MASTERY SKILLS PATHWAY

ARTERIAL LINE INSERTION

CONTACT

Address

Medical Education Directorate
Clinical Skills & Assessment Centre
Western General Hospital
Edinburgh, EH4 2XU

Phone

MED: 0131 536 1000

Online

Email: mastery@nhslothian.scot.nhs.uk

Website: www.med.scot.nhs.uk

AUTHORS

DR BENJAMIN CLARKE	EMERGENCY MEDICINE REGISTRAR, NHS LOTHIAN
DR THALIA MONRO-SOMERVILLE	CONSULTANT ANAESTHETIST & ICM, NHS LOTHIAN
DR SIMON EDGAR	DIRECTOR OF MEDICAL EDUCATION, NHS LOTHIAN
DR OLIVER DALY	CONSULTANT ANAESTHETIST, NHS LOTHIAN
DR JAMES TIERNAN	CONSULTANT PHYSICIAN, NHS LOTHIAN
DR DAVID FALZON	CONSULTANT ANAESTHETIST, NHS LOTHIAN

MED education safety quality
Medical Education Directorate

TABLE OF CONTENTS

MED education safety quality

Medical Education Directorate

01 MASTERY SKILLS PATHWAY OVERVIEW

NHS Lothian Mastery Skills Pathway has been developed to enhance the technical and non-technical skills of clinicians undertaking complex clinical procedures

MED education safety quality
Medical Education Directorate

MASTERY SKILLS PATHWAY OVERVIEW

A NEW DEVELOPMENT

Welcome to the NHS Lothian Mastery Skills Pathway Arterial Line Insertion Reading Pack. We hope you find this pack a valuable learning resource to complement your simulated practice sessions.

The Mastery Skills Pathway is an educational, quality assurance and patient safety initiative to promote high-quality training and safe, effective patient care for high-risk procedural skills.

Your pre-learning (Videos and Reading pack), Deliberate Practice and Simulation-based assessment sessions will optimally prepare you for real-life procedural performance, under direct supervision.

MED education safety quality
Medical Education Directorate

METHODS

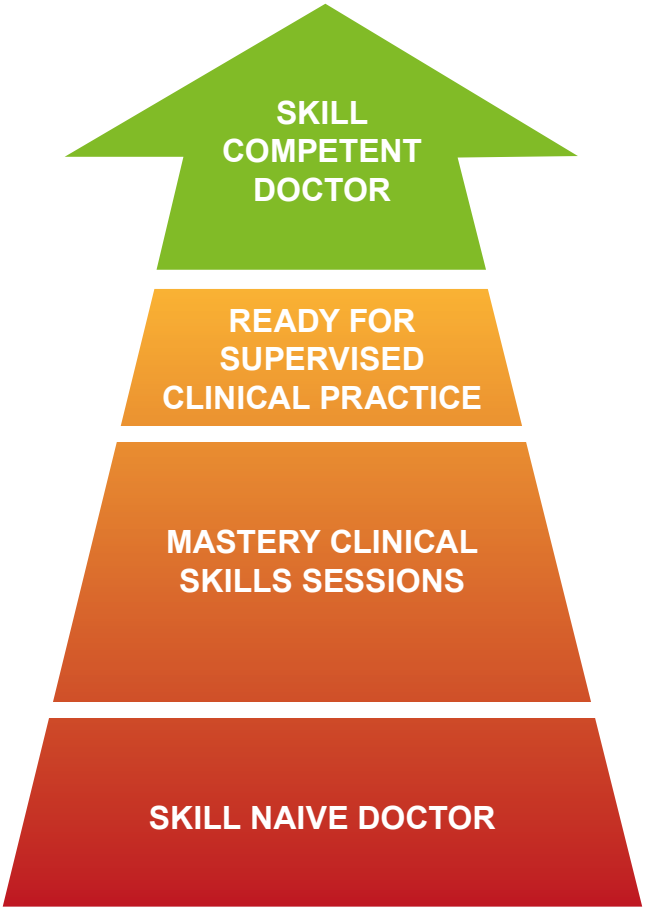
GAINING COMPETENCY

We recognise that the traditional model of “see one, do one, teach one” is no longer realistic. Our new approach allows development of fundamental skills, in a completely safe manner before real-life practice.

In addition, this novel approach allows refreshment of old skills, minimising the effects of potentially harmful skill decay.

The path to procedural competency for clinicians is suported by the following:

- A trained faculty
- Knowledge packs containing a combination of written and video educational resources for each procedural skill, with a consistent emphasis on patient safety
- Self-directed deliberate practice where you can spend as much time as you like familiarising yourself with the technical aspects of the procedure
- A supervised simulated checklist-based assessment session where you will receive feedback on your performance from your tutor
- Real-life practice under direct supervision until you are independently competent



- **WPBA provision**
- **Real-life practice under direct supervision until independently competent**

- **Mastery Assessment Session**
- **DOPS and Mastery certificate provision upon achieving passing standard**

- **Self Directed or Peer Assisted Deliberate Practice**
- **Peer Observation**

- **MED site: www.med.scot.nhs.uk**
- **Reading pack**
- **Videos: Exemplar skill performance & demo Mastery session**

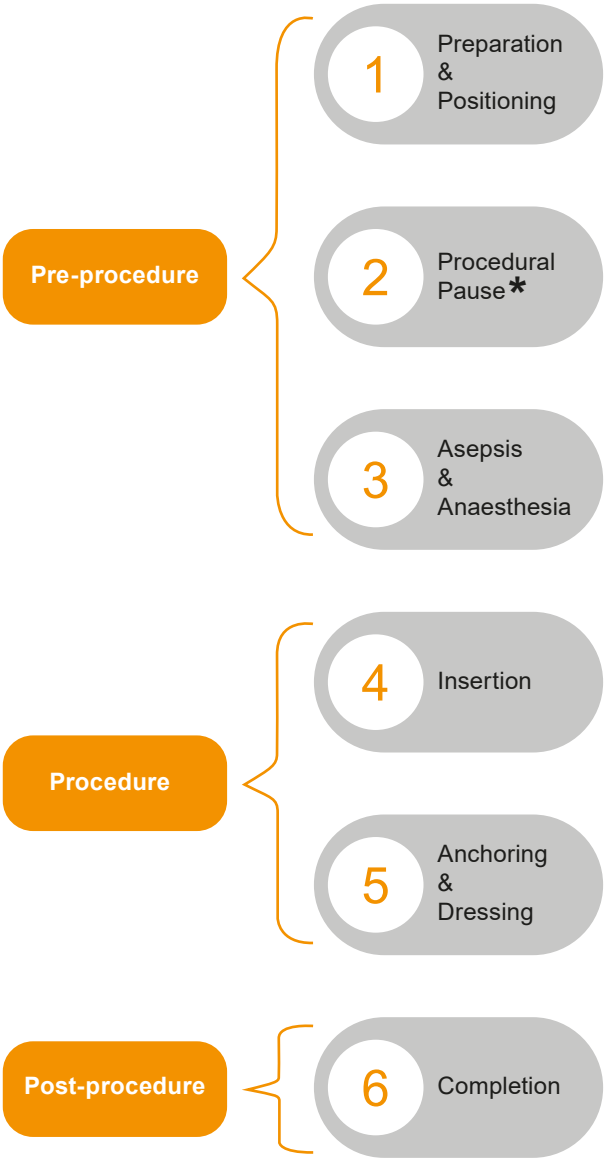
MED education safety quality
Medical Education Directorate

