·临床研究·

老年慢性阻塞性肺疾病合并慢性呼吸衰竭患者正压通气失败的影响因素及其对生活质量的影响

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【摘 要】 **目的** 探讨老年慢性阻塞性肺疾病(COPD)合并慢性呼吸衰竭(CRF)患者正压通气失败的影响因素及其对生活质量的影响。**方法** 回顾性分析2020年1月至2023年12月扬州大学附属医院收治的150例老年COPD合并CRF患者的临床资料。患者均采用正压通气治疗,根据治疗效果分为治疗有效组($n=108$)和治疗无效组($n=42$)。采用圣乔治呼吸问卷(SGRQ)评估患者生活质量。对比两组患者一般临床资料及生活质量评分。采用SPSS 20.0统计软件进行数据分析。依据数据类型,组间比较分别采用t检验或χ^2检验。采用logistic回归分析影响老年COPD合并CRF患者正压通气失败的影响因素。采用Spearman相关性分析老年COPD合并CRF患者正压通气失败与生活质量得分之间的线性关系。**结果** 两组患者入院时急性生理学及慢性健康状况评价(APACHEⅡ)评分及格拉斯哥昏迷量表(GCS)评分,治疗前动脉血氧分压、血二氧化碳分压($PaCO_2$)、心率、pH值、呼吸频率、血乳酸、C反应蛋白(CRP)及B型脑钠肽(BNP)比较,差异均有统计学意义(均$P<0.05$)。多因素logistic回归分析显示,入院时APACHEⅡ评分≥15分($OR=4.778$,95%$CI=1.398\sim16.329$)、治疗前$PaCO_2$≥75 mmHg($OR=3.971$,95%$CI=1.166\sim13.518$)、治疗前血乳酸≥1.7 mmol/L($OR=5.099$,95%$CI=1.258\sim20.665$)、治疗前CRP≥85 mg/L($OR=3.377$,95%$CI=1.188\sim9.599$)、治疗前BNP≥250 ng/L($OR=4.468$,95%$CI=1.183\sim16.876$)是影响老年COPD合并CRF患者正压通气失败的独立危险因素($P<0.05$)。正压通气治疗有效组SGRQ中疾病影响、活动受限和呼吸症状维度得分以及总得分均显著低于治疗无效组,差异均有统计学意义(均$P<0.05$)。Spearman相关性分析发现,老年COPD合并CRF患者正压通气失败与生活质量得分呈显著正相关($r=0.923$,$P<0.05$)。**结论** 入院时APACHEⅡ评分≥15分、治疗前$PaCO_2$≥75 mmHg、治疗前血乳酸≥1.7 mmol/L、治疗前CRP≥85 mg/L、治疗前BNP≥250 ng/L是影响老年COPD合并CRF患者正压通气失败的独立危险因素,临床需强化对上述指标的监测,并制定针对性干预措施,这对提升治疗有效率及改善患者生活质量具有重要意义。

【关键词】 老年人;慢性阻塞性肺疾病;呼吸衰竭;正压通气;失败;影响因素;生活质量
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Influencing factors of positive pressure ventilation failure and its effect on quality of life in elderly patients with chronic obstructive pulmonary disease complicated with chronic respiratory failure

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【Abstract】 **Objective** To investigate the influencing factors for positive pressure ventilation failure and its effect on quality of life in elderly patients with chronic obstructive pulmonary disease (COPD) complicated with chronic respiratory failure (CRF). **Methods** A retrospective analysis was conducted on 150 elderly COPD patients with concomitant CRF admitted to our hospital from January 2020 to December 2023. All of them received positive pressure ventilation, and according to the treatment efficacy, those with effective treatment were assigned into an effective group ($n=108$), and those without into an ineffective group ($n=42$). St. George's respiratory questionnaire (SGRQ) was used to evaluate their quality of life. The general clinical data and score of quality of life were compared between the two groups. SPSS statistics 20.0 was used for data analysis. Depending on data type, student's t test or *Chi*-square test was employed for comparison between groups. Logistic regression analysis was utilized to identify the influencing factors for positive pressure ventilation failure in these patients. Spearman correlation analysis was applied to analyze the linear relationship of positive pressure ventilation failure and

