

DOI:10.16781/j.CN31-2187/R.20220070

· 专题报道 ·

## 急性心肌梗死患者早期康复实践及影响因素分析

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**[摘要]** **目的** 探讨急性心肌梗死(AMI)患者住院期间早期康复训练的可行性和影响因素。**方法** 前瞻性纳入2021年2月至4月上海交通大学医学院附属第六人民医院心脏ICU收治的102例AMI患者。根据病情严重程度和入院后首次下床活动时间将患者分为早期活动组(首次下床活动时间 $\leq 48$  h)和非早期活动组(首次下床活动时间 $> 48$  h),比较两组患者的临床资料和康复治疗数据,记录早期活动的不良事件及阻碍因素。采用多因素logistic回归分析探讨影响AMI患者下床活动时间的危险因素,ROC曲线分析相关指标对下床活动时间的预测价值。**结果** 102例AMI患者中,101例在出院时成功下床活动,其中62例归入早期活动组,39例归入非早期活动组。与早期活动组相比,非早期活动组患者年龄更大,全球急性冠状动脉事件登记(GRACE)评分更高,左心室射血分数(LVEF)更低,前壁心肌梗死占比更高,吸烟者占比更高,合并肾脏疾病和高脂血症者占比更高,辅助治疗措施应用更多,住院时间更长( $P$ 均 $< 0.05$ )。多因素logistic回归分析结果显示高GRACE评分和低LVEF是影响早期下床活动的独立危险因素( $OR=0.960$ , 95%  $CI$  0.939~0.981,  $P<0.001$ ;  $OR=1.139$ , 95%  $CI$  1.038~1.251,  $P=0.006$ )。ROC曲线分析显示GRACE评分可作为AMI患者能否早期下床活动的预测因子( $AUC=0.833$ , 95%  $CI$  0.742~0.924,  $P<0.001$ ),其最佳临界值为167分(灵敏度为0.650,特异度为0.986)。**结论** 对AMI患者进行危险因素分级并实施早期康复训练安全、可行,GRACE评分和LVEF可作为判断能否实施早期康复训练的有效指标。

**[关键词]** 急性心肌梗死; I期心脏康复; 早期活动; 心脏重症监护; 经皮冠状动脉介入术

**[中图分类号]** R 542.22 **[文献标志码]** A **[文章编号]** 2097-1338(2022)10-1143-06

### Early mobilization and its influencing factors in patients with acute myocardial infarction

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**[Abstract]** **Objective** To investigate the feasibility and influencing factors of early mobilization in acute myocardial infarction (AMI) patients. **Methods** A total of 102 AMI patients who were admitted to the cardiac intensive care unit of Shanghai Sixth People's Hospital, Shanghai Jiao Tong University School of Medicine were prospectively enrolled from Feb. to Apr. 2021. The patients were divided into early mobilization group (the time of admission to the first mobilization $\leq 48$  h) and non-early mobilization group (the time of admission to the first mobilization $> 48$  h) according to the severity of the patient's condition and the time of admission to the first mobilization. The clinical data and rehabilitation data of patients in the 2 groups were compared, and the adverse events and barriers to early mobilization were recorded. Multivariate logistic regression analysis was used to explore the risk factors affecting the time of early mobilization, and receiver operating characteristic (ROC) curve analysis was used to analyze the predictive value of related indicators on the time of early mobilization. **Results** Among 102 AMI patients, 101 were successfully mobilized at the time of discharge, of which 62 were included in the early mobilization group and 39 in the non-early mobilization group. Compared with that in the early mobilization group, the patients in the non-early mobilization group were older, had higher Global Registry of Acute Coronary Events (GRACE) score, lower left ventricular ejection fraction (LVEF), a higher proportion of anterior myocardial infarction, more smokers, more renal diseases and hyperlipidemia, more adjuvant therapy, and longer hospital stay (all  $P<0.05$ ). Multivariate logistic regression analysis showed that high GRACE score and low LVEF were independent risk

**[收稿日期]** 2022-01-18 **[接受日期]** 2022-04-29

**[基金项目]** 上海市科学技术委员会科技创新行动计划(21Y1909400)。Supported by Scientific and Technological Innovation Action Plan of Science and Technology Commission of Shanghai Municipality (21Y1909400)。

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factors for early mobilization (odds ratio [OR] = 0.960, 95% confidence interval [CI] 0.939-0.981,  $P < 0.001$ ; OR = 1.139, 95% CI 1.038-1.251,  $P = 0.006$ ). ROC curve analysis showed that GRACE score could be used as a predictor for early mobilization of AMI patients (area under curve [AUC] = 0.833, 95% CI 0.742-0.924,  $P < 0.001$ ), and the optimal cut-off value was 167 (sensitivity 0.650, specificity 0.986). **Conclusion** It is safe and feasible to grade the risk factors of AMI patients and implement early rehabilitation training. GRACE score and LVEF can be used as effective indicators to judge whether early rehabilitation training can be implemented.

