

Critical Care

Revision pack





**Respiratory Assessment**

LOOK, LISTEN & FEEL

DO WE KNOW ANY PATIENT HISTORY?

**OBSERVATION**

**Cyanosis** – Central cyanosis of tongue or lips usually means the patient has low oxygen or PaO2 in the blood. A very late sign!

Peripheral cyanosis of extremities or tip of the nose or ears may be due to diminished blood flow or polycythaemia.

**Breathing** – The use of accessory muscles (scalene and sternomastoid muscles)

Intercostal retractions – sucking in of skin and muscles between ribs during inspiration.

Use of the abdominal muscles during expiration - Paradoxical Breathing.

Whether or not the patient can speak a full sentence, SOB.

Increased diameter of anteroposterior chest – caused by overexpansion of chest, seen in COPD.

**Posture** – Pts with COPD often prop themselves up or lean over pillows to gain better expansion of lungs.

**Position of trachea** – Is it central or deviated?

Deviated away from affected side = Pleural effusion, pneumothorax, haemothorax.

Pulled toward the affected side = Atelectasis, fibrosis.

**Respiratory rate** – Should be compared with patient’s normal if known.

**Depth of respiration** – Fast and shallow may indicate severe respiratory distress.

Fast and deep may indicate compensation for a metabolic acidosis, i.e. Kussmaul respirations (seen in DKA).

**I:E ratio** – Normally 1:2. Expiration may be longer in pts with obstructive lung disorders.

**General chest expansion** – Is there equal expansion?

Unequal expansion may be a sign of atelectasis, mucus plug, and flail chest.

It could also mean the ETT is down too far, i.e. only ventilating one lung (Auscultate, then seek help immediately).

Do chest and abdomen rise and fall together? Unsynchronised respiratory effort increases work of breathing and may necessitate ventilation.

**VAP care bundle** considered.

**AUSCULTATION**

**Never listen through the patients clothing!**

If the patient is self ventilating (SV), ask them to breathe normally but thorough their mouth and to take some deep breaths while you are listening. If they are ventilated, breath sounds may appear louder as the air is pushed in. Ensure you listen to the whole respiratory cycle – inspiration and expiration. Listen for any additional sound – crackles, wheeze.

-Start at the top, above the clavicles.

-Work your way down the chest, comparing left and right.

-If possible listen at the back, as the bases are heard best there.

**Normal breath sounds**

* Bronchial - trachea, high pitched loud, short inspiration.
* Bronchovesicular- lung apices, medium pitched, louder than vesicular.
* Vesicular- most lung fields, continuous, low pitch and volume, like rustling wind, short expiratory phase.

**Abnormal breath sounds**

* Crackles- fine/course- bubbling from fluid, exudate or secretions.
* Wheeze- Sound of air squeezing through airways, due to bronchoconstriction.
* Stridor- Airway obstruction, e.g. post extubation, due to laryngeal oedema, foreign object.
* Pleural rub- grating sound from friction between pleura.

**Absent breathe sounds to one side**

* ? Pneumothorax- seek help immediately.
* ETT incorrectly positioned, seek help immediately.

**PALPATION**

-Feel for tenderness, temperature, deformities.

Place hands on either side of chest and feel if there is equal expansion.

-Feel for any secretions. If there are secretions you will feel the vibration on inspiration.

-Feel for a crackling sensation under your fingers- may be indicator of surgical emphysema (air that has entered the subcutaneous tissue).

**PERCUSSION**

**NOT ROUTINELY PERFORMED BY CRITICAL CARE NURSES AS MOST HAVE NO FORMAL TRAINING.**

Percussion of the chest results in motion of the chest wall and underlying structures, resulting in audible and tactile vibrations.

-Place one finger flat on the chest and strike the knuckle with a fingertip from the other hand.

-Normal is resonant, hollow.

-Consolidation, effusions will cause dull sound.

-Pneumothorax will sound hyper-resonant, very hollow.

VENTILATOR TERMINOLOGY

**Invasive Ventilation Modes-** Hamilton C6

The Hamilton ventilator has numerous modes available for use, but the following modes are the ones commonly used on the General ICU.

In basic terms, modes can be categorised in to mandatory or spontaneous.

Mandatory means that the ventilator (set by nursing/ medical staff) dictates how many breaths the patient needs per minute.

Spontaneous means that the patient themselves will dictate how many breaths they take per minute.

**APVcmv-** Adapted pressure ventilation with controlled mandatory ventilation

A mandatory mode, so the respiratory rate is set.

