

Nasal high-flow in acute hypercapnic exacerbation of COPD

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Introduction

Since the late 1980s non-invasive ventilatory support (NIV) has become a standard treatment in acute exacerbation of COPD (AECOPD) with hypercapnia.¹ Although NIV has been shown to be extremely useful in this situation, but up to 30% of hypercapnic AECOPD patients do not tolerate NIV for several reasons.²

Nasal high-flow (NHF) provides a warmed and humidified airflow up to 60 Liter/min through a specialized nasal cannula. Oxygen admixture is readily available and should be dosed to a desired saturation.³ NHF combines a wash-out effect with a decrease in CO₂ rebreathing, support of inspiratory flow, a small increase in airway pressure, a lowering of ambient air admixture during inspiration and possibly a beneficial effect of warmed and saturated air in the airways. Together, these effects lead to a stabilization of oxygen delivery at higher respiratory rates, a decrease in the work of breathing noticeable by a lower respiratory rate and reduced hypercapnia.⁴⁻⁶

Several studies evaluated the effectiveness of NHF therapy in a variety of clinical situations with effects comparable to NIV.^{3,7} Most of these investigations excluded patients with hypercapnia. It is therefore, impossible to draw meaningful conclusions on the effectiveness of NHF in AECOPD. Several smaller series have observed a significant decrease in partial arterialized carbon dioxide pressure of CO₂ (paCO₂) in chronic hypercapnic COPD patients.^{4,6} There are no data available about other endpoints or in a cohort of solely hypercapnic AECOPD patients.

Methods

Thirty-eight patients were treated between 2015 and 2017 at the Department of Respiratory Medicine, University hospital Leipzig, Germany. Patients were included if they a) did not tolerate NIV following a regular trial (intolerance of NIV), b) fulfilled AECOPD criteria (Anthonisen), c) had a decrease in pH (pH \leq 7.38) and a capillary paCO₂ >45 mmHg at admission, d) had absence of acute metabolic disorders, and e) did not fulfill criteria for intubation. Initiation of NHF (Softflow 50; TNI medical AG, Würzburg) was titrated to achieve a flow rate with greatest tolerability. Oxygen flow (as part of the total flow) was then adjusted to achieve baseline SpO₂ values. Changes in partial pressures of oxygen (paO₂) and paCO₂ as well as pH in capillary blood gas analysis were monitored closely. NHF was terminated when pH increased to more than 7.38 or when the patient no longer tolerated the device or had lesser symptoms. Statistical analysis was performed using an ANOVA test (Sigma Plot; Systat Software GmbH, Ekrath, Germany). This study was approved by the University of Leipzig ethics committee (110/18-ek) and registered (NCT03523481). Patients provided written informed

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Table 1 Parameters during NHF treatment

Parameters	All patients (pH \leq 7.38; n=38)			
	Baseline (mean \pm SD)	End (mean \pm SD)	Change (mean \pm SD)	P-value
pH	7.339 \pm 0.041	7.392 \pm 0.048	0.052 \pm 0.048	0.000
pCO ₂ mmHg	67.6 \pm 12.9	58.5 \pm 9.7	-9.1 \pm 8.8	0.001
pO ₂ mmHg	58.3 \pm 15.2	58.3 \pm 17.6	-	0.983
SO ₂ %	85.3 \pm 9.5	86.2 \pm 11.3	-	0.798
HCO ₃ mmol/L	30.8 \pm 5.1	31.6 \pm 5.3	-	0.636
Base excess mmol/L	6.9 \pm 4.9	7.7 \pm 5.4	-	0.633
NHF flow L/min	-	25.8 \pm 8.2	-	-
Treatment time min	-	195 \pm 231	-	-
Patients with pH <7.35 (n=17)				
pH	7.298 \pm 0.046	7.379 \pm 0.051	0.082 \pm 0.060	0.000
pCO ₂ mmHg	73.7 \pm 13.7	59.6 \pm 11.2	-14.2 \pm 10.6	0.002
pO ₂ mmHg	56.9 \pm 14.8	55.6 \pm 20.7	-	0.845
SO ₂ %	84.8 \pm 10.1	84.3 \pm 11.9	-	0.904
HCO ₃ mmol/L	31.6 \pm 5.5	32.5 \pm 5.6	-	0.661
Base excess mmol/L	7.4 \pm 5.3	8.5 \pm 5.7	-	0.591
NHF flow L/min	-	26.3 \pm 7.9	-	-
Treatment time min	-	252 \pm 251	-	-

Notes: Changes in blood gas analyses data, usage time and flow rates during NHF therapy in all patients and in the subgroup with pH <7.35. All data are organized as mean \pm SD. "-" indicates no significant differences to report.

Abbreviation: NHF, nasal high-flow.

consent. The study was carried out in accordance with the principles of the Declaration of Helsinki.

Results

A significant treatment effect was seen in mean capillary blood pH and in mean paCO₂ (Table 1, Figure 1). Greatest improvements in pH and paCO₂ were found in 17 patients with baseline pH <7.35 (Table 1).

Conclusion and limitation

To our knowledge, this is the first observation evaluating NHF in a cohort with solely hypercapnic (partly acidotic)

AECOPD patients. We found significant improvements of pH and paCO₂. Our study demonstrates that using NHF in severe-to-moderate acidotic and non-acidotic hypercapnic AECOPD patients who did not tolerate NIV is useful.

The limitation of this investigation is best described by its retrospective nature with the lack of a control group. The number of patients was low but appears to be sufficient for a first answer as to whether NHF may be useful in hypercapnic AECOPD patients.

Disclosure

The authors report travel grants, non-financial support (equipment), and lecture fees from TNI medical AG and report no other conflicts of interest in this work.

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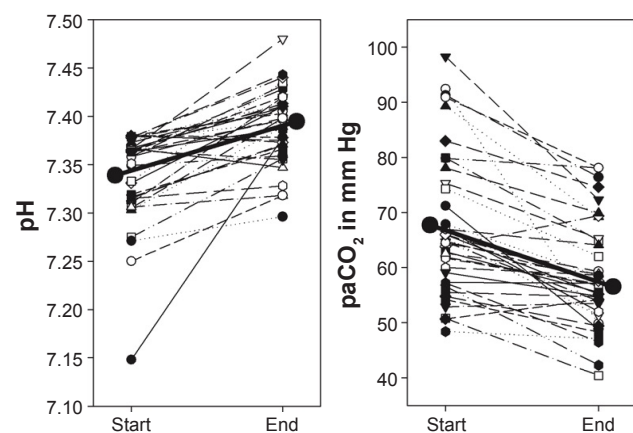


Figure 1 Changes in pH and paCO₂ in all patients; the bold line marks mean values; P<0.05.

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