2ND EDITION

ESSENTIALS OF NURSING CRITICALLY ILL ADULTS

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CRITICAL CARE RELATED TO THE RESPIRATORY SYSTEM

COLIN STEEN, SAMANTHA FREEMAN AND GREGORY BLEAKLEY

> Providing supportive breathing to a patient who is struggling is both challenging and rewarding. It is the fundamental strategy we can use to help support life. It can often be confused as the media call it a 'life support' machine but really, it's just support for a single failing organ.
>
> **Jane, Nurse Practitioner, 35 years' experience**

Learning Outcomes

When you have finished studying this chapter you will be able to understand:

- The overview of anatomy and physiology
- Some types of respiratory failure
- How to care for a person with an artificial airway
- The basics of artificial ventilation
- Some of the available **interventions** in the management of respiratory failure

INTRODUCTION

This chapter aims to provide you with an overview of the relevant anatomy and physiology of the respiratory system, and provides signposting for those who need more in-depth revision. The focus will be on assessment, the nursing interventions relating to the airway, and then breathing, with topics such as the use of artificial airways and adjuncts, tracheostomy management and care. In relation to breathing, topics covered will be the types of respiratory failure, respiratory management including invasive and non-invasive ventilation, oxygen therapy, **prone positioning** and Extra Corporeal Membranous Oxygenation.

OVERVIEW OF THE ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY SYSTEM

Respiration is usually an effortless physiological process characterised by the inspiration and expiration of air. Breathing occurs as an involuntary reflex controlled by the medulla oblongata and pons, which are part of the brainstem (Waugh and Grant, 2018). A normal adult's breathing rate is approximately 12–18 breaths per minute (bpm). However, the respiration rate can increase or decrease as a result of exercise, ill health, mental state and/or drug therapy.

Tortora and Derrickson (2016) describe the key anatomical structures of the respiratory system as including the nose, pharynx (throat), larynx (voice box), trachea (windpipe), bronchi and two lungs. Functionally, the respiratory system is divided into two components. First, the upper respiratory tract includes the nares (nostrils), nose, nasopharynx (nasal cavity) and pharynx. Second, the lower respiratory tract includes the larynx, trachea, bronchi and two lungs (see Figure 5.1).

Crucially, the respiratory system allows gas exchange to occur. This includes the intake (inspiration) of oxygen (O_2) for delivery to body cells and the removal of carbon dioxide (CO_2) following cellular activity, helping to regulate blood pH and maintain **homeostasis**.

The respiratory system also has innate protective mechanisms to help protect the body from invading organisms and airborne debris. The normal level for blood pH is 7.35–7.45 and acidosis occurs when the pH of the blood falls below 7.35. Respiratory acidosis is usually caused when blood pH falls below 7.35 resulting from CO_2 levels being abnormally high because of ill health or disease. Conversely, respiratory alkalosis occurs when blood pH rises above 7.45 because of breathing too fast and reducing CO_2 levels below normal (Brinkman and Sandeep, 2018).

Inspired air travels down the bronchial tree towards the distal end of the respiratory tree, the terminal bronchioles. The trachea is a tubular passageway for air, which splits into a right main bronchus and is connected to the right lung and a left primary bronchus which is connected to the left lung. The point where the trachea divides is known as the carina. On entering the lung, the bronchi further divide to form smaller bronchi (secondary bronchi), continuing with smaller divisions to form bronchioles. The extensive branching from the trachea resembles an inverted tree (Tortora and Derrickson, 2011).

The terminal bronchioles end in a collection of microscopic air sacs called alveoli. In the alveoli, gas exchange occurs, and oxygen is absorbed into the blood steam and is either dissolved in the plasma of the blood or bound to haemoglobin.

Carbon dioxide travels from the bloodstream to the alveoli, where it is exhaled. The transport of carbon dioxide around the body is discussed later in this chapter. A thin layer

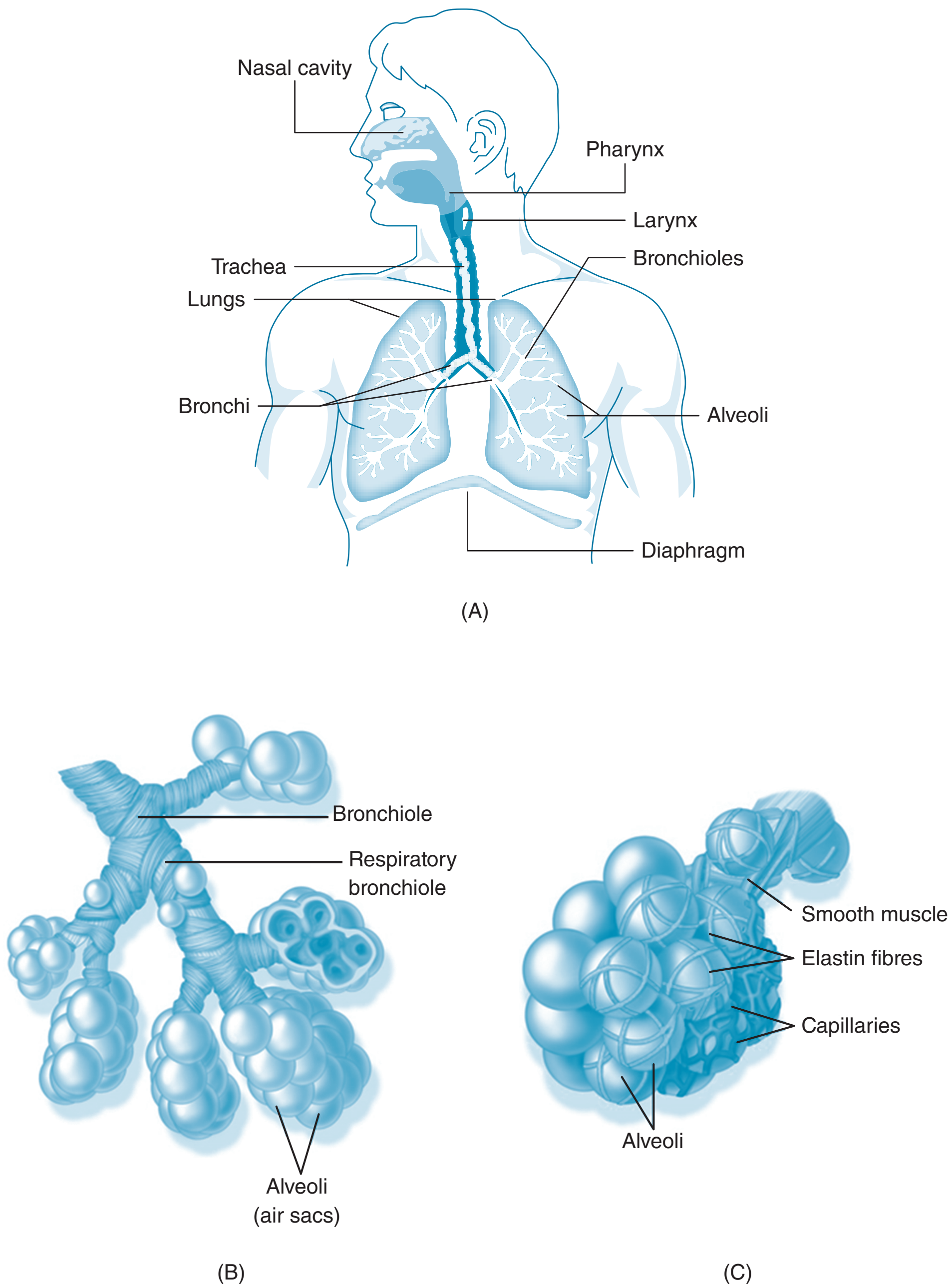

Figure 5.1 (A) Main organs of the respiratory system (B) Bronchioles, respiratory bronchiole and alveoli (C) Smooth muscle is shown in the walls of the bronchioles

Source: Ashelford et al., 2019

of cells called the **interstitium** is found throughout the body, but in the lungs, it is situated between the alveoli and terminal bronchiole. It contains a network of small blood vessels and cells which enables efficient gas exchange to occur (Cook et al., 2021).

The lungs are the largest organ of the respiratory system and are in the thorax. There is a left lung and a right lung. The left is divided into two lobes and the right into three lobes. The right lung is bigger than the left owing to the space occupied by the heart.

Each lung is covered by its own double-thin layer of tissue known as the plural membrane. The outer layer, or parietal pleura, lines the inside of the protective rib cage and the diaphragm while the inner layer, or visceral pleura, covers the lungs. Between the parietal and visceral pleura is a space referred to as the pleural cavity. The membranes of each pleura secrete a serous 'lubricating' fluid into the pleural cavity which reduces friction during respiration (Waugh and Grant, 2018).