[ **Key words** ] acute myocardial infarction; phase I cardiac rehabilitation; early mobilization; cardiac intensive care; percutaneous coronary intervention

[ Acad J Naval Med Univ, 2022, 43(10): 1143-1148 ]

急性心肌梗死 (acute myocardial infarction, AMI) 是冠心病中一种较为严重的类型, 具有高致死率和致残率<sup>[1]</sup>。既往 AMI 后卧床、限制活动是普遍观念, 然而较长时间卧床休息可诱发血栓性疾病, 出现肌肉废用综合征、全身炎症反应、皮肤压疮等不利于疾病恢复的并发症, 延长住院时间<sup>[2]</sup>, 尤其合并心力衰竭、高龄等因素时可对日常生活活动能力、生活质量产生深远影响<sup>[3-4]</sup>。目前已证实 AMI 患者早期下床活动能有效改善抑郁情绪、心率变异性、生活质量, 促进心肺功能恢复, 缩短住院时间<sup>[5-6]</sup>。因此早期活动 (early mobilization, EM) 对 AMI 患者急性期恢复具有重要意义, 是 I 期心脏康复的核心组成部分。

国际上多个诊疗指南指出 AMI 患者应尽早开展心脏康复, 鼓励下床活动, 但对最佳下床活动时间尚未达成共识, EM 缺乏标准方案<sup>[1,7]</sup>。欧洲心脏病学会 (European Society of Cardiology, ESC) ST 段抬高心肌梗死 (ST-segment elevation myocardial infarction, STEMI) 诊疗指南指出, 经桡动脉穿刺成功实施经皮冠状动脉介入术 (percutaneous coronary intervention, PCI) 的 STEMI 患者若无并发症, 在术后 24 h 内即可下床活动<sup>[1]</sup>。日本循环协会提出对于无活动性胸痛、心力衰竭和恶性心律失常的 AMI 患者可在入院 12 h 后下床<sup>[7]</sup>。有关 AMI 患者 EM 的研究多集中在 20 世纪 70 年代<sup>[8-10]</sup>, 随着冠状动脉介入技术不断普及, AMI 诊疗已发生巨大变革, 关于 EM 的临床证据亟须更新。国际上报道再灌注时代 AMI 患者卧床时间为 2~28 d<sup>[10-12]</sup>。AMI 患者个体差异大, 伴发不同危险因素, 应制定个体化活动方案。本研究前瞻性纳入 AMI 患者, 观察 AMI 危险分级指导下的早期康复方案的效果和安全性, 分析影响早期下床活动的因素, 为 AMI 患者早期康复的最佳临床决策提供数据支持。

## 1 对象和方法

1.1 研究对象 本研究为前瞻性研究设计, 连续性纳入 2021 年 2 月至 4 月在上海交通大学医学院附属第六人民医院心脏中心心脏 ICU 住院并接受早期康复指导的 AMI 患者 102 例。排除标准: (1) 存在严重合并症, 如骨折创伤、严重消化道出血、其他手术等; (2) 合并冠状动脉痉挛; (3) 中途转科; (4) 住院时间 < 2 d。本研究通过上海交通大学医学院附属第六人民医院伦理委员会审批 [2017-KY-003 (K)], 所有患者均签署知情同意书。

### 1.2 研究方法

1.2.1 分级 EM 方案 早期康复方案启动标准<sup>[13]</sup>:

(1) 急诊再灌注治疗后 8 h 没有新发或再发胸痛; (2) 无明显心力衰竭失代偿表现; (3) 过去 8 h 内没有新发心律失常或心电图改变; (4) 心肌损伤标志物水平无进一步升高。每日早晨查房后, 经心脏 ICU 心脏康复小组 (成员包括心脏重症主管医师、心脏康复医师、护士、康复治疗师) 共同评估, 决定患者当日是否可启动早期康复方案。心脏重症主管医师与心脏康复医师分别为临床与康复诊疗的决策者, 护士与康复治疗师为康复方案的共同执行者与协调者。早期康复方案在指南<sup>[13]</sup>的基础上结合科室诊疗情况进行了改编, 增加了进阶活动测试, 按照活动范围、活动强度分为 4 级 (表 1), 从床上活动逐渐过渡至步行。每日进行 2 次 EM 干预, 活动内容按照 1、2、3、4 级方案循序渐进, 通过相应等级的进阶活动测试后方可进入下一等级。

