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Non-invasive ventilation in the emergency department for patients in type II respiratory failure due to COPD exacerbations

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ABSTRACT

Introduction: Acute chronic obstructive pulmonary disease (COPD) exacerbations can cause respiratory failure and may require non-invasive ventilation (NIV). There is a paucity of studies examining their NIV implementation within the emergency department (ED).
Aim of the study: The aims were (i) to establish whether NIV was beneficial for patients using arterial blood gas analysis (ABG), (ii) to observe whether current ED practice met the guidelines of obtaining ABG measurements within 15 minutes of arrival and commencement of NIV within 1 hour of clinical indication and (iii) to examine which healthcare professionals (HCPs) initiated NIV.
Methods: A retrospective observational study reviewing all patients commenced on NIV in the ED due to COPD exacerbations was undertaken.
Results: A total of 48 patients were included and the majority received NIV within 1 hour (n = 36, 75%) as recommended by the guidelines. Over 50% of the patients in the study had ABG analysis within 15 minutes and 89% (n = 43) within 30 minutes and statistically significant improvements were noted in respiratory rate, oxygen saturation and ABGs from baseline to repeat measurements undertaken 58 minutes post NIV initiation ($p < 0.001$). The largest healthcare group to initiate NIV was the nursing team (50% n = 24) with the majority of emergency nurses being experienced nurses [band 6 (n = 17)].
Conclusion: From this small single centre study, early ABG analyses and NIV initiation were beneficial to COPD patients presenting in respiratory failure with the majority receiving treatment within the recommended guidelines.

1. Introduction

Acute chronic obstructive pulmonary disease (COPD) exacerbations cause worsening respiratory insufficiency and increased resistive load on ventilatory muscles leading to respiratory failure requiring emergency treatment (Pam et al., 2009) with the potential for prolonged hospitalisation in acute hospital beds often more than once a year (British Thoracic Society, 2011). It is expected that COPD presentations to emergency departments (ED) will continue to increase, remaining a significant burden on healthcare resources (Rose and Gerdtz, 2009). COPD exacerbations can result in reduced oxygen levels and inability to eliminate CO_2 effectively and thus patients present in type II respiratory failure (T2RF) (Roberts et al., 2008). It is essential that immediate treatment is commenced in the ED including controlled oxygen therapy, regular nebulisers, high dose steroids, anti-biotic therapy (if indicated) and ABGs to analyse severity of COPD exacerbation (National Institute for Health and Clinical Excellence, 2008).

The National Institute for Health and Clinical Excellence (2008) guidelines promote non-invasive ventilation (NIV) as an adjunct for patients with T2RF not responding to medical treatment as an alternative to endotracheal intubation (ETT). Due to its invasive nature, ETT can worsen patient outcomes as detrimental side-effects are numerous including barotrauma, respiratory muscle atrophy, nosocomial infections including pneumonia and difficulty in weaning patients from invasive ventilation (Barbetti et al., 2009; Pam et al., 2009). NIV is the provision of ventilatory support through the upper airway using external masks (British Thoracic Society, 2011). This includes continuous positive pressure support or Bi-Phasic for T2RF in order to augment oxygenation and assist the patient to reduce levels of hypercapnia (Pertab, 2009). NIV potentially reduces the number of required intubations and consequently the burden on intensive care unit (ICU) bed capacity. It has become increasingly recognised as a key intervention for T2RF due to COPD exacerbations (British Thoracic Society, 2011; National Institute for Health and Clinical Excellence, 2008; Hess, 2009, Pam et al., 2009). NIV provides regulated respiratory pressure support allowing spontaneous breathing.

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Guidelines recommend that NIV is commenced for patients presenting with T2RF due to COPD exacerbations within an hour of clinical indication (British Thoracic Society, 2011; National Institute for Health and Clinical Excellence, 2008). The concept of a "golden hour" of treatment has resulted in efforts over the last decade to initiate NIV in EDs (M'Brien, 2009). Several trials have demonstrated the efficacy of NIV with improvements in ABGs recorded 30–90 minutes following initiation (Bott et al., 1993; Brochard et al., 1995; Barbe et al., 1996; Çelikel et al., 1998; Plant et al., 2000; Dikensoy et al., 2002; Conti et al., 2002; Thys et al., 2002).

The other benefits of NIV compared to ETT are that it is associated with reduced morbidity (i.e. barotrauma and difficulty in weaning) and a decreased length of hospital stay (Brochard et al., 1995; Çelikel et al., 1998; Dikensoy et al., 2002). Thus, the majority of studies support the benefits of NIV in treating T2RF induced by COPD exacerbations. However there was a lack of robust studies performed in EDs concerning early NIV initiation, particularly within 1 hour of clinical indication, as recommended by National Institute for Health and Clinical Excellence (2008). Although the importance of nurses in recognising and managing patients requiring NIV has previously been noted (Tippins, 2005), there is a paucity of studies analysing healthcare professionals' involvement in NIV initiation. Given that ED nurses are often required to care for patients requiring NIV, nurses need to be appropriately educated and demonstrate competence in their role (Department of Health, 2012). Based on these findings, this study aims to examine NIV within the emergency setting.