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quality of life in elderly COPD patients with CRF. **Results** There were significant differences between the two groups in terms of APACHE Ⅱ score and GCS score at admission, PaO_2, $PaCO_2$, heart rate, pH value and respiratory rate before treatment, and levels of blood lactic acid, C-reactive protein (CRP) and B-type natriuretic peptide (BNP) before treatment (all $P<0.05$). Multivariate logistic regression analysis showed that baseline APACHE Ⅱ score ≥15 ($OR=4.778$, 95%*CI* 1.398-16.329), $PaCO_2$ before treatment ≥75 mmHg ($OR=3.971$, 95%*CI* 1.166-13.518), blood lactic acid ≥1.7 mmol/L ($OR=5.099$, 95%*CI* 1.258-20.665), CRP ≥85 mg/L ($OR=3.377$, 95%*CI* 1.188-9.599) and BNP ≥250 ng/L ($OR=4.468$, 95%*CI* 1.183-16.876) before treatment were independent risk factors for positive pressure ventilation failure in elderly COPD patients with CRF ($P<0.05$). The dimension scores of disease impact, activity limitation and respiratory symptoms, and total score of SGRQ were significantly lower in the effective group than the ineffective group (all $P<0.05$). Spearman correlation analysis indicated that the failure of positive pressure ventilation was positively correlated with the score of quality of life in the elderly COPD patients with CRF ($r=0.923$, $P<0.05$). **Conclusion** APACHE Ⅱ score ≥15 at admission, and $PaCO_2$ ≥75 mmHg, blood lactate ≥1.7 mmol/L, CRP ≥85 mg/L and BNP ≥250 ng/L before treatment are independent risk factors for the failure of positive pressure ventilation in elderly COPD patients with CRF. In clinical practice, it is necessary to strengthen the monitoring of the above indicators and put forward targeted countermeasures, which is of great significance to improve the effectiveness and quality of life among the patients.

【Key words】 aged; chronic obstructive pulmonary disease; respiratory failure; positive pressure ventilation; failure; influencing factors; quality of life

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老年慢性阻塞性肺疾病(chronic obstructive pulmonary disease,COPD)合并慢性呼吸衰竭(chronic respiratory failure,CRF)患者常面临严峻诊疗挑战,而正压通气治疗失败作为该群体常见且对预后影响重大的并发症,已成为影响临床疗效的关键因素[1]。随着人口老龄化趋势的加剧,老年COPD合并CRF患者数量不断增加[2],患者由于呼吸系统功能受损且合并慢性疾病,更容易出现呼吸困难和氧合不足等症状,从而增加正压通气失败的风险[3]。正压通气失败不仅会导致疾病进展和治疗效果的降低,还会严重影响患者的生活质量和长期预后[4,5]。因此,本研究拟探讨老年COPD合并CRF患者正压通气失败影响因素,并分析其对患者生活质量的影响,旨在为临床实践和医疗决策提供有益的参考依据。

1 对象与方法

1.1 研究对象

回顾性分析2020年1月至2023年12月扬州大学附属医院收治的150例老年COPD合并CRF患者的临床资料。所有患者均采用正压通气治疗,根据治疗效果分为治疗有效组108例及治疗无效组42例。纳入标准:(1)符合《慢性阻塞性肺疾病基层诊疗指南(2018)》[6]中COPD相关诊断标准;(2)符合CRF相关诊断标准[7];(3)年龄≥60岁;(4)临床资料完整。排除标准:(1)合并恶性肿瘤;(2)合并脓毒症、败血症等严重感染性疾病;(3)合并心源性休克;(4)合并肺栓塞;(5)合并免疫缺陷。本研究符合赫尔辛基宣言相关伦理准则。

1.2 方法

1.2.1 资料收集 收集患者一般临床资料,包括性别,年龄,COPD病程,低蛋白血症,合并糖尿病,合并高血压,合并高血脂,入院时急性生理学及慢性健康状况评价Ⅱ(acute physiology and chronic health evaluationⅡ,APACHE Ⅱ)评分及格拉斯哥昏迷量表(Glasgow coma scale,GCS)评分,通气时间,治疗前动脉血氧分压(partial pressure of oxygen,PaO_2)、血二氧化碳分压(partial pressure of carbon dioxide,$PaCO_2$)、心率(heart rate,HR)、pH值、收缩压(systolic blood pressure,SBP)、舒张压(diastolic blood pressure,DBP)、呼吸频率(respiratory rate,RR)、血乳酸、C反应蛋白(C-reactive protein,CRP)及B型脑钠肽(B-type natriuretic peptide,BNP)。GCS评分是评估患者意识状态的标准化工具,包括睁眼反应(1~4分)、语言反应(1~5分)和肢体运动反应(1~6分)3个维度,评分范围3~15分。15分属于情况正常,意识清楚;12~14分为轻度意识障碍;9~11分为中度意识障碍;<8分为重度意识障碍。APACHEⅡ评分系统包括急性生理评分(包括体温、HR、脉搏、意识、RR、SBP、血常规、血气分析、生化全套,慢性病评分、GCS评分及年龄指标,分值0~60分)、慢性健康状况评分(分值2~5分)和年龄评分(≤44岁为0分,45~54岁为2分,55~64岁为3分,65~74岁为5分,≥75岁为6分),总评分范围0~71分,分数越高表示病情越重。