In some conditions, the pleural cavity fills with air (pneumothorax), blood (haemothorax) pus or chyle (pleural effusion). Air, blood, pus and/or chyle in the plural cavity are abnormal and their presence can indicate trauma to the lung, infection or **inflammation**.

Activity 5.1: Reflective Practice

Consider the roles of key anatomical structures involved in respiration.

1. What are the names of the main structures and their function in respiration?
2. As a healthcare practitioner you need to be aware of situations that can affect gaseous exchange in the lungs. Consider what these may be.
3. Can you list some of the common causes of air, blood, pus or chyle entering the pleural cavity?

The most significant muscle involved in the physiological process of respiration is the diaphragm. This is a dome-shaped muscle and located in a gap between the thoracic cavity above and the abdominal cavity below (see Figure 5.2).

During respiration, the diaphragm contracts and pulls in a downward direction, which encourages greater space in the thoracic cavity (Cohen and Hull, 2015). The movement of the diaphragm results in the inhalation of air (breathing in). Equally, movement of the intercostal muscles upwards and outwards contributes to the increase in intrathoracic volume and a decrease in intrathoracic pressure sucking air into the lungs from the atmosphere. The intercostal muscles are located between the ribs and can be visualised during laboured or rapid breathing.

RESPIRATORY FAILURE

Respiratory failure is a condition that affects the gas exchange within the lungs. It occurs when the gas exchange organ (lung), the ventilatory pump (respiratory muscles and the thorax) or the neurological stimulus arising from the brain and neural pathways fail to work properly. Respiratory failure is divided into Type I and Type II. Type I is characterised by low O_2 levels (hypoxaemia) with normal or low CO_2 levels (hypocapnia) and occurs because of

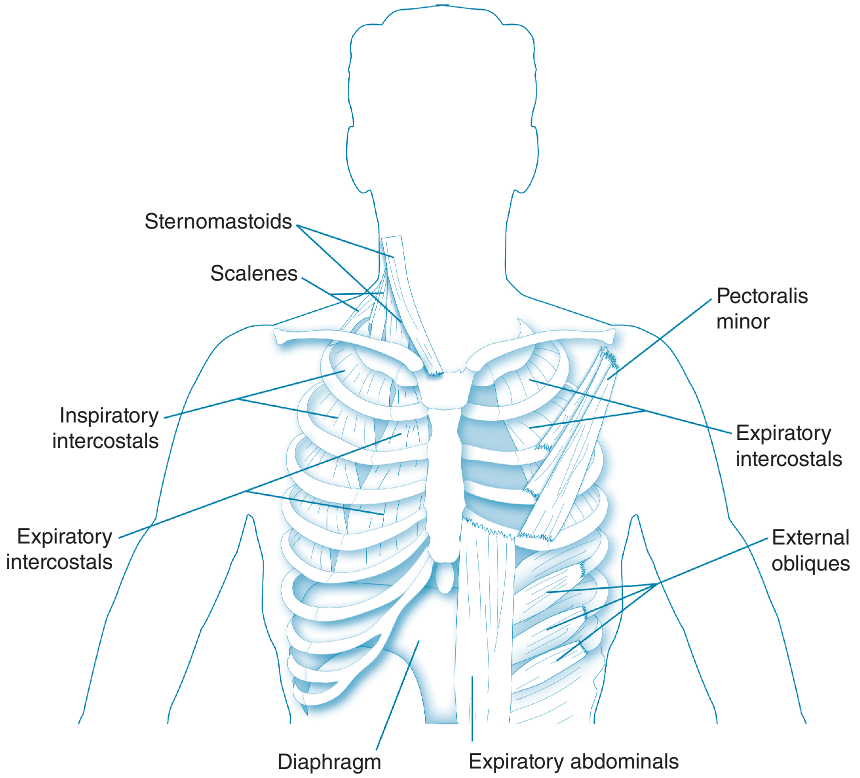

Figure 5.2 Muscles of respiration

Source: Cook et al. (2021)

inadequate oxygenation of the blood (hypoxaemia) or excessive excretion of carbon dioxide. Typical causes of Type I respiratory failure include **pulmonary** oedema, pneumonia, acute lung injury (ALI), acute respiratory distress syndrome (ARDS), idiopathic pulmonary fibrosis, lung cancer and emotional distress leading to tachypnoea.

Type II respiratory failure involves low O_2 levels (hypoxaemia) with high CO_2 levels (hypercapnia). This type of respiratory failure or 'ventilatory failure' occurs when alveolar ventilation is insufficient to remove residual carbon dioxide from the bloodstream. It is frequently caused by chronic obstructive pulmonary disease (COPD), asthma and other respiratory muscle weaknesses (e.g., Guillain-Barré syndrome).

Interventions in the Management of Respiratory Failure

Oxygen Therapy

When people have abnormally low oxygen levels in their blood, they may require oxygen therapy to be prescribed. Oxygen is classed as a drug and requires a prescription. There are several different kinds of oxygen therapy.

1 Long-term oxygen therapy (LTOT)

This is used to describe the oxygen therapy people with chronic hypoxaemia receive when they require the use of oxygen to maintain their blood oxygen levels within normal range.

2 Nocturnal oxygen therapy (NOT)

This term is used when oxygen therapy is administered to people who experience a reduction in blood oxygen levels whilst they are asleep.

3 Ambulatory oxygen therapy (AOT)

If, whilst a person is active or involved in physical exertion, their blood oxygen levels fall, then they might be prescribed ambulatory oxygen therapy.

4 Palliative oxygen therapy (POT)

Oxygen therapy may be prescribed to people who experience severe breathlessness that is unresolved using other treatments. See previous section on Type II respiratory failure in this chapter.

In Type 1 respiratory failure, people who are acutely unwell may be prescribed oxygen to maintain blood oxygen saturation levels within the normal range (SaO_2 94–100%). In Type II respiratory failure the target SaO_2 for treatments is 88–92% (O'Driscoll et al., 2017).

There are several different devices that are used to deliver oxygen therapy. The **non-rebreather mask** or reservoir bag-mask (Figure 5.3) delivers oxygen at high concentrations. The precise percentage is unknown but is judged to be in the region of 80%, but this requires oxygen flow rates to be at 15 litres per minute (L/min). The reservoir bag needs to be filled with oxygen prior to positioning the mask on the person and a close fit over the mouth and nose is required.

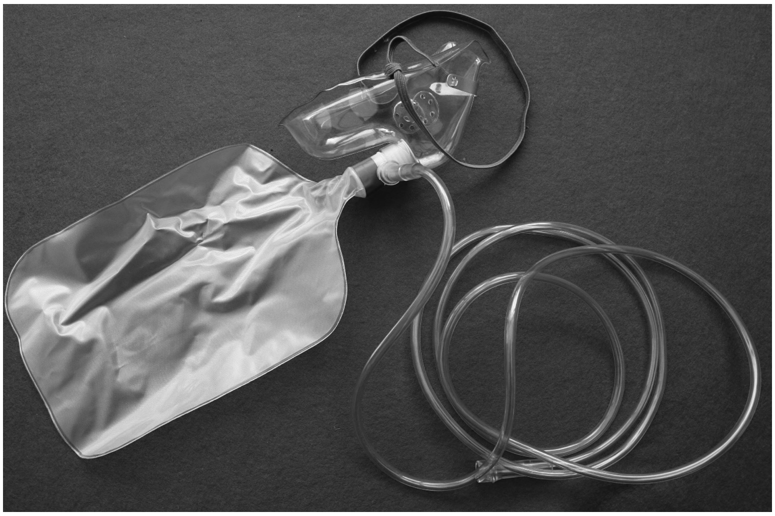

Figure 5.3 Oxygen mask with reservoir bag

Source: © C. Steen

A simple facemask (Figure 5.4) is intended for short-term use such as following surgery. Oxygen is delivered at 2–10 L/min. The concentration of oxygen inspired is unknown as air is drawn into the mask during breathing, diluting the oxygen concentration.

Figure 5.4 Simple oxygen mask

Source: © C. Steen

Nasal cannulae are a method of delivering oxygen nasally. They do not impact on the patient's ability to eat or drink and are generally well tolerated. These are used in situations where a low concentration of oxygen is required. Typically, the oxygen flow rate is between 2–4 L/min. Caution is needed in this method of delivery as high flow rates via nasal cannulae can cause drying of the nasal mucosa unless humidification is used.

Fixed performance devices deliver oxygen via a Venturi valve, which gives an accurate and known concentration of oxygen (Figure 5.5). The flow rate varies between manufacturers and is dependent upon the concentration of oxygen required.

