British Association of Perinatal Medicine

Central Venous Access Devices in Neonates

A DRAFT BAPM Framework for Practice

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Contents

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Glossary

AP	Anteroposterior
AXR	Abdominal X-ray
CLASBI	Central Line Associated Bloodstream Infection
CVAD	Central Venous Access Device
CICC	Centrally Inserted Central Catheter
CXR	Chest X-ray
ELBW	Extremely Low Birth Weight
EPR	Electronic Patient Record
IPC	Infection Prevention and Control
IRMER	Ionising Radiation (Medical Exposure) Regulations
IVC	Inferior Vena Cava
LFPSE	Learning from Patient Safety Events
NCMD	National Child Mortality Database
NNAP	National Neonatal Audit Programme
NRLS	National Reporting and Learning System (now known as LFPSE)
PICC	Peripherally Inserted Central Catheter
PN	Parenteral Nutrition
POCUS	Point of Care Ultrasound
SVC	Superior Vena Cava
UAC	Umbilical Arterial Catheter
UVC	Umbilical Venous Catheter

Language

The British Association of Perinatal Medicine is committed to continuously fostering an inclusive environment and we acknowledge the effect language can have on individuals and populations. BAPM frameworks use the terms ‘woman / mother or birthing parent’ to include people who do not identify as women but who are pregnant, in labour and in the postnatal period. Please always take time to make sure you are using the preferred pronouns and terminology of the patient and their support network.

The BAPM language guide is a work in progress and comes from work developed by our communications team and equality, diversity and inclusion steering group. The language guide is specific to the UK context and to aid the creation and review of documents designed for the healthcare professional audience. therefore, it may not be relevant in other settings. We also acknowledge that we may not get the language right every time, and welcome feedback on our work.

Process of framework development

The **Use of Central Venous Catheters in Neonates** BAPM framework was first published in December 2015 and subsequently revised in August 2018. This current revision was commissioned to review and consider new evidence to guide best practice on the safe insertion, imaging, maintenance and removal of all central venous catheters, including what are traditionally called "surgical venous lines" (this terminology and class are discussed later in the framework) recognising the ongoing national reporting of patient harm due to central line complications. To ensure thematic learning from all reported central line complications was considered within this framework, we commissioned the National Patient Safety Team at NHS England to provide a further National Reporting and Learning System (NRLS) review of all central venous line complications, which was completed in February 2025.
Key safety reports which have informed this framework include;

- NHS England Patient Safety Team; National Reporting and Learning System (NRLS) Analysis
    - Neonatal cardiac tamponade associated with long line insertion- August 2023
    - Complications associated with neonatal central catheters- February 2025
- National Child Mortality Database (NCMD)
    - Critical central venous line complications in neonates- February 2025

A literature search interrogating Medline, Embase, Cochrane Library and Google Scholar was performed in April 2024. Any publications reviewed in previous versions of the framework were not revisited. Search terms included can be seen in Appendix 1.

Practice Points were defined utilising any new evidence or by professional consensus where strong evidence was lacking.

The emerging role of point of care ultrasound (POCUS) in neonatal central venous access device insertion and imaging is considered.

Nomenclature

A standardised approach to terminology for venous access is essential for clear communication and coordination within the healthcare community. This has historically been complicated by the use of:

(i) interchangeable terms such as 'line' and 'catheter,'
(ii) ambiguous terms such as 'long line' and 'surgical line,' and
(iii) industry brand names (eg Hickman™, Broviac™).

This problem has been recognised and resulted in a global initiative to develop structured and coherent terminology (Van Rens 2024). The working group agreed the following nomenclature be utilised throughout this BAPM framework.

- **UVC: Umbilical venous catheter.**
- **PICC: Peripherally inserted central catheter**
  - Catheter inserted into a peripheral vein of upper or lower limb or scalp with the aim to have the tip reaching a central position.
- **CICC: Centrally inserted central catheter**
  - Catheter inserted into the deep veins of the supraclavicular area (mainly internal jugular or brachiocephalic vein). These lines can be
    - Cuffed
    - Uncuffed
    - Tunnelled (eg onto the chest wall or thigh)
    - Non-tunnelled (typically used in anaesthetic/PICU settings)
    - TIVAD: Totally implantable vascular access device ('ports'- these are not considered further in this document as they are rarely used in the neonatal patient).
- **FICC: Femorally inserted central catheter**
  - Catheter inserted into the common femoral vein.
- **CVAD: Central venous access device**
  - All methods of venous access where the aim is to position the catheter within a central vein.

Executive summary of recommendations and practice points

Insertion

- Ultrasound should be used routinely for CICC placement in the internal jugular vein (IJV), brachiocephalic vein (BCV), subclavian vein (SCV) and FICC insertion in the common femoral vein (CFV).

- Point of care ultrasound (POCUS) can be used to plan and perform PICC placement where veins are not visible, palpable or identifiable using other modalities (eg cold light, vein localiser).

Imaging

- All CVADs should be imaged in their final position after any adjustment of length and before use.

- It is recommended that UVC tip position is confirmed with X-ray and an additional method depending on available local services. Suitable additional methods of imaging include a lateral X-ray or POCUS. It is recommended that additional imaging is performed within 24 hours of insertion.

- The upper limb should be positioned off the chest in a neutral position (~30 degrees abducted) with the elbow flexed when imaging an upper limb PICC.

- Upper limb PICC tip position can be additionally imaged by POCUS if local services are available.

- Lower limb PICC should be imaged using contrast.

- If there is uncertainty about lower limb PICC tip position after contrast, imaging should be discussed with an experienced radiologist and a lateral X-ray considered before use.

- Migration of CVAD tip should be actively considered and its position reviewed on repeat imaging within the first 48 hours after insertion.

- All CVADs should be imaged weekly to review position and at any time when there are concerns of device migration or dysfunction.

- Training and expertise in POCUS for all practitioners is essential before utilising as a method to confirm CVAD tip position. POCUS is a complimentary imaging modality which can reduce the number of X-ray taken when a CVAD is in use.

Position

- When a UVC tip lies at or below T10 it should only be used if essential and for a maximum of 24 hours.

- The tip of all UVC, PICC, CICC and FICC should be outside the cardiac chambers. Care should be taken to correctly identify the position of the cardiac chambers on AP X-Ray (see Appendix 3 Figure 3).

- The junction between the SVC and right atrium can be estimated at 1.5 vertebral body units below the carina. The thymus can obscure the cardiac landmarks on an AP x-ray.

Complications

- CVAD training resources should include education on the recognition and management of CVAD complications both immediate and late.

- The risks and benefits of maintaining central venous access should be considered daily and all CVADs should be removed promptly when no longer required.

- All units should utilise CLABSI data to inform and guide quality improvement initiatives to reduced infection rates.

- All units should utilise a care bundle which includes all aspects of insertion, use and on-going management of CVADs.

- Significant adverse events related to CVAD use should be investigated according to local adverse event governance processes.

- Significant adverse events related to CVAD use should be reported to national learning systems using standardised nomenclature.

Introduction

Central venous access is critical for many neonatal patients. Establishing optimally positioned, functional and secure central venous access is the goal. However, many uncertainties and challenges exist with CVAD selection, insertion and mode of imaging. CVAD use is also not without significant risk. CVADs are associated with a high rate of complications, including central line associated bloodstream infection (CLABSI), extravasation, thrombosis, and mechanical issues, all of which contribute to increased morbidity and mortality in neonatal populations (Berger 2024, Gibson 2024, Kisa P 2015, Levit 2020, Mutlu 2016, Sulemanji 2017, Wen 2017, Yeung 2020).

Given these risks, there is a pressing need to make CVAD use safer and more consistent across neonatal units. Standardising care through evidence-based protocols and structured training is essential to reduce variability in practice and improve outcomes. The development and implementation of this national CVAD framework aims to address these challenges by promoting best practices in insertion, maintenance, imaging and care of these devices.

Data from the National Neonatal Audit Programme (NNAP) between 2016 and 2023 reveal encouraging trends with a reduction in the total number of all CVAD days, likely reflecting earlier initiation of enteral feeding and a growing awareness of the risks associated with prolonged device use (NNAP 2024). Additionally, the number of “surgical venous lines” (referring to tunnelled and non-tunnelled CICCs and FICCs) has declined, potentially indicating improvements in the insertion, care and maintenance of PICCs. Despite these gains, more than 5,000 “Surgical Venous Line” care days were recorded in 2023, with the greatest proportion being infants born at <27 weeks, reflecting the challenges of maintaining long term access in preterm born infants. Sadly, there continues to be potentially preventable harm and death related to CVAD use in neonates, underscoring the continued need for improvements in care (NHS E Patient Safety Team 2023 & 2035, NCMD 2025). This framework aims to consolidate current knowledge, align practice with national standards and support clinicians in delivering safer, more effective vascular access care for neonates.

Central Venous Access Device insertion

General Principles

The most appropriate CVAD should be selected for each patient. The appropriate device is dependent on patient size, intended function and intended dwell time. Appendix 2 lists several commonly used CVADs in UK neonatal units. Practitioners should be familiar with devices available in their own unit.

Knowledge of venous anatomy (Appendix 3) is important to allow appropriate vein selection and subsequent interpretation of imaging following CVAD insertion.

All neonatal units should have CVAD guidelines with agreed local policies on method of determining CVAD insertion distance, insertion technique, fixation method, imaging and maintenance protocols. All practitioners should have received education and training on local policies and equipment. Sterility for all CVAD insertions in the neonatal unit is critical. Skin cleansing policies should adhere to the Neonatal and Paediatric Pharmacists Group position statement "Chlorhexidine for Skin Cleansing in Neonates"(NPPG 2024). Particular care should be taken to ensure chlorhexidine does not pool within drapes or skin folds at the time of insertion.

