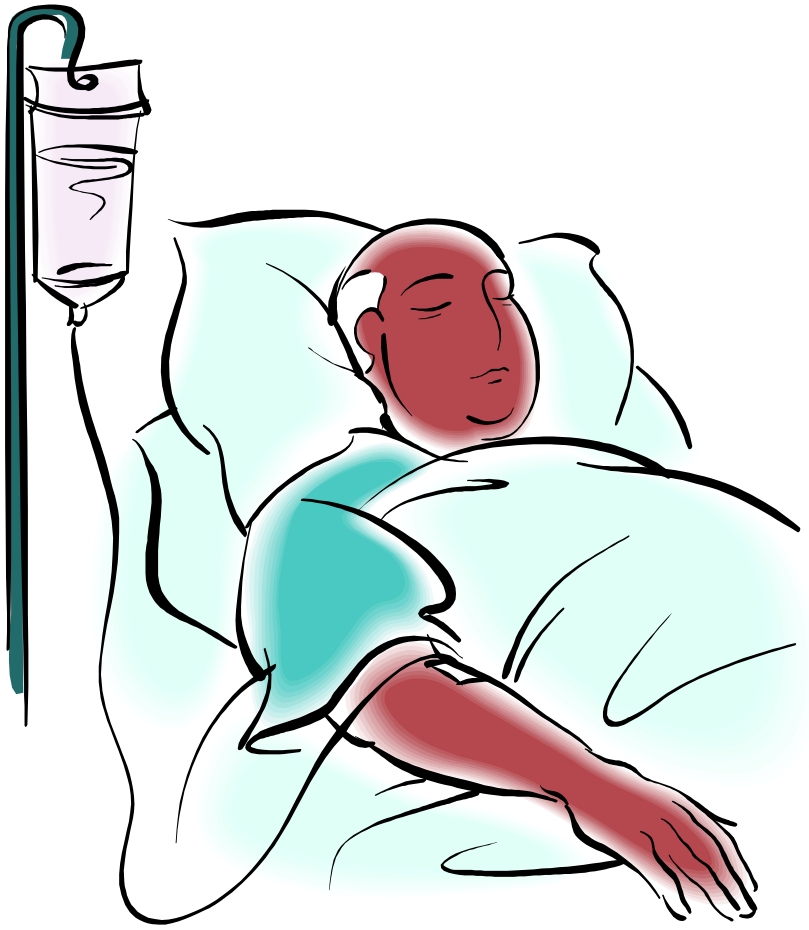
INTENSIVE CARE UNIT
HIGH DEPENDENCY UNIT



LEARNER
INFORMATION
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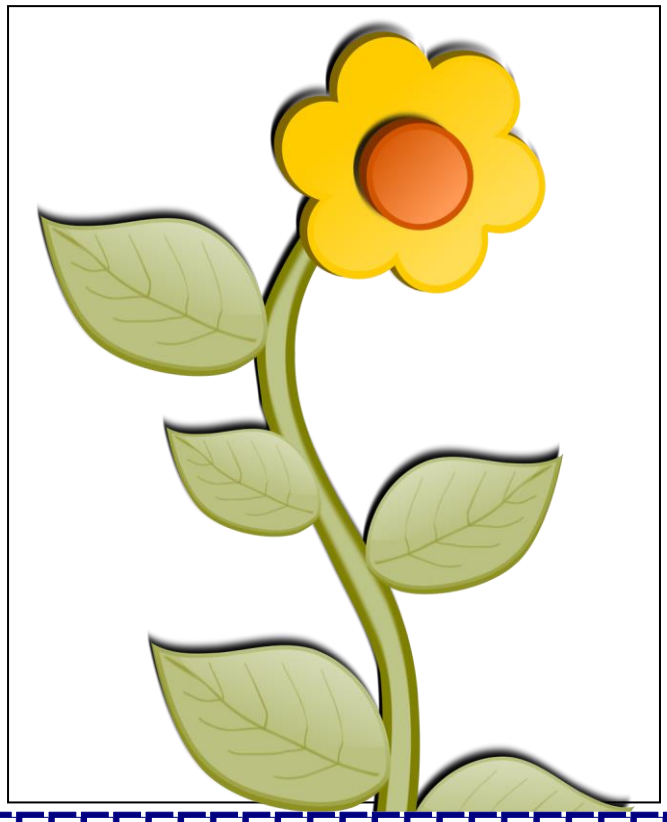
Welcome to Southport Intensive Care unit

Welcome to our unit . We are comprised of a six bed Intensive Care Unit, and a six bed high dependency unit. You will be working on all areas during your stay with us. Critical care can be quite intimidating so we will try to help you get the best out of your placement by thinking about the transferable skills that you can take with you to your future placements. In order to make you feel settled we have placed you in a nurture group of 1 practice assessor who will help you set our learning outcomes on the first day and 3 practice supervisors who will work closely with you and feed back to your assessors . You will also work with the HCAs and have the opportunity to go on spoke placements.



Role of the Pre-registration Nurse in Intensive Care and High Dependency unit

(Mentor/Student guide)

Allocation of patients – Pre-registration nurses must **not**, under any circumstances be left to care for a patient on their own. They must always work with a RN, and any task they undertake **must** be supervised.

Bedside Safety Checks – Pre-registration nurses can perform the following safety checks under **direct** supervision:

- Water circuit
- Suction
- Alarm limits on monitors and ventilators
- NG length and pH
- Artificial airway cuff pressures
- Zeroing of monitor lines
- Chest auscultation
- IV infusion expiry times/dates
- Patient wristband

Breaks – Pre-registration nurses must **not** be left at the bed area unsupervised during breaks; although they may have breaks at different times to their mentor. The RN caring for that patient must **not** delegate the care and responsibility to a pre-registration nurse.

