

# Physiotherapy On Call Work Book





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## Background

Respiratory Physiotherapy has been a vital role within hospitals for the treatment and prevention of respiratory conditions, such as pneumonia and exacerbation of COPD.

This role does not just occur Monday to Friday 8.30 to 4.30pm, it needs to be provided 24 hours a day.

On Call physiotherapy is integral to the delivery of a comprehensive and effective physiotherapy service to provide round the clock care to patients who are becoming unwell due to a respiratory problem.

Physiotherapists working in an on call situation and away from their normal clinical area, should be aware of their professional responsibility in the on call situation. They should be confident in their skills, but also able to know their limitations and decline to provide treatment if they feel they are no longer competent to or if they feel it is not indicated and explain their clinical reasoning as to why not.

It is recognised in numerous sources that providing on call physiotherapy is a challenging and often a difficult environment to work in. The patients are more unwell, requiring more support, relatives and carers are more anxious and decisions often need to be made quickly and under pressure.

This is recognised and that is why the on call policy has been written to support you, this work book has been written to support you in addition to the theory and practical training which you will receive throughout the year to ensure that you maintain your core skills for on call.

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## Aim and Objectives

- ✚ To ensure all on call staff are appropriately competent for the work they are undertaking.
- ✚ To enable staff to identify and treat respiratory patients in conjunction with other teams, in an appropriate setting and in a timely manner.
- ✚ To provide evidence of competence for each member of staff, in line with the knowledge and skills framework and the competency framework.
- ✚ To enable on call staff to feel confident to undertake on call duties as per their job description.
- ✚ To increase knowledge and skills to assess and deliver effective respiratory treatment to prevent patients becoming more unwell.
- ✚ To enable staff to maintain competence once achieved, by a process of reviews, appraisals with their line manager and training throughout the year.
- ✚ To identify and address individual learning needs of each member of staff on the on call rota.
- ✚ To highlight to managers / trainers any areas where more training and development is needed with individuals or as a whole, to develop and alter the courses as needed.

## Competency Framework

There is already a competency framework in place to help you identify your learning needs, for the trainers to assess and sign off competencies which you have met and for training opportunities to be highlighted and met by the Senior Respiratory Physiotherapy Team.

You should have a copy of this competency package. Section 1 is a self assessment for you to complete which highlights where you think your current learning needs are. This gives the trainers a greater idea of the particular aspects which you are looking to learn.

It is important that you realise that it is your responsibility to ensure that you are competent to undertake an on call and that you highlight when you feel you are not competent to ensure training is undertaken. Once assessed by the Senior Respiratory Team, it will be your responsibility to raise any ongoing training needs related to confidence and ability to competently continue with on calls (see On call Policy).

The remainder of the competency package will then be assessed during your on call course and any practical time which you may need with the Senior Respiratory Physiotherapy Team.

Your competencies will be reviewed annually with your line manager as part of your annual appraisal to ensure that you remain competent with on call duties. To ensure that you maintain the core level of skills for the on call work, it is mandatory that you attend and complete regularly training both theory and practical throughout the year.

## Respiratory Physiotherapy On call – Guidance for on call staff

### On call Rota

The on call rota is done several months in advance by the Lead respiratory physiotherapist and is then sent out to everyone on the on call rota. A copy is also sent to switchboard and the accommodation office so that they have a record of who is on call and when. This allows for plenty of time for you to note and save the dates which you are on call.

### Contact Details

It is your responsibility to ensure that switchboard have the right name and details for you. You should always give them more than one number, e.g. pager and home and check that those contact numbers are working prior to leaving the hospital.

### Swapping on calls

If you are unable to do an on call which you have been allocated to do, then it is your responsibility to contact other physiotherapists who are on the on call rota and ask them to swap. It is not acceptable for you to swap out of the on call altogether as this will affect the on call frequency for both yourself and the person who takes the on call. Where possible all on call changes need to be swaps so that everyone maintains the same on call frequency.

If you swap an on call it is your responsibility to let both the Lead respiratory physiotherapist and switchboard know, giving them the name of who is now doing the on call and which date you have swapped to.

If you are unable to swap an on call you still have to do the on call, it is not acceptable to try and force others to take on your duties.

### Being Unwell

This is covered in the Trust on-call policy – if you are unwell you need to inform your line manager when you call in with as much notice as possible (for example if you are off all week and on call on the Friday, tell them on the Monday, not the Friday).

Your manager will then contact the Lead respiratory physiotherapist to let them know.

The Respiratory Physiotherapy team will contact staff on the on call list to ask whether anyone is able to step in and take the on call. They will initially call staff who are in work and then try staff who are on a day off. If someone is able to swap into the on call, the person off sick is then expected to take back an on call from that person at a later date.

In some circumstances the person who is able to cover the on call may only be able to cover from later in the evening (e.g. 6.30pm instead of 4.30pm) or they are only able to cover if they remain at home which could mean a longer response time. In these circumstances if there is no-one else able to do the on call, it is better to have



someone who can do the on call and both Switchboard and CCOT will be informed of this change to cover.

### The day of your on call

On your on call day you need to do the following:

- 1) Contact the respiratory physiotherapy team by 2.00pm on bleep 1628 to let them know that you are in, aware you are on call and if there are any patients which you should be aware of.
- 2) Pick up the on call pager from the office by 2.00pm
- 3) Contact switchboard before 4.30pm let them know your name and contact phone numbers (mobile, home phone and pager)
- 4) If the respiratory physiotherapy team have not heard from the on call person by 2.00pm, then they will try to contact them. If that person is on annual leave or unwell, then they will try to find a replacement.

### Failure to do an on call

It is a serious matter if you cannot be contacted when you are on-call. If this situation does occur, your line manager will be informed. You will be expected to meet with your line manager, the Physiotherapy Professional Advisor and the Lead Respiratory Physiotherapist to discuss what happened. While each case will be considered on a case by case basis, subsequent failures may result in disciplinary action.

For full details about your responsibilities when on call – please refer to the Respiratory Physiotherapy On call policy which is available on ICID.

## **Core on call skills**

All on call staff are expected to have and maintain the following skills:

Respiratory Assessment to include:

- Patient history
- Patient airway management
- RR, saturations, HR, Rhythm, BP, Temp
- Auscultation
- Pattern and work of breathing – signs of distress and obstruction
- Recognition of paradoxical breathing
- Secretions
- Cough ability / strength
- CXR interpretation
- ABG interpretation
- Positioning advice – awareness of restrictions and able to problem solve / advise nursing staff with consideration of the respiratory condition
- Fluid balance
- Medication chart
- Pain score if applicable
- AVPU or GCS

Acute spinal injury treatment for paraplegic and tetraplegic and respiratory pathology in spinal cord injury (includes awareness of autonomic dysreflexia).

Oxygen and humidification

- High and low flow systems
- Set up and rationale for humidification – hot and cold

Ventilation

- IPPB, CPAP, BiPAP and ventilator settings – rationale for use and monitoring (does not include set up of NIV or ventilator)

Tracheostomy care

- Indications
- Tracheostomy tubes – ID, OD, inner cannula, cuff pressures, potential problems
- Communication options
- Respiratory distress and actions to solve obstruction
- Complications with tracheostomy insertion immediately and within 36 hours

Treatment to include:

- Manual Techniques – chest shaking, vibrations, percussion
- ACBT
- Manual assisted cough
- Set up and use of cough assist machine
- Tracheal suctioning
- MHI
- Postural drainage
- IPPB

# Respiratory Assessment

## A, B, C, D, E Approach

As an on call respiratory physiotherapist you should be able to assess patients with a range of respiratory problems. These include patients with acute respiratory problems such as pneumonia, long term patients with conditions such as COPD and acute trauma such as burns or spinal injuries.

The same assessment tool can be used for all patients, but it is important to not just look at the respiratory function, but the whole picture.

### A, B, C, D, E

This is an assessment tool used by other health care professionals to ensure a complete and comprehensive assessment.

#### **A = Airway**

A – this stands for airway. It refers to what type of airway the patient has and whether it is patent (open and secure).

Such airways include: patients own, tracheostomy, laryngectomy and endotracheal tube.

You should always document the type, size and whether the airway is patent.

Causes of partial or complete airway obstruction:

- ✚ Secretion plugging
- ✚ Inflammation
- ✚ Decreased GCS
- ✚ Laryngeal oedema, trauma or spasm – such as foreign body, inhaled irritant
- ✚ Pulmonary oedema – infection, near drowning, cardiac failure
- ✚ Anaphylaxis
- ✚ Tongue displacement – trauma, fitting, arrest

Signs and symptoms of airway obstruction:

- ✚ Stridor – upper airway obstructed
- ✚ Gurgling – presence of liquid
- ✚ Snoring – pharynx partially occluded
- ✚ Crowing – laryngeal spasm
- ✚ Inability to speak
- ✚ Cyanosis
- ✚ Decreased saturations
- ✚ Increased RR
- ✚ Increased WOB
- ✚ Patient distress

If the airway is not patent, then you should not continue your assessment – you should try to open the airway using a chin tilt and jaw lift. If the patient has a tracheostomy then remove the inner tube to make the airway patent. You should then seek help, if the airway is not patent, it does constitute a crash call.

## **B = Breathing**

This means how is the patient breathing. Examples include self ventilating on air, or on BiPAP 14/4, or on PS (pressure support) 10, PEEP (positive end expiratory pressure) 5.

Under this section you should include:

Any ventilator settings and type of ventilator (CPAP, BiPAP), oxygen amount and how it is delivered, humidification, respiratory rate, pattern and work of breathing, signs of respiratory distress, oxygen saturations, ABG's, auscultation findings and chest x-ray findings.

(N.B SpO2 reading using a probe can be affected by circulation, location of the probe and nail polish).

Also check oxygen recorded is the same as what the patient is receiving.

## **C = Circulation**

This includes both observations of circulation as well as other factors which affect circulation, such as fluid balance and medications.

Under this section you should record:

Heart rate, rhythm, blood pressure, temperature, urine output over the last three hours, fluid balance, peripheral oedema, capillary refill time and medications such as inotropes or sedatives.

It would also be appropriate to record any blood results which were significant, such as INR, Platelets, WCC, CRP and albumin as this would give you more information about clotting or inflammatory markers.

## **D = Disability**

Disability relates to how alert / conscious the patient is. This gives you an idea of how much they can assist with treatment, how unwell the patient is and how their airway may be compromised.

This is measured using the AVPU scale:

A – Alert

V – Responds to voice

P – Responds to pain

U – Unresponsive

If you find the patient unresponsive, ensure the doctors are alerted to assess immediately.

## **E = Exposure**

You need to be assessing whether there is anything else which may be causing this patient to become unwell, which may have been overlooked.

You should do a head to toe exam where you look for lines, drains, catheters etc and any signs of trauma, bleeding which may not have been noticed.

Note in your records any invasive attachments which could be a source of infection or bleeding. Such as catheter or IV cannula.

## **EWSS**

The early warning system score is used within this hospital and it is a score based on the patients observations. If the score is 4 or above, the nurse should contact the medical team and ask for a review. Please be aware of this scoring system and it is useful for you to use it to see if there is a trend, such as spiked temperature or RR at times and what this could indicate.

Finally.....

Position – this is important to note as it will affect your assessment findings, such as auscultation, cardiovascular readings, such as BP and VQ matching.

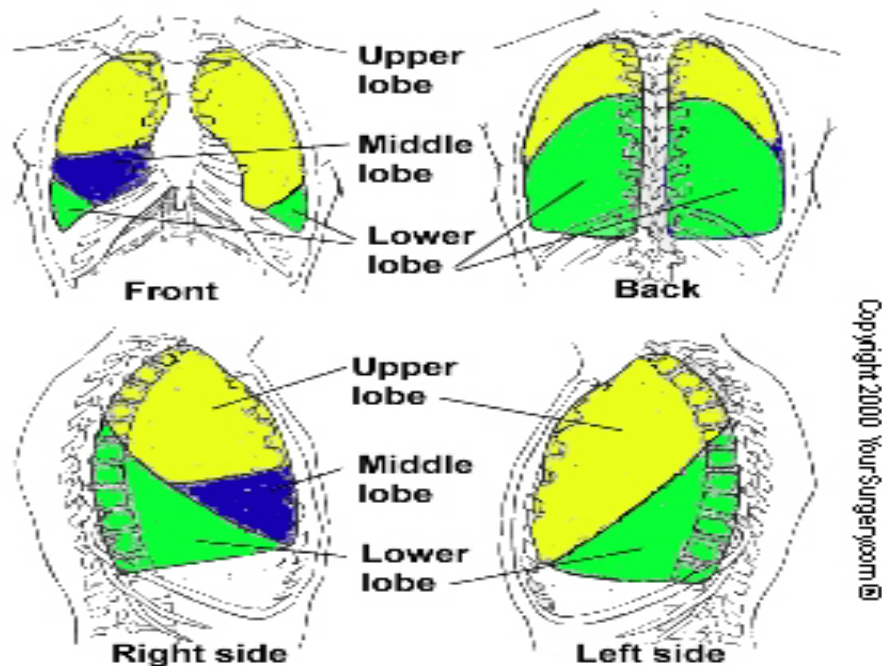
Always consider what position your patient is in, this is something which will be covered in more detail later in the work book.

# Auscultation

- Before listening with your stethoscope, listen for audible breath sounds.
- Noisy breath sounds from the mouth is abnormal, they are generally caused by secretions and you should ask the patient to cough and clear these before you listen.
- Observe how the patient is breathing, their pattern of breathing and chest expansion. This can be assessed using your hands placed on the chest to feel whether they have good expansion, any secretions, whether the chest is moving symmetrically and what tidal volume (if measured) is being recorded.

## Technique

- The patient should be in a good position
- Remove the clothing from the chest so that your stethoscope is directly on the skin if possible
- Compare one side to the other at exactly the same point
- You should ask the patient to breathe in and out through their mouth
- Make sure you listen to each lobe, there are 5 in total.
- You should try to listen anteriorly and posteriorly.



## Breath Sounds

Normal breath sounds – this is the sound of air moving in and out of the proximal airways, you should be able to hear the air throughout, with more air audible at the top of the lungs compared to the bases, it should sound the same right and left.

## Abnormal breath sounds

Bronchial Breathing – this is indicative of consolidation. Consolidation acts like a solid piece of tissue and sound waves are transmitted clearly through it – giving a harsh, hollow blowing sound on inspiration and expiration.

A higher pitched form is heard over a pleural effusion.

### Decreased breath sounds

These can occur if the patient is not breathing deeply, has no air entry, such as atelectasis or there is airflow but the transmission is hindered due to a pleural effusion or pneumothorax.

Silent chest – when you listen they have quiet air entry throughout. This can be a dangerous sign, such as an asthmatic suggesting they are not ventilating or could be normal for some patients such as those with COPD.

### Added Sounds

If the added sounds are louder on one side than the other, this could be due to increased added sounds on that side or decreased breath sounds on the other side.

### What types of added sounds are there?

#### Crackles / Creps

Crackles / creps – short interrupted sounds which can be due to airflow trying to pass moving secretions or the opening of deflated airways as air passes through narrowed airways.

You can hear crackles/ creps at different phases, which will give you an idea of where in the lung they are:

- 📍 Early expiratory phase – upper lobes
- 📍 Mid – end expiratory phase – mid to lower lobes
- 📍 Late inspiratory – dependant lung areas or suggestive of pulmonary oedema

### Wheeze

A continuous wheeze sound caused by vibration of airway walls.

- Polyphonic – high pitched wheeze caused by bronchospasm or early pulmonary oedema. (cardiac wheeze)
- Non-polyphonic – a low pitched wheeze caused by sputum, tumours or foreign bodies.