When CVAD insertion is required, an assessment should be made as to who is the most appropriate person to undertake the procedure.

Although obtaining formal written consent is regarded as best practice, it is not currently a standard requirement for CVAD insertion in neonatal units. As a minimum, there should be a documented discussion with the parents or legally responsible guardian outlining the indication for the procedure, associated risks, and available alternatives. In situations where CVAD insertion is required as an emergency, the rationale for proceeding without prior discussion should be recorded. Local policy for procedural consent should be applied for CVAD insertion occurring outside of the neonatal unit, with written consent being standard practice.

Technical Considerations: UVC

Care should be taken to identify the umbilical vein and artery correctly.

There are a number of methods for calculating insertion depth. None have been proven to be superior to the other (Akar 2020, Kieran 2016, Patel 2022).

UVC malposition is common with optimal positioning achieved between 28% and 71% in published cohorts (Kieran 2015, Patel 2022, Soonsawad 2022, Yazdani 2020). Techniques to improve correct catheter placement such as "double catheter technique", positioning in the right lateral decubitus position or liver mobilisation to align the umbilical vein and ductus venosus have been described (Kishigami 2020, Torres Del Pino 2023), however evidence is limited.

The diameter of vessels within the path of a UVC have been measured in infants from 25-43 weeks (Eifinger 2018). Vessel size increases with gestational age. The narrowest point along the path of the UVC is the ductus venosus measuring 2.5mm (1.6-3.4mm) (median (IQR)). Therefore, catheters of no greater than 4Fr (1.33mm) should be used in preterm infants to avoid obstruction. With flow rates of up to 13.8 millilitres per minute through each lumen of a 4Fr double lumen UVC, this size of catheter is adequate for the neonatal population and may reduce risk of complications such as malposition, extravasation and thrombus (Soonsawad 2022).

Umbilical venous catheters should be secured using methods that avoid fixation to the abdominal wall, in order to preserve skin integrity.

Cyanoacrylate glue can be used when fixing a UVC but repeat application may be required over the duration of UVC placement. Centimetre markings on the UVC should remain visible to allow monitoring of catheter depth.

Technical Considerations: PICC & CICC

Appropriate vein selection will increase the chance of successful PICC and CICC insertion and potentially reduce complication rates (Barone 2019).

There are a number of introducers available for PICC insertion (Appendix 2). The appropriate introducer should be selected for the size of the PICC. Insertion through a cannula which cannot be removed entirely is not recommended practice.

Migration and dislodgement of CVADs can occur (Acun 2021, Franta 2016, Gibson 2024, Gupta 2016, Plooij-Lusthusz 2019, Stekhova 2023). The use of cyanoacrylate glue at the insertion site of PICC and CICC has been found to reduce complication rates including central line associated bacterial infection (CLABSI) and dislodgement (Piersigilli 2023).

Intracardiac electrocardiogram (IC-ECG), where changes in P wave amplitude are utilised to position CVAD tip has been reported in paediatric patients including neonates (Zhang 2024). However, evidence of effectiveness, safety, superiority, and availability has not been established and therefore IC-ECG is not recommended.

Shortening the external portion of tunnelled CICC and large calibre PICC prior to insertion is accepted practice when performed according to the manufacturer's instructions for use and local policy. There is no evidence to determine the safety of shortening catheters before PICC insertion in the neonatal patient and this practice is not currently recommended as standard (Jahagirdar 2019).

Ultrasound guided CVAD insertion

The advantages of ultrasound guided vascular access are well established in adult and paediatric patients (Brass 2015). In neonatal vascular access, the use of ultrasound has been less widespread, but its advantages over an anatomical 'landmark' technique are numerous and well established in practice if less so in formal specific evidence (Brusciano 2024, Johnson 2016, Kumar 2020, Zini 2024). Ultrasound is known to reduce the number of attempts required for vessel access and reduce complications such as pneumothorax and arterial puncture (Oulego-Erroz 2018).

An ultrasound guided technique for neonatal internal jugular device placement is now recommended by the European Society of Paediatric and Neonatal Intensive Care (ESPNIC, Singh 2020) bringing neonatal guidance in line with the 2002 NICE recommendation for this approach in adults and children (NICE 2002).

Facilitating a percutaneous approach by ultrasound has proven advantages over open surgical options for both peripheral and central access sites in terms of medium to long term venous patency.

Ultrasound is a complementary imaging modality which can assist practitioners at the time of PICC insertion. Assessment of vein size by ultrasound in the neonatal unit including ELBW infants has been demonstrated to be feasible although not currently routinely performed (Ren 2022). The current adult and paediatric recommendation of the external diameter of the device being no more

than 1/3 the internal diameter of the vein is considered applicable in the neonatal population (Barone 2019). Therefore a 1Fr CVAD requires vein diameter to be >1mm, 2Fr a vein >2mm and 3Fr vein >3mm. Should ultrasound assessment of vein size be performed prior to CVAD insertion, this suggested rule should be considered when selecting the appropriate device.

The roles of ultrasound in neonatal vascular access include:

1. Assessing vessel anatomy and target selection/planning
    a. Site, size, patency; where otherwise invisible/impalpable or not detectable by other means (eg cold light, vein localiser)
    b. Defining anatomy including tributaries/distributaries and relationship to arteries and other structures
2. Real-time access guidance with needle/cannula
3. Confirmation of guidewire placement within the vessel
4. Guiding device insertion
    a. Navigation (including UVC) into the desired position
    b. Confirmation of final device tip position

Documentation

Insertion of every CVAD should be documented contemporaneously within the patient record. Standard nomenclature for device type as defined in this framework is recommended. Documentation should include;

- Indication for CVAD insertion
- Consent obtained/Parental discussion
- Basic Demographics
    - Patient ID (Name, DoB, NHS# or other unique ID)
    - Exact date and time
    - Operator (Name, Role, ID)
- Primary procedure details
    - Clinical evaluation
        - eg Ultrasound assessment, decision making re access site/type
    - Site and mode of access
        - Vein and entry point
        - Landmark/visual, Ultrasound guided, cold light, vein visualiser etc
    - Insertion technique
        - Catheter via removable/peelable cannula
        - Seldinger technique (including details where appropriate)
            - Simple catheter over wire
            - Wire access with peel away sheath and details as appropriate
    - Catheter details
        - Cuffed/tunnelled
        - Calibre, number of lumens
        - For PICC/Untunnelled CICC
            - Total Line length
                - Note: Tunnelled CICC are nearly always cut to an appropriate length prior to insertion but are not typically measured
            - Insertion length and/or external length
    - Technical narrative/validation
        - Confirmation of catheter localisation method and findings
            - Use of contrast or other adjuncts
        - Confirmation of aspiration and flushing
            - Any line lock used

        - Any additional securement (suture, glue, invasive fixation device)
        - Any difficulties or deviations including:
            - Failed access attempts/needle passes, including sites
            - Immediate complications, remedies, consequences
            - Accepted compromises & rationale, recommended modifications in management/catheter usage (for example due to tip position)
            - Handover/communication of plan for any residual concern or problem
- Secondary details/compliance/audit
    - Confirmation of line readiness for use
    - Compliance with infection prevention and control policy
    - Any routine care plan documentation (daily/weekly checks or processes)
    - Removal date, indication and any notable issues including line related complications
        - Note: consideration of imaging to detect asymptomatic vessel occlusion may be appropriate for some patients where future CVAD attempts are anticipated

Practice Points for CVAD Insertion

- The general principle of the smallest device, with fewest lumens needed to meet patient requirements is recommended.
- Maximum 4 Fr UVC for preterm infants.
- Neonatal units should utilise one consistent method for calculating UVC insertion length.
- The double catheter technique where a second UVC is inserted past a malpositioned UVC is not recommended due to risk of vessel perforation.
- Resistance encountered during the insertion of a CVAD often indicates malposition and the catheter should be withdrawn to a point at which it freely aspirates blood.
- Any CVAD which does not aspirate blood at the time of insertion (with the exception of the smallest PICCs where “flashback” should be confirmed) should not be used and should be removed.
- Practitioners should be familiar with the equipment available in their clinical setting for the insertion, maintenance and removal of CVADs.
- Practitioners using ultrasound for CVAD insertion should have appropriate training and competencies.
- Ultrasound should be used routinely for CICC placement in the internal jugular vein (IJV), brachiocephalic vein (BCV), subclavian vein (SCV) and FICC placement in the common femoral vein (CFV).
- The smallest diameter CICC to achieve the intended use is recommended.
- Ultrasound can be used to plan and perform peripheral vein access for the placement of PICCs where veins are not visible, palpable or identifiable using other modalities (eg cold light, vein localiser).

Central Venous Access Device imaging

General Principles

Imaging is required to confirm the correct placement of all newly inserted CVADs, conventional radiography (X-ray) being the most well-known method. Neonatal radiography requires careful preparation and positioning to ensure CVAD tip can be located while artefacts and radiation dose are minimised. Radiographers must be trained and competent at ensuring high quality images, using optimised imaging protocols, collimating to the area of interest and minimising the need for repeat imaging (Russo 2024).

All staff must adhere to the principles of the Ionising Radiation (Medical Exposure) Regulations (IRMER) in diagnostic and interventional radiology. Dose levels should be audited and Diagnostic Reference Levels (DRLs) should not be exceeded (IR(ME)R 2020).

Under IRMER, referrers have a duty to supply sufficient information to enable the practitioner to justify the request, to tailor the study required and to ensure that the reporter understands the clinical query. Such information might include the site of CVAD insertion, any previous unsuccessful attempts or concern for possible complication.

Prompt direct verbal communication between the reporter and the neonatal team is required when there is a suspected CVAD malposition or complication. Additional methods of confirmation of tip position such as use of contrast, additional X-ray views and POCUS should always be performed if there is uncertainty about CVAD tip position. Line misplacement can rapidly lead to serious complications (Chen 2020, Weil 2010) and therefore tip position must be confirmed prior to use.