Blood Sugar Monitoring – If the pre-registration nurse has undertaken the hospital Blood Sugar Monitoring training, they can ***under direct supervision*** obtain a patient's capillary blood and process a sample.

Blood Transfusion – In the current policy, a blood transfusion must be done by the administering Registered Nurse, Doctor or ODA/ODP who checks this with another qualified professional, e.g. RN, Doctor or ODA/ODP. The pre-registration nurse may be present when the checking of the blood is being undertaken and they should be involved in the accompanying observations that a patient requires during a blood transfusion.

Checking the Emergency Trolley – The pre-registration nurse can observe and assist the RN check the emergency trolley. They must not be delegated the task of checking this on their own.

Documentation/Clinical Assessment – A Registered Nurse **must** countersign all documentation and assessments completed by the pre-registration nurse. A pre-registration nurse must **not** write in documents care that has been delivered by someone else, though this is the same for the Registered Nurse.

Drug Administration – Please refer to the 'Medication Administration and Student Nurses' Policy enclosed later in this booklet.

Enteral Nutrition – Students can under ***direct supervision*** prepare the equipment for NG feeding if they have received suitable education in there use and under ***direct supervision*** administer drugs via this route.

Handover/Leaving the shift – Handover in any clinical area is a vital part of nursing care and pre-registration nurses should be encouraged to either observe or even undertake this role, under ***direct supervision.*** In their experience in ITU/HDU/CCU, they must experience one handover per day or night, so this could be the one at the beginning or the end of a shift.

Invasive Lines – The pre-registration nurse may assist with the removal of invasive lines, but must **not** be allowed to undertake this practice

unsupervised. Under ***direct supervision***, pre-registration nurses can clean and redress arterial and central lines after observation of the procedure and education and training from the RN.

Intravenous medications must only be administered by a registered Nurse.

Pre-registration nurses are not allowed to:

- Administer intravenous bolus injections. This includes the flushing of peripheral and central cannulae of any medication.
- Mix or administer intravenous drugs
- Administer any drugs via epidural

Moving and Handling – The majority of level 2 and 3 patients are red within the Trust Moving and Handling policy, which means there is a high risk of injury to the patient and staff in ITU/HDU. All critical care staff can sustain musculo-skeletal injuries if safe moving and handling practices are not established and patients can obtain a variety of injuries during the moving process:

- Accidental extubation
- Accidental removal of central and peripheral cannulas
- Pressure sores due to shearing force if slide sheets are not used
- Injury due to fall in unsafe use of hoist or unsafe transfer from bed to chair or chair to bed.

In order to minimise the above risks, a risk assessment must be performed and planned care implemented. If hoists are to be used, the student may assist with insertion of the hoist sling and with ***direct supervision*** attach the sling to the hoist. The RN, to reduce the risk of accidental extubation and line removal, even if the pre-registration nurse has received hoist training during other placements or at university, should only perform any manoeuvring of the hoist frame.

Accidental line removal and extubation can also occur whilst turning a patient or moving up the bed. Pre-registration nurses can assist with turning and moving in the bed provided they have received moving and handling training and are **not** positioned at the head of the bed so that the Registered Nurse can manage airway patency. Preregistration nurses can assist the registered nurses and physios under direct supervision and instruction when using the combiliser and stand aid and can be part of the Team for proning.

Pre-registration nurses should be discouraged from transferring patients from bed to chair / chair to bed when a hoist would be a safer option. However, they can assist the Registered Nurse and/or Physiotherapist during such transfer if it is linked to the patient's therapy.

Students under ***direct supervision*** may insert slide sheets if training has been received.

Students can be involved in transfer of a patient from a trolley to bed using a Pat Slide, provided they are not at the head of the bed and have received Pat Slide training.

The student can use the profiling bed to lift the bed frame and bed head up and down on level 1 and level 2 patients under indirect supervision; however, bed frame movement of level 3 patients should only be performed under ***direct supervision***.

Nasogastric Tube – Insertion should not be performed by inexperienced staff (including pre-registration students), unless this is part of their professional development and under the supervision of a competent practitioner. Insertion of nasogastric tubes on level 3 patients should only be performed by a member of the medical team.

Neurological observations – The pre-registration student nurses may perform neurological observations once they have received suitable education and understand the implications of them in practice.

Observations via Vitalpac in HDU & CCU

Pre registration nurses can use the Vitalpac once they have been trained to do so. You can easily be provided with a password.

Physiological & Mechanical Ventilation Observations – There is an expectation that the pre-registered nurse should be able to interpret and document simple physiological observations. However, it is not suitable for the pre-registration nurse to record ventilator observations on the ITU/HDU observation chart.

Tracheostomy/Endotracheal Tube Care – Under ***direct supervision***, pre-registration nurses can clean, redress and change the inner tube of the tracheostomy and also perform tracheal suctioning. It is essential that observations of and indications/contra-indications and side effects of these procedures have been discussed beforehand with the RN.

Transfer of Patients – A pre-registration nurse must **not** transfer a patient without a RN accompanying them, throughout the hospital. This does include a patient who has been discharged to the ward. A verbal handover over the telephone by the RN does not substitute for a nurse-to-nurse handover of care on the ward, due to the complexity of most of the ITU/HDU patients. In addition, the pre-registration nurse may not be able to answer any questions that are above their current level of knowledge and understanding.

