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Research paper

Heated, humidified, high-flow nasal oxygen usage in the adult Emergency Department

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ABSTRACT

Objective: The aim of this study was to determine the role that heated, humidified high-flow nasal oxygen (HHHFNO) plays in the adult ED with particular focus on the indications and outcomes of use.
Methods: An explorative study was undertaken using retrospective chart review to identify characteristics of adult patients who received HHHFNO in a tertiary adult ED between January and December 2014.
Results: Thirty-nine patients were identified as having received HHHFNO during the study period with a range of indications for this use. No clear guidelines existed for initiation of this use. Two patients failed on HHHFNO therapy, requiring increased respiratory support; twenty-seven patients were admitted to hospital with HHHFNO still being delivered and seven patients were successfully treated with HHHFNO in the ED. The use of HHHFNO was associated with a 4.91 bpm (95% CI 2.23–7.59; $P = 0.001$) decrease in mean RR and an 11.26 bpm (95% CI 4.62–17.90; $P = 0.002$) decrease in mean HR from baseline at 120 min of use. Hypercapnic patients showed a significant decrease in mean $PaCO_2$ levels after one hour of HHHFNO use (70.33 mmHg (SD 19.63) vs. 55.00 mmHg (SD 13.28), $P = 0.041$) with no change in $PaCO_2$ levels in patients who were not hypercapnic prior to HHHFNO use ($PaCO_2$ 32.71 mmHg (SD 5.28) vs. 32.38 mmHg (SD 3.70), $P = 0.919$).
Conclusions: HHHFNO is currently being used as a device for supplemental oxygen delivery within the adult Emergency Department; however, further research is needed in this area to quantify its use in many of the indications seen.

Introduction

Supplemental oxygen therapy plays an important role in the Emergency Department (ED). Drawbacks of conventional oxygen therapy typically administered through a nasal cannula or facemask, include an inability to supply sufficient flows and concentrations of oxygen to meet patient needs [1,2]. Heated, humidified high-flow nasal oxygen (HHHFNO) allows for high concentrations (up to 100% FiO_2) and flow rates (up to 60 L/min) of oxygen to be delivered at physiological temperatures (37 °C) and humidity levels (44 mg H_2O/L) through a wide-bore nasal cannula [3,4]. It has been widely used and studied in neonatal populations [5] and is increasingly being used in adult populations, despite limited research available on HHHFNO use in this population [6].

Previous research has shown that HHHFNO therapy is useful in the management of a range of conditions that may present to the ED including acute respiratory failure [1,4], pneumonia [4], Influenza A infection [7], pleural effusion [2], pulmonary embolism [2] and acute heart failure [8]. HHHFNO use leads to improvements in a number of clinical parameters including respiratory rate (RR), heart rate (HR) peripheral oxygen saturations (SpO_2), arterial oxygen pressures (PaO_2) and dyspnoea scores; with some of these improvements seen as early as 15 min after the commencement of therapy [2,4]. Furthermore HHHFNO has been found to be beneficial for both pre-oxygenation and peri-oxygenation of adult patients requiring endotracheal intubation [4].

The majority of research on HHHFNO in adult populations has been within ICU settings [1,2,4,7,9] with only two studies [3,10] conducted within the ED environment. These studies demonstrate a beneficial role for HHHFNO in the ED, however focus only on the management of hypoxaemic respiratory failure. Given the success of HHHFNO elsewhere, further research on the use of HHHFNO within an ED environment is warranted.

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Methods

Study design and setting

An explorative retrospective study was undertaken within a tertiary level ED that sees approximately 60,000 primary adult presentations per year. The study received ethical approval from both the relevant hospital and university human ethics committees prior to commencement, and complied with the National Statement on Ethical Conduct in Research Involving Humans. Within this ED there are several methods of supplemental oxygen delivery available for use. The HHHFNO system available uses a humidifier with an integrated flow generator to deliver heated and humidified oxygen to spontaneously breathing patients (Fisher and Paykel AirvoTM Auckland, New Zealand [11]). Use of this system is at the discretion of the treating clinician. The objectives of this study are to describe the use of HHHFNO oxygen within the ED and explore the outcomes of this use. Specifically, HHHFNO is evaluated using the key physiological parameters of heart rate, respiratory rate, oxygen saturations and oxygen requirement over the period of use of HHHFNO in the ED.

Data collection

Retrospective chart review was utilised to identify adult (≥17 years of age) patients who were commenced on HHHFNO in the ED between January and December 2014 [12]. All patients admitted to specialised respiratory wards (including the respiratory high dependency unit [HDU]), general medical wards, coronary care unit and ICU with a primary pulmonary diagnosis had their chart reviewed for HHHFNO usage for all their presentations to ED during the study period. Of the approximately 1000 cases searched, a total of 39 cases were identified as having received HHHFNO in the ED during the study period.