Breaths are volume targeted (a tidal volume is set) but pressure regulated ( a peak airway pressure alarm is set for safety)

The ventilator will deliver the set tidal volume using the lowest pressure possible. The peak airway alarm will alert you when the pressure is 10 below what you have set.

Patient is allowed to breathe at any time of the Respiratory cycle, delivering the user set Vt and set TI. Triggered mandatory breaths will be represented by the triangle under Pressure waveform.

I:E ratio is dependent on the inspiratory time (TI) and Resp rate(RR)

**DuoPAP- Duo (2) positive airway pressure**

A mandatory mode, so the RR is set, but the patient can trigger.

Mandatory breaths are pressure controlled. 2 pressures are set. A low pressure (CPAP/PEEP) and a high pressure.(P high)

A T high is set which dictates length of time at the higher level.

Patients can take spontaneous breaths which will be supported with a set pressure.

**SPONT**

A spontaneous mode, so the patient must initiate each breath and they will dictate their own respiratory rate.

Each breath will be supported with a set pressure. The set pressure can be adjusted according to the size of each breath (tidal volume) and then reduced as their lungs improve. This is what is known as ‘weaning’.

**Non Invasive Ventilation Modes:**

**Biphasic Inspiratory Positive Airway Pressure (BIPAP)**

This mode provides a high flow of air and oxygen to a patient via a face mask or nasal mask to assist spontaneous breathing. As the patient breathes in, this mode delivers an inspiratory positive airway pressure (IPAP) to assist the patient to take a larger breath. This therapy also enables an expiratory positive airway pressure (EPAP) to be set, which inhibits end expiration at a set level to create back pressure in the lungs, thus keeping the alveoli open for gas exchange. This prevents or reverses atelectasis (alveoli collapse).

BIPAP is most commonly used for type 2 respiratory failure

**Continuous Positive Airway Pressure (CPAP)**

This mode provides a high flow of air and oxygen to a patient via a face mask or nasal mask on inspiration which helps with work of breathing (but there is no inspiratory pressure/support). The patient then breathes out against a valve (PEEP valve) which inhibits end expiration at a set level to create back pressure in the lungs, thus keeping the alveoli open for gas exchange. This prevents or reverses atelectasis (alveoli collapse).

CPAP is most commonly used for type 1 respiratory failure

**Ventilator Observations**

Depending on which ventilator mode is selected, will determine what ventilation observations are required to be documented.

**Each single observation is as important as the next – they tell you how well your patient is ventilating. Watch for upward or downward trends in observations.**

**Set pressure limit (cm/H2O)**

This is the set pressure limit of which the ventilator will permit, in gas delivery to the patient.

**Set tidal volume (VT)**

Size of breath delivered to the patient (mls).

**Expired tidal volume (VT)**

Amount of gas expired in one breath. Small VT can indicate blockages in the system, leaks or a deteriorating respiratory function.

**Measured minute volume (Mv)**

Amount of gas inspired and/or expired in one minute (l/min).

Minute volume= Respiratory rate x tidal volume

Minute volume can indicate over (too high) or under ventilation (too low) as well as problems with the circuit and changes in the patient’s condition.

**Set rate/ total rate (per/min)**

Patient’s measured respiratory rate, either spontaneous or set ventilator breaths.

Set rate: Checking to see the machine is delivering the breaths it is set to.

Spontaneous: Tells us how well a patient is coping with breathing spontaneously, if too high or low, seek help immediately to review your patient and their ventilator settings (*tachypnoea­ –* RR >30/min and *bradypnoea* – RR <8/min).

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**Peak airway pressure (cm/H2O)**

Peak inspiratory pressure measured within the airways.

Low airway pressures may indicate leaks in the ventilation circuit. Highairway pressures can indicate a blockage in the tubing or deterioration in the condition of the patient’s lungs.

**Mean airway pressure (cm/H2O)**

Mean pressure measured within the airways.

**Pressure support (cm/H2O)**

Amount of pressure required to support the patient’s spontaneous breath.

**I:E ratio**

Inspiratory/Expiratory ratio.

In normal respiration the ratio is 1:2 (i.e. 10bpm= 6 seconds per breath= 2 secs to inspire, 4 secs to expire.)

When lungs have been damaged, this ratio can be manipulated, depending on the condition of the patient.

**PEEP/CPAP (cm/H2O)**

A constant pressure maintained in the airways, throughout inspiration and expiration. Increases functional residual capacity and therefore increases time for gas exchange to occur.

**IPAP (cm/H2O)**

Amount of pressure required to support the patient’s inspiration.

**EPAP (cm/H2O)**

Amount of pressure maintained in the airways at the end of expiration.