12 Lead ECG recording – The pre-registration nurse may perform this procedure under ***direct supervision*** providing they have received the

appropriate training and education and can satisfy the RN that they are competent with lead placement etc.

Urinary Catheterisation – This procedure for a female should not be attempted by inexperienced staff (including pre-registration nurses), unless this is part of their professional development and under the supervision of a competent practitioner.

Pre-registration nurses are **not** permitted to perform male catheterisation. However they may observe and assist a RN with male catheterisation.

Wound Management and Removal of Clips/Drains – under ***direct supervision*** the pre-registration nurse can redress wounds and remove clips/drains. In addition, they may assist in any care or completion of documentation related to this practice.

Shift Patterns and Allocation – The staff on Critical Care rotate between the Intensive Care Unit, High Dependency Unit and Coronary Care Unit. You will be expected do work some of your time within all these specialities and the shift patterns are the same for all three areas.

- Early Shift: **0700 - 1430**
- Late Shift: **1200 - 1930**
- Long Day: **0700 - 1930**
- Night Shift: **1900 - 0730**

In order to work with your team/mentor you may be rostered onto night shifts as part of your allocation – this will give you a more rounded experience and opportunities to fulfil your learning outcomes.

I.V. FLUID ADMINISTRATION

In critical care nursing, I.V fluid administration is a major role; therefore critical care nurses are somewhat experts at this task, being familiar with a large variety of I.V. fluids and the administration of these Fluids. Please do take this opportunity to practise whilst under supervision.

1. **When administering an I.V. fluid against a prescription written by a registered medical practitioner or another authorised prescriber, the prescription should :-**

- Be clearly written.
- Clearly identify the patient for whom the fluid is intended.
- Clearly specify the substance to be administered, using its generic name, its stated form together with the strength, dosage, Timing, frequency of administration, start and finish dates/times and route of administration.
- Be signed and dated by the authorised prescriber.
- Not be for a substance to which the patient is known to be allergic or otherwise unable to tolerate (i.e. care should be taken with I.V. Glucose preparations and Diabetes).

2. **In exercising your professional accountability in the best interests of your patients you must:-**

    - Know the therapeutic uses of the fluid to be administered, the normal dose, side effects, precautions and contra-indications.
    - Check the expiry date of the fluid to be administered.
    - Contact the prescriber or another authorised prescriber without delay where contraindications to the fluids are discovered, where the patient develops a reaction to the fluid

- Remember, ***ANTT practice***
- Be aware of incompatibilities of I.V. fluids and drugs being mixed or infused in the same line.
- When administering I.V. fluids to a patient on ITU the nurse observes the ECG, arterial BP and CVP for signs of fluid depletion or overload. If there is any adverse reaction to this therapy then the infusion is terminated and a medical opinion is sought.

Student Nurses ARE allowed to run through lines, UNDER DIRECT SUPERVISION, pre-prepared I.V. fluids including Normal Saline and Glucose preparations containing Potassium Chloride, but are not allowed to attach them to a patient.

(This excludes high dose preparations such as 40mmol Potassium Chloride in 100mls Normal Saline).

Please refer to the Edge Hill Policy: Medication Administration and Student Nurses over-leaf.

Edge Hill University
FACULTY OF HEALTH

Medication Administration and Student Nurses

Notes:

1) Direct supervision is defined as:
   'The registered nurse is physically present with the student from the commencement of the procedure until its completion'.

2) Where a Trust's policy is more restrictive, the Trust policy applies.

3) Students undertaking Child Branch may only observe the administration of Controlled Drugs.

4) Please note that intravenous therapy relates only to saline, glucose, gelofusine, Hartmann's solution and saline and glucose with potassium already added. Connection of other solutions to patients is NOT permitted by student nurses. Mixing of intravenous drugs and antibiotics by student nurses is NOT permitted.

Acknowledgement

Edge Hill University would like to acknowledge the input from The Royal Liverpool and Broadgreen University Hospitals NHS Trust in the formulation of this policy.

Medication Administration and Student Nurses

Route/Class/Activity	**Year 1**	**Year 2**	**Year 3**
Single nurse medication administration	Not applicable	Not applicable	Not applicable
Oral excluding Controlled Drugs (CD's)	Can administer medications under direct supervision of Registered Nurse	Can administer medications under direct supervision of Registered Nurse	Can administer medications under the Direct supervision of a Registered Nurse
Intravenous (IV) medication administration & Flushing of cannulae	Can observe only	Can observe only	Can observe only
Subcutaneous/ Intramuscular medication administration (sc/IM)	Can observe and practice under direct supervision of the Registered Nurse	Can observe and practice under direct supervision of the Registered Nurse	Can observe and practice under direct supervision of the Registered Nurse.
Intravenous Therapy (*not attach to pt)	Can observe and practice under direct supervision of the Registered Nurse	Can observe and practice under direct supervision of the Registered Nurse	Can observe and practice under direct supervision of the Registered Nurse
Per Rectum (PR)	Can administer suppositories and enemas under direct supervision of Registered Nurse	Can administer suppositories and enemas under direct supervision of Registered Nurse	Can administer suppositories and enemas under direct supervision of Registered Nurse
Inhaled therapy	Can administer under direct supervision of the Registered Nurse	Can administer under direct supervision of the Registered Nurse	Can administer under direct supervision of the Registered Nurse
Topical	Can apply topical creams and solutions under direct supervision of the Registered Nurse	Can apply topical creams and solutions under direct supervision of the Registered Nurse.	Can apply topical creams and solutions under direct supervision of the Registered Nurse.
Controlled Drug administration (CDs)	Can observe administration of CDs.	Can act in role of 2nd checker	Can act in role of 2nd checker
Via Nasogastric Tube or Percutaneous Endoscopic Gastrostomy	Can administer medications under direct supervision of the Registered Nurse	Can administer medications under direct supervision of the Registered Nurse	Can administer medications under direct supervision of a Registered Nurse
Blood Products	Can observe only	Can observe only	Can observe only

UNDERSTANDING INOTROPES & VASO-ACTIVE DRUGS

What is an Inotrope?