1.2.2 正压通气失败标准 (1)患者于撤机后6 h

内无法自主呼吸,并出现呼吸窘迫症状,在撤机后 48 h 需再次行通气治疗;(2)氧合指数难以维持在 100 mmHg(1 mmHg=0.133 kPa)以上;(3)气道中存在大量分泌物,未纠正呼吸困难,呼吸肌疲劳症状改善不明显,使用血管活性药物下血流动力学依旧不稳定[8]。

1.2.3 生活质量评估 采用圣乔治呼吸问卷(St. George's respiratory questionnaire,SGRQ)评估患者生活质量,包括疾病影响(焦虑、痛苦、失望等)、活动受限(穿衣、家务等)、呼吸症状(咳嗽、咳痰、气喘等)维度,各维度得分之和为 SGRQ 总得分,总分 100 分,总得分越低,提示患者生活质量越佳。

1.3 统计学处理

采用 SPSS 20.0 统计软件进行数据分析。计量资料呈正态分布者以均数±标准差($\bar{x}\pm s$)表示,组间比较采用 t 检验。计数资料以例数(百分率)表示,组间比较采用 χ^2 检验。采用 logistic 回归模型分析影响老年 COPD 合并 CRF 患者正压通气失败的危险因素。采用 Spearman 相关性分析老年 COPD 合并 CRF 患者正压通气失败与生活质量得分之间的线性关系。$P<0.05$ 为差异有统计学意义。

2 结 果

2.1 影响老年 COPD 合并 CRF 患者正压通气失败的单因素分析

两组患者入院时 APACHE Ⅱ 评分及 GCS 评分,治疗前 PaO_2、$PaCO_2$、HR、pH 值、RR、血乳酸、CRP 及 BNP 比较,差异均有统计学意义(均 $P<0.05$;表 1)。

表 1 影响老年 COPD 合并 CRF 患者正压通气失败的单因素分析

Table 1 Univariate analysis of positive pressure ventilation failure in elderly COPD patients with CRF

Factor	Ineffective group($n=42$)	Effective group($n=108$)	t/χ^2	P value
Gender[n(%)]			0.014	0.907
Male	23(54.76)	58(53.70)		
Female	19(45.24)	50(46.30)		
Age(years, $\bar{x}\pm s$)	69.78±7.11	70.23±8.15	0.314	0.754
Course of COPD(years, $\bar{x}\pm s$)	10.36±2.55	10.17±2.61	0.403	0.688
APACHE Ⅱ score at admission(points, $\bar{x}\pm s$)	25.47±2.36	12.55±1.49	40.044	<0.001
PaO_2 before treatment(mmHg, $\bar{x}\pm s$)	47.25±5.16	59.46±6.22	11.294	<0.001
$PaCO_2$ before treatment(mmHg, $\bar{x}\pm s$)	85.69±9.33	70.22±4.16	14.057	<0.001
HR before treatment(times/min, $\bar{x}\pm s$)	103.26±11.34	89.23±9.12	7.884	<0.001
PH value before treatment($\bar{x}\pm s$)	7.03±0.42	7.26±0.54	2.482	0.014
SBP before treatment(mmHg, $\bar{x}\pm s$)	130.25±14.17	131.97±14.56	0.654	0.514
DBP before treatment(mmHg, $\bar{x}\pm s$)	71.42±8.55	70.97±8.62	0.288	0.774
RR before treatment(times/min, $\bar{x}\pm s$)	29.54±3.11	23.12±3.17	11.195	<0.001
Blood lactic acid before treatment(mmol/L, $\bar{x}\pm s$)	2.87±0.29	1.61±0.18	32.055	<0.001
CRP before treatment(mg/L, $\bar{x}\pm s$)	91.66±9.21	47.39±6.25	33.845	<0.001
GCS score at admission(points, $\bar{x}\pm s$)	11.26±2.34	15.33±2.49	9.138	<0.001
BNP before treatment(ng/L, $\bar{x}\pm s$)	287.65±29.33	134.25±17.58	39.257	<0.001
Hypoalbuminemia[n(%)]			0.004	0.950
Yes	29(69.05)	74(68.52)		
No	13(30.95)	34(31.48)		
Combined with diabetes mellitus[n(%)]			1.663	0.197
Yes	20(47.62)	64(59.26)		
No	22(52.38)	44(40.74)		
Combined with hypertension[n(%)]			0.376	0.540
Yes	21(50.00)	60(55.56)		
No	21(50.00)	48(44.44)		
Combined with hyperlipidemia[n(%)]			1.799	0.180
Yes	14(33.33)	49(45.37)		
No	28(66.77)	59(54.63)		
Duration of ventilation(d, $\bar{x}\pm s$)	17.54±2.33	17.61±2.58	0.153	0.879

