



## REVIEW

# The role of high-flow oxygen therapy in acute respiratory failure<sup>☆</sup>



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### KEYWORDS

High-flow oxygen therapy;  
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**Abstract** Acute respiratory failure (ARF) represents one of the most common causes of intensive care unit admission and oxygen therapy remains the first-line therapy in the management of these patients. In recent years, high-flow oxygen via nasal cannula has been described as a useful alternative to conventional oxygen therapy in patients with ARF. High-flow oxygen via nasal cannula rapidly alleviates symptoms of ARF and improves oxygenation by several mechanisms, including dead space washout, reduction in oxygen dilution and inspiratory nasopharyngeal resistance, a moderate positive airway pressure effect that may generate alveolar recruitment and an overall greater tolerance and comfort with the interface and the heated and humidified inspired gases. However, the experience in adults is still limited and there are no clinical guidelines to establish recommendations for their use. This article aims to review the existing evidence on the use of high-flow oxygen via nasal cannula in adults with ARF and its possible applications, advantages and limitations.

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### PALABRAS CLAVE

Oxigenoterapia de alto flujo;  
Insuficiencia respiratoria aguda;  
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### Papel de la oxigenoterapia de alto flujo en la insuficiencia respiratoria aguda

**Resumen** La insuficiencia respiratoria aguda supone una de las causas más frecuentes de ingreso en los servicios de Medicina Intensiva y la oxigenoterapia sigue constituyendo una terapéutica de primera línea en el manejo de estos pacientes. En los últimos años, la oxigenoterapia de alto flujo ha sido descrita como una alternativa útil a la oxigenoterapia convencional en los pacientes con insuficiencia respiratoria aguda. La oxigenoterapia de alto flujo permite

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administrar un flujo de gas totalmente acondicionado hasta a 60 L/min mediante cánulas nasales, obteniendo una rápida mejoría de los síntomas debido a diferentes mecanismos como, por ejemplo, una reducción de la resistencia de la vía aérea superior, cambios en el volumen circulante y la generación de cierto grado de presión positiva. Además, todo ello se consigue junto con una mejor tolerancia y comodidad por parte del paciente. Sin embargo, la experiencia en adultos es todavía limitada y no existen guías clínicas que establezcan recomendaciones para su uso. En este artículo se pretende revisar la evidencia existente sobre el uso de oxigenoterapia de alto flujo en pacientes adultos con insuficiencia respiratoria aguda, así como sus posibles aplicaciones, ventajas y limitaciones.

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## Introduction

Acute respiratory failure (ARF) is a frequent cause of admission to Intensive Care,<sup>1</sup> and oxygen therapy undoubtedly remains one of its first-line management options.<sup>2</sup> Under conditions of ARF, oxygen can be administered on an invasive or noninvasive basis. However, whenever possible, we should try to avoid invasive ventilation support.

Noninvasive oxygen therapy can be administered in different ways, for example, through an oronasal mask or using nasal cannulas. However, noninvasive oxygen therapy has a number of limiting factors that condition its efficacy and therefore the correction of hypoxemia and the clinical manifestations associated to ARF. The main limiting factors are tolerance of the application system on one hand, and limitation of the administered oxygen flow on the other. The latter is generally limited to 15 l/min,<sup>3</sup> and the flow is normally administered under conditions that do not coincide with the ideal temperature and humidity specifications (37 °C and 100% relative humidity). This limitation in administered flow implies dilution of the administered oxygen with room air, conditioned by the patient peak inspiratory flow. In this regard, the greater the peak inspiratory flow, the greater the dilution—thereby lowering the real fraction of inspired oxygen (FiO<sub>2</sub>) administered to the patient.<sup>2,4</sup> This situation has little impact upon patients with mild hypoxemia, though in individuals with severe ARF and important hypoxemia with peak inspiratory flows of >30 l/min, conventional oxygen therapy may not suffice to correct ARF. An alternative that would overcome these limitations of conventional oxygen therapy is the use of noninvasive mechanical ventilation (NIMV) systems—though the main problem with these systems is patient discomfort and poor tolerance of the interfaces.<sup>5</sup>

A recently introduced alternative is high-flow oxygen therapy (HFOT),<sup>6</sup> which allows us to administer a gas flow of up to 60 l/min using silicone nasal cannulas, with ideal conditions of administered gas temperature and humidity (i.e., 37 °C and 100% relative humidity). Until a few years ago, this technique had been used mainly in newborn infants.<sup>7–9</sup> However, its use in adult patients has increased exponentially in recent years.<sup>10</sup>

The use of HFOT affords better oxygenation through a series of different mechanisms such as reduced dilution of the administered oxygen with room air,<sup>11,12</sup> dead space washout,<sup>12–14</sup> increased tidal volume<sup>15,16</sup> and the generation of continuous positive airway pressure (CPAP)<sup>16–19</sup>. The

technique could also offer benefits at hemodynamic level,<sup>20</sup> increase patient physical exertion capacity and wellbeing,<sup>5</sup> and improve mucociliary transport thanks to the active humidification of the administered gas.<sup>21,22</sup>

The aim of the present study is to offer an update on the possible clinical applications of HFOT, examining the mechanisms whereby it may prove useful in adults with ARF, identifying the patients in which it may be most useful, and establishing the way in which the technique should be used.

## Equipment

The administration of HFOT requires four elements: (1) a patient interface; (2) a high-flow administration system allowing control of the administered flow and FiO<sub>2</sub>; (3) a humidifying-warming system; and (4) non-condensing tubing (Fig. 1).

### Interface

The patient interface consists of special silicone nasal cannulas that are longer than the conventional cannulas. The silicone cannulas come in different sizes, and we must choose the size that best adjusts to the nostrils of each individual patient. Adaptors are also available for tracheotomized patients.

### Fraction of inspired oxygen (FiO<sub>2</sub>)

A system capable of administering a high gas flow (0–60 l/min) and of adjusting the administered fraction of inspired oxygen (FiO<sub>2</sub>) is required. Two different systems are able to do this:

- Mixing of oxygen and compressed air through two independent wall outlets connected by a Y-tube, or using commercial respirators (Dräger, Lübeck, Germany).
- Mixing of oxygen with room air by means of a turbine (Airvo™ system, Fisher & Paykel Healthcare Ltd., Auckland, New Zealand).

### Humidifying-warming system

The fundamental element for clinical use of the technique is effective humidification of the administered gas.

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