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HFNC 与 NPPV 治疗急性 1 型呼吸衰竭的临床效果比较 *

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摘要 目的: 比较经鼻高流量氧疗 (High-flow Nasal Cannula, HFNC) 与无创正压通气 (Non-invasive positive pressure ventilation, NPPV) 治疗 1 型呼吸衰竭的临床疗效及安全性。方法: 选取 2016 年 9 月到 2017 年 12 月我院收治的急性 1 型呼吸衰竭患者 46 例, 根据入院的顺序数字表法随机分为 HFNC 组和 NPPV 组, 每组 23 例, 分别给予 HFNC 治疗与 NPPV 治疗。比较两组治疗前及治疗后 2 h、24 h、48 h 的动脉血气 pH 值、动脉二氧化碳分压 (Arterial carbon dioxide partial pressure, PaCO₂)、动脉血氧分压 (Arterial oxygen partial pressure, PaO₂)、氧合指数、呼吸频率、心率等指标的变化情况。结果: 两组动脉血气 pH 值治疗前、治疗后 2 h、24 h、48 h 比较无显著差异性 ($P>0.05$), 组间比较也无显著性差异 ($P>0.05$); 两组治疗后 2 h、24 h 及 48 h PaO₂ 和动脉血气氧合指数均显著高于治疗前, 且随着时间的延长逐渐升高 ($P<0.05$), 且治疗后 48 h, NPPV 组显著高于 HFNC 组 ($P<0.05$); 两组治疗后 2 h、24 h 及 48 h 的 PaCO₂ 值与治疗前比较无显著性差异 ($P>0.05$), 而治疗后 48 h 的 PaCO₂ 值 NPPV 组显著低于 HFNC 组 ($P<0.05$); 两组治疗后 2 h、24 h 及 48 h 呼吸频率均显著低于治疗前, 且随时间逐渐降低 ($P<0.05$), 且治疗后 2 h、24 h 及 48 h 的呼吸频率 NPPV 组显著高于 HFNC 组 ($P<0.05$); 两组治疗后 2 h、24 h 及 48 h 心率显著低于治疗前, 且随着时间的延长逐渐降低 ($P<0.05$), 组间比较无显著性差异 ($P>0.05$)。结论: HFNC 与 NPPV 治疗单纯 1 型呼吸衰竭的临床效果相当, 但 HFNC 在提高患者治疗中的舒适度及耐受性等方面可能优于 NPPV。

关键词: 急性 1 型呼吸衰竭; 经鼻高流量氧疗; 无创正压通气; 临床效果; 安全性

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A Comparative Study on High-flow Nasal Cannula and Noninvasive Positive Pressure Ventilation in the Treatment of Type 1 Acute Respiratory Failure*

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ABSTRACT Objective: To investigate the clinical efficacy and safety of high-flow nasal cannula (HFNC) and non-invasive positive pressure ventilation (NPPV) in the treatment of type 1 respiratory failure. **Methods:** 60 patients with acute type 1 respiratory failure admitted to our hospital from September 2016 to December 2017 were randomly divided into the HFNC group and the NPPV group according to the order of admission, 23 patients in each group were treated with HFNC and NPPV treatment respectively. The arterial blood gas pH value, PaCO₂, PaO₂, oxygenation index, respiratory rate, heart rate were compared before and at 2 h, 24 h and 48 h after treatment. **Results:** There was no significant difference in the pH value of arterial blood gas before treatment and at 2 h, 24 h and 48 h after treatment ($P>0.05$). The PaO₂ and arterial blood oxygenation index were significantly higher in the two groups at 2 h, 24 h and 48 h after treatment, and gradually increased with time ($P<0.05$), and at 48 h after treatment, it was significantly higher in the NPPV group than that of the HFNC group ($P<0.05$). The PaCO₂ values at 2 h, 24 h and 48 h after treatment showed no significant difference from those before treatment ($P>0.05$), while the PaCO₂ values in the NPPV group at 48 h after treatment were significantly lower than those in the HFNC group ($P<0.05$). The respiratory rate at 2 h, 24 h and 48 h after treatment was significantly lower than that before treatment, and gradually decreased with time ($P<0.05$), and the respiratory rate of NPPV group was significantly higher than those of the HFNC group at 2 h, 24 h and 48 h after treatment ($P<0.05$). The heart rate at 2 h, 24 h and 48 h after treatment were significantly lower than that before treatment, and gradually decreased with time ($P<0.05$). **Conclusion:** The clinical effect of HFNC and NPPV is comparable in the treatment of type 1 respiratory failure, but HFNC may be superior to NPPV in improving the comfort and tolerance during treatment.

