In part 2 of our focus on oxygen therapy, we look at how developing a spectrum of respiratory support aids the appropriate administration of oxygen

Delivering oxygen therapy in acute care: part 2

In this article...

- The eight steps of the respiratory spectrum for oxygen therapy
- The circumstances in which each method of delivering oxygen should be used
- Using the respiratory spectrum to assess patients and select the most appropriate treatment

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Abstract
Respiratory problems are common and require prompt assessment and management. The implications for patients if such problems are not managed correctly can be serious.

A spectrum of respiratory support can be used by nurses to aid respiratory assessment and treatment.

Part one discussed normal respiratory function, respiratory failure and positive and negative pressure ventilation. Part two looks at methods of administering oxygen, and their indications and contraindications.

This article describes a respiratory treatment spectrum that runs from mild breathing difficulties to severe respiratory failure. It examines a series of steps for respiratory support – from room air to intubation and mechanical ventilation – and investigates the appropriate use of each step.

A spectrum of respiratory support can guide nurses on which interventions are appropriate in a given situation, and help them understand the severity of disease by the support required (Table 1).

The methods of respiratory support most widely used are covered.

Step 1: room air
Normal breathing is achieved by expanding the size of the thoracic cavity to create a drop in pressure and force air to flow into the lungs; it uses negative pressure ventilation.

Atmospheric air is typically 21% oxygen and a patient experiencing shortness of breath may still be able to oxygenate their blood adequately without respiratory support (Adam and Osborne, 2005). The British Thoracic Society says oxygen is a treatment for hypoxia, not shortness of breath, and oxygen has no therapeutic benefit to a person experiencing shortness of breath who has adequate levels of oxygen (BTS, 2008).

As oxygen is neither risk free nor cost free, it is important to include the treatment-free patient group as the first stage of the respiratory spectrum.

Step 2: nasal cannulas
Nasal cannulas are a common intervention for patients with chronic and acute respiratory problems. Most nasal cannulas can deliver only up to 4L/min of oxygen. High-flow nasal cannulas that can administer up to 15L/min of oxygen are available.

Nasal cannulas are relatively comfortable, allowing access to the mouth for eating and drinking, but can dry the nasal mucosa, particularly at higher oxygen volumes. If a patient breathes through their mouth, this makes it difficult to determine the amount of oxygen they are receiving (Adam and Osborne, 2005).

Nasal cannulas are for patients who require only minimal support to maintain oxygenation. Many patients with COPD use nasal cannulas in the long term, or during periods of exacerbation and hospitalisation. Saturations of 88-92% should be aimed for in patients presenting with COPD exacerbation, unless an alternative range is indicated, and oxygen should be titrated to achieve this (BTS, 2008).

Because it is difficult to tell exactly how much oxygen is delivered, nasal cannulas are not usually the first choice for patients presenting with breathing difficulties.

Step 3: simple face masks
A simple face mask provides larger volumes of oxygen than a nasal cannula. At 15L/min, it is possible to achieve 70% oxygen delivery (Dougherty and Lister, 2008). However, they are unable to deliver fixed concentrations of oxygen as room air is mixed with the oxygen (Moore, 2000).

The advantage of mixing oxygen with air is a reduced need for humidification (Adam and Osborne, 2005). However, there can be large discrepancies between the amount of oxygen administered and the amount actually received by the patient.

Face masks do not allow access to the mouth for eating and drinking, and anecdotal evidence suggests they are poorly tolerated by confused or disorientated people.
5 key points

1. Oxygen is a treatment for hypoxia, not shortness of breath. It has no therapeutic benefit to a person experiencing shortness of breath who has adequate levels of oxygen.

2. Nasal cannulas should be used only for patients who require minimal support to maintain oxygenation. Many patients with COPD use nasal cannulas in the long term or during periods of exacerbation.

3. CPAP is commonly used for patients with type I respiratory failure who can breathe unaided, and to prevent upper airway collapse in sleep apnoea.

4. NIPPV is used for patients with type II respiratory failure caused by chest wall deformity, COPD with hypercapnia and acidosis, and cardiogenic pulmonary oedema.

5. Mechanical ventilation requires an invasive, secured airway to bypass the upper respiratory tract and create a closed system of oxygen delivery. This is usually through an endotracheal tube.

Patients receiving this therapy require more oxygen than a nasal cannula can comfortably provide, but can self-ventilate.

Adam and Osborne (2005) say this method is appropriate for delivering low levels of oxygen for a short period of time.

Rates of 5-10L/min should be used as rebreathing of carbon dioxide is possible at flow rates below 5L/min (BTS, 2008), which can lead to hypercapnia (high carbon dioxide) and even acid-base imbalance.

Nasal cannulas and face masks are often called low-flow systems (Moore, 2000).

Step 4: Venturi system

Venturi masks take their name from the venturi barrel in which a relatively low flow rate of oxygen is forced through a narrowed jet; this increases the velocity of the gas moving through it and also forces air through side holes in the barrel to give accurate mixtures of oxygen and air (Dougherty and Lister, 2008).

Venturi systems look similar to simple face masks but have the advantage of achieving accurate oxygen delivery of 24-60% using a valve (Adam and Osborne, 2005). However, relatively high oxygen flow rates have to be used to achieve this. The Venturi valve increases the speed of the oxygen flow, which forces room air through specifically sized ports (Moore, 2000). As the flow of gas exceeds the demands of respiration, the mixture of oxygen and air delivered to the patient remains constant (Dougherty and Lister, 2008).