It is a drug which produces an increase in myocardial contractility or peripheral resistance by controlling the contractility of blood vessels via **vasoconstriction**, e.g. Adrenaline, Noradrenaline, Dopamine and Dobutamine.

Why do we use these drugs?

a. To control the haemodynamic state of the patient i.e. to increase or decrease systemic blood pressure. Causes peripheral dilation and hence improve peripheral perfusion.

b. To assist the heart with low cardiac output.

Noradrenaline

Noradrenaline is a **vasoconstrictor** and is used to raise blood pressure transiently by acting on alpha-adrenergic receptors, but also acts on beta receptors. Vasoconstrictors are sometimes used as an emergency method of elevating blood pressure where other measures have failed, e.g. **ephedrine**.

Side effects of the use of vasoconstrictors

1. The danger of vasoconstrictors is that although they raise blood pressure they can do so at the expense of perfusion of vital organs such as the kidneys. Peripheries such as fingers and toes can suffer too. The blood flow to them may be restricted due to the blood vessels being constricted and can lead to necrosis of the tissues.
2. Tachycardia or bradycardia.
3. Headaches.

Adrenaline

Adrenaline gives mixed beta stimulation with some added alpha mediated effects. It is used chiefly when combined inotropic/chronotropic stimulation is desired, where the alpha stimulatory effect helps to maintain the blood pressure despite the peripheral vasodilatation achieved by beta 2 stimulation. Basically it acts as an inotrope, chronotrope, vasoconstrictor centrally and a vasodilator at the peripheries.

Side effects of adrenaline

1. Tachycardia.
2. Arrhythmias.

Nursing Implications when using these drugs.

1. All usual precautions of I.V. drug administration must be observed.
2. Monitor BP, HR (E.C.G), C.V.P. urine output, temperature.
3. Correction of hypovolaemia and investigation of arrhythmia should be accomplished and relevant ordered treatment administered.
4. Maintain constant infusion. Extreme caution when altering or renewing drugs. Do not mix with other drugs. Inotropes are never suddenly discontinued. Even if another Inotrope is to be substituted it must be discontinued by weaning. New Inotropes should be started cautiously. Even supposedly similar drugs can react differently on a patient. Use a reliable infusion pump.
5. Observe for side effects (unwanted).
6. Inotropes should be given via a central vein. Peripheral veins are sensitive to these drugs and they are not as reliable e.g. Cannula can be positional and blockage can also occur causing tissue infiltration etc.
7. Explain to patient and/or relatives the equipment in use and reasons for drug administration.

What is a Vasodilator?

It is a drug that produces vasodilatation, e.g. Isoket.

As the physiological effects of these drugs are unfolded, many of these drugs have overlapping effects. For example Dobutamine has vasodilator qualities as well as having inotropic qualities. Depending upon the patient's illness, the drugs will exhibit different qualities.

Finally remember that all patients are individuals and such as the predicted effect of these drugs may be extremely variable particularly when linked with certain disease processes such as septic shock.

Isosorbide Dinitrate (Isoket)

1. Causes vascular smooth muscle relaxation with **vasodilatation**. (It predominantly affects venous rather than arterial vessels).
2. Systemic vascular resistance is reduced causing a fall in systemic blood pressure.
3. Cardiac output remains the same and in some patients it is improved e.g. in LVF.
4. Coronary vasodilatation is improved.
5. Myocardial oxygen consumption is reduced.
6. Pulmonary vascular resistance is reduced. Both CVP and PCWP are reduced.

Excretion of Isoket

Isoket is metabolised within the liver and metabolites are excreted by the kidneys.

Side Effects of Isoket

1. Hypotension
2. Tachycardia (Hypovolaemia will exacerbate side effects).

Adrenaline and noradrenaline are used only on ITU/CCU at present so it is unlikely that you will use them on the wards.

Anaphylaxis

1. **Symptoms :-**
   - Bronchospasm.
   - Cardiovascular collapse (low Bp etc).
   - Skin rashes.
   - Oedema in nose and throat.
   - Vomiting.

2. **Treatment :-**
   - Requires prompt administration of adrenaline 1mg initially given intramuscularly, can be repeated every 10 minutes until the blood pressure and pulse improve. Antihistamines given after the adrenaline are useful e.g. Chlorphenamine Maleate (Piriton). Hydrocortisone may be given I.V to help reduce the swelling, but this will take hours to work.
   - **The anaphylaxis box is located on the Resus trolley**