MASTERY PROCEDURE PHASES

PROCEDURAL PHASES

Complex procedural skills can be daunting prospects initially. It is not uncommon for novices to become overwhelmed when performing such procedures, resulting in avoidable error or harm. It can be helpful to fragment the task into discrete, manageable parts, ensuring one is complete before moving onto the next.

Our "Mastery Procedural Phases" is one method of approaching any complex skill. Six Procedural Phases have evolved to help break down skills into more manageable components. These can be more broadly grouped into domains of Pre-procedure, Procedure and Post-procedure (as shown across). This will be discussed more in the videos and simulation skills sessions.



Phase 1 - Preparation, Assistance and Positioning
Consider whether a procedure is indicated, that no contraindications exist and that informed consent has been given. An appropriately trained assistant should be available to assist you with preparing equipment and in positioning the patient correctly to make the procedure as easy as possible.

Phase 2 - A Three-point Procedural Pause*
The procedural pause is an opportunity for all those involved in the procedure, including the patient, to acknowledge that they are content and happy to proceed.

1. Ensure that the patient is comfortable and that they are happy to proceed
2. Your assistant should have the opportunity now to voice any concerns, identify any problems or anything else that needs addressed
3. The clinician should ensure that the equipment is all present, checked and laid out in the order of use.

Once this is completed the insertion can begin.

Phase 3 - Asepsis and Local Anaesthetic Infiltration
Asepsis should be strictly observed to prevent potentially life altering infective sequelae. Local anaesthetic should be used to minimise any discomfort experienced by the patient.

Phase 4 - Insertion
This phase will be covered in a later section of this pack and during the video demonstration.

Phase 5 - Anchor & Dress
All indwelling devices must be secured & dressed to minimise risk of movement, failure and contamination.
Each procedure has specific requirements.

Phase 6 - Completion
You should communicate with the patient and the team looking after them, particularly with regard to symptoms to report and observations required.
Document the procedure, in detail, including any difficulties encountered and immediate complications.

***please note that you can pause as offten as desired. Some clinicians prefer to perform the three point pause after the insertion of local anaesthetic.**

MED education safety quality
Medical Education Directorate

02 LEARNING OUTCOMES

Each skill covered in NHS Lothian Mastery Skills Pathway has been assigned learning outcomes for you to achieve

MED education safety quality
Medical Education Directorate

LEARNING OUTCOMES

After reading and viewing the content contained within this pack the trainee should gain the following:

1. An understanding of the indications for inserting an arterial line and its use in the clinical practice
2. An understanding of risk assessment, patient safety concerns and contraindications to the procedure
3. An understanding of the potential complications of the procedure and the basic principles of their management
4. An understanding of the practicalities of the procedure in a safe and structured fashion
5. An awareness of your own personal limitations and when to obtain help from a senior clinician

03 INDICATIONS & RISK ASSESSMENT

MED education safety quality
Medical Education Directorate

INDICATIONS

Invasive blood pressure monitoring	Repeated blood sampling	Diagnostic or interventional procedure
Labile blood pressure	Respiratory therapy is being titrated (e.g. mechanical ventilation)	Intra-arterial drugs
Anticipated haemodynamic instability (e.g. major surgery)	Frequent biochemistry testing is required (e.g. DKA)	Endovascular procedures
Haemodynamic therapy is being titrated (e.g. vasoactive drugs such as noradrenaline)		Intra-aortic ballon counterpulsation
When non-invasive blood pressure monitoring is unreliable or inaccurate (e.g. morbid obesity)		

CONTRAINDICATIONS

Complications occurring as a result of arterial line insertion are related to the insertion site, patient related factors and the skill and experience of the operator. Prior to each insertion the indication for the procedure should be considered alongside an appropriate timeframe.

In some situations, insertion of an arterial line may be a component of life-saving intervention and therefore **the only absolute contraindication** is refusal from a patient with capacity.

Relative contraindications to insertion of an arterial line include:

- Infection, trauma or full thickness burns at the insertion site
- Coagulopathy (INR >1.5) or thrombocytopaenia (platelets <50)
- Previous arterial surgery and presence of graft
- Damage to the artery proximal to the insertion site
- Presence of arterio-venous fistula in that limb
    - e.g. previous radial harvesting would lead to poor circulation in the hand if the ulnar artery is cannulated
- Thrombophlebitis/vasculitis, occlusive disease
    - e.g. Raynaud's Disease, Buerger's Disease

Experienced clinicians can make decisions to insert an arterial line despite these relative contraindications but their presence should prompt discussion with a senior anaesthetist or intensivist.

For standard elective insertion, the benefits of ignoring these contraindications would probably be outweighed by the risks.

MED education safety quality
Medical Education Directorate

04 PATIENT SAFETY CONSIDERATIONS

With all skills, time should be taken to consider patient safety and how and potential risk factors can be mitigated

MED education safety quality
Medical Education Directorate

SAFETY

SPECIFIC CONSIDERATIONS

As with any clinical procedure, the goal is to safely perform arterial line insertion having removed or minimised any potential risk factors.

If there is any concern that significant risk of harm may compromise patient safety, delay the procedure and seek senior advice.

