携带的病原微生物会形成生物气溶胶,毛发进入呼吸道还会造成黏膜机械损伤,同时宠物皮屑、唾液中的过敏原可激活 Th2 免疫通路,诱发气道慢性炎症,进一步削弱呼吸道防御能力^[32]。长期粉尘接触会诱导呼吸道纤毛上皮鳞状化生,破坏黏液 - 纤毛清除系统,同时刺激杯状细胞增生、黏液分泌过量,易形成痰栓堵塞小气道,为病原菌定植提供微环境,最终提升肺炎发病风险。

综上所述,影响老年人发生社区获得性肺炎的独立危险因素包括吸烟史、脑血管病、贫血以及肝肾功能

能不全,感染病原菌多为白色念珠菌和肺炎克雷伯菌。对于已经存在社区获得性肺炎危险因素老年人,应尽早制定预防措施并及时控制,以此降低老年人群发生社区获得性肺炎的机率。但本次研究总样本量较小,未来建议开展样本量更大、研究质量更高的临床研究项目。

利益冲突声明 本研究不存在任何利益冲突

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收稿日期: 2026-01-04

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收稿日期: 2026-01-19