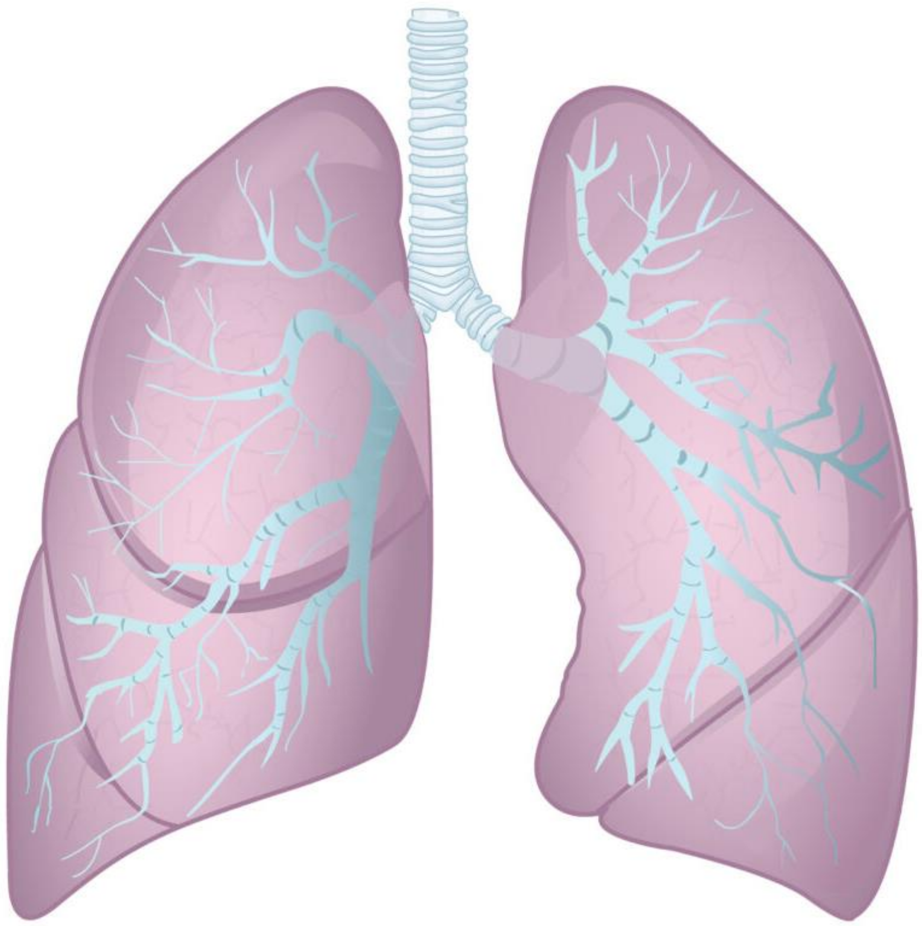
Sheffield Teaching Hospitals NHS Trust

CRITICAL CARE DIRECTORATE

Supporting Staff Nurse Step Competencies

Respiratory Guide

including Ventilation and Non-ventilation Information



Version Three - Written by:

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Introduction

The purpose of this document is to provide entry level and refresher information on respiratory support provided in general critical care and to outline some key principles relating to ventilation. This document is not intended to be a comprehensive guide to ventilation and is designed to be used in conjunction with other educative resources and guidelines that are available.

Other Resources can include….

-Taught Induction Day One PowerPoint on Respiratory. Accessible on Learning Zone.

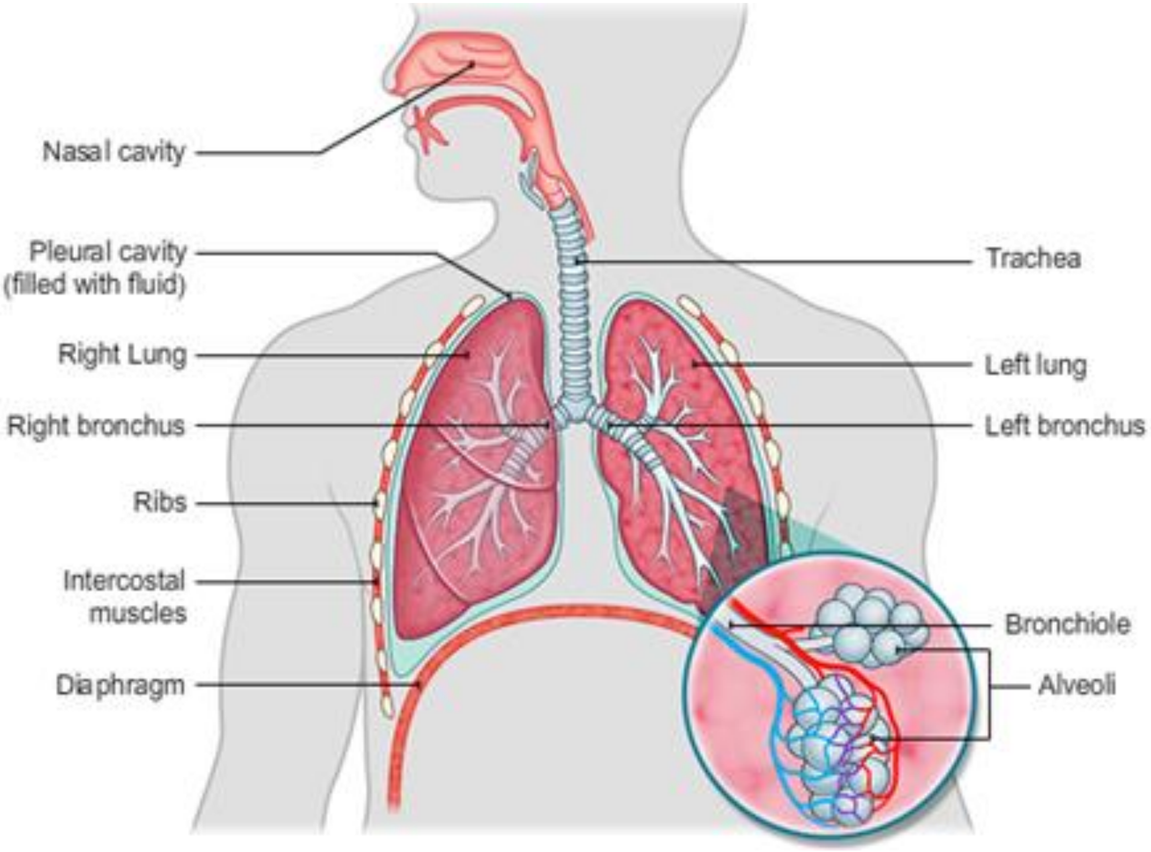
-Greater Manchester Critical Care Skills Institute Anatomy and Physiology Workbook.

-Resources under the ‘Respiratory System’, found on Learning Zone by clicking on ‘Clinical Information’.

Principles of Normal Breathing and Respiration

In normal breathing and respiration:

- Air is warmed, moistened and filtered as it travels through the **mouth** and **nasal passages**.
- It then passes through the trachea, which then divides into the left and right **main bronchus**. The two main bronchus then branch off into smaller and smaller bronchioles.
- After passing into the many **bronchioles**, it finally arrives at some of the millions of tiny sacs called **alveoli**.
- This is where gas exchange takes place - **oxygen** passes out of the air into the blood, and **carbon dioxide** passes out of the blood into the air in the alveoli.

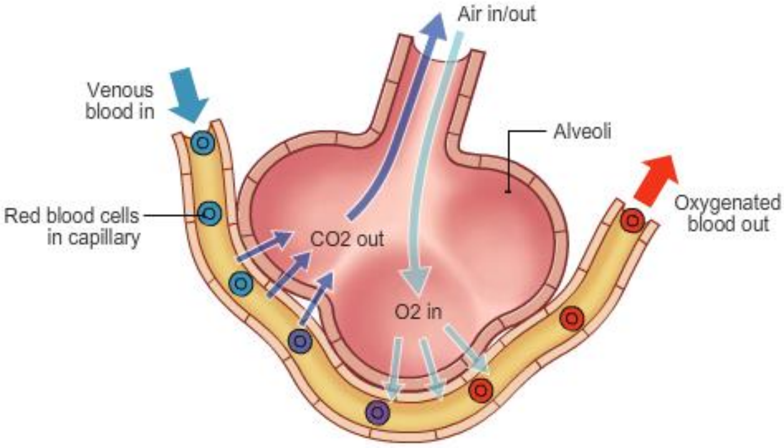


Gas exchange takes place by **diffusion** in the alveoli within the lungs (alveoli are highly elastic).

Diffusion is where particles move from a region where they are in high concentration to a region where they are in low concentration.

Through the process of diffusion, **oxygen** moves from the alveoli to the blood through the capillaries and **binds to haemoglobin**. This oxygen rich blood flows back to the heart, which pumps it through the arteries to organs and tissues.

Simultaneously **carbon dioxide**, (which has been excreted from tissues), passes into the alveoli through the process of diffusion to be exhaled.

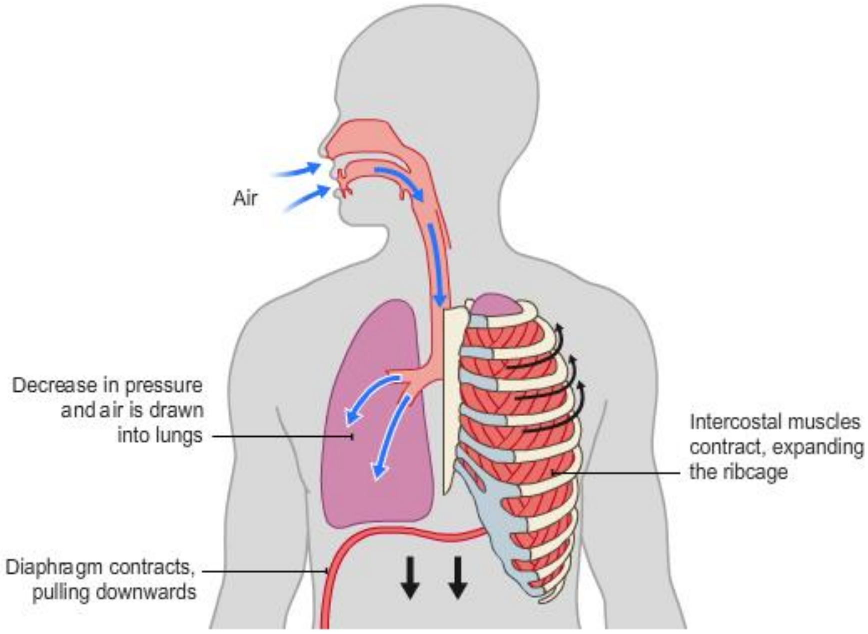


The diffusion process at the alveoli-capillaries will continue to occur, provided there is a concentration gradient.

The Diaphragm is the main respiratory muscle. Electrical impulses are generated from the respiratory centre which stimulates muscle contraction.

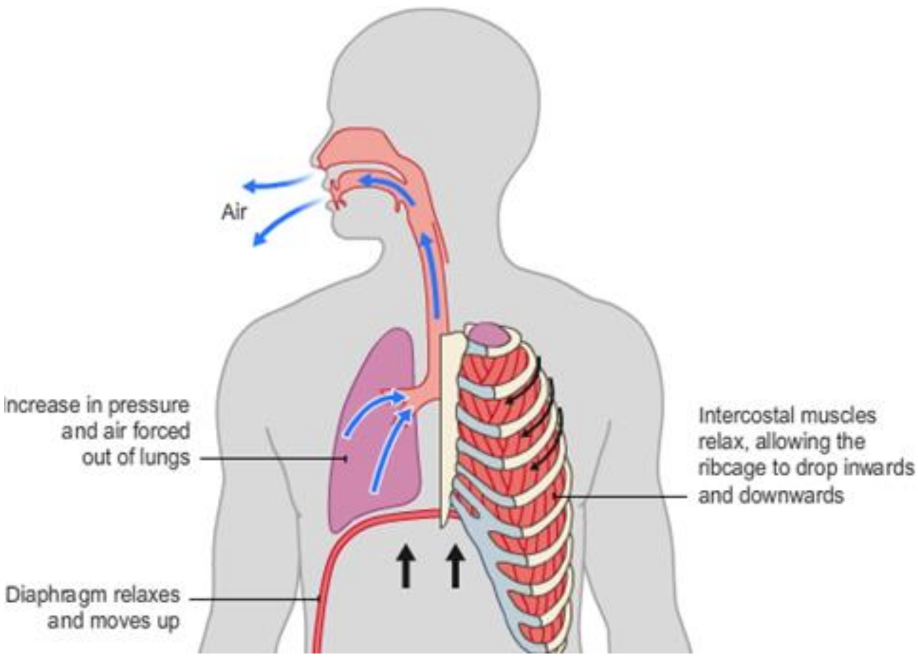
Inspiration:

- The **intercostal muscles** contract, expanding the ribcage.
- The **diaphragm** contracts, pulling downwards to increase the volume of the chest.
- This creates a negative pressure and air is sucked into the lungs.



Exhalation:

- The **intercostal muscles** relax, the ribcage drops inwards and downwards.
- The **diaphragm** relaxes, moving back upwards, decreasing the volume of the chest.
- This creates positive pressure and air is forced out.



Respiratory Failure

All patients requiring respiratory support have some degree of respiratory failure.

Type One Respiratory Failure

Low PaO2

Normal or Low PaCO2

Type One Respiratory Failure (T1RF)

-Occurs when there is a problem with oxygenation.
-Can occur for many reasons including ventilation/perfusion mismatch within the lungs, leading to a reduction in oxygen diffusion.
-Patients present with low saturations and low PaO^2.
-CO^2 may be normal or low due to increased respiratory rate.

<u>Common Causes:</u>

-Pneumonia
-Collapsed lung
-Pulmonary Oedema
-Pulmonary Embolus (PE)

Type Two Respiratory Failure

Normal or Low PaO2

High PaCO2

Type Two Respiratory Failure (T2RF)

-Occurs when patients retain carbon dioxide (CO^2).
-Patients may or may not be hypoxic.
-Often patients may present with T1RF, then become tired due to increased work of breathing, resulting in T2RF.

<u>Common Causes:</u>

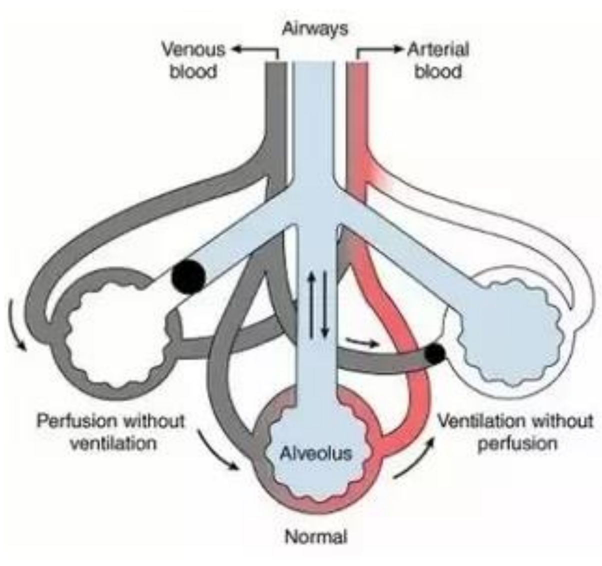
-Respiratory depression (↓RR = Reduced amount of exhaled CO^2)
-Acute exacerbation of COPD (Often related to infection)
-Acute Neuromuscular disease (e.g. Guillan-Barre Syndrome)

V/Q Mismatch

-Ventilation (V) is the air reaching the alveoli and Perfusion (Q) is the blood reaching the alveoli via the capillaries. Changes to either V or Q will affect the ratio and ultimately affect gaseous exchange.