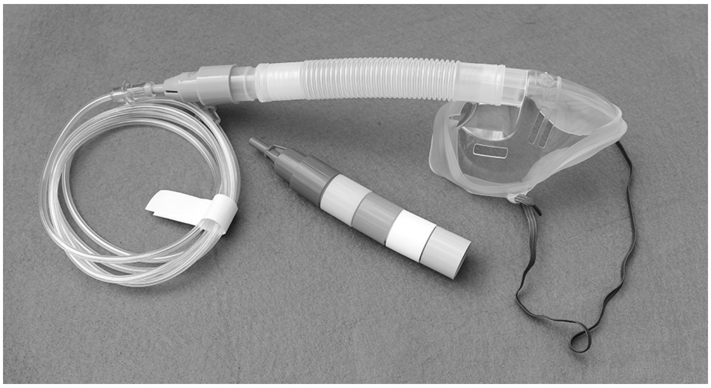

Figure 5.5 Venturi mask. The adaptors shown are colour-coded to indicate the different oxygen concentrations available

Source: © C. Steen

When caring for patients receiving oxygen therapy it is important to continue to monitor their oxygen saturation regularly using a pulse oximeter. As oxygen is a dry gas, it can affect the mucosal membranes of the upper respiratory tract as well as drying secretions in the lungs, which can lead to infection. Therefore, those patients who require oxygen therapy longer than 24 hours must have humidification added to the oxygen delivery system.

> Patient comfort is paramount and having dried nasal secretions stuck to the inside of the nose is very uncomfortable and painful. I need to understand and ensure that the treatment I apply tries to avoid this.
>
> **Jenny, Registered Nurse, eight years' experience in Level 2 care**

What's the Evidence? 5.1

Read the British Thoracic Society's guidelines (2017):

O'Driscoll, B.R., Howard, L.S., Earis, J. and Mak, V. (2017) 'BTS guideline for oxygen use in adults in healthcare and emergency settings', *Thorax*, 72: 1–90. doi.org/10.1136/thoraxjnl-2016-209729

This document describes the national guidelines for the use of oxygen in adults suffering acute illness.

When you're assessing patients in practice, review the measurements of the patients' clinical status and, based on the evidence you have read, consider whether the person requires oxygen or not.

UNDERSTANDING ARTERIAL BLOOD GAS (ABG) ANALYSIS

A common assessment carried out by the team in critical care is arterial blood gases. Normally the sample will be obtained from the invasive arterial pressure monitoring system. The system allows for a small sample of blood to be withdrawn for testing. An appropriately trained member of the team should carry out this procedure. Once you have a sample, the department will have a blood gas analysis machine, and you can use this to get a result within a minute or two. There are many parameters such as potassium or haemoglobin levels, which are also obtained on this sample.

As mentioned previously, the normal pH range is 7.35 to 7.45 and is affected by changing levels of carbonic acid. This acid is produced because of cellular metabolism. It results from metabolic activity that produces CO_2 and water (H_2O) and these two chemicals combine to produce carbonic acid (H_2CO_3). Carbonic acid is unstable in water. Plasma, the liquid portion of blood, contains 92% water, and, as carbonic acid is unstable in water, it splits into hydrogen ions (H^+) and bicarbonate (HCO_3^-). The pH scale is an inverse scale that measures the amount of H^+ in the blood. Consequently, the higher the H^+ in the blood the more acidic the blood is and the lower the pH level will be. To maintain homeostasis, CO_2 is carried to the lungs and excreted, thus reducing the amount of carbonic acid and H^+, and restoring pH to normal levels. This is a rapid response to a change in **metabolic** activity; however, there are alternative ways of controlling the pH level that are slower, such as the kidneys excreting H^+ in the urine or retaining HCO_3^-. When someone is unwell, the body will respond by trying to maintain normal homeostasis through these compensatory changes, and it is the role of the nurse and medical teams to detect these mechanisms working in this way. It provides vital information that illness is present and its severity.

The partial pressure of oxygen (PaO_2) dissolved in arterial blood should be >10 kPa and the partial pressure of carbon dioxide ($PaCO_2$) dissolved in arterial blood should be between 4.5 kPa and 6.1 kPa. The bicarbonate (HCO_3^-) reading should be between 22 and 26 mmol/l.

Before analysing the blood result, you need to know what level of oxygen the person is receiving. This is because there is a difference between the levels of oxygen we inhale and the PaO_2 dissolved in arterial blood. The difference is normally around 10 kilopascals (kPa). In a person with damage to their lungs, either by infection or illness, this difference will be bigger. The size of the gap between what concentration of oxygen the person inhales and their PaO_2 indicates the degree of damage. This difference is referred to as the Alveolar–arterial (A–a) gradient.

When we start to interpret the ABG we can use five simple questions:

1. Is the patient hypoxic?
2. How does this relate to the inspired O_2?
3. Do they have acidosis or alkalosis (the pH level)?
4. Is the cause respiratory or metabolic (determined by $PaCO_2$ and HCO_3^-)?
5. Is there any attempt at compensation (determined by $PaCO_2$ and HCO_3^-)?

These last two questions can sometimes be challenging; however, using the diagram below may help (see Figure 5.6). If the results are marked on the same side as the pH, then that is the cause of the deterioration, and if the result is on the opposite side, it is the compensatory mechanism trying to correct the pH.

> I found this diagram really helpful. I even printed it out and put the questions on the back. It's small so it fits in my pocket and is laminated. I use it in placement with real ABGs. It really helped me learn how to read them.
>
> **Louise, 3rd Year Student Nurse**

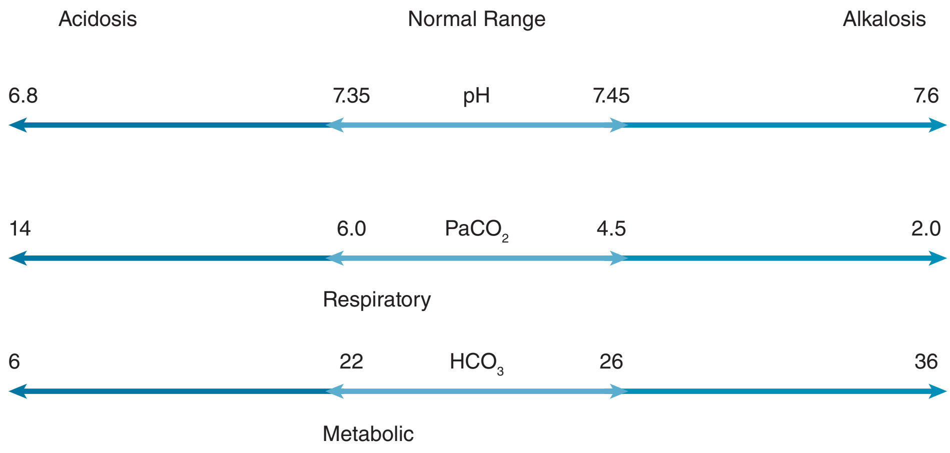

Figure 5.6 Method of determining the outcome of arterial blood gas analysis

Source: Freeman et al. (2019)

Activity 5.2: Case Study

Harold is an 86 year old who is experiencing a persistent cough and is easily short of breath. He is wheezy during cold weather and is more chesty than usual. He is married to Hilda and lives in a terraced house. He stopped smoking ten years ago and is a retired mill worker. Harold has become more forgetful recently and is developing Alzheimer's disease. On admission to hospital, his respiration rate is 28 breaths per minute and his arterial blood gas (ABG) analysis is pH 7.30; pCO_2 8kPa; pO_2 7.5kPa.

1. What is causing Harold's respiration rate to increase?
2. What type of respiratory failure is Harold likely to be experiencing?

AIRWAY

Caring for somebody who has an artificial airway in place can feel frightening as it poses several nursing challenges related to maintaining the safety of the person.

Before establishing artificial ventilation, you will need to secure the airway, and there are several ways you can do this. Simple airway protective procedures such as the recovery position and oropharyngeal or nasopharyngeal airways are not suitable for invasive ventilation. Occasionally, devices such as **laryngeal masks** or subglottic masks, which are inserted into the upper airway but remain above the vocal cords, are used in emergency situations. These are more advanced than oropharyngeal/nasopharyngeal airways and can facilitate artificial ventilation. These are preferred as they are easy to insert but are only used until the patient is stabilised and then they are exchanged for more substantial airways such as an endotracheal tube (ET tube) (Figure 5.7) or a tracheostomy tube (Figure 5.8). These are more secure airways and enable prolonged artificial ventilation. To insert an ET tube, the person needs to be anaesthetised and paralysed to prevent the triggering of the gag reflex as the tube is passed through the oropharynx. Continuous background **sedation** is required so the tube can be tolerated.