Key words: Type 1 acute respiratory failure; High-flow nasal cannula; Noninvasive positive pressure ventilation; Clinical effect; Safety

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前言

急性呼吸衰竭是常见的呼吸系统急症,具有起病急、进展快、病死率高等特点,严重影响患者的生活质量^[1],是由呼吸道病变、肺组织病变、肺血管疾病、胸廓病变、神经中枢及其传导系统呼吸肌疾引起的肺通气或换气功能严重障碍,引起一系列生理功能和代谢紊乱的临床综合征^[2-4]。临床上,根据有无二氧化碳潴留分为 I 型呼吸衰竭和 II 型呼吸衰竭^[5]。急性 I 型呼吸衰竭是重症医学科(Intensive Care Unit, ICU)常见的急危重症,是由多种因素所引发的严重呼吸功能障碍,常见的是肺部感染导致的呼吸功能障碍。对于 I 型呼吸衰竭患者,在治疗原发病的同时,呼吸支持是最为重要的措施,应尽早进行氧疗纠正低氧血症,缓解机体缺氧,减少脏器因缺氧进一步损伤。无创正压通气(Noninvasive positive pressure ventilation, NPPV)是最常见的治疗方法,以其具有无创、并发症少、改善氧合快等优点已在临床上应用广泛,取得了较好效果,缩短了有创机械通气时间,降低了再插管率及呼吸机相关性肺炎 (Ventilator associated pneumonia, VAP) 的发生率。但因无创正压通气存在腹胀明显、面部皮肤因面罩压迫缺血坏死及痰液干燥等缺点,患者不易耐受,容易导致治疗失败^[6,7]。

与传统氧疗相比,经鼻高流量吸氧(High-flow nasal cannula, HFNC)能改善患者氧合和呼吸窘迫症状,且具有更好地可耐受性,能增加患者舒适感和依从性,已成为部分替代无创机

械通气的治疗措施^[8,9]。其主要是通过无需密封的鼻导管将经过加湿、加温的较高浓度的空氧混合高流量气体输送给患者的一种氧疗方式,是一种无创的呼吸支持方式,可以迅速的改善缺氧患者的氧合。早期应用于婴幼儿的呼吸衰竭的治疗,近年来逐渐应用到成人急性单纯性缺氧患者、外科术后患者、急性呼吸衰竭未行插管患者及心功能不全患者等,这些国内外开展大量的临床研究也肯定了 HFNC 的临床价值,在某些方面的优势逐渐得到临床认可^[10]。HFNC 最初作为替代经鼻持续气道正压通气的呼吸支持方式,应用于新生儿急性呼吸窘迫综合征的治疗,而在急重症成人患者中的应用尚缺乏严格的论证指导临床使用^[11]。本研究将我院 ICU 内应用经鼻高流量吸氧治疗和无创呼吸氧疗患者的临床效果进行对比,现报道如下:

1 资料与方法

1.1 临床资料

选择 2016 年 9 月到 2017 年 12 月在本科明确诊断 I 型呼吸衰竭的病人 46 例,根据入院顺序随机数字表法分为 NPPV 组(23 例)及 HFNC 组(23 例)。其中, NPPV 组男 19 例,女 4 例,平均年龄(64.91±18.65)岁; HFNC 组男 17 例,女 6 例,平均年龄(67.13±17.97)岁。两组的基础病为急性胰腺炎、慢性支气管炎急性发作、吸入性肺炎、骨折、肺挫伤、冠心病等,基础病构成比较无统计学差异($P>0.05$),见表 1。两组患者均签署知情同意书,获得医院伦理委员会批准。

表 1 两组的基础病构成比较[例(%)]

Table 1 Comparison of the distribution of the Basic disease between two groups [n(%)]

Basic disease	NPPV group(n=23)	HFNC group(n=23)
Acute pancreatitis	4 (17.4%)	3 (13.0%)
Acute attack of chronic bronchitis	3 (13.0%)	3 (13.0%)
Aspiration pneumonia	2 (8.7%)	2 (8.7%)
Cataclasis	3 (13.0%)	3 (13.0%)
Contusion of lung	2 (8.7%)	3 (13.0%)
Coronary disease	2 (8.7%)	3 (13.0%)
Heat apoplexy	2 (8.7%)	0 (0%)
Cerebral infarction	0 (0%)	2 (8.7%)
No obvious underlying diseases	3 (13.0%)	1 (4.3%)

