

Brief report

High-Flow Therapy via Nasal Cannula in Acute Heart Failure

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ABSTRACT

Various oxygenation methods are used in the treatment of respiratory failure in acute heart failure. Occasionally, after patients are stabilized by these ventilation methods, some maintain a degree of dyspnea or hypoxemia which does not improve and is unrelated to deterioration in the functional class or the need to optimize pharmacological treatment. High-flow oxygen systems administered via nasal cannula that are connected to heated humidifiers (HFT) are a good alternative for oxygenation, given that they are easy to use and have few complications. We studied a series of 5 patients with acute heart failure due to acute pulmonary edema with stable dyspnea or hypoxemia following noninvasive ventilation. All the patients were successfully treated with HFT, showing clinical and gasometric improvement and no complications or technical failures. We report our experience and discuss different aspects related to this oxygenation system.

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Terapia de alto flujo de oxígeno con cánulas nasales en la insuficiencia cardiaca aguda

RESUMEN

En el tratamiento de la insuficiencia respiratoria en la insuficiencia cardiaca aguda se utilizan diferentes métodos de oxigenación. En ocasiones los pacientes, tras ser estabilizados con dichos modos ventilatorios, mantienen un grado de disnea o hipoxemia que no mejora y no es atribuible a un empeoramiento del grado funcional o la necesidad de optimizar el tratamiento farmacológico. Los sistemas de alto flujo con interfase nasal con un calentador humidificador acoplado (AFHC) son una buena alternativa como método de oxigenación, de fácil aplicación y escasas complicaciones. Presentamos una serie de 5 pacientes con insuficiencia cardiaca aguda por edema agudo de pulmón con disnea o hipoxemia mantenidas tras la aplicación de ventilación no invasiva. Todos ellos fueron tratados con sistemas de AFHC de forma satisfactoria, con mejoría clínica y gasométrica, sin complicaciones ni fracasos de la técnica. Describimos nuestra experiencia y discutimos diversos aspectos relacionados con dicho sistema de oxigenación.

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Palabras clave:

Insuficiencia cardiaca aguda

Ventilación no invasiva

Terapia de alto flujo

INTRODUCTION

Acute heart failure (AHF) is one of the main causes of acute respiratory failure (ARF) and is generally treated with conventional oxygenation systems (nasal cannula, Venturi mask); however, newer means of ventilation are now available that are more effective and easier to use.¹⁻³ New respiratory devices make it possible to heat and humidify air flows administered through a nasal cannula, enabling use of higher flows of up to 60 l/min.

These high-flow nasal systems with a built-in heated humidifier provide an alternative and effective means of oxygenation. They have been widely used in the home treatment of chronic respiratory failure patients, in post-surgical ARF, in intensive care of children and adult patients with ARF, but above all in cases of

hypoxemia and dyspnea that do not respond to treatment with traditional Venturi masks. These systems provide a higher and more constant oxygen fraction, reduce respiratory dead space, generate positive airway pressure, and offer improved comfort and tolerance.⁴⁻⁶

We describe our experience with the humidified high-flow oxygen therapy via nasal cannula to treat 5 patients initially treated with noninvasive ventilation but who developed hypoxemia refractory to conventional oxygenation methods.

METHODS

The clinical profile of 5 patients with AHF due to acute pulmonary edema (APE) treated with a high-flow system via nasal cannulas with a built-in heated humidifier (HFT) (ie, the Optiflow[®] by Fisher and Paykel with a rotameter of up to 60 l/min) was detailed. The patients suffered dyspnea and refractory hypoxemia

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Table 1
Demographic Characteristics and Comorbidity of the 5 Patients

Age (years)	84.2 ± 4.6
Women	3 (60)
Arterial hypertension	5 (100)
Diabetes mellitus	1 (20)
Chronic heart failure	5 (100)
COPD	2 (40)
Atrial fibrillation	3 (60)
Chronic kidney disease	1 (20)
Dyslipidemia	4 (80)
Ischemic heart disease	2 (40)
Barthel index	36 ± 38
Charlson index	6 ± 1

COPD, chronic obstructive pulmonary disease.
Data are expressed as N (%) or mean ± standard deviation.

at 24 h after admission and were treated with conventional oxygenation systems (Venturi mask with unheated Aqua-pack®-type humidifier and a rotameter of up to 15 l/min) in a short stay unit (SSU). Both systems used a theoretical fraction of inspired oxygen (FiO₂) of 1.

Clinical variables collected include degree of dyspnea (modified Borg⁷ scale), blood oxygen saturation (SaO₂) measured by pulse oximeter, heart rate, respiratory rate, and systolic blood pressure. Arterial gasometry was performed at 24 h after admission and 24 h after treatment with the HFT system.

We also recorded the patients' degree of comfort,⁸ complications, and total time of high-flow oxygenation.

Drug therapy followed European Society of Cardiology recommendations.⁹

Statistical Analysis

Quantitative variables were examined using the Shapiro-Wilks W test for normality. The assumption of normality was only rejected in the case of SaO₂ at 24 h. The rest of the variables were analyzed using a Student T test for the intrasubject comparison of 2 means. Variables not meeting the assumption of normality were analyzed using a Wilcoxon T test. Qualitative variables were

compared with the chi-square test. Statistical analysis was carried out using the SPSS 15 software.