<u>How could V or Q be impacted?</u>

-Sputum load (V)
-Collapse (V)
-Pulmonary Oedema (V/Q)
-PEs (Q)



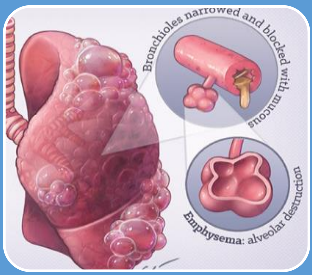
-Both of these variables can be changed with positioning and the load on the chest.

-Ventilation (V) can be impacted depending on the patients position as certain positions (e.g. proning) would open the air spaces and 'recruit' more of them leading to improved ventilation. Likewise, if the patient had a lot of secretions, postural drainage (side lying) can help improve ventilation.

-Perfusion (Q) can be impacted as the distribution of blood flow in the lung is gravity dependent. This means the base has better perfusion than the apex. However, if you put the patient in a prone position then the blood will pool at the front of the lung and therefore would only provide limited perfusion.

Respiratory Conditions

COPD



- Chronic obstructive pulmonary disease is the name for a group of lung conditions that cause breathing difficulties and happens when the lungs become inflamed, damaged and narrowed.
- It includes: emphysema (damage to the air sacs in the lungs) and chronic bronchitis (long-term inflammation of the airways).
- Symptoms: shortness of breath, particularly when you're active, a persistent chesty cough, frequent chest infections and persistent wheezing.
- Treatments: Stopping smoking | Inhalors and medications for symptom relief | Pulmonary rehabilitation | In severe and special cases, lung transplant.

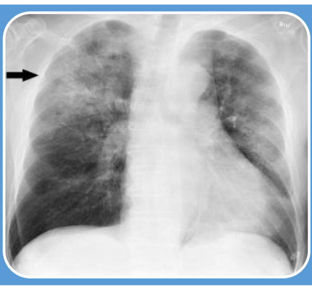
Asthma

- Asthma is a common lung condition that causes occasional breathing difficulties and affects people of all ages.
- In critical care, we usually see patients whos asthma has been exacerbated and require bronchodilators and close monitoring. They are difficult to ventilate due to bronchospams.
- Symptoms: A whistling sound when breathing (wheezing) | Breathlessness | A tight chest, which may feel like a band is tightening around it | Coughing.
- Treatments: Reliever inhalers (used when needed to quickly relieve asthma symptoms for a short time) | Preventer inhalers (used every day to prevent asthma symptoms happening) | Steroids | Oxygen | Cause.

Acute Respiratory Distress Syndrome (ARDS)

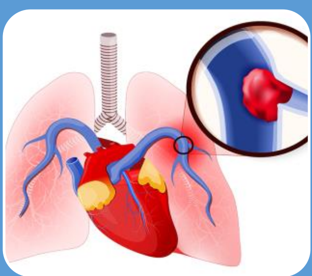
- ARDS is an acute, diffuse, inflammatory form of lung injury and life-threatening condition in seriously ill patients, characterized by poor oxygenation, pulmonary infiltrates, and acute onset.
- In ARDS, fluid builds up inside the tiny air sacs of the lungs, and surfactant breaks down. Surfactant is a foamy substance made by your body that keeps your lungs fully expanded so you can breathe. The fluid buildup and lack of surfactant that happen because of ARDS prevent the lungs from properly filling with air and moving enough oxygen into the bloodstream and throughout the body. The lung tissue may scar and become stiff.
- Symptoms: Shortness of breath | low blood oxygen | rapid breathing | bubbling or rattling sounds in the lungs when breathing.
- Treatments: Oxygenation | Usually mechanical ventilation | Lung protective ventilation | Proning | Potentially diuretics / fluid management.

Pneumonia / VAP



- Infection that inflames the air sacs in either one or both lungs.
- Pneumonia is usually caused by infection with viruses or bacteria.
- Symptoms: Producive or dry cough | Shortness of Breath | Fatigue | Pyrexia | Hypoxia.
- Treatments: Oxygen therapy | Antibiotics (if bacterial) | Analgesia | Steroids | Fluids.

Pulmonary Embolism (PE)



- A pulmonary embolism is a sudden blockage in your pulmonary arteries, the blood vessels that send blood to your lungs.
- It usually happens when a blood clot in the deep veins in your leg breaks off and travels to your lungs. A blood clot that travels to another part of your body is called an embolus.
- Critical care patients are at extremely high risk of developing blood clots due to immobility.
- Symptoms: Signs of DVT (redness or swelling to calf) | Sudden shortness of breath | Chest pain | Coughing up blood.
- Preventative measures: Mechanical prophylaxis (Flotrons or TEDs) | Chemical prophylaxis (Dalteparin).
- Treatments: Anticoagulation (Treatment Dalteparin / Heparin) | Analgesia.

Oxygen Therapy

-Delivery of supplemental oxygen to treat hypoxia.
-Atmospheric Air equals 21% Oxygen.

-Indications (Including diseases which interfere with lungs ability to properly absorb oxygen):

Not enough oxygen	Pneumonia	COPD	Asthma	Sleep Apnea	Emphysema

Blood problems: Anemia	Heart Failure	Pulmonary Embolism

-Potential Complications:

Dry or bloody nose	Tiredness	Headaches	Fire Risk	Oxygen Toxicity	Pressure damage from delivery devices

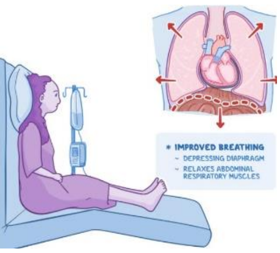
Oxygen Toxicity

-Lung damage that happens from breathing in too much extra (supplemental) oxygen.
-The clinical settings in which oxygen toxicity occurs are predominantly divided into two groups; one in which the patient is exposed to very high concentrations of oxygen for a short duration, and the second where the patient is exposed to lower concentrations of oxygen but for a longer duration.
-Can cause oxidative damage to cell membranes leading to the collapse of the alveoli in the lungs.
Signs and symptoms:
Coughing | Throat irritation | Chest pain | Dizziness | Blurred vision | Nausea | Confusion | Seizures.

Interventions and Monitoring to Help Oxygen Delivery

Humidification

-Humidification plays an important role in respiration. The nose aids cleaning, warming and humidifying the inhaled air.
-If the air we breathe does not pass through the nose, then the lower airways are at risk of drying. This would make the respiratory tract more prone to infection and bronchospasm.
-This is why we humidify almost all of our oxygen therapies within critical care.



Patient Positioning

-Both sitting up and prone positions provide beneficial impact on the respiratory mechanics of mechanically ventilated patients.
-If the patient is awake, if able, they benefit from sitting in a chair for lung expansion.

Effective Coughing

-Coughing is an important reflex that helps protect your airway and lungs against irritants.

Pulse Oximetry

-Non-invasive monitoring technique that measures the oxygen saturation in the blood by shining light at specific wavelengths through tissue, most commonly the fingernail bed.
-It measures the saturation of oxygen carried in your red blood cells. Normal >94%.
Limitations: Poor circulation | Skin pigmentation | Skin thickness | Skin temperature | Tobacco use | fingernail polish.

Oxygen Therapies on Critical Care

Escalation of Oxygen Therapies…

Nasal Cannula → Basic Face Mask with Venturi or Low Flow Oxygen → Non-Rebreathe Face Mask → High Flow Oxygen (Via FM or Nasal Specs) → NIV: CPAP (Via Hood or Tight fitting FM) → NIV: Non-Invasive Ventilation with Pressure Support → Invasive Ventilation

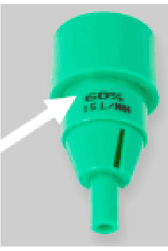
Oxygen Litres per Minute	Approximate FiO2 %
1 L	24%
2 L	28%
3 L	32%
4 L	36%

Low Flow Oxygen

-Low flow oxygen can be delivered via several different devices including a nasal cannula, a face mask with a venturi valve, a face mask connected to an aquamist humidification adapter or via the FD140. For oxygen delivery to count as ‘low flow’, the flow rate must be <15L.


Nasal Cannula

-A traditional nasal cannula can only effectively provide up to 4 litres per minute of supplemental oxygen. Above this number, nasal mucosal irritation occurs with the drying of the passages, and there is, therefore, an increased potential for bleeding with prolonged use.



-It is not often used in critical care, however there is an option to esculate oxygen therapy from a nasal cannula to a face mask with a venturi valve. Each valve is a different colour and can deliver a different concentration of oxygen therapy; this value can be found on the venturi valve device (as shown in the adjacent image). It also indicates how many L/min to put the patient on at the wall. When documenting this, always record the oxygen percentage, rather than the flow rate.


Venturi Valves and Mask

-Low Flow oxygen therapy can also be delivered via a cold humidified device which uses an aquamist humidification adapter, a bottle of sterile water, elephant tubing and a normal face mask (See adjacent image). This is the most used low flow oxygen therapy in critical care, if the patient has not required escalation using the FD140.

-The FD140 (to be discussed in following pages) can deliver low flow oxygen up to 100%, using the purple humidified circuit and a face mask. Remember, for this to count as ‘low flow’, the flow rate must be <15L.

High Flow Oxygen (HFO)

-High Flow Oxygen Therapy is the next escalation following low flow oxygen therapy. This is usually used alongside CPAP/NIV-PS therapy which will be discussed in following pages.

-High-flow oxygen therapy can deliver up to 100% humidified and heated oxygen at a flow rate of up to 60L/min. It reduces heat and moisture loss from the airway, reduces anatomical dead space, reduces work of breathing, washes out CO2 and potentially provides small amounts of PEEP, thus improving oxygenation.

-High Flow Oxygen therapy is delivered using the FD140 Purple machine and can be delivered via a face mask (HFO) or a specific high flow wide-bore nasal prong (HFNO).

-When starting a patient on HFNO, always start at a reduced flow rate (e.g. 20L) and build up as the patient becomes more tolerant. Weaning high-flow oxygen therapy is subjective and patient dependent, it is worth attempting to start reducing flow rate once FiO2 ≤ 40%.

Indications for HFO Therapy:

(Please be mindful this is a guide and clinical conditions change and may require changing oxygen therapies).
(Efforts should be made to promote compliance if CPAP or NIV-PS are clinically indicated).

- Weaning from CPAP/NIV-PS
- Breaks from CPAP/NIV-PS Therapy
- Patients not tolerating CPAP or NIV-PS Therapy

Contra-Indications for HFO Therapy via Nasal Prongs:

- Nasal Trauma
- Complex fractures posterior to the nose
- Epistaxis

Non-Invasive Ventilation (NIV)

Non-Invasive ventilation is an umbrella term which refers to the provision of ventilatory support through the patient's upper airway using a mask or similar device. In terms of NIV Oxygen therapies, we provide Continuous Positive Airway Pressure (CPAP) (via the FD140) predominantly for those patients suffering from T1RF, and NIV-PS (Via Macquet Ventilator) predominantly for those patients suffering from T2RF.

Indications for NIV Therapy

(Colour Key: Predominantly requires CPAP / Predominantly requires NIV-PS).
(Please be mindful this is a guide and clinical conditions change and may require changing oxygen therapies).

Prevention of deterioration to invasive ventilation	Pulmonary Oedema	Post-Operative Care	Chest Trauma
Acute Hypercapnic Respiratory Failure	Alternative to invasive ventilation	Spinal Cord Injury	Asthma* (*Medical management dependent on patient condition. CPAP IF required but be concious of intristic PEEP)
Obesity Hypoventilation	Obstructive Sleep Apnea	Neuromuscular Disease	Acute Exacerbation of COPD

Contraindications for NIV Therapy

(Colour Key: Absolute Contraindication / Relative Contraindication / Use with Caution).

Undrained Pneumothroax	Facial Burns / Trauma	Severe Facial deformity	Fixed upper airway obstruction	Cardiac / Respiratory Arrest
GCS <8	Severe Agitation / Confusion	Haemodynamic Instability	Upper GI Bleed	Vomiting
Post Operative Restrictions	Uncontrolled Bronchospasm	Severe Hypoxia	Sedation required to facilitate	

Continuous Positive Airway Pressure (CPAP)

-CPAP uses flow/air and PEEP to keep the airways open and maintain positive pressure throughout.

-This positive pressure keeps the alveoli open for gas exchange at end expiration.