### Pleural Rub

Caused by inflammation of the pleura – roughening of the pleural surface. Sounds like boots crunching on snow. Usually localised, normally painful to the patient on inspiration.

**Note: It is important that you auscultate before and after treatment and document both. This gives you the opportunity to evaluate how effective your treatment has been.**

# Chest X-ray interpretation

All x-rays will be available on PACS – please ensure that you have access and know how to use this programme. You should be able to review a chest x-ray and comment on it in your notes.

## Technical Quality

- ✚ Check the right name, date and hospital number.
- ✚ Make sure you know whether the x-ray is AP or PA. This will affect the size that the heart appears to be, your interpretation of which side the problem is and the visibility of the right middle lobe. Do not always assume that the heart is on the left.
- ✚ Observe patient position, does it show all of their lungs? Are they rotated?

## Easy way to review x-rays

A - Airway  
B - Bones  
C - Cardiac  
D - Diaphragm  
E - Exposure  
F - Fields  
G –Gadgets  
H – Hidden areas

### A – Airway

- ✚ You should be able to see the main bronchus to the carina where it bifurcates into the right and left bronchi.
- ✚ Is it deviated to either side?
- ✚ Is there an airway on the x-ray, such as a tracheostomy in situ?

### B – Bones

- ✚ Is the x-ray rotated in any way? Check by looking at the clavicles to see if they are symmetrical, if they are rotated, then this could cause one lung to appear larger and more penetrated, therefore black.
- ✚ Are there any fractured bones, such as the ribs?

### C – Cardiac

- ✚ The width of the heart should be no more than half the width of the chest.
- ✚ The edge of the mediastinum should be clear.
- ✚ 1/3 of the heart width should lie to right of the midline, 2/3 to the left and the cardiac borders should be clear.

### D – Diaphragm

- ✚ Outlines should be smooth, clear and dome shaped.
- ✚ The right hemi diaphragm should be higher on the left, approx 3.5cm.
- ✚ Clear costophrenic angles should be present.



## E – Exposure

- ✚ When exposure is correct, the vertebral bodies should only be visible down to the lower part of the heart shadow.
- ✚ If you can see them clearly, then the film is over-exposed and the x-ray will be darker throughout.
- ✚ If you can barely see them, then the film is under exposed.
- ✚ Remember white - under exposed as in underpants! or black - over exposed as in burnt toast!

## F – Fields

- ✚ Both lungs should be equally translucent.
- ✚ They should appear black with lung markings throughout.
- ✚ Increased vascular markings are present in the hilar regions, higher on the right than on the left.
- ✚ Check for abnormal shadowing.
- ✚ Remember on a female patient, her breasts will be visible which can make viewing the x-ray more difficult depending on their size!

## G – Gadgets

- ✚ Items attached to the patient will show up on x-ray, such as ECG leads, artificial airways such as ETT or tracheostomy, pacemakers, nasogastric tubes, drains, lines, stents and valve replacements.

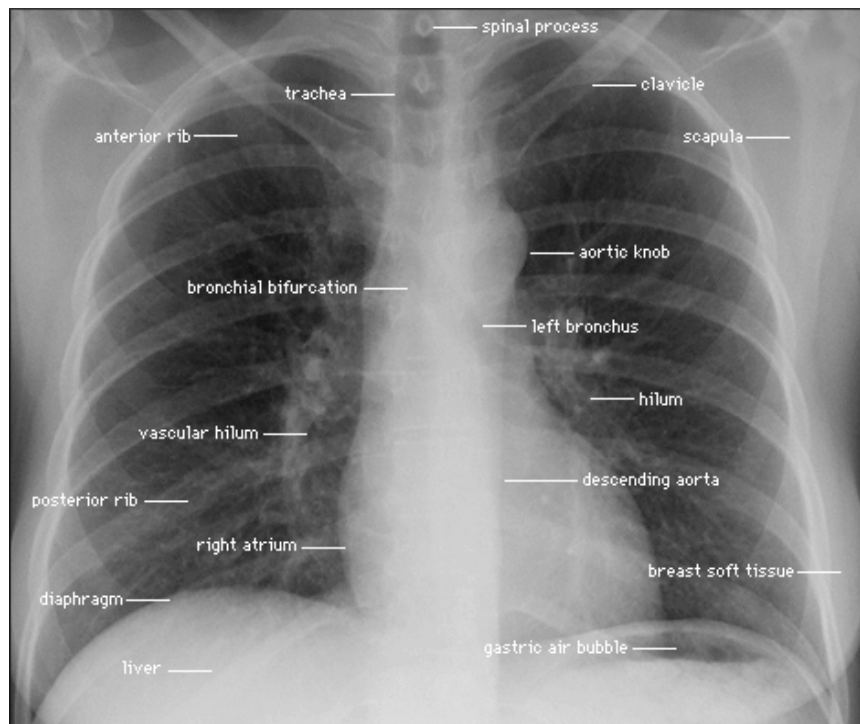
## H – Hidden areas

- ✚ There are certain conditions which can be seen on a chest x-ray but have not been covered in the previous categories. This refers to conditions such as surgical emphysema which can be in the skin tissue around the lungs.
- ✚ Abdominal issues: such as hernias and perforations which can be seen and can help to explain your auscultation findings. Free gas may be visible, if in conjunction with a raised diaphragm this should be discussed with the medical team.

## What do different pathologies look like on x-ray?

- Collapse – partial or complete – loss of volume to an area meaning normal landmarks are distorted. Trachea is normally deviated towards the collapsed side.
- Consolidation – Less uniform appearance, shadowing, poorly defined borders, no mediastinal shift.
- Bullae – Densely black area with a fine white outline.
- Pulmonary Oedema – Bat's wings appearance, can have an enlarged heart.
- Pleural Effusion – fluid line which can be concave or horizontal, dense opacity.
- Pneumothorax – Black area, no lung markings, mediastinum can be shifted away from affected side and you may see surgical emphysema.
- Ground glass appearance - widespread fine grainy appearance indicative of widespread inflammatory changes +/- fibrotic changes.

## Normal Chest X-ray



Now familiarise yourself with some other conditions and how they may appear on chest X-ray.

This chest x-ray shows COPD – Chronic Obstructive Pulmonary Disease, note the increased lung markings and the hyper inflated lungs.



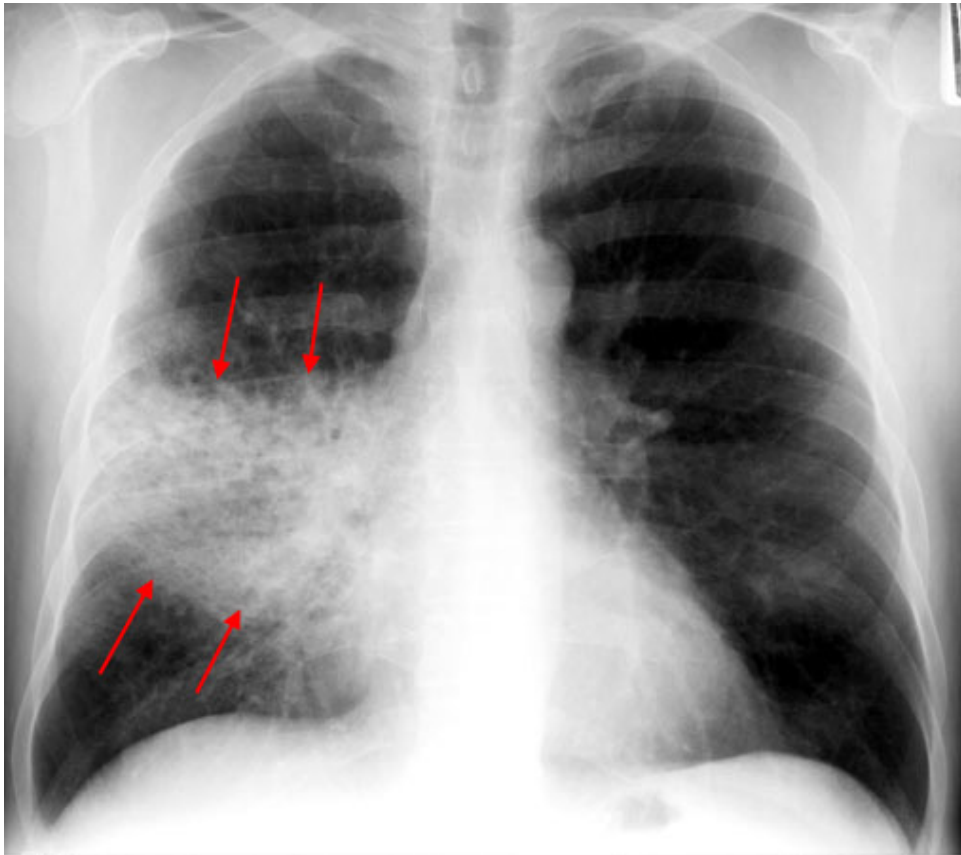
This x-ray shows a large emphysematous Bullae – this is the large black area in the right upper lung. This would mean that you would not use IPPB / NIV as this could cause it to worsen and cause a pneumothorax.



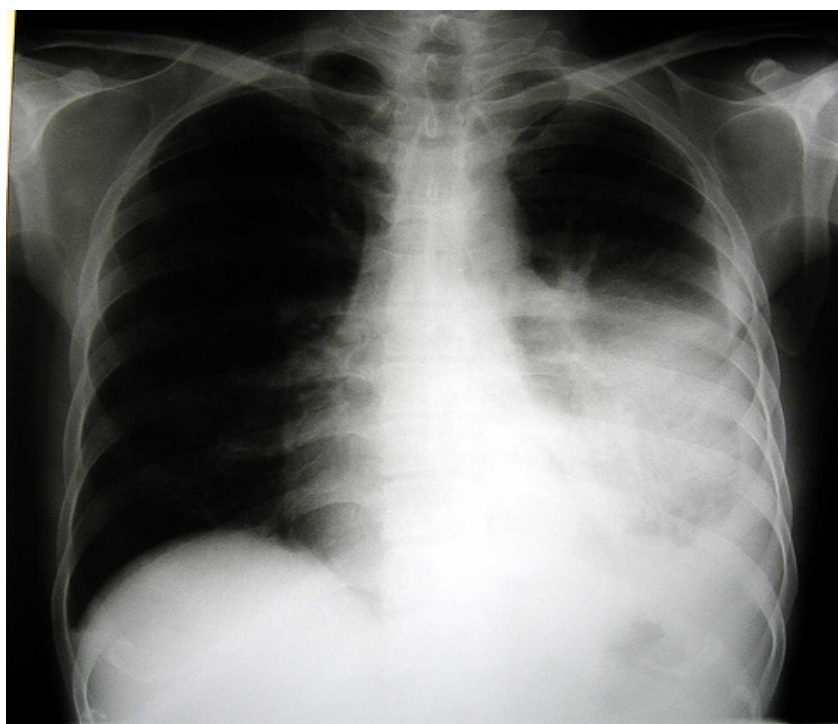
This Chest x-ray shows a tension pneumothorax with multiple left sided fractured ribs. Urgent medical input is required before any physiotherapy is done with this patient.



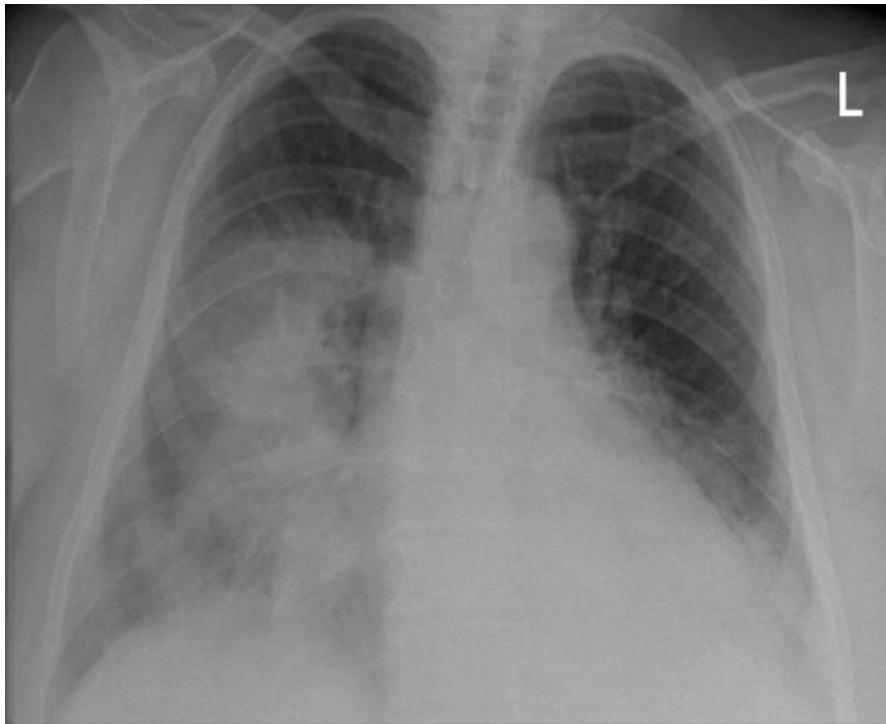
The next chest x-ray shows a right middle lobe pneumonia as identified by the red arrows. Note the right heart border is obscured and there is clear increased marking / white out in the right middle lobe. Physiotherapy can do a lot for this patient to help loosen and clear secretions.



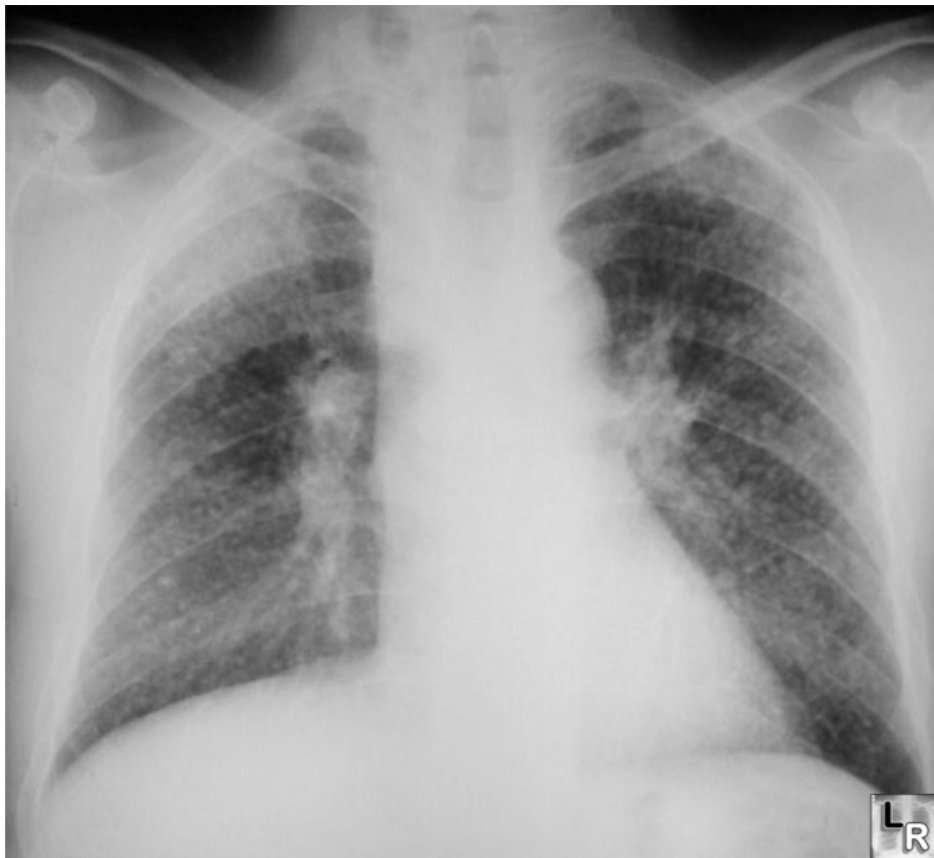
This chest x-ray shows an advanced left pleural effusion. It is clear that it is an effusion due to the flat clear line of fluid which can be seen. There is normally very little physiotherapy can do except advise on positioning and oxygen. This would need to be treated by the medical team by the insertion of a chest drain.