RESULTS

Of the 5 patients in the study, 3 were women (60%); the mean age was 84.2 ± 4.6 years; all were highly dependent in basic activities of daily living (Barthel index 36 ± 38 points), with high rates of comorbidity (Charlson index 6 ± 1); 100% were hypertensive and had chronic heart failure; 60% had permanent atrial fibrillation and chronic ischemic cardiopathy; and 20% suffered chronic obstructive pulmonary disease (Table 1).

All 5 patients were treated with non-invasive ventilation in the emergency room, 3 with constant positive airway pressure and 2 with bi-level PAP.¹⁰

The clinical and gasometric parameters and the degree of dyspnea showed significant improvement after 24 h of treatment with the HFT system (Table 2). In patients with moderate or severe dyspnea, the intensity of the condition improved significantly, becoming mild in 80% of the patients, with a reduction in respiratory effort and tachypnea.

The degree of patient comfort with the HFT system was high: 2 patients had a feeling of tracheal discomfort, which was self-limited after the adaptation period and did not require withdrawal of the treatment.

Mean length of HFT system use was 62.4 ± 21.4 h.

DISCUSSION

It is common to find patients with AHF who, after being stabilized, maintain a level of dyspnea or hypoxemia which does not improve with conventional oxygenation systems and cannot be attributed to deterioration in functional level or a need to optimize medical treatment. In our case, the HFT system was effective with all the patients and improvement was observed in the evolution of the disease: significant reduction in the intensity of the dyspnea, improved respiratory effort and tachypnea, and the disappearance of hypoxemia.

Active HFT systems have been used for years to treat chronic respiratory failure in adults (sleep apnea syndrome and neuromuscular diseases), as they offer dyspnea control and efficient oxygenation with good tolerance.¹¹

Table 2
Clinical and Gasometric Parameters Before Administering High-Flow Oxygen and After 24 h

	Before high-flow oxygen; FiO ₂ 100%	After 24 h of high-flow oxygen	P
PaO ₂ (mmHg)	73.4 ± 4.3	98.8 ± 4.76	<.001
PaCO ₂ (mmHg)	53.2 ± 13	47.4 ± 8	.109
pH	7.33	7.39	.047
SaO ₂ (%)	85.4 ± 2.41	99.4 ± 0.89	.042 ^a
HCO ₃	38.5 ± 7.59	40 ± 4.69	.188
HR (bpm)	103 ± 7	91 ± 3	.024
SBP (mmHg)	154 ± 21	149.6 ± 15	.379
RR (bpm)	35 ± 2	24 ± 3	.002
Degree of dyspnea, ^b %			
Mild	0	80	
Moderate	20	20	
Severe	80	0	

bpm, breaths per minute; bpm, beats per minute; FiO₂, fraction of inspired oxygen; HR, heart rate; PaCO₂, partial pressure of CO₂ in arterial blood; PaO₂, partial pressure of O₂ in arterial blood; RR, respiratory rate; SaO₂, Saturation level of O₂ by pulse oximeter; SBP, systolic blood pressure.

^a Wilcoxon T test.

^b In accordance with Borg's modified scale.

There is little evidence of treating ARF adults with HFT systems. In 2010, Roca et al.¹² compared the comfort and efficacy of an HFT system with a conventional Venturi mask in 20 ARF patients of diverse etiology who were treated in an intensive care unit. They obtained statistically significant results in favor of the HFT system, which produced few side effects. These data are in agreement with those from our patients, although ours remained on high-flow treatment longer (62 h compared to 30 min) and all were admitted due to APE.

The improvements in clinical and gasometric parameters with this system have two main causes: first, HFT systems provide a more constant FiO₂, and second, the use of a nasal cannula as the interface reduces the amount of respiratory dead space and generates a constant positive pressure directly proportional to the flow used and to the resistance created during expiration, which contributes to increased oxygenation.¹³

Other beneficial characteristics of note are that the active humidification and heating of the gas facilitates bronchial secretion clearance, improves the sensation of dyspnea and bronchial hyperreactivity, reduces the likelihood of atelectasis due to mucous accumulation, and increases patient tolerance when used for long periods.¹⁴

Even in elderly patients with functional dependence, like those in our series, the degree of comfort is significant because the use of a cannula as the interface enables patients to speak, eat, and take medication without interrupting oxygenation. It is important to highlight two aspects of this system: that it is easy to learn and use, and that it can be used in conventional hospital rooms without the need for constant monitoring.

As in the study by Roca et al.,¹² the reduction in respiratory rate (a sign of clinical improvement) was at no time associated with changes in arterial CO₂ pressure or pH.

The most commonly described side effects in the literature with respect to the use of HFT systems are: cervical and tracheal discomfort, feeling hot, and nasal mucosal lesions.¹⁵ The first 2 are mild and disappear in most cases after the adaptation period, as was the case in 2 of our patients. Mucosal lesions are reported less often and are related to the misuse of the technique.

In short, the use of HFT systems is a good alternative to traditional oxygenation systems for the treatment of patients with ARF secondary to AHF due to APE that have dyspnea and refractory hypoxemia. The system is well tolerated and produces

significant improvements in clinical and gasometric parameters after 24 h.

CONFLICTS OF INTEREST

None declared.

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