Main Indications:

-Acute hypoxemic respiratory failure without hypercapnia

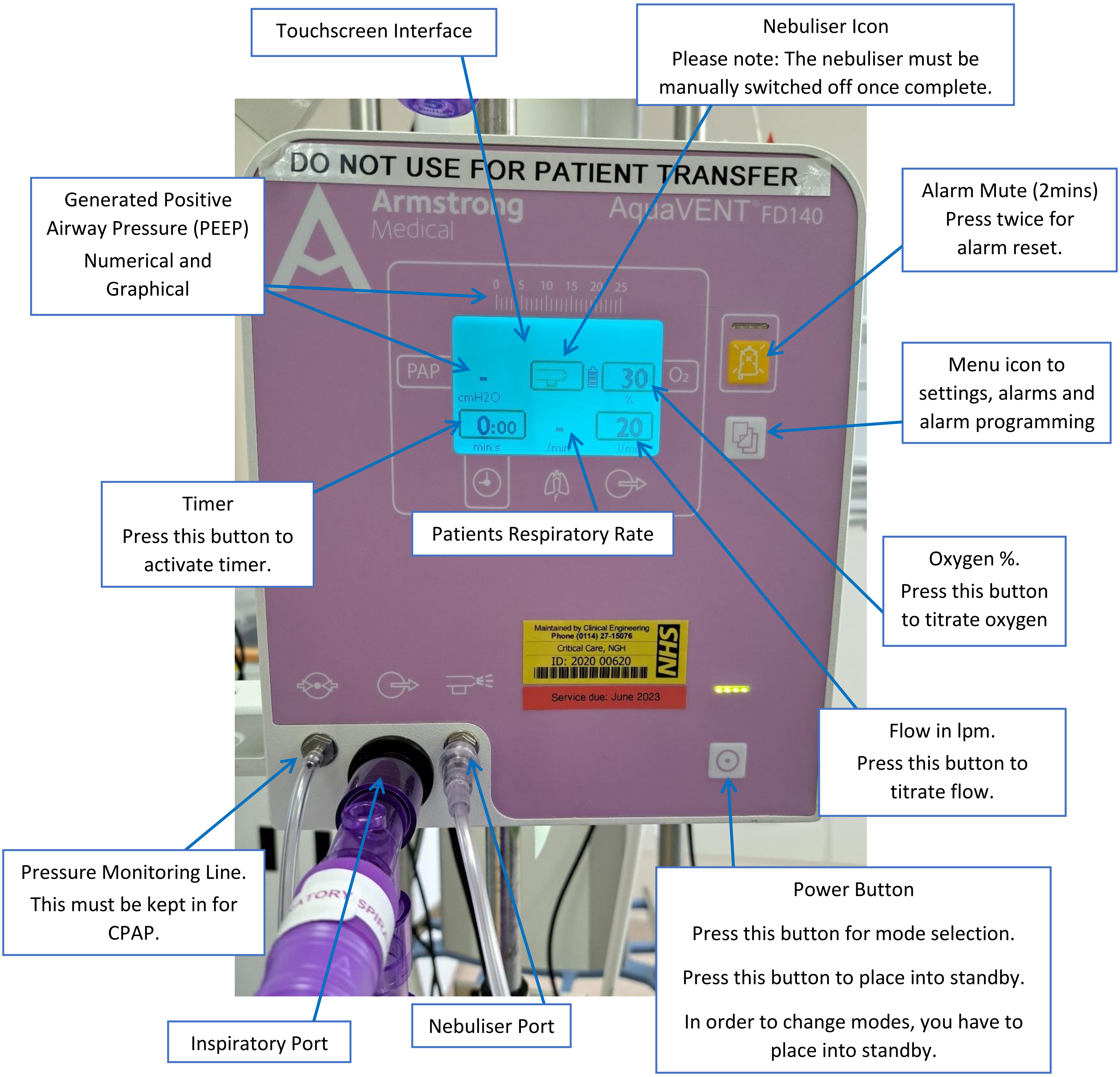
-Weaning from mechanical ventilation

-Pulmonary Oedema

We use the Armstrong AquaVENT FD140 for High Flow Oxygen (HFO), High Flow Nasal Oxygen (HFNO) and Continuous Positive Airway Pressure (CPAP). Please see the guide below for set-up.

Armstrong AquaVENT FD140

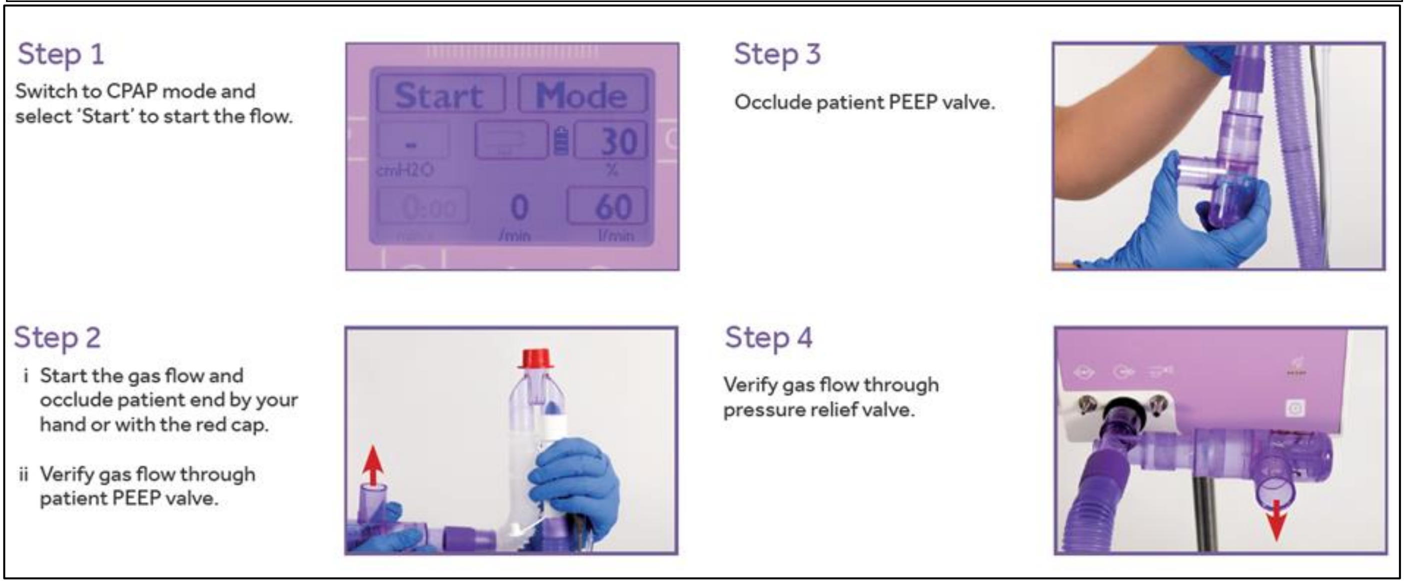
Please see image below which indicates key parts of the FD140 machine.



Settings and Equipment for the Different Modes for the FD140

PRIOR TO USE

Perform **GAS FLOW VERIFICATION.** This tests the performance of the pressure relief PEEP valve and the PEEP valve being used for patient treatment.
Follow steps 1 to 4 in the pictures below.
Once gas flow verification complete, place in STANDBY.



FD140 Basic Set-Up

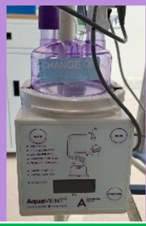
-Ensure plugged into mains power.

-FD140 should not be used for transporting patients as not all the FD140 have battery back-up!

Turn FD140 on; There should be two beeps, this is the initial self-test. If you only hear one beep the volume has been turned off and must be turned back on.
Select which interface is required and associated equipment (See table on next page).
Select appropriate Mode: **HFOT (light blue) / CPAP (magenta) / CPAP HELMET (yellow).**
If using NFO/HFNO/CPAP mode then activate humidifier on 'non-invasive' mode and ensure sterile water connected.
If using HELMET mode (CPAP Hood) then humidifier must remain switched off. Sterile water may remain connected.
Select starting gas. -HFNO – 20lpm, titrating up to 60lpm. -HFO/CPAP/HELMET - 70 lpm, titrating to achieve PEEP.
Select O_2 %.
Set the following alarm settings: -Alarm volume 70% -Apnoea 20 sec -F_{max} off -P_{max} 7 above patient PEEP valve -P_{min} 3 below patient PEEP valve
Start therapy and connect to patient.
Adjust flow rate to ensure required PEEP level is being achieved. Seek expert help if unsure about flow adjustment.

<u>Equipment Required for Different Modes</u>

(Green: Required / Red: Not Required).

	End-Piece	20 cmH_2O Safety PEEP Valve 	Y-Piece with Expiratory Limb 	Humidifier 	PEEP Valve 
High Flow Oxygen via Facemask (HFO)	Facial or tracheostomy oxygen mask	(Green)	(Red)	(Green)	(Red)
High Flow Nasal Oxygen (HFNO)	High Flow Nasal Specs	(Green)	(Red)	(Green)	(Red)
CPAP via Hood	CPAP Hood	(Green)	(Red)	(Red)	(Green)
CPAP via Facemask	CPAP Mask or FaceShield	(Green)	(Green)	(Green)	(Green)
CPAP via Tracheostomy (External CPAP)	Closed-circuit Tracheal suction.	(Green)	(Green)	(Green)	(Green)

Please Note…

-As O2 % level is increased from 21% towards 100%, the maximum flow rate that is possible to deliver reduces from 140lpm to 80lpm.

-Monitor peak airway pressure (PAP) value.

- The average PAP is a useful guide to achievement of prescribed CPAP therapy.
- If concerned about achieving appropriate PAP or concern over inadequacy of flow, seek expert help immediately.
- Pressure alarms can be caused by patient coughing or talking but always check for leakage and adequate flow.
- Pressure alarms may need small adjustments if there are spurious alarms that cannot be corrected by correcting leaks or adjusting flow. Seek advice if unsure.

-Check patient connection is satisfactory e.g. mask fit or tracheostomy connection.

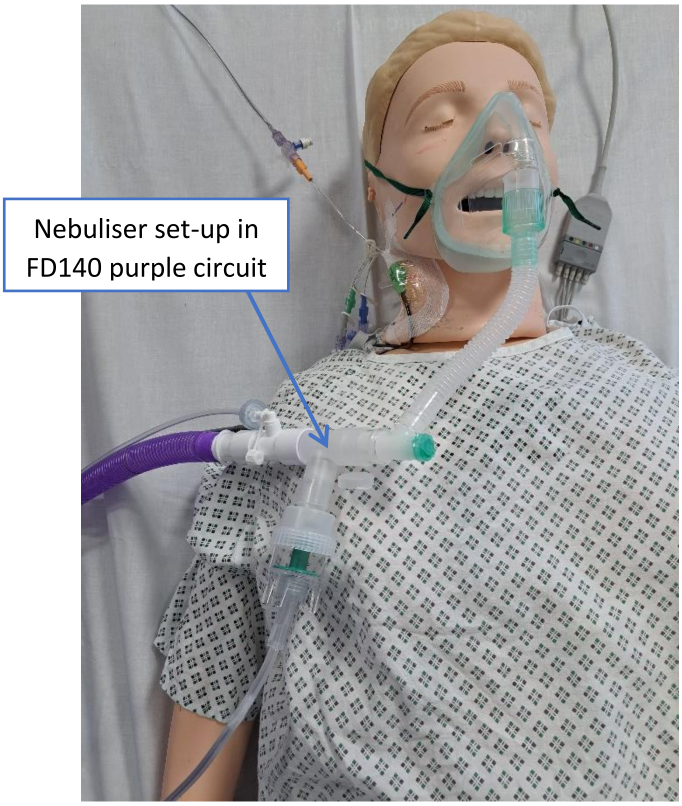
-**<u>Check pressure areas</u>** relevant to interface being used. This includes, nose/nares, top/behind ears, back of head (where CPAP straps sit), and neck (CPAP Hood).

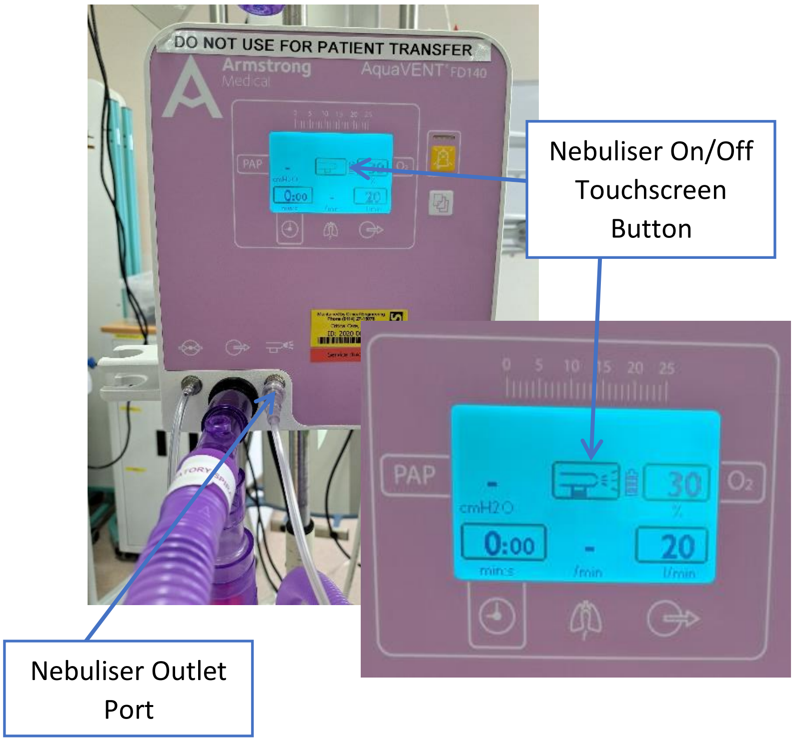
-If your patient is on a significant amount of support and as a result is unable to remove oxygen therapy, please document this! Although we would rather prevent a pressure sore, oxygen therapy of this kind is the priority and is lifesaving!

NEBULISER THERAPY

- The FD140 has a nebuliser function. This cannot be used in HELMET mode.
- If patient is on HFNO then you will need to replace the nasal cannula with an O2 facemask.
- If the patient is using a full-Face Shield for CPAP therapy, this will need to be change to either an O2 facemask or standard CPAP facemask.

Attach nebuliser tubing to nebuliser outlet port.
The FD140 adds 6lpm of air to drive the nebuliser. The nebuliser function cannot be activated if the patient requires a very high FiO2.
During nebuliser, the use of O2 % measurement and O2 alarms are disabled. The FD140 will still calculate the O2 % delivered as an approximate guide.
Administer nebuliser using normal oxygen mask, CPAP facemask or via tracheostomy T-piece.





FD140 Equipment Information:

-Bact-trap filter should be changed every 24 hours.

-Circuit should be dated and changed every 7 days; if the circuit has been previously used then stood without being used for 24 hours, then the circuit should be changed before re-use.

-The filter between the expiratory limb and PEEP valve can increase the generated PAP which may necessitate modifying the high PEEP alarm limit.

-The FD140 nebuliser function does not have a timer and so will not switch itself off.

-Always seek advice if unsure.

-There is a set up video on E-learning zone for more information.