Specific safety considerations are listed below:

Mandatory Component	Comments
Access to full resuscitation equipment	• Arterial line insertion should only be performed in clinical areas with staff who are experienced with both the procedure and post-procedural care of arterial lines; and which are set up to maintain sterility and provide mandatory monitoring. In NHS Lothian these areas are the Emergency Department, Critical Care and Anaesthetic Theatres. • Consider establishing IV access pre-procedure • Ensure ongoing resuscitation is in progress if clinically required. Arterial line insertion should not be prioritised over improving patient's clinical condition
Competent Practitioner	• Experienced supervisor for trainee (senior registrar, experienced associate specialist or consultant)
Appropriate Assistant	• Must be present throughout the procedure • Competent to contribute to equipment checking and ensure patient comfort etc

QUESTIONS TO CONSIDER

ALWAYS CONSIDER THE FOLLOWING

- Are there any absolute or relative contrainidications to insertion?
- Does it need to be done?
- Does it need to be done now?
- Am I competent to do this?
- Is supervision / assistance available?
- Am I familiar with the equipment?
- Is this the correct environment?
- Does the patient have capacity to consent to the procedure?

PATIENT EDUCATION

ALWAYS TALK WITH THE PATIENT

Communicating and informing the patient of exactly what the procedure involves can reduce anxiety and facilitate better positioning for the procedure.
The patient should be made aware why they are having the procedure, the benefits, the potential risks / complications and the alternatives to the procedure.

Once this has been done, informed consent should be sought and documented.

If the patient does not have any capacity to give informed consent, and the procedure is deemed clinically necessary, ensure an Adults with Incapacity form is completed.

Always establish whether the patient has any known allergies prior to the procedure - they may have an allergic reaction to local anaesthetic or antiseptic skin preparation.

IN SUMMARY

Tell the patient:

- Why there is a need for the procedure
- How the procedure will be performed
- What the potential risks / complications are
- What the alternatives are

Gain consent.

Always offer the patient the oppertunity to ask questions.

MED education safety quality
Medical Education Directorate

05 POTENTIAL COMPLICATIONS

There are several complications associated with anterial line insertion. Some of these, although rare, can be extremely serious. It is your responsibility to explain these risks so that the patient may make an informed decision about their care.

MED education safety quality
Medical Education Directorate

COMPLICATIONS

Complication		How to mimimize the risk
Thromboembolic	Air embolism	• Prime the transducer adequately to ensure there is no air in the system prior to connecting to arterial line
	Wire embolism	• Ensure wire is controlled throughout procedure, aiming to have a grip on it as much as possible
	Catheter related thrombosis	• Appropriate VTE thromboprophylaxis
Mechanical	Haemorrhage	• Optimise coagulopathy prior to insertion
	Nerve/vein injury Bowel injury (femoral)	• Careful palpation prior to insertion or use of ultrasound
	Artery injury (vasospasm/ dissection/ pseudoaneurysm)	• Avoid repeated attempts, rest artery or attempt at alternative site if injury suspected, avoid end artery insertion if possible (e.g. brachial)
	Haematoma formation	• Avoid multiple attempted insertions at same site, correct coagulopathy prior to attempt, apply adequate pressure (force and time) over site if bleeding
Infectious	Catheter colonisation	• Aseptic technique on insertion • Use of 2% chloraprep to clean skin for insertion (can use appropriate chloraprep sponges)
	Catheter related blood stream infection	• Transparent dressing • Daily review of need for arterial line • Remove if signs of infection
Ongoing line use	Disconnection and exsanguination	• Monitoring of line in critical care setting, always transduced
	Intra-arterial injection	• All accessible ports clearly labelled

COMPLICATIONS

THROMBOEMBOLIC COMPLICATIONS

Thrombosis can be caused by blood clots, atheroma, insertion wire or inadvertent air embolism from the giving set attached to the arterial line. The column of fluid that is attached to the arterial line should be free of any air bubbles. Injection of air into the distal extremity could disrupt blood flow to the hand or feet and cause distal ischaemia.

It is important to ensure the system is free of air by flushing the column of water into a syringe via a port proximal to the arterial line and then aspirating blood from the arterial line to ensure that any air in the system is cleared. It is then possible to flush the line at that stage.

During the procedure the guide wire should never be fully inserted into the artery and must be held securely when passing the arterial catheter over it. Loss of the guide wire into the arterial tree can cause significant distal ischaemia.

Any suspected distal ischaemia needs to be treated promptly by discussing with a senior and potentially referring to vascular surgery.

MECHANICAL COMPLICATIONS

The sharp needle that is used to gain access into the arterial lumen can cause damage to nearby structures and the artery itself. Nerves e.g. the median nerve during brachial artery, veins and nearby structures e.g. bowel during femoral artery catheterisation) can all be damaged.

The arterial wall can be damaged, causing acute vasospasm and increasing difficulty inserting the guidewire. If vasospasm is suspected and threading the wire is proving difficult then resting that artery for a period of time or attempting insertion at an alternative site would be advised. The arterial wall can suffer long term damage from repeated punctures, such as dissection, pseudo-aneurysm formation and arterio-venous fistula formation.

Significant haematoma can occur with multiple attempts at cannulation occur or when significant coagulopathy is present. A few minutes of firm manual pressure and pressure bandages will reduce the chances of haematoma formation. Haematoma could cause significant pain, compression on a nerve and potentially compartment syndrome if severe.

Major haemorrhage is a very rare but life-threatening complication. The highest risk insertion site is the femoral artery, where patients can suffer large, concealed retroperitoneal bleeds.

MED education safety quality
Medical Education Directorate

COMPLICATIONS

INFECTIOUS COMPLICATIONS

Sterile and aseptic technique is crucial when inserting arterial lines. The skin should be prepared with an anti-septic (2% chlorhexidine is recommended) and full sterile precautions should be taken.

Sites of infection could include the suture or insertion sites and the catheter itself after colonisation with bacteria. The introduction of catheter related blood stream infection (CRBSI) bundles introduced for central venous catheters have reduced sepsis caused by indwelling vascular catheters. The adherence of these bundles when caring for arterial lines is just as important as for venous lines.

A transparent dressing should be used to allow for easy visualisation and daily checks of the arterial line should be carried out to assess for signs of infection. Regular, daily review of the need for the line should also occur as the longer the line is in the more likely it is to become infected.

If infection is suspected, then removing the catheter needs to be considered. If removed, the catheter tip should be sent to microbiology along with contemporaneous blood cultures. If an arterial line is still required, it should be inserted at a separate site.

Consider antimicrobial treatment either from antimicrobial guidelines or local advice from a microbiologist.

ONGOING LINE USE

If an arterial line is not being transduced and a disconnection occurs or the arterial line gets pulled out, then exsanguination through the arterial line or puncture site could occur. This is why arterial lines should only be cared for in critical care or HDU areas and should always be transduced; should a disconnection occur the system will no longer be able to give a reading for the blood pressure and this will set off alarms, alerting you to a problem.