Every opportunity must be used to review CVAD position to identify migration when radiographs are taken for other indications while CVAD remains in situ.

If the umbilical vein and artery have been misidentified at the time of insertion, both catheters will be malpositioned. When imaging, venous and arterial catheters can be positioned on either side of the abdomen to help correctly identify each catheter on X-ray. The entire course of the line should be imaged noting that an initial downward displacement of the venous catheter indicates incorrect arterial placement.

On AP X-ray, the umbilical venous line follows an almost straight course upwards, along the umbilical vein, into portal sinus, then via the ductus venosus in the liver to the hepatic vein and to the inferior vena cava/right atrium (IVC/RA) junction. On X-ray, this point is outside the heart, near the level of the diaphragm. Appendix 3 Figure 2 illustrates the path of a UVC.

AP X-ray has been found to be imprecise when identifying malposition of UVC and PICCs in preterm infants (Akar 2022, Jain 2012). The addition of a lateral x-ray improves the recognition of UVC in a low position (Yeoh 2024). A low UVC position has a higher risk of extravasation and may also cause microinjury to the vessel wall leading to liver parenchymal damage without vessel perforation (Hollingsworth 2015, Shahroor 2022) therefore accurate identification of low position is critical.

Changes in limb position can influence PICC tip position (Saha 2013, Shalygin 2018). Arm adduction moves the PICC tip closer to the heart when inserted via the basilic vein and away from the heart when in the cephalic vein (Nadroo 2002). Arm abduction generally displaces the tip away. Elbow flexion moves the tip closer to the heart (Connolly 2006). A lower limb PICC can also vary with position, with knee to chest positioning drawing the tip closer to the heart and straight leg positioning pulling it away. When imaging a PICC, positioning the limbs in a more physiological,

natural posture will help ensure the device tip is visualised in the location it is most likely to remain during routine care.

Correctly identifying the position of the cardiac chambers on AP X-ray is critical to achieving an optimally placed catheter tip. While anatomical landmarks can be affected by poor quality imaging practitioners can consider the position of the SVC/RA junction to be estimated by 1.5 vertebral body units below the carina, where a vertebral body unit includes the vertebral body and the adjacent disc space (Baskin 2008, Jacob 2020). In addition, the thymus which typically lies between the 3rd and 5th thoracic vertebral level should not be confused with the heart. Appendix 3 Figure 3 shows a schematic of the heart and surrounding structures on AP X-Ray.

While some larger calibre CICCs can be positioned with their tip within the RA in older patients, the principle of neonatal CVAD tips being positioned outside the cardiac chambers should be considered as standard to minimise the risk of cardiac extravasation and tamponade (DOH 2001).

POCUS is an emerging method of CVAD tip imaging and is considered complimentary to conventional radiography. It can reduce the number of radiographs required, the radiation dose, the cost related to CVAD X-rays and reduce the time taken to confirm CVAD tip position (Franta 2017, Jain 2012, Liu 2022, Rossi 2022, Seigel 2020, Shabeer 2021). It has been demonstrated to be feasible for even the smallest calibre PICC (Grasso 2022). However, ultrasound imaging is not yet a standard of care in the United Kingdom with limitations in its adoption relating to knowledge and skill of neonatologists and lack of certified neonatal training courses.

Central venous access can be challenging to establish in the optimal position on every occasion. The need for critical intravenous infusions must be balanced with the risk of CVAD complications. At times a suboptimal position may be tolerated for a short time, under close observation, until further access has been established. A traffic light system such as the previously published example in Appendix 4 could be developed to assist clinicians when balancing the need for central access with the risks of malposition. Clear illustration of accepted position will ensure consistency of practice.

Practice Points for CVAD Imaging

- All CVADs should be imaged in their final position after any adjustment of length and before use.
- Correct position should be verified in writing within 24 hours of insertion by a consultant neonatologist/paediatrician or from a radiologist's report.
- Migration of CVAD tip should be actively considered and its position reviewed again on imaging within the first 48 hours after insertion.
- All CVADs should be imaged weekly to review position and at any time when there are concerns of catheter migration or dysfunction.
- CVAD position should be reviewed opportunistically on all subsequent X-ray and tip position compared to previous known position.
- Training and expertise in POCUS for all practitioners is essential before utilising as a method to confirm CVAD tip position. POCUS is a complimentary imaging modality which can reduce the number of X-ray taken when a CVAD is used.
- CVAD tip should be positioned outside the cardiac chambers. See Appendix 3 Figure 3.

Practice Points for imaging Umbilical Venous Catheters

- The first X-ray should include the entire course from umbilical cord to the tip of the UVC (thoraco-abdominal radiograph).
- UVC tip should be positioned outside the cardiac chambers, near the level of the diaphragm.
- It is recommended that UVC tip position is confirmed with X-ray and a second method depending on available local services. Suitable additional methods of imaging include a lateral X-ray or POCUS. It is recommended that additional imaging is performed within 24 hours of insertion.
- On a lateral shoot-through radiograph, with the baby supine, the UVC will follow the umbilical vein into the liver and travel posteriorly towards the heart to reach the posteriorly located IVC/RA junction. See example imaging.
- A low-lying UVC projected over the liver should not be used due to the risk of intrahepatic extravasation.
- A low lying UVC with tip at T10 or below should be used for maximum of 24 hours due to the high risk of extravasation.

Practice Points for imaging Upper Limb PICC

- Upper limb PICC should be imaged with an AP chest X-ray (CXR) which includes the limb and site of insertion.
- The upper limb should be positioned off the chest in a neutral position (~30 degrees abducted) with the elbow flexed when imaging a PICC.
- The PICC should follow the expected course of the left or right subclavian veins, into the brachiocephalic vein and into the SVC. The ideal location is at the SVC/RA junction or in the SVC.
- The use of intravenous contrast is not routinely recommended, but can be useful in situations where there is a variation in anatomy or the tip is difficult to visualise.
- Left upper limb PICC should cross the midline and then descend towards the right atrium.
- Consider arterial placement or persistent left SVC if PICC is seen to descend to the left of the spine.
- Right upper limb PICC should not cross the midline.

Practice Points for imaging Lower Limb PICC and FICC

- Lower limb PICC and FICC should be imaged with an abdominal X-ray (AXR).
- Lower limb PICC should be imaged using contrast according to local guidance which should be developed with neonatal and radiology input.
- When imaging in the neonatal unit a 10 millilitre(ml) syringe should be used to prime the PICC with the volume of contrast stated by the manufacturer. A further 0.2-0.3ml contrast should then be injected and AXR image should be taken as the final volume of contrast is injected. The PICC should then be flushed with saline.
- If there is uncertainty about suspected malposition of a lower limb PICC after contrast injection AXR, imaging should be discussed with an experienced radiologist. A lateral X-ray could be considered to review for erroneous cannulation of the paraspinal veins.
- On a lateral x-ray a lower limb PICC must not be projected over the bony spinal canal while travelling towards the heart. A correctly sited PICC will lie anterior to the vertebral bodies, in the IVC.
- On AXR, PICC and FICC should follow the expected course of the iliac veins and inferior vena cava (IVC), with the ideal position in the upper IVC at or near the IVC/RA junction.
- Avoid tip at renal vein level (~L2).
- A correctly positioned left lower limb PICC and FICC will cross the midline.

Practice Points for imaging CICC

- When CICC position has been confirmed with fluoroscopy it can be used immediately.
- CICC tip should be reimaged by CXR or ultrasound within 24-48 hours, although migration and unrecognised malposition is less common than PICC.

Central Venous Access Device care and maintenance

Appropriate care and maintenance of CVADs will reduce complication rates. Care and maintenance policies should be included in unit guidance with regular staff training and adherence to practice monitored.

Models utilising CVAD teams, responsible for insertion and maintenance have been shown to reduce complication rates including CLABSI in addition to improving rates of successful insertion (Chan 2020, Levit 2020).

Regular position checks are vital for early detection of malposition, prevention of life-threatening complications, and ensuring proper CVAD function.

Practice Points for care and maintenance

- Neonatal units should have standardised protocols to minimise CVAD dwell time.
- Neonatal units should have CLABSI prevention protocols and should be aware of their CLABSI rate though national audit.
- Integrity of CVAD fixation and dressing should be considered and documented at every care encounter and patient examination.
- Routine dressing change is not required but should be performed when the benefit of changing the dressing outweigh the risk of dislodging the CVAD or introducing infection.
- Redressing a CVAD is a minimum two-person, aseptic procedure.
- CVAD entry site and limb should be inspected and palpated for any erythema and oedema at every care encounter and patient examination.
- CVAD position should be reviewed at every care encounter and patient examination. If there are concerns about migration, CVAD tip position should be reconfirmed.
- Review of the measurement visible at the umbilical stump should be utilised to detect migration of UVC.
- CVADs should be accessed using a minimum of a 10ml syringe.
- CVAD flushes to ensure patency or after administering medication should be with 0.9% sodium chloride. Prefilled syringes are recommended.
- Tunnelled CICC/larger PICC can be locked when not in use using heparin solutions labelled “for maintenance of patency of intravenous devices”. Use the volume appropriate for the size of CVAD.
- All CVAD should be inspected at the time of removal to ensure the whole device has been removed.
- If unable to remove PICC a radiograph should be taken to look for knot formation.
- Following UVC removal, ensure haemostasis has been achieved before placing prone.