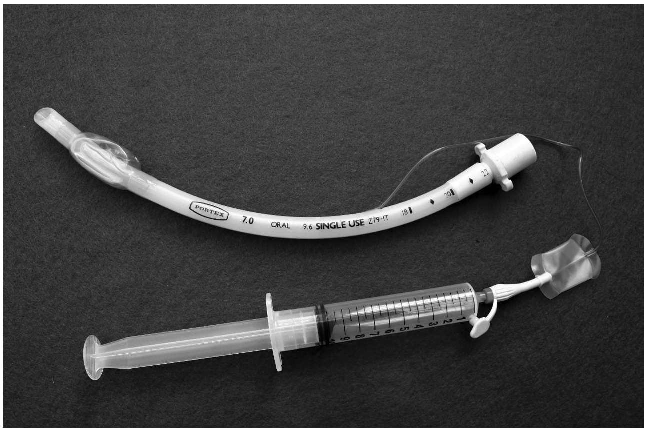

Figure 5.7 Endotracheal tube with syringe attached to inflate cuff

Source: © C. Steen

Figure 5.8 Tracheostomy tube with cuff

Source: © C. Steen

Caring for a Person with an Artificial Airway

An artificial airway is a medical device that can be inserted into the upper or lower respiratory tract to secure the airway and to facilitate respiration and/or ventilation and the removal of secretions. Firstly, the airway needs to be secure and not easily dislodged or it will cause unnecessary damage to the trachea. Then the nurse needs to ensure the patency of the artificial airway, prevent **aspiration** of any secretions, or in the case of a tracheostomy, liquids, or food, which can result in **aspiration pneumonia**. This is achieved through endotracheal **suctioning**. You can read further details on this technique later in this chapter in the section on 'Nursing interventions: Endotracheal suctioning'.

Endotracheal tubes (ET) and temporary tracheostomies are the two most common artificial airways you will see in critical care units. There are other airway adjuncts, such as oropharyngeal or nasopharyngeal, which you may observe in some units such as accident and emergency, and specialist head and neck surgery departments.

Activity 5.3: Reflective Practice

Both the insertion of an ET tube and a tracheostomy bypasses the normal physiology of the person's upper airway.

1. Consider what natural defences the insertion of the airway bypasses.
2. Consider how the bypassing of these defences may affect the person.
3. What assessment and management strategies do we need to consider that will assist the person's natural defences?

Endotracheal Tube Insertion

There will be several staff from the multidisciplinary team involved in an airway insertion. The anaesthetist leads the procedure. All equipment will be checked ready before the procedure.

What's the Evidence? 5.2

All equipment should be checked before, during and after intubation and a full list of all the equipment that may be used can be seen on the Faculty of Intensive Care Medicine website. Read the Faculty of Intensive Care Medicine (2019) detailed guidance and invasive procedure checklist with a specific list for ITU Intubation: www.ficm.ac.uk/sites/ficm/files/documents/2021-10/safety_checklist_-_itu_intubation-final_0.pdf (accessed 22 October 2023).

If the person is awake prior to the procedure, it is likely to be a frightening experience for them and they will require constant reassurance and information about what is happening. The area around the bed space is often noisy and busy and there are a lot of people so try to remain aware of this and offer support to the person and remind the staff of the person's presence.

If not done so already, you should ensure access to the head of the bed by removing the headboard, as this makes positioning the person easier. The person will receive a period of pre-oxygenation and then be laid flat. Should the person be considered at high risk of aspiration during the procedure you may hear the anaesthetist ask for someone to apply cricoid pressure (also known as cricothyroid pressure). This is a technique where the anaesthetist's assistant presses on the cricoid cartilage during endotracheal intubation, thus occluding the oesophagus which passes directly behind it. The purpose is to reduce the incidence of aspiration of gastric contents from occurring; however, there is some debate as to the effectiveness of this procedure, and some anaesthetists may request this whilst others may not.

What's the Evidence? 5.3

The **mortality** rate of aspiration pneumonia is very high but preventable. To help prevent this from occurring during intubation cricoid pressure is applied. Listen to this podcast: https://theresusroom.co.uk/cricoid-pressure/. Also read this paper:

Birenbaum, A., Hajage, D., Roche, S., Ntouba, A., Eurin, M., Cuvillon, P. […] and Riou, B. (2019) 'Effect of cricoid pressure compared with a sham procedure in the rapid sequence induction of anesthesia: The IRIS randomized clinical trial', *JAMA Surgery*, 154 (1): 9–17. doi.org/10.1001/jamasurg.2018.3577

The person will need to have **intravenous** (IV) access prior to the procedure to administer the sedatives. Monitoring such as electrocardiograph (ECG), heart rate (HR), blood pressure (BP), oxygen saturation (SaO_2) and end-tidal carbon dioxide measurement ($EtCO_2$) is used to monitor the condition of the patient during the procedure and to confirm correct positioning of the ET tube.

Once all the team and equipment are ready the person is given a combination of drugs: sedation, analgesia and a paralysing agent. Once the patient is asleep and relaxed, the ET tube is inserted directly into the trachea with the aid of a laryngoscope. The average size of the tube for an adult male is 8.0, and for an adult female is 7.0, but this can vary between practitioners (Ahmed and Boyer, 2023).

However, it is crucial that the largest tube suitable for the patient is selected, as narrower tubes result in greater resistance to gas flow. This is particularly important for patients who are breathing spontaneously, as they will have to exert more effort to overcome the increased resistance.

Once the tube is inserted, the cuff, which is at the distal end of the ET tube, is inflated and checked for pressure with a manometer. The optimal pressure for a cuff is 20–30cmH_2O (Sole et al., 2011). An over-inflated ET tube cuff can cause damage and/or necrosis to the trachea. Conversely, an underinflated ET tube can cause air to leak from the lungs and allow aspiration of gastric contents and secretions into the trachea. The cuff pressure should be frequently monitored and recorded in the medical/nursing case notes. The person's chest will be observed for equal expansion and auscultation performed to ensure gas is entering both lungs.

The ET tube is then secured in place with a tie and attached to an appropriate ventilator.

Following the procedure, arterial blood gases and a chest X-ray are performed to determine the tube position and to guide the settings of the ventilator. In addition, a nasogastric (NG) tube should be inserted to reduce the possibility of **aspiration pneumonia** and/or facilitate nutritional intake (Faculty of Intensive Care Medicine, 2019). This topic is also explored in Chapter 10.

The Nurse's Role Following ET Tube Insertion

The nurse's role is to monitor and maintain the position and patency of the ET tube. The ET tube has markings in centimetres on the outside to indicate how deep the tube is placed in the trachea. The length of the tube should be noted at either the lips or the teeth. This gives you a baseline position and should be recorded in the medical/nursing case notes. To identify whether the tube has moved or dislodged, you should check the position, particularly after repositioning the patient. Any suspicion of ET tube movement or displacement should be treated as an emergency and the airway assessed by a clinician trained in tracheal intubation.

There may be post-intubation complications you need to be aware of, such as:

- Hypoxia
- Trauma to lips, teeth and vocal cords
- Transient cardiac **arrhythmias** due to vagal nerve stimulation
- Hypertension, tachycardia or raised intracranial pressure
- Aspiration
- Misplacement – potential oesophageal intubation
- Infection/pneumonia
- Reduced cough reflex
- Bronchial and tracheal ulceration or stenosis
- Laryngeal oedema (swelling of the larynx)
- Bronchospasm
- Discomfort and anxiety
- Endotracheal tube kinked or damaged
- Damage to the tracheal mucosa

Tracheostomy Tube Insertion

Typically, a tracheostomy is performed to support weaning from mechanical ventilation. A prolonged period of mechanical ventilation is associated with significant **morbidity** and mortality. Consequently, weaning from ventilation should be initiated at the earliest opportunity and formation of a tracheostomy makes this possible. A tracheostomy is a tube inserted through the anterior wall of the trachea, just below the larynx and cricoid cartilage.

The insertion procedure can be either surgical insertion or by percutaneous dilatation. The insertion via percutaneous dilatation is often carried out within the person's bed area rather than in a theatre environment. It involves a very small incision being made in the skin and the anterior wall of the trachea. Then, dilators of increasing width are used and once sufficiently dilated, a tracheostomy tube is inserted and secured in place.

Either way the procedure is not without risk and insertion will be based on clinical need in conjunction with discussion with the family. The most common problems with tracheostomy tubes are obstruction or displacement of the tube. The Intensive Care Society Guidance for Tracheostomy Care (2020) provides a detailed breakdown of the procedure. Some of the potential complications are:

- Airway occlusion
- Displaced tubes or blocked tubes
- Air leaks
- Impaired cough
- Surgical emphysema – when gas or air enters the layer under the skin
- Infection-wound/chest
- Haemorrhage
- Tracheal stenosis – narrowing of the windpipe
- Ulceration tissue damage
- Altered body image

The Intensive Care Society *Tracheostomy Care Guidance* (2020) states there are four indications for a temporary tracheostomy to be sited. These are:

- Maintenance of a patent airway
- Protection of the airway
- Aid the removal of excessive secretions
- Aid weaning from intermittent, positive pressure ventilation

Activity 5.4: Reflective Practice

1. Given the potential risks of the procedure, why do you think it would be in a person's best interest to have a tracheostomy inserted? Write this down in a list.
2. Look at your list. Do your items link to any of the four indications above?

