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Original article

Nasal high flow oxygen therapy in the ward setting: A prospective observational study

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ABSTRACT

Background: Whilst research demonstrates the benefits of nasal high flow oxygen in the intensive care setting, limited literature exists on its benefits in ward patients.
Objectives: This study evaluated the use of nasal high flow oxygen in adult ward patients with respiratory failure or at risk of respiratory deterioration. Primary outcome was an improvement in pulmonary function as indicated by decreases in respiratory and heart rates and an increase in arterial oxygen saturation via pulse oximetry.
Research methodology: Using a prospective observational research design, purposeful sampling recruited 67 adult ward patients receiving nasal high flow oxygen between May and July 2015 (inclusive). All recruited patients were included in the data analysis.
Results: The median age was 71.0 years (q25, q75 = 58.0, 78.0) and most patients were medical specialty patients ($n = 46$, 68.7%). After commencing nasal high flow oxygen, respiratory rate ($t = 2.79$, $p = <0.01$) and heart rate ($t = 2.23$, $p = 0.03$) decreased and arterial oxygen saturation via pulse oximetry increased ($t = 4.08$, $p = <0.001$).
Conclusion: Nasal high flow oxygen appears effective in a selective group of ward patients with respiratory failure, or at risk of respiratory deterioration, and may reduce demand on critical care beds; this warrants further research.

Implications for clinical practice

- Nasal high flow oxygen reduces ward patients' respiratory and heart rates and improves their oxygen saturations.
- Most ward patients receiving nasal high flow oxygen can be successfully managed in the ward setting and clinically improve.
- No delays in escalating care were found in the small number of ward patients receiving nasal high flow oxygen that were transferred to intensive or high dependency care.

Introduction

Nasal high flow oxygen delivers heated and humidified oxygen via nasal cannulae at high flow rates up to 60 L per minute (LPM) (Frat et al., 2015a). These flow rates are designed to meet the patient's inspiratory demand and prevent the patient entraining room air and diluting their fraction of inspired oxygen (FiO_2). An oxygen concentration of up to 100% may be added to the system. The warm humidified air makes the system comfortable for patients to use (Hernández et al., 2016) and improves sputum clearance (Nishimura, 2016). The combination of high flow gas and oxygen reduces the work of breathing by: 1) providing low levels of dynamic positive pressure in the upper airways, 2) enabling adjustments to the FiO_2 and 3) reducing dead space by washing out

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nasopharyngeal carbon dioxide from the upper airway (Frat et al., 2015a; Hernández et al., 2016; Stéphan et al., 2015).

Recent studies demonstrate the benefits of nasal high flow (NHF) oxygen over conventional oxygen therapy and/or non-invasive ventilation (NIV) within the intensive care unit (ICU) setting. These studies demonstrate NHF oxygen reduces mortality (Frat et al., 2015a), ventilation time (Frat et al., 2015a), intubation and reintubation rates (Frat et al., 2015a Hernández et al., 2016) and dyspnoea (Frat et al., 2015a; Roca et al., 2010). Patients receiving NHF oxygen find the therapy comfortable (Frat et al., 2015a0, Roca et al., 2010) and report less mouth dryness (Roca et al., 2010).

Whilst an increasing body of literature demonstrates the benefits of NHF oxygen in the ICU setting, we are unaware of any literature focusing on its use in the ward patient population. In the global setting of increased healthcare demands and fiscal constraints (Pirret, 2016), NHF oxygen has the potential to firstly, reduce the likelihood of ward patients with respiratory failure requiring ICU admission and secondly, reduce the associated costs related to an ICU admission and lengthened ward stay.

Administering NHF oxygen therapy is not without its risks. Kang et al. (2015) highlighted the increased mortality associated with NHF oxygen failure when delays in escalating treatment occur. This has led to others calling for appropriate monitoring of ward patients receiving NHF oxygen to ensure patient deterioration is recognised early and treatment escalated in a timely manner (Mathay, 2015). This paper shares the results of a study evaluating the use of NHF oxygen in adult ward patients with respiratory failure or at risk of respiratory deterioration.

Methods

Study design

This study used a prospective observational design to evaluate the use of NHF oxygen in adult ward patients with respiratory failure or at risk of respiratory deterioration.