**FiO2**

Fraction of inspired oxygen as a decimal(i.e. 60%= 0.6,100%= 1.0)

**Pulse oximetry**

Peripheral saturation of haemoglobin by O2, detected with infrared light.

**Humidifier temperature**

Either HME filter (heat and moisture exchange) or fisher paykel/ Hamilton heated humidifier recorded in degrees Celsius.

**ETCO2**

Non invasive monitoring of expired carbon dioxide.

Provides an estimation of whether the patient is being hypoventilated or hyperventilated

ARTERIAL BLOOD GASES

**Why do we measure arterial blood gases?**

- to give an indication of the effectiveness of ventilation and gas exchange.

- to determine acid-base balance, the body’s ability to maintain a balance between acids and alkalis.

- to clarify the cause for pH disturbance.

- act as a guide for treatment and to evaluate response to treatment.

**NORMAL PARAMETERS**

pH 7.35 – 7.45

PaO2 10 – 14 kPa

PaCO2 4.5 – 6 kPa

HCO3- 22 – 26 mmol/l

BE - 2 - + 2

SpO2 95 ­- 100%

K+ 4.0 – 5.0 mmol/l

**ACID-BASE BALANCE**

pH = measurement of H+ ion concentration in the blood.

The body must maintain a normal pH despite constant H+ ion production by metabolic processes.

A pH < 6.8 or >7.8 is incompatible with life!

In healthy individuals, pH is maintained through ‘buffering’ and excretion of acids, via lungs and kidneys.

Buffering (Operates immediately)

Chemical buffers are pairs of substances that prevent major changes in pH.

Principle system of buffering is the carbonic acid/bicarbonate buffer system.

Henderson hasselbach equation

H+ + HCO3 = H2CO3 = H2O + CO2

(tissues) (transport) (lungs)

This reaction is reversible

If H+ levels increase, bicarb binds with H+ to form carbonic acid, (a weak acid) and correct pH.

If H+ levels decrease, dissociation occurs to free H+ ions and correct pH. Other buffers include: Hb, Sodium, Phosphate, Ammonia, Chloride, Other proteins.

Excretion via the lungs (Occurs within minutes)

The lungs, via the influence of the respiratory centre, control the level of carbon dioxide and carbonic acid in the blood.

An increase in respiratory rate or tidal volume causes PaCO2 to fall, increasing the pH to alkalosis.

A decrease in resp rate or tidal volume causes PaCO2 to rise, decreasing the pH to acidosis.

Excretion via the kidneys (Occurs within hours/ days)

The kidneys regulate the amount of bicarbonate present in extracellular fluid, by reabsorbing and regenerating bicarbonate ions.

Metabolic/ respiratory acidosis – the kidneys excrete excess H+ ions and conserve bicarbonate ions to restore balance.

Metabolic/ respiratory alkalosis – the kidneys conserve H+ ions and begin to excrete bicarbonate ions.

**DISORDERS OF ACID- BASE BALANCE**

**METABOLIC ACIDOSIS**

Caused by either accumulation of H+ ions or loss of base.

**Causes**

Poor perfusion

Hypovolaemia

Hypotension

Small bowel losses

Excess lactate

Renal failure

Excess ketones

Sepsis

**METABOLIC ALKALOSIS**

Caused by either loss of H+ ions or accumulation of base.

**Causes**

Massive blood transfusion

Diuretics

Hypokalaemia

Liver failure

Large bowel/ gastric losses

Excessive vomiting

Post cardiac arrest

Too many antacids

**RESPIRATORY ACIDOSIS**

Caused by hypoventilation

**Causes**

Respiratory failure

Hypoventilation

Coma

Opiate overdose

**RESPIRATORY ALKALOSIS**

Caused by hyperventilation

**Causes**

Hyperventilation

Anxiety

Respiratory failure

Pain

**COMPENSATION**

This is when the body attempts to correct acid/base imbalances to bring pH back to normal.

Compensation can be fast (respiratory) or slow (metabolic)

It can be seen when there is a normal pH, with deranged respiratory and metabolic values.

Non compensation – alteration of only PaCO2 or HCO3-

Partial compensation – both PaCO2 and HCO3- are abnormal and because compensation is incomplete, the pH is also abnormal.

Complete compensation – both PaCO2 and HCO3- are abnormal and because compensation is complete, pH is normal

**GUIDELINES FOR ABG INTERPRETATION**

**Evaluate pH**

< 7.35 reflects acidosis

> 7.45 reflects alkalosis

**Evaluate ventilation**

Partial pressure of arterial CO2

< 4.5kPa indicates alveolar hyperventilation, resp alkalosis.