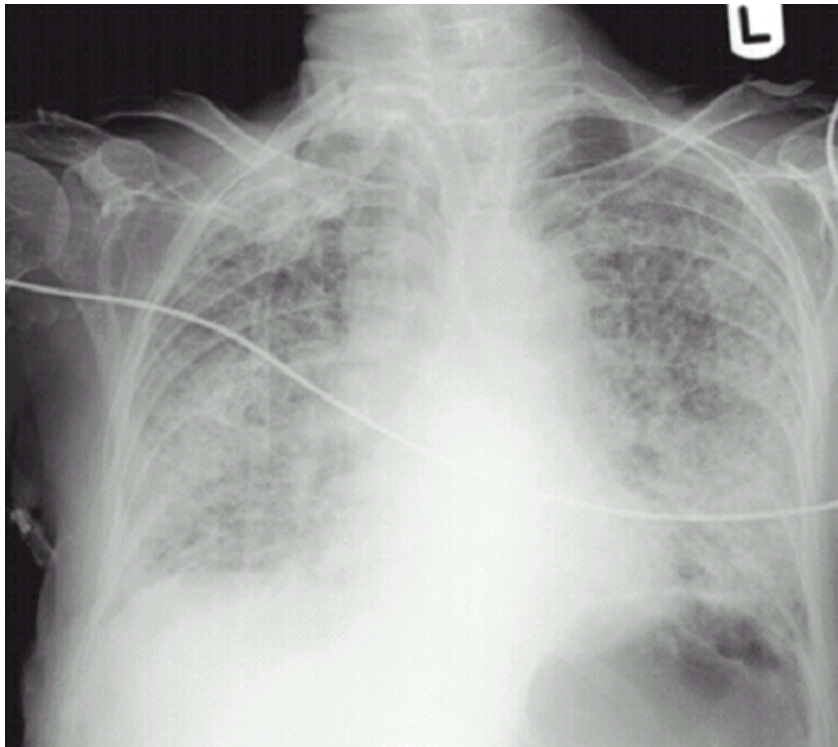
This next chest x-ray clearly shows a widespread right basal and middle lobe consolidation with some loss of volume at the left base as well.



The following chest x-ray is a very good example of ground glass appearance. This is suggestive of inflammatory changes +/- fibrosis.



This chest x-ray shows an advanced ARDS picture (Acute respiratory distress syndrome). This patient was ventilated but his chest gradually worsened to what you can now see.



The final chest x-ray shows a patient who has had a pneumonectomy – this means that the whole of the right lung has been removed. In this case it was due to lung cancer.





## Arterial Blood Gases

Arterial blood gas measurements give an indication of ventilation, gas exchange and acid-base status. They are normally taken from the radial artery at the wrist.

### Normal Values (they do vary in different reference sources)

pH	7.35 – 7.45
PaCO <sub>2</sub>	4.6 – 6 KPa
PaO <sub>2</sub>	11 – 14 KPa
HCO <sub>3</sub>	22-26 mmol/l
Base Excess	-2 to +2

- ✚ pH indicates your body's overall acid base balance.
- ✚ CO<sub>2</sub> indicates your respiratory status.
- ✚ HCO<sub>3</sub> and BE indicates your metabolic status.
- ✚ PaO<sub>2</sub> – partial pressure of oxygen dissolved in blood plasma in arterial blood.
- ✚ PaCO<sub>2</sub> – partial pressure of carbon dioxide dissolved in arterial blood.
- ✚ SaO<sub>2</sub> – extent to which haemoglobin in arterial blood is saturated with oxygen (normal level of 95 – 100%)
- ✚ Hypoxaemia – reduced oxygen in arterial blood caused by hypoventilation, diffusion abnormality and inadequate oxygen therapy. (PaO<sub>2</sub> less than 8Kpa or saturations below 90%)
- ✚ Hypoxia – reduced oxygen at tissue level, more relevant than hypoxaemia but difficult to measure. This can be due to decreased cardiac output, decreased oxygen carrying capacity (anaemia), decreased blood flow and retained secretions.
- ✚ Hypercapnia – Increased PCO<sub>2</sub> in arterial blood
- ✚ Hypocapnia – decreased PCO<sub>2</sub> in arterial blood

### Arterial Blood Gas analysis

This is essential in monitoring respiratory failure and determining its cause.

Excess PaCO<sub>2</sub> will cause acidosis in acute respiratory failure.

In chronic respiratory failure the body will compensate by renal retention of bicarbonate.

### Method of analysis

- ✚ Evaluate the pH
- ✚ Evaluate Ventilation (PaCO<sub>2</sub>)

- ✚ Evaluate metabolic status ( $\text{HCO}_3$  and BE)
- ✚ Evaluate oxygenation ( $\text{PaO}_2$ )
- ✚ Identify primary and compensating disorder

### The pH

$\text{pH} < 7.35 - 7.40 = \text{acidosis}$

$\text{pH } 7.40 - > 7.45 = \text{alkalosis}$

You can have respiratory or metabolic acidosis or alkalosis, examples of all four are given below:

Respiratory Acidosis	pH	7.30
	$\text{PCO}_2$	8.3
	$\text{PaO}_2$	5.6
	$\text{HCO}_3$	24
	BE	1.0
Respiratory Alkalosis	pH	7.50
	$\text{PCO}_2$	3.5
	$\text{PaO}_2$	8.2
	$\text{HCO}_3$	23
	BE	0.3
Metabolic Acidosis	pH	7.32
	$\text{PCO}_2$	5.5
	$\text{PaO}_2$	12.4
	$\text{HCO}_3$	19
	BE	-4
Metabolic Alkalosis	pH	7.52
	$\text{PCO}_2$	4.2
	$\text{PaO}_2$	11.4
	$\text{HCO}_3$	32
	BE	8

On an ABG there are other values recorded as well, such as lactate and Hb. These values can tell you important information which can link to your physiotherapy assessment. For example a low Hb can cause shortness of breath.

### Causes of Acidosis

- ✚ Acute metabolic or respiratory change within the body, such as infection, sepsis, diabetes and renal failure.

### Causes of Alkalosis

- ✚ Problems such as hyperventilation, anxiety, asthma, vomiting and dehydration.



## Compensation

If the pH is improving or within normal limits, then compensation is occurring within the body. The respiratory system (PCO<sub>2</sub>) can compensate for a metabolic problem within hours, therefore you should see the pH improve quickly back to normal levels. However if the problem is respiratory, the metabolic system (HCO<sub>3</sub> and BE) can take several days to compensate and get the pH back to normal.

This means that you can have complete or partial compensation depending on whether the pH is back to normal levels.

### For example:

Respiratory Acidosis	pH	7.32	Complete compensation	7.38
	PCO <sub>2</sub>	7.6		7.4
	PaO <sub>2</sub>	6.5		7.2
	HCO <sub>3</sub>	23		28
	BE	1.4		8.6

This ABG could be suggestive of a patient with COPD with long term respiratory failure which has metabolic compensation.

## ABG Test

Interpret these ABG results and if you are unsure please ask for one of the Senior Respiratory Physiotherapists to go through the answers with you.

1) pH 7.31  
PCO<sub>2</sub> 7.0  
PaO<sub>2</sub> 7.5  
HCO<sub>3</sub> 22  
BE 2

2) pH 7.48  
PCO<sub>2</sub> 5.4  
PaO<sub>2</sub> 12  
HCO<sub>3</sub> 30  
BE 7.6

3) pH 7.31  
PCO<sub>2</sub> 4  
PaO<sub>2</sub> 13.3  
HCO<sub>3</sub> 20  
BE -3.5

4) pH 7.52  
PCO<sub>2</sub> 3.4  
PaO<sub>2</sub> 12  
HCO<sub>3</sub> 25  
BE 1.8

5) pH 7.25  
PCO<sub>2</sub> 11.2  
PaO<sub>2</sub> 5.4  
HCO<sub>3</sub> 32  
BE 8.6

# Respiratory Failure

## Definition

'Acute respiratory failure occurs when the pulmonary system is no longer able to meet the metabolic demands of the body.'

## Normal Respiration

The respiratory system performs the vital function of gaseous exchange. Oxygen is transported through the upper airways to the alveoli that diffuses across the alveolar capillary membrane and enters the capillary blood. There it combines with haemoglobin and is transported by the arterial blood to the tissues. In the tissues the oxygen is utilised for essential metabolic processes. The major product of cellular metabolism is carbon dioxide, which diffuses from the tissues into the capillary blood and transported to the lungs by venous blood. In the lungs it diffuses from the pulmonary blood into the alveoli and is exhaled into the atmosphere.




Respiration is accomplished and regulated by an intricate set of structures, these include:

- 1) The lungs which provide the gas exchange surface.
- 2) The conducting airways that convey the air into and out of the lungs.
- 3) The thoracic wall that acts as a bellows and supports and protects the lungs.
- 4) The respiratory muscles that create the energy necessary for the movement of air in and out of the lungs.
- 5) The respiratory centres with their sensitive receptors.

## Types of respiratory failure





**Type I respiratory Failure** -  $\text{PaO}_2$  less than 8kPa (hypoxaemia) with a normal or low  $\text{PCO}_2$ .

Causes:

-  Conducting airway problems (i.e. severe asthma)
-  Alveolar problems (i.e. pneumonia, pulmonary oedema, atelectasis)
-  Pulmonary vasculature (i.e. pulmonary embolism)

**Type II respiratory failure** -  $\text{PaO}_2$  less than 8kPa with a raised  $\text{PCO}_2$  above 6.5kPa (hypercapnic and hypoxaemia).

Causes:

-  Inadequate flow in the alveoli causing carbon dioxide to build up (i.e. neurological problems, obstructive disorders such as COPD)
-  Reduced breathing effort (i.e. tired patient)
-  Increased resistance to breathing (i.e. asthma)
-  Increase in the area of the lungs that is not available to gas exchange (i.e. emphysema)

### Potential signs of hypoxaemia

- Cyanosis
- Tachypnoea
- Increased cardiac output
- Tachycardia
- Peripheral vasoconstriction
- Respiratory muscle weakness
- Restlessness, confusion, coma

### Potential signs of hypercapnia

- Flapping tremor of hands
- Tachypnoea
- Tachycardia
- Peripheral vasodilation, warm hands and headache
- Respiratory muscle weakness
- Sweating
- Altered mental status – drowsiness, hallucinations, coma

### Other signs of respiratory distress

- Accessory muscle use
- Nasal flaring
- Intercostal, suprasternal and supraclavicular recession
- Bradycardia
- Hypotension or hypertension

### Causes of respiratory failure

There are numerous causes, a few are listed below:

- Pneumonia / Infection
- Exacerbation of COPD
- Acute lung injury
- Pulmonary oedema
- Congestive cardiac failure
- Post Operative
- Pneumothorax
- Inhalation injury
- Atelectasis
- Muscle weakness / fatigue

### Physiotherapy interventions

Type I respiratory failure:

- Oxygen therapy
- Positioning
- Active clearance techniques
- Mobilisation
- IPPB

- CPAP if oxygen is already as high as possible and deemed appropriate by the medical team.

Type II respiratory failure:

- As for type I respiratory failure, except BiPAP, not CPAP
- Remember IPPB can help to blow off PCO<sub>2</sub> but it should not be used purely for this (See section on IPPB).

Physiotherapists can suggest NIV but we are not responsible to set up NIV. If you assess a patient who you feel needs non-invasive ventilation, liaise with the doctors and write your recommendation in your therapy notes. Doctors can then contact the Critical Care Outreach team or Radnor if they feel it is appropriate.

# Oxygen and Humidification

## When is oxygen therapy needed?

Room air is normally 21% oxygen.

If the patient has saturations below 95% or a PaO<sub>2</sub> below 8Kpa, which is abnormal for that patient, then oxygen therapy needs to be considered.

The doctors should write on the drug chart a saturation range for that patient and the oxygen can then be titrated to maintain those saturation levels.

## COPD and Oxygen

Some but not all COPD patients are dependent on hypoxaemia for respiratory drive; therefore increased oxygen concentrations may impair their respiratory function (knock off their respiratory drive). Symptoms of this could include twitching, drowsiness, agitation, confusion and shortness of breath.

The doctors should take an arterial blood gas (ABG) to determine whether that patient CO<sub>2</sub> retains or check back through the patients medical records to see whether they CO<sub>2</sub> retain based on old ABG results.

If a COPD patient needs more oxygen, then check the ABG and liaise with the doctor. Remember that saturations in the high 80's may be normal for that patient.

Not all COPD patients retain CO<sub>2</sub>, there is a much higher chance of a patient dying with hypoxia, then hypercapnia.

## Oxygen Delivery

- Nasal Cannulae
- High Flow performance masks
- Humidified Oxygen
- Non-rebreathe mask
- Nebulisers

## Nasal Cannulae

Advantages – patient can talk, cough, eat, drink. It is less claustrophobic compared to a mask, often used for long term oxygen patients.

Disadvantages – low flow system, unmeasurable amount of oxygen which the patient is receiving.

They should not be used above 4L due to potential damage to the nasal passages. Nasal Specs do not need humidification, the nose has a natural humidification system which warms and filters air going into the lungs.



Rough guide to flow rates and percentages:

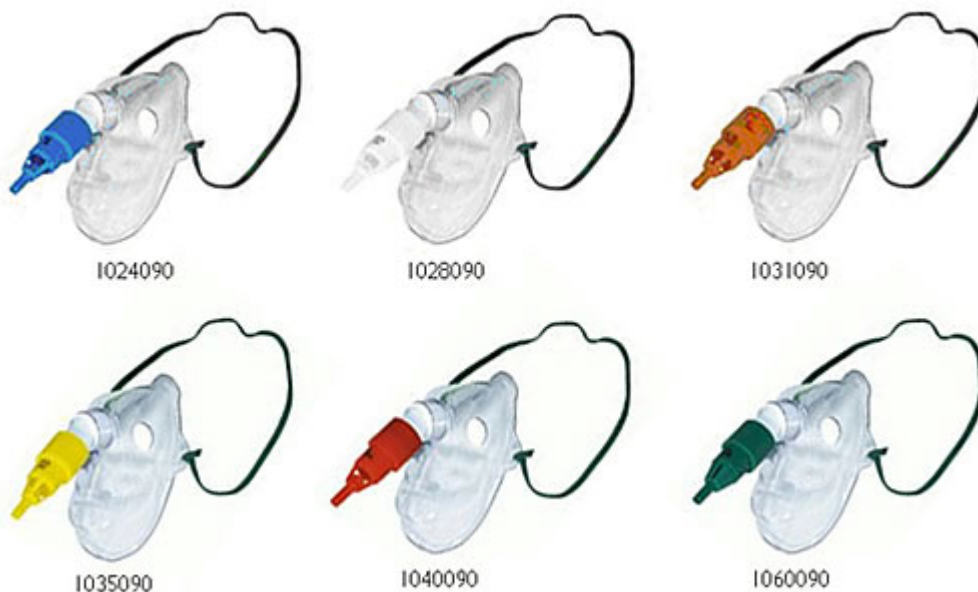
- 1L/ Min = 24%
- 2L/ Min = 28%
- 3L/ Min = 32%
- 4L/ Min = 36%

### Venturi valve Masks

Advantages – delivery of oxygen is accurate and measured due to the entrained valve.