1.2 病例纳入标准

符合 I 型呼吸衰竭的诊断标准:呼吸频率 >25 次/分,动脉血氧分压 <60 mmHg,或吸氧状态下氧合指数 <300 mmHg,二氧化碳分压 <45 mmHg。

1.3 病例排除标准

需紧急行气管插管的患者;血流动力学不稳定、休克需使用血管活性药物患者;动脉血二氧化碳分压 >45 mmHg;昏迷患者;有无创通气禁忌症患者。

1.4 研究方法

所入选患者均按照基础原发病的治疗原则予抗感染、化痰、促进气道分泌物排出、维持酸碱度、电解质稳定等治疗。在进行相应治疗前,先予面罩吸氧,流量 6 L/min,持续吸氧 15 min,

观察氧合指数情况,若 $\text{PaO}_2/\text{FIO}_2<300$ mmHg。NPPV 组:采用 Drger Carina,初始设置模式为 BIPAP 模式,潮气量 8-10 ml/kg, FIO_2 50-80 %,压力支持 10-15 cm H_2O 。HFNC 组:采用 Fisher Paykel AIRVO₂,初始设置流量 45 L/min,吸氧浓度 60-80 %。定期复查动脉血气分析,根据氧合指数调整呼吸参数,维持血氧饱和度在 92 %及以上。

1.5 观察指标

观察治疗前及治疗后 2 h、24 h、48 h 的动脉血气 PH 值、 PaCO_2 、 PaO_2 、氧合指数、呼吸频率、心率等指标变化。

1.6 统计学方法

所有数据用 SPSS 19.0 统计软件进行统计处理。计量资料以均数±标准差($\bar{x}\pm s$),重复测量数据用采用重复测量方差分

析(Repeated Measures ANOVA)进行统计。两组数据比较采用独立样本 t 检验。计数资料以频数、百分率(%)表示,两组间比较采用卡方检验。 $P<0.05$ 为差异具有统计学意义。

2 结果

表 2 两组患者基线资料的比较(n=23)

Table 2 Comparison of the baseline information between two groups of patients(n=23)

Project	NPPV group	HFNC group
Ages	64.91± 18.65	67.13± 17.97
Male/Female	19/4	17/6
pH	7.41± 0.07	7.41± 0.07
PaCO ₂	34.31± 6.56	35.72± 5.35
PaO ₂	55.57± 3.44	56.29± 2.49
Oxygenation index	123.41± 7.67	125.08± 5.55
Breathing rate	26.57± 2.46	25.57± 1.83
Heart rate	101.35± 10.48	103.17± 13.29

2.2 两组动脉血气 pH 值的比较

两组治疗前、治疗后 2 h、24 h、48 h 动脉血气 pH 值比较无

2.1 两组基线资料的比较

两组年龄、性别、基础疾病构成、治疗前的动脉血气 pH 值、PaCO₂、PaO₂、氧合指呼吸频率、心率、数等比较差异均无统计学意义(P 均 >0.05),见表 2。

显著差异性($P>0.05$),两组间在治疗前、治疗后 2 h、24 h、48 h

动脉血气 pH 值比较无显著差异性($P>0.05$),见表 3。

表 3 两组治疗前和治疗后不同时点动脉血气 pH 值的比较($\bar{x} \pm s$)

Table 3 Comparison of the arterial blood gas pH value between two groups before and after treatment($\bar{x} \pm s$)

Groups	n	Before treatment	At 2 h after treatment	At 24 h after treatment	At 48 h after treatment
NPPV group	23	7.43± 0.07	7.42± 0.04	7.42± 0.04	7.41± 0.04
HFNC group	23	7.41± 0.07	7.40± 0.04	7.41± 0.03	7.41± 0.03

2.3 两组动脉血气 PaO₂ 值的比较

两组治疗后 2 h、24 h 及 48 h PaO₂ 值均显著高于治疗前,且随着时间延长逐渐升高($P<0.05$);两组间治疗前、治疗后 2 h

及治疗后 24 h PaO₂ 值比较无显著性差异($P>0.05$),而治疗后 48 h 的 PaO₂ 值 NPPV 组显著高于 HFNC 组($P<0.05$),见表 4。

表 4 两组治疗前和治疗后不同时点 PaO₂ 值的比较($\bar{x} \pm s$, mmHg)

Table 4 Comparison of the PaO₂ value of arterial blood gas between two groups before and after treatment($\bar{x} \pm s$, mmHg)

Groups	n	Before treatment	At 2 h after treatment	At 24 h after treatment	At 48 h after treatment
NPPV group	23	55.57± 3.44	66.43± 6.56 ^a	79.63± 14.72 ^a	96.38± 18.56 ^{a#}
HFNC group	23	56.29± 2.49	64.78± 6.44 ^a	73.42± 8.73 ^a	80.57± 10.29 ^a

Notes: Compared with the HFNC group, ^a $P<0.05$; compared with before treatment in this group, [#] $P<0.05$.