> 6.0kPa indicates ventilatory failure, resp acidosis

**Evaluate metabolic processes**

HCO3-< 22mmols/l and/or BE < -2 reflects metabolic acidosis.

HCO3- > 26mmols/l and/or BE > +2 reflects metabolic alkalosis.

**Is there compensation?**

When both PaCO2 and HCO3- are deranged, one reflects the primary acid-base balance disorder, and the other reflects the compensating disorder.

To decide which, check the pH.

I.e. The ABG shows respiratory acidosis and metabolic alkalosis

The pH is 7.25

The primary cause is respiratory.

Safety Checks and Top to Toe Patient Assessment

Before assessing your patient, you must carry out safety checks in case of an emergency.

Firstly, ensure your patient is safe and not at any immediate risk. Do they look comfortable?

Ensure you explain to the patient and their family what you are doing in order to alleviate any anxiety.

Visual inspection of bedside- rremove any unused equipment from bedside and maintain a tidy, safe environment. Then check the following:

* O2 cylinder more than 2/3 full
* Waters bag- check it is in a sealed bag, only to open when required
* Face masks- sizes 3, 4 and 5.
* Working suction unit and correct level of suction applied to any drains
* Check patient name band for correct details
* Check infusions- Compare prescription chart details to the infusions running ensure the drug infusions and colloid /crystalloid infusions that are running are a) prescribed correctly and b) are running according to a correct prescription. i.e. route, dose, solution, rate and that a Doctor has signed the prescription. If in any doubt check with a more senior member of staff
* Check when infusions are due for renewal and ensure that the replacement infusions will be ready
* Ensure correct level of transducer plate in relation to patient’s position, pressure bag inflated to 300mmHg
* Monitor checks and alarm settings
* Check ventilator settings, alarms and circuit/humidifier check
* Check sharps bin is assembled correctly and appropriate **PPE** is available within the bed space

**TOP TO TOE ASSESSMENT**

Top to toe assessment should be carried out at the beginning of every shift. The aim is to provide you with a baseline, from which any changes can be detected in a prompt manner. **The top to toe assessment is performed following the assessment of airway, breathing and circulation for safety purposes.**

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| ASSESSMENT | CONSIDERATIONS |
| **A**irway | Maintaining own airway?  Endotracheal tube- Size, insertion date, length cut, position tied, cuff pressure  Tracheostomy- Type, size, insertion date, dressing, cuff pressure, emergency equipment  ETT inline suction –  how to measure = (ETT size - 2) x 2  Suction pressure:  inline suction =< 20mmHg    oral suction =<30mmHg  Strength of cough, type and amount of secretions  Humidification, nebulisers |
| **B**reathing | Mode of ventilation, trends and readings FiO2, PEEP.  SpO2, ETCO2, ABGS.  General colour and appearance, RR, depth, pattern, work of breathing effort/accessory muscles, chest movement, symmetry, breath sounds  Wean screen |
| **C**irculation | Check readings and trends for: HR and rhythm, ABP and MAP, return to flow, CVP and any drugs.  Limb warmth, colour, perfusion, capillary refill, pulses, oedema.  Temperature, WCC, CRP, septic screen. |
| Head and neck  Hair  Face  Ears  Eyes  Nose  Mouth  CVP line | Condition ?washing tidying brush and comb  Expression, colour, skin turgor, signs of weight loss. Ability to communicate: mouthing or writing.  History of deafness or hearing aid? Check pressure areas  Pupil size, shape, reaction, sedation score  Assess need for GCS  History of cataracts, sight limitations/glasses, ?eye surgery  Nasogastric tube, type, position, grip-lock clean/insitu, feeding protocol. Skin damage  Condition of lips and the mouth score, teeth/dentures.  Insertion date, 4 sutures, condition of site- ?any sign of infection and intact dressing. Lines labelled correctly with date and time of commencement.  3 way tap/bionectors as per infection control guidelines. |
| Trunk  ECG electrodes  Chest drain  Abdomen  Catheter | 5 lead, monitoring in leads 2 & 5, correct position.  Position, swinging/bubbling action, amount of drainage, clamps available  Distended, hard/soft, ascites, pain, bowel sounds  Bowel protocol.  Also consider:  Nutrition- weight, NG/NJ feed, prokinetics, stress ulcer prophylaxis  TPN, blood sugar control, insulin  Wounds, drains, dressings infection etc.  Size, date inserted, long/short term  Swelling, oedema, hygiene /infection  Urine output, urinalysis, fluid balance |
| Limbs  Legs  Feet and Heels  Hands  Arms  Arterial line  Peripheral cannula | DVT prophylaxis- AES, IPC’s heparin  limb strength/mobility  Oedema/swelling, heels pressure/skin integrity  Nails, rings. Oedema  Limb strength/mobility  Date inserted, return to flow, site check, well secured  Date inserted, site check still required, VIPs paperwork present. |
| General | Past medical history and drugs  Blood results, CXR, 12 lead ECG  Sedation score, GCS  Mobility- passive exercises, chair  Fluid balance, insensible losses  Parameters- Inotropes, MAP, PaO2  Pressure areas, bruising, old scars, wound chart  Spinal checklist, MRSA screen and risk reduction.  Family situation, Next of kin |