Managing the Armstrong FD140

Top Tips

General points

- Make sure you have the correct mode for the chosen therapy. The window on the **FD140** is colour coded as per critical care interim guideline
- It's really important to titrate your patients oxygen and flow in order optimise therapy
- Remember higher flow rates reduce the amount of available oxygen i.e. 140lpm can only give 60% oxygen
- Giving oxygen in high percentages reduces the amount of flow available i.e. 100% oxygen can only be given with maximum flow 80lpm
- Monitor the flow to ensure the patient is getting the right amount of **PEEP.** Visually check that the PEEP valve is oscillating but not closing
- If you are overachieving the required positive airway pressure (**PAP**) there is scope to reduce the flow
- If you are underachieving the required **PAP** there scope to increase the flow
- Filters between the expiratory limb and peep valve can increase the generated PAP which may necessitate modifying the high peep alarm limit

CPAP

- Make sure the pressure monitoring line is connected to the device at all times as this measures the amount of PAP being delivered and avoids alarm activation

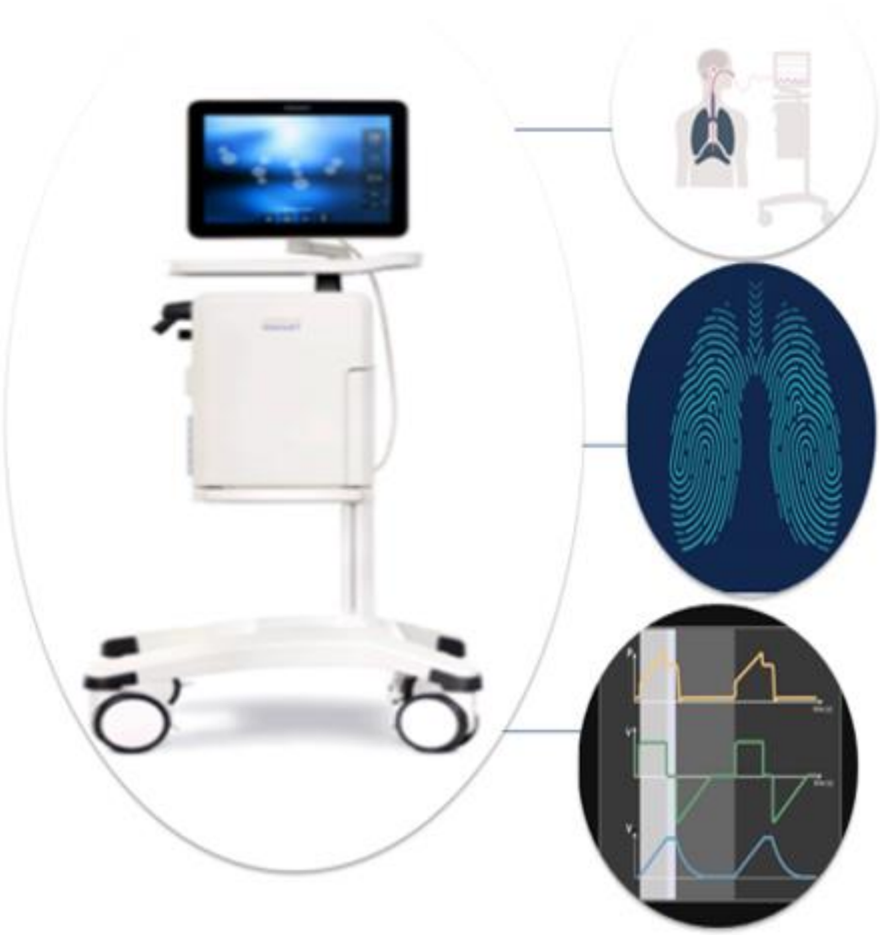
- When using mask **CPAP** be mindful of the fact you will need to get a good seal in order to avoid a low pressure alarm (this can be difficult in patients with NG tubes)

Nasal high flow

- Set flow at 20 litres per minute and O_2% as needed, leave running for 2 minutes to allow circuit to warm.

- Gradually titrate the flow up as tolerated. Aim for a flow rate of 45-60 lpm according to patient comfort /tolerance (NB: humidification must be used)

Maquet (Servo-U) Basic Training and Help Guide



Ventilator/Ventilation Training QR Codes

Maquet Servo-U Set Up	Modes of Ventilation – Module 1	Modes of Ventilation – Module 2

Maquet Ventilator Set-up

Please see QR code on previous page and photo's below.

Expiry dates of tubing

-7 days

-Label the circuit with a change on sticker (date and initials of the person setting it up).

-If a used circuit has not been used for 24 hours please remove

Expiry dates of expiratory filter

-24 hours on squire filter

-48 hours on round filter

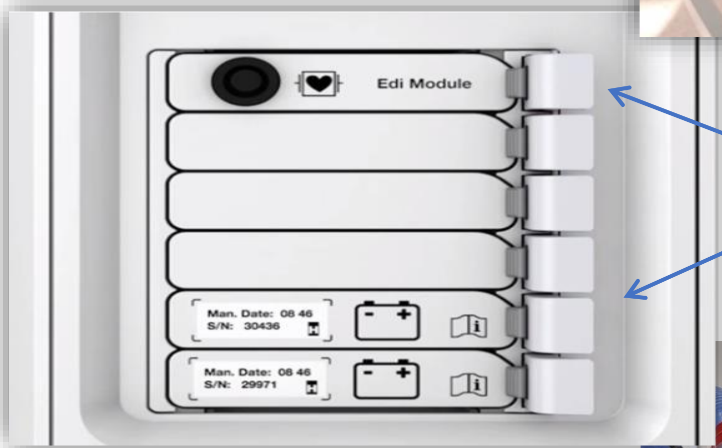
Expiry date of C02 monitoring

-Mindray lines 3 days (label line as part of your safety checks).

-Line should be facing upwards to ensure accurate reading.

-May need changing before if excessively wet.

Connecting the Maquet ventilator to metavision – See image.



-Battery modules

-Optional modules such as NAVA.

Nebuliser set-up within tubing.

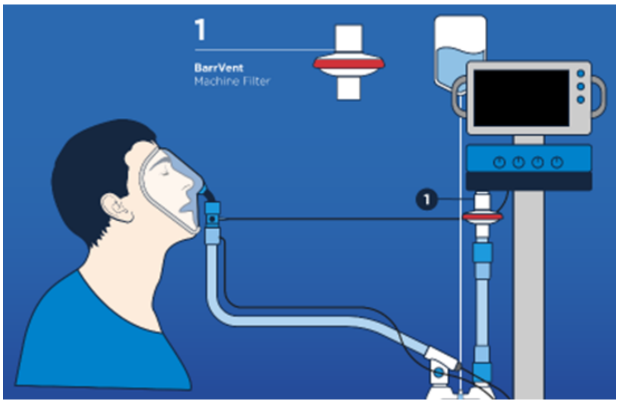
Place nebuliser kit between humidifier and short inspiratory tubing.

A wire connects the nebuliser kit to the ventilator (see image).

Use 'Maneuvers' menu (on left column) to start/stop/start timer for nebuliser.

NIV-PS:

Non-Invasive Ventilation with Pressure Support



-NIV keeps airways of lungs open by delivering air at different positive pressures, through settings including PEEP and Pressure support.

-When you breathe in, machines deliver more air pressure. This is known as inspiratory positive airway pressure (IPAP). The IPAP is calculated by adding the PS above PEEP and PEEP settings together.

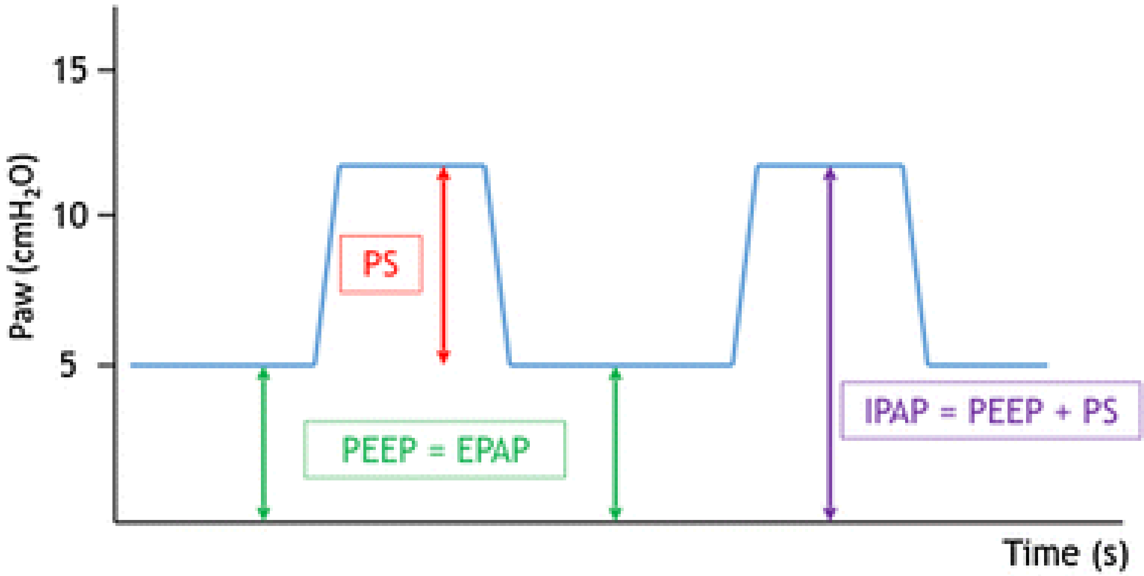
-When you breathe out, the machine reduces the air pressure. This is called expiratory positive airway pressure (EPAP), otherwise known as PEEP.

-NIV-PS (otherwise known as BiPAP) is predominantly used for patients in T2RF and is delivered via the Maquet ventilator.

<u>Main Indications:</u>

-Type two Respiratory Failure.

-Acute-on-chronic hypercapnic respiratory failure.



If the patient does not breathe, the ventilator will go into NIV-PC in which the ventilator will also deliver respirations.

The Maquet can deliver this mode in isolation, but this is something that is not used on critical care.

-NIV-PC is the back-up mode for if the patient stops taking spontaneous breaths.

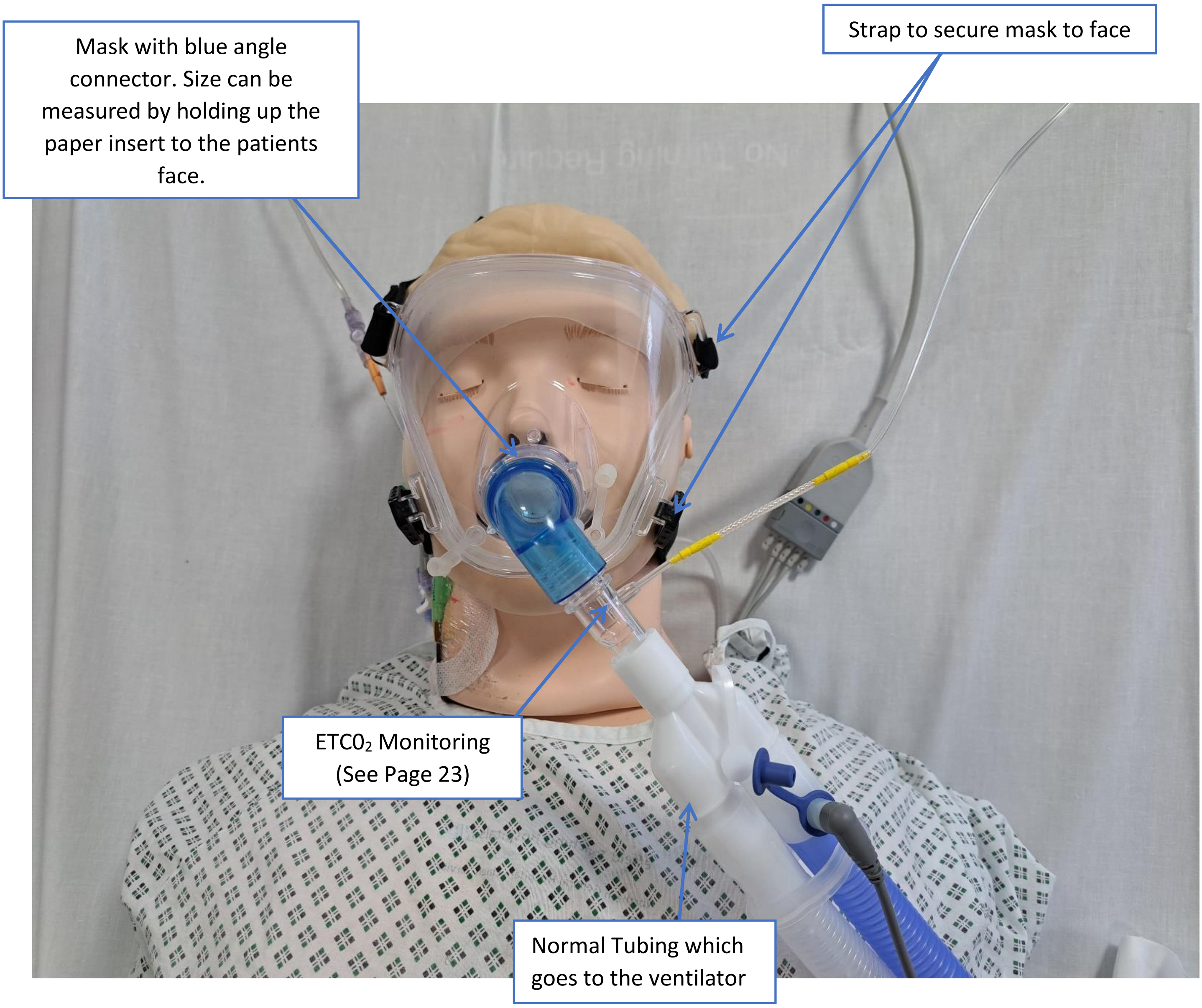
-The ventilator pushes in oxygen and air up to a pre-set pressure. The pressure is the endpoint rather than volume, so inspiration ends when a pre-set pressure is reached, regardless of the volume delivered.

NIV-PS: Patient and Maquet Ventilator Set-up

-When decision has been made to connect a patient to NIV-PS, a Maquet ventilator needs to be set up as normal (see ventilator section on page 25).

-This therapy can be delivered via a Face mask (CPAP Mask) or full-faceshield mask which is then connected to the ventilator tubing. Please see below diagram for further instructions.

-You **<u>MUST</u>** use $ETCO_2$ monitoring with this set-up. Please be mindful that there should always be a trace, but this can sometimes be distorted due to leakage.



