Australian Critical Care 29 (2016) 17–22

Contents lists available at ScienceDirect

Australian Critical Care

journal homepage: www.elsevier.com/locate/aucc

Research paper

Nasal high-flow oxygen therapy in ICU: A before-and-after study

Nigel Fealy RN, MN, ICU Cert, Grad Dip Ed, ACCCN[a,b,c,*],
Claire Osborne RN, ICU Cert[a],
Glenn M. Eastwood RN, PhD, GradDip Crit Care, ACCCN[a,c],
Neil Glassford MBChB, MRCP[a,d],
Graeme Hart MD, FCICM, FANZCA, FACHI[a],
Rinaldo Bellomo MD, FRACP, FCICM[a,d]

[a] Department of Intensive Care, Austin Hospital, Melbourne Australia
[b] School of Nursing and Midwifery, Griffith University, Brisbane Australia
[c] School of Nursing and Midwifery, Deakin University, Melbourne, Australia
[d] Australian and New Zealand Intensive Care Research Centre (ANZICS-RC), School of Preventative Medicine and Public Health, Monash University, Melbourne, Australia

ARTICLE INFORMATION

Article history:
Received 24 November 2014
Received in revised form 26 March 2015
Accepted 18 May 2015

Keywords:
Oxygen therapy
Intensive care nasal high-flow
Nasal prongs
Nasal cannulae
Acute nursing care
Critical illness

ABSTRACT

Background: Non-intubated intensive care patients commonly receive supplemental oxygen by high-flow face mask (HFFM), simple face mask (FM) and nasal prongs (NP) during their ICU admission. However, high-flow nasal prongs (HFNP) offer considerable performance capabilities that may sufficiently meet all their oxygen therapy requirements.
Study aims: To assess the feasibility, safety and cost-effectiveness of introducing a protocol in which HFNP was the primary oxygen delivery device for non-intubated intensive care patients.
Method: Prospective 4-week before-and-after study (6 months apart) for all adult patients admitted to a 22-bed tertiary ICU in Melbourne, Australia.
Results: 117 patients (57 before, 60 after) were included: 86 (73.5%) received mechanical ventilation. Feasibility revealed a significant reduction in HFFM (52.6–0%, $p < .001$), FM (35.1–8.3%, $p = .002$) and NP (75.4–36.7%, $p < .001$) use and an increase in HFNP use (31.6–81.7%, $p < .05$) during the after period. Following extubation, there was a significant reduction in HFFM use (65.7% vs. 0%, $p < .05$) and an increase HFNP use (8.6% vs. 87.5%, $p < .05$). Costing was in favour of the after period with a consumable cost saving per patient (AUD $32.56 vs. $17.62, $p < .05$). During the after period, more patients were discharged from ICU with HFNP than during the before period (5 vs. 33 patients, $p < .05$) and fewer patients (5 vs. 14 patients) used three or more oxygen delivery devices. Safety outcomes demonstrated no significant difference in the number of intubations, re-intubations, readmissions or non-invasive ventilation use between the two time periods.
Conclusions: Using HFNP as the primary oxygen delivery method for non-intubated intensive care patients was feasible, appeared safe, and the oxygen device costs were reduced. The findings of our single-centre study support further multi-centre evaluations of HFNP therapy protocols in non-ventilated intensive care patients.

1. Introduction

Intensive care patients commonly receive supplemental oxygen therapy during their intensive care unit (ICU) admission.[1–3] For non-intubated intensive care patients, nasal prongs (NP) and face mask (FM) oxygen delivery devices are commonly used. Benefits of these devices include adequate humidification of the upper airway and the ability to more precisely control the fraction of inspired oxygen (FiO_2).[4] Two high-flow oxygen delivery devices are the high-flow face mask (HFFM) and high-flow nasal prongs (HFNP).

High-flow oxygen therapy devices are used in clinical practice in order to deliver an oxygen flow rate exceeding the patient's

* Corresponding author at: Department of Intensive Care, Austin Hospital, Studley Road, Heidelberg, VIC 3084, Australia. Tel.: +61 3 94964834; fax: +61 3 94963932.
E-mail address: nigel.fealy@austin.org.au (N. Fealy).

http://dx.doi.org/10.1016/j.aucc.2015.05.003
1036-7314/

inspiratory flow rate. By exceeding the patient's inspiratory flow rate, high-flow oxygen delivery devices are able to deliver a more precisely known fraction of inspired oxygen (FiO_2).[4] Delivering higher oxygen flow rates can dry the patient's upper airway, cause discomfort and may result in the patient removing the device and being exposed to unnecessary hypoxaemia. To enhance the comfort and efficacy of this form of oxygen therapy, humidifiers are used in conjunction with high-flow oxygen devices. However, HFNP therapy in contrast to HFFM allows patients to eat and drink more easily. To date most studies examining the use of HFNP have been conducted for or with patients with respiratory failure, post-cardiac surgery and during palliative care. There has not yet been a pragmatic examination of HFNP in the ICU setting.[5,7–12]

Accordingly, we examined the introduction of a HFNP protocol in a tertiary ICU that sought to provide a uniform approach to supplemental oxygen therapy for non-ventilated intensive care patients. We hypothesised that the HFNP protocol would be; feasible in terms of increasing HFNP use and reducing other oxygen device use; safe in relation to intubation and re-intubation rates, non-invasive ventilatory (NIV) requirements and ICU length of stay, readmission to the ICU; and cost-effective in reducing the number of oxygen delivery devices used per-patient.