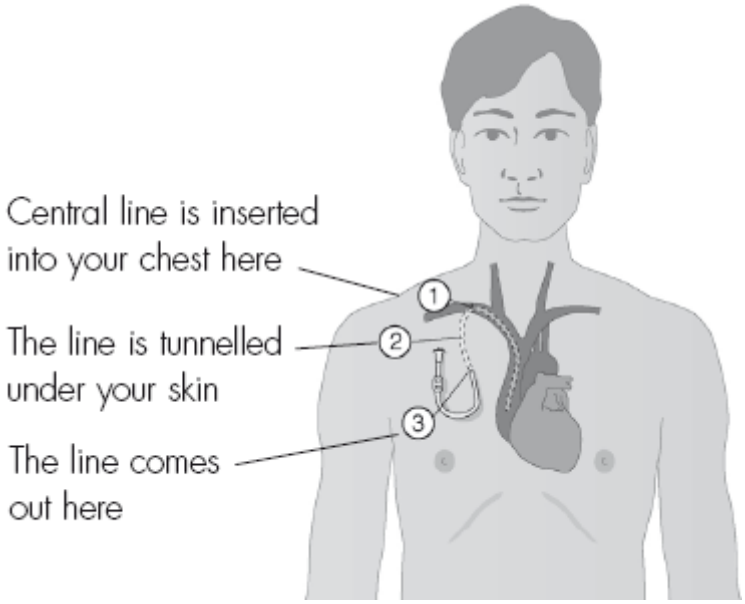
Antagonists for central and respiratory depression

(Reversal drugs)

Respiratory depression is a major concern with opioid analgesics and it may be treated by artificial ventilation or be reversed by **Naloxone.** Naloxone will immediately reverse opioid-induced respiratory depression but the dose may have to be repeated due to the short duration of action of naloxone. **Flumazenil (Annexate)** is a benzodiazepine antagonist for the reversal of the central sedative effects of benzodiazepines such as **diazepam** or **midazolam**.

CENTRAL LINES

Central lines are now being used less frequently on the wards, as the device of choice for clinicians is the Mid. or PICC line. As critical care is most likely the only area you will care for this type of line, it would be beneficial for you, during this placement, to familiarise yourself with the insertion (assisting the doctor), the complications and aftercare of a patient with a central line.



Reason for insertion

They are used for monitoring of central venous pressures and used for giving drugs and solutions that shouldn't be used peripherally. On CCU a specific central line is inserted in some patients who require a temporary pacemaker.

What are normal CVP pressures?

The figures for a normal healthy human are:-

- 5-15 cmH_2O (using the basic manometers on the wards)
- 0-10 mmHg (using transducers) – adjusting for PEEP

Do remember that most of our patients are not healthy and may be used to living with abnormal CVP pressures so attempting to correct these to normal pressures may not be in the best interests of the patient.

Hazards associated with central lines

It is easy to remember hazards if you start by insertion of the line.

- The skin is broken so potentially ***infection*** could be introduced.
- A large needle is inserted in and out until entry to the vein is established. So being close to the lungs a ***pneumothorax*** can be caused.
- The central line is inserted to sit in the right atrium or just outside. Therefore a ***pericardial tamponade*** can be caused by the catheter piercing the wall of the right atrium and entering the pericardial sac.
- ***Cardiac arrhythmias*** are less likely to occur however, the catheter is entering the heart it can potentially stimulate the conduction pathways.
- The vessel that is used for insertion could become ***blocked,*** by kinking of the line or a blood clot could adhere to it.

Preparation of the patient

Explain the procedure to the patient. The patient will need to be lying flat with his/her arms straight down by his/her side and one pillow may be satisfactory. If the patient does not feel comfortable lying flat then the doctor could be asked to prepare himself and prepare the area for insertion first before you lay the patient flat. If possible hold the patients hand during the procedure and talk to him/her.

Aftercare

Make the patient comfortable, you should be able to sit the patient up. Ensure the central line is secure with the I.V. 3000 An X-ray must be taken before using the central line to check it is in the right place and that there is not a pneumothorax. When connecting lines, or administering drugs, always remember **asepsis.** This line is ideal access for bugs! The line should only be in as long as necessary. It should be considered for changing:-

- If the site becomes red and inflamed.
- If the patient develops pyrexia, wcc is raised etc.

Removal

On ITU/HDU the nurses remove central lines. But there is an art to it and even if you don't remove lines on the ward it is useful to know the best procedure so that you can check that the doctor does it correctly, in the best interest of the patient. The main hazards associated with removal are air entry into the vessel and arrhythmias. The procedure is as follows:-

- Explain the procedure to the patient.
- Lay the patient flat.
- Remove the dressing.
- Clean the area aseptically.
- Remove the stitch.
- If it is required, ask another member of staff to be ready to cut the tip of the central line and let it drop in a sterile pot, (to be sent for C&S when necessary on ITU/HDU – this needs to be recorded on the insertion sheet).
- If sending the tip, remove the catheter taking care not to let the end touch anything except the inside of the sterile pot and the nurse will snip the end off. When the catheter has been removed then immediately occlude the site with gauze (this is the point where air can get in). When the site has stopped bleeding then place a transparent dressing over it.

INFUSION PUMPS AND SYRINGE DRIVERS

During your placement on Critical Care you will have prime time in developing an expertise in the use of this equipment. Use them often until you are confident. Although these types of equipment will differ in make and model elsewhere, remember they are all basically the same.

Infusion pumps

- They all have an on and off button, whether it be a click type switch or an electronic touch button and have a start/stop electronic touch button.
- Check the equipment has had its annual service which is displayed with a date on the equipment.
- Run the set through, usually manually, into a receiver and make sure all the air has run through. When this is done you can connect it to the patient but clamp it first if is not inserted in the pump as it will run through freely otherwise.
- Place the set in the pump carefully you should not need to use force. This is the main difference with each type of pump, some may be fiddly. Once in you can unclamp it.
- Commonly used drugs in Critical care will be found in the drug library, this is to be used wherever possible.
- Set the rate, it is in mls per hour.
- Set the volume to be infused. **Tip**: - set a lower figure than what is in the bag (i.e. 40ml 1st bag, 20ml for subsequent bags) because you will waste some when you run the set through and you don't want the infusion finishing and air running through the line. Also if you set it to alarm earlier, (when you are busy) this will warn you to prepare another bag if it is required.
- Beginners should have the settings checked by another qualified nurse.
- It is always useful to make a mental note of the volume in the bag before it is infused so that when it has finished infusing, you will have an idea that the volume has gone through in the time you expected it to

go through. Infusion pumps have been faulty but fortunately this rarely happens.