Disadvantages – patients may feel claustrophobic with masks and there is a lower amount of humidification when compared to the respiflo system.

### Concentration levels:



- |     |        |         |
|-----|--------|---------|
| 24% | Blue   | 3L/Min  |
| 28% | White  | 6L/Min  |
| 35% | Yellow | 10L/Min |
| 40% | Red    | 12L/Min |
| 60% | Green  | 15L/Min |

### Humidified Oxygen

If the patient requires more than 4L/Min of oxygen then their oxygen should be humidified. This is because the oxygen can be drying which can thicken secretions and cause damage to the airways. Patients with tracheostomies should always have their oxygen humidified to help keep secretions loose and their chest clear.



### Different humidification systems:

- ✚ Cold – respiflo humidification system
- ✚ Heated humidified system – creates vapour by passing gas over hot liquid, as it cools along the tubing to the patient, it reaches relative 100% humidity at 37 degree C. You would consider heated humidification for tracheostomy patients and those patients with thick secretions which are difficult to clear.

### Advantages of humidification

- ✚ Aid sputum clearance
- ✚ Avoid drying and damage to airways from dry oxygen
- ✚ Can help with airway dilation

### Disadvantages of humidification

- ✚ Patients can be affected by the noise of the system
- ✚ Some patients find heat irritates their chest
- ✚ Water / condensation can collect in the tubing, causing turbulence which can affect the oxygen delivery.

### Cold Humidified Systems – respiflo system

#### Levels of Oxygen:

- ✚ 28% delivered via 5L / Min
- ✚ 35%, 40%, 60%, 80%, 98% delivered via 8L / Min.

( Be aware that the patient will not be receiving this percentage of oxygen as some of the concentration is lost in the tubing and around the mask.)

### Heated humidified Systems

There are two systems within the hospital – on the wards the heater unit is put into the cold circuit.

On Radnor ward, they use Fischer Paykel humidification systems which are separate units to heat the oxygen / ventilation pressure being delivered.



### Non-rebreathe Bag

- ✚ This should be used when a patient needs oxygen urgently during an acute phase or a significant deterioration.
- ✚ It should be set at 15L / Min.
- ✚ Before applying it to the patient, the bag must be filled up with oxygen.
- ✚ As soon as the patient is stabilised, they should be changed to humidified oxygen.
- ✚ Research shows that after 24-48 hours of dry high flow oxygen, irreversible lung damage can be caused.



### Nebulisers

Nebulisers can be delivered through compressed air or oxygen. If a patient has COPD and is known to CO<sub>2</sub> retain, then their nebuliser should be put through a porta-neb which uses compressed air or the air port on the wall. If using oxygen, it should be set at 6-8L / Min.



### Changing Oxygen

If you are making any changes to oxygen, either turning it up or down, you should inform the nursing staff of what changes you have made and that their saturations are being maintained between the prescribed level set by the doctors on the drug chart.

Your first concern should be hypoxia, as patients would die from this first not hypercapnia.



## Fluid Balance

- ✚ Assessment of fluid balance is an important element of all respiratory examinations.
- ✚ Information can be obtained from fluid balance charts, investigations and objective examination.

### Fluid Balance Charts

Look over the last few days, input and output should roughly match. (remember if the patient came in with dehydration, then they will try and get their fluid balance positive to correct this)

Inputs include: oral, NG, IV, infusions of drugs and blood transfusions.

Outputs include: Urine, Diarrhoea, Wounds, chest drains, vomit, insensible loss (sweating which can allow 500-700mls/day)

The ideal urine output is 1ml/kg/hr and the minimum accepted per hour is 0.5ml/kg/hr. If after one hour the urine output is low, they will allow another hour to see if it improves, if not, then fluids will be given.

Normal overall fluid balance is +0mls to +500mls. If the patient is dehydrated this will thicken retained secretions. If the patient is overloaded, then the patient may have pulmonary oedema or be at risk of developing it.

Surgical patients – remember these patients may have large discrepancies due to large losses or gains in theatre.

If input is more than output, this suggests fluid overload due to renal failure (associated with deranged urea and creatinine), cardiac failure or arrhythmias, profound malnutrition or restoration of fluid status after dehydration.

If output is more than input this suggests resolving previously overloaded state, fluid depletion or dehydration. This may be associated with dry secretions, low blood pressure or hypovolaemic shock.

### Signs of overload:

- ✚ Peripheral oedema
- ✚ Chest x-ray is fluffy with fluid in the horizontal fissure, pleural effusions, ? enlarged heart
- ✚ Auscultation: fine inspiratory creps in dependant areas (i.e. bases), overall wet sounding
- ✚ Raised central venous pressure (CVP 3-15cmH<sub>2</sub>O)
- ✚ Raised JVP
- ✚ Frothy white or pink sputum

### Signs of dehydration:

- ✚ Low BP
- ✚ High HR

- ✚ Decreased skin turgor
- ✚ Thirst / dry mouth
- ✚ Concentrated urine
- ✚ Low CVP
- ✚ Patient report of thirst, tiredness or being light headed
- ✚ Thickened secretions

## **Positioning and V / Q Matching**

Positioning is a primary part of physiotherapy treatment as treatments will not be effective if performed in an inappropriate position.

Positioning should be continued in between physiotherapy sessions and you should advice nursing staff on the positions which are best for that patient, it should be a MDT approach.

In bed patients often assume a supine position, this however could be associated with:

- 1) Decreased lung volumes
- 2) Increased work of breathing
- 3) Closure of dependent airways
- 4) Decreased Functional residual capacity

### **Why do we position patients?**

- 1) To aid sputum clearance
- 2) To reduce work of breathing
- 3) To increase lung volumes
- 4) V/ Q matching

### **Sputum clearance**

Position these patients side lying with the lung you are trying to clear upper most. This is utilising postural drainage, using gravity to assist with the drainage and then clearance of chest secretions (See postural drainage section for further information later in this workbook).

### **Reduce work of breathing**

There are a few different positions such as relaxed sitting, forward lean sitting and high side lying. You are trying to support them, facilitate the inspiratory muscles and bring the abdominal contents forward allowing the diaphragm more space to move. In patients with COPD this may be different. They may prefer to sit with their knees together or in the foetal position as the resistance from the abdominal contents underneath their flattened diaphragm may make their breathing feel more comfortable. Ultimately positions will depend on the patient and what is most comfortable for them.

### **Improving lung volumes**

Ideally use side lying to bring the abdominal contents forward, allow full excursion of the diaphragm, improve gas exchange, increase lung volume and decrease work of breathing.

### **V / Q Matching**

V = Ventilation. Moving air in and out of the lungs. The dependant (lowermost) lung is the best ventilated in non-ventilated patients because:

- 1) The upper alveoli are already more inflated as they are pulled open by the weight of the lung



2) The lower alveoli have more potential to expand

In a ventilated patient the uppermost lung will be the best ventilated as the positive pressure will take the path of least resistance.

Q = Perfusion. The presence of a blood supply to the alveoli. Due to gravity there is a steep perfusion gradient from apices to the bases, meaning that there is more blood at the base of the upright lung, but this may cause airway closure.

Optimal V/ Q matching occurs in the mid zones

Lung Volume has an effect on perfusion:

-  Blood vessels stretch in a hyper inflated lung
-  Blood vessels partly collapse at low lung volumes

### V / Q Ratio

When ventilation is reduced, hypoxic vasoconstriction can limit V / Q mis-matching by diverting blood to better-ventilated regions by local constriction (upper lobe diversion).

### Caution

Patients with a pleural effusion or pulmonary oedema should not be positioned in supine as the fluid will spread with gravity, you should sit these patients up into high sitting.

This is also the case for patients with a large bronchial tumour, do not position them in side lying as it can cause the bronchus to occlude.

### Postural Drainage

This is utilising gravity to assist with sputum clearance. These positions have been used for years and have been proven to work effectively. Some evidence suggests (Button, 2003) that head tipped down is no longer encouraged as side lying is suggested to be just as effective, patients will clear the same amount of secretions with fewer side effects. Potential complications with head tipped down include reflux, headaches, vomiting and dizziness.

If a patient has been doing head tipped down for several years with no problems, then allow them to continue. For new patients, encourage alternative side lying instead of head tipped down.

You would normally treat or advise a patient to utilise these positions for 20-30 minutes in each position. This will vary some patients will use one position for one treatment session and a different position for another treatment session in the same day.

## Airway Clearance Techniques

There are numerous clearance techniques which you could use with patients. These range from simple breathing exercises to more complex machines and techniques. Techniques can be used in conjunction with other techniques, such as ACBT with positioning or ACBT with manual techniques.

### ACBT - The Active Cycle Of Breathing Technique

A cycle used to increase lung volumes and help to clear secretions. This cycle involves breathing control / relaxed breathing, deep breathing, forced expiration technique (huff) and cough.

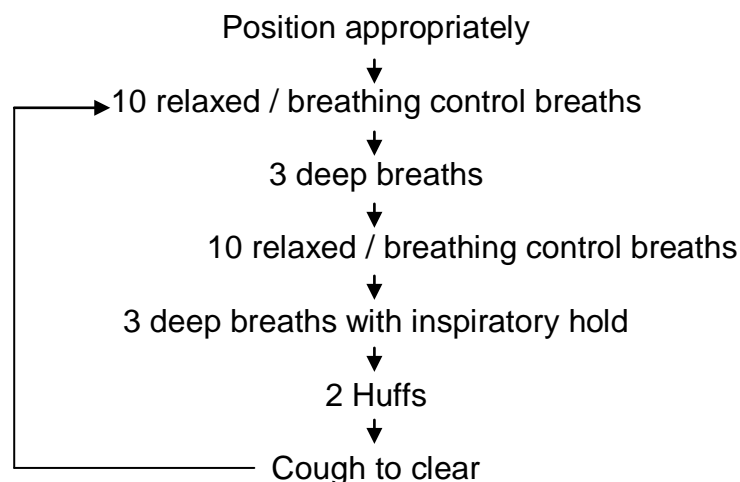
#### Indications

- ✚ Retained secretions
- ✚ Decreased tidal volumes
- ✚ Decreased mobility
- ✚ Chest optimisation to prevent infections

This cycle increases tidal volume to use collateral ventilation to get behind secretions and gradually bring them from the distal airways to the proximal airways, so that the patient can then huff / cough to expectorate them.

To do this technique, the patient needs to be awake, alert and following commands. Remember the cycle is not just about a deep breath and a cough, it should involve diaphragmatic breathing, deep breathing, deep breathing with an inspiratory sniff, deep breathing with an inspiratory hold, forced expiration technique and coughing.

An example cycle is illustrated below:



You should advise the patient to do this technique until their chest is clear or they are tired and need to rest. They should try to repeat this cycle every hour where possible.

### Manual Techniques

There are a number of manual techniques which can be used with patients and can be used with other techniques, such as ACBT, suctioning and IPPB.

Manual techniques include percussion, vibrations, shakes and assisted coughing.

### Indications

- ✚ Retained thick secretions
- ✚ ACBT or suction alone not clearing secretions

Percussion is where you percuss over the chest wall with your hand in a cupped shape to provide an external vibration to the chest wall to help loosen secretions and make them more moveable within the lungs. It is important to use a towel between your hand and the patients skin to prevent any damage and to get feedback from the patient about the pressure in which you are using.

Vibrations is where you provide a vibration to the chest wall. You place both of your hands onto the chest wall, then as the patients exhale, you provide a firm pressure with vibrations until just before the end of expiration. Be sure to stop before the patient has fully expired to prevent atelectasis.

Shakes – these are similar to vibrations but involve a much greater movement using the whole arm. These may be more appropriate with patients who have a high BMI or dislike the sensation of vibrations.

Assisted Cough – this can be used for patients who are unable to cough independently to clear secretions due to a neuromuscular weakness. It can be a one person or two person technique. You place your hands / arms just below the patients rib cage, as the patient breaths out, your arm is brought in and up to assist with forced exhalation. Another alternative to this is the cough assist machine which is mentioned later.

### Precautions / contraindications

With manual techniques you should be aware of precautions associated with them and patients for whom they may not be appropriate. These precautions include:

Precautions:

- ✚ Cardiovascularly unstable
- ✚ Burns patients
- ✚ High respiratory rate
- ✚ Patient distress
- ✚ Abdominal pain
- ✚ Nausea (assisted cough)

Contraindications:

- ✚ Osteoporotic patients
- ✚ Bony metastases
- ✚ Multiple myeloma
- ✚ Fractured ribs
- ✚ Skin grafts to chest areas within 5 days of grafting
- ✚ Recent sternotomy
- ✚ Chest pain
- ✚ Active vomiting (assisted cough)

## Adjuncts

You may come across a patient who has an adjunct such as a flutter device, acapella, pari PEP or inspiratory muscle trainer. If a patient has been given one of these devices, they are to aid sputum clearance either by giving an internal vibration by affecting airway flow to help loosen secretions (flutter, acapella) or by creating positive expiratory pressure to help hold open airways to aid with sputum movement (pari PEP). The patient should have also been shown how to use the device and have an advice leaflet about the device (leaflets available on ICID). In an on call situation you do not need to use this device with the patient, they should be independent with the device and been using it before you arrived.



## Autogenic Drainage

This is a more complex breathing cycle which some patients may have been taught which involves using different sized lung volumes to loosen, collect and clear secretions. If a patient has been taught this technique, they will have been given an advice sheet and you would not be expected to teach them the technique.

## **IPPB – Intermittent Positive Pressure Breathing (BIRD)**

This is a machine which delivers inspiratory positive pressure to increase tidal volume and use collateral ventilation to help clear secretions. You need to have been assessed competent to set up and use this machine with patients, which involves being aware of risk factors, precautions and contraindications.



### **Indications**

- ✚ Retained secretions
- ✚ Ineffective deep breath
- ✚ Ineffective cough

### **Precautions**

- ✚ Surgical emphysema
- ✚ Increased airway resistance
- ✚ Increased WOB
- ✚ Barotrauma
- ✚ Gastric distension
- ✚ Flail chest segment / # ribs
- ✚ Agitated / confused / non-compliant patient
- ✚ Singulation (hiccups)

### **Contraindications**

- ✚ Undrained pneumothorax
- ✚ Large bullae
- ✚ Proximal bronchial tumour
- ✚ Active TB
- ✚ Unstable CVS
- ✚ Intracranial pressure >15mm Hg
- ✚ Recent facial, oral or skull surgery
- ✚ Tracheoesophageal fistula
- ✚ Recent oesophageal surgery
- ✚ Active haemoptysis
- ✚ Active vomiting

### **Setting up the BIRD**

You need to ensure that the patient has had an x-ray within 24 hours and this has been checked by a F2 or above prior to commencing the BIRD.

Set up the circuit and ensure that you use a filter, so that the BIRD can be used for multiple patients.



You can use either a mouthpiece or mask, which ever is best for your patient. Always use normal saline in the circuit to provide moist air, dry air will not help with sputum clearance it would do the opposite. You can use a bronchodilator in the nebuliser chamber if your patient has some mild bronchospasm, the doctor should prescribe this for you.

If you need to use air instead of oxygen with the BIRD, then ask porters to switch over the cylinder to a medical air cylinder, contact them on bleep 1313.

Starting settings – start with a flow 7, sensitivity 7 and pressure 10 and then alter settings according to your patient.

Flow = how quickly the pressure is delivered to the patient, the higher the flow, the more quickly the pressure is met (i.e. high flow for high RR)

Sensitivity = how hard or difficult is it for the patient to trigger the machine. Generally keep the sensitivity low unless you are doing muscle training with the patient.