Central Venous Access Device complications

CVADs are essential in neonatal care however complications are more frequent than in paediatric patients and can result in significant morbidity and mortality (Haas 2003). Staff education, training and insertion bundles or protocols can reduce CVAD complication rates (Chan 2020, D'Andrea 2024, Pittiruti 2023). Preterm and lower birth weight infants are at greater risk of complications and have the highest risk of mortality associated with CVAD complications (Levit 2020, Zhang 2024 , NMCD 2025). The NCMD reported that most deaths occurred in the first 28 days of life and of 13 identified cases, 3 were related to cardiac tamponade. The cause of death in the remaining cases could not be ascertained at the time of the review.

While complications are frequently reported in the literature, this is principally through case report or case series which limits the ability to appreciate overarching themes and therefore improve care. The framework working group therefore requested a review of incidents reported to NRLS and LFPSE by the NHS England patient safety team to better understand themes of CVAD complications occurring in the UK. While many of the incidents were considered no or low harm they contribute to the burden of a neonatal unit admission for families.

Most cases of moderate and severe harm were related to extravasation; 8 into liver, 4 into the abdomen, 3 into pleural cavity, 1 into heart, and 1 into the spine. In a further 26 cases the site was not specified. Three cases of cardiac tamponade were included (2 PICC, 1 UVC). Unfortunately comprehensive thematic review was not possible due to limited incident detail. One emerging theme was either delayed or lack of recognition of device malposition. Device fracture or leakage was reported in 31 cases. Again, lack of detail limited thematic review but excessive use of antiseptic solutions is known to weaken device material and could be a contributing factor. Problems due to poor device fixation technique was also an emerging theme.

Significant numbers of complications related to CVAD use are reported annually and clinicians are encouraged to use national patient safety systems to report adverse events. Systems should support standardised nomenclature and promote the recording of sufficient detail to allow for thematic analysis. This should include patient characteristics, device type, position, duration of use and complication experienced.

Malposition, migration and extravasation

Malposition related CVAD complications are common with malposition at the time of insertion being reported in up to 60% of insertions of some types of CVAD (Gibson 2024, Huang 2021, Mutlu 2016). Malposition within the heart requires prompt identification and resolution before any CVAD is used. UVC migration occurs frequently and can cause significant harm (Dubbink-Verheij 2019, Gupta 2016, Sobczak 2021, Xie 2023). A UVC will typically migrate inward in the first 48 hours, followed later by an outward migration (Franta 2017, Soonsawad 2022). Umbilical cord contraction or lung expansion will potentially move the UVC inwards. Distension of the abdomen could contribute to later outward migration.

Upper limb PICCs can migrate within 24 hours of insertion, often without any visible change in external catheter length (Gupta 2016, Stekhova 2023). Most migration occurs in the first 3 days after insertion with one case series reported migration in 33% of PICCs (Acun 2021).

CVAD tip migration can lead to extravasation within a short timeframe i.e 1-4 days following line insertion with potentially significant adverse events including**:**

- Cardiac tamponade
- Pericardial effusion
- Pleural effusion
- Liver abscess/subcapsular haematoma
- Abdominal compartment syndrome (greater risk with low lying UVC)
- Hemidiaphragmatic paralysis

When correctly identified and repositioned, harm can be avoided therefore accurately identifying and monitoring device tip position is critical.

Ultrasound has been reported to be superior to conventional X-ray when identifying CVAD malposition (D'Andrea 2023, Guimaraes 2017) and can be helpful in the diagnosis and management the above complications (Yousef 2022). Appropriate knowledge, training and understanding of the limitations of ultrasound in this setting are essential and comprehensive training programmes and ongoing evaluation of practitioner competency are required (McNamara 2024).

Infection

Incidence of CLABSI is variable from 3-36% (Yeung 2021). Risk factors include low gestational age, low birth weight and longer catheter dwell time (Catho 2023, Soares 2018). CVAD care bundles and dedicated CVAD teams have been shown to reduce infection rates (Levit 2020). Localised cellulitis/phlebitis is more common with lower limb PICC, although not always infective in origin it should be evaluated and treated with caution.

Device fracture or transection

In the event of CVAD fracture or transection, it is essential that the distal/inserted end be secured with artery forceps to prevent embolisation. Limited local venotomy may be required to retrieve the line. If the line cannot be retrieved, consider early discussion with a NICU with onsite interventional radiology, cardiology and surgery to discuss management.

Risk of fracture increases with increased dwell time (Balasundaram 2023). Excessive force when flushing or when removing can cause device failure and practitioners should be aware of this possibility.

If resistance is met during catheter removal, excessive force should not be applied. Consider using a warm compress over the vein with gradual traction and rotation of the catheter.

Vascular

Thrombosis can occur with all CVADs although traditionally is believed to be rare. FICC have been found to have the highest rate of thrombosis in neonates (Dubbink-Verheij 2018). Selecting the appropriate size CVAD for vein size may reduce the risk. A malpositioned CVAD has a higher risk of thrombosis (Kisa 2015).

Inadvertent arterial cannulation can cause vascular compromise which must be recognised and prompt immediate CVAD removal. A Glyceryl Trinitrate patch placed over the affected artery should be considered and early referral to plastic surgery teams is recommended or other immediate care/monitoring instituted.

Practice Points to reduce and manage complications

- The clinical deterioration of a baby in whom a CVAD is present should raise the question of device related complications, particularly infection, extravasation, thrombosis, cardiac tamponade and intra-abdominal extravasation.
- Potentially fatal complications such as pleural effusion, cardiac tamponade, hepatic injury/necrosis and intra-abdominal extravasation can occur within a short timeframe. To minimize risk, CVAD tip position must be reassessed within the first 48 hours after insertion as migration is common.
- CVAD complications can be reduced through guideline implementation and staff education. How to identify and manage acute CVAD complications should be included in guidance.
- CVAD complication rates increase with increased dwell time. Manufacturer recommended timescale for use should be noted. While a functioning line need not be removed, clinicians should be aware of the increased rate of complications as dwell time increases and justify retention if not in active use.
- Intravascular position and CICC patency can be confirmed by aspirating blood and should be performed while CICC is in use in accordance with local guidance.
- Consider migration and extravasation of CVAD if not able to aspirate blood. CVAD tip position must be reconfirmed before ongoing use.
- Cyanoacrylate glue can reduce CVAD migration and dislodgement .
- Practitioners should be aware that a low UVC is at greatest risk of extravasation and should be used for a maximum of 24 hours.
- If CVAD complications are suspected, early removal of the device is recommended.
- CICC/PICCs should be dressed keeping the entry site visible and with the area where the catheter meets the hub supported/fixed to reduce the risk of catheter fracture due to flexing or twisting at this point.

Education and training

Neonatal units should have a standard CVAD education package which includes guidance on:

- Anatomy
- Insertion
- Imaging and its interpretation
- Maintenance
- Risk factors for, recognition of and management of complications

All professionals involved in the insertion, imaging and care of neonatal CVADs are required to establish and maintain competency and those delivering training must have current knowledge of best practice. Competency should be determined by an objective method of assessment rather than number of procedures performed.

Simulation training could be utilised within education packages to facilitate early familiarity and competence in the core skill sets, particularly familiarity with technical principles and equipment. Short courses on UVC and UAC are available via RCPCH website and are a useful addition to an education package.

Practitioners using POCUS during the insertion of or to confirm the position of central venous access devices in neonatal patients must have documented evidence of competency in ultrasound imaging and interpretation in this setting (Pittiruti 2024). Lack of training courses are a recognised barrier to wider use of ultrasound by neonatologists (Oulego- Erroz 2022) and the development of standardised training courses are recommended (McNamara 2024).

Key horizons and research

- Review and standardisation of central venous access device terminology within neonatal electronic patient records and national reporting systems.
- National audit and reporting of all central venous access device complications on a routine, comprehensive and real time basis.
- National reporting of significant adverse events related to central venous access device use in neonates should be supported by EPR.
- Development of structured training programmes for the use of POCUS for central venous access devices in neonatology (diagnostic and interventional).

Audit standards

- All staff have completed CVAD training appropriate to their role. Competency is assessed annually or during neonatal placement for rotational staff.
- All UVC tip position are confirmed using 2 modalities within 24 hours of insertion.
- Practitioners performing ultrasound-guided insertion of central venous access devices in neonatal patients have documented evidence of competency in ultrasound-guided vascular access techniques.
- Practitioners using point-of-care ultrasound to confirm the position of a central venous access device in neonatal patients must have documented evidence of competency in ultrasound imaging and interpretation.

Imaging Examples

UVC

Image 1: A well-positioned UVC demonstrating a normal course with tip at the level of the diaphragm (T8) out with the cardiac chambers.

