

# Asthma and chronic obstructive pulmonary disease in the intensive care unit

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## Abstract

There are many pitfalls in the management of patients with asthma or COPD especially when their condition becomes severe enough to warrant intensive care. Mortality in both groups remains significant. Standard principles of oxygen and drug administration and mechanical ventilation technique used for typical critically ill patients can all cause problems in this patient group. Recognition of the presence of airflow obstruction, the potential for dynamic hyperinflation and careful adherence to the principles of therapy specific to this group are required to avoid complications. This article addresses the physiological derangements in airflow obstruction, their treatment consequences and how to avoid the management pitfalls that are important contributors to the morbidity and mortality of both conditions.

**Keywords** Asthma; COPD; dynamic hyperinflation; invasive mechanical ventilation; non-invasive ventilation

**Royal College of Anaesthetists CPD Matrix:** 1A03, 2C02, 3C00

## Demographics and medical treatment

Asthma and chronic obstructive pulmonary disease (COPD) are conditions characterized by airflow limitation which when sufficiently severe, mandate critical care management.

COPD is more commonly in critical care than asthma. Mortality from COPD is increasing worldwide, exacerbations of COPD are triggered by infection (50%) and episodes of heart failure (25%). In others, no obvious cause is identified. COPD also commonly presents as a co-morbidity of another illness where mechanical ventilation is required, such as major elective or emergency surgery, or trauma.

There is also an increasing prevalence of asthma amongst populations worldwide, with significant morbidity and impact on quality of life.<sup>1</sup> Mortality accounts for approximately one in 250 deaths worldwide.<sup>1</sup> The prevalence of asthma is highest amongst

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## Learning objectives

After reading this article, you should be able to:

- outline the medical management of acute exacerbations of COPD and asthma
- list the appropriate initial investigations for a patient with an exacerbation of asthma or COPD, interpret the results, and initiate appropriate interventions such as non-invasive ventilation (NIV)
- understand the limitations of NIV and the features of patients who are likely to fail treatment with NIV
- list specific complications associated with intubation and mechanical ventilation in patients with these conditions, and know how to appropriately manage these complications if they arise
- utilize appropriate ventilation strategies to minimize complications commonly associated with the intubated COPD or asthma patient

first world countries.<sup>1</sup> Asthma guidelines and the increased use of inhaled steroids have reduced the asthma mortality, hospital and critical care admission rates. However, mortality remains significant, with approximately 1500 (0.3%) deaths per year in England and Wales attributed to acute exacerbations. Patients who do require critical care commonly have very difficult and severe, refractory asthma. Recent data suggest that 40% of Australia's 2.4 million asthma sufferers have poorly controlled symptoms. Acute asthma attacks are attributed to a variety of causes including antigen exposure, non-specific irritants (cold air, smoke, pollution), anxiety and unknown factors (up 25% of acute attacks). Risk factors for asthma death include rural location, psychosocial issues, smoking, drug and alcohol dependence, lower socioeconomic status, allergies, respiratory tract infections and delay in seeking help.

Guidelines written and published by various expert bodies (British Thoracic Society (BTS), National Asthma Council of Australia) have been well implemented in primary care, leading to a diminishing burden on acute hospital services. These guidelines can easily be accessed online and are simple to understand and implement. The key components of them include earlier recognition of asthma severity, more widespread use of inhaled steroids, and pre-set plans to ensure prompt treatment of exacerbations.

There are comparable and excellent resources guiding the medical management of COPD (Global Initiative for Chronic Obstructive Lung Disease, BTS). In either case it is important that these medical measures are instituted as soon as an exacerbation of either condition is identified.

## Involvement of critical care services and the use of non-invasive ventilation (NIV)

Most referrals to critical care are for consideration of ventilatory support in patients with a severe presentation or who have failed to improve despite optimal medical therapy. Non-invasive ventilation (NIV) has become a care standard in the management of acute exacerbations of COPD, with good evidence

proving its role.<sup>2</sup> A large Cochrane meta-analysis<sup>2</sup> demonstrated that NIV significantly reduced mortality and invasive ventilation rates and led to a shortened hospital length of stay. NIV improves respiratory physiology with improvements in both PaO<sub>2</sub> and PaCO<sub>2</sub>.<sup>2</sup> Excellent, concise specific NIV guidelines exist,<sup>3</sup> focusing on the targeted use of NIV in patients with exacerbations of COPD and concomitant respiratory acidosis, which has failed to respond to optimal medical therapy.