Intra-arterial injection is also potentially devastating. It is crucial that people caring for the patient are aware that they have an arterial line in situ and that this is clearly labelled as such at every potential port that can be used for injection. Should intra-arterial injection occur the injection should stop immediately and senior help sought.

MED education safety quality
Medical Education Directorate

06 BASIC SCIENCES

A sound understanding of the relevant basic sciences related to arterial line insertion will allow you to improve your practice, predict and prevent problems

MED education safety quality
Medical Education Directorate

ANATOMY

Arterial lines can be inserted in a number of arteries in the human body which can be found by palpation or ultrasound guidance. The most common site for insertion is the radial artery in the wrist. Upper limb alternatives include the ulnar and brachial arteries and in the lower limb the femoral posterior tibial and dorsalis pedis arteries can all be used.

It is important to know the anatomy of the region of where you are inserting an arterial line. Some sites require more careful consideration than others.

All sites can be visualised using ultrasound to minimise inadvertent damage or puncture to near-lying structures but a good knowledge of the surface and neighbouring anatomy is also vital to minimise risk.

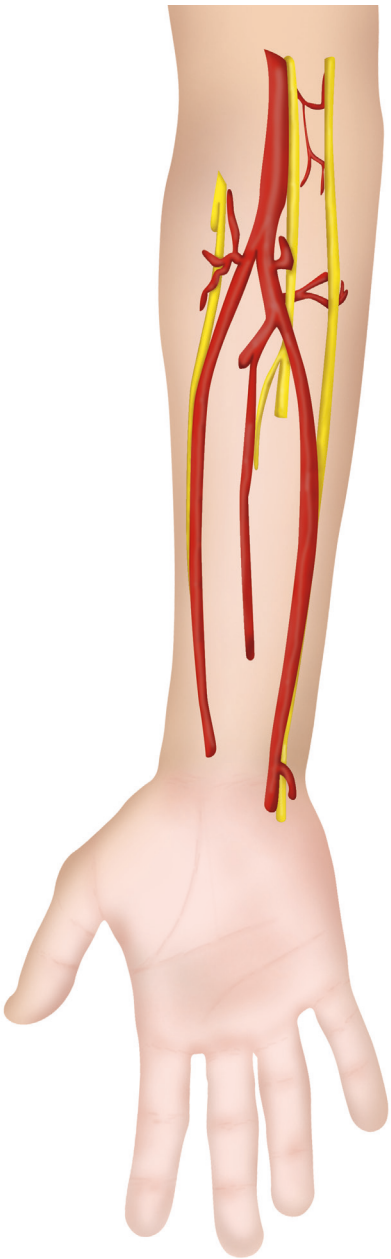


Fig 1. Anatomy of the brachial, radial and ulnar arteries

MED education safety quality
Medical Education Directorate

ANATOMY

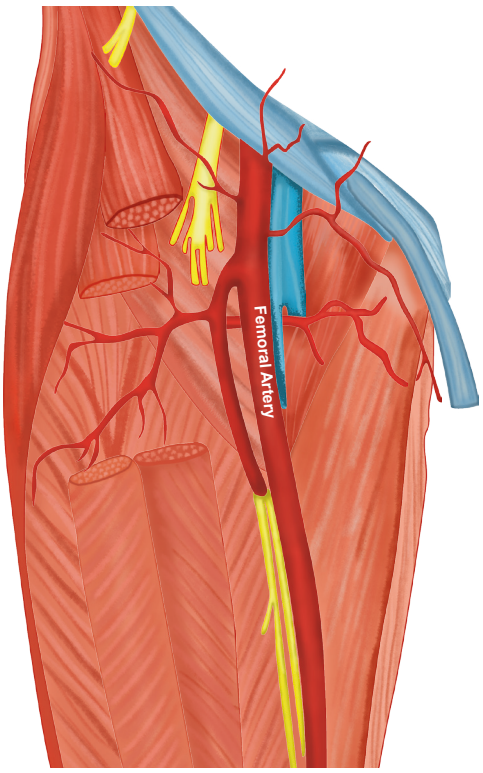
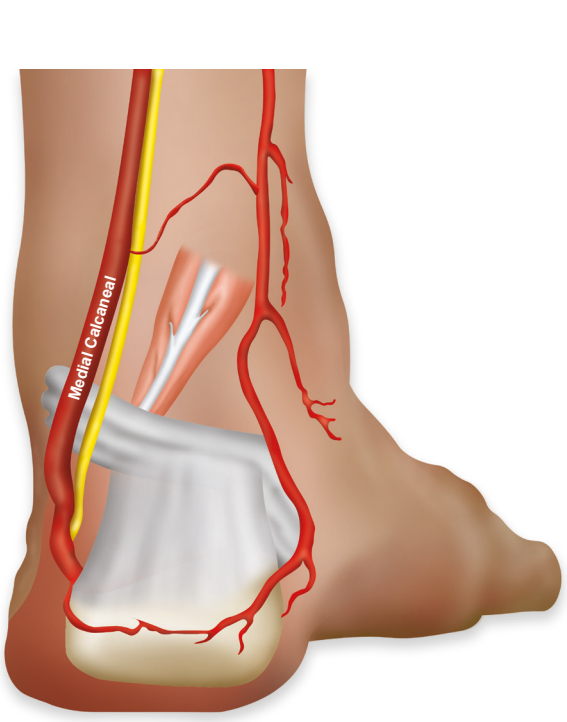


Fig 2. Anatomy and relations of the femoral artery in the groin



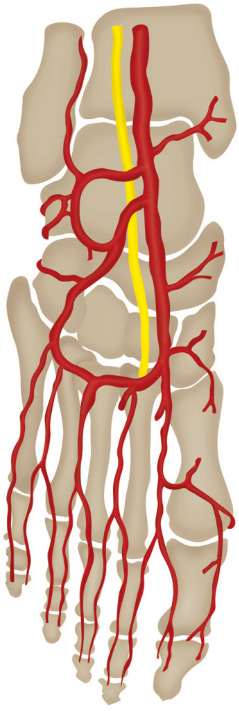


Fig 3. Anatomy of the arteries in the foot

SPECIFIC CONSIDERATION FOR COMMONLY USED INSERTION SITES

RADIAL ARTERY

The radial line is the most common site for arterial line insertion – it is convenient, easily accessible, wasy to clean and probably the most comfortable site for the patient.