1.2.2 数据采集 (1) 基本信息: 包括性别、年龄、BMI、入院时生命体征、心肌梗死类型、再灌注治疗方式、并发症、合并症、实验室检查指标及影像学资料等, 并计算全球急性冠状动脉事件登记 (Global Registry of Acute Coronary Events, GRACE) 评分<sup>[14]</sup>。(2) 首次下床时间: 定义为入院后患

者首次自主或在辅助下从床上转移至床边坐位的时间。根据首次下床活动时间,将患者分为EM组(首次下床时间 $\leq 48$  h)和非早期活动(non-early mobilization, NEM)组(首次下床时间 $> 48$  h),以入院后首次下床活动为事件终点进行相关危险因素分析。(3)出院时活动等级:定义为出院记录的康复治疗记录单记录的通过进阶活动测试的最高EM等级。如出院时通过500 m步行测试,其活动等级为4

级。中途拒绝活动测试者不计入统计。(4)EM提前终止事件:任何记录于康复治疗记录单的提前终止EM方案的事件及原因,主要包括低血压、心率上升 $> 40 \text{ min}^{-1}$ 、心电图ST段改变、恶性心律失常、血氧饱和度 $< 90\%$ 、胸闷胸痛、头晕、跌倒等。

(5)EM实施阻碍:任何记录于护理、康复治疗记录单的无法执行EM的原因,主要包括患者拒绝与不配合、疼痛、病情因素、安全因素、时间因素等。

表1 早期活动分级方案

Tab 1 Progressive early mobilization program

Level	Place	Rehabilitation training	Rehabilitation progression test
1	Bed	Active/passive ROM exercise; breathing exercise; sitting position	Able to perform ROM exercise in sitting position
2	Sitting bedside	Active transfer to chair; chair sitting ROM exercise; ambulation along bedside	Able to stand for 2 min
3	Ward	Ambulation with telemetry monitor, 10 min, twice a day	Able to walk for 200 m
4	Ward	Ambulation without telemetry monitor, 10 min, 2-3 times a day	Able to walk for 500 m

ROM: Range of motion.

1.3 统计学处理 采用SPSS 26.0软件进行统计学分析。计量资料采用Kolmogorov-Smirnov法进行正态性检验,符合正态分布的计量资料以 $\bar{x} \pm s$ 表示,两组间比较采用独立样本 $t$ 检验;呈偏态分布的计量资料以中位数(下四分位数,上四分位数)表示,两组间比较采用Mann-Whitney  $U$ 检验。计数资料以例数和百分数表示,两组间比较采用 $\chi^2$ 检验或Fisher确切概率法。采用多因素logistic回归分析探讨早期下床活动的潜在影响因素。绘制ROC曲线,评估相关指标对早期下床活动的预测价值。检验水准( $\alpha$ )为0.05。

## 2 结果

2.1 EM组与NEM组患者资料比较 纳入AMI患者102例,共有101例(99.0%)在住院期间下床活动,其中62例(60.8%)首次下床活动时间 $\leq 48$  h,39例(38.2%)首次下床活动时间 $> 48$  h(表2)。101例下床活动的患者中,EM组62例,NEM组39例。相较于EM组,NEM组患者年龄更大,GRACE评分更高,左心室射血分数(left ventricular ejection fraction, LVEF)更低,前壁心肌梗死占比更高,吸烟者占比更高,合并肾脏疾病和高脂血症者占比更高,辅助治疗措施应用更多( $P$ 均 $< 0.05$ )。NEM组住院时间长于EM组( $P < 0.001$ )。EM组入院时的心率、血肌酐水平较NEM组更低,Killip分级1级者占比更高( $P$ 均 $< 0.05$ )。

出院时EM组达到的活动等级优于NEM组,差异有统计学意义( $P < 0.001$ )。56例(55.4%)在出院时可耐受500 m步行(活动等级4级),其中EM组44例(71.0%)、NEM组12例(30.8%)。NEM组有16例(41.0%)患者出院时活动等级为2级。