COPD: chronic obstructive pulmonary disease; CRF: chronic respiratory failure; APACHE Ⅱ: acute physiology and chronic health evaluation Ⅱ; PaO_2: partial pressure of oxygen; $PaCO_2$: partial pressure of carbon dioxide; HR: heart rate; PH: potential of hydrogen; SBP: systolic blood pressure; DBP: diastolic blood pressure; RR: respiratory rate; CRP: C-reactive protein; GCS: Glasgow coma scale; SGRQ: St. George's respiratory questionnaire; BNP: B-type natriuretic peptide. 1 mmHg=0.133 kPa.

2.2 影响老年 COPD 合并 CRF 患者正压通气失败的多因素 logistic 回归分析

对上述差异有统计学意义的单因素变量进行赋值(表2),行多因素 logistic 回归分析。结果显示,入院时 APACHE Ⅱ 评分≥15 分、治疗前 $PaCO_2$≥75 mmHg、治疗前血乳酸≥1.7 mmol/L、治疗前 CRP≥85 mg/L、治疗前 BNP≥250 ng/L 是影响老年 COPD 合并 CRF 患者正压通气失败的独立危险因素(P<0.05;表3)。

表2 量化赋值表

Table 2 Quantization assignment

Factor	Quantization assignment
APACHE Ⅱ score at admission	≥15 scores=1, <15 scores=0
PaO_2 before treatment	≤50 mmHg=1, >50 mmHg=0
$PaCO_2$ before treatment	≥75 mmHg=1, <75 mmHg=0
HR before treatment	≥95 times/min=1, <95 times/min=0
PH value before treatment	≥7.2=1, <7.2=0
RR before treatment	≥25 times/min=1, <25 times/min=0
Combined with diabetes mellitus	Yes=1, No=0
Blood lactic acid before treatment	≥1.7 mmol/L=1, <1.7 mmol/L=0
CRP before treatment	≥85 mg/L=1, <85 mg/L=0
GCS score on admission	≥51 points=1, <51 points=0
BNP before treatment	≥250 ng/L=1, <250 ng/L=0

APACHE Ⅱ: acute physiology and chronic health evaluation Ⅱ; PaO_2: partial pressure of oxygen in arterial blood; $PaCO_2$: partial pressure of carbon dioxide in arterial blood; HR: heart rate; PH: potential of hydrogen; RR: respiratory rate; CRP: C-reactive protein; GCS: Glasgow coma scale; BNP: B-type natriuretic peptide. 1 mmHg=0.133 kPa.

表3 影响老年 COPD 合并 CRF 患者正压通气失败的多因素 logistic 回归分析

Table 3 Multivariate logistic regression analysis of positive pressure ventilation failure in elderly COPD patients with CRF