Insertion of an arterial line could potentially disrupt blood flow to the extremity that is being supplied. It is good practice to perform an Allen's Test prior to insertion to assess for adequate collateral flow from the corresponding ulnar artery.

An Allen's test is performed by elevating the patient's hand, asking the patient to clench their fist for thirty seconds and then applying pressure over the ulnar and radial arteries so as to occlude them.

The patient is then asked to open his hand – this should be pale as any blood in it has been drained and blood flow to it is occluded. At this point pressure over the ulnar artery is released. Colour to the hand should return within 5-15 seconds. A slow return of colour implies that the ulnar artery's blood supply to the hand is insufficient and any damage to the radial artery (by insertion of an arterial line for example) could cause critical ischaemia to the hand. If this is the case consider choosing an alternative site to insert the arterial line.

BRACHIAL ARTERY

This is an end artery and untreated disruption of flow through this artery will lead to irreversible ischaemia of the forearm and hand. It should therefore be used after careful consideration of other options. As can be seen in the ultrasound image above, the median nerve lies very close to the median aspect of the artery. Repeated trauma to this nerve with a sharp needle could potentially lead to temporary or permanent damage to the nerve.

It is also a slightly awkward place to site the arterial line as it can be quite positional and ineffective if the patient is awake and keeps on bending their arm.

SPECIFIC CONSIDERATION FOR COMMONLY USED INSERTION SITES

FEMORAL ARTERY

The femoral artery is cannulated in the groin distal to the inguinal ligament. It is important to identify the femoral artery below the inguinal ligament as repeated punctures of the artery high above the ligament could potentially lead to significant bleeding into the retroperitoneum from iliac vessels. It is also useful to keep in mind that the groin is a common area for hernias and they are not always known about or clinically obvious. Careful consideration should be taken when attempting cannulation if a hernia is present.

The groin is also the site which is most likely to get infected when compared to other sites.

Transducing the arterial pressure from the femoral artery gives a more accurate 'central' pressure which more accurately reflects the pressure in the aorta and therefore the blood pressure perfusing organs, this becomes increasingly relevant in conditions like septic shock when large doses of vasopressors are being used and severe vasoconstriction can lead to an inaccurate reading from a peripheral arterial line.

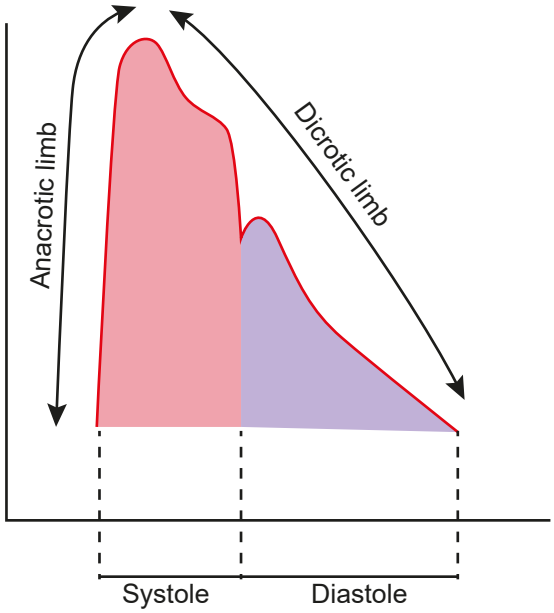
SITES WITH ABNORMAL ANATOMY

Patients affected by peripheral vascular disease can undergo a number of revascularisation procedures to improve limb perfusion. Beware a scar in the groin as this probably means the anatomy is altered and could signify that a graft has been put in place during previous surgery. Successfully inserting an arterial line in an artery with poor flow will be very difficult and possibly give you inaccurate readings and puncturing an artificial graft could be life or limb threatening.

ARTERIAL PRESSURE WAVEFORM

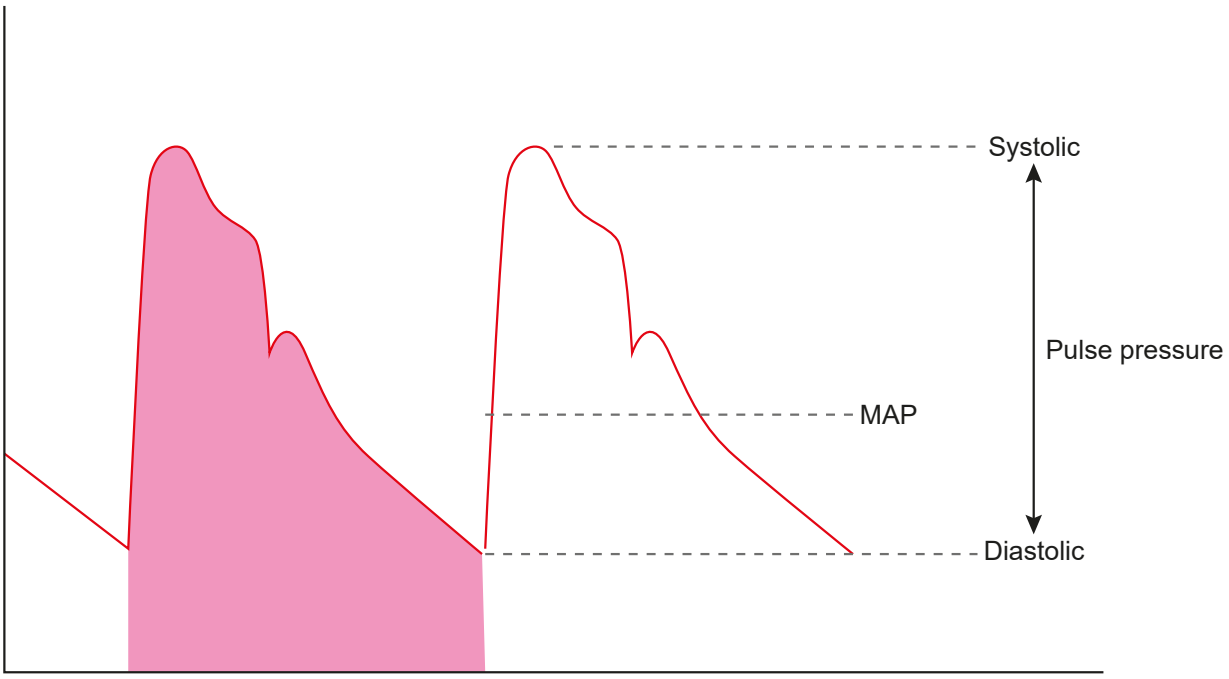
The arterial pressure wave travels much faster than the actual blood which is ejected, representing the impulse of left ventricular contraction.