The potential for exact administration of oxygen makes the venturi system preferable to face masks for almost all patients.

Beecroft and Hanly (2006) say the
system is most commonly used by patients who must avoid high levels of oxygen, for example those with COPD, or patients at risk of developing hypercapnia due to oxygen administration.

Because it allows oxygen to be administered at a low but specific percentage, it provides a much-needed degree of control for patients with COPD who require oxygen.

**Step 5: Non-rebreathing mask**

Non-rebreathing masks contain an oxygen reservoir bag with a one-way valve between the reservoir and mask. Nurses must ensure the reservoir is filled before applying the mask to the patient. This prevents the accumulation and rebreathing of expired gases (Dougherty and Lister, 2008).

Non-rebreathing masks are capable of administering 90-95% oxygen with a flow rate of 15 l/min (Adam and Osborne, 2005). Use is indicated in seriously ill patients who can still self-ventilate, such as severely hypoxaemic patients who do not have risk factors for hypercapnic respiratory failure (BTS, 2008).

As non-rebreathing masks are only suitable for giving high volumes of oxygen, prolonged use is inappropriate and patients will move up or down the spectrum as their condition changes.

Venturi and non-rebreathing masks are known as high-flow systems.

**Step 6: Continuous positive airway pressure (CPAP)**

Continuous positive airway pressure (CPAP) is a continuous low level of positive pressure that prevents patients from totally exhaling and their lungs or alveoli collapsing. It increases the amount of air left in the lungs at the end of inspiration (Moore, 2000). This allows alveoli to be recruited and retained, allows gas exchange to continue between breaths, can resolve pulmonary oedema and can prevent the need for invasive ventilation (Woodrow, 2006).

CPAP is commonly used for patients with type I respiratory failure who are able to self-ventilate, and to prevent upper airway collapse in sleep apnoea.

As the therapy requires a tight-fitting, sealed mask to maintain pressure, there can be problems with comfort, pressure ulcers and compliance. The drying effect of oxygen can be severe and a humidified circuit can be used. Other problems include not being able to eat or drink, and swallowing air (Adam and Osborne, 2005).

CPAP has elements of both positive and negative pressure ventilation. It can help stave off intubation or wean a patient following a period of artificial ventilation.

**Quick Fact**

21% of atmospheric air is typically oxygen.

*It is not suitable for patients with impaired consciousness, a restricted airway or an impaired respiratory drive.

Both CPAP and NIPPV are contraindicated where pneumothorax is present or suspected.

**Step 7: Non-invasive positive pressure ventilation (NIPPV)**

Non-invasive positive pressure ventilation (NIPPV) is the application of positive pressure ventilation through a mask or similar device (BTS, 2002). It is easy to confuse with CPAP as the patient must also have a patent airway and their own respiratory drive. A similar tight-fitting mask is also required.

The major difference between CPAP and NIPPV is that NIPPV is a mode of positive pressure ventilation, fluctuating between the inspiratory (IPAP) and expiratory (EPAP) positive airway pressure. This replaces the normal physiological system of negative pressure ventilation and improves carbon dioxide clearance (Woodrow, 2006).

Although close monitoring is required, using NIPPV is now common on many respiratory wards. Indications for use include:

- COPD with hypercapnia and acidosis;
- Type II respiratory failure secondary to chest wall deformity (acute on chronic respiratory failure);
- Cardiogenic pulmonary oedema unresponsive to CPAP and when weaning from intubation (BTS, 2002).

**Step 8: Mechanical ventilation**

Mechanical ventilation can assist or replace breathing. The decision to ventilate can be difficult so is conducted alongside an assessment of respiratory mechanics, ventilation and oxygenation (Dougherty and Lister, 2008). Mechanical ventilation can be used for a variety of reasons, from elective surgery to total respiratory failure. Common indications include:

- Mechanical respiratory dysfunction;
- Respiratory failure uncorrected by other methods;
- High levels of sedation;
- To correct elevated intracranial pressure (Adam and Osborne, 2005).

The physiological effects of positive pressure ventilation include:

- Decreased cardiac output and venous return;
- Decreased urine output;
- Impaired sputum excretion;
- Traumatic lung injuries (Adam and Osborne, 2005).

Although terminology often differs; invasive mechanical ventilation works on the principle of positive pressure and oscillates between an IPAP and EPAP. The IPAP is commonly controlled by a preset volume or pressure, and the EPAP is more commonly referred to as positive end expiratory pressure (PEEP) (Woodrow, 2006).

The major difference between NIPPV and mechanical ventilation is that mechanical ventilation requires an invasive, secured airway to bypass the upper respiratory tract and create a closed system of oxygen delivery. This is typically through an endotracheal tube or tracheostomy (Adam and Osborne, 2005). Patients often have to be sedated and paralysed to insert the airway, which can cause complications.

Ventilators have a whole host of variables and settings, including:

- Breathing rate;
- Inspiratory pressure and volume;
- Expiratory pressure;
- Inspired oxygen.

Ventilation requires slow weaning as the patient’s condition improves. This can involve a slow step down through the spectrum.

**Conclusion**

There is a clear spectrum of respiratory support from health to life-threatening respiratory failure and each method of delivering oxygen should be used in specific circumstances. The spectrum graduates from negative pressure through to positive pressure ventilation, and from low, poorly controlled amounts of oxygen to total control and high amounts of delivered oxygen. This spectrum aids nurses in selecting the most appropriate oxygen therapy.

**References**