2.2 AMI患者早期下床活动影响因素的多因素logistic回归分析 将单因素分析中差异有统计学意义且对早期康复临床决策具有潜在影响的10个变量作为自变量(包括年龄、前壁心肌梗死、心率、血肌酐、GRACE评分、高脂血症、吸烟、采用辅助设备、LVEF、肾脏疾病,分类变量“无”赋值0、“有”赋值1,连续变量和等级变量输入实际值),因变量EM赋值0、NEM赋值1,采用逐步回归法进行多因素logistic回归分析,结果显示高GRACE评分( $OR = 0.960$ ,  $P < 0.001$ )是影响早期下床活动的危险因素,高LVEF( $OR = 1.139$ ,  $P = 0.006$ )是早期下床活动的保护因素(表3)。

2.3 GRACE评分对早期下床活动的预测价值 绘制GRACE评分对AMI患者首次下床时间的ROC曲线(图1),结果显示GRACE评分可作为AMI患者入院后能否在48 h内下床活动的预测因子( $AUC = 0.833$ ,  $95\% CI 0.742 \sim 0.924$ ,  $P < 0.001$ )。取约登指数最高值时的GRACE评分为最佳临界值,其结果为167分,此临界值预测48 h内下床活动的灵敏度为0.650,特异度为0.986。

表2 EM组与NEM组患者资料比较

Tab 2 Comparison of patient information between EM and NEM groups

Item	Total N=101	EM N=62	NEM N=39	Statistic	P value
Age/year, $M(Q_L, Q_U)$	62.00 (54.00, 70.00)	58.50 (50.75, 64.25)	70.60 (63.25, 79.75)	$U=577.5$	<0.001
Female, $n$ (%)	14 (13.9)	6 (9.7)	8 (20.5)	$\chi^2=2.188$	0.153
Body mass index/( $\text{kg}\cdot\text{m}^{-2}$ ), $\bar{x}\pm s$	24.72 $\pm$ 2.81	24.75 $\pm$ 2.85	24.68 $\pm$ 2.78	$t=0.132$	0.896
STEMI, $n$ (%)	61 (60.4)	33 (53.2)	28 (71.8)	$\chi^2=2.846$	0.103
Anterior infarction, $n$ (%)	44 (43.6)	21 (33.9)	23 (59.0)	$\chi^2=5.534$	0.025
SBP/mmHg, $\bar{x}\pm s$	130.21 $\pm$ 28.18	133.44 $\pm$ 25.75	125.2 $\pm$ 31.28	$t=1.449$	0.151
Heart rate/ $\text{min}^{-1}$ , $M(Q_L, Q_U)$	80.00 (73.75, 90.00)	78.00 (71.50, 88.00)	80.00 (78.25, 96.50)	$U=942.0$	0.041
Serum creatinine/( $\text{mmol}\cdot\text{L}^{-1}$ ), $M(Q_L, Q_U)$	82.00 (69.00, 94.50)	78.50 (68.00, 78.50)	88.00 (69.75, 88.00)	$U=864.0$	0.010
Killip classification, $n$ (%)				$\chi^2=9.727$	0.020
1	91 (90.1)	60 (96.8)	31 (79.5)		
2	8 (7.9)	2 (3.2)	6 (15.4)		
3	1 (1.0)	0	1 (2.6)		
4	1 (1.0)	0	1 (2.6)		
Partial revascularization, $n$ (%)	41 (40.6)	23 (37.1)	18 (46.2)	$\chi^2=0.632$	0.535
Additional mechanical support <sup>a</sup> , $n$ (%)	7 (6.9)	1 (1.6)	6 (15.4)	$\chi^2=5.205$	0.014
GRACE score, $\bar{x}\pm s$	148.58 $\pm$ 37.35	132.47 $\pm$ 26.35	173.55 $\pm$ 38.39	$t=-6.411$	<0.001
LVEF/%, $M(Q_L, Q_U)$	58 (54.00, 61.00)	60 (57.25, 67.25)	55 (48.25, 57.00)	$U=1893.0$	<0.001
Hypertension, $n$ (%)	62 (61.4)	36 (58.1)	26 (66.7)	$\chi^2=0.491$	0.537
Hyperlipidemia, $n$ (%)	44 (43.6)	32 (51.6)	12 (30.8)	$\chi^2=5.365$	0.041
Smoking, $n$ (%)	61 (60.4)	43 (69.4)	18 (46.2)	$\chi^2=2.842$	0.023
Diabetes mellitus, $n$ (%)	37 (36.6)	21 (33.9)	16 (41.0)	$\chi^2=0.395$	0.536
Renal diseases, $n$ (%)	12 (11.9)	2 (3.2)	10 (25.6)	$\chi^2=11.489$	0.001
Cardiac arrest at admission, $n$ (%)	2 (2.0)	0	2 (5.1)	$\chi^2=3.162$	0.077
Ventricular thrombus, $n$ (%)	1 (1.0)	0	1 (2.6)	$\chi^2=1.606$	0.386
Malignant arrhythmia, $n$ (%)	2 (2.0)	0	2 (5.1)	$\chi^2=3.244$	0.072
Hospital stay/d, $M(Q_L, Q_U)$	4.59 (3.49, 6.07)	3.86 (3.17, 4.75)	5.87 (5.08, 7.78)	$U=389.5$	<0.001
Admission to first mobilization time/h, $M(Q_L, Q_U)$	41.02 (31.08, 68.27)	33.48 (18.99, 39.39)	84.15 (60.16, 114.98)	$U=2480.0$	<0.001
Mobilization level, $n$ (%)				$\chi^2=63.276$	<0.001
1	0	0	0		
2	21 (20.8)	5 (8.1)	16 (41.0)		
3	18 (17.8)	10 (16.1)	8 (20.5)		
4	56 (55.4)	44 (71.0)	12 (30.8)		
Unable to access	6 (5.9)	3 (4.8)	3 (7.7)		