The arterial pulse waveform can be separated into three distinct components:



- The systolic phase, characterised by a rapid increase in pressure to a peak, followed by a rapid decline. This phase begins with the opening of the aortic valve and corresponds to the left ventricular ejection
- The dicrotic notch, which represents the closure of the aortic valve
- The diastolic phase, which represents the run-off of blood into the peripheral circulation

The waveform can also be separated into anacrotic (upstroke) and dicrotic (downstroke) limbs. The peak correlates with the systolic blood pressure as measured by a normal non-invasive cuff. The trough (i.e. the lowest reading before the next pressure wave) is the diastolic pressure. The mean arterial pressure (MAP) is calculated from the area under the pressure curve, which is a more accurate measurement than the traditional “diastolic plus one-third times the pulse pressure” method.



TRANSDUCING THE ARTERIAL LINE

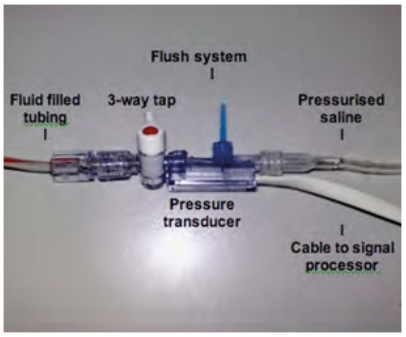
The above waveform is created by attaching an electrical transducer to the arterial line which converts the mechanical energy from the arterial pulse to electrical energy that can be displayed on the monitor.

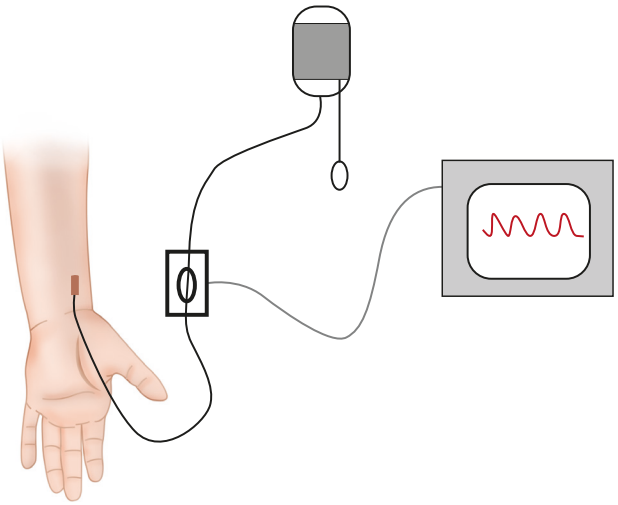
A pressurised saline-filled line is attached to the arterial catheter and pulsation within this moves a diaphragm within the transducer. This is attached to a strain gauge and the resultant changes in electrical resistance represent waveforms, which are then displayed on the monitor.

Equipment required to transduce the central line:

- Pressure bag
- Transducer and fluid giving set specific to arterial lines (see below picture)
- 500ml 0.9% saline

TYPICAL IABP MEASURING SYSTEM





DAMPING AND UNDER-DAMPING

There are multiple waves that are transmitted to the transducer. The processor collates all these waves via a process known as “Fourier Analysis”. The faultless transmission of energy from the artery to the transducer is crucial to accurately display the patient’s true blood pressure.

Every material (in this case the cannula, tubing and fluid in the giving set) oscillates at its own frequency. Resonance in arterial monitoring occurs when the patients pulse oscillates with a similar frequency to the material that transmits the energy to the transducer. If resonance or underdamping occurs, the systolic blood pressure will be inaccurately and erroneously displayed as higher than its true value. The length, diameter, fluid and compliance of the tubing and arterial cannula all affect the system’s natural frequency and likelihood of resonance to occur.

Over damping occurs when the transmission of energy through the system is reduced by faults in the system (e.g. blood clots, kinked tubing, air bubbles). If a system is over damped the systolic blood pressure is under-read and the diastolic is over-read.

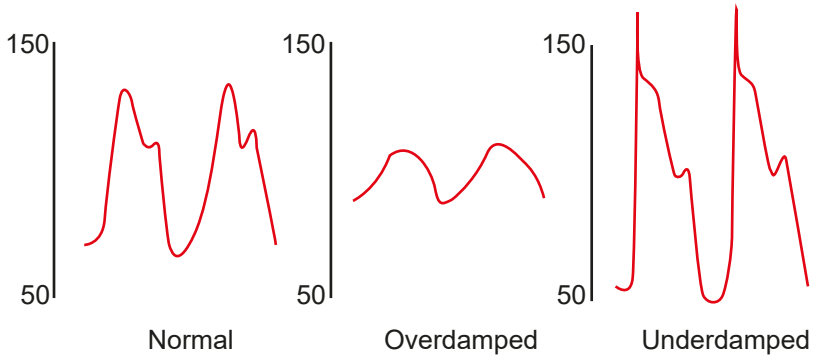


Fig: Over and underdamping inaccurately represent the true blood pressure (normal). Please note that the Mean Arterial Pressure (MAP) is the same in all three readings

LEVELLING AND ZEROING

For accurate readings the transducer needs to be at the correct level and “zeroed” to atmospheric pressure.

Levelling – To reflect a true blood pressure the height at which the transducer is placed must be at the height at which you want to read the patient’s blood pressure. This height is usually taken to be the 4th intercostal space, in the mid-axillary line – the level of the heart. If the transducer is too low, pressure exerted by the column of fluid will be added on to the patient’s true blood pressure while if the transducer is too high the display will under-read the patient’s true blood pressure.

Zeroing – In practical terms this is done by closing off the valve to the patient and opening the system to atmospheric pressure. The system is then calibrated to discount – “zero” – atmospheric pressure. This process can be seen in the video which is part of this teaching package and should be performed several times per day to ensure that the readings remain accurate.

