Non-invasive ventilation for acute exacerbations of COPD

Acute exacerbations of chronic obstructive pulmonary disease (COPD) causing respiratory failure are associated with mortality rates of up to 26%. A new Royal College of Physicians guideline aims to impart standards and practical advice to those providing a non-invasive ventilation service for these patients. This article examines the guideline.

Exacerbations of chronic obstructive pulmonary disease are a common cause of emergency admission to acute hospitals. They are associated with significant morbidity and mortality. Patients with more severe exacerbations may develop type II respiratory failure. Those with respiratory acidosis after initial medical management ought to be considered for treatment with non-invasive ventilation. A new short guideline has been developed to aid those faced with managing this common scenario. This review sets the guideline into context and briefly describes it, focusing on the key concepts of the guideline and its implications for practise.

Background

Chronic obstructive pulmonary disease is the second most common cause of emergency admission to hospital in the UK. Exacerbations of chronic obstructive pulmonary disease are associated with a deterioration of respiratory symptoms and are commonly initiated by respiratory viruses and bacteria. Exacerbations appear to be more common in patients with more severe chronic obstructive pulmonary disease. They may be recurrent and are more common during the winter months. Current outpatient treatments reduce exacerbation frequency by around one quarter (Calverley et al, 2007).

Importance of chronic obstructive pulmonary disease exacerbations

Studies of inpatient mortality associated with chronic obstructive pulmonary disease exacerbations have produced widely differing figures. They differ between alarming and frankly shocking: 5–11% for patients without respiratory failure, increasing to as much as 26% in those with respiratory failure. The finding of a 1-year mortality rate of 43% was published as recently as 1996 (Connors et al, 1996). Chronic obstructive pulmonary disease exacerbations deleteriously affect quality of life (Seemungal et al, 1998), as well as the natural history of the disease (Kanner et al, 2001).

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Most exacerbations are managed in primary care. However, there has been a steady increase in the number of emergency admissions to hospital for chronic obstructive pulmonary disease. Chronic obstructive pulmonary disease exacerbations are associated with modest falls in peak expiratory flow rate, forced expiratory volume in 1 second and worsening oxygenation. More severe exa-cerbations are usually managed in hospital, at least initially, and may be complicated by type II respiratory failure.

Non-invasive ventilation

Non-invasive ventilation facilitates better gas exchange during chronic obstructive pulmonary disease exacerbations through the generation of greater tidal volumes and, consequently, improved alveolar ventilation. Respiratory muscles are offloaded and the work of breathing is reduced.

One study indicated that if non-invasive ventilation was used in all patients admitted with chronic obstructive pulmonary disease and sustaining a pH of <7.35 after initial medical treatment, then a typical acute hospital in the UK should expect to treat around 70 patients per year (Plant et al, 2000a).

Initial management of acute type II respiratory failure secondary to chronic obstructive pulmonary disease is with controlled oxygen therapy (to maintain an oxygen saturation of between 88 and 92%), nebulized bronchodilators and systemic corticosteroids. Antibiotics are included when two out of three of the following symptoms are present: increased breathlessness, sputum volume and sputum purulence. In many patients conservative treatment will be sufficient to initiate reversal of blood gas abnormalities and recovery. Non-invasive ventilation should be considered for patients who fail to respond, namely those with a respiratory acidosis ($PaCO_2$>6kPa, pH <7.35 ≥7.26) despite standard medical treatment as described for no more than 1 hour.

Strong evidence exists to support the use of non-invasive ventilation in such situations. Non-invasive ventilation has been shown in randomized controlled trials to reduce intubation rate and mortality in chronic obstructive pulmonary disease patients with uncompensated respiratory acidosis (pH <7.35 and $PaCO_2$ >6 kPa) fol-

lowing immediate medical therapy. Initial trials of non-invasive ventilation were performed within the intensive care environment, for example Brochard et al (1995).

A landmark UK study (Plant et al, 2000b) later compared non-invasive ventilation with standard therapy on general respiratory wards. Failure of treatment criteria were defined in the study and precipitated a need for intubation. The use of non-invasive ventilation significantly reduced this need and reduced mortality: 32/118 (27%) of the standard group failed compared with 18/118 (15%) of the non-invasive ventilation group (P=0.02). In-hospital mortality was reduced by non-invasive ventilation: 24/118 (20%) died in the standard group compared with 12/118 (10%) in the non-invasive ventilation group (P=0.05). pH, $PaCO_2$ and respiratory rate were found to improve by 4 hours. Systematic reviews of available trials, such as that of Lightowler et al (2003), have also recommended non-invasive ventilation as a first-line treatment in addition to usual medical care.