- If you are changing a bag on an already established line remember this should be done as aseptically as possible. There may be need for haste if it is an inotrope for which the patient is dependant on, so there will be a need for as little disruption to the flow of that drug as possible. The ITU nurses will show you several ways of doing this.

Syringe drivers

- Run the line through manually expelling all the air, clamp the line, then once connected to the patient, you can unclamp it.
- Set the rate mls per hour, double check it and, for beginners, check with another qualified nurse. When changing the syringe on an established line clamp the line before removing the completed syringe, connect the new syringe then unclamp and check the set rate is correct and start. Remember, again, as above haste may be required. Also please remember ***asepsis.***
- Use Drug library where possible.

All equipment should be plugged in at the mains even when not in use (to charge the battery if needed for transport).
They work on WiFi which draws energy from the battery.

Please note that the use of infusion devices by pre-registration nurses should be under the direct supervision of a Registered Nurse or Doctor.

OXYGEN THERAPY

Oxygen is widely used for correcting hypoxaemia of acute and chronic respiratory failure.
It is also used for postoperative recovery as there is an increased incidence of myocardial infarction in the first 2-5 days of recovery. Oxygen is used as part of the treatment for myocardial infarction patients and patients who have angina with chest pain.

Patients in **acute** respiratory failure have normal respiratory control and can be given oxygen in any amount sufficient to correct the hypoxaemia.

Chronic patients, where respiratory control is abnormal and a degree of hypoxaemia is a necessary stimulus for breathing, too rapid correction may remove this drive, so oxygen may need to be given in increasing amounts. Caution may be given only to those patients who have had increasing CO_2 levels over a long time. This does not mean that these patients may not be given 98% oxygen they may eventually need this for a short period to sustain life.

Administration of oxygen – O2 has to be prescribed

Face masks in general are uncomfortable but must be worn correctly at all times because of the dangers of intermittent oxygen therapy. Some masks have a reservoir bag attached (Hudson non-rebreathable masks) which are designed to give a 100% oxygen, however they actually deliver approximately 85%.

Nasal specs can be used at 1 to 6 litres which will give approximately 25% to 44%.

Hi Flow O2 is being used more frequently.

Humidification

If oxygen has to be given for more than a few hours, it must be humidified and if possible warmed. If humidified oxygen is not used then the tracheal mucosa becomes dry, sputum is tenacious, and becomes encrusted in the trachea, and atelectasis and secondary infection may then occur in the lungs. The humidification bottles that are used on ITU/HDU can give up to 98% oxygen.

Monitoring

Patients who receive oxygen for long periods, particularly at high amounts require monitoring with a SaO2 monitor (pulse oximetry) and regular observation of blood gases. SaO2 monitoring using pulse oximetry is a simple method of monitoring the % of Hb saturated with oxygen using a non-invasive technique. SaO2 can give you an indication of the amount of pO2 in the blood, (for more details look up the oxygen dissociation curve). At about 90% SaO2 the paO2 will be around 8Kpa and at 100% SaO2 the paO2 will be around 13.3Kpa, (13.3Kpa being the normal). The use of pulse oximetry is covered briefly on the next page.

Measuring blood paO2 and paCO2 (normal paCO2 is around 5.3Kpa) can be done by taking an arterial specimen and sending it to the lab for ABG analysis. The rest of the values that you will see from the ABG report are pH, AB (actual bicarbonate), SB (standard bicarbonate) and BE (base excess). These are explained in more depth in the section called acid base balance. Finally remember that different patients with different disease states may have been used to living with abnormal paO2 and paCO2 levels and it is important that this is taken into account whilst analysing ABG results.

PULSE OXIMETRY

A simple method of monitoring the percentage of haemoglobin saturated with oxygen using a non-invasive technique

LET THE FINGER DO THE TALKING

DO

- Line up the lights on the probe.
- Choose the correct site finger or ear.
- Choose a well perfused site.
- Remove dark coloured nail varnish.
- Cover the probe if the overhead lights are bright.
- Set the alarm limits correctly 90% or above.
- Move the probe site regularly.

Arterial Lines

Direct measurement of arterial blood pressure is obtained via a peripheral artery catheter that is connected to a transducer and is a continuous display/recording device or monitor. Intra-arterial or direct blood pressure provides a continuous display of the arterial waveform along with measurements of mean arterial pressure, systolic and diastolic pressure.

Monitoring direct arterial pulse pressure provides valuable information in terms of pressure value or measurement, but it also provides valuable information in terms of its shape and contour. The arterial pulse wave can exhibit changes that are related to specific underlying pathology.

Indications for the use of direct arterial blood pressure monitoring include shock, critical illness, peripheral vasoconstriction, and intra-operative and post-operative monitoring of high-risk patients. In addition, arterial catheters allow for frequent monitoring of blood gas measurements.

Arterial lines are routinely used in critical care areas for monitoring arterial blood pressure or serial blood gas measurements. Patients should not be nursed outside these areas with arterial lines in order to avoid complications of insertion such as:

- Ischaemia.
- Bleeding.
- Accidental intra-arterial administration of drugs.
- Nerve trauma.
- Air Embolus

Arterial lines and arterial blood gas sampling can be associated with morbidity and mortality and so the clinical indication for the insertion of an arterial line should be documented.