Temporary tracheostomies are commonplace in critical care, and you will need to be aware of the additional equipment required, the potential risks and how to manage these. Table 5.1 below outlines the minimum equipment required at the bedside.

Table 5.1 Equipment checklist for temporary tracheostomies

Suction	Appropriately sized suction catheters and suction unit, which should be checked at least daily, with suction tubing attached
PPE	Non-powdered, latex-free gloves, aprons, and eye protection
Safety Equipment	Spare tracheostomy tubes of the same type as inserted: one the same size and one a size smaller
	Tracheal dilators
	Re-breathing bag with tubing and a connection to an oxygen supply
	Catheter mount or connection
	Tracheostomy disconnection wedge
	Tracheostomy tube holder and dressing
	Easy access to resuscitation equipment
	10ml syringe (if tube cuffed)
	Artery forceps
	Easy access to resuscitation equipment
	Manometer to measure cuff pressure

Source: Adapted from Intensive Care Society (2014)

There are various types of tracheostomy tube. They either have a cuff, which can be inflated during mechanical ventilation, or not (Myatt, 2015). The purpose of the cuff is the same as that of an ETT (see section on 'Cuff Management' later in this chapter). The other difference is whether the tracheostomy has a removable inner tube. The different types of tube are listed on the National Tracheostomy Safety Project (2013) website at: www.tracheostomy.org.uk/storage/files/Tube%20types.pdf (accessed 22 October 2023).

You should note that there are some differences in resuscitation approaches for individuals who have a temporary tracheostomy. If effective ventilation can be provided with a bag/valve, then continual chest compressions should be carried out along with ventilation at approximately 10 breaths/minute (Resuscitation Council UK, 2021).

Activity 5.5: Reflective Practice

1. Consider which members of the multidisciplinary team are required to establish artificial ventilation.
2. Consider why it is necessary to have a dedicated department, i.e. intensive care, to look after these patients.

Nursing Assessment

It does not matter which of the two artificial airways the person you are caring for has, fundamentally the assessment will be the same. Working in ACCU, you will notice that there are comprehensive respiratory assessments carried out at the start of a shift, after any significant change in the person's condition, or following repositioning. The person's chest will be auscultated, and the staff will be observing for bilateral air entry, which is equal in all lobes, and abnormal air noises that may be a result of moisture, secretions, or airway changes.

Nursing Interventions

Endotracheal Suctioning

Suctioning is one of the most common procedures performed to help maintain patency of the endotracheal (ET) tube or tracheostomy. There are many things you need to consider before, during and after ET suctioning. ET tube suction is an uncomfortable and distressing experience. It can lower the person's oxygen saturation and their heart rate and therefore should only be carried out following a clinical assessment. NICE has provided this document outlining the full procedure: http://rc.rcjournal.com/content/respcare/55/6/758.full.pdf. (accessed 22 October 2023).

When performing endotracheal suctioning via tracheostomy, if the person can cough loose sections into the end of the tube, then shallow suctioning can be sufficient (Myatt, 2015). However, for those sedated and ventilated with thick secretions, this may not be effective and deeper bronchial suction may be required.

This should be carried out by an appropriately trained practitioner as it can lead to complications such as hypoxia, mucosal trauma, cardiac arrhythmias and raised intracranial pressure, which increases the risk of infection (Dougherty and Lister, 2008). This is a sterile procedure, and the person may require pre-oxygenation administration beforehand. Guidance from the National Tracheostomy Safety Project (NTSP) (2013) states that the suction catheter is advanced until resistance is felt – this is at the carina – and is then withdrawn slightly before the application of suction. The procedure should not last more than ten seconds (NTSP, 2013). Suctioning can be painful and distressing so adequate pain relief and reassurance should be given (Freeman, 2011).

There are different types of suction systems in use. They are termed 'closed' and 'open' suction systems and which you should use is dependent on local policy. The size of the suction catheter should be equal to or less than half the inner diameter of the ET tube or tracheostomy tube. This is to allow air into the lungs during suctioning and prevent alveolar collapse and atelectasis, and reduce the risk of hypoxia and cardiovascular instability.

Activity 5.6: Research and Evidence-Based Practice

Carry out some research and further reading on the benefits and disadvantages of open and closed suction systems.

Following your reading of the evidence base, review your local policy to determine how it compares to your findings.

There is no template answer to this activity as it is based on your own reflection.

Humidification

The insertion of an artificial airway disrupts the normal humidification of the airway. Dry secretions can lead to blockage of the tube with thick, difficult to remove sputum. All oxygen administered to those with an artificial airway should be humidified. The type and level of humidification will be determined by the way in which the person is ventilated and their clinical picture. The NTSP (2013) offers suggestions to help decision-making as to the type and level of humidification required with the humidification ladder, which is shown in Table 5.2.

Table 5.2 Requirements for types of humidification

Method of humidification	Presenting symptoms
Heated water bath (active humidification)	Ventilated patient with thick secretions Self-ventilating patient (on oxygen) with thick secretions
HME for breathing circuit	Ventilated patient with minimal secretions (replace every 24 hrs) Monitor effectiveness (less likely to be effective if required for more than 5 days)
Cold water bath	Self-ventilating patient (on oxygen)
HME: (Buchanan bib, Swedish nose)	Self-ventilating patients (no oxygen)
Add saline nebulisers or mucolytics and ensure adequate hydration if secretions are not improving	

Source: National Tracheostomy Safety Project (2013)

Management of Tracheostomy Inner Cannula

Many tracheostomy tubes are manufactured with an inner cannula. One of the advantages of an inner cannula is it can provide immediate relief of life-threatening airway obstruction in the event of blockage of a tracheostomy tube (Intensive Care Society, 2014). The National Tracheostomy Safety Project (NTSP) (2013) recommends the inner cannula is removed and cleaned at least once per eight-hour shift; however, NCEPOD (2014) suggested this should be every four hours. Consequently, you may see some clinical variation in the frequency of cleaning, and you should learn which is applicable in your ACCU. The inner cannula can be cleaned with sterile gauze or cannula brushes. The soaking of the inner cannula is not recommended as it has been shown to increase the risk of exposure to pathogens (Intensive Care Society Standards, 2014; NCEPOD, 2014).

Stoma Care and Tracheostomy Tube Securement

The tracheal stoma, like any wound, requires appropriate care. The application of a sterile dressing absorbs secretions from the stoma and reduces the risk of pressure injury caused by the tracheostomy (Mallet et al., 2013). Regular checking for any signs of wound breakdown is important and as this is a surgical wound it requires aseptic cleaning with 0.9% sodium chloride at least once every 24 hours (Intensive Care Society, 2014). To prevent the accidental removal of the tracheostomy during dressing changes, two staff are required to carry out the procedure (Freeman, 2011). The tracheostomy tube is secured around the person's neck with either a commercial tracheostomy holder or tracheostomy tapes (Myatt, 2015). These tapes need to be secure but not too tight to cause any damage to the skin, and in severe cases compromise venous return. It is recommended that once tied you should be able to insert one or two fingers between the tape and the person's neck (Mallet et al., 2013).

Cuff Management

The cuff creates a sealed airway in both an ET tube and a tracheostomy. Underinflation of the cuff leads to ineffective ventilation, and leakage of gastric contents into the lungs and risks the airway being dislodged. Overinflation can lead to damage and complications within the trachea. Further information can be found in the 'What's the evidence?' box below.

What's the Evidence? 5.4

Read the detailed guidance on cuff management provided by the National Tracheostomy Safety project (2013): www.tracheostomy.org.uk/storage/files/Cuff%20management.pdf (accessed 3 November 2020)

Mouth Care

As the normal flow of air has been disrupted, oral secretions are reduced (Myatt, 2015). Meticulous mouth care is vital to maintain the comfort and hygiene of the person. It may also reduce the risk of ventilator-associated pneumonia (Hellyer et al., 2016). The concentration of chlorhexidine may also influence the effectiveness of oral hygiene (Andrews and Steen, 2013). There is some discussion and controversy regarding the use of chlorhexidine in the prevention of pneumonia – please see the What's the evidence? 5.5 for further guidance.

What's the Evidence? 5.5

It is recommended by NTSP (2013) that chlorhexidine mouthwash is used in between twice daily teeth brushing. Research the current evidence about the benefits and risks of using chlorhexidine mouthwash.

1. Read the detailed guidance on the use of chlorhexidine provided by the National Tracheostomy Safety Project (2013) at: www.tracheostomy.org.uk/storage/files/Cuff%20management.pdf
2. Also, read this Cochrane review:

Hua, F., Xie, H., Worthington, H.V., Furness, S., Zhang, Q. and Li, C. (2016) 'Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia', *Cochrane Database of Systematic Reviews*, 10: Article #CD008367. doi.org/10.1002/14651858.CD008367.pub3

There is also an excellent a podcast of this review, which can be heard at: www.cochrane.org/podcasts/10.1002/14651858.CD008367.pub3

Nutrition and Hydration, and Swallowing

A person with an artificial airway inserted is likely to have a nasogastric tube. Adequate nutrition and hydration are vitally important in the critically ill person. The presence of a tracheostomy increases the risk of the person developing **dysphagia** or swallowing difficulties. It is vital that **speech and language therapists** are involved in the person's care to assess the person's swallow and gag reflex to minimise any complications. This topic is also explored in Chapter 10.