Study outcomes

We hypothesised NHF oxygen would improve the pulmonary function of adult ward patients with respiratory failure or at risk of respiratory deterioration. The primary outcome was an improvement in pulmonary function after commencing NHF oxygen, as indicated by reductions in respiratory and heart rates and an improvement in saturation of oxygen via pulse oximetry (SpO_2). The study's secondary outcomes were improvements in dyspnoea and sputum retention.

Treatment failure was defined as worsening respiratory failure following enrolment into the study that required a change to another device providing respiratory support.

In our hospital the Patient at Risk team (PART) and physiotherapists predominantly prescribe and implement NHF oxygen in the ward setting. The PART's role in identifying and responding to ward deteriorating patients and the physiotherapists' role in improving respiratory function and incorporating preventative treatments may mean they are prescribing NHF oxygen for two different patient populations. If this was the case, differing patient populations may respond differently to NHF oxygen. The study therefore, also sought to identify any differences between patients prescribed NHF oxygen by the PART and those prescribed the therapy by physiotherapists.

Setting

The study was undertaken in a 990 bed tertiary metropolitan hospital in New Zealand. The hospital has used NHF oxygen for adult ward patients with respiratory failure since 2008. NHF oxygen is currently used across all acute adult wards in the hospital. The hospital has a critical care complex which has 12 ICU beds and six high dependency unit (HDU) beds. The hospital has an aggregated early warning scoring system (EWSS) which triggers one of two teams. At a lower threshold the EWSS triggers a 24 hour a day, seven day a week (24/7) nurse-led PART and at a higher threshold a 24/7 physician-led medical emergency team. The PART also forms part of the medical emergency team.

NHF oxygen system

We used the Fisher and Paykel Airvo™ 2 and Optiflow™ systems. Some NHF oxygen systems require both piped air and oxygen outlets to drive the system. The Airvo™ 2 uses electrical power whilst oxygen is titrated via the ward oxygen flow meter; both these factors make this system suitable for ward use. The Airvo™ 2 entrains atmospheric air while oxygen enters the system via oxygen tubing from an oxygen flow meter. A disposable circuit then directs the air from the Airvo™ 2, through a humidifier, to the patient via a soft nasal cannula known as the Optiflow™ (See Fig. 1).

Patient selection

Prospective power analysis calculated the desired sample size; a minimum of 60 participants were needed for a medium effect size, and for subgroup analysis, a minimum of 30 patients were needed for a large effect size. Effect size was calculated using Cohen's *d*. Effect size determines the magnitude of the therapy's effect; a *d* of 0.2 indicates a small effect, a *d* of 0.5 demonstrates a medium effect and a *d* of 0.8 constitutes a large effect (Clark-Carter, 2010).

Purposeful sampling was used to recruit a minimum of 60 adult ward patients requiring NHF oxygen. Patients were included in the study if they were: 1) ward patients $\geq$18 years of age, 2) had clinical signs of ongoing acute hypoxaemia despite receiving conventional low-flow oxygen therapy, or were at risk of respiratory deterioration as per clinicians' assessment, and 3) had the PART or physiotherapists involved in their care.

Patients excluded from the study included end of life care patients, those with facial trauma/surgery, those with conditions that contraindicated the application of continuous positive airway pressure, those who were using NHF oxygen intermittently with NIV, and those in non-ward areas such as emergency care and the critical care complex.

During the study period, 105 ward patients received NHF oxygen. Following assessment for eligibility, 76 patients were recruited into the study. Nine patients were removed from the study due to incomplete data collection (see Fig. 2).

Ethical approval

As NHF oxygen was an established ward practice, the National Health and Disability Ethics Committee deemed in writing that the study did not require their approval. The study was registered with and approved by the hospital research office which enabled collection of patient data and access to patient records. The study was also registered with the Australian and New Zealand Clinical Trial Register (identification number 368054).

Data collection

Data were collected between May and July 2015 (inclusive) using data collection sheets. Data collected included demographic data, the prescribing clinician, conditions requiring NHF oxygen, length of time on NHF oxygen, hospital length of stay (LOS) and survival to hospital discharge. Assessment of patients' respiratory and

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