Pressure = the amount of inspiratory pressure the patient is receiving (cm H<sub>2</sub>O)

### Birding a patient

Always have the patient connected to a saturations probe to monitor oxygen saturations and heart rate throughout treatment.

How many breaths – a rough guide is 3 sets of 10 breaths allowing a rest in between each set. Some patients will feel lightheaded with the deeper breaths and oxygen, so allow for this by resting in between. You should aim to do 3-4 sets, but no more as this will tire your patient. Encourage your patient to huff and cough between sets and at the end. You may need to consider suction alongside the BIRD if the patient is still unable to clear.

How often – this is down to your assessment. If a patient has a lot of secretions and is only able to clear them using the BIRD, then you may want to use it every few hours.

If you use the BIRD and the patient dislikes it or can clear more effectively without it, then stop using it and document this clearly for colleagues to see why the technique was stopped.

The patient should not use the BIRD without you present and the nursing staff are not trained to use it, therefore should not be doing so.

### Trouble shooting

Patient unable to trigger – reduce your sensitivity level until the patient does trigger and make sure there is a good seal around the mouthpiece or mask to prevent leaks.

Machine does not cut out to allow expiration – check mask / mouth piece seal for leaks, reduce inspiratory pressure until the machine reaches the pressure and allows for expiration.

Patient coughing during sets – stop using the BIRD and encourage the patient to huff and cough to clear secretions, then try using the BIRD again.

Patient desaturating during BIRD – stop using the BIRD and put the patient back onto their normal oxygen. Wait for saturations to return to normal. Check your oxygen is connected to the BIRD, check whether your inspiratory pressure is high enough, check to see if the patient needs to clear secretions. If it continues to happen, stop using the BIRD and document this outcome.

#### After birding

You should be using the BIRD alongside ACBT or suctioning for sputum clearance, so try and get the patient to clear after using the BIRD. Once you have finished check the patient is stable by doing a set of observations and auscultate prior to leaving to evaluate your treatment session.

Do not leave saline in the circuit, clean it out, as it will leak everywhere and can cause problems with stale saline being reused from an infection point of view. Remember, does the next person know that you actually used saline?

Place the circuit into a clear bag, labelled with the patient's details and leave it with the patient, to protect from infection.

# **Non-Invasive Ventilation**

## **What is NIV?**

NIV is the use of either negative/ positive pressure/ volume ventilation (without the use of an endotracheal tube) to augment an individual's ventilation and correct hypoxic or / and hypercapnic respiratory failure.

Non invasive ventilation (NIV) refers to the provision of ventilatory support through the patients upper airway using a mask or similar device.

*(BTS Guidelines 2002)*

## **What are the indications for the use of NIV?**

### **Type I respiratory failure (CPAP):**

- ✚ Pulmonary oedema
- ✚ Obstructive sleep apnoea
- ✚ Weaning from mechanical ventilation

### **Type II respiratory failure (BiPAP):**

- ✚ COPD ( $\text{PCO}_2 > 7.5\text{KPa}$  and acidotic pH – specific to COPD patients)
- ✚ Obesity hypoventilation(OHS)
- ✚ NMD
- ✚ Chest wall deformity
- ✚ Weaning from mechanical ventilation
- ✚ Bridge to transplant

### **Other Indications:**

- ✚ Ventilatory support for patients that are not suitable for intubation and ventilation
- ✚ Acute on chronic respiratory failure with chest wall deformity or neuromuscular disease
- ✚ Acute pneumonia

Please note: If a patient has a pH of  $< 7.2$  intubation is normally considered due to increased mortality rates.

## **Advantages of NIV**

- ✚ Can be applied and removed according to the patients needs therefore making communication and mobilisation easy
- ✚ Complications such as URTI and LRTI and tracheal stenosis are avoided
- ✚ Patients very rarely require sedation
- ✚ Avoids intubation
- ✚ Early mobilisation
- ✚ Maintains nutrition
- ✚ Better patient morale

## **Disadvantages of NIV**

- ✚ Claustrophobia
- ✚ Facial pressure sores
- ✚ Airway not protected

- ✚ Difficulty accessing bronchial secretions for suction
- ✚ Time consuming
- ✚ Patient may not tolerate

### Types of NIV

- ✚ CPAP - Continuous Positive Airways Pressure throughout both inspiration and expiration.  
CPAP involves setting a PEEP (positive end expiratory pressure) which splints open the patients airways to improve alveolar ventilation and gaseous exchange.
- ✚ BIPAP - Bi-level Positive Airway Pressure that delivers a pre-determined positive pressure to a spontaneously breathing patient on inspiration and expiration with independent control of inspiratory and expiratory pressures. This involves setting an IPAP (inspiratory positive airway pressure) and an EPAP (Expiratory positive airway pressure, same as PEEP). The IPAP gives a larger tidal volume to help reduce carbon dioxide and the EPAP helps splint open the airways to improve oxygenation.

### Contraindications to NIV

- ✚ Undrained pneumothorax
- ✚ Frank haemoptysis
- ✚ Facial fractures/burns/trauma
- ✚ Raised ICP
- ✚ Active pulmonary tuberculosis
- ✚ Upper airway surgery
- ✚ Vomiting
- ✚ Inability to protect own airway






### Precautions to NIV

- ✚ Copious bronchial secretions
- ✚ Severe co-morbidity
- ✚ Confusion/agitation
- ✚ Upper gastrointestinal surgery
- ✚ CVS instability
- ✚ Lung abscess
- ✚ Haematemesis
- ✚ Proximal lung tumours

### Physiological effects of NIV

- ✚ Improved oxygenation
- ✚ Reduction in PaCO<sub>2</sub>
- ✚ Correction of acidosis
- ✚ Decreased work of breathing
- ✚ Reduced sensation of breathlessness
- ✚ Improved quality of sleep
- ✚ Reduced mortality

## Interfaces

-  Nasal Masks
-  Full face masks
-  Nasal Pillows
-  Mouth piece
-  Tracheostomy

There are numerous different interfaces available, when you are on call you are not expected to know them, but it is just so that you are aware there are different options.

## Humidification

All patients who are on NIV should have it humidified. This is normally done using heated humidification in the form of a Fischer paykel system as previously mentioned. If patients just use their NIV overnight, then they may not normally have humidification, but when they are unwell due to a chest infection, due to presence / increase in chest secretions their NIV should then be humidified.

## On call

You can treat a patient on NIV with normal techniques such as ACBT, PD and Manual techniques. They can remove the mask to communicate with you and to clear secretions by coughing / suctioning.

Any changes in the settings of an NIV machine should ALWAYS be performed by a medical professional who can interpret ABG's, clinically reason the changes and then monitor their impact / effectiveness.

During an on call situation, the only person changing settings should be the doctor or CCOT. If you are called regarding problems with an NIV machine, you should advise them to contact CCOT for assistance.

## The Cough Assist Machine



The cough assist machine (also known as insufflation and exsufflation) is a machine which uses lung volume recruitment to stimulate a cough. It is a mechanical way of using positive and negative pressure to clear secretions from the airways.

It works by giving positive pressure on inspiration and then shifting to negative pressure during expiration.

It needs to generate a peak flow of 300-660l/m to stimulate a cough.

It can be used via mask, ETT, Trache

### Why use it?

- ✚ Inability to cough.
- ✚ Other techniques fail.
- ✚ Neuromuscular conditions such as MND, muscular atrophy and spinal atrophy which require regular coughing to clear secretions to maintain a clear chest.
- ✚ Decreases risks involved with manual assisted cough.
- ✚ Greater independence for the patient.

### Settings

Manual / auto – you can work this machine manually to time with your patient or set up the machine to work automatically. You set a timing mechanism which alternates between inspiratory and expiratory cycle and pause phase.

You also set the:

- ✚ Inhale pressure – you should start with pressures of +15 / -15 then increase as tolerated to the optimal range.
- ✚ Inhale flow

Max treatment pressures are +40 / -40 cmH<sub>2</sub>O, but minimum effective pressures are +30 / -30 cm H<sub>2</sub>O. You can have unequal pressures, such as +30 / -35.

Before using it with a patient you need to be assessed to be competent to use the machine. You need to ensure that you set up the circuit, use a filter and you explain the machine to the patient. During an on call situation if a patient is already using the machine, then their settings should be documented. If you want to start using the machine, you need to ensure that you have had an x-ray within the last 24 hours

which has been cleared by a F2 and above and the doctors are happy for you to use the technique.

Please note for the spinal unit, patients must have the cough assist machine prescribed. If the Spinal Physiotherapists have been using the machine already the patient will have a prescription and record of use in their red folder. If they have never used the machine, you will need the Spinal consultant to prescribe the machine and settings for you before you can start.

Do not use the machine with patients who do not have a neuromuscular or permanent muscle weakness. This machine should only be used currently with this patient group.

The Respironics cough assist machine cannot be used with oxygen entrained, but the clear way machine can be used with oxygen.

#### How often should it be used?

- ✚ About 4 Sessions / day
- ✚ Each session 3-5 cycles, each cycle consisting of insufflation and exsufflation
- ✚ Always finish your session on insufflation to avoid airway collapse following exsufflation (negative pressure)
- ✚ Before meals and at bedtime
- ✚ Avoid hyperventilation – no more often than 10 mins

#### Tracheostomies

The cough assist can be used with tracheostomies, you need to obtain an adaptor, the cuff needs to be inflated and for cuffless tracheostomies use via mask / mouth or trache site.

#### Contraindications

- ✚ Pneumothorax
- ✚ Bullous emphysema
- ✚ Recent barotrauma
- ✚ Impaired consciousness / inability to communicate

#### Precautions

- ✚ Cardiac instability / arrhythmias
- ✚ Chest pain, dyspnoea

#### Potential problems with the cough assist

It may cause chest pain from over-stretched intercostal muscles  
It may cause early closure in flaccid airways (CF, Bronchiectasis)

## Suctioning

For all types of suctioning you should have been assessed and deemed competent as per the competency framework. This is especially the case for naso-pharyngeal suctioning and the insertion of NP airways.

### Indications

- ✚ Retained secretions
- ✚ Unable to clear secretions with other techniques, such as ACBT.
- ✚ Decreased oxygen saturations / PaO<sub>2</sub>
- ✚ Increased work of breathing
- ✚ Clear pooled upper respiratory tract secretions

### Methods of suctioning

- ✚ Nasopharyngeal with or without an airway
- ✚ Oral-pharyngeal with airway
- ✚ Tracheostomy
- ✚ Yanker suction orally
- ✚ Closed suction unit on the ventilated patient

### Precautions

- ✚ Previous epistaxis (NP route)
- ✚ Cardiac instability (tachycardia)
- ✚ Intracranial surgery
- ✚ Bronchospasm
- ✚ Partial airway obstruction
- ✚ Trauma / bleeding
- ✚ Bradycardia (especially spinal patients)
- ✚ Correct tracheostomy inner tube
- ✚ Undrained pneumothorax

### Contraindications

- ✚ Active epistaxis
- ✚ Acute neck, facial or head injury (particularly basal skull fractures, CSF leakage and raised ICP – especially NP suction)
- ✚ Inhalation injury
- ✚ Severe bronchospasm
- ✚ Cardiac instability (Fast AF, VT, VF, low BP)
- ✚ Severe coagulopathy and / or frank haemoptysis
- ✚ Recent oesophageal or tracheal anastomosis
- ✚ Airway obstruction – not from secretions

### Nasopharyngeal airway and suction

- ✚ Used to clear retained secretions.



- ✚ Should always try ACBT and yankeur suction first, then escalate to NP suction.
- ✚ Should always use an airway if suctioning regularly to decrease nasal trauma.
- ✚ Airway size should be measured for the patient using their little finger or the distance from edge of nose to ear lobe.
- ✚ Catheter size – most adults you should use a size 10 or 12, but can use a size 14 if secretions are very thick and the airway allows.
- ✚ Suction pressure of 150 - 200mmHg.

### Oral-Pharyngeal suction

- ✚ Use this type of suctioning when a patient has an ETT in place and you can suction through this.
- ✚ Try to avoid suction with a soft catheter through the mouth unless there is a guedel airway in place, use a yankeur or NP suction instead.

### Tracheostomy

- ✚ Check the size of the tracheostomy to ascertain what size catheter you can use. On most tracheostomies you would use a size 10 or 12 catheter.
- ✚ Rough guide to work out what catheter size, take the tracheostomy size x2 and then -2 to obtain the right catheter size to use.
- ✚ Sterile technique to minimise risk of further infection to the patient.
- ✚ Depending on the type of tracheostomy in situ, you need to ensure what inner tube is in situ. If the patient has a fenestrated tracheostomy, you need to ensure that before you suction you have the non-fenestrated (always white capped) tube in situ as this does not have a hole, through which you could cause damage to the trachea.

### Yanker suction

- ✚ Using a yanker to the back of the mouth to clear retained secretions.
- ✚ Always try ACBT and yanker suction on the conscious patient before considering NP suction.

### Suctioning technique – ventilated patient

- ✚ Most patients have a closed circuit in place.
- ✚ Consider optimal positioning of your patient first.
- ✚ Pre-oxygenate for 2 mins – press pre-oxygenate button on the ventilator and the mute alarm as when you suction the ventilator will alarm.
- ✚ Connect catheter to suctioning tubing, check pressure of 150 - 200mmHg
- ✚ Open suction valve in the closed circuit
- ✚ Slide the catheter down the patent airway, until the patient coughs or you feel a block, place thumb on suction and slowly pull back, pausing if you feel lots of secretions.
- ✚ You have 10-15 seconds of suctioning time, so don't rush.
- ✚ Suction again if indicated.
- ✚ Ensure patient is stable CVS post suction.
- ✚ Check oxygen has returned to normal and clean suction tubing.
- ✚ Re-auscultate to evaluate your treatment post suctioning.

## Suctioning technique – non-ventilated patient

- ✚ Personal protective clothing – gown, gloves and goggles
- ✚ Position your patient appropriately for the treatment session.
- ✚ Pre-oxygenate for 2 mins, increase oxygen through the face mask / tracheostomy mask.
- ✚ Explain the procedure to the patient, if doing NP suction, they will feel burning at the back of the nose and their eyes may run, but advice them to try and continue breathing gently throughout.
- ✚ Turn on suction and check the pressure is correct.
- ✚ Connect catheter to suction tubing.
- ✚ Put on sterile gloves.
- ✚ Lubricate tip of catheter with gel (not required if you have an airway in situ, including NP airway).
- ✚ With your thumb off the suction, slide the catheter through the airway (NP aim towards the occiput) when the patient coughs or you feel a block, put your thumb on suction and start to pull the catheter out.
- ✚ If you feel lots of secretions, then remain at the place for 2-3 seconds, then continue to withdraw.
- ✚ You can suction for up to 10-15 seconds.

## Problems with suctioning

- ✚ Trauma – can cause capillaries to burst and blood stained secretions, especially with NP airways being put in.
- ✚ Damage to mucosa
- ✚ Unstable CVS
- ✚ Laryngospasms – patient stops breathing, catheter feels stuck, get help quickly.
- ✚ Apnoea post suctioning – the patient through coughing has an apnoea event

## Post-suctioning

- ✚ Turn oxygen back to normal
- ✚ Turn off suction and clean tubing.
- ✚ Check patient CVS stable
- ✚ Auscultation to evaluate treatment
- ✚ Ensure nursing staff are aware of the treatment session, any problems and continuing care.