COMMUNICATION

In any clinical setting communication is a vital component in supporting person-centred care, and this is no different in critical care. Communication will be covered in more detail in Chapter 15

It is important to acknowledge communication here, as this is the most likely point where the person loses their ability to verbalise their wishes. Critical care survivors, even when the person is unconscious or sedated, may often recall communication at the bedside. The conscious and subconscious recall of the noises and conversations at the bedside can have an adverse impact on long-term psychological outcomes. You need to be aware of the techniques and technology available for those intubated to engage in communication, including the use of spelling boards, icon charts and electronic aids.

> It is vital that the person can convey their thoughts, feelings and concerns to us by using alternative means when they cannot vocalise.
>
> **Sarah, 28 years' experience working in a Level 3 critical care department**

VENTILATION

There are many different strategies and methods of ventilating people, but the two main and basic methods will be presented here. These are invasive and non-invasive ventilation. As to which is used depends on the type and severity of the underlying pathology. The terminology and delivery of ventilation can vary according to the manufacturer of the equipment used.

Non-Invasive Ventilation

Non-invasive positive pressure ventilation (NIPPV or sometimes NIV) is a method of enhancing gas exchange in the lungs. It is typically delivered via a tight-fitting face or nasal mask. This is offered to avoid the need for invasive ventilation and the associated increased risks. It is also used to help with weaning from invasive ventilation (see the section on weaning from ventilation later in this chapter). An advanced method of NIPPV is bi-level ventilation.

NIPPV differs from invasive ventilation in that the stimulus to breathe comes from the patient. Once the machine recognises this effort, it blows gas into the lungs under positive pressure. This pressure is sustained at a pre-set level until the machine senses that the patient starts the expiration phase and then it ceases to blow. The clinician determines the amount of assistance provided during the inspiration phase. For those patients who are very tired or struggling to breathe the pressure is set higher than for those who are recovering or only require a low level of support.

A positive pressure can be retained within the respiratory circuit at the end of expiration to splint the lungs open. This pressure is termed continuous positive airway pressure or CPAP. When CPAP is used, it helps to recruit redundant alveoli and improves gaseous exchange in the lungs. It also helps to reduce the work of breathing in as the lungs are already partially inflated, meaning the patient doesn't have to work so hard to inflate their lungs with each inspiration. For those patients who have to work hard to maintain effective breathing CPAP helps in reducing this workload.

As CPAP and PEEP, which relates to invasive mechanical ventilation and is discussed below, increases intrathoracic pressure, the effect on the cardiovascular system can have advantages and disadvantages. There is evidence that CPAP can be beneficial in the management of patients experiencing acute myocardial infarction; however, it can reduce cardiac output in patients who have heart failure.

Invasive Mechanical Ventilation (MV)

Invasive mechanical ventilation (MV) requires inserting an endotracheal tube through the mouth and into the trachea. The end of the tube should rest 2–3cm above the carina. The purpose of MV is to take over the process of breathing, thus reducing the workload associated with breathing, reducing **fatigue** and the associated oxygen consumption. The indications for implementing MV are loss of consciousness and loss of the ability of the individual to protect their own airway, respiratory distress and failure and to improve gaseous exchange in the lungs. To provide MV the person is sedated and paralysed to establish the airway and to facilitate compliance with ventilation. This process can have an adverse effect on blood pressure and associated oxygen delivery to tissues, resulting in tissue hypoxia. Depending on the condition of the person and their compliance with MV, sedation and paralysis may continue until such a time that their lung function and haemodynamic state has recovered and is stable.

The type of ventilation required will determine the equipment used. With invasive ventilation an artificial ventilator is attached to either the endotracheal tube or tracheostomy. Gas, a mixture of air and oxygen at a pre-prescribed concentration, is forcibly blown through the tube by the ventilator, inflating the lungs. This positive pressure ventilation differs from the normal method of breathing where the chest cavity expands, resulting in a reduction in intrathoracic pressure to less than atmospheric pressure and air is sucked into the lungs. Using invasive ventilation requires forcibly blowing air into the lungs and can cause a variety of problems.

Activity 5.7: Critical Thinking

1. How does positive pressure ventilation adversely affect the lungs?
2. What issues can you think of that can arise from the use of sedation and paralysing agents to facilitate positive pressure ventilation?

The main problems with forcing air into the lungs are barotrauma (trauma caused to the lungs by the force, which can result in pneumothorax), inflammation, selective ventilation of areas of the lung that are more flaccid, and under-ventilation of areas of the lung that are redundant. These redundant areas of the lungs can result in infection. The forces involved can induce bronchospasm similar to that seen in asthma where gas becomes trapped in the lungs.

Invasive ventilation needs to be very carefully managed and closely observed by the multidisciplinary team. Doctors specialising in intensive care medicine working with intensive care nurses are required to manage the ventilation and interpret the biological findings that are frequently monitored and need to adjust the ventilation accordingly.

Nurses are required to manage ventilation, and oral hygiene to prevent lung and oral infection, and to ensure the airway remains clear and patent. Frequent endotracheal suctioning is required to ensure the tube remains patent.

Physiotherapists are required to help maintain optimal lung function and gas exchange in the lungs. Radiographers perform regular chest X-rays so the condition of the lungs can be observed.

A ventilator is a machine that has a number of different modes of ventilation that can be used to reduce trauma to the lungs and attempt to achieve optimal gas exchange. The ventilator is designed to force gas into the lungs at a set respiratory rate (breaths per minute). Forcing gas into the lungs under positive pressure can have negative effects on cardiac output. This topic is also explored in Chapter 6.

In adults, there are two differing forms of MV, volume and pressure control ventilation. Volume ventilation is where a set volume and set respiratory rate are provided. For example, 14 breaths per minute of 70 mls of gas for each breath, resulting in a minute volume of 980 mls/min (9.8l/min). The hazard of this type of ventilation is that the inhaled gas goes to the area of least resistance, resulting in atelectasis in other areas; and these selected areas of the lung are exposed to excessively high pressures, resulting in barotrauma. The alternative to volume ventilation is pressure-controlled ventilation. This is where the pressure at which the gas is forced into the lungs is controlled, the rate of ventilation is set, and the volume varies. Where the lungs are stiff and hard as seen in acute lung injury, infection and oedema, higher pressures may be needed, but when the lungs are flaccid and clear the pressure required to obtain the same volume is less. Controlling pressure this way means clinicians can control the extent of the barotrauma more effectively. Manipulating the inspiratory and expiratory time along with pressure control ventilation means more areas of redundant lung can be recruited for gas exchange. To maintain the effectiveness of the recruited areas of the lung, additional pressure can be applied within the circuit to prevent the lungs from collapsing completely at the end of each breath. This additional pressure is called 'positive end-expiratory pressure' or 'PEEP'. This means that at the end of expiration the lungs are 'splinted' open by the presence of this pressure, alveoli can be recruited, drainage of sections is facilitated, and gaseous exchange is more efficient. The concern when applying PEEP in ventilation is the unnatural state of retaining a positive pressure within the lungs, which can contribute to barotrauma and increase cardiac afterload.

If it is likely that direct access to the lungs will be required for a prolonged period, then a tracheostomy may be considered.

Activity 5.8: Case Study

Sandra, 72 years old, is admitted to hospital following a bout of flu. She is diagnosed with community acquired pneumonia. Her condition is deteriorating, and she is exhausted. Her pattern of breathing is very laboured, and the healthcare professional team review her condition, and the decision is to admit her to the intensive care unit, intubate and ventilate.

1. What type of respiratory failure does Sandra have?
2. How would you persuade Sandra to consent to this treatment plan?
3. What resources do you need to prepare prior to Sandra's admission to your ACCU?
4. Which members of the multidisciplinary team are required to support Sandra?

Prone Positioning

In ACCU a strategy to help improve blood oxygen levels in people who, despite high levels of ventilation, continue to have poor gas exchange in the lungs, is to turn the person to lie on their front in the prone position. This is a widely practised procedure that has become more frequently used in recent years due to its effectiveness during the COVID-19 pandemic. One piece of evidence triggering this was a landmark Randomised Controlled Trial (RCT) which showed that patients with ARDS and severe hypoxemia can benefit from prone treatment when it is used early and in relatively long sessions (Guérin et al., 2013).