Maquet Ventilator: NIV-PS Basic Screen Configuration

Alarm Silence

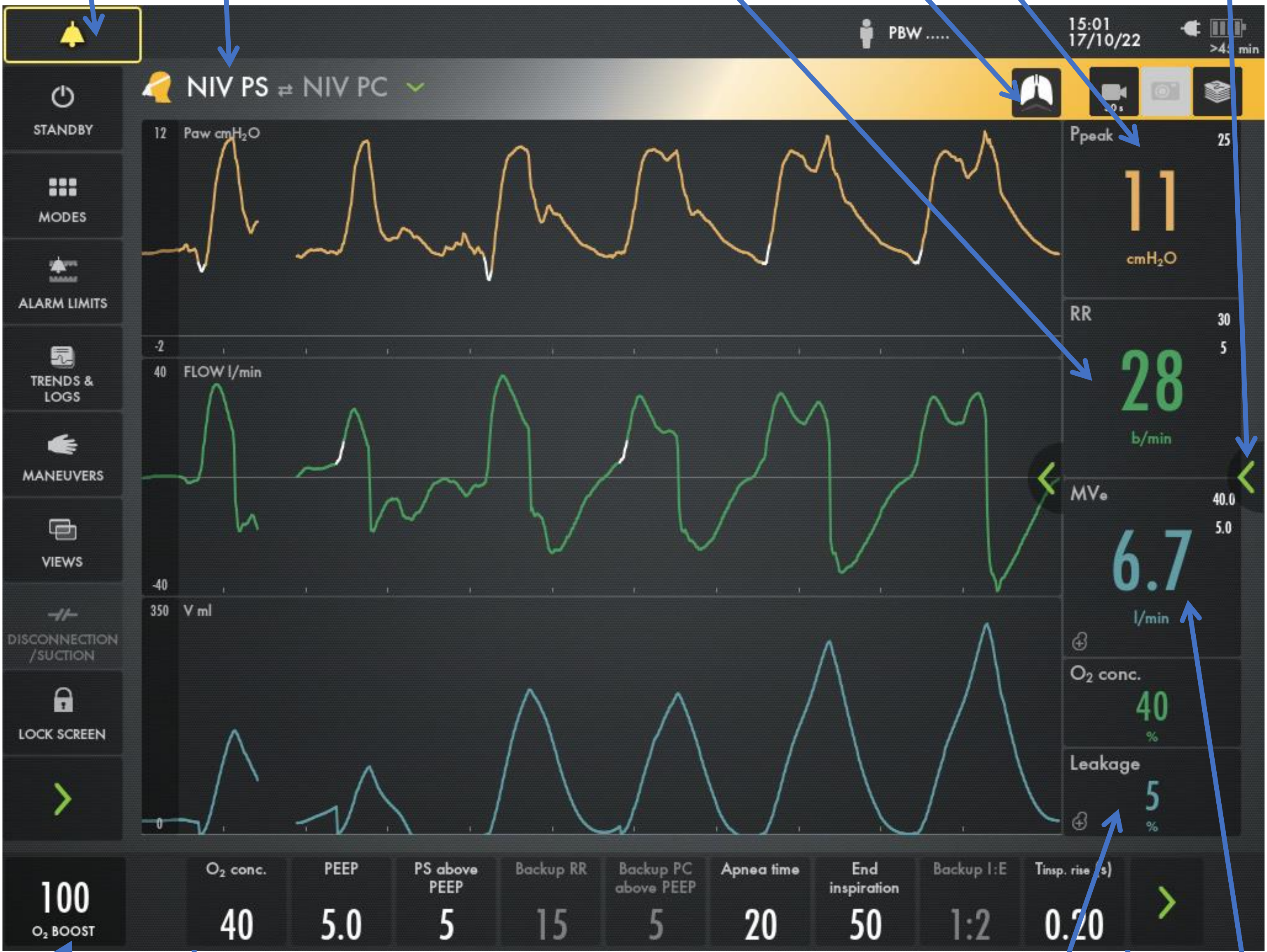
Mode of ventilation

Respiratory Rate

Lung Trigger

Peak pressure (cmH_2O)

Press this button for Extra Values, including Expired tidal volume (VTe)



Oxygen boost to 100%

Ventilator settings (can be adjusted)

Minute volume (MVe)
MVe = RR x TV

Leakage
This indicates how well the mask is fitted. This needs to be as low as possible, with consideration for lines/devices.

Maquet Ventilator: NIV-PS Alarm settings

There is risk associated with non-invasive ventilation and the alarms are there to safeguard against possible adverse events. We must ensure we utilise these, ensure appropriate levels set and silence activated only when we are 100% sure it is safe to do so and we fully understand the reason for the alarm.
Your alarms may require modification on an individual patient basis.

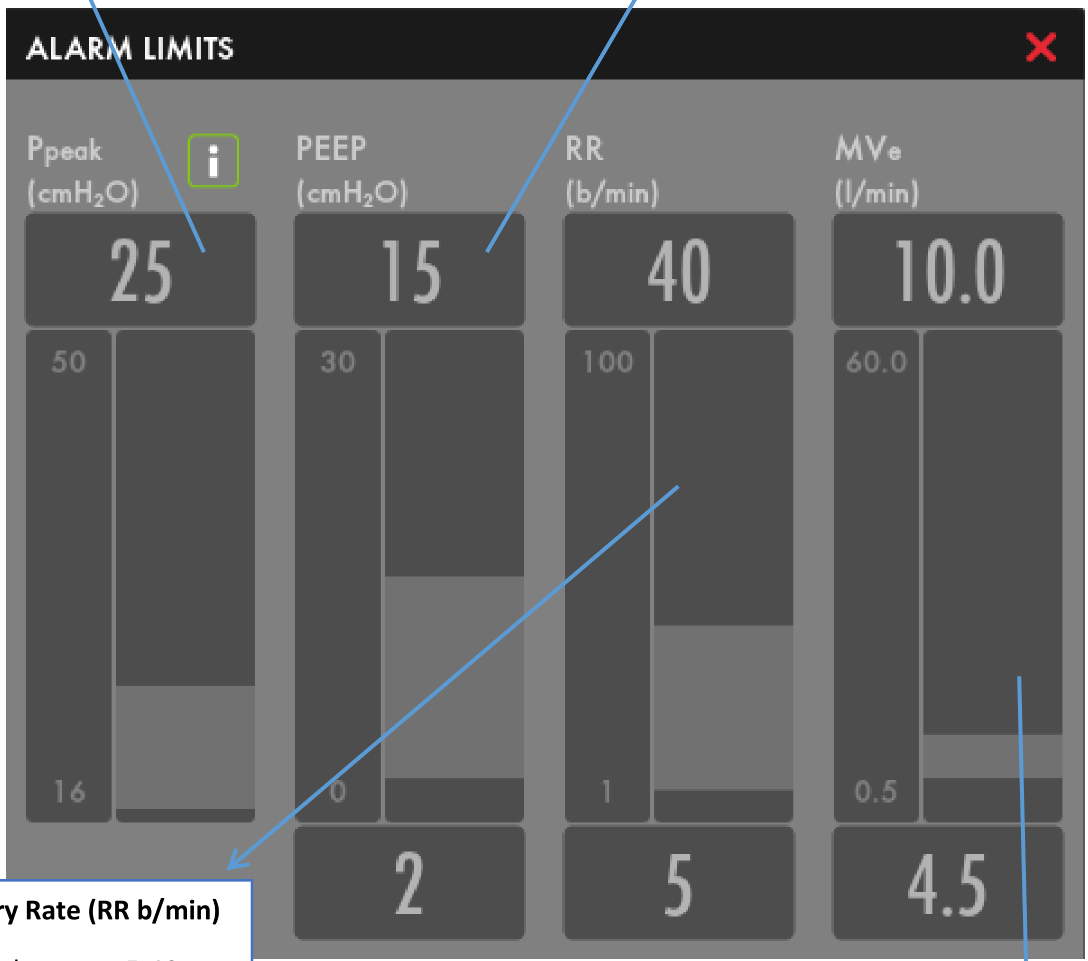
-When setting alarms it is important to consider what it is you would want to be notified of to force you to look at the ventilator.

Peak Pressure (cmH$_2$0)

Peak pressure should be set at 25.

PEEP (cmH$_2$0)

Usually set 2-15 but this may need to be changed if your patient is requiring a high PEEP



Respiratory Rate (RR b/min)

Usually set between 5-40

Minute volume (l/min)

Minute volume is tidal volume times by the number of respirations in a minute.

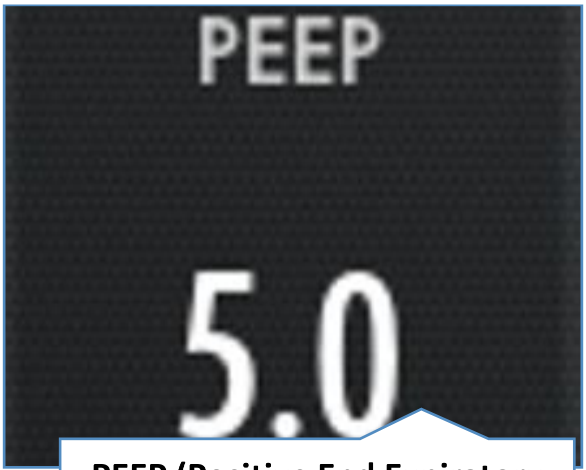
MV=TV X RR

You must set this so you are alerted when your patient's tidal volumes or respiration rate have dropped too low or are too high: 4.5-10 is a reasonable start.

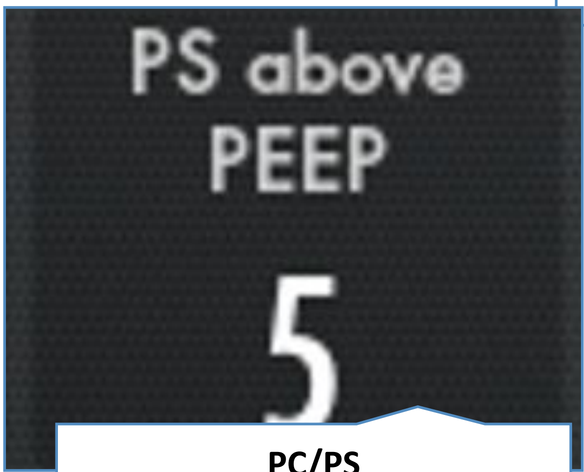
Guide to Ventilator Settings and Changes

Various settings can be altered on the ventilator to help achieve the desired result.

Oxygen
A percentage of oxygen can be delivered and titrated as needed.



PEEP (Positive End Expiratory Pressure, a.k.a. EPAP)
PEEP creates a constant pressure within the lungs above that of the atmosphere, stopping the lungs from deflating fully and preventing alveolar collapse.
This helps improve oxygenation.



PC/PS
The level of pressure the ventilator rises when pushing air in under pressure.

Mechanical / Invasive Ventilation

Mechanical or invasive ventilation is the artificial management of someone's breathing; a ventilator pushes a warm, humidified mixture of oxygen and air into the lungs and creates positive pressure in the thorax during inhalation. To be ventilated you must first have an artificial airway such as an endotracheal tube or a tracheostomy tube.

Indications for Invasive/Mechanical Ventilation:

Respiratory Failure	Reduced Level of Consciousness	To Facilitate Procedures / Post-op	Airway Protection
Status Epilepticus	Severe / Dangerous Agitation	ICP management in traumatic Brain Injury	Temperature Management
To Facilitate Transfer	Sepsis Management	Secretion Management	Cardiovascular Instability

Invasive ventilation uses POSITIVE pressure. This causes pressure changes in the thorax. Positive pressure ventilation affects preload, afterload and ventricular compliance. The net effect in most situations is a decrease in cardiac output.

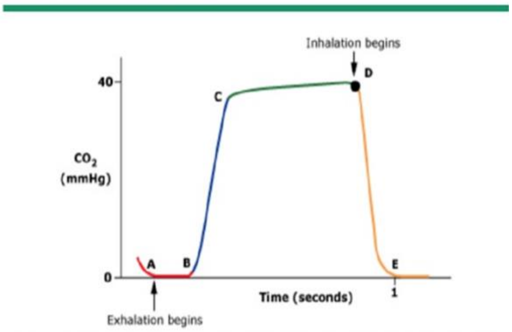
End-Tidal Carbon Dioxide ($EtCO_2$)

-End Tidal C02 ($EtC0_2$) is the level of carbon dioxide that is released at the end of an exhaled breath. Normal levels are 4-6kpa.

-$C0_2$ is <u>only</u> found in the lungs and therefore Capnography is Essential to monitor ventilation.

No Trace – Wrong Place!

Normal CO2 waveform



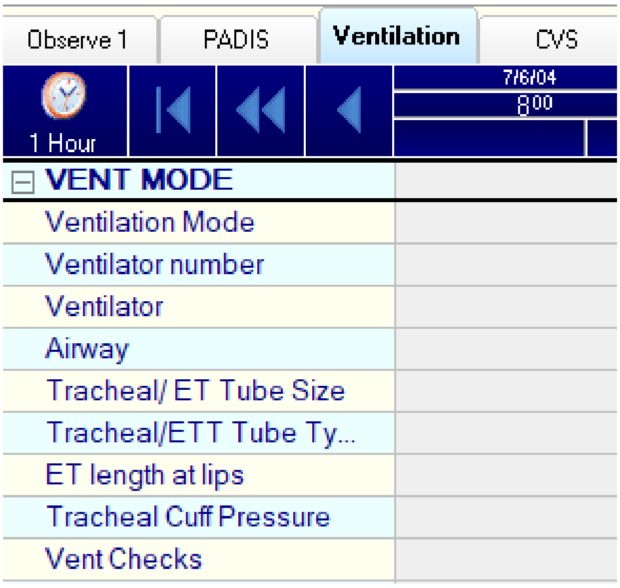
A - B: Dead space ventilation
B - C: Ascending expiratory phase
C - D: Alveolar Plateau
D: End-tidal CO_2
D - E: Descending inspiratory phase

Intubation and Endotracheal Tube

-Invasive ventilation involves inserting an artificial airway (also known as intubating).

-In the first instance usually an endotracheal tube (ETT) is inserted into the patient's airway which is then attached to a ventilator.

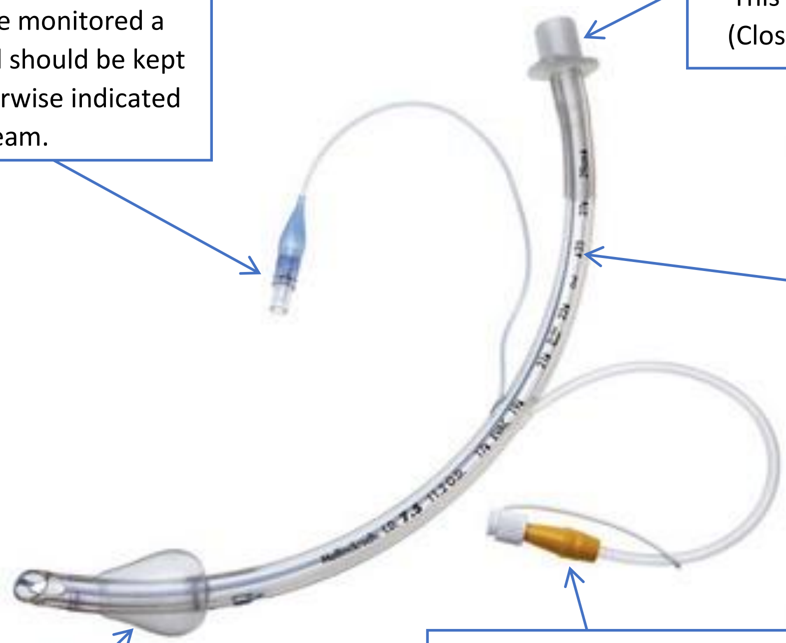
-The endotracheal tubes we use are called **Taper-guard tubes**. They have a port which allows for suctioning of subglottic secretions helping to prevent aspiration of these and the development of ventilator acquired pneumonia (VAP). The endotracheal tubes come in different sizes and the ones we use most commonly use are 7, 8 and 9. There are numbers along the endotracheal tube, and these indicate how many centimetres the ETT has been inserted into. It is **important to note this number** and record it on Metavision so it is clear if the position has changed.



-Endotracheal Tube checks should be performed as part of safe practice checks, following any repositition or intervention and as clinically indicated.

-Checks specific to the ETT include tube size, tube type, ETT length at lips and tracheal cuff pressure. Please see adjacent image as an indicator for metavision documentation.

Please note that Non-Taperguard ETT's are documented as Hilo ETT.



Port to inflate/deflate cuff.
Cuff pressure should be monitored a minimum of 6hourly and should be kept at 25cmH20 unless otherwise indicated by medical team.

External End
This is where the trache-care (Closed suction) is connected.

Centimetre (cm)
Indicates how many cm's the tube is inserted by.