2.4 两组动脉血气氧合指数的比较

两组治疗后 2 h、24 h 及 48 h 动脉血气氧合指数均显著高于治疗前,且随着时间的延长逐渐升高($P<0.05$);两组间治疗

前、治疗后 2 h 及治疗后 24 h 动脉血气氧合指数比较无显著性差异 ($P>0.05$), 而治疗后 48 h 的 PaO₂ 值 NPPV 组显著高于 HFNC 组($P<0.05$),见表 5。

表 5 两组治疗前和治疗后不同时点动脉血气氧合指数的比较($\bar{x} \pm s$)

Table 5 Comparison of the arterial blood oxygenation index between two groups before and after treatment($\bar{x} \pm s$)

Groups	n	Before treatment	At 2 h after treatment	At 24 h after treatment	At 48 h after treatment
NPPV group	23	123.41± 7.67	147.05± 15.75 ^a	175.08± 33.81 ^a	214.35± 41.51 ^{a#}
HFNC group	23	125.08± 5.55	143.26± 16.13 ^a	163.43± 23.2 ^a	179.38± 24.54 ^a

Note: Compared with the HFNC group, ^a $P<0.05$; compared with before treatment in this group, [#] $P<0.05$.

2.5 两组动脉血气 PaCO₂ 值的比较

两组治疗后 2 h、24 h 及 48 h 的 PaCO₂ 值与治疗前比较无显著性差异($P>0.05$);两组间治疗前、治疗后 2 h 及治疗后 24 h

的 PaCO₂ 值比较无显著性差异($P>0.05$),而治疗后 48 h 的 PaCO₂ 值 NPPV 组显著低于 HFNC 组($P<0.05$),见表 6。

表 6 两组治疗前和治疗后不同时点 PaCO₂ 值的比较($\bar{x} \pm s$, mmHg)

Table 6 Comparison of the PaCO₂ value of arterial blood gas between two groups before and after treatment($\bar{x} \pm s$, mmHg)

Groups	n	Before treatment	After treatment	After treatment	After treatment
			2 h	24 h	48 h
NPPV group	23	34.31± 6.56	34.95± 5.10	36.7± 3.17	35.85± 3.35*
HFNC group	23	35.72± 5.35	36.83± 4.12	37.64± 2.65	38.47± 1.90

Note: Compared with the HFNC group, * $P < 0.05$; compared with before treatment in this group, # $P < 0.05$.

2.6 两组呼吸频率的比较

两组治疗后 2 h、24 h 及 48 h 呼吸频率均显著低于治疗前,且随着时间逐渐降低($P < 0.05$);两组间治疗前呼吸频率变化

比较无显著性差异($P > 0.05$),治疗后 2 h、24 h 及 48 h 的呼吸频率 NPPV 组显著高于 HFNC 组($P < 0.05$),见表 7。

表 7 两组治疗前和治疗后不同时点呼吸频率的比较($\bar{x} \pm s$)

Table 7 Comparison of the respiratory rate between two groups before and after treatment($\bar{x} \pm s$)

Groups	n	Before treatment	After treatment	After treatment	After treatment
			2 h	24 h	48 h
NPPV group	23	26.57± 2.46	24.30± 1.99*#	21.96± 1.40*#	20.87± 1.14*#
HFNC group	23	25.57± 1.83	22.87± 1.94#	20.48± 1.75#	19.35± 1.34#

Note: Compared with the HFNC group, * $P < 0.05$; compared with before treatment in this group, # $P < 0.05$.

2.7 两组心率的比较

两组治疗后 2 h、24 h 及 48 h 心率显著低于治疗前,且随着

时间的延长逐渐降低($P < 0.05$);两组间治疗前、治疗后 2 h、24 h 及 48 h 的心率比较均无显著性差异($P > 0.05$),见表 8。

表 8 两组治疗前和治疗后不同时点心率的比较($\bar{x} \pm s$)

Table 8 Comparison of the heart rate between two groups before and after treatment($\bar{x} \pm s$)

Groups	n	Before treatment	After treatment	After treatment	After treatment
			2 h	24 h	48 h
NPPV group	23	101.35± 10.48	94.83± 11.81#	88.00± 8.50#	81.09± 8.34#
HFNC group	23	103.17± 13.29	95.04± 11.93#	88.39± 9.74#	82.83± 7.11#

Note: Compared with the HFNC group, * $P < 0.05$; compared with before treatment, # $P < 0.05$.