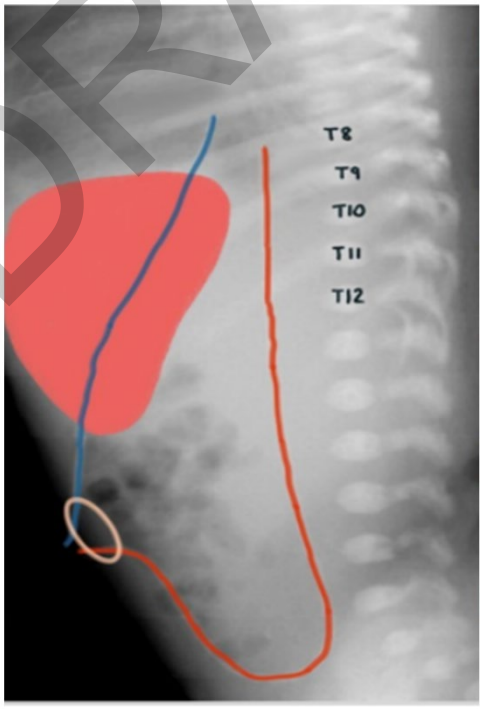
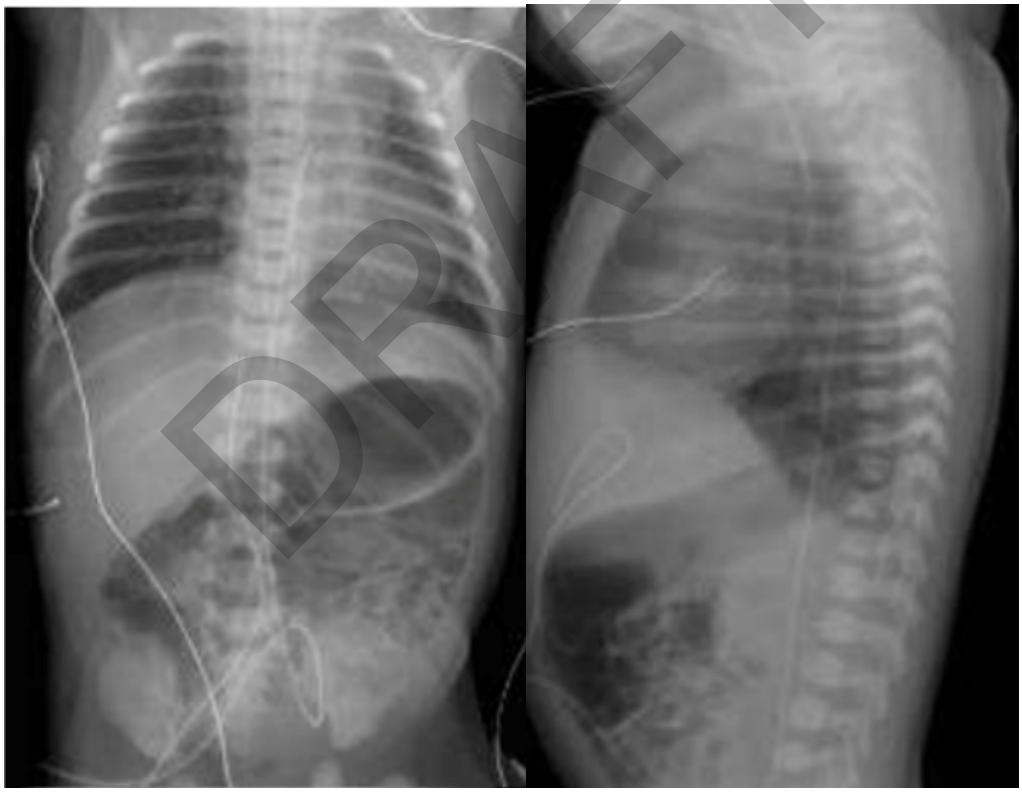


Image 2: Schematic of expected course of UVC (blue line) as seen on lateral X-ray

Image 3: UVC inserted, deviated into right portal vein, air in the portal veins



Images 4 and 5: UVC looped back into the liver (lateral and AP images) - course identified by lateral X-ray

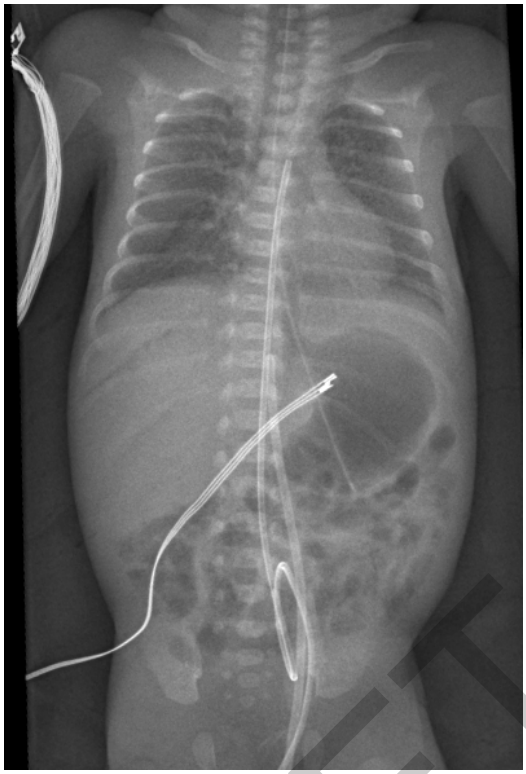


Image 6: AP X-ray. UVC tip in midline at T11. UAC T3/4.

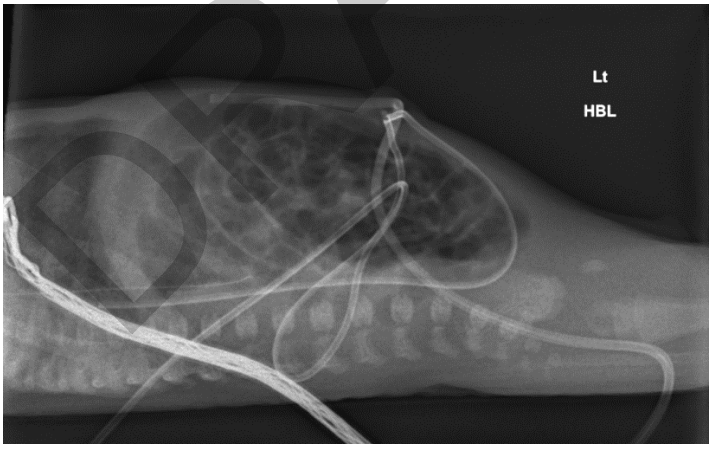
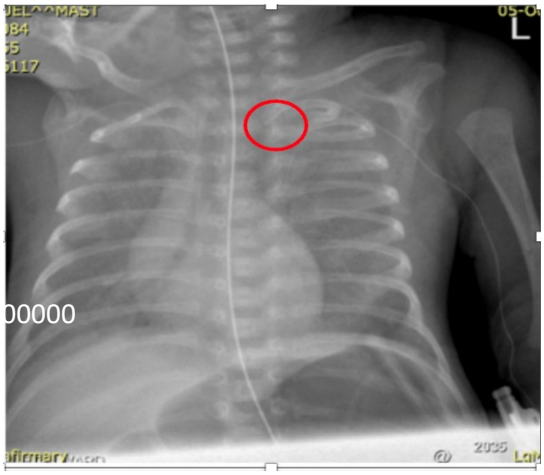
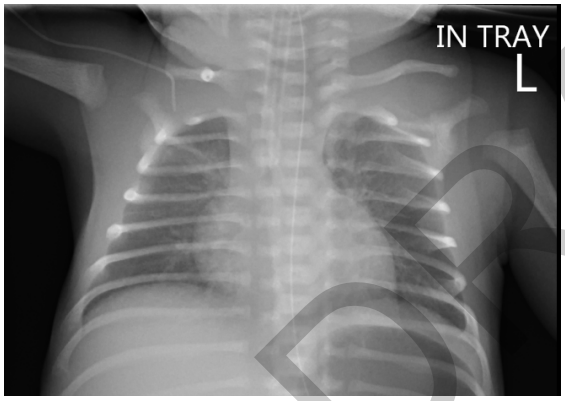


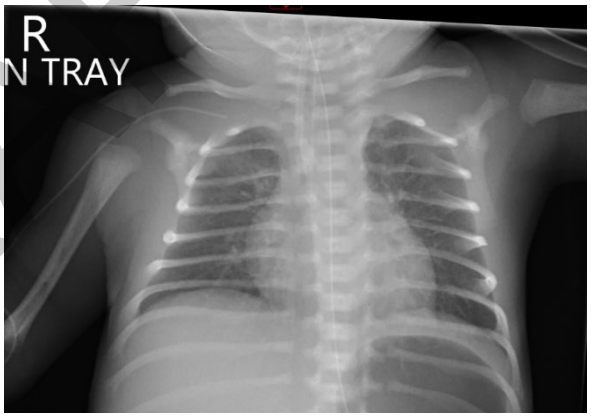
Image7: Lateral X-ray of UVC shown in image 6 demonstrating malposition with UVC running close to abdominal wall rather than taking posterior course. This UVC was intra-abdominal

Upper limb PICC

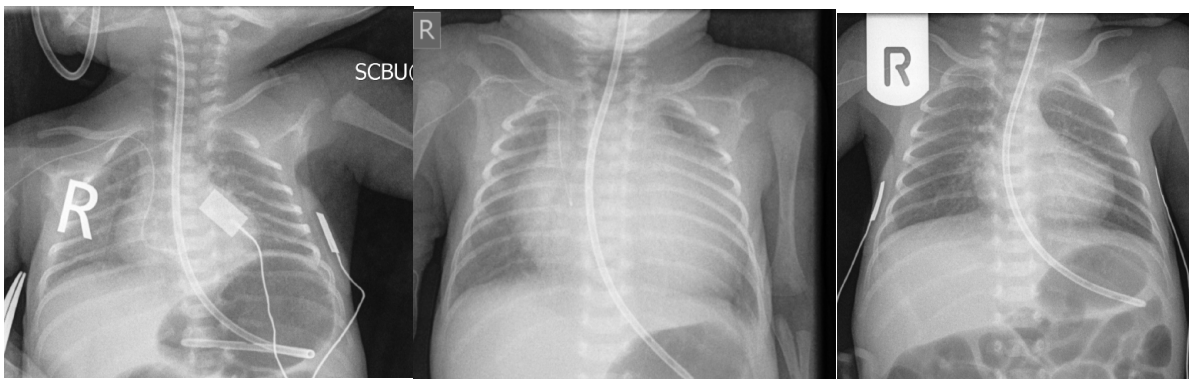


Images 8 and 9: Movement of PICC with change in arm position. Images taken 12hr apart with no apparent change in external PICC position





Images 10 and 11: Movement of PICC with change in arm position. Images taken 15 minutes apart with no apparent change in external PICC position.