2. Methods

The aims of the observational study were: (i) to establish whether NIV was beneficial for patients presenting with T2RF due to COPD exacerbations from ABG analysis, (ii) to observe whether current ED practice met British Thoracic Society (2011) and National Institute for Health and Clinical Excellence (2008) guidelines of obtaining ABG measurements within 15 minutes of arrival and commencement of NIV within 1 hour of clinical indication (British Thoracic Society, 2011; National Institute for Health and Clinical Excellence, 2008) and (iii) to analyse the role of the healthcare professionals (HCPs) and whether this impacted upon length of time taken for NIV initiation. For this study, the term NIV refers to bi-phasic pressure support. The initial pressure support settings were aligned to department policy: inspiratory positive airway pressure (IPAP) 15 cmH_2O and expiratory positive airway pressure (EPAP) 5cmH_2O. This was recommended by the majority of studies as higher settings were related to more successful therapy (Keenan and Mehta, 2009; Pam et al., 2009).

2.1. Study sample

A retrospective observational study in one inner London ED was undertaken from November 2012 to February 2013 reviewing all patients commenced on NIV in the ED due to COPD exacerbations. A convenience sampling method of all patients commenced on NIV with T2RF was the most appropriate for the study design with clear inclusion/exclusion criteria (see Table 1). All patients commenced on NIV in the ED had a completed proforma. This provided patient information which formed the central data for the analysis of the episodes of NIV in the ED.

The baseline SpO_2 on air was taken on patient arrival to the ED and the second reading on 4 L of oxygen via the NIPPV 3 + machine. It is recommended that initial ABGs are taken for all patients presenting with respiratory compromise within 15 minutes (British Thoracic Society, 2011). The ED ABG machine, the COBAS b221 model, was fully serviced the month before the study commenced and technicians ensured weekly calibrations of equipment. All patients on NIV had the same initial settings on the same NIPPV 3 + machine (IPAP 15, EPAP 5) which ensured homogeneity within the data and the settings were recorded on a proforma enabling an assessment of measurements.

Table 1
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Hypoxaemia	Respiratory arrest
T2RF secondary to neuromuscular disease/chest wall deformity	Reduced conscious level (GCS <10)
T2RF with respiratory acidosis	Inability to protect airway
Pulmonary oedema	Airway obstruction
	Profuse vomiting
	Undrained pneumothorax
	Recent upper airway, facial or gastric surgery
	Cranial or facial trauma or burns
	Bowel obstruction

Information from patients' medical notes ascertained their destination following discharge from ED providing information regarding the number of patients transferred to ICU, HDU or acute medical wards. Analysis of data required statistical paired t-tests as appropriate for normal distribution of data (ABG, RR, SpO_2) taken pre and post NIV. Data were analysed using SPSS version 12.0 for paired t test statistical analysis and confidence interval data. A p value <0.05 was considered statistical significant. Other data consisted of times taken for procedures to be completed (ABG, NIV initiation) compared to British Thoracic Society (2011) and National Institute for Health and Clinical Excellence (2008) recommendations and from patient records of discharge destinations.

Due to the nature of the study design, ethical approval was not required as the study was deemed a service evaluation.

3. Results

From data collection over 4 months, 72 NIV episodes in the ED were collected. Seventeen patients were commenced on CPAP and seven patients with neuromuscular diseases presented with NIV in situ. These 24 separate patient episodes were excluded from analysis as they did not fit study criteria. A total of 48 patients were included in the study with completed sets of recorded data for analysis and no patients were subsequently excluded from the study. The data for each admission were included separately as the aim of the study was to analyse all episodes of NIV (see Table 2).

The mean patient age was 70.6 years (range 43–94) and the majority ($n = 36$, 75%) presented with a known diagnosis of COPD. Fourteen (29%) patients had received NIV within the previous year and one individual appears in the data on three separate occasions. Direct comparisons were made on all 48 patients between baseline measurements of RR, SpO_2, pH, pCO_2 and pO_2 and secondary measurements taken after NIV initiation. The time frame of the second measurement was between 30 minutes and 1 hour of the commencement of NIV. Statistical differences were observed between baseline to 60 minutes following initiation in pCO_2, pO_2 and pH ($p < 0.001$) (Table 3).

The baseline RR was recorded immediately upon patient arrival to the ED. The other variables (SpO_2, pCO_2, pO_2 and pH) were recorded from ABG analysis an average of 21 minutes post arrival in ED. The second measurements were taken whilst NIV was in situ, an average of 58 minutes post initiation for all patients in the study and all were statistically improved post NIV initiation.

Data analysis was undertaken examining if the current ED practice guidelines (British Thoracic Society, 2011; National Institute for Health and Clinical Excellence, 2008) of obtaining ABGs and commencing NIV within the recommended 15 minutes of arrival were