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The use of high-flow nasal oxygen therapy in the management of hypercarbic respiratory failure

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***Abstract*:** Hypercarbic respiratory failure, occurring secondary to chronic lung disease, is a frequently encountered problem. These patients present a significant challenge to respiratory and critical care services, as many are unsuitable for mechanical ventilation and most have multiple comorbidities. Recently, noninvasive ventilation (NIV) has become established as the primary modality for respiratory support in this group of patients. Several factors limit patient compliance with NIV, not least comfort and tolerability. A recent innovation in adult critical care is the use of high-flow nasal oxygen (HFNO) devices. These systems are capable of delivering high gas flows via nasal cannulae, with the ability to blend air and oxygen to give a controlled FiO_2. Few clinical studies have been conducted in adults, although several are planned. To date the majority of available evidence addresses the use of HFNO in hypoxemic respiratory failure. Here we present a case in which a HFNO system was used to successfully manage hypercarbic respiratory failure in a patient unable to tolerate conventional NIV.

Keywords: chronic obstructive pulmonary disease, high-flow nasal oxygen, hypercarbic respiratory failure, noninvasive ventilation, type II respiratory failure

Introduction

Noninvasive ventilation (NIV) has revolutionized the treatment of hypercarbic respiratory failure. It has been shown to reduce the need for intubation and to reduce in-hospital mortality [Brochard *et al.* 1995; Plant *et al.* 2000]. Despite this, compliance with NIV is often complicated by issues of patient tolerability. For some individuals this limits its effectiveness and results in treatment failure. Recently, the use of high-flow nasal oxygen (HFNO) therapy has attracted attention for the management of hypoxemic respiratory failure in the adult population. This technology has been used extensively in neonatal ICUs for several years but has not been widely evaluated in adults. One postulated advantage of HFNO is the improved CO_2 clearance seen when high gas flows are used to flush anatomical dead space [Ricard, 2012]. In addition, HFNO is thought to generate positive pressure [Parke *et al.* 2009]. Despite this, clinical studies in adults have principally addressed hypoxemic respiratory failure, whilst only a few have included patients with hypercarbic respiratory failure [Sztrymf *et al.* 2011, 2012]. We present a case in which a HFNO device (Airvo II, Fisher & Paykel, New Zealand) was used to successfully manage a patient with hypercarbic respiratory failure.

Case report

A 57-year-old woman presented to our institution in acute respiratory distress. She had a diagnosis of chronic obstructive pulmonary disease (COPD) and continued to smoke 20 cigarettes per day. On arrival, her peripheral oxygen saturation was measured at 88% on room air and her respiratory rate was 30 breaths per minute. An arterial blood gas analysis was performed and is shown in Table 1. The patient was counselled regarding the use of NIV. Owing to prior experiences she was adamant that she would not accept NIV on this admission but agreed to a trial of therapy using HFNO.

The nasal cannulae were applied and the device set to deliver 50 L min^{-1} with an FiO_2 of 28% and

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Table 1. Arterial blood gas measurements.

	Arrival	30 minutes	60 minutes	6 hours
pH	7.31	7.33	7.35	7.36
P_aCO_2 (kPa)	9.2	8.3	7.7	7.3
P_aO_2 (kPa)	7.7	7.9	8.0	9.1
Base excess (mmol/l)	5.6	4.6	4.6	4.3
SO_2 (%)	87.6	90.2	90.8	92.7

at a temperature of 37°C. This was well tolerated and the patient reported some immediate relief in the sensation of dyspnoea. Medical therapy with nebulized β-agonists, hydrocortisone and intravenous antibiotics was continued. She improved steadily on HFNO with blood gas analysis being undertaken at 30 and 60 minutes (Table 1). Her respiratory rate improved and she was able to eat and drink. A final arterial blood gas, obtained 6 hours after commencing HFNO, showed a normal pH, a significant reduction in $PaCO_2$ and an improvement in oxygenation. The patient was discharged home 6 days after admission.

Discussion

HFNO exhibits a number of attributes which are potentially attractive in the management of hypercarbic respiratory failure. In addition, this modality is well tolerated by patients, allowing them to converse and to eat and drink. Whilst NIV is clearly a well established and efficacious treatment, this case highlights a potential adjunctive use for HFNO. To date, clinical trials examining HFNO in adults are scant. We feel that well-designed prospective trials examining the use of HFNO in hypercarbic respiratory failure are warranted.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

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