**ABBREVIATIONS**

CVP- Central venous pressure

ABP- Arterial blood pressure

CRP- C- reactive protein (marker for sepsis)

MAP- Mean arterial pressure

FiO2- Fraction of inspired oxygen

ABG- Arterial blood gas

PEEP- Positive end expiratory pressure

GCS- Glasgow coma scale

PaO2- Partial pressure of oxygen in arterial blood

DVT- Deep vein thrombosis

ETCO2- End tidal carbon dioxide

WCC- White cell count

**COMMONLY USED DRUGS**

**PROPOFOL**

Short acting, intravenous anaesthetic.

Used for induction and maintenance of anaesthesia, sedation in intensive care units.

Side effects- Respiratory depression, hypotension, bradycardia.

Metabolised by liver, excreted in urine.

Dose= 1-25ml/hr of 1% solution.

**MIDAZOLAM**

Benzodiazepine

Short acting sedative, anticonvulsant.

Longer acting than propofol, therefore used for longer-term ventilation.

Side effects- Hypotension, apnoea.

Metabolised by liver, excreted in urine.

CAUTION IN RENAL/HEPATIC IMPAIRMENT.

Dose= 1- 10mg/hr

Reversed by flumazenil.

**FENTANYL**

Short acting opioid analgesic

Used in anaesthesia and as analgesic

Side effects- Respiratory depression, bradycardia, hypotension.

CAUTION IN RENAL/HEPATIC IMPAIRMENT.

Dose= 0- 5ml/hr (50mcg/hr)

**ROCURONIUM**

Aminosteroid non-depolarising neuromuscular blocker

Rapid onset, brief duration (2-6 mins)

Used to facilitate intubation.

Side effects- Tachycardia, arrhythmia, bronchospasm

CAUTION IN PATIENTS WITH ANY MUSCULAR DISORDER/ASTHMA

Dose= 50-100mg bolus

**CISATRACURIUM**

Bisbenzyltetrahydroisoquinolinium [neuromuscular](https://en.wikipedia.org/wiki/Neuromuscular-blocking_drug) blocker

Half life (10-30 mins)

Used to facilitate intubation and aid mechanical ventilation

Side effects- Hypotension, bradycardia

CAUTION IN PATIENTS WITH ANY MUSCULAR DISORDER.

Dose= 30-600mcg/kg/hr

**NORADRENALINE**

Vasopressor

Beta 1 and alpha receptor agonist. Used mainly for alpha effects.

Increases systolic and diastolic blood pressure.

Used in refractory hypotension.

CENTRAL ADMINISTRATION ONLY

Side effects- Peripheral ischaemia, bradycardia, hyperglycaemia.

Dose= 0.01- 0.5mcg/kg/min. (Max 1mcg/kg/min).

**DOBUTAMINE**

Inotrope

Beta 1 and Beta 2 agonist, used in heart failure.

Beta 1- Increased contractility, increased cardiac output

Beta 2- Vasodilation

Side effects- Tachycardia, nausea, headache, anginal pain.

Dose= 2.5- 20mcg/kg/min

**HEPARIN**

Anticoagulant (unfractionated)

Prophylaxis and treatment of DVT and PE, M.I, unstable angina, prevention of thrombus in AF, prosthetic heart valves.

Side effects- Bleeding, thrombocytopenia, hyperkalaemia

Dose= Prophylaxis- 5000iu s/c BD

Treatment- Infusion 1000- 2000 iu/hr adjusted according to APTR.

Reversed by Protamine sulphate (may cause hypotension)

**RANITIDINE**

Histamine 2 antagonist. Reduces gastric acid secretion.

Prophylaxis against gastric, duodenal and stress ulcers

Side effects- Bradycardia, headache, dizziness

Dose= IV – 50mg TDS (BD if renal impairment)

Oral- 150mg BD

**PANTOPRAZOLE**

Proton pump inhibitor (PPI). Inhibits gastric acid secretion.

Used to treat peptic ulcers and post gastric surgery.

Side effects – Headache, nausea, diarrhoea and rashes

Dose = IV – 40mg OD