<sup>a</sup>: Additional mechanical support including intra-aortic balloon pump, ventilatory support and continuous renal replacement therapy. 1 mmHg=0.133 kPa. EM: Early mobilization (mobilized $\leq$ 48 h); NEM: Non-early mobilization (mobilized>48 h); STEMI: ST elevated myocardial infarction; SBP: Systolic blood pressure; GRACE: Global Registry of Acute Coronary Events; LVEF: Left ventricular ejection fraction;  $M(Q_L, Q_U)$ : Median (lower quartile, upper quartile).

表3 AMI患者入院后早期下床活动影响因素的多因素logistic回归分析

Tab 3 Multivariate logistic regression analysis of influencing factors of early mobilization of AMI patients after admission

Item	OR (95% CI)	P value
LVEF	1.139 (1.038, 1.251)	0.006
GRACE score	0.960 (0.939, 0.981)	<0.001

AMI: Acute myocardial infarction; LVEF: Left ventricular ejection fraction; GRACE: Global Registry of Acute Coronary Events; OR: Odds ratio; CI: Confidence interval.

2.4 EM安全性与实施阻碍 未观察到与EM相关的院内主要不良心血管事件。体位性低血压为最常见的EM提前终止原因,其次为气喘与头晕,其他原因有心率增加>40  $\text{min}^{-1}$ 、ST段改变和心绞痛;阻碍EM实施的原因主要为与其他治疗时间冲突、患者自觉虚弱、股动/静脉置管、患者拒绝与缺乏设备(表4)。

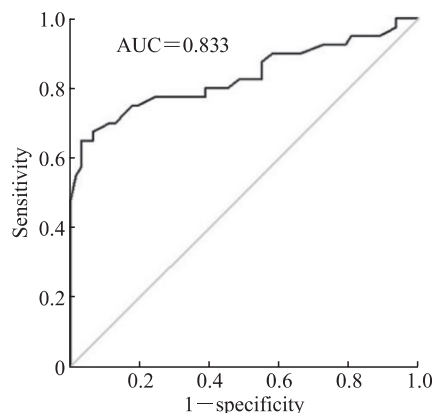


图1 GRACE评分预测AMI患者入院后能否早期下床活动的ROC曲线

Fig 1 ROC curve of GRACE score in predication of early mobilization in AMI patients

GRACE: Global Registry of Acute Coronary Events; AMI: Acute myocardial infarction; ROC: Receiver operating characteristic; AUC: Area under curve.

表4 EM提前终止原因及实施阻碍

Tab 4 Cause for early termination and barrier to implementing EM program

Cause	n (%)	
	EM N=62	NEM N=39
Early termination		
Postural hypotension	2 (3.2)	4 (10.3)
Heart rate increase > 40 min <sup>-1</sup>	0	1 (2.6)
ST change	1 (1.6)	1 (2.6)
Dizziness	1 (1.6)	2 (5.1)
Angina	0	1 (2.6)
Dyspnea	0	3 (7.7)
Barrier		
Pain	2 (3.2)	1 (2.6)
Femoral sheath	0	3 (7.7)
Weakness	0	5 (12.8)
Nausea	1 (1.6)	1 (2.6)
Patient refuse	3 (4.8)	3 (7.7)
Lack of equipment	1 (1.6)	3 (7.7)
Conflict to other therapy	3 (4.8)	6 (15.4)

EM: Early mobilization (mobilized ≤ 48 h); NEM: Non-early mobilization (mobilized > 48 h).