There is some evidence from randomized controlled trials for the efficacy of non-invasive ventilation in chronic obstructive pulmonary disease patients who are more acidotic (Conti et al, 2002). However, such patients have higher rates of non-invasive ventilation treatment failure and intubation.

The report of the 2008 National COPD Audit (Royal College of Physicians and British Thoracic Society, 2008) records that non-invasive ventilation is now available in 97% of units receiving acute chronic obstructive pulmonary disease admissions in the UK. In 1982 non-invasive ventilation was essentially limited to three specialist centres (Shneerson, 2007), illustrating the dramatic growth in this treatment's popularity. However, the same survey indicates that only 46% of units have locally-adapted, written protocols for the management of chronic obstructive pulmonary disease. Only one third of units are satisfied that medical and nursing staff outside of specialist respiratory wards know how to manage patients with chronic obstructive pulmonary disease and are aware of the indications for and benefits of non-invasive ventilation. This background suggests that the publication of a short, practise-focused guideline (Roberts et al, 2008) by the Royal College of Physicians is extremely timely.

The aim of the Royal College of Physicians guideline is to impart standards and practical advice to those providing a non-invasive ventilation service for patients with chronic obstructive pulmonary disease and type II respiratory failure in acute hospitals. The guideline describes some important concepts in the practice of non-invasive ventilation. Emphasis will now be given to these concepts. A brief summary of the remaining guideline will then be provided along with the implications for service delivery. Both full (British Thoracic Society et al, 2008) and concise (Royal College of Physicians et al, 2008) versions of the guideline are available.

Royal College of Physicians guideline: key concepts

At the initiation of treatment for type II respiratory failure it is important to establish whether non-invasive ventilation is suitable at all, and if it is, the possibility of non-invasive ventilation failure should be planned for. The appropriateness of escalation to invasive ventilation should be considered and documented at this stage rather than later, when a patient has failed to tolerate or respond to non-invasive ventilation and is deteriorating. There is evidence that a decision to proceed to intubation and ventilation ought to be made within the first 4 hours of treatment. Treatment options should be considered with the patient if possible. When uncertainty exists or when invasive ventilation is not felt appropriate, this ought to be discussed with the consultant responsible for the patient.

The guideline recommends the stratification of patients into five groups based on their pre-morbid state, the severity of the physiological disturbance, the reversibility of the acute illness, the presence of contraindications, and patients' wishes. The five patient groups are those:

1. Requiring immediate intubation and ventilation
2. Suitable for non-invasive ventilation and suitable for escalation to intubation and ventilation if needed
3. Suitable for non-invasive ventilation but not suitable for escalation to intubation and ventilation
4. Not suitable for non-invasive ventilation but for full active medical management
5. For whom palliative care is agreed as the most appropriate management.

Inclusion criteria for non-invasive ventilation include those patients who are sick but not moribund, able to protect the airway and without excessive respiratory secretions. However, data exist to support the use of non-invasive ventilation in patients with coma secondary to hypercapnoea and who respond rapidly to this treatment (Díaz et al, 2005). Chronic obstructive pulmonary disease patients with pH<7.26 and receiving non-invasive ventilation require more intensive monitoring with a lower threshold for intubation and should be treated in a high dependency or intensive care setting according to local protocol.

The patient's consent ought to be sought if possible and the decision to commence non-invasive ventilation should be made by a doctor of at least ST level 2 or other competent designated health-care professional as locally agreed.

Summary of remaining guideline

Recommended initial pressures are an inspiratory positive airways pressure of 10 cm H_2O and an expiratory positive airways pressure of 4–5 cm H_2O. These settings are generally well tolerated and allow the patient to become accustomed to non-invasive ventilation, particularly if he/she is receiving it for the first time. Indeed, most patients will tolerate an initial inspiratory positive

airways pressure of 14 cm H_2O. Starting at a higher inspiratory positive airways pressure will facilitate a speedier attainment of a therapeutic pressure. Some ventilators are specified with a 'ramp' setting that increases inspiratory positive airways pressure to the chosen pressure over a pre-determined amount of time. The use of a ramp is best avoided in the acute setting as it will only delay the attainment of a therapeutic inspiratory positive airways pressure. Inspiratory positive airways pressure should be adjusted by 2–5 cm increments until a therapeutic response is achieved. A target inspiratory positive airways pressure of at least 20 cm H_2O is generally required. Oxygen should be entrained into the circuit, preferably via a port close to the ventilator, in order to maintain the target saturation of 88–92%.