Acute hypercapnic respiratory acidosis may also be triggered or worsened by excess oxygen therapy in a patient subset whose chronic relative hypoxaemia is essential for stable ventilatory function. The majority of patients with severe COPD (FEV<sub>1</sub> <30% predicted), especially those with pre-existing hypercapnia are at risk of an increasing PaCO<sub>2</sub> when oxygen therapy results in SpO<sub>2</sub> greater than 95%. This is due to a combination of factors (Figure 1). Improvement may occur with titration of FiO<sub>2</sub> to a SpO<sub>2</sub> target of 88–92%. If an oxygen-induced rise in PaCO<sub>2</sub> has occurred in a patient with an exacerbation of COPD then hypercapnia may improve but not resolve when FiO<sub>2</sub> is reduced, such that NIV is often still necessary – hence the need for constant monitoring and regular review (Table 1).

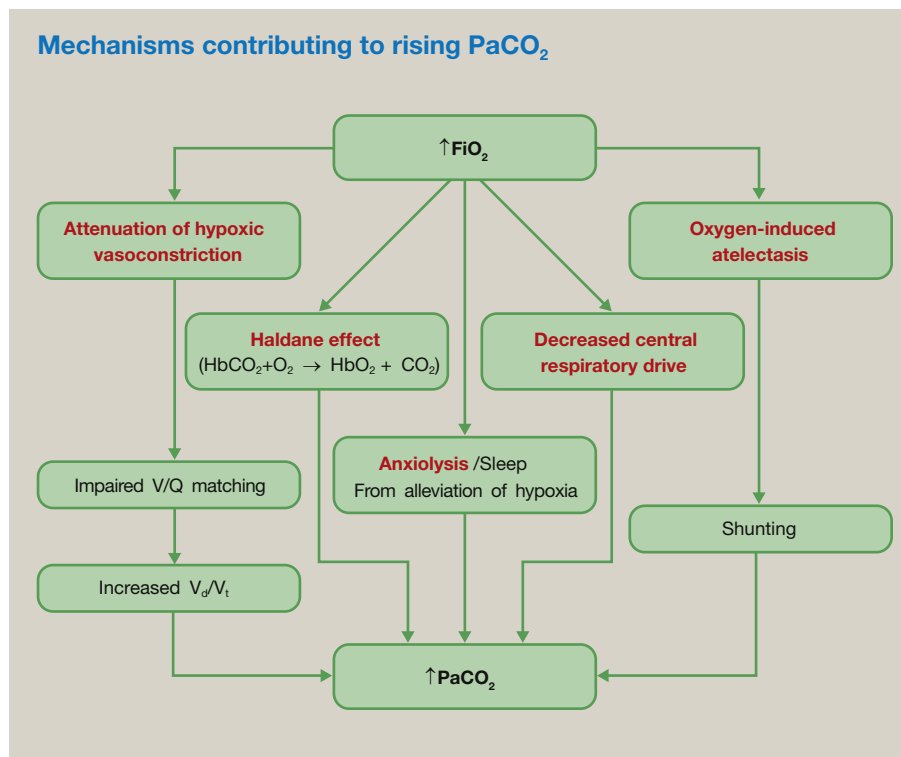
The aims of NIV are to unload respiratory muscles, whilst augmenting ventilation and oxygenation, and to offset the adverse effects of sleep on ventilation and airway resistance (Table 2).

Although the use of NIV for asthma has not been definitively established in large randomized trials, there is a growing consensus, supported by a recent meta-analysis,<sup>4</sup> that the judicious use of NIV in a critical care setting for severe acute asthma can reduce fatigue, improve gas exchange, improve airflow

obstruction more rapidly and obviate the need for invasive ventilation.

NIV is being increasingly implemented both inside and outside intensive care areas including emergency departments and ward areas specializing in this modality. The application of NIV is a significant intervention, requiring skill and adaptation to individual patient needs and patients may deteriorate despite its institution. The evidence suggests it is best delivered in a dedicated critical care or NIV-trained environment, where experienced staff can easily escalate care as required. Such an environment is mandatory in high-risk groups (Table 2).

Despite optimal medical management and the correct usage of NIV, a proportion of patients with COPD and acute asthma will still require endotracheal intubation for severe or increasing respiratory failure (increasing respiratory acidosis, exhaustion, hypoxia, reduced conscious level or respiratory arrest). The life expectancy in patients with COPD falls with deteriorating FEV<sub>1</sub> and episodes of acute respiratory failure. Of all patients with COPD, those admitted to ICU for invasive ventilatory support have the highest mortality; even those patients who survive to discharge from ICU have a decreased life expectancy in comparison to the general COPD population. Careful consideration of any course of invasive treatment needs to be undertaken in patients who have severe COPD and end-stage lung disease (often in association with significant co-morbidity). This assessment should include age, severity of COPD, the presence of a reversible component and functional status. Functional status prior to the exacerbation is perhaps the most important factor; this often-omitted information should be carefully collected. In patients with severely limited mobility (housebound or worse) and



**Figure 1** Mechanisms contributing to rising PaCO<sub>2</sub> as a result of excessive oxygen therapy, four major causes highlighted in red.<sup>11</sup>

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