### 3 讨论

I期心脏康复的主要目的为缩短住院时间、促进患者日常生活及运动能力的恢复、避免卧床带来的不利影响<sup>[13]</sup>。EM是I期心脏康复的核心组成部分,安全、有效的EM对合并心力衰竭、肾功能不全及高龄等高危因素的心脏病患者具有重要意义。既往关于AMI患者EM的研究大多着重针对无并发症的患者<sup>[1,7,15]</sup>,而对高危人群的研究尚不充分,其主要原因是AMI院内死亡率高(7%~9%)<sup>[16-17]</sup>,临床上对高危人群开展EM存在顾虑。本研究发现分级EM方案对高危AMI患者是安全、可行的,99.0%(101/102)的AMI患者在出院前成功下床活动。

得益于健全的急救和康复体系建设,西方国家AMI患者住院时长在近几十年内大幅度缩短,美国CathPCI注册研究结果显示接受直接经皮冠状动脉介入术(primary percutaneous coronary intervention, PPCI)后STEMI患者住院时长为(3.6±2.7)d<sup>[18]</sup>。我国AMI患者住院时长为(11.06±6.82)d<sup>[19]</sup>,明显长于西方国家。随着PPCI技术的普及和康复体系的健全,我国AMI患者住院时长的缩短是必然趋势。既往研究报道的EM方案多以时间为标准进阶<sup>[20-21]</sup>,活动方案周期为6~14d。此类方案已不适用于住院时间较短的患者。本研究按照活动功能分级的EM方案,以活动测试的结果为标准

进阶,确保了EM进阶及时、安全和规范。在住院期间成功下床活动的101例患者住院时长为4.59(3.49, 6.07)d,基本接近西方国家水平<sup>[18]</sup>。通过分级活动方案,60.8%(62/102)的AMI患者在入院后48h内下床活动,54.9%(56/102)在出院时可耐受500m步行,满足出院后日常活动的功能需求。

多因素logistic回归分析结果表明高GRACE评分和低LVEF是影响AMI患者早期下床活动的独立危险因素。晚下床的患者GRACE评分较高,为(173.55±38.39)分,且具有年龄大、前壁心肌梗死、肾功能不全、LVEF低、接受辅助治疗多等特征。与其他研究结果<sup>[5,11,22]</sup>相似,本研究中晚下床的患者住院时间长、活动能力降低。住院期间卧床和不活动可导致肌肉质量与功能迅速退化,使活动功能下降,并可在出院后持续很长时间,这种现象在老年人群中尤为常见<sup>[23]</sup>。GRACE评分为高危且合并机体衰弱的患者1年全因死亡率显著增高<sup>[24]</sup>,因此晚下床组的患者应得到心脏康复团队的重点关注,以预防住院相关失能、衰弱。

GRACE评分系统广泛运用于AMI患者院内、院外的预后评估,本研究结果表明GRACE评分对于预测患者是否能在入院后48h内下床具有良好的效能,其最佳临界诊断值为167分,对于指导AMI患者EM具有潜在价值。心脏康复团队可根据GRACE评分结合LVEF确定患者下床的最佳时机,制定个体化早期康复方案;识别无法早期下床的患者,并给予其他更有效的康复干预措施。

本研究未观察到与EM相关的院内主要不良心血管事件,EM提前终止最常见的原因因为体位性低血压,实施阻碍因素主要包括病情、患者观念、设备资源缺乏和时间冲突。部分患者担心活动会加重病情,另外疼痛、睡眠障碍、置管、焦虑心理也在一定程度上阻碍了EM。早期康复的开展需要临床多团队合作参与,管理者应制定合理的临床康复路径,重视人力资源和设备配置,避免因诊疗冲突和设备缺乏导致EM开展不利。

总之,本研究结果表明采用分级指导早期康复治疗对于AMI患者是安全、可行的,GRACE评分对于开展EM具有指导价值,尤其是高危的AMI人群。GRACE评分和LVEF有助于心脏康复团队为AMI患者制定个体化的院内康复方案。本研究为

单中心研究,样本量有限,今后仍须开展大样本、多中心研究以进一步探讨早期康复训练在AMI患者中的应用价值和影响因素。

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