Factor	β	SE	$Wald\ \chi^2$	OR	95%CI	P value
APACHE Ⅱ score on admission	1.564	0.627	6.222	4.778	1.398-16.329	0.013
PaO_2 before treatment	1.366	0.789	2.997	3.920	0.835-18.402	0.084
$PaCO_2$ before treatment	1.379	0.625	4.868	3.971	1.166-13.518	0.028
HR before treatment	1.458	0.869	2.815	4.297	0.783-23.600	0.094
PH value before treatment	1.377	0.954	2.083	3.963	0.611-25.709	0.150
RR before treatment	1.621	0.877	3.416	5.058	0.907-28.217	0.065
Combined with diabetes	1.842	0.963	3.658	6.309	0.956-41.657	0.056
Blood lactic acid before treatment	1.629	0.714	5.205	5.099	1.258-20.665	0.023
CRP before treatment	1.217	0.533	5.213	3.377	1.188-9.599	0.023
GCS score on admission	1.394	0.781	3.186	4.031	0.872-18.630	0.075
BNP before treatment	1.497	0.678	4.875	4.468	1.183-16.876	0.028

COPD: chronic obstructive pulmonary disease; CRF: chronic respiratory failure; APACHE Ⅱ: acute physiology and chronic health evaluation Ⅱ; PaO_2: partial pressure of oxygen; $PaCO_2$: partial pressure of carbon dioxide; HR: heart rate; PH: potential of hydrogen; RR: respiratory rate; CRP: C-reactive protein; GCS: Glasgow coma scale; BNP: B-type natriuretic peptide.

2.3 两组患者生活质量评分比较

正压通气治疗有效组 SGRQ 中疾病影响、活动受限和呼吸症状维度得分以及总得分均显著低于治疗无效组,差异均有统计学意义(均 P<0.05;表4)。

表4 两组患者生活质量评分比较

Table 4 Comparison of quality of life scores between two groups (points, $\bar{x}\pm s$)

Group	n	Disease effect	Limited movement	Respiratory symptom	Total score
Effective	108	8.64±1.51	9.55±1.27	8.76±0.94	26.95±3.11
Ineffective	42	17.23±2.56	16.34±2.58	17.69±2.55	51.26±6.44
t		25.380	21.521	31.436	31.096
P value		<0.001	<0.001	<0.001	<0.001

2.4 老年 COPD 合并 CRF 患者正压通气失败与生活质量的相关性分析

Spearman 相关性分析发现,老年 COPD 合并 CRF 患者正压通气失败与生活质量得分呈显著正相关(r=0.923,P<0.05;图1)。

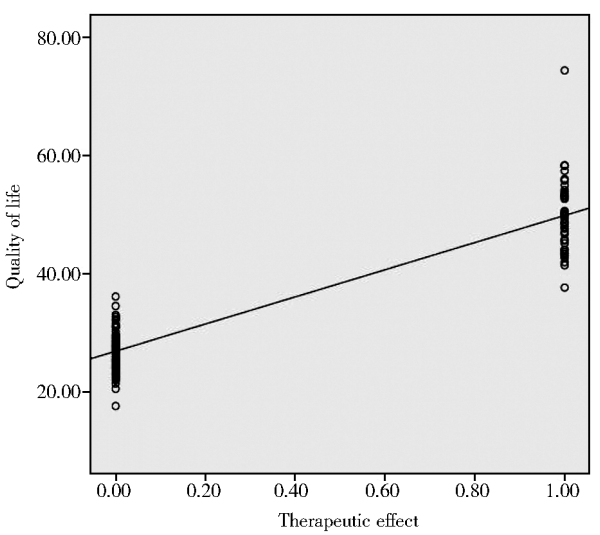


图1 老年 COPD 合并 CRF 患者正压通气失败与生活质量评分的相关性分析散点图

Figure 1 Scatter chart of correlation analysis between positive pressure ventilation failure and quality of life score in elderly COPD patients with CRF

COPD: chronic obstructive pulmonary disease; CRF: chronic respiratory failure. Regarding X-axis, 0.00 indicates effective positive pressure ventilation, 1.00 indicates ineffective positive pressure ventilation.

3 讨 论

老年 COPD 合并 CRF 患者通常伴有多种合并疾病和功能障碍,治疗难度较大。正压通气作为一种重要的呼吸支持治疗手段,在这类患者的治疗过程中得到了广泛的应用[9]。然而,正压通气失败却是治疗常见的并发症,严重影响患者的预后[10]。随着医疗技