Cuff
The cuff should be kept at a constant pressure to prevent aspiration from under inflation and tracheal trauma or ischemia from over inflation.

Subglottic Port
The subglottic port is a tube that has an opening immediately above the cuff.
It is used for aspiration of subglottic secretions to prevent aspiration.

Principles of Mechanical / Invasive Ventilation

There are different ways to ventilate a patient and various settings and modes used. A patient can be ventilated, and the ventilator can be controlling all the breathing and delivering all of the breaths, or it can help the patient to breathe and provide support when they take their own breath; we call this controlled or supported ventilation.

Breaths can be controlled or supported using either pressure or volume.

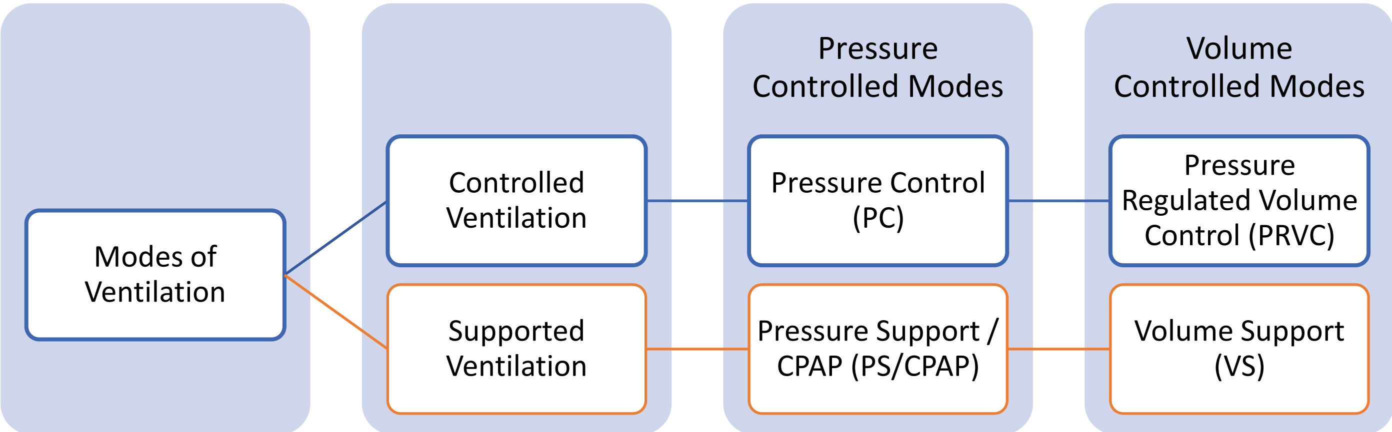
Pressure Controlled Modes

The ventilator pushes in oxygen and air up to a pre-set pressure. The pressure is the endpoint rather than volume, so inspiration ends when a pre-set pressure is reached, regardless of the volume delivered.

Volume Controlled Modes

This setting means the ventilator is programmed to deliver a pre-set volume of oxygen and air, called the tidal volume (VT), regardless of the amount of pressure required to deliver the volume.

Please see the modes below:



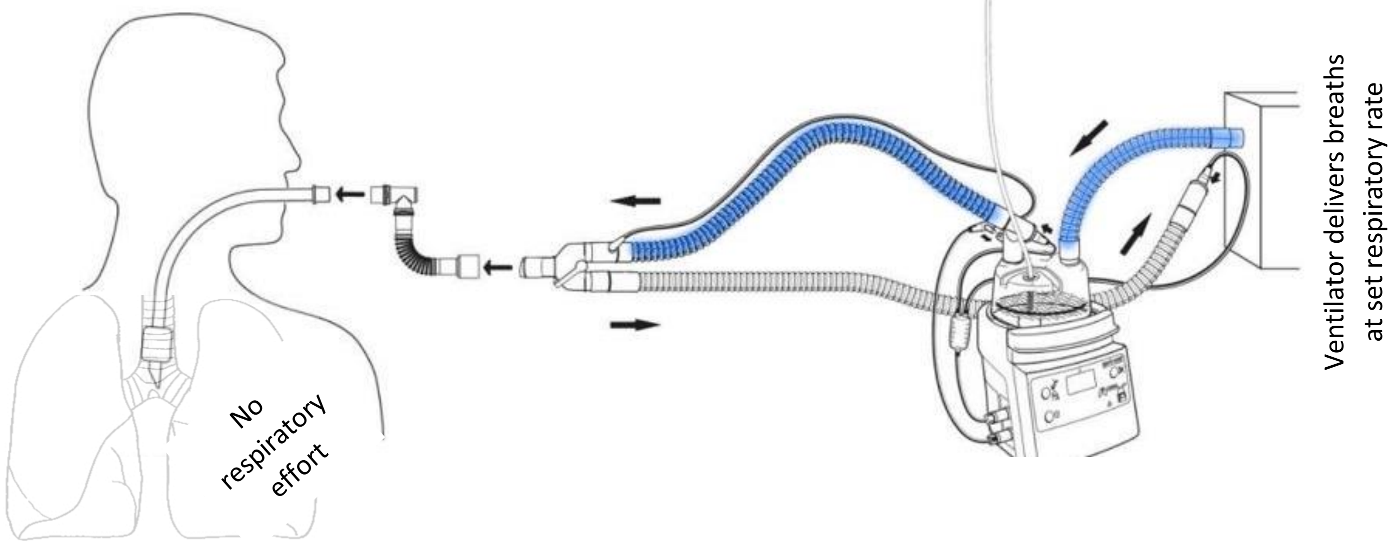
Automode PRVC≠VS

- Automode automatically controls the transition between controlled (ventilator triggered) and supported (patient triggered) modes in accordance with the patients' breathing efforts.
- If no respiratory effort is detected, the ventilator will remain in PRVC and delivers set breaths using pre-set settings.
- When the ventilator detects the patient triggering a breath, the ventilator allows this and swaps into Volume Support (VS) mode, delivering enough volume support to aid the patient to take a breath to the set tidal volume.
- This is the most commonly used mode as it minimises patient-ventilator dyssynchrony and promotes/facilitates spontaneous breathing when the patient is able.

Mandatory / Controlled Ventilation

The ventilator provides all the breaths.

Patient not making any respiratory effort → Ventilator delivers breaths at set respiratoy rate → Breath provided to set tidal volume or with set pressure → Patient Ventilates



Controlled Mode: Pressure Control (PC)

- Mandatory, controlled mode where you set respiratory rate and pressure control setting (PC Above PEEP).
- Mode delivers mandatory breaths with oxygen and air up to a pre-set constant pressure.
- The breath is delivered to the pre-set pressure regardless of the volume. This is extremely important to be aware of, as it can cause lung trauma if the pressure is set too high.

Controlled Mode: Pressure Regulated Volume Control (PRVC)

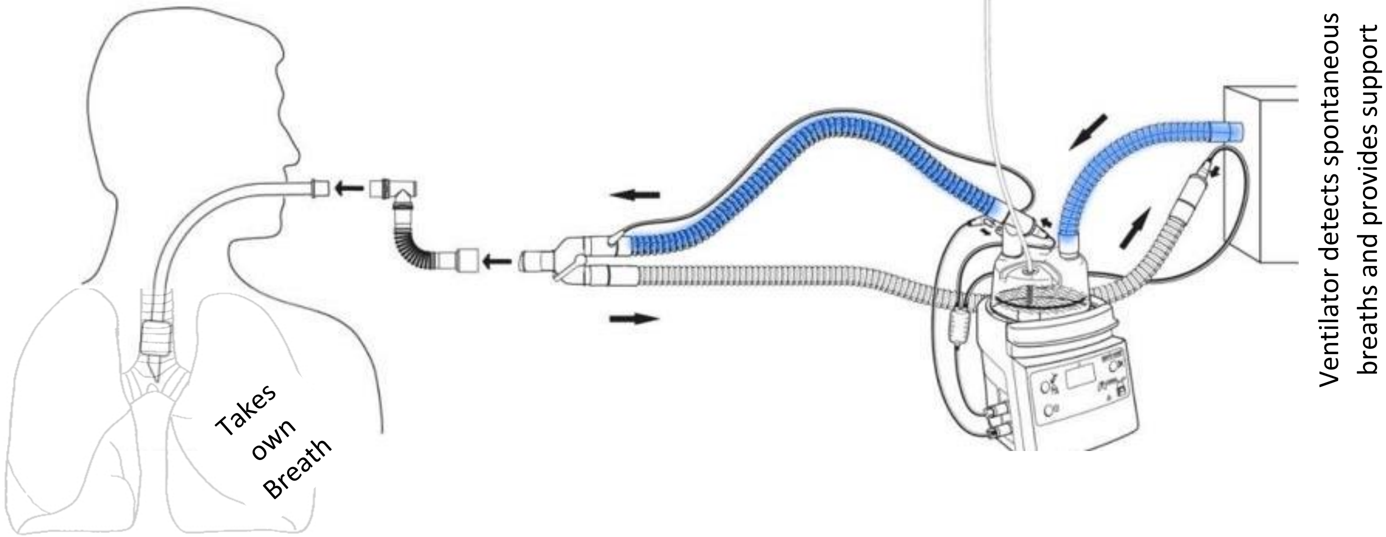
- Mandatory, controlled mode where you set respiratory rate, set tidal volume, and set pressure limit.
- Mode delivers breaths at set rate, set volume, using the lowest pressure possible.
- This mode adapts to changing compliance of the lungs to adjust inspiratory time and pressure to maintain a pre-set tidal volume.
- The pressure limit setting is extremely important as it will not deliver a breath that requires more pressure than the set limit.

When would you use Controlled Ventilation?	ARDS (Acute Respiratory Distress Syndrome
	Deeply Sedated and not making respiratory effort
	Proned Patient
	Pt not ventilating in supported mode (e.g. severe bronchospansm)
	On paralysing agent
	ICP management and PaCO2 Control

Spontaneous / Supported Ventilation

The ventilator provides support for breaths taken by the patient.

Patient takes a breath → Ventilator detects patient effort → Ventilator supports spontaneous breath with pressure support or volume support → Patient Ventilates



Supported Mode: Volume Support (VS)

- Spontaneous, supported mode where you set the tidal volume.
- Patient triggers all their own breaths, and when the ventilator detects a breath it delivers the amount of pressure required to allow the patient to reach their set tidal volume.
- Mode delivers mandatory breaths with oxygen and air up to a pre-set constant pressure.

Supported Mode: Pressure Support/Continuous Positive Airway Pressure (PS/CPAP)

- Spontaneous, supported mode where you set FiO2, Positive end-expiratory pressure (PEEP) and Pressure Support (PS).
- Patient triggers all their own breaths, and when the ventilator detects a breath it delivers the set amount of pressure support to aid the breath.
- The pressure support needs to be titrated to ensure adequate tidal volumes are being achieved.

Unless there is contraindication, a supported ventilation mode should <u>always</u> be used.

This utilises the patient's own muscles and assists in quicker weaning from the ventilator. Like any muscle not being used, it will weaken over time.

Principles of Lung Compliance

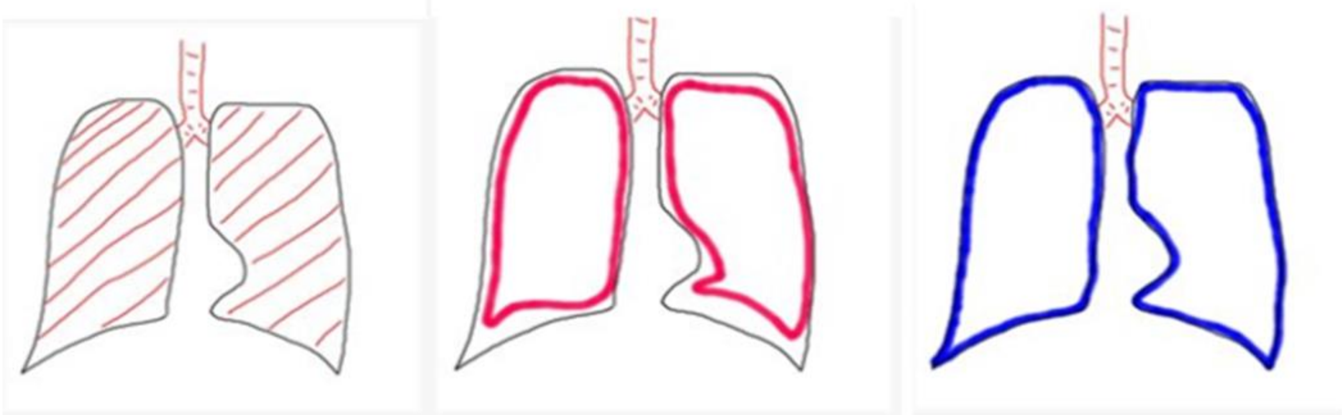
Lung compliance: the ability to inflate and deflate.

- Lung compliance determines the amount of pressure which is needed for the lungs to expand.
- If the lungs have poor compliance, then more pressure will be needed.
- If the lungs have good compliance, then less pressure will be needed.

- Compliance is labelled Cdyn, is measured in ml/cmH_2O and can be found in the bottom right-hand side of the ventilator screen (See adjacent image).
- Compliance depends on the elasticity and surface tension of the lungs.
- A **good compliance is usually ≥60ml/cmH_2O**.
- Anything less than this would be classed as poor compliance, but significantly poor compliance would be ≤25ml/cmH_2O.
- Your tidal volumes can also indicate compliance; TV ≥500ml can indicate good compliance and TV ≤200ml can indicate poor compliance.

Compliance can change throughout the day dependent on the patient's position, when they last had physio and other factors (See next page).

This is one of the benefits of a volume control mode of ventilation; As the compliance changes, the ventilator will change the level of pressure being used to deliver the volume required.