2. Methods

2.1. Study design and setting

We performed a prospective 4 week before-and-after pilot study (6 months apart) in December, 2012 and May, 2013. This study was conducted at the Austin Hospital, a tertiary academic hospital admitting approximately of 65,000 patients each year. From January 2012 to December 2013, 4260 critically ill patients were admitted to our 22-bed general medical-surgical ICU. During the study there were 220 nurses filling 134 full-time-equivalent positions. All patients admitted to the ICU over the study period (November 2012 and May 2013) were included in our analysis.

In the before period, oxygen delivery and oxygen management decisions were jointly performed by the bedside nurses and treating doctors. During this period the available oxygen delivery devices included nasal prongs, simple face masks, high-flow face mask and HFNP. In our unit there was no protocol regarding oxygen delivery device use at different stages of oxygen therapy requirements.

Throughout December 2012, a comprehensive education programme lead by the ICU nurse educators, involving formal lectures, informal bedside teaching, and feedback was performed to introduce a new protocol for the use of HFNP therapy. In-service lectures were performed to provide nursing staff with background information on oxygen delivery in ICU, the rationale supporting the introduction of HFNP and practical information about HFNP use. At the bedside we used the Optiflow, MR 850 (Fisher & Paykel Healthcare, Auckland, New Zealand) to provide HFNP therapy. For HFNP therapy, the humidifier water chamber temperature was set at 37 °C to deliver 44 mg H_2O/L. Bedside teaching sessions, performed by the ICU educators, supported the formal in-service lectures and provided the ability to troubleshoot any problems associated with HFNP use.

Where possible, HFNP therapy utilised the existing regulated humidification system from the ventilator set-up. In each instance nurses were instructed to set initial therapy to FiO_2 0.4 and a flow rate of 40 L/min. Subsequent alterations in FiO_2 or L/min were at the bedside nurse's discretion. The HFNP protocol was uploaded to the ICU intranet website and a physical copy made available at each patient bed space. The protocol was embedded in ICU practice over a six-month period. After period data were collected for patients admitted to the ICU during May 2013.

2.2. Data collection and management

Using a purpose developed case report form, we collected demographic information for age, gender, type of admission and Acute Physiology and Chronic Health Evaluation (APACHE) III scores. Feasibility outcome variables for oxygen therapy related information (duration and type of oxygen delivery device use (excluding mechanical ventilation), the presence of humidification, recorded FiO_2 and L/min were also recorded. Safety measurements included outcome information (ICU length of stay, requirement for NIV and NIV hours, incidence of intubation and re-intubation and ICU readmission). Cost of oxygen therapy was calculated as the median cost per device multiplied by the number of oxygen devices used on a per patient basis, excluding ventilator circuits and allowing for patients to use each device more than once during their admission. All study related information was additionally retrieved via a retrospective medical record audit and via an electronic database search for illness severity and outcome data.

2.3. Data analysis

Data were analysed using a commercially available statistics package (Statview, Abacus, CA.). Continuous data are presented as median and interquartile range (25th–75th percentiles) and dichotomous data are presented as percentages. Groups were compared using the Mann Whitney U test or Fisher's exact test as appropriate. A p-value < .05 was used to indicate statistical significance.

2.4. Ethical considerations

The Austin Health Human Research Ethics Committee approved our study (H2011/04434), including a waiver of consent.

3. Results

3.1. Patient characteristics

During the study period, there were a total of 117 patients admitted to the ICU: 57 patients in the before period and 60 patients in the after period. The two groups had similar baseline characteristics with respect to age and gender. There was, however, a statistically significant difference between the groups in relation to the number of patients admitted to the unit following liver transplantation. There was no difference in median ICU or hospital length of stay between groups (Table 1). Of the 117 patients admitted, 86 (73.5%) received mechanical ventilation during their ICU admission. More patients were ventilated during the after period of the study: 36 (63.2%) vs. 50 (83.3%) (p = .02). However, median duration of ventilation was similar for the before and after periods, 13 h (IQR 7–56 h) vs. 16 h (IQR 17–90 h) (p = .69) respectively (Table 1).

3.2. Oxygen delivery and oxygen delivery device use

Of the 86 patients mechanically ventilated during their ICU admission, 83 patients were extubated to spontaneously breathing oxygen devices. One patient in the before period and two patients in the after period died without being extubated. Of these 83 patients, 35 in the before period and 48 in the after period proceeded to extubation. For those participants extubated in the ICU, there was a significant decrease in patient HFFM oxygen device use immediately post-extubation in the after period group (65.7% vs. 0%, p < .001). The corresponding application of HFNP immediately post