Images 12, 13 and 14: Right arm PICC, the tip is in the heart. Withdrawn but no repeat imaging. Days later, new cardiorespiratory compromise, pericardial tamponade. Parenteral nutrition (PN) aspirated via xiphisternal approach, baby fully recovered. Post aspiration of PN and pulled back right arm PICC

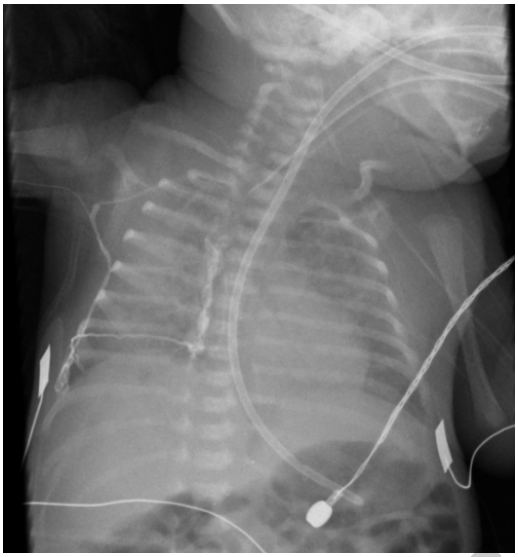


Image 15: Right upper limb PICC. Tip in axilla and draining via an intercostal vein into azygos vein outlined by contrast

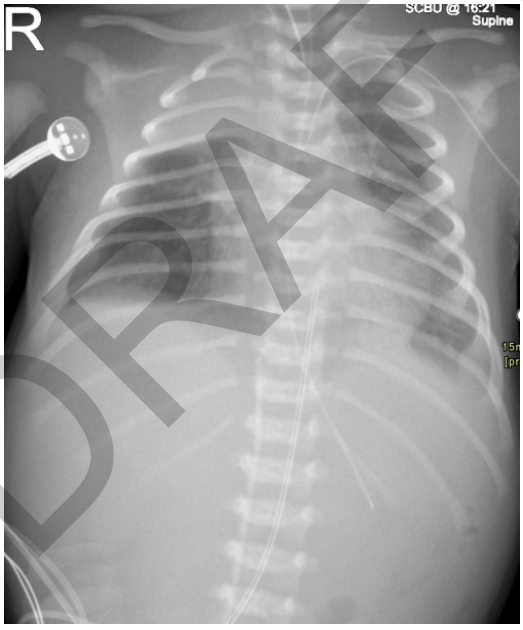


Image 16: Left upper limb PICC, not crossing midline showing arterial malposition

Lower Limb PICC

Images 17 and 18: Right lower limb PICC. Tip in low position. Contrast injected and IVC outlined

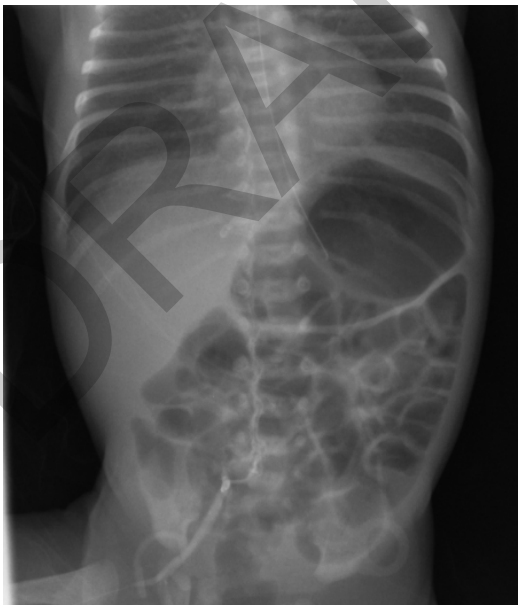
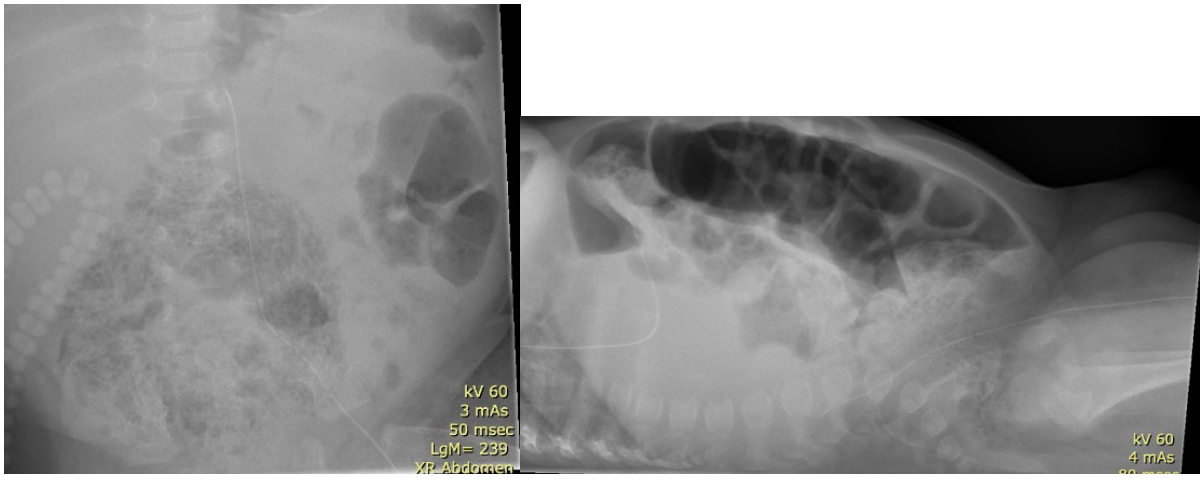
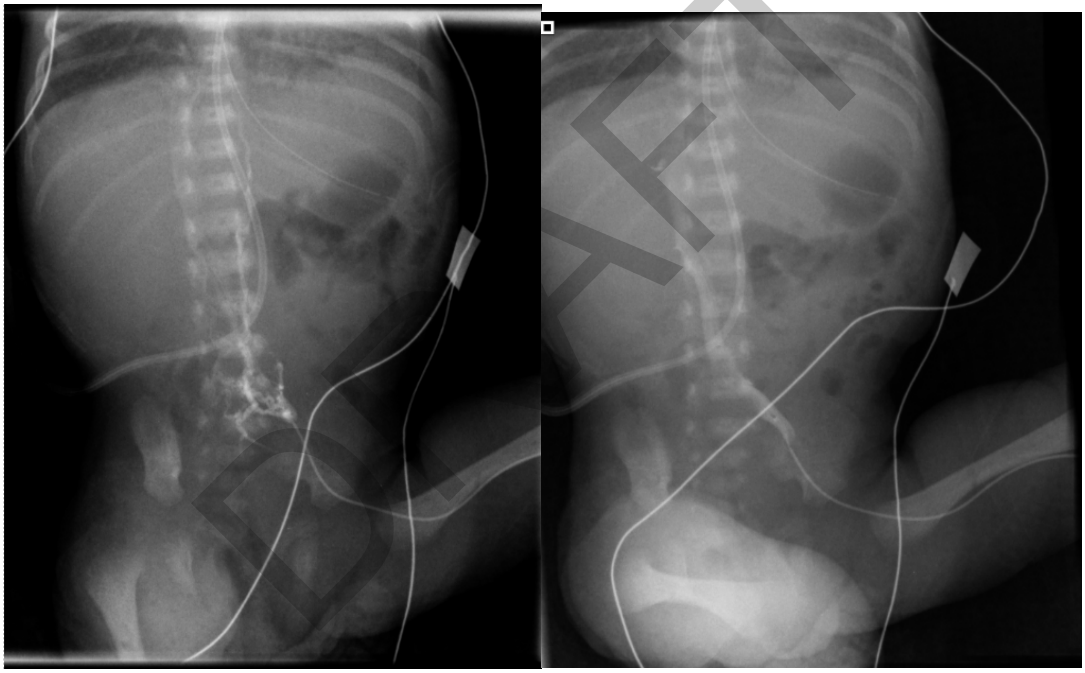


Image 19: Right lower limb PICC, with the contrast jet outlining the paraspinal veins. Note the wavy course medial to the vertebral pedicles, inside the bony spinal canal.



Images 20 and 21: Left lower limb PICC. Not crossing midline. Lateral X-ray of left lower limb PICC showing malposition in paraspinal veins



Images 22 and 23: Left leg PICC with contrast injection outlining paraspinal veins: Note the contrast between the pedicles. UVC high. PICC pulled back with contrast then going into IVC

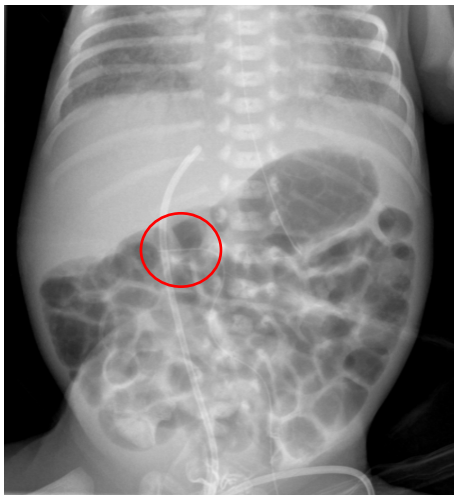


Image 24: Lower limb PICC inserted. The tip is sharply deviating to the right, likely within the right renal vein. Low lying UVC.