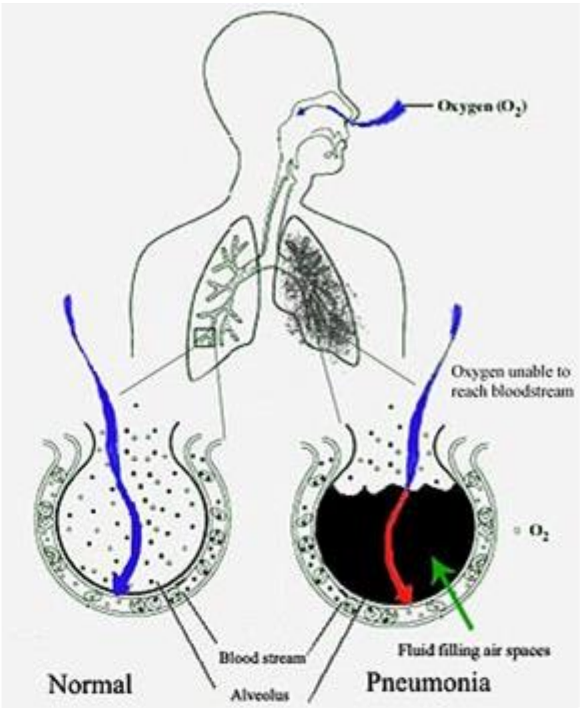


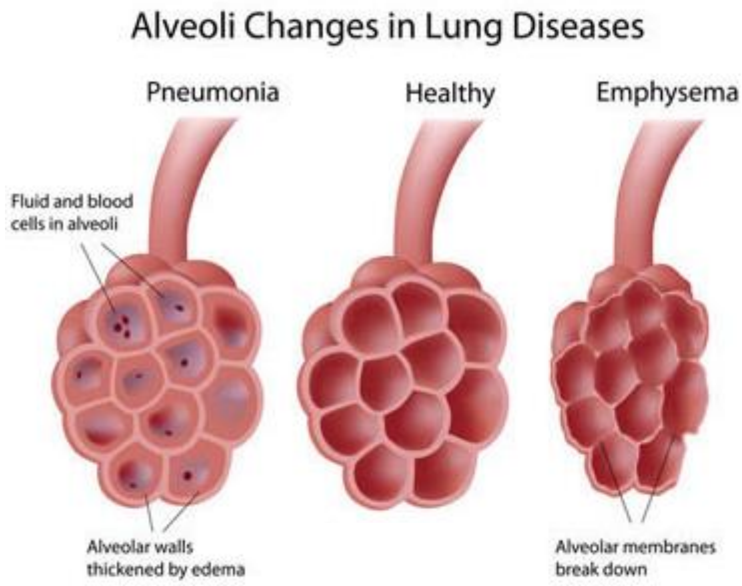
Normal Lungs- Normal inflation/deflation | 'Floppy' lung- Easy to inflate, deflates slowly | Stiff lung- Hard to inflate- deflate quickly

Can lead to *gas trapping*, not getting rid of your C02 which leads to hypercapnia and acidosis

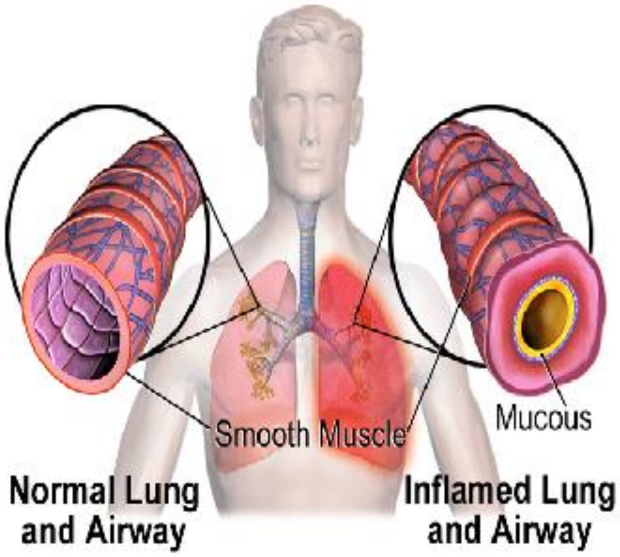
Requires *higher pressures* that a compliant lung to achieve the same *tidal volumes*

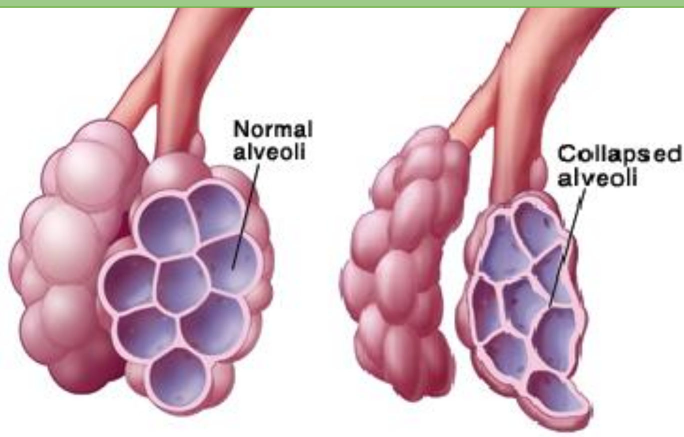
Factors Affecting Lung Compliance	
	Atelectasis
	Pulmonary Oedema
	Fluid Filled Alveoli
	Emphysema
	Fibrosis
	Inflammation of the Alveoli
	Bronchospasm
	COPD





Higher pressures will be needed to create a good tidal volume in inflamed, diseased and fluid fills lungs, compared with healthy ones.

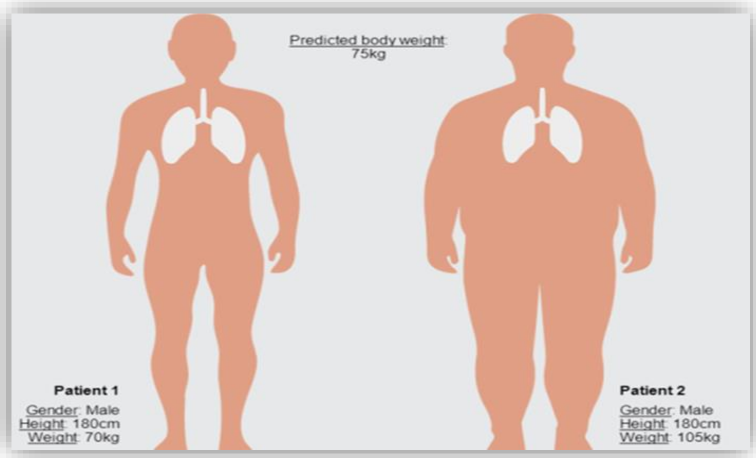




Calculating Appropriate Tidal Volume

We use an individual's Height and Weight to calculate their predicted body weight (PBW), which we can then use to calculate appropriate tidal volumes.

○ For example, the predicted body weight for a male patient of 180cm is 75kg regardless of their actual body weight.



Lung size depends on the patient's <u>Height</u> and <u>Gender</u>.

○ ML/KG (TV/PBW) acts as a guide when predicting ventilation targets.
○ We **MUST** always input the patient's height and gender using the **'Patient Data'** tab on the left-hand side of the ventilator screen.
○ This allows you to monitor the ml/kg (right-side of ventilator next to lung compliance – See adjacent image) to avoid over-inflation.

○ We ventilate patients at **<u>6-8mls/kg</u>**. This is called Lung protective ventilation.

Ventilator-Associated Lung Injury (VALI)

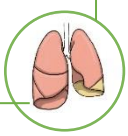
The reason we set and monitor ml/kg tidal volumes, is to protect the lungs from the damage that invasive ventilation can cause.

Ventilation causes atelectasis, which is a collapse of lung tissue affecting part or all of one lung. This condition prevents normal oxygen absorption to healthy tissues. Studies have shown that a high proportion of patients can develop an acute lung injury or ARDS and one of the main risk factors for this is large tidal volumes.

Other types of VALI include:

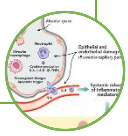
- Repeated recruitment and collapse

Atelec-trauma



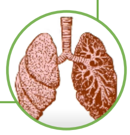
- Release of Inflammatory Mediators

Biotrauma



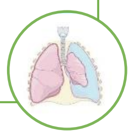
- Overdistention, Hperinflation and Shearing Injury

Volutrauma



- High-Pressure Induced Lung Damage
- Alveolar Rupture and Pneumothorax

Barotrauma



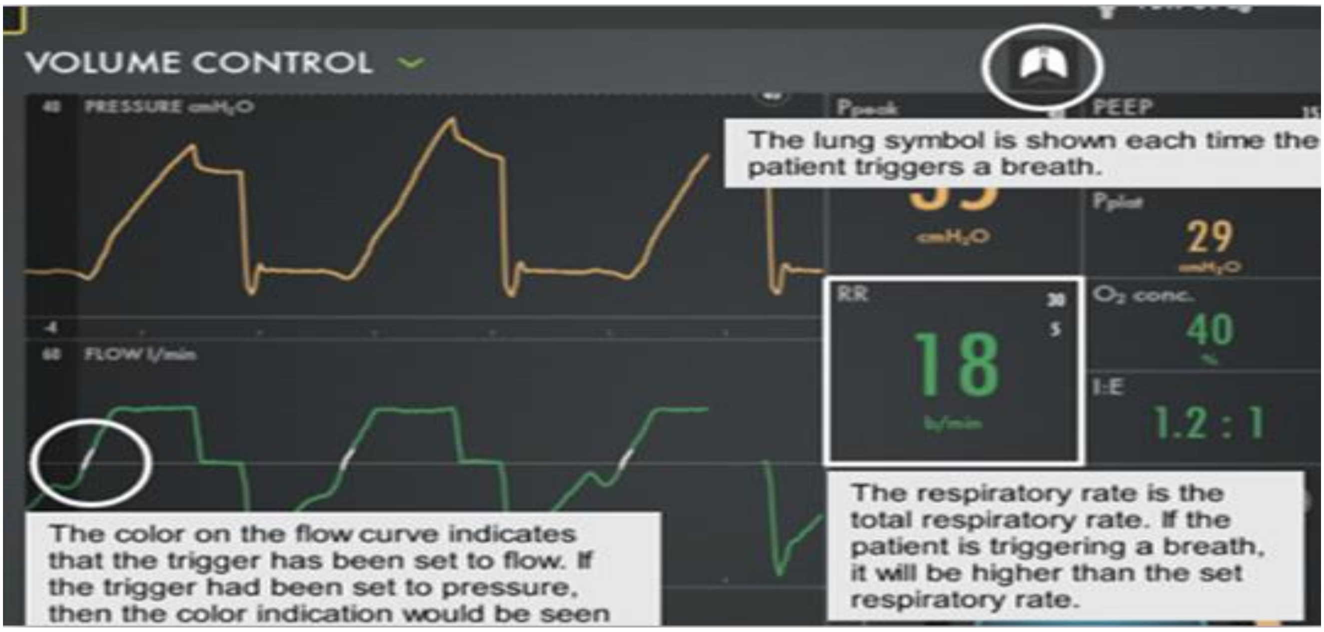
ALWAYS check your tidal volume (ml/kg) settings – Aim 6-8ml/kg!

Try and AVOID Ventilator-Associated Lung Injury!

Maquet Ventilator: Invasive Ventilation Basic Screen Configuration

Lung Triggering

Lung triggering indicates that the patient has triggered their own spontaneous breath.
Lung triggering can be identified by the lung symbol, white colour indication and increase in respiratory rate (See image below).



Maquet Ventilator: Invasive Ventilation Alarm Examples and Meanings

Volume Delivery Restricted = the ventilator is unable to deliver the volume you want with the pressure you are allowing it.

- *Why do they need so much pressure? Has this changed? Do they need suction? Physio? Position change? Medical review?*

Minute Volume Low = the volume of air in a minute is low meaning either the respiratory rate or the tidal volumes are too low.

- *Have your bolused sedation? Have you reduced their pressure support? Do they need suction? Position change? Is it too early for supported mode?*

Minute Volume High = the volume of air in a minute is high meaning either the respiratory rate or the tidal volumes are too high.

- *Does there pressure support need reducing? Are they breathing too fast as they are in pain? Do they need a mode change?*

Maquet Ventilator: Invasive Ventilation Alarm Settings

Peak Pressure (cmH20)

Peak pressure should be set at **35**. Occasionally this will be changed for a procedure such as recruitment or bronchoscopy, at the end of the procedure it must be reduced back to 35 or we risk damaging our patient's lungs. If a member of medical staff wants it set higher than 35 they must clearly document this.

PEEP (cmH20)

Usually set 2-15 but this may need to be changed if your patient is requiring a high PEEP.

Respiratory Rate (RR b/min)

Usually set between 5-40.

Minute volume (l/min)

Minute volume is tidal volume times by the number of respirations in a minute.

MV=TV X RR

You must set this, so you are alerted when your patient's tidal volumes or respiration rate have dropped too low or are too high: 4.5 - 10 is a reasonable start.

Invasive ventilation is dangerous and alarms are there to safeguard against possible adverse events.

We must ensure we utilise these, ensure appropriate levels set, and silence activated only when we are absolutely sure it is safe to do so and we fully understand the reason for the alarm. Your alarms may require modification on an individual patient basis.

Maquet Ventilator: Invasive Ventilation Settings

Various settings can be altered on the ventilator to help achieve the desired result.

Oxygen

- A percentage of oxygen. Otherwise known as FiO2 (Fraction of Inspired Oxygen).
- Can be delivered in all modes.
- Atmospheric Air contains 21% Oxygen.

Peak Pressure (Ppeak)

- Highest amount of pressure applied during inspiration.
- Should be <30cmH2O. Alarm settings at 35cmH2O.
- High pressure can be due to increasing resistance (e.g. secretions blocking tube) and/or decreasing lung compliance (e.g. bronchospasm, narrowing airways).

Positive End Expiratory Pressure (PEEP)

- Can be delivered in all modes.
- PEEP creates a constant pressure within the lungs above that of the atmosphere, stopping the lungs from deflating fully and preventing alveolar collapse.
- PEEP can be adjusted to improve oxygenation.

Tidal Volume (VTe)

- Vte stands for Exhaled Tidal Volume.
- The volume of air that is exhaled in each breath.
- It represents how much air is expanding the lungs.
- Should be 6mls/kg of IBW.

Minute Volume (MVe)

- Total volume entering lungs in a minute
- Minute Volume = RR X TV
- Normally 5-6L.

Pressure Control (PC above PEEP)

- Used in controlled modes.
- When the ventilator delivers a breath, it provides pressure to help, to the pre-set pressure control above PEEP.
- The breath is delivered to the pre-set pressure regardless of the volume.

Pressure Support (PS above PEEP)

- Used in supported modes.
- When the ventilator recognises a spontaneous breath, it increases pressure to help, to the pre-set pressure support.
- More pressure means less work for the patient.

Respirtory Rate (RR)

- The amount of respirations to be delivered per minute or the amount of respirations being taken in spontaneous mode.
- Set RR in controlled modes.

Apnea Time

- The length of time the ventilator will allow the patient to be apnoeic (no respiratory effort) before delivering controlled ventilation.
- Usually set at 20seconds.

I:E Ratio

- Inspiration to expiration ratio.
- The time for inspiration in relation to the time for expiration.

Tinsp Rise

- Time of inspiration in seconds.

Trigger (L/min)

- Indicates how many L/min the patient has to breathe for the ventilator to notice they are triggering their own breath.

Lung Compliance (Cdyn)

- A measure of the lung's ability to stretch and expand.
- Poor Compliance = <60ml/cmH2O
- Good Compliance = >60ml/cmH2O

Neurally Adjusted Ventilatory Assist (NAVA)

NAVA is a mode of ventilation that is closely related to pressure support, except it is triggered by the patient's diaphragm electrical activity, rather than flow or pressure changes in the airway.

-NAVA is triggered by the onset of the patient's inspiratory effort, in proportion with their diaphragm contraction and terminated when their diaphragm relaxes. Standard pressure support relies on a change in flow or pressure and there is often a delay in the change of flow in patients with compromised lung function. This is because the change in pressure takes an appreciable time to get from the pleura, through the lungs and to the tubes to trigger the ventilator to start and stop the breath. NAVA avoids this delay and can reduce the work of breathing and reduce breathlessness.