# **Manual Hyper-inflation**

## **Definition**

‘ A technique that uses a manual bag circuit to deliver a breath 1.5 times greater than that being delivered by a ventilator, where the ventilator is recording a tidal volume of up to 700mls’ (Clapham et al, 1995)

## **Indications**

- ✚ Atelectasis
- ✚ Retained secretions
- ✚ Assess lung compliance
- ✚ Chest maintenance

It can help to reverse atelectasis (Lumb, 2000), sustain improvement in lung compliance and oxygen saturation and improve sputum clearance. (Hodgeson et al, 2000)

## **Precautions**

- ✚ PEEP greater than 10
- ✚ Lung surgery in last 14 days
- ✚ Unstable BP
- ✚ Raised ICP
- ✚ Risk of barotrauma
- ✚ Recent # ribs
- ✚ Cardiovascular instability

## **Contraindications**

- ✚ Undrained pneumothorax
- ✚ Severe bronchospasm
- ✚ Peak airway greater than 40cm H<sub>2</sub>O
- ✚ PEEP greater than 15
- ✚ 100% oxygen
- ✚ Haemoptysis
- ✚ Large Bullae
- ✚ Surgical emphysema
- ✚ Recent surgery with a high anastomosis

## **Benefits and risks**

Benefits – Increased volume, splint open airway to re-open atelectasis, clear secretions.

Adverse effects – barotrauma, Arrhythmias, increase ICP, reduce respiratory drive, bronchospasm, loss of PEEP, pulmonary oedema, patient distress, patient apnoeic on the ventilator afterwards.

## Equipment needed

- ✚ 2L bag used for adults
- ✚ HME filter
- ✚ Manometer
- ✚ Catheter mount
- ✚ Gloves and apron
- ✚ Goggles
- ✚ Oxygen
- ✚ Suction equipment

## How to set up MHI circuit and perform MHI

- 1) Put on apron and gloves
- 2) Assess your patient and decide whether MHI is indicated and appropriate.
- 3) Consent from your patient and/or nurse
- 4) Ensure your nurse is free to help you, MHI always needs 2 people.
- 5) Position your patient appropriately based on what lung areas you are trying to ventilate / clear.
- 6) Connect MHI bag to the HME filter, catheter mount and manometer
- 7) Ensure the valve on the MHI is fully open to start
- 8) Connect the tubing to the oxygen source and set flow at 15L/min
- 9) Reassure the patient about what is about to happen
- 10) Put on protective goggles
- 11) Disconnect the patient from the ventilator at the end of inspiration and connect to the catheter mount.
- 12) Begin MHI and use the techniques below.
- 13) Monitor throughout, watch the patient, observations and feedback from feeling any resistance in the bag.
- 14) Do not exceed pressures of 40cmH<sub>2</sub>O as measured on the manometer.
- 15) Open the valve prior to suctioning to minimise resistance to coughing and reduce risk of barotrauma.
- 16) Manual techniques can be used during MHI.
- 17) Ensure that your technique is at a rate to maintain the patient's minute volume.
- 18) To finish MHI, at the end of inspiration, connect the patient back to the ventilator and monitor.
- 19) Ensure that the patient is stable by reviewing their observations, auscultation and ventilator readings prior to leaving.

## Techniques

- ✚ A slow deep inspiratory phase – increase tidal volume
- ✚ An inspiratory hold of 1-2 secs – encourage collateral ventilation to help remove secretions
- ✚ A rapid release of the bag to stimulate a huff – secretion clearance using the elastic recoil of the lungs.

## Saline bolus

At times it may be appropriate to use saline instilled into the lungs to aid with sputum clearance. This is not appropriate routinely and should be assessed in the same way as any other physiotherapy technique. During MHI sometimes secretions are very thick and difficult to clear with suction. A saline bolus may help, by using 2-3mls of saline down the ETT or tracheostomy and then suction back to help dislodge

secretions and allow them to be suctioned. This should be used when it can be clinically justified, please note that this is not supported by an evidence base.

### Troubleshooting

Resistance in the bag – if you feel this then you may not have the valve completely open, the patient may be coughing or trying to breathe against you or the patient may have very stiff and fibrotic lungs. Open your valve to relieve this and try to work your MHI breaths with what the patient is trying to do.

Patient coughing – open the valve and suction to try and clear secretions and then try slow inspiratory breaths to help the patient to settle.

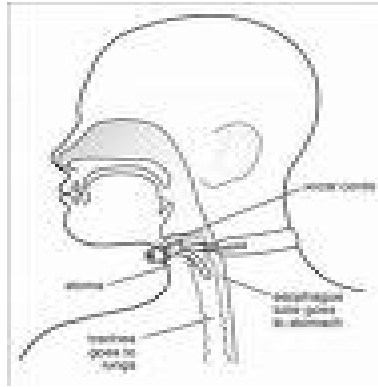
Patient becomes unstable – this may be changes such as the patient desaturates or become bradycardic – if this occurs then put the patient back onto the ventilator and monitor until their observations return to normal.

Patient becomes distressed – try slow inspiratory breaths, try to work with the patient, but if they do not settle, then transfer their circuit back to the ventilator.

The patient does not breathe back on the ventilator – this can be quite common mainly because the nursing staff may give the patient a sedation bolus during MHI and / or the patient may have become used to receiving controlled breaths. Ensure they are put onto a mode of ventilation which supports them and allow the nursing staff to try and wean them back to their normal mode later once the sedation has worn off.

The nursing staff on Radnor are trained to use MHI, so they can always do this while you do suctioning or manual techniques.

# Tracheostomies



## What is a tracheostomy?

Surgical opening in the anterior wall of the trachea to facilitate ventilation. The tube enables air flow to enter the trachea and lungs directly, thus bypassing the nose, pharynx and larynx.

## Physiological changes

- ✚ A tracheostomy tube reduces the upper airway anatomical dead space by up to 150ml or 50%.
- ✚ This benefits the patient by reducing the effort required for breathing, when compared to oral endotracheal airway management and concurrently increases alveolar ventilation whilst reducing airway resistance.

## Indications

- ✚ To facilitate weaning from positive pressure ventilation in acute respiratory failure and prolonged ventilation.
- ✚ To secure and clear an airway in upper respiratory tract obstruction risk.
- ✚ To facilitate removal of bronchial secretions.
- ✚ To protect / minimise aspiration risk in absence of laryngeal reflexes.
- ✚ To obtain an airway in patients with injuries or surgery to the neck and head.

## Percutaneous Tracheostomy

The Griggs technique – dilating forceps to form a stoma, a guide wire is then inserted, the tracheostomy is then threaded over the guide wire and into the trachea, the guide wire and forceps are then removed.

Ciaglia technique – use of a guide wire with a series of dilators which are placed over the guide wire and gradually increase the size of the stoma, then the tracheostomy is inserted.

## Surgical Tracheostomy

Performed in theatre, normally by ENT consultant.

An incision is made over the second and third tracheal rings approx 4-5 cm in length to which the tracheostomy is inserted.

## Types of Tracheostomy Tubes

### Portex and Shiley

**Portex** – short term immediate tracheostomy, cuffed and needs changing in 7-10 days. You can get removal inner tubes for these tracheostomies, therefore they may be used for longer than 10 days.

**Shiley** – long term tube, various types, manufacturers recommend changing every 28 days, is being left longer 2-3 months in the community.



### Shiley Tracheostomies

Different types:

- ✚ Cuffed or uncuffed
- ✚ Single lumen or double lumen
- ✚ Fenestrated (hole in the tube) or non-fenestrated

### Function of the Inner tube

The inner tube is important should a tracheostomy become blocked as it can be easily removed to open the airway or it is important to cover a fenestrated tube so that when you are suctioning, you are not able to push the suction catheter out of the tracheostomy against the trachea.

### Function of the cuff

The cuff is in situ to create a air tight seal to maintain pressure from ventilation support in the lungs and to prevent aspiration of oral saliva and protect the airway. Most tracheostomy cuffs do not create an airtight seal therefore patients do experience some aspiration of saliva and some air coming up through into their mouth.

### Oxygen

If a patient who has a tracheostomy is requiring oxygen then this can be delivered through a tracheostomy mask – which would sit over the tracheostomy and should always be humidified.

### Speaking Aids

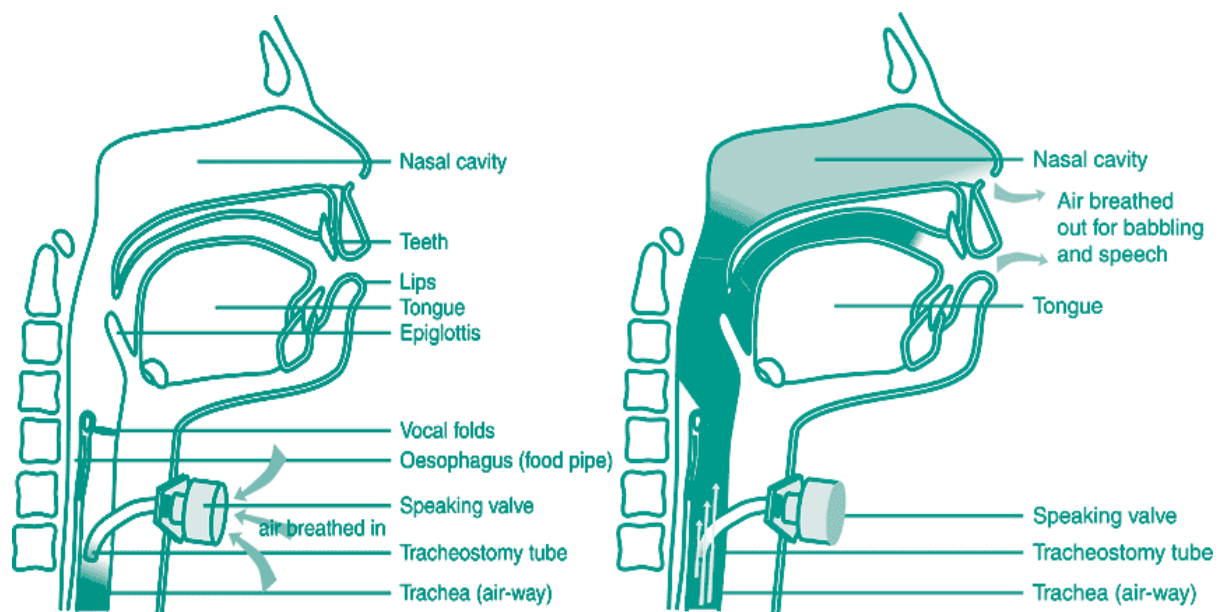
There are two main types of speaking valves which can be used onto a tracheostomy with the cuff deflated to allow speech:

- 1) Passy Muir Valve
- 2) Rusche Valve

### How do speaking valves work?

They have one way valves, which means that during inspiration the valve is open, allowing air into the lungs, but on expiration, the valve closes forcing the air up through the larynx and pharynx, enabling speech as the air passes through the vocal cords.

### Speaking Valve In Action



### Essential bedside equipment

It is important that all patients have the correct equipment bedside the bed should the tracheostomy need changing in an emergency. This is equipment includes:

- ✚ Suction equipment
- ✚ Emergency tracheostomy kit – contains two spare tracheostomy tubes, one the same size and one smaller.
- ✚ Cuff manometer
- ✚ Spare inner tubes
- ✚ Irrigation water
- ✚ Syringes
- ✚ Sterile gloves

### Signs of respiratory distress

It is important to be aware of what signs may suggest a problem with the tracheostomy, these include:

- ✚ Increased work of breathing
- ✚ Increased RR



- ✚ Cyanosis
- ✚ Accessory muscle use
- ✚ Decreased SpO<sub>2</sub>
- ✚ Intercostal, suprasternal and supraclavicular recession
- ✚ Decreased tidal volumes if being measured

#### Complications immediately after insertion

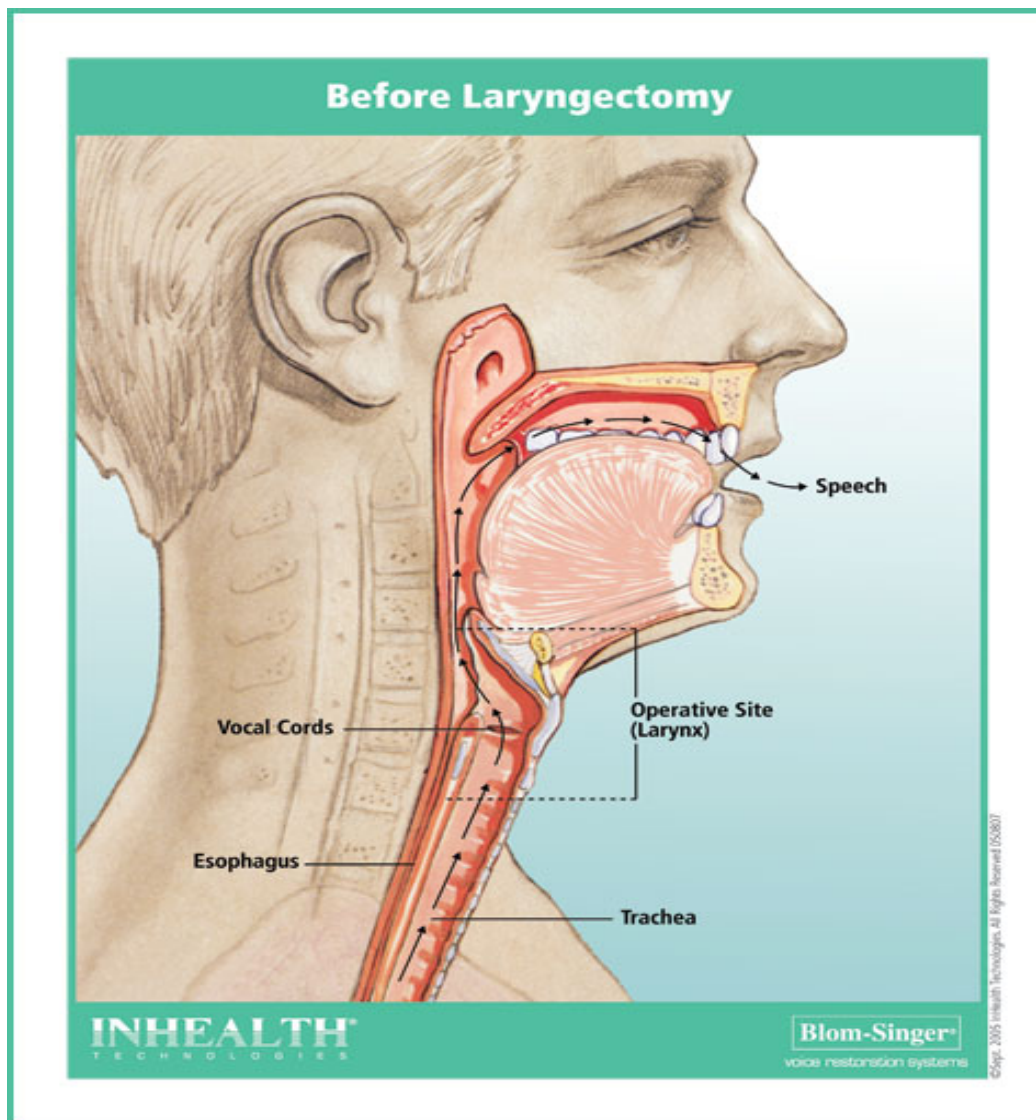
It is possible when changing or inserting a tracheostomy tube that complications may occur, these include:

- ✚ Trauma / bleeding
- ✚ Airway irritation
- ✚ Inability to ventilate

#### Further complications which may occur later include:

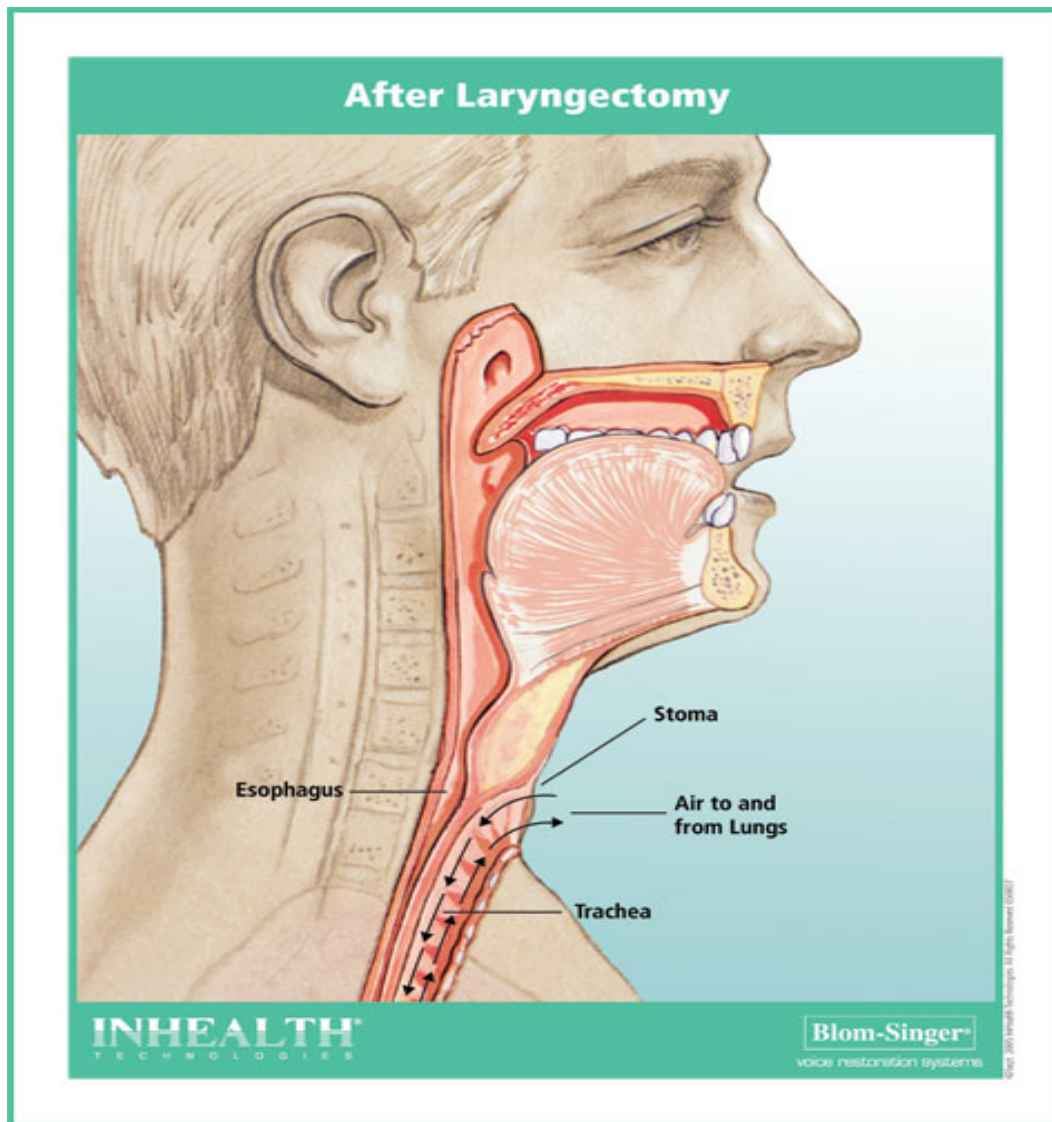
- ✚ Granulation
- ✚ Trauma / bleeding
- ✚ Secretions plugging
- ✚ Dislodgment of the tube
- ✚ Cuff leak

# Laryngectomies



## What does a laryngectomy involve?

- ✚ Complete removal of larynx
- ✚ Pharyngeal wall closed and trachea brought forward to create stoma
- ✚ Pharyngo-oesophageal segment is upper oesophageal sphincter. Composed of inf. pharyngeal constrictor muscle, cricopharyngeus and upper fibres of oesophagus
- ✚ Tonicity essential for function as pseudo-glottis
- ✚ Tonic at rest and relaxes on swallow



### Respiratory Management

- ✚ Permanent 'neck breathers'. Take air directly into trachea. No natural means of warming, moisturising and filtering air. Therefore if administering oxygen, this should be given by a humidified tracheostomy mask over the stoma.
- ✚ Most patients normally will wear a heat/moisture exchange (HME) filter over the stoma to humidify their air, which should be removed if delivering humidified oxygen via the stoma.
- ✚ Suctioning this patient group should be done via their stoma.
- ✚ Your main concern should be their airway, not speech.
- ✚ Some patients may have a one way valve fitted into a fistula between the oesophagus and trachea, which allows voice and prevents aspiration. If the patient is a likely aspiration and has this valve, ENT should be contacted to review if the valve is still patent.

# Modes of Ventilation

This is an area where you should have a basic understanding of what the different modes of ventilation are and the basic differences between them. You need to ensure that you are familiar with the main modes of ventilation used in this hospital, so that you are competent to interpret their settings when you are on call.

## Classification

There are two basic categories:

- ✚ Controlled - where the ventilator initiates the breath
- ✚ Assisted - where the patient initiates the breath with ventilator support

The mode chosen will depend on how much of the work of breathing the patient can perform. Patients on a controlled mode are normally heavily sedated and can therefore be considered to be more unwell.

Within the basic categories there are also sub-sections which refer to whether the patient is on full ventilatory support or partial ventilatory support. Full ventilatory support occurs when a patient is unwell and is unable to contribute to their own breathing, whereas partial ventilatory support means that the patient is able to contribute to their work of breathing and the ventilator assists this effort.

## Breaths

This describes what mechanism causes the ventilator to cycle from inspiration to expiration:

- ✚ Mandatory (controlled) – the ventilator is preset to do this after a certain amount of time
- ✚ Assisted (SIMV, PS) – the ventilator recognises effort from the patient and works with them
- ✚ Spontaneous (CPAP) – the patient is in control and does this automatically

## Mode or Breath Pattern

- ✚ CMV – controlled mechanical ventilation – this is where the ventilator has been preset with RR and tidal volume and does not work with any of the patients efforts to breathe. It is appropriate for patients such as guillian barre, drug overdose and those heavily sedated. If a patient is on this mode of ventilation they are unable to follow commands or assist with physiotherapy. They tend to be more unwell on this mode of ventilation.
- ✚ Assist-control – this is similar to CMV, but if the patient tries to initiate their own breath, the ventilator will recognise this.
- ✚ Intermittent mandatory ventilation (SIMV, PSIMV) – this mode is a mix of controlled and spontaneous breaths. The ventilator has been preset with RR and tidal volume, but the patient can trigger their own breath. In P-SIMV the ventilator will support the patients attempt to initiate a breath and work with them.
- ✚ Pressure support – this mode is where the patient has control over all aspects of his/her breath such as RR and tidal volume. The ventilator during this mode will monitor airway pressures and any apnoea and will alarm if there are any concerns.

# High Frequency Oscillatory Ventilation (HFOV)

## Indications:

- ✚ Difficult to ventilate patients
- ✚ Patients requiring high pressures and PEEP i.e. ARDS

## Aims of HFOV:

Damage of stiff lungs may be caused in conventional ventilation by the large changes in pressure and volume required. The HFOV allows the use of high mean airway pressures (MAP) but without the large changes in volume. It is therefore a lung protective strategy to prevent barotrauma due to the excessive pressures required to ventilate patients with poorly compliant lungs.

## Settings:



- Mean airway pressure (mPaw):

Achieves oxygenation by applying and maintaining inflation and recruitment of the lungs. It is the main determinant of oxygenation. Usually set initially at 5cmH<sub>2</sub>O above the mean airway pressure that was used during conventional ventilation. It is increased according to ABG results until adequate PO<sub>2</sub> is achieved whilst allowing weaning down FiO<sub>2</sub>. Maximum levels used are 45-55 cmH<sub>2</sub>O

Large drops in mPaw should be avoided so that the lungs are not de-recruited. This is achieved by avoiding disconnection of the patient from the oscillator and being cautious when suctioning. A method of intermittent suctioning is helpful in minimising large drops in mPaw. Press alarm silence button prior to suctioning.

During suctioning, the mPaw will decrease and may cause the oscillator to stop. The nursing staff will be familiar with this and will be able to restart the oscillator. It is therefore advisable to have the nurse with you at all times.

- Delta P (amplitude/power):

The most effective determinant of PaCO<sub>2</sub>, this is the initial setting that should be altered to lower PaCO<sub>2</sub>. The power should be initiated at a level that is sufficient to allow the patient to vibrate down to mid thigh. Increased by increments of 5-10 cmH<sub>2</sub>O to decrease PaCO<sub>2</sub> as required.

- Frequency:

This is a determinant of PaCO<sub>2</sub>. This is effectively the rate of delivery of the oscillations. 6Hz = 6 oscillations per second. Usually initiated at 6 Hz it should be decreased to lower PaCO<sub>2</sub> (opposite to conventional ventilation) Generally the frequency should not be set lower than 4Hz.

### Physiotherapy considerations

- ✚ On observation the patient should be oscillating to mid-thigh and there should be equal chest movement on both sides.
- ✚ Auscultation and palpation should be done to assess for symmetry and presence of sputum.
- ✚ If the patient is not oscillating symmetrically, suspect sputum plug, ETT position change, pleural effusion or pneumothorax.
- ✚ Rising mPaw or PCO<sub>2</sub> may also indicate presence of sputum.
- ✚ Suctioning to clear sputum should be done after pre-oxygenating and using intermittent application of suction pressure when withdrawing the catheter. Use of saline lavage(2-5 mls) will increase effectiveness of suctioning.
- ✚ If no cough reflex is present this may be due to the patient being muscle relaxed to enable them to tolerate the oscillator. In this case use of an assisted cough during suction could be tried.
- ✚ If there is no cough reflex and the patient is not muscle relaxed, it could be that a reduction in sedation is appropriate to allow a cough.
- ✚ If still no sputum is cleared then consider change of position of the patient to supine +/- head down tip in cardiovascular stable patients.

## **Common Drugs**

There are a number of drugs which patients may be on which you need to be aware of or to ask the doctor to prescribe.

### **Mucolytics**

Many of the patients you are called to will have retained secretions. As well as looking at their fluid balance, you may need to consider what medication they are on, which could help loosen secretions.

These include nebulisers such as normal saline, parvolex and tablets such as carbocysteine / erdosteine.

### **Bronchodilators**

It is important that if you recognise a patient who has bronchospasm that you ask for medication to be optimised to help in the form of bronchodilators. For immediate bronchodilation, short acting beta 2 agonists such as salbutamol (ventolin) or short acting anticholinergics such as atrovent (ipratropium bromide) but also for long acting version such as serevent and formoterol to maintain long lasting bronchodilation.

Some times bronchodilators are needed to be given IV for example during an asthma attack, this may consist of IV salbutamol or IV magnesium.

Normally if a patient has that much bronchospasm, physiotherapy is limited until medication to allow bronchodilation has taken effect.

### **Steroids**

For some patients bronchodilators are not enough to bronchodilate their airways because they have inflammation as well as bronchospasm. For these patients they are normally on steroids. The most common steroid will be prednisolone, but remember a lot of the inhalers have steroids in them, such as pulmicort or seretide. For patients on long term steroid use, be aware of bone density and other associated problems when deciding on treatment techniques.

### **Sedatives**

These will be used in intensive care to sedate patients whilst they are being ventilated. These drugs include propofol, mizaolam and morphine. You should note if the patient is sedated and what drug they are receiving. If the patient is heavily sedated the patients cough reflex may be suppressed impacting on sputum clearance.

### **Inotropes**

These will be used if the patient is cardiovascularly unstable in intensive care. They are drugs which act on the heart. Dopamine is used to increase blood supply to the kidneys in a low dose, but can also be used with Dobutamine for patients in cardiogenic shock.

Noradrenalin is used for patients who are hypotensive, it vasoconstricts causing the blood pressure to rise.



### Anti-arrythmics

These are drugs given when the patient has an irregular heart beat, such as atrial flutter. These drugs include digoxin, amiodarone and lignocaine.

### Analgesics

These are drugs given to control and relieve pain. They include weak analgesics such as paracetamol and aspirin. Moderate analgesics such as co-proxamol, dihydrocodeine, co-codamol and co-dydramol. Then there are strong analgesics such as morphine, diamorphine, fentanyl.

Non-steroidal anti-inflammatory drugs may also be given which relieve pain and inflammation, these include diclofenac and ibuprofen.

In the case of an opiate overdose, drugs such as Naloxone. The signs of opiate overdose include pin point pupils, depressed respiratory rate and drowsiness.

### Anti-biotics

There are a number of different anti-biotics depending on the type of infection. These can be given IV, nebulised or orally and include ciprofloxacin, amoxiclav, clarithromycin, augmentin, erythromycin and flucloxacillin.

### Anti-coagulants

Drugs which are given to prevent or treat deep vein thrombosis and / or pulmonary emboli. These include heparin, clexane, fragmin and warfarin.



# Acute Spinal Cord Injuries

## Acute Phase

Following a spinal cord injury, the important information to know:

- ✚ Level of injury – fracture levels and resulting neurological deficit
- ✚ Complete or incomplete
- ✚ Mechanism of injury (e.g. diving injury → potential aspiration etc)
- ✚ Spinal stability – consider need for shoulder hold – see below
- ✚ Other injuries
- ✚ Past medical history

This will then give you the understanding of the impact of the spinal cord injury on respiration, and what precautions or contraindications there are to treatment.

## Precautions

- ✚ If a patient has confirmed or suspected unstable / unfixed cervical fracture, then a shoulder hold may be needed for:
  - Leg ROM
  - Manual Techniques – which should be bilateral shakes and vibes
  - Assisted Cough
  - Suction
  - Moving bed clothes

It is the responsibility of the spinal consultant to specify what precautions are needed and they should be documented in the medical notes.

In the event of any uncertainty about precautions required, contact the spinal consultant on call.

- ✚ Unstable or unfixed fracture at T10 or below, limit hip flexion to 45°. Limit hip abduction to the edge of the bed, or less if pelvic movement is observed.
- ✚ Ensure INR is within therapeutic range prior to lower limb passive ROM to decrease risk of Pulmonary Embolism.

## Assessment

You should assess this patient using the A,B,C,D,E approach.

By the time you are called to see them, their airway will be protected and their respiration needs should have been addressed.

## Treatment

You can treat with normal techniques, but some care is needed with certain techniques.

- ✚ Manual techniques – these can be used if secretions are present with suctioning and MHI if required. You need to be aware of any other injuries such as thoracic injuries and consider precautions needed for spinal

stability as detailed above. You may need two people to perform these techniques effectively.