3 讨论

各种原因所致急性呼吸功能不全导致的呼吸衰竭是 ICU 常见的疾病,机体缺氧将增加患者原发病的治疗难度,若不及时早期纠正低氧血症,将导致患者呼吸衰竭进行性加重,机体长时间缺氧将导致多脏器功能障碍^[12]。NPPV 是治疗急性低氧性呼吸功能衰竭的有效手段,但 NPPV 治疗急性呼吸衰竭需要至少 10 cm H₂O 的呼气末正压通气(positive end expiratory pressure, PEEP)才能显著改善 PaO₂/FiO₂,同时面罩漏气以及患者耐受性较差等因素可能影响了 PEEP 及压力支持水平的调整,从而影响了 NPPV 的疗效。更重要的是,多项研究均未发现 NPPV 能改善患者的病死率^[13,14]。

HFNC 是一种新的无创的呼吸支持方式,有越来越多的临床研究证实经鼻高流量氧疗在不同病因导致的急性呼吸衰竭治疗方面均有较好的效果^[15-17]。研究表明 HFNC 可能产生一定的持续的气道压力,虽然这个压力并不是持续恒定的,其大小与气体流量、患者是否张口有密切关系,尤其是呼吸相明显,但这个持续的压力类似于 PEEP 的作用,能降低上呼吸道呼吸阻力,减少呼吸做功^[18,19]。同时,HFNC 提供的高流量氧气,通过鼻塞吸氧,对鼻咽部的解剖无效腔能起到冲洗作用,减少了上呼吸道死腔,减少重复呼吸气体,提高呼吸效率,从而达到改善氧

合的作用^[20-22]。HFNC 提供主动地加温加湿氧气吸入,可促进气道的湿化,改善气道粘液纤毛系统功能,促进了粘液分泌,减轻气道分泌物的粘稠度,能促进分泌物的排出,减少了呼吸肌做功,也减少肺不张的形成,进而改善患者氧合^[23,24]。因此,目前临床上采用 HFNC 代替 NPPV 应用于急性呼吸衰竭、拔管后低氧血症、慢性阻塞性肺疾病(chronic obstructive pulmonary disease, COPD)及部分围手术期等疾病的治疗。随着临床应用经验的增加,大量临床试验均证实 HFNC 在以上疾病治疗方面与 NPPV 相比存在一定的优势^[25,26]。

1 型呼吸衰竭主要的临床检测指标有动脉血气指标、pH 值、呼吸频率和心率等,其变化可辅助评估呼吸衰竭的进展情况和治疗情况^[27-30]。本项目对 HFNC 与 NPPV 治疗 1 型呼吸衰竭的疗效进行了对比研究,发现 HFNC 与 NPPV 对各种疾病导致的单纯急性 1 型呼吸衰竭病人的 PaCO₂、PaO₂、氧合指数、呼吸频率、心率的影响具有统计学意义,而与引起急性 1 型呼吸衰竭的基础疾病本身无统计学差异,即基础疾病本身并不会影响 2 组病人治疗方式的选择及治疗效果,说明 HFNC 与无创正压通气均能有效的改善急性 1 型呼吸衰竭病人的供氧。HFNC 与 NPPV 之间在 PaO₂、氧合指数、呼吸频率方面组间差异具有统计学意义,提示两种疗法在改善 PaO₂、氧合指数、呼吸频率存在差异。HFNC 与 NPPV 的 PaO₂ 及氧合指数在治疗后 48 h 存

在显著差异,说明当治疗时间超过 48 h,NPPV 改善缺氧的疗效更加明显,在 2 h 及 24 h 前两者的疗效相当。我们还发现在治疗后 3 个时间点,HFNC 组的呼吸频率均显著低于 NPPV 组,提示 HFNC 改善呼吸频率的效果优于 NPPV,这可能与 HFNC 治疗舒适度较高,产生不良反应相对较少,病人更易耐受,治疗的依从性较好等因素有关。

综上所述,HFNC 的治疗单纯急性 1 型呼吸衰竭患者的临床效果与 NPPV 相当,但在病人的耐受及对治疗的依从性等方面可能要优于 NPPV。因此,在此类患者的治疗中,应合理地尽早使用 HFNC,以减少因延迟使用 HFNC 或 HFNC 治疗失败所造成的严重后果,并在 HFNC 的应用过程中严密观察患者临床症状及氧合指数的变化,及时评估治疗效果决定是否需要进行有创通气治疗。

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