Indications for the insertion of arterial lines:

Continuous arterial pressure monitoring:

- Haemodynamically unstable patients.
- Patients on vasopressor or vasodilator drugs.
- Major surgical procedures.

Serial blood gas measurements:

- Patients in respiratory failure.
- Patients being maintained on or being weaned from mechanical ventilatory support.
- Patients with severe acid/base abnormalities.
- Where frequent blood samples are required to measure electrolyte concentrations.

Insertion of arterial lines:

Suitable sites for the insertion of arterial lines include:

- Radial Artery.
- Brachial Artery.
- Femoral Artery.
- Dorsalis Pedis.
- Axillary arteries.

The arterial line must be inserted by a doctor or other practitioner competent in the procedure. If the radial artery is selected the operator may perform an "Allen Test" to assess peripheral limb perfusion distal to the proposed arterial cannula site prior to insertion.

Identification of Arterial Lines:

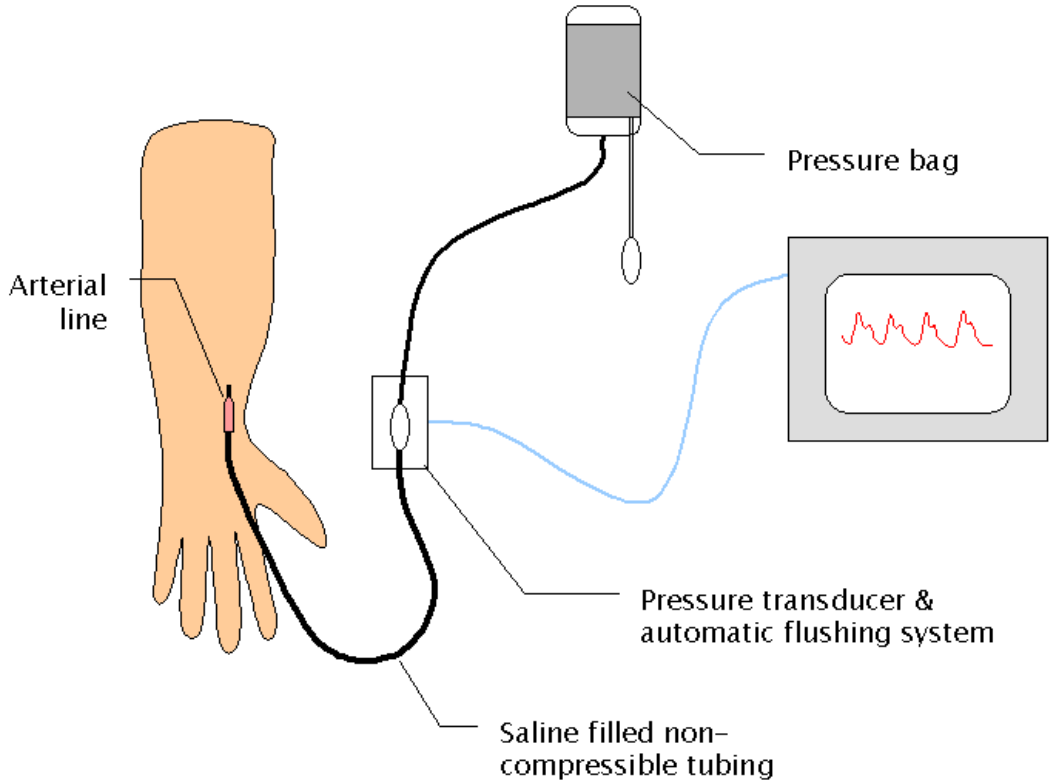
The arterial line must be clearly labelled with an arterial line dressing and red bungs should be used on sample ports.

Arterial Line Fluid Prescription:

- Appropriate fluids must be used, usually Normal saline.
- The arterial line fluid must be prescribed on the patient's drug chart or ITU/HDU chart.
- The fluid must be checked by two registered practitioners before it is connected to the arterial line.

The Transducer System

The measurement of a patient's blood pressure with a pressure transducer involves the arterial cannula being connected to a pressurized line. The pressures in the cannula are transmitted through fluid filled tubing to the transducer diaphragm. The movement of the diaphragm is converted to a low voltage electrical signal. The signal is amplified and converted to a real-time waveform display on the monitor. The measurements are then digitally displayed in mmHg.



Sampling from an Arterial Line:

Staff should always ask themselves "do I need to take this sample?"

Indications include:

- Changes in monitored respiratory variables e.g. oxygen saturation or tidal volume
- Monitoring of results of changes in ventilation
- Monitoring of electrolytes
- Monitoring of bleeding or coagulation tests
- Monitoring acid/base abnormalities

Sampling from arterial lines should only be performed by staff competent in the technique.

ACID BASE BALANCE

In chemistry:

- A substance that donates hydrogen ions (H+) is an acid
- A substance that accepts H+ ions is a base (or alkali – they are essentially the same).

The concentration of H+ ions in a substance/solution will determine whether it is acid or alkali.

- Large numbers of H+ ions = **ACID**
- Small numbers of H+ ions = **ALKALI**

The role of H+ ions is measured by a scale (devised by ***Sohesen in 1909***):

14	**ALKALINE**
7	**NEUTRAL**
0	**ACID**

Blood Plasma has a pH. Is it acid or alkaline?

What about these other substances?

- Saliva pH 6.2
- Bile pH 8.0
- Gastric Juice pH 1.8
- CSF pH 7.4

Acids in the body can be chemically neutralised by bases to form salts and water. It is vital that the body keeps the acids and the alkalis balanced. Generally the body prefers an alkaline environment.