术的不断进步和老年人口比例的增加，了解正压通气失败的发生机制、影响因素和其对生活质量的影响，对于改善患者的治疗效果至关重要。

本研究中 logistic 回归分析结果显示，入院时 APACHE Ⅱ评分≥15 分、治疗前 $PaCO_2$≥75 mmHg、治疗前血乳酸≥1.7 mmol/L、治疗前 CRP≥85 mg/L、治疗前 BNP≥250 ng/L 是影响老年 COPD 合并 CRF 患者正压通气失败的独立危险因素。分析原因如下：高 APACHE Ⅱ评分反映了患者身体状况较差，而老年 COPD 合并 CRF 患者本身存在呼吸功能受限的情况，如果伴随有其他系统的功能障碍，如心脏、肾脏等器官功能不全等，会增加正压通气失败的风险[11,12]。研究发现，高 $PaCO_2$ 水平常伴随低氧血症，导致氧合不足，进而影响组织氧供并加重器官功能损伤，增加正压通气失败的风险[13,14]。对于老年 COPD 合并 CRF 患者，氧合不足还会促使乳酸生成增加、组织代谢紊乱，进一步增加正压通气失败的风险[15,16]。高水平的 CRP 通常反映了患者体内存在的炎症状态。在老年 COPD 合并 CRF 患者中，炎症反应可能会导致肺部病变加重，气道狭窄加剧，影响气体交换，增加呼吸困难的程度，使正压通气治疗效果受到影响[17,18]。BNP 是一种由心脏分泌的激素，在心脏负荷增加或心脏功能受损时会分泌增加，高水平的 BNP 提示右心的压力负荷过重，可能导致心脏功能不全，从而影响正压通气的有效性[19]。

本研究还发现，正压通气治疗有效组 SGRQ 中疾病影响、活动受限和呼吸症状维度得分以及总得分均显著低于无效组，且相关性分析发现，正压通气失败与生活质量得分呈显著正相关性。原因有以下几个方面。(1)症状缓解。有效组的患者在接受正压通气治疗后，呼吸困难等症状得到明显缓解，可更好地进行日常活动、社交和工作，从而提高生活质量[20]。(2)心理状态调整。有效组的患者在正压通气治疗后心理状态更加积极乐观，对疾病的应对能力更强。(3)疾病控制。有效组患者在正压通气治疗后疾病得到控制，病情稳定，从而能够更好地管理疾病、遵循医嘱，并且享受到更多的生活乐趣，生活质量得到改善[21]。

综上，临床需加强对入院时 APACHE Ⅱ评分、治疗前 $PaCO_2$、治疗前血乳酸、治疗前 CRP、治疗前 BNP 水平的监测及管理，为提高老年 COPD 合并 CRF 患者正压通气治疗有效率及改善患者生活质量奠基。

【参考文献】

[1] Duiverman ML, Vonk JM, Bladder G, *et al*. Home initiation of chronic non-invasive ventilation in COPD patients with chronic hypercapnic respiratory failure: a randomised controlled trial[J]. Thorax, 2020, 75(3): 244-252. DOI: 10.1136/thoraxjnl-2019-213303.

[2] McNicholas WT, Hansson D, Schiza S, *et al*. Sleep in chronic respiratory disease: COPD and hypoventilation disorders[J]. Eur Respir Rev, 2019, 28(153): 190064. DOI: 10.1183/16000617.0064-2019.

[3] MacLeod M, Papi A, Contoli M, *et al*. Chronic obstructive pulmonary disease exacerbation fundamentals: diagnosis, treatment, prevention and disease impact[J]. Respirology, 2021, 26(6): 532-551. DOI: 10.1111/resp.14041.

[4] Rüegger CM, Owen LS, Davis PG. Nasal intermittent positive pressure ventilation for neonatal respiratory distress syndrome[J]. Clin Perinatol, 2021, 48(4): 725-744. DOI: 10.1016/j.clp.2021.07.004.

[5] Moretti C, Gizzi C. Synchronized nasal intermittent positive pressure ventilation[J]. Clin Perinatol, 2021, 48(4): 745-759. DOI: 10.1016/j.clp.2021.07.005.

[6] 中华医学会, 中华医学会杂志社, 中华医学会全科医学分会, 等. 慢性阻塞性肺疾病基层诊疗指南(2018 年)[J]. 中华全科医师杂志, 2018, 17(11): 856-870. DOI: 10.3760/cma.j.issn.1671-7368.2018.11.002.

[7] 郭仓. 呼吸衰竭的表现、诊断标准及防治原则[J]. 中华危重病急救医学, 1996, 8(1): 37-38. DOI: CNKI:SUN:ZWZB.0.1996-01-017.

[8] 中华医学会呼吸病学分会呼吸生理与重症监护学组, 《中华结核和呼吸杂志》编辑委员会. 无创正压通气临床应用专家共识[J]. 中华结核和呼吸杂志, 2009, 32(2): 86-98. DOI: 10.3760/cma.j.issn.1001-0939.2009.02.003.