- ✚ MHI – if the patient is conscious then careful timing is required to coordinate with their breathing pattern – watch their abdomen rise and fall; otherwise normal contraindications apply.
- ✚ Suction – there is a danger of bradycardia related to unopposed vagus stimulation from the suction catheter and from hypoxia. This can lead to cardiac arrest. Always pre-oxygenate and do not do deep, prolonged suctioning. Atropine should be at the bedside for nursing staff to give if bradycardia is not resolving – monitor heart rate during the suctioning procedure. See also ICID <http://iisint-fin/ICID/clinicalmanagement/respiratory/protocolforsuctioningviaatracheostomyCPr.asp>
- ✚ Positioning – regular turning (usually log rolling and supine) should be carried out every 3 hours. It is advantageous to plan your treatment around these turns. The spinal consultant will recommend how many staff are needed to turn depending on spinal stability, this should be documented in their medical notes.
- ✚ Assisted cough / Cough Assist machine – note precautions with these techniques include rib fractures and paralytic ileus (common in acute spinal cord injuries). You may be able to carry out a modified technique. You may need two people to perform these techniques effectively. You should be familiar with ALL the precautions. There is a detailed guideline on Assisted Coughing on ICID <http://iisint-fin/ICID/clinicalmanagement/spinalinjuries/AssistedCoughing.asp>

# Acute Burn Injuries

## Aims of chest physiotherapy

- ✚ Maintenance of the airway
- ✚ Removal of excess bronchial secretions
- ✚ Improve gaseous exchange
- ✚ Prevention and / or treatment of atelectasis
- ✚ Maintain range of movement as per precautions

## Assessment

Follow the A,B,C,D,E assessment as you would for any patient. If they have suffered an inhalation injury, then their airway should be secure and patent before your arrival.

## Acute Stage

During this stage depending on the severity of burns and inhalation, they will be some processes occurring which you should be familiar with.

There will be damage to the mucosa with an inhalation injury, this will involve ulceration, tissue necrosis, increased secretions, increased risk of atelectasis, increased risk of infection and reduced lung compliance.

Initially this patient will be overloaded, this is because the team are trying to fluid resus this patient as burns will dry out the body and its system. This will cause problems with their airway with pulmonary oedema alongside increased mucus and sloughing of the airway with reduced cilia action. It will also cause problems with their joint range of movement.

## Treatment

You can treat with normal techniques, but care needs to be taken with certain techniques.

- ✚ Manual techniques – care should be taken over a grafted area to avoid shearing (movement on the graft onto the area it is trying to take to) ideally for 5 days, but if it is essential to clear secretions and maintain their airway and you have already tried MHI and suctioning, then do so but with caution.
- ✚ NP suction – extreme care should be taken and if at all possible avoid this technique. The mucosa are already damaged and NP suction could cause excessive bleeding with inhalation injuries.
- ✚ Manual Hyperinflation – caution should be taken due to the increased risk of barotrauma due to the reduced compliance and high airway pressures. Patients may be more unstable, therefore will require close monitoring during MHI.

Points to note:

- ✚ Be aware at the extent of the burns and what limbs are affected.
- ✚ Caution should be taken with passive range of movement, guidance should be sought before doing PROM on hands with burns to the dorsal region. This is due to possible damage to the extensor tendons.
- ✚ No passive movements should be done on areas with grafts within the first 5 days of grafting. This is to allow the graft to take and not cause movement or shearing.
- ✚ Passive range of movement is important with these patients as they lose range very quickly.

## **Role of CCOT**

Within the hospital there is a team of specialist critical care nurses who will review, monitor and assist with acutely unwell patients on the wards, those being discharged from Radnor and those with non-invasive ventilation or tracheostomies.

Their role is to support the medical staff on the wards, by reviewing the patient as a whole, ensuring the right professionals are involved with the patient and helping the nursing staff on the ward to care for this patient.

For the respiratory physiotherapy on call service, CCOT or the HaNT will review the patient and then contact the on call physiotherapist if their input is appropriate. It is important to be aware that whilst they are critical care nurses, they are not physiotherapists. Therefore if the patient has problems such as retained secretions which need clearing, they will call the on-call physiotherapist. It should also be clear that CCOT will have already assessed the patient using the A,B,C,D,E approach and therefore their referral is likely to be appropriate (see referral flow chart in the Trust Respiratory Physiotherapy on call policy).

The exception to the above is the spinal unit. The nurses on the Spinal Unit are more specialist and will themselves assess the patient, try to resolve the problem with the techniques which they are competent to do so (this may include cough assist machine and manual techniques). If despite trying these techniques, the patient still has retained secretions, they will call the on call physiotherapist directly (see referral flow chart in the Trust Respiratory Physiotherapy on call policy).

## **Case Studies**

The following case studies have been prepared on the different topics for you to use as needed, to help you prepare for the on call situation.

### **Case Study 1**

A 73 year old was admitted to an acute ward after having been involved in an RTA. He has fractured ribs R2-9 with a flail segment of R5-8. He also has a fractured R NOF for which he had a dynamic hip screw fitted under GA in theatre.

Currently he is desaturating, self ventilating on 40% FiO<sub>2</sub> via a face mask and is in a great deal of pain. You are called in to assess and treat him.

#### **Questions**

- 1) What are his main problems?
- 2) What might you hear on auscultation?
- 3) What might you ask for or check before going in?
- 4) What physiotherapy treatment might you give?
- 5) Are there any techniques which you could not use or need to be careful with?

#### **Your answer**

## **Case Study 2**

A 65 year old woman has been admitted to an acute medical ward. She has had a dense hemiplegia and has a reduced level of consciousness. She has lost her swallow / gag reflex and possibly aspirated at the time of her CVA.

She has now developed a chest infection. You are called in as she has deteriorating oxygen saturations and to treat her 'bubbly' chest. A CXR shows R lower lobe consolidation.

### **Questions**

- 1) What are her main problems?
- 2) What might you hear on auscultation?
- 3) What treatment is indicated?

### **Your answer**

### **Case Study 3**

A 76 year old woman was admitted to ICU last night with smoke inhalation after being in a house fire.

#### **PMH**

OA both knees

Orthopnoea – 4 pillows

COPD

Ventilated on P-SIMV, PC 15, PS 12, FiO<sub>2</sub> 60%, PEEP 10, Minute volume 14L/Min, sats 99%, temp 38 degrees C, BP 140/105, HR 105, AF.

Drugs – frusemide, digoxin, lisinopril, propofol, alfentanil, insulin.

ABG's pH 7.49, PaCO<sub>2</sub> 4.85, PaO<sub>2</sub> 17.4, HCO<sub>3</sub> 27.9, BE 4.6

CXR – slightly increased lung markings L LL, otherwise clear

Auscultation – breath sounds throughout with harsh inspiratory crackles and bibasal wheeze.

#### **Questions**

- 1) Describe the type of ventilation which she is on.
- 2) Why are the ABG's significant in forming your treatment plan?
- 3) Is there anything else you would check before treating the patient?
- 4) Formulate a treatment plan based on the information given.

#### **Your answer**



## **Case Study 4**

A 58 year old man fell and hit his head while drunk and sustained a subdural bleed. He had a frontal craniotomy and evacuation at Wessex Neurological centre in Southampton. He vomited and aspirated the following day. He was then transferred back to Salisbury.

He is sedated and ventilated

P-SIMV PC 16, PS 18, PEEP 4, FiO2 30%, SpO2 98%

Temp 36.4, BP 112/94, HR 90, Fluid balance +1101mls, good urine output.

ABG's pH 7.46, PaCO2 4.35, PaO2 10.4, HCO3 23.2, BE 0.1

CXR – diffuse shadowing L side

Auscultation – coarse crackles R UL and L LL

### **Questions**

- 1) What test or investigation would you want to know had been performed on this patient before doing any physiotherapy?
- 2) Explain the ABG's
- 3) How much support is the patient getting from the ventilator?
- 4) Would you use manual techniques on this patient? What do you need to know / monitor?
- 5) Could you use manual hyper-inflation on this patient? Explain.
- 6) Explain why the patient has a low temperature.

### **Your answer**

### **Case Study 5**

A 65 year old man is admitted to A&E with history of COPD. He has increasing SOB and retained secretions.

His is self ventilating on 60%, his RR is 35 and his is accessory muscle breathing. He cannot talk in full sentences and appears to be in respiratory distress.

His ABGs are:

PH7.2

PCO<sub>2</sub> 8.9

PO<sub>2</sub> 6.5

HCO<sub>3</sub> 28

Questions

- 1) What else do you want to know for your assessment?
- 2) Explain the ABG's and what may be indicated?
- 3) Who might you call to assist / make a treatment plan?
- 4) Is NIV indicated? If so what type.

**Your answer**

## **Case Study 6**

A 40 year old lady with known Motor Neurone Disease is admitted to an acute ward with a severe pneumonia. Her respiratory condition is deteriorating and she is unable to clear her secretions.

She is self ventilating on 60% FiO<sub>2</sub> and her RR is 23.

Auscultation – coarse crackles throughout R side.

Her ABGs are:

PH 7.3

PCO<sub>2</sub> 7.5

PO<sub>2</sub> 8

HCO<sub>3</sub> 28

Questions

- 1) What does your assessment involve?
- 2) What is your immediate treatment plan?
- 3) Would you use the IPPB? Explain
- 4) Would you use the cough assist? Explain
- 5) Is NIV indicated? Explain

**Your answer**

## **Case Study 7**

You are called to A&E to a man admitted with SOB and a diagnosis of aspiration pneumonia.

PMHx includes a CVA with residual L sided weakness.

Patient is currently slumped in bed, 15L non-rebreathe mask in situ.

CXR shows shadowing around R cardiac notch ? What

Doctors ask for chest physio and reports CXR clear

Questions

- 1) What else would you want to assess, know?
- 2) What treatment would you do?
- 3) Would you use the bird?

You find out later that the patient has Ca lung with a proximal tumour obstructing his airway.

- 4) Would you have done anything differently?

**Your answer**

### **Case Study 8**

You are asked to review a patient post laparotomy on Radnor. The patient is a 48yr old male who was extubated 4 hours ago.

On assessment you find he has sats 93-100% on 40% $\text{fio}_2$  via FM. On ausc: retained secretions throughout. The patient is drowsy and experiencing pain from his abdominal wound. He is slumped in bed.

ABG's pH 7.402,  $\text{PCO}_2$  4.8,  $\text{PO}_2$  11.2, BE -2,  $\text{HCO}_3$  28.1

#### Questions

1) What is your initial treatment plan?

On ACBT, you find the patient is not taking an effective deep breath or coughing and clearing.

2) What is your treatment plan now?

#### **Your answer**

### **Case Study 9**

You are called to a 34yr old female asthmatic just transferred from A&E to Pitton ward.

On observation: Sats 95% on air, RR 33, pt unable to maintain sentences. Ausc: harsh exp creps with exp wheeze, accessory breathing and decreased a/e bibasally.

The patient is sensitive to oxygen, she is already on saline and salbutamol nebs. Pt sat upright in bed, very tired, but scared to sleep due to SOB, no ABG's, CXR clear.

#### **Questions**

- 1) What is your initial impression?
- 2) What are your treatment options?
- 3) would you consider IPPB? What do you need to consider regarding oxygen for this patient?

#### **Your answer**

## **Case Study 10**

You are called to Radnor to a patient who has just been admitted. A 24 year old male who has just had a parachuting accident where his shoot did not open. He has been stabilised.

He is intubated and sedated - P-CMV, PC 20, PEEP 8, FiO<sub>2</sub> 40%. His ABG' s are normal.

### **Questions**

- 1) What investigations / tests do you need the results of before you can assess and treat?
- 2) What precautions are involved with spinal patients?

You are told the results of the test, the patient has spinal fractures which are stable and no other injuries. On assessment you find he has decreased air entry bibasally.

- 3) Formulate a treatment plan. What precautions are involved with the treatment you are suggesting?
- 4) Would you use MHI? Explain

### **Your answer**

## **On Call Check List**

- ✚ Complete your self-assessment and identify anything which you do not feel competent or confident about.
- ✚ Contact the Senior Respiratory Team or the Spinal Physiotherapy Team and ask to book some time to meet your learning needs.
- ✚ Know when you are on call and ensure you follow the Trust Respiratory Physiotherapy On call Policy.
- ✚ Obtain from the Medical / Surgical Therapy Office the On call physiotherapy check list form to complete for any calls you may get. This will help you record valuable information and prompt you on what questions to ask.
- ✚ During your on call never do techniques or make decisions which you do not feel competent or happy to do so.
- ✚ Always evaluate any treatment which you have done and record this in the notes.
- ✚ If you feel it is inappropriate to do a technique which the medical team are asking for, document what the technique is and your clinical reasoning why you did not feel it was appropriate.
- ✚ Always communicate with the nursing staff and leave them instructions about ongoing physiotherapy and positioning to optimise the patient.
- ✚ Remember CCOT are a resource which can help you overnight, they however are not there to do the job of a respiratory physiotherapist, nor are they competent to do so, that is your job.



## On-Call Physiotherapy Checklist

This is the form which you will find in the medical / surgical office. Fill one out for every patient which you see, it will help you and it is a good record for the team.

Date:				Physiotherapist:			
Time of Call:	5-8 pm		8-12 pm		12-6 am		6-8.30am
Referring Clinician:				Ward:			
Patient Hospital Number:							
Brief Patient History/Diagnosis:							
Has the patient already been seen by the ward physiotherapist?							
<b>Observations:</b>							
Temperature (37°C):				BP (95/60-140/90 mmHg):			
HR (50-100 bpm)				SaO2 (96-100%):			
RR (12-16 bpm):				FiO2:		Humidified:	
<b>Auscultation:</b>							
<b>ABG's:</b>		Date:		Time:			
PH (7.35-7.45):		PaO2 (11-14kPa):		PaCO2 (4.6-6 kPa):			
HCO3 (22-26 mmol/L):		SBE (-2+2):		SaO2 (96-100%):			
<b>CXR:</b>		Date:		Time:			
Findings:							
<b>Pain Score</b> (if appropriate):							
VAS at rest		/10		VAS on coughing/moving		/10	
<b>Conscious Level/Co-operative state:</b>							
Fully Alert:		Drowsy but Co-operative:		Unresponsive:			
Non-compliant:		Confused:		Other:			
<b>Problem:</b>							
Retained Secretions:				Decreased Lung Volumes/Lung collapse:			
Worsening ABG's:				Respiratory Distress:			
Bronchospasm:							
<b>Other Problems:</b>							
Pulmonary Oedema				CCF			
Acute/Severe bronchospasm				Severe Haemoptysis			
<b>Advice Given Over The Phone:</b>							
Nebuliser:				Positioning:			
Oxygen Therapy (via Dr):				Suction: Oral/Nasopharyngeal			
Other:							
<b>Did You Attend:</b>		Yes		No			
<b>Appropriate Call Out:</b>		Yes		No			

## **Normal Values Checklist**

### **Respiratory**

Respiratory Rate	10-16BPM
Tidal Volume	around 500mls
Peak airway pressures	10-20 cmH2O

### **ABG's**

pH	7.35 – 7.45
PCO <sub>2</sub>	4.6– 6.0
PaO <sub>2</sub>	11-14
HCO <sub>3</sub>	22-26
BE	-2 to +2

### **Cardiac**

Temperature	37 degrees C
Heart Rate	60-80 bpm
B/P	120/60
Cardiac Output	4.5 – 6
Capillary Refill Time	Normal is within 3 seconds

### **Blood results**

Hb	Female 11.5 – 16, Male 13.5 - 18
WCC	4.0 – 7.0
Platelets	150-400
Neut	2.0 – 7.5
MCV	80-100
INR	0.8-1.2
APTR/APTT	0.8-1.2
Na	135-145 mmol/L

K	3.5 – 5.0 mmol/L
Urea	3.0 – 6.5 mmol/L
Creat	60-125 mmol/L
TP	63-80 g/L
Alb	32-47 g/L
Bili	0-17 umol/L
ALP	120-460 iu/L
ALT	5-42 iu/L
Ca	2.15 – 2.55 mmol/L
Phos	0.7 – 1.5 mmol/L
Mg	0.7 – 0.95 mmol/L
CRP	0-0.6 mmol/L
Albumin	35-50 grams / litre

### **Fluids**

U/O	1ml/kg/hr
CVP	3-15 cmH2O

### **Others**

ICP	< 10 mmHg (< 1.3kPa)
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