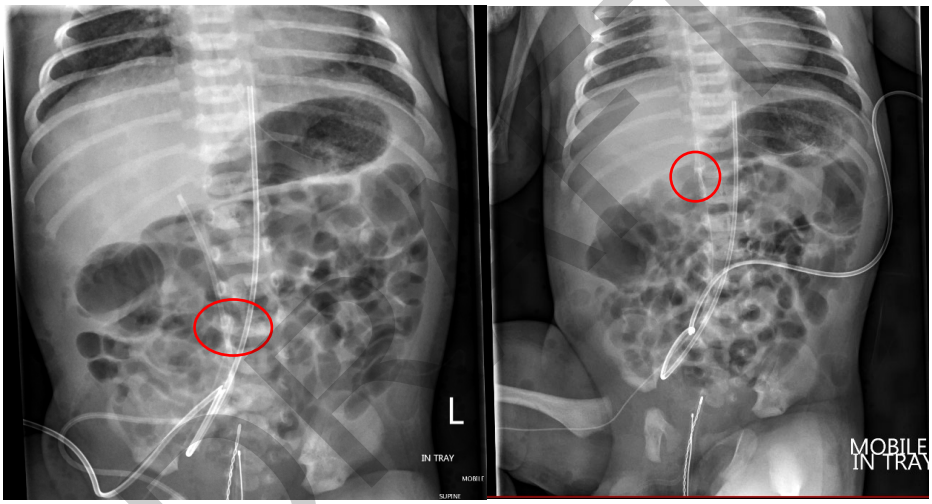


Image 24: Low UVC in situ. Lower limb PICC inserted. Hip extended. Tip at L4.
Image 25: UVC removed. PICC position unchanged. Reimaged with contrast and hip flexed. Tip at T12.

Appendix 1: Literature Search

Date completed: 24/04/2024

Resources searched: Medline, Embase, Cochrane Library, Google Scholar for forward citation searching of selected references

Search strategy

Ovid MEDLINE(R) ALL <1946 to May 01, 2024>

Number	Searches	Results
1	exp infant, newborn/ or intensive care, neonatal/ or intensive care units, neonatal/	688154
2	(infant* or newborn* or neonate* or gestational age or neonatal intensive care or nicu or nicus or prematur* or preterm or low birth weight or lbw or vlbw).ti,ab,kf.	893467
3	1 or 2	1222770
4	*Catheters/	3244
5	*Central Venous Catheters/	3074
6	*Catheterization, Central Venous/	14009
7	(central line* or central venous catheter* or central catheter* or longline catheter* or long line catheter* or umbilical venous catheter* or umbilical vein catheter* or peripherally inserted central catheter or peripherally inserted central catheter* or picc).ti,ab,kf.	21981
8	4 or 5 or 6 or 7	31379
9	3 and 8	3946
10	(insert* or position* or secur* or bundle* or checklist* or safety).ti,ab,kf.	1974530
11	9 and 10	1834
12	limit 11 to (english language and yr="2015 -Current")	862
13	(systematic review or metaanaly* or meta-analy* or "review of reviews" or umbrella review or evidence summary).ti,ab,kf.	457115
14	12 and 13	44
15	random*.ti,ab,kf,hw.	1761815
16	12 and 15	121
17	14 or 16	136
18	from 17 keep 1,4,6-11,13,16,19-21,23-26,29-33,38-39,41-42,45,48-49,55-56,62,66,68,70,72-75,77-78,80,82,84,86-87,90,98,100,104-105,108,118,123-124,126,129,134,136	59
19	Ultrasonography/	203559
20	(ultrasound or ultrasonography or pocus).ti,ab,kf.	416032
21	19 or 20	503125
22	tip.ti,ab,kf.	84058
23	3 and 8 and 21 and 22	122
24	from 23 keep 1-2,5-13,15-16,20-32,36,38-44,46-47,49-52,54-56,58-60,62-65,67,69,71-74,76,78-79,81-83,89-93,95-96,98-105,108-109,111-112,115-117,119-120	86
25	(intracavitary electrocardiography or intracavitary ECG or IC-ECG or image guidance or imaging guidance or radiograph* or echocardiograph* or X-ray* or xray*).ti,ab,kf.	887553
26	3 and 8 and 22 and 25	206
27	26 not 23	131

28	limit 27 to english language	118
29	from 28 keep 2-8,10,12-13,15,17-21,24-25,27-29,32-35,38-43,46,49,53,55-61,63,65,67,69-70	46
30	Catheters/ae	1028
31	Central Venous Catheters/ae	1803
32	Catheterization, Central Venous/ae	10066
33	(adverse event* or adverse effect* or complication* or malposition* or misplacement or thrombosis or extravasation or cardiac tamponade or liver).ti,ab,kf.	2695626
34	7 and 33	9185
35	30 or 31 or 32 or 34	17524
36	3 and 10 and 35	1253
37	17 or 23 or 27	363
38	36 not 37	1011
39	limit 38 to (english language and yr="2015 -Current")	414
40	2 and 39	352
41	40 not exp Child/	285
42	from 40 keep 1,7-8	3
43	from 41 keep 1,7-8,15-16,18-19,23,25,28,33,36-38,40,43-44,47-48,50,52,56,59,61,64-65,69,71,73-75,78-79,83,85-86,99,106-111,117,120,129,131,136,142-143,145-146,150,153-156,164,167-168,175,177,179,181,183,187,189,194-195,198,202-206,219,221,232,234,236,239-240,246,249,254,256,258,263,266,269,273-274,281-285	97
44	24 or 29 or 43	229
45	44 not 18	213

Appendix 2: Neonatal Central Venous Access Devices

Manufacturer	Device Name	Type	Size	Gauge	Length	Features	Intended Use (manufacturer)
Vygon UK	Premicath®	PICC	1Fr	28	8/10/15/20/30cm	Polyurethane; X-ray opaque; peelable cannula introducer, with or without stylet	Neonates <1kg. Short to medium term ≤29 days
Vygon UK	Nutriline®	PICC	2Fr/3Fr/4Fr	18/20/24	15cm/30cm	Polyurethane; X-ray opaque; peelable cannula introducer, with stylet	Short to medium term ≤ 30 days
Vygon UK	Nutriline Twinflo®	PICC	2Fr	24	20/30cm	double lumen; X-ray opaque; markings every 1cm, with or without stylet	Medium to long term ≤4 weeks *note variation in definition
Vygon UK	Premistar	PICC	1Fr	28	20cm/30cm	Polyurethane impregnated with Rifampicin and Miconazole, with or without stylet	≤ 29 days
Vygon UK	Epicutaneo Cava (si)	PICC	2Fr	24	15cm/30cm	Silicone, mark every cm with black mark at distal end, removable easy lock connector	Medium to long term (days not specified)
Vygon UK	Epicutaneo Cava (PUR)	PICC	2Fr	24	30cm	Polyurethane, X-ray opaque, marking every 5cm, removable easy lock connector	Duration not specified
Vygon UK	Epicutaneo 2	PICC	1.9Fr	24	15/30/50cm	Silicone, mark every cm with black mark at distal end, integrated 4cm extension tubing	medium to long term (days not specified)
Vygon UK	Nutricath	Tunnelled, cuffed, CICC			58cm	Silicone, subcutaneous cuff	Long term (days not specified)

Vygon UK	Lifecath XS-CT PICC™ Maestro	PICC	3Fr		30cm	Polyurethane	
Vygon UK	Umbilical Catheter	UVC	2.5Fr/3.5Fr/4Fr/5Fr/8Fr		30cm/40cm	Polyurethane, single lumen	
Vygon UK	Umbilical Catheter	UVC	4Fr/5Fr		20cm/40cm	Polyurethane, double lumen	
Vygon UK	Umbilical Catheter	UVC	4.5Fr		20cm	Polyurethane, triple lumen	
Bard Access Systems	Groshong ™	CICC	4.5Fr/5Fr			Silicone, 2-way valve, trimmable proximally, available as double lumen	
Bard Access Systems	PowerGroshong ™ PICC	CICC	5Fr			Silicone, 3-way valve, increased flow rate over single lumen PICC	
BD	Hickman™ Broviac ™	Tunnelled, CICC	2.7Fr/4.2Fr	24/22	71cm	Silicone, cuff	
Teleflex Medical	Arrowg+ard Blue®	CICC	4Fr/5Fr/5.5Fr	22	5/8/13/30	Single, double, triple lumen available, Antimicrobial	≤30 days 4Fr min wt 2kg, 5fr min wt 2.5kg, 5.5Fr min Wt 3kg
Delta Med	Delta PICC	CICC	3Fr/4Fr/5Fr		55cm	Polyurethane, Single, double and triple lumen available, trimmable	
B Braun	Certofix® Paed	CICC	3fr/4Fr/5Fr	18/20/22	8/10/13/20cm	X-ray opaque, Single, double and triple lumen available	
Med-comp	Vascu-PICC	PICC	2.6Fr		50cm	Polyurethane	

Med-comp	Pro-Line® CT	PICC	various sizes 3F+		60cm	Polyurethane	
Insertion Devices							
Vygon UK	Microsite® 2Fr Introducer Kit	Micro-Seldinger Kit containing 24G puncture needle, guidewire, dilator up to 2Fr, 20G peelable sheath cannula					
Vygon UK	Breakaway/ splitting Needle	24G 19mm for use with 1Fr PICC, 20G 25mm for use with 2 Fr PICC					
Vygon UK	Microflash Peelable Cannula	20G, 18mm long for use with 1Fr and 2Fr PICC					