For more details on the basic sciences behind invasive line monitoring please see the “Further Reading” section below

07 EQUIPMENT & RESOURCES

Taking time to ensure you have the equipment and resources you require will ultimately make your task easier, allowing you to consider eventualities and how you will deal with them

MED education safety quality
Medical Education Directorate

CHECKLIST

EQUIPMENT AND RESOURCES

The following should be available before commencing the procedure:

- Experienced and skilled assistant +/- competent supervisor
- Place of safe and sterile insertion - theatres/HDU/ICU and ED if appropriate
- Inco pads
- Large sharps bin
- Sterile gloves, surgical barrier mask and surgical headcap
- Procedure trolley
- Appropriate monitoring depending on clinical circumstances
- Transducer equipment for line set up before line is inserted
- Antiseptic solution (1 of):
  - 2% Chloraprep sponge applicators (recommended)
  - Iodine based solution (if no allergy)
- Local anaesthetic – 1% or 2% lignocaine
- Arterial line insertion pack, which should include:
  - Surgical drape with adhesive edges to fix around the site of insertion
  - 2 syringes and hypodermic needle
  - Introducer needle
  - Arterial line and guidewire
  - Sterile swabs and dressing
- Equipment to secure arterial line (usually non-absorbable suture, scissors and tegaderm dressings)
- (Optional) Ultrasound machine with linear probe, sterile probe cover and sterile gel

08 INSERTION PROCEDURE

Phase 1 - Preparation & Positioning

Phase 2 - Procedural Pause

Phase 3 - Asepsis & Anaesthesia

Phase 4 - Insertion

Phase 5 - Anchoring & Dressing

Phase 6 - Completion

MED education safety quality
Medical Education Directorate

PHASE 1 - PREPARATION AND POSITIONING

OBTAIN INFORMED CONSENT FOR THE PROCEDURE

- Explain the procedure and provide patient information leaflet if possible
- Explain the alternatives to the procedure
- Discuss potential complications and their management
- Written informed consent is the gold standard
- Adults with incapacity form if appropriate

ASSESS RELATIVE CONTRAINDICATIONS

- Check for anticoagulant or antiplatelet medications
- Clotting screen and platelet count
- Ensure competent practitioners and adequate supervision available
- If the patient is seriously unwell and/ or agitated, contact ICU senior for advice and assitance
- If the patient is unwell it might be more appropriate to delay arterial line insertion until ongoing resuscitation is effective

PATIENT AND CLINICIAN PREPARATION

- The patient may wish to visit the bathroom prior to positioning
- Ensure bed height is appropriate and seat available if required
- Remove pager and mobile phone
- Ensure your assistant is prepared and appropriately skilled to support you
- Reassure patient

PATIENT POSITIONING

- Identify site of insertion
- Ensure positioning is excellent – as with any procedure poor positioning leads to poor success. The ideal position depends on the site of insertion
  - If cannulating the radial artery, the suggested position is the wrist supine so as to have the forearm parallel to the floor with the wrist slightly extended resting on a rolled up incopad. This set up can be seen in the video attached with this teaching package
  - Other sites need other considerations – e.g. an assistant lifting the abdominal wall if covering the insertion site for the femoral artery
- Note in your head the site of insertion – in the wrist this is usually 2-3 cm proximal to the crease of the palmar aspect of the wrist. It is important to have an idea of how deep the artery is and how straight it is. It would be ideal to find a “straight” section of artery to allow for easier insertion
- Check patient is comfortable in this position
- Remove pager and mobile phone
- Assistant prepared and equipment prepared
- Reassure patient

ARRANGE EQUIPMENT

- Ascertain best ergonomics of patient and tray around yourself.
- If using ultrasound, you are best to position the patient’s wrist between you and the ultrasound screen. Ensure the ultrasound probe is used with sterile gel and a sterile probe cover
- Ensure trolley on correct side for clinician

PHASE 2 - PROCEDURAL PAUSE

- Visualise the procedure in the correct order
- Perform a verbal rehersal with your assistant
- Perform a 3 point check; Patient, Assistant and yourself
- Provide everyone present the opportunity to speak up prior to commencing
- Perform a final equipment check

MED education safety quality
Medical Education Directorate

PHASE 3 - ASEPSIS & ANAESTHESIA

ASEPSIS

- Ensure that the absorbent pads are placed under intended insertion site and that area around site is cleared of items that could get in the way or compromise asepsis
- Put on surgical mask and hat
- Surgically scrub hands and dry with sterile hand towels before sterile pack is opened by assistant, to reduce risk of contamination from spash back
- Put on sterile gown and gloves
- Apply antiseptic skin wash via non-touch technique
- Allow skin to dry

DRAPE THE PATIENT

- Take care not to touch the patient or surroundings
- Ensure a large enough sterile field (including ability to feel and reassess landmarks without contamination)
- Assistant may need to tape corners of drape

IDENTIFY INSERTION SITE

- If using landmark technique then re-palpate to ensure you have identified insertion site
- If using ultrasound place ultrasound into sterile sheath using sterile gel inside and outside sheath, maintaining sterility whilst doing so; re-visualise anatomy and double check probe orientation

LOCAL ANAESTHETIC

- Infiltrate skin and subcutaneous tissue with local anaesthetic
- Ensure local anaesthetic covers areas where stitches will be inserted
- Allow local anaesthetic time to work

MED education safety quality
Medical Education Directorate

PHASE 4 - INSERTION

INSERT INTRODUCER NEEDLE

- Insert the needle (bevel up) into the skin. This can be left free or attached to a 2ml or 5ml cannula (with slight negative pressure on the syringe), depending on what you feel gives you more control over the angle of the needle
- The needle should be inserted at 45° into the skin at the point of greatest pulsation in the artery
- It should be directed along the direction of the artery to ensure that the needle hits the artery in the centre of the lumen
- If using ultrasound direct the tip of the needle under ultrasound guidance into the pulsating artery, identifying the needle tip at all times
- Once entering the artery with the needle you should get a pulsatile jet of blood coming through the needle - only introduce the wire when you have pulsatile flow coming out of the needle

INSERT GUIDEWIRE

- Thread the guidewire through the needle
- The guidewire should freely enter the artery – there should be no resistance and it should not be forced through. If resistance is experienced despite pulsatile flow from the needle this may be due to:
  - The guidewire is hitting the back wall of the artery and not quite managing to turn out of the needle into the vessel - tilt the needle downwards to the skin to a more acute angle
  - An inadequate amount of the needle lumen is inside the vessel lumen - rotate the needle 180degrees to expose more of the needle lumen and/or insert the needle slightly further
  - You are not in the centre of the lumen and the guidewire is brushing against the wall – you need to reinsert the needle through the lumen closer to the centre of the artery
- Once the wire is safely introduced into the artery lumen remove the introducer needle over the guidewire
- Introduce the arterial cannula over the wire and ensure you **ALWAYS** keep hold of the wire before introducing the cannula into the artery
- While holding the guidewire insert the cannula into the artery

MED education safety quality
Medical Education Directorate

PHASE 5 - ANCHORING & DRESSING

INSERT SUTURE

- It would be advisable to suture the cannula before connecting it to the giving set as the weight of the giving set might be enough to pull the cannula out of the artery as you are stitching it in
- Leave the wire in situ while stitching – this will stop the cannula from bleeding and any clots that might form will be pulled out of the cannula when you remove the wire
- We suggest the arterial line be sutured in place using the eyes of the cannula to anchor the cannula

New image required.