Data was collected from three sources. The ED Information System (EDIS) provided the patient's presentation, diagnosis and identification. The medical record provided clinical observations, indications for HHHFNO, pre- and post-HHHFNO oxygen delivery devices and HHHFNO treatment settings. The hospital laboratory database provided results of blood gas analyses and patient influenza status.

Data collected was entered into an Excel spreadsheet (Microsoft Corporation) and analysed in SPSSv21.0 (IBM Corporation). Analysis included basic descriptive statistics for the study population as well as paired *t*-tests for changes in key parameters over time. Continuous variables were described using mean and standard deviations as they were thought to approximate the normal distribution; categorical variables were presented as frequencies and percentages of the population.

Results

The use of HHHFNO within the ED

A total of 39 patients with an average age of 60 years (SD 17.20), were identified as having received HHHFNO. No factors were identified as being clearly associated with the initiation of HHHFNO therapy and no policy or procedure was in place in the Emergency Department during this study. A wide variety of oxygen delivery devices were used prior to HHHFNO (see Table 1). In the majority ($n = 34$; 87.1%) of subjects HHHFNO was used to increase ventilatory support from simple oxygen delivery devices, while for the remaining subjects ($n = 5$; 12.8%) HHHFNO was used to step-down support after a period of non-invasive ventilation (NIV).

Table 1
Characteristics of patients who received HHHFNO in ED.

Variable	*N* (%)
Gender	
Male	29 (74.4%)
Triage score	
ATS 1	6 (15.4%)
ATS 2	26 (66.7%)
ATS 3	6 (15.4%)
ATS 4	1 (2.6%)
Admission status	
Admitted	38 (97.4%)
Discharged	1 (2.6%)
Mean length of stay in ED	615.54 min (SD 446.42 min)
Mode of arrival	
Road ambulance	33 (84.6%)
Walked in	3 (7.7%)
Helicopter ambulance	2 (5.1%)
Other	1 (2.6%)
Pre-commencement oxygen delivery device	
Simple face mask	14 (35.9%)
Non-rebreather mask	13 (33.3%)
Nasal prongs	4 (10.3%)
Room air	1 (2.6%)
Venturi mask	2 (5.1%)
BiPAP	4 (10.3%)
CPAP	1 (2.6%)
Indication for treatment	
Acute pulmonary oedema	4 (10.2%)
Asthma	7 (17.9%)
COPD	12 (30.7%)
CAP	12 (30.7%)
Pericardial effusion (malignant)	1 (2.6%)
Pneumothorax	1 (2.6%)
STEMI	1 (2.6%)
Sea water aspiration	1 (2.6%)

BiPAP, bi-level positive airway pressure; CPAP, continuous positive airway pressure; COPD, chronic obstructive pulmonary disease; CAP, community acquired pneumonia; STEMI, myocardial infarction with ST segment elevation.

Based on available results of blood gas analyses HHHFNO therapy was indicated as management of type one respiratory failure in 20 (51.2%) patients and was indicated as management of type two respiratory failure in 11 (28.2%) patients. An additional four (10.2%) patients had normal blood gas analyses prior to receiving HHHFNO therapy. Patients receiving HHHFNO demonstrated a range of primary diagnoses as determined in the ED (see Table 1). The most common diagnoses were COPD, CAP, Asthma and APO. Influenza A was isolated by viral PCR in 5 (27.7%) of the 18 patients tested.

Clinical effects of HHHFNO use

In the reporting of the clinical effects of HHHFNO, patients that received NIV prior to the initiation of HHHFNO were excluded from the cohort so that the clinical improvement seen with HHHFNO use could be better defined. When NIV was used prior to HHHFNO any, improvements seen in the clinical condition could not be entirely associated with the use of HHHFNO. The mean values of key clinical parameters recorded over time are demonstrated in Table Two. Key physiological parameters were analysed using paired *t*-tests. Respiratory rate was significantly decreased, compared to baseline, 30 min after commencement of HHHFNO ($P = 0.004$). Heart rate was significantly decreased, compared to baseline, 60 min after treatment with HHHFNO ($P = 0.024$) while SpO_2 was significantly increased at the same time ($P = 0.048$) At 120 min of HHHFNO use, there was a mean difference in respiratory rate of 4.91 (95% CI 2.23–7.59; $P = 0.001$) breaths per minute and a mean difference in