[9] Zhang X, Yang P, Guo C, *et al*. Effects of volume-assured pressure support noninvasive ventilation in stable COPD with chronic respiratory failure: Meta-analysis and literature review[J]. Heart Lung, 2020, 49(3): 287-295. DOI: 10.1016/j.hrtlng.2020.01.007.

[10] 胡慧芳, 程炜炜, 郭传辉. 电子支气管镜辅助无创机械正压通气治疗老年慢阻肺合并呼吸衰竭的临床及疗效观察[J]. 中华保健医学杂志, 2021, 23(1): 93-94, 100. DOI: 10.3969/j.issn.1674-3245.2021.01.026.

[11] Zhu X, Qi H, Feng Z, *et al*. Noninvasive high-frequency oscillatory ventilation *vs* nasal continuous positive airway pressure *vs* nasal intermittent positive pressure ventilation as postextubation support for preterm neonates in China: a randomized clinical trial[J]. JAMA Pediatr, 2022, 176(6): 551-559. DOI: 10.1001/jamapediatrics.2022.0710.

[12] 王明明, 宋立强, 杨学敏, 等. 非 HIV 肺孢子菌肺炎伴急性呼吸衰竭患者无创机械通气失败的影响因素分析[J]. 医学临床研究, 2023, 40(5): 652-655. DOI: 10.3969/j.issn.1671-7171.2023.05.004.

[13] 周大文, 杨晓梅, 赵文婷, 等. 慢性阻塞性肺疾病合并呼吸衰竭患者无创呼吸机治疗失败的影响因素及其风险预测列线图模型构建[J]. 实用心脑肺血管病杂志, 2023, 31(7): 11-16. DOI: 10.12114/j.issn.1008-5971.2023.00.130.

[14] 魏娜, 周斌, 傅兴隆. 有创-无创序贯机械通气治疗 AECOPD 合并呼吸衰竭失败的相关因素分析[J]. 海南医学, 2021, 32(4): 446-449. DOI: 10.3969/ j.issn.1003-6350.2021.04.010.

[15] 李艳敏, 成旭明, 楼翰健. 有创-无创序贯通气治疗 AECOPD 失败的危险因素分析[J]. 中国中西医结合急救杂志, 2022, 29(1): 45-48. DOI: 10.3969/j.issn.1008-9691.2022.01.010.

[16] 李嘉. 老年慢性阻塞性肺疾病急性加重期并呼吸衰竭患者机械通气脱机失败的多因素分析[J]. 中国临床医生杂志, 2020, 48(1): 57-60. DOI: 10.3969/j.issn.2095-8552.2020.01.016.

[17] 吴国斌, 陈兴峰, 黄芳, 等. 慢性阻塞性肺疾病急性加重期并发呼吸衰竭有创机械通气患者撤机失败的危险因素分析[J]. 中国中西医结合急救杂志, 2023, 30(1): 46-50. DOI: 10.3969/j.issn.1008-9691.2023.01.010.

[18] 周晓蕾, 张娟, 赵志国, 等. 持续正压通气治疗对阻塞性睡眠呼吸暂停低通气综合征患者血清白细胞介素-23 及 C 反应蛋白的影响[J]. 中国呼吸与危重监护杂志, 2020, 19(1): 36-40. DOI: 10.7507/1671-6205.201812006.

[19] 苏建花, 韦守福, 石宝平, 等. 无创机械通气干预治疗慢性阻塞性肺疾病急性发作合并脑钠肽升高患者的临床研究[J]. 山西医药杂志, 2021, 50(6): 893-896. DOI: 10.3969/j.issn.0253-9926.2021.06.003.

[20] 郭晓亮, 李俊艳, 袁宇, 等. 重组人脑利钠肽联合无创正压机械通气对重症心力衰竭患者的临床治疗效果[J]. 广东医学, 2024, 45(11): 1361-1367. DOI: 10.13820/j.cnki.gdyx.20241827.

[21] 王翠, 施敏骅. 经鼻高流量氧疗治疗慢性阻塞性肺疾病急性加重合并Ⅱ型呼吸衰竭的临床疗效观察[J]. 中国呼吸与危重监护杂志, 2021, 20(11): 807-812. DOI: 10.7507/1671-6205.202101041.

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