Nursing people in the prone position is problematic due to the reduced access to the front of the person. There is an increased risk of the airway being dislodged and IV access being accidentally removed. It is not possible to reposition the person for pressure area relief resulting in pressure injuries, including facial sores, which, along with facial oedema, can be distressing for the relatives. Often the absorption of nasogastric feed is disrupted resulting in malnutrition. This topic is also explored in Chapter 9.

Extra Corporeal Membranous Oxygenation (ECMO)

If you are looking after a severely ill person where traditional forms of ventilation may not be adequate, you may hear an alternative to positive pressure ventilation being discussed called extracorporeal membranous oxygenation (ECMO). This is an advanced form of gas exchange to support failing lungs and heart. It is a highly specialised treatment and is only performed in selected intensive care units in the UK. There are two types of ECMO, venovenous to support failed lungs and venoarterial to support both lungs and heart.

Working on the same principles of a **cardiopulmonary bypass** machine that is used in cardiac surgery, venovenous ECMO is used in people who have a reversible, i.e. potentially curable, lung condition such as ARDS, chest trauma or severe infection, such as a Covid pneumonia. It requires the insertion of two large bore cannulas into two large veins such as the groin or neck. Deoxygenated blood is drawn from one vein, passed through an oxygenator where carbon dioxide is removed and the blood oxygenated. It is then returned to the person through the second vein.

Venoarterial ECMO works in the same way, but the main difference is that the oxygenated blood is returned to the arterial system. This method is typically used in the management of either lung or cardiac failure.

What's the Evidence? 5.6

These two papers give national guidance on the selection and administration of ECMO in adults.

NICE guidance (IPG391) on ECMO and severe acute respiratory failure in adults: www.nice.org.uk/guidance/ipg391 (accessed 27 October 2023)

and

NICE guidance (IPG482) in ECMO use for acute heart failure in adults: www.nice.org.uk/guidance/ipg482 (accessed 22 October 2023).

ECMO requires the blood to be drawn from the body into an external circulatory system, passed through an artificial oxygenator and then returned to the patient. The main complication that can arise is the development of thrombi. Consequently, people on ECMO will also receive IV anticoagulation, the dose of which is constantly monitored and adjusted accordingly. Other hazards are a leak in the circulation resulting in major blood loss and the risk of air embolism is high and needs careful monitoring and management. The care of these patients is complicated and requires the nurse to be very knowledgeable and skilled in the discipline. In very unstable patients two nurses may be deployed to look after the one patient.

As the lungs are rendered mostly useless during the process, artificial ventilation may not be required and, although unusual, in some stable patients, the patient can be awake and extubated while receiving this treatment.

In people with lung failure, discontinuation of the treatment is dependent on the recovery of the lungs, which can be judged by X-ray analysis, improvement in the compliance of the lungs and the improvement in gas exchange gained through the lung function. Withdrawal of ECMO from people who need it for lung and cardiac support is more difficult as an assessment of the recovery of both lung and cardiac function is required (NICE, 2011).

Discontinuation of Mechanical Ventilation

Ventilatory support should ideally follow a **continuum**, beginning with the initial support for respiration and hopefully ending with the ability to sustain independent spontaneous breathing (Haas and Loik, 2012). For some people the process is quick, a few hours, while other people require more time, which can be as long as several weeks. The discontinuation of mechanical ventilatory support is known as 'weaning' (Blackwood et al., 2011). Weaning should be considered as early as possible, as early liberation from mechanical ventilation has many positive effects. Once the patient is assessed as ready to commence weaning, sedation is reduced (Blackwood et al., 2011). This topic is also explored in Chapter 11.

Weaning can be an immediate move from full ventilatory support to breathing without assistance from the ventilator or a gradual reduction in the amount of ventilator support. The process of ventilatory weaning can be categorised as simple, difficult, or prolonged (Cederwall et al., 2018). Those who experience a difficult or prolonged weaning process spend longer on the mechanical ventilator and in critical care. This increased length of stay is linked to several negative outcomes including **depression**, agitation and **delirium** as well as increasing the risk of hospital-acquired infection, **sepsis** and lung damage. The weaning process should ideally be structured, and the plan clearly communicated to the person, their family and the wider clinical team. Within the evidence-base and critical care communities, there is uncertainty about the best approach to weaning. Weaning protocols have been developed which promote different methods such as a physician-driven approach, a nurse-led strategy, or a protocol-driven team approach to weaning (Smyrnios et al., 2002). The evidence supports a variety of methods which work in different ways to support a person's unique needs.

What's the Evidence? 5.7

The ideal strategies to promote timely and successful weaning from mechanical ventilation remain a research and quality improvement priority (Rose, 2015). With no consensus on the approach, reading the following articles will help you understand the different issues:

https://warwick.ac.uk/fac/sci/med/research/ctu/trials/critical/breathe (accessed 22 October 2023).

https://erj.ersjournals.com/content/29/5/1033.long (accessed 22 October 2023).

www.crd.york.ac.uk/crdweb/ShowRecord.asp?LinkFrom=OAI&ID=12001008306 (accessed 22 October 2023).

When you are working in a critical care unit, ask if you can read the weaning protocol and try to find out what evidence supports its use.

Extubation

Extubation is the term used to describe the removal of the ET tube and is a hopefully final step in the person's liberation from the ventilator. After assessment it should be clear that the person no longer requires ventilation and can maintain their airway with a good cough effort. Once this is established, the process of removing the ET tube can begin.

Activity 5.9: Research and Evidence-Based Practice

1 Look at the local practice policy on how to remove the ET tube.

There is no template answer to this activity as it differs depending on location.

Post-extubation risks

Following extubation, vigilant observation is required. Despite someone being deemed to be ready to be extubated, approximately 15% of people will need re-intubating (Thille et al., 2016).

Other common risk factors you need to be aware of are:

- Pharyngeal or laryngeal obstruction due to trauma, increased swelling and oedema
- Laryngospasm
- Bleeding
- Reduced cough and increased secretions
- Latent effect of previously given medication causing drowsiness, reducing consciousness level and subsequent risk to their ability to maintain their airway

DECANNULATION

As the person starts their recovery and becomes independent of any respiratory support their artificial airway can be removed. The term 'decannulation' refers to removing the person's tracheostomy tube and is a significant event in the person's recovery. Again, there are several different ways in which the person can be weaned from their tracheostomy and the process will be guided by the clinical condition of the individual. The person will be assessed to see if removal of the tracheostomy is appropriate and will probably undergo a period with the tracheostomy in place but with the cuff deflated. Nursing assessment of any changes to the respiratory status is vital. The tracheostomy will not be as secure with the cuff deflated and greater care is needed when assisting with movement. With the cuff deflated the person may be able to vocalise, although if this is not the case, you should reassure them that their voice will return following decannulation.

Once all the criteria for decannulation are met, then the team can carry out the procedure. As a nurse, you will need to constantly inform and reassure the person during the procedure, as they will experience discomfort. They may also experience the sensation of shortness of breath as the tracheostomy comes out.

If not already, the cuff is deflated using a 10 ml syringe. Suction will be needed via the tracheostomy tube to remove any secretions that may have been on top of the cuff and have now trickled into the trachea. It might be advisable to clean the stoma at this point. The tapes will be cut and removed; the tracheostomy will need to be temporarily supported by hand. The tracheostomy is then removed, and the stoma covered with a sterile dressing.

Activity 5.10: Theory Stop Point

1 Consider the procedure outlined above and list the equipment you think you would need to decannulate a person.
2 What assessment would you carry out before and after this procedure?

What's the Evidence? 5.8

Take a look at the St George's NHS Trust resources on tracheostomy weaning at: www.stgeorges.nhs.uk/gps-and-clinicians/clinical-resources/tracheostomy-guidelines/weaning/ (accessed 22 October 2023).

Chapter Summary

This chapter has supported your understanding of:

- The anatomy and physiology of the respiratory system
- The types of respiratory failure
- The administration of oxygen therapy
- How to read arterial blood gas analysis
- The different types of artificial airways including tracheostomy and endotracheal tubes and the nursing assessment and management
- Artificial respiration and ventilation
- The use of prone positioning in intensive care
- The process of ECMO
- The ways in which mechanical ventilation is removed

GO FURTHER

Books

Albarran, J.W. and Richardson, A. (eds) (2013) *Critical Care Manual of Clinical Procedures and Competencies*. Oxford: Wiley-Blackwell.

- This book is a manual that is aimed at all healthcare practitioners from beginners to experts. It encompasses evidence-based guidelines in all aspects of critical care practices.

Bersten, A.D. and Handy, A.M. (2018) *Oh's Intensive Care Manual* (8th edn). London: Elsevier.

- This book is one of the key texts used by all members of the multidisciplinary team working in the discipline of intensive care.

The Intensive Care Foundation (2015) *Handbook of Mechanical Ventilation: A User's Guide*. London: Intensive Care Society. Available at: https://dl.icdst.org/pdfs/files3/64490310a98c6c9ef7029b2e5cbe2c0d.pdf (accessed 22 October 2023).