Appendix 3: Anatomy

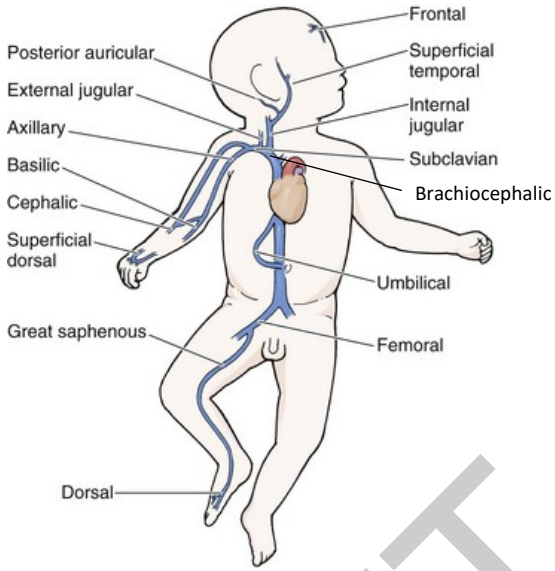


Figure 1: Venous System anatomy

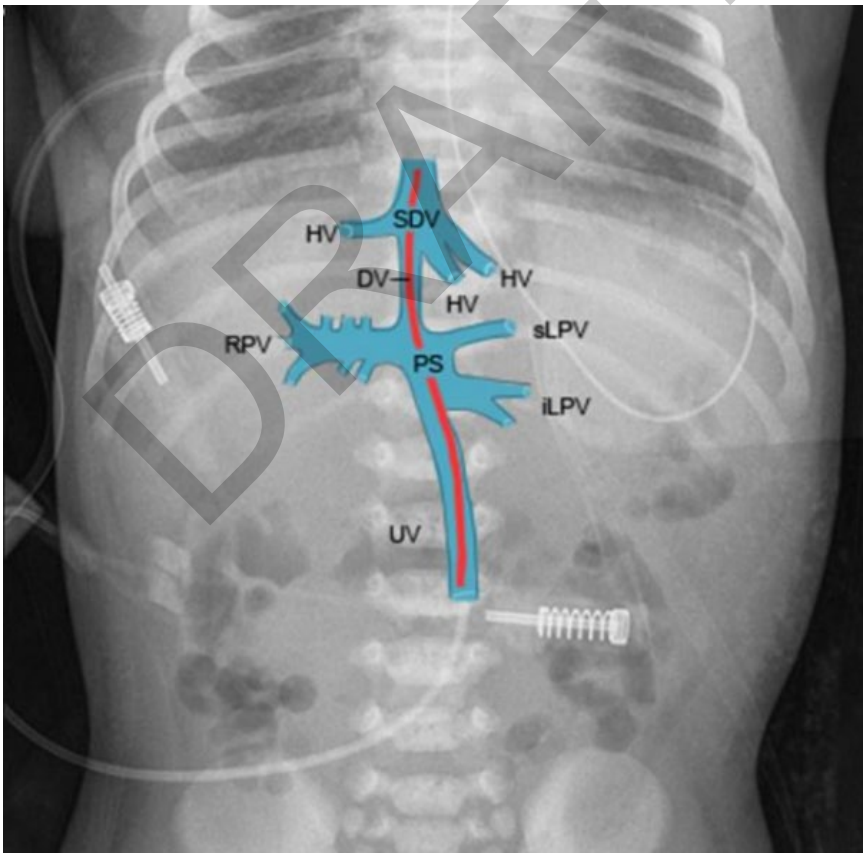


Figure 2: Umbilical vein, hepatic and portal venous anatomy. UV, umbilical vein, PS, portal sinus, iLPV inferior left portal vein, sLPV, superior left portal vein, RPV, right portal vein, DV, ductus venosus, HV, Hepatic Vein, SDV, subdiaphragmatic vestibulum

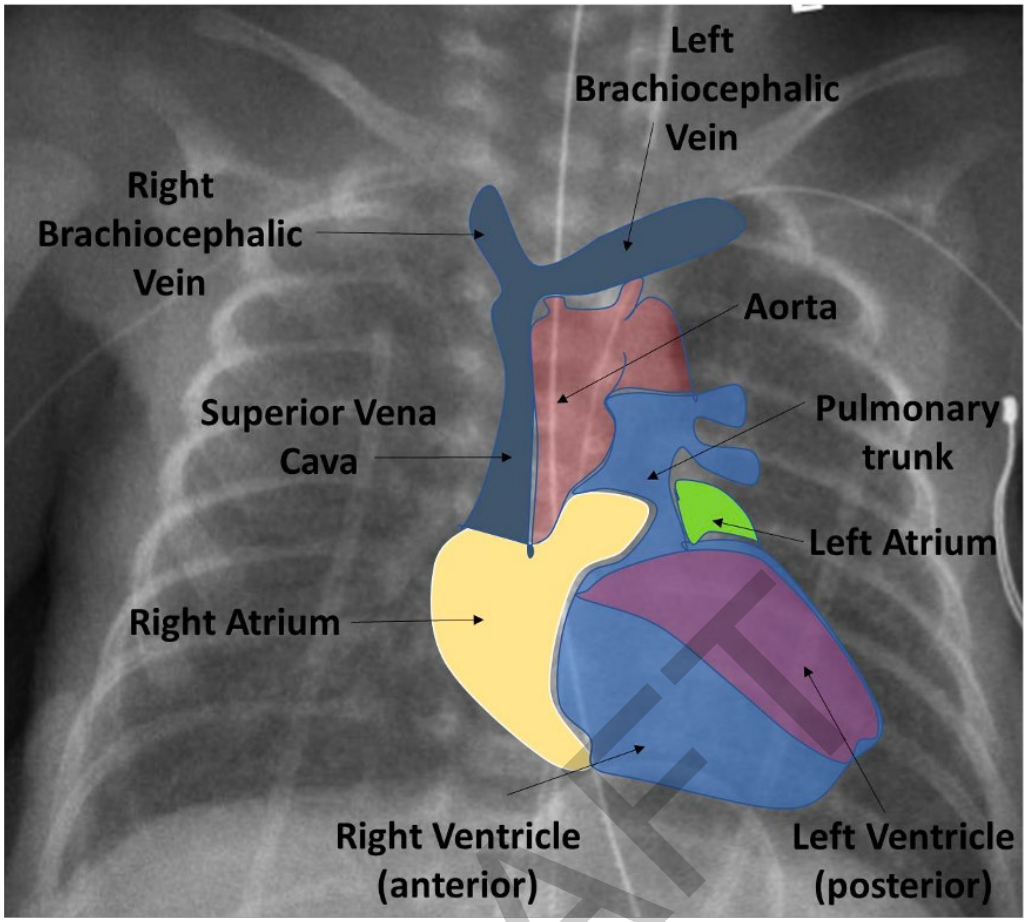
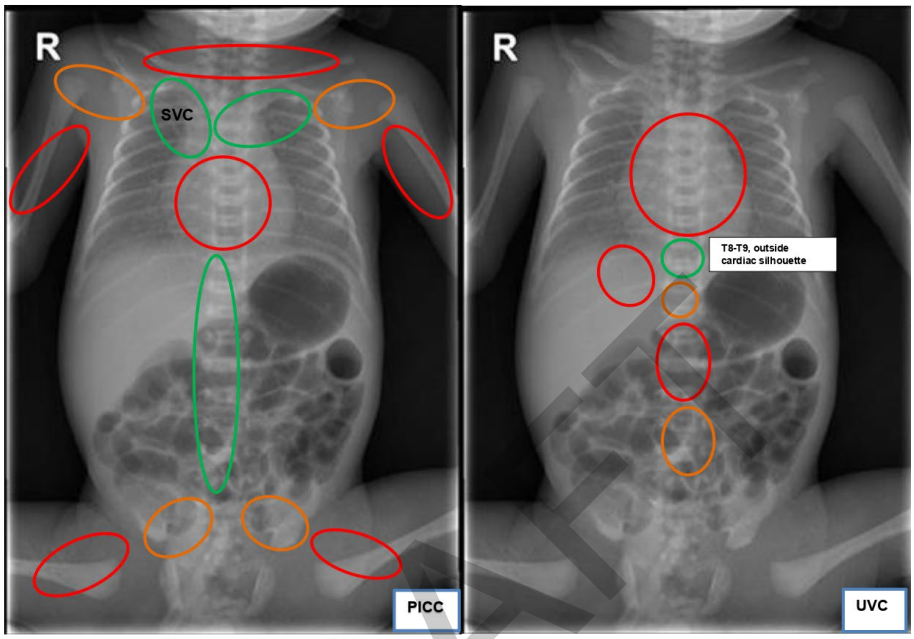


Figure 3: **Schematic showing the position of the cardiac chambers and related structures on AP chest X-ray. Note in this X-ray a left upper limb PICC has been sited. This did not cross the midline before traveling downwards, indicating arterial malposition. Anatomical variants should also be considered e.g persistent left SVC .** Yorkshire & Humber Neonatal ODN - NHS Networks.

Appendix 4: Neonatal CVC QI Project example

Traffic Light Guide to Neonatal Central Venous Catheter Positions



Peri-renal vessels:
UVC should not lie at L1-L3 level, but PICC safe to use unless clinical/ radiological concerns of malposition

GREEN	Optimal line position
AMBER	Acceptable with extra caution and not for PN
RED	Unacceptable position - remove line or pull back

UAC: goes through one of the umbilical arteries, descents to the iliac artery before it ascends to the aorta. Appropriate placement is **T6-T10**

Every PICC, UVC, UAC line positioning should be confirmed with the consultant on call

Reference: 'A lifeline: enhancing neonatal central venous catheters safety'
https://doi.org/10.1136/archdischild-2024-326977

Am I X-Ray ready?

Things to check prior to taking an X-ray.

Have all artifacts been removed?

Chest X-ray: ECG leaas/ NGT not over chest
Abdominal X-Ray: nappy and temperature probe to be removed

For ETT placement

Is my head in the midline?

Central lines

UL PICC: shoulders abducted at 30° with elbows flexed
LL PICC: frog leg position
Umbilical catheters: keep body straight

Infants in the Neonatal Unit are susceptible to multiple images.
It is our duty to make sure we keep the radiation exposure to the minimum, by checking all of the above prior to an X-ray being taken.

How settled am I?

Will I stay still during the X -ray or do I need holding?
Rotated X-Rays are very difficult to interpret.

Central lines

Use clear drapes to cover main part of body.
Don't forget to use contrast for ALL lower limb longlines and also consider for upper limbs. Contrast will reduce the chance of repeat X-rays.

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