Monitoring of respiratory rate, heart rate, level of consciousness, ventilator synchrony and oxygen saturation should be recorded regularly. A frequency of every 15 minutes in the first hour, every 30 minutes up to 4 hours, and hourly up to 12 hours is recommended. Arterial blood gas should be measured after 1 hour of non-invasive ventilation and 1 hour after every change in settings.

The most important outcome measures associated with outcome of non-invasive ventilation are pH and $PaCO_2$ at 1, 4 and 12 hours, respiratory rate at 1 hour and heart rate at 1 hour (Lightowler et al, 2003; Ram et al, 2004).

Any decision to proceed to invasive ventilation ought to be made within the first 4 hours of non-invasive ventilation. Invasive ventilation should also be considered for patients suffering 'late failure', defined as failure after 48 hours of initially successful non-invasive ventilation, as this is associated with lower mortality than continued non-invasive ventilation (Moretti et al, 2000).

Patients who benefit from non-invasive ventilation should receive it for as long as possible (minimum of 6 hours) with breaks for medication, food and drink, and physiotherapy. A gradual reduction in the duration of non-invasive ventilation rather than pressure settings should then be determined by clinical improvement. Initially, weaning should take place during the daytime. Evidence suggests a 4-day weaning period with 16 hours treatment on day 2, 12 hours on day 3 and discontinuation on day 4 (Plant et al, 2000b). Patients making a very rapid recovery or those disinclined to continue with treatment also require a documented weaning strategy.

Palliation is appropriate if non-invasive ventilation fails or is considered inappropriate when a decision not to escalate to invasive ventilation has been made. If possible, non-invasive ventilation should be withdrawn and breathlessness palliated using standard medications. Any decision to initiate palliative care should involve the patient and family.

KEY POINTS

- Acute exacerbations of chronic obstructive pulmonary disease are associated with high mortality rates.
- Non-invasive ventilation is now widely available and is used to treat patients with respiratory acidosis associated with these exacerbations.
- A new, concise guideline is available that provides straightforward, practical advice.
- Early decision making is key.
- The guideline suggests stratification of patients into five groups to facilitate appropriate decision making.

Implications for service delivery

Non-invasive ventilation should be delivered within a dedicated location of the hospital. Locations ought to be limited and common examples include accident and emergency, acute medical units and high dependency units. Patients with predictors for a poorer outcome should be managed in either a high dependency or intensive care unit depending on local availability. These predictors include more serious arterial blood gas abnormalities, high baseline heart rates, lower levels of consciousness and large volume secretions. Invasive ventilation should be available on site for suitable patients in case non-invasive ventilation is not successful. A ratio of one nurse to two patients is recommended for the first 24 hours of non-invasive ventilation.

There should be a named clinical lead for the non-invasive ventilation service, usually a consultant respiratory physician. The service should be provided by staff appropriately trained in non-invasive ventilation and aware of its limitations. Formal competency assessments are recommended. A rolling programme of training for new staff involved with the service should be organized and this training should be updated annually.

A local protocol ought to be drawn up stating criteria for selection and treatment of patients. Selection of patients should refer to the inclusion criteria of randomized controlled trials contained in national guidance. Each patient receiving non-invasive ventilation should have a written prescription with clear documentation of treatment parameters including inspiratory positive airways pressure, expiratory positive airways pressure and supplementary oxygen flow rate. Patient compliance and duration of non-invasive ventilation should be recorded.

A hospital's non-invasive ventilation service should be audited annually including availability of ventilators. The aim should be to demonstrate appropriate application of non-invasive ventilation and treatment outcomes measured against national guidance. The service should be reviewed on a regular basis.

Conclusions

Acute exacerbations of chronic obstructive pulmonary disease are a common cause of emergency admission to hospital in the UK and are associated with considerable morbidity and mortality. Non-invasive ventilation reduces intubation rate and mortality in chronic obstructive

pulmonary disease patients with uncompensated respiratory acidosis. The Royal College of Physicians guideline recommends the stratification of patients into five treatment groups based on pre-morbid state, severity of the physiological disturbance, reversibility of the acute illness, presence of contraindications, and patients' wishes. Any decision to proceed to intubation and ventilation ought to be made within the first 4 hours of treatment. **BJHM**

Conflict of interest: none.

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