-NAVA **measures the electrical signal from the diaphragm** by using a **modified nasogastric tube** with electrodes situated at the gastric end to measure electromyelogram (EMG) potentials generated by the diaphragm. Once the catheter is positioned to the correct length the value should be recorded on the ventilator as this provides the ideal placement length should the tube be dislodged. The NAVA tube can be used for feeding once it has been confirmed to be in the stomach as per existing trust guidelines.

Candidates for NAVA include:

- Any patient who is likely to be difficult to wean
- Patient who has had a failed extubation
- Patient who has failed to progress after 2 spontaneous breathing trials
- Spinal injury affecting cervical spine below C5, with neurological impairment
- Thoracic spinal injury with abnormal neurology
- Patients who are likely to have ventilator asynchrony e.g. COPD

Circumstances you would NOT use NAVA:

- Unable to insert NG Tube (Oesophageal, pharyngeal or maxillofacial injuries or abnormalities/surgery).
- Patients currently on neuromuscular blockade. (the diaphragm EMG will be turned off by the neuromuscular blockade, so until this wears off NAVA ventilation will not work).
- High spinal (above C3) or brainstem injury.
- Indwelling electrical devices such as pacemakers or implantable defibrillators (these may interfere with the Edi signal).
- MRI Scan (Remove NAVA NG Tube if needs MRI Scan).

-The main NAVA specific observation values are Edi Minimum, **Edi Peak**, **NAVA level** and Edi Trigger.
-**Edi** is the term used for **electrical activity of the diaphragm**.
-**Higher Edi peak signals** indicate a **stronger muscle contraction** of the diaphragm.
-If the Edi becomes high (consistently above 30 microvolts) then the patient may be under supported and **need their level of support increased**. Some patients may have a normally high Edi (above 30 microvolts), most likely people with chronic respiratory disorders.
-**Lower Edi signals** mean **weaker diaphragmatic activity**.
-Low Edi (consistently below 10 microvolts) could mean that their current level of support is too high, **suppressing their drive to breathe**. This means that the level of **support can be reduced**.
-**NAVA level** determines how much **pressure support a patient receives in relation to Edi** by means of a multiplication factor. When the NAVA level is set at 1.0, for every 1 microvolt of change in Edi the ventilator will provide 1cmH2O of Pressure Support. **By monitoring Edi, we can safely reduce the level of support by changing the NAVA level.**

There is a comprehensive critical care clinical guideline for NAVA, which can be accessed via the STHFT intranet - type in NAVA.

Portable Ventilator: Hamilton T1

Information and videos regarding set-up, software and modes can be found on the following website:

https://www.hamilton-medical.com/en_GB/E-Learning-and-Education/College.html

Scan adjacent QR Code to direct you to this website.

Hamilton-Medical has a youtube channel with simple videos and explanations.

Please see one of the Critical Care Education Team members or one of the Critical Care ODPs for any queries regarding the Hamilton T1 Portable Ventilator.

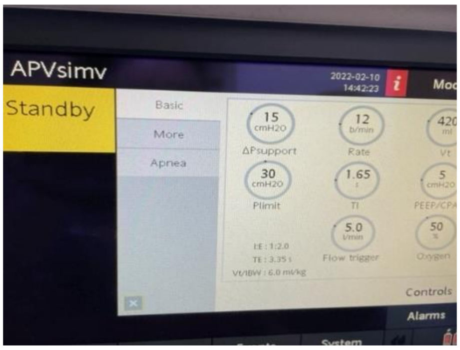
Please also see the help guide which covers the modes and useful points on the next couple of pages.

Hamilton T1 Ventilator: Help Guide

Please input patient data (Height and Gender) to calculate IBW

(Tidal volumes are created on 6mls/kg).

Modes of Ventilation



APVsimv- Adaptive Support Ventilation with SIMV (Synchronized Intermittent Mandatory Ventilation)

Aka : Maquet - SIMV (PRVC)

- Synchronized intermittent mandatory ventilation (SIMV) is a type of volume control mode of ventilation.
- With this mode, the ventilator will deliver a mandatory (set) number of breaths with a set volume while at the same time allowing spontaneous breaths with pressure support.

APVcmv - Adaptive Support Ventilation with CMV (Continuous Mandatory Ventilation)

Aka : Maquet - PRVC

- APVcmv is a mandatory volume controlled mode of ventilation.
- The ventilator attempts to achieve the set tidal volume using the lowest possible airway pressure.

SPONT

Aka: Maquet - PS/CPAP

- Ventilated patient, spontaneously breathing needing P-support.
- Do not use for NIV patient.
- SPONT is a spontaneous ventilation mode where patients consistently take their own breaths but are supported in doing so through set Pressure Support (PSupport) and PEEP.

BE AWARE: Plimit settings and alarm settings are linked by 10cmH2O. The Plimit higher alarm is defaulted to set 10cmH20 above the Plimit. Changing one changes the other. E.g., If you set your Plimit higher alarm to 35cmH20 (Like we do with the Maquet ventilators) this would automatically change your Plimit to 25cmH20. If this occurs, your ventilator may start alarming with 'Pressure Limit Limitation' (Otherwise known as 'Volume Delivery Restricted' on the Maquet Ventilators). This means your patient is not receiving their desired volumes or PEEP due to the restriction set by the Plimit (I.e., your settings cannot be delivered within the set pressure limit).

TOP TIPS for using the Hamilton Portable Ventilator

General Tips:

- Don't cover the back air-port (e.g. Don't place your ventilator with back down on the bed or stand).
- When making changes or setting up, ensure that you always click to accept or confirm settings. If you do not, the change will not be saved and it will revert to default or original settings.
- If ventilator alarms and you are unsure of its meaning, you can click onto the alarm in buffer and it will provide a description of the alarm and possible solutions.

Tubing Set up and Pre-op checks:

- Be careful when removing tubing from packaging, you should have included; An expiratory valve with membrane attached[1], an Adapter[2] (For flow sensor checks), and Tubing with Y connector at one end (Blue inspiratory tubing inside White expiratory tubing) and Blue flow/pressure sensor on other end[3].
- When setting up, always place the tubing with the Y facing the front screen.
- ALWAYS check your membrane on the expiratory valve – Make sure that it is on correctly, secure with no kinks with the silver plate facing outwards.
- If you are having problems passing tubing checks (E.g. Leak Test), remove your expiratory valve, check this membrane and put the valve back into place.
- Save the adapter (Box in techs room/storeroom).
- Remember to put an HME on the end of the circuit prior to connecting to the patient.

(1)

(2)

(3)

Ventilator Set up:

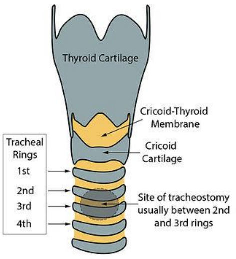
- When preparing the ventilator mode and settings for patient transfer always work from left to right. First click the appropriate mode, then input patient gender and height (Use same as on Maquet), and lastly use the control and alarm tabs to input settings.
- Be mindful that your gender and height automatically calculates and changes your set tidal volume to 6ml/kg (IBW).
- Be aware that changing mode or height/gender changes the settings back to default.

PLEASE SET UP IN THE ORDER PRESENTED IN FIRST BULLET POINT TO AVOID THIS

- Electric port/wire is screwed in.

Tracheostomy Care

A tracheostomy is the creation of an opening into the trachea through the neck. Once formed the tracheostomy opening is kept patent with a tube which is curved to accommodate the anatomy of the trachea.

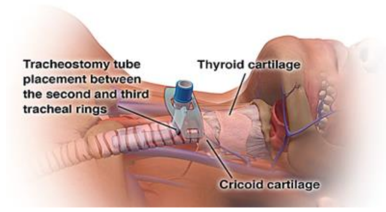


Anatomical Position

-The ideal location for placement of the tracheostomy tube is between the second and third tracheal rings. In order to do this, Medics should identify the key anatomical landmarks; the thyroid cartilage, the cricoid cartilage, and the sternal notch.

Indications for Insertion:

-To enable the aspiration of tracheobronchial secretions.
-To bypass any upper respiratory tract obstruction.
-To aid in weaning from ventilator support.



Types of Tracheostomies

Percutaneous

- Can be performed in the clinical area.
- A guide wire is inserted through the skin into the trachea, and then progressively larger dilators are passed over the guide wire until the stoma is of the desired diameter.

Surgical

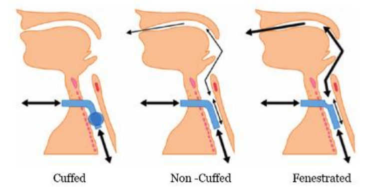
- Performed in the operating theatre under anaesthetic.
- The tracheostomy is inserted through a surgical incision approximately 4 - 5cms long.
- Patients with anatomical difficulties (e.g. obese), enlarged thyroid or head and neck surgery.

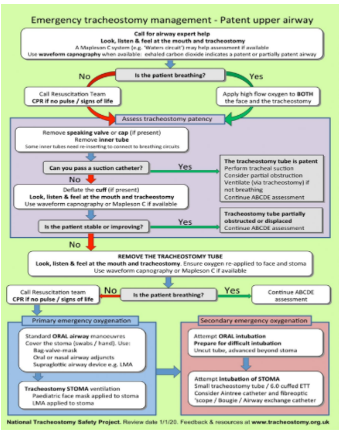
Mini

- A technique to assist in the removal of airway secretions while maintaining glottic function.
- A flanged, reclosable cannula 4.0 mm in internal diameter is inserted through the cricothyroid membrane into the trachea.

Types of Tracheostomy Tubes

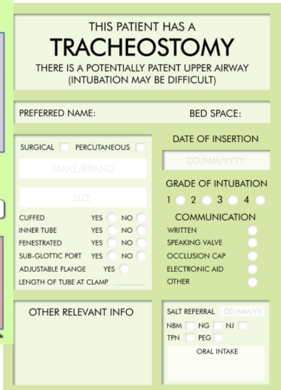
-We use cuffed tracheostomy tubes (e.g. Trachoe or Portex)





Tracheostomy Signs

-These MUST be present at every bedspace of a patient who has a tracheostomy.



Tracheostomy Box

-MUST also be present at every single bedspace who has a patient with a Tracheostomy.
-*Contents:* Tracheostomy tube (One size same as patient and One size smaller) | 10ml Syringe | Gauze | Stitch Cutters | Dilators.

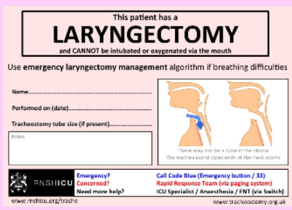
NCEPOD - Tracheostomy Care: On the Right Trach? (2014).

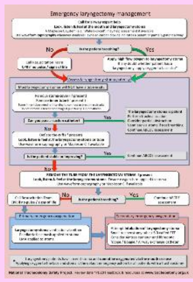
Laryngectomy

-A total laryngectomy is the complete removal of the larynx (voice box).
-The larynx is removed, and the trachea is sutured in position to form a permanent structure known as a laryngectomy stoma. **There is no connection between the nasal passages and the trachea.**

****Extremely Important****

-A patient with a laryngectomy has a different emergency pathway!
The adjacent signs MUST be present at every bedspace of patient who has a laryngectomy. These signs may be the ONLY visual difference between a patient with a tracheostomy and a patient with a laryngectomy.





Associated Pharmacology

-There are several medications that help the respiratory system in different ways.

Bronchodilators / Nebulisers

-Drugs that make breathing easier by relaxing the muscles in the lungs and widening the airways (bronchi).

-Bronchodilators also help clear mucus from the lungs. As airways open, mucus moves more freely, which allows patients to cough mucus out.

-Three types: Beta-2 Agonists | Anticholinergics | Theophylline (Aminophylline).

-**Effects:** Bronchodilation | Relieve cough, wheezing, and SOB.

-**Cautions:** Can cause hypokalemia | Headaches.

-**Indications:**

Pneumonia	Bronchospams	Asthma	COPD

-**Examples include:**

- Beta-2 Agonists work by stimulating Beta-2 receptors in the muscles that line the airways, which causes them to relax and allows the airways to widen / dilate.
- Anticholinergics cause the airways to widen by blocking the cholinergic nerves. These nerves release chemicals that can cause the muscles lining within the airways to tighten.
- Aminophylline reduces any inflammation in the airways in addition to relaxing the muscles lining them.

Beta-2 Agonist: Nebuliser: Salbutamol	Anticholinergic: Nebuliser: Ipratropium Bromide	Anticholinergic: Inhaler: Tiotropium Bromide	IV Drug: Aminophylline

Steroids

-Reduce inflammation in your airways.

-**Effects:** Reduce airway inflammation | Reduce risk of mucus plugging.

-**Cautions:** Hyperglycaemia | Hypernatremia and Fluid Retention | Immunosuppression | Increased risk of delirium | ICU-Acquired weakness.

-**Indications:**

Airway Oedema	Analphyaxis	ARDS	Exacerbation of Asthma	Exacerbation of COPD	Pneumonia

-**Examples include:**

Methylprednisolone	Hydrocortisone	Dexamethasone	Prednisolone

Sedation / Paralysing Agents

-Sedative drugs suppress the central respiratory centre and reduce the ventilatory response to a given level of carbon dioxide.

-Neuromuscular Blocking Agents (NMBAs) induce reversible muscle paralysis.

-**Effects:** Ability to control respiratory system via ventilator | ↓patient-ventilator asynchronies.

-**Cautions:** Apnoea | Hypotension | Bradycardia | Caution not to over-ventilate.

-**Indications:**

Facilitate Mechanical Ventilation (Lung-protective ventilation)	Hypoxia	Bronchospasm	ARDS	Facilitate alveolar recruitment	Proning

-**Examples include:**

Sedative: Propofol	Sedative: Midazolam	NMBA: Atracurium	NMBA: Rocuronium

Antibiotics

-Drugs that are used to treat and prevent some types of bacterial infection. They kill bacteria or prevent them from reproducing and spreading.

-Antibiotics are not effective against viral infections, including common cold, flu, and coughs.

-Treatment is usually guided by microbiologists, who have reviewed cultures.

-**Cautions:** Allergies | Antibiotic resistance.

-**Indications:**

Chest Infection / Pneumonia	Epiglottitis	Exacerbation of COPD

-**Examples include:**

Tazocin	Amoxicillin	Co-Amoxiclav	Clarithromycin	Levofloxacin	Meropenem

Analgesia

-Drugs that reduce pain or distress / treat symptoms that may increase oxygen demand (e.g. fever).

-**Cautions:** Respiratory depression.

-**Indications:**

Breathlessness	Signs of pain / distress

-**Examples include:**

Paracetamol	Alfentanil	Oxycodone	Morphine	Epidural (To allow deep breathing post surgery)

Acknowledgments: Kelly Billing | Donna Barnett | Phil Murch | Emma Barlow.