- The Intensive Care Society, a multidisciplinary organisation that focuses its work on research and pioneering developments in UK critical care, publishes this guide.

Journal Articles

National Confidential Enquiry into Patient Outcome and Death (NCEPOD) (2014) *On the Right Trach? A Review of the Care Received by Patients who Underwent a Tracheostomy*. London: NCEPOD. Available at: www.ncepod.org.uk/2014tc.html (accessed 22 October 2023).

National Tracheostomy Safety Project (2013) *NTSP Manual 2013*. Available at: www.tracheostomy.org.uk/storage/files/Comprehensive%20Tracheostomy%20Care.pdf (accessed 22 October 2023).

- These two publications, NCEPOD and NTSP, related to tracheostomy care, are required reading for those who may care for a person who has a tracheostomy. These texts report the causes of avoidable complications associated with tracheostomy care and provides guidance for future practice to prevent these complications and enhance care.

Boles, J.-M., Bion, J., Connors, M., Herridge, M., Marsh, B., Melot, C. […] and Welte, T. (2007) 'Weaning from mechanical ventilation', *European Respiratory Journal*, 29: 1033–56. doi.org/10.1183/09031936.00010206

- This paper provides guidance on strategies for weaning from ventilation.

Useful Websites

British Medical Journal Best Practice (2020) *Acute Respiratory Distress Syndrome (ARDS)*: https://bestpractice.bmj.com/topics/en-gb/374 (accessed 22 October 2023).

- This website gives an overview of acute respiratory distress syndrome which is the major condition that requires artificial ventilation in critical care.

European Federation of Critical Care Nursing Associations (2020) *Ventilation*: www.efccna.org/clinical-practice/info-clinical-practice?id=178 (accessed 22 October 2023).

- This website has guidelines for nurses across the European Union on artificial ventilation in critical care.

Intensive Care Society (2020) *ICS Standards and Guidelines*: https://ics.ac.uk/guidance.html (accessed 22 October 2023).

- This website has up-to-date clinical guidelines and professional standards for the multi-professional body working in intensive care.

REFERENCES

Ahmed, R.A. and Boyer, T.J. (2023) *Endotracheal Tube*. Available at: www.ncbi.nlm.nih.gov/books/NBK539747/ (accessed 20 October 2023).

Andrews, T. and Steen, C. (2013) 'A review of oral preventative strategies to reduce ventilator-associated pneumonia', *Nursing in Critical Care*, 18 (3): 116–22. doi.org/10.1111/nicc.12002

Ashelford, S., Raynsford, J. and Taylor, V. (2019) *Pathophysiology and Pharmacology in Nursing* (2nd edn). London: Sage.

Blackwood, B., Alderdice, F., Burns, K., Cardwell, C., Lavery, G. and O'Halloran, P. (2011) 'Use of weaning protocols for reducing duration of mechanical ventilation in critically ill adult patients: Cochrane systematic review and meta-analysis', *BMJ*, 342: c7237.

Brinkman, J.E. and Sandeep, S. (2018) *Respiratory Alkalosis*. Available at: www.ncbi.nlm.nih.gov/books/NBK482117/ (accessed 22 October 2023).

Cederwall, C.J., Olausson, S., Rose, L., Naredi, S. and Ringdal, M. (2018) 'Person-centred care during prolonged weaning from mechanical ventilation, nurses' views: An interview study', *Intensive and Critical Care Nursing*, 46: 32–7. doi.org/10.1016/j.iccn.2017.11.004

Cohen, B.J. and Hull, K.L. (2015) *The Human Body in Health and Disease* (13th edn). London: Wolters Kluwer.

Cook, N., Shepherd, A. and Boore, J. (2021) *Essentials of Anatomy and Physiology for Nursing Practice* (2nd edn). London: Sage.

Dougherty, L. and Lister, S. (2008) *The Royal Marsden Hospital Manual of Clinical Nursing Procedures* (7th edn). Oxford: Blackwell Publishing.

Faculty of Intensive Care Medicine (2019) *Invasive Procedure Safety Checklist: NG Tube Insertion*. Available at: www.ficm.ac.uk/sites/ficm/files/documents/2021-10/safety_checklist_-_ng_tube_insertion_-_final_0.pdf (accessed 22 October 2023).

Freeman, S. (2011) 'Standards for the care of adult patients with a temporary tracheostomy', *Nursing Standard*, 26 (2): 49–56. doi.org/10.7748/ns2011.09.26.2.49.c8706

Freeman, S., Steen, C. and Bleakley, G. (2019) 'Caring for the critically ill adult', in D. Burns (ed.), *Foundations of Adult Nursing*. London: Sage. pp. 404–32.

Guérin, C., Reignier, J., Richard, J.-C., Beuret, P., Gacouin, A., Boulain, T. [. . .] and PROSEVA Study Group (2013) 'Prone positioning in severe acute respiratory distress syndrome', *New England Journal of Medicine*, 368 (23): 2159–68. doi: 10.1056/NEJMoa1214103

Haas, C.F. and Loik, P.S. (2012) 'Ventilator discontinuation protocols', *Respiratory Care*, 57 (10): 1649–62. Available at: http://rc.rcjournal.com/content/57/10/1649 (accessed 22 October 2023).

Hellyer, T.P., Ewan, V., Wilson, P. and Simpson, A.J. (2016) 'The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia', *Journal of the Intensive Care Society*, 17(3): 238–43. doi: 10.1177/1751143716644461

Intensive Care Society (ICS) (2014) *Standards for the Care of Adult Patients with a Temporary Tracheostomy*. London: The Intensive Care Society. Available at: ICS-Tracheostomy-Standards-2014 (1).pdf (accessed 06 November 2024).

Intensive Care Society (ICS) (2020) *Guidance for Tracheostomy Care*. London: The Intensive Care Society. Available at: www.ficm.ac.uk/sites/ficm/files/documents/2021-11/2020-08%20Tracheostomy_care_guidance_Final.pdf (accessed 22 October 2023).

Mallett, J., Albarran, J.W. and Richardson, A. (eds) (2013) *Critical Care Manual of Clinical Procedures and Competencies*. Oxford: Wiley Blackwell.

Myatt, R. (2015) 'Nursing care of patients with a temporary tracheostomy', *Nursing Standard*, 29 (26): 42–9.

National Confidential Enquiry into Patient Outcome and Death (NCEPOD) (2014) *On the Right Trach? A Review of the Care Received by Patients who Underwent a Tracheostomy*. London: NCEPOD. Available at: www.ncepod.org.uk/2014tc.html (accessed 22 October 2023).

National Tracheostomy Safety Project (NTSP) (2013) *NTSP Manual 2013*. Available at: www.tracheostomy.org.uk/storage/files/Comprehensive%20Tracheostomy%20Care.pdf (accessed 22 October 2023).

NICE (2011) *Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Failure in Adults* (Interventional Procedures Guidance 391). London: NICE. Available at: www.nice.org.uk/guidance/ipg391 (accessed 22 October 2023).

O'Driscoll, B.R., Howard, L.S., Earis, J. and Mak, V. (2017) 'BTS guideline for oxygen use in adults in healthcare and emergency settings', *Thorax*, 72: i1–i90. doi.org/10.1136/thoraxjnl-2016-209729

Resuscitation Council UK (RCUK) (2021) *Resuscitation Guidelines*. Available at: www.resus.org.uk/library/2015-resuscitation-guidelines (accessed 22 October 2023).

Rose, L. (2015) 'Strategies for weaning from mechanical ventilation: A state of the art review', *Intensive and Critical Care Nursing*, 31 (4): 189–95.

Smyrnios, N.A., Connolly, A., Wilson, M.M., Curley, F.J., French, C.T., Heard, S.O., Stephen, O. and Irwin, A. (2002) 'Effects of a multifaceted, multidisciplinary, hospital-wide quality improvement program on weaning from mechanical ventilation', *Critical Care Medicine*, 30: 1224–30.

Sole, M.L., Xiaogang, S., Talbert, S., Penoyer, D.A., Kalite, S., Jimenez, E., Ludy, J.E. and Bennett, M. (2011) 'Evaluation of an intervention to maintain endotracheal tube cuff pressure within therapeutic range,' *American Journal of Critical Care*, 20 (2): 109–18.

Thille, A.W., Boissier, F., Ben-Ghezala, H., Razazi, K., Mekontso-Dessap, A., Brun-Buisson, C. and Brochard, L. (2016) 'Easily identified at-risk patients for extubation failure may benefit from noninvasive ventilation: A prospective before-after study', *Critical Care*, 20 (1): 1–8.

Tortora, G.J. and Derrickson, B. (2016) *Principles of Anatomy and Physiology*, Volume 2 (15th edn). Singapore: Wiley and Sons.

Waugh, A. and Grant, A. (2018) *Anatomy and Physiology* (13th edn). London: Elsevier.