The control of pH is of crucial importance to enzyme reactions and cellular processes within the body.

Three homeostatic mechanisms ensure that the pH of the blood plasma remain within the limits of 6.8 and 8.0. A pH value outside these limits is incompatible with life over time.

Blood pH is mediated by three distinct but interdependent mechanisms:

- Buffering
- Respiratory Regulation
- Kidney Regulation

1. Buffers

Buffers are known as 'Chemical Sponges' as they 'soak up' or 'mop up' acids or alkalis in the body. They chemically react with strong acids/bases to make weak acids/bases. There are three main types of buffering systems within the body:

- Bicarbonate Buffer System

- Phosphate Buffer System
- Protein Buffer System

2. Respiratory Regulation

The respiratory centre is sensitive to changes in pH and is stimulated by a fall in pH. This causes hyperventilation and an increased rate of excretion of carbon dioxide.

$$CO_2 + H_2O = H_2CO_3 \text{ (Carbonic Acid)}$$

3. Kidneys

The kidneys regulate blood pH by…

a) They regulate the concentration of H+ ions when the pH is low. The kidneys excrete H+ and conserve **H_2CO_3 -.**

b) They regulate the concentration of bicarbonate ions when the pH is high. They conserve H+ and excrete **H_2CO_3 -.**

This process is relatively slow (24-36 hrs) compared with the rapid elimination by the lungs (a few minutes).

ALKALOSIS AND ACIDOSIS

Common causes of Acid-base disturbances:

Respiratory Acidosis

Ventilation failure.

Respiratory Alkalosis

Hyper-ventilation.

Metabolic Acidosis

- Overproduction of acids e.g. shock, cardiac arrest, Diabetic Ketosis.
- Impaired renal excretion of acid: in acute and chronic.
- Ingestion of acids
- Loss of bicarbonate rich intestinal secretions e.g. ileostomies

Metabolic Alkalosis

- Loss of gastric acid e.g. through vomiting or NG suctions.
- Provision of excess base e.g. blood transfusion or soda bicarbonate.

An acidosis and alkalosis may have a mixed cause e.g. shock and ventilation failure.

An increase in pH is Alkalosis

A decrease in pH is Acidosis

The ways in which either of the two might arise can be appreciated by studying the 'tail' of the ***Henderson-Hasselbalch*** equation i.e. the ratio of bicarbonate to carbon dioxide e.g.:

- An increase in **CO_2**, as occurs in respiratory failure, reduces the value of the ratio and hence the pH falls giving a respiratory acidosis
- A decrease in **CO_2**, by hyperventilation increases the value of the ratio and increases the pH giving a respiratory alkalosis.
- Primarily metabolic processes that affect the acid content of the body change the bicarbonate concentration.
- A decrease in bicarbonate occurs when there is excess acid as in shock where lactic acid production is increased so the pH decreases causing metabolic acidosis.

An increase in bicarbonate concentration produces a metabolic alkalosis.

Plasma Bicarbonate

The normal value of plasma bicarbonate is 21-26 mmo1/L but is influenced by the **CO_2**, content in the blood. To eliminate this respiratory variation the level can be measured with the **CO_2** tension of the sampled fixed at the normal value of 5.3 KPa. This figure is the standard bicarbonate.

Base Excess

Defined as, 'the number of moles of acid or base that is required to restore one litre of blood to a pH of 7.4 KPa while the **PCO_2** is held constant at 5.3 KPa. The value is therefore, helpful in quantifying the metabolic component of an acid base disturbance. It is usually zero.

In an acidosis it is a negative value – Base Deficit

In an alkalosis it is a positive value – Base Excess

The approach to an abnormal result:

1. Is it an acidosis pH <7.35 or an alkalosis pH >7.45? If the pH is normal, are the values of SB and CO2 abnormal? If so then the body has compensated to correct its pH.
2. Are the disturbances metabolic or respiratory? E.g. for an acidosis, if the **PCO_2** increases it is respiratory, and if there is a base deficit it is metabolic.

TRACHEAL SUCTION

Are you a safe practitioner? Do you know the risks?

The risks: ''Trauma, bronchoconstriction, hypoxaemia, cardiac arrest and death'' (Chen et al 1998)

Patient assessment

Auscultation of the chest, check for secretions, check oxygenation. Remember suction is not a routine intervention.

Patient stress

Reassure your patient, explain the procedure, get consent if possible and administer analgesia if required.

Prevention of hypoxaemia

The use of hyperoxygenation or the use of hyperinflation.

Maintain sepsis

Hand hygiene, use sterile gloves, aprons and goggles. Use closed circuit suction wherever possible.

Use correct catheter- we use closed suction

The external diameter of the suction catheter should not exceed one half of the internal diameter of the endotracheal tube

Depth of insertion

Advance catheter to the carina enough to feel resistance or to stimulate a cough and withdraw 1cm before applying suction.

Negative pressure

Limit pressures between 80-150 mmHg and apply continuous pressure not intermittent.

Suction procedure duration

Suction for a maximum of 10-15 seconds only. Some recommend allowing oxygen saturation levels to return to pre-suctioning parameters between passes. Others recommend that no more than 3 passes should be made during each episode.

Use of saline

For: if secretions are tenacious it is occasionally permissible to use no more than 2mls to aid coughing and prevent tube blockage.
Against: Not all the saline is removed therefore saturation levels can fall and it can increase the risk of infection.

After suctioning

Re-assess your patient for any ill effects e.g. observe breathing sounds, skin colour, pulse rate and auscultate the chest.