REMOVE GUIDEWIRE AND CONNECT TO TRANSDUCER

- When finished suturing, put a swab underneath the cannula and apply pressure to the proximal end of artery to occlude it
- Ensure your assistant is ready with the giving set flushed and ready to attach to the cannula
- Remove the wire, allow any clot formed to bleed back and attach the giving set to the lumen of the artery, ensuring this is properly connected and secure – if this gets disconnected then the patient could potentially exsanguinate
- Once the giving set is attached, transduce the line to ensure that an arterial waveform is present to confirm correct placement of the cannula
- Attach a 10ml syringe to the three-way tap attached to the giving site. Open the three-way tap to the syringe and the patient and aspirate blood into the syringe. Then open the three-way tap to the pressurised bag and the syringe and flush saline into the syringe. This ensures no air and blood clots are within the system

DRESS ARTERIAL LINE AND OPTIMISE TRANSDUCER

- Ensure the site is clean and use appropriate dressings – the video associated with this teaching package is the way we would recommend dressing the catheter
- “Zero” the system and place transducer at optimal level as explained above and in the video

education safety quality
Medical Education Directorate

PHASE 6 - COMPLETION

- **DISPOSE OF WASTE AND SHARPS APPROPRIATELY**
- **ENSURE PATIENT COMFORTABLE AND SAFE**
- **PROVIDE INSTRUCTIONS TO PATIENT AND NURSING STAFF**

PATIENT INSTRUCTIONS

- Please let the team know if you have any pain, notice any bleeding from the site of insertion

STAFF INSTRUCTIONS

- Arterial lines should only be managed by staff that are trained and competent to do so. Please refer to your local policies

DOCUMENTATION

- Document the procedure
- Complete invasive devices record

HANDOVER OF INFORMATION

- To the team regarding ongoing care of the line, suitability for use and plans for reviewing need / replacement with an appropriate timescale for removal

ULTRASOUND MACHINE CARE

- Ensure US machine has been cleaned appropriately and returned

MED education safety quality
Medical Education Directorate

09 APPENDICES

MED education safety quality
Medical Education Directorate

Arterial Line Insertion Checklist

Name				Date	
Grade		Tutor		Session	
Hospital				Unit	

Skill Phase & Component	Start Yes	Start No	End Yes	End No
Phase 1 - Preparation & Positioning				
Discusses consent, contra-indication and patient preparations (appendix 1)				
Lists risks (see appendix 1)				
Lists correct equipment (see appendix 2)				
Optimises environment and ergonomics, minimises distraction				
Identifies preferred insertion site (+/- ultrasound)				
Establishes satisfactory position (discussion and demonstration)				
Phase 2 - Procedural Pause				
Performs 3-point check: Patient, Assistant and Clinician				
Phase 3 - Asepsis & Anaesthesia				
Puts on surgical mask & hat / washes hands / gown & sterile gloves				
Applies antiseptic to skin and allows to dry				
Drapes patient (non-touch technique)				
Infiltrates local anaesthetic				
Phase 4 - Insertion				
Inserts introducer needle (+/- ultrasound guidance)				
Identifies pulsatile flow and inserts guide-wire				
Inserts arterial catheter				
Maintains control of wire throughout				
Phase 5 - Anchoring & Dressing				
Inserts suture(s) to secure line				
Removes wire and connects transducer line				
Removes any clots and air bubbles from the system				
Applies adhesive dressing(s) over insertion point				
Phase 6 - Completion & Global Points				
Maintains sharp safety throughout, disposes appropriately				
Maintains asepsis throughout				
Completion (discussion – documentation, patient/staff instruction)				
Total Score (out of 22)	/ 22		/ 22	

Comments:

MED education safety quality
Medical Education Directorate

APPENDIX 1 - CONSENT

ARTERIAL LINE INSERTION

Item	Achieved
Describes procedure	
Indications: Vasoactive drugs, unreliable NIBP, repeated blood sampling, diagnostic/procedural	
Contraindications: Patient refusal, local infection, coagulopathy, abnormal anatomy, no collateral circulation	
Risks	
Thromboembolic (air embolism, wire embolism, catheter related thrombosis)	
Mechanical (haemorrhage, haematoma, arterial injury, injury to surrounding structures)	
Infectious (catheter colonisation, catheter-related bloodstream infection)	
Informed consent if patient has capacity, or AWIA if not	
Safety	
Identifies correct patient & well enough for procedure	
Checks bleeding risks (Plt > 50 / INR < 1.4 / Drugs e.g. LMWH/DOAC)	
Patient position	
Personal preparation: empty bladder, hand over bleep, brief assistant, fatigue, hunger/thirst, distractions, safety on the ward	

APPENDIX 2 - ESSENTIAL EQUIPMENT

ANTERIAL LINE INSERTION

Item	Achieved
Transducer kit, run through and set up	
Sterile gloves, surgical barrier mask and surgical headcap	
Appropriate monitoring depending on clinical circumstances	
Inco-pads (both to help position the patient and to catch any blood spillage)	
Procedure trolley	
Arterial line insertion pack (usually includes) - Surgical drape with adhesive edges to fix around the site of insertion - 2 syringes and hypodermic needle - Introducer needle - Arterial line and guidewire - Sterile swabs and dressing	
Antiseptic solution (1 of): - 2% Chlorprep sponge applicators (recommended) - Iodine based solution (if no allergy)	
Local anaesthetic – 1% or 2% lignocaine	
Non-absorbable suture (e.g. 2/0 silk)	
Sterile scissors to cut the sutures	
Sharps bin	

REFERENCES

RADIAL VERSUS FEMORAL ARTERIAL BLOOD PRESSURE MONITORING:

Kim WY, Jun JH, Huh JW, et al. Radial to femoral arterial blood pressure differences in septic shock patients receiving high-dose norepinephrine therapy. Shock. 2013 40(6):527-31.

PHYSICAL PRINCIPLES OF INVASIVE BLOOD PRESSURE MONITORING:

http://www.frca.co.uk/Documents/137%20Physical%20principles%20of%20intra-arterial%20blood%20pressure%20measurement.pdf