British Association of Perinatal Medicine

Use of Central Venous Access Devices in Neonatal Units

A BAPM Framework for Practice

July 2026

Developed in partnership with

British Association of Paediatric Surgeons · 1953

British Society of Paediatric Radiology (BSPR)

APAGBI Association of Paediatric Anaesthetists of Great Britain & Ireland

Contents

Members of the Working Group

Dr Louise Leven	Consultant Neonatologist, Royal Hospital for Children, Glasgow BAPM Safety Lead (2022-2025). Chair
Mr Basil Bekdash	Consultant Paediatric Surgeon, Leeds Children's Hospital British Association of Paediatric Surgeons
Dr Sumit Das	Consultant Paediatric Anaesthetist, John Radcliffe Hospital, Oxford President-Elect Association of Paediatric Anaesthetists of Great Britain and Ireland
Dr Louise Hattingh	Consultant Radiologist, Bradford Teaching Hospitals. British Society of Paediatric Radiology
Dr Anoo Jain	Consultant Neonatologist, University Hospitals Bristol and Weston NHS Foundation Trust BAPM Honorary Treasurer (2025-2028)
Mr Nick Lansdale	Consultant Paediatric Surgeon, Royal Manchester Children's Hospital British Association of Paediatric Surgeons; Co-chair Neonatal Surgical Forum
Dr Ahmed Moharram	Consultant Neonatologist, Royal Oldham Hospital, Greater Manchester
Dr Emily Mullan	Consultant Neonatologist, Princess Royal Maternity Hospital and Royal Alexandra Hospital, Glasgow
Dr Ourania Pappa	Consultant Neonatologist, Hull University Teaching Hospitals. Former Quality Improvement Fellow Leeds Children's Hospital
Dr Tayyaba Yasmeen	Consultant Neonatologist, Aberdeen Maternity Hospital, Aberdeen

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. Our frameworks/toolkits use the terms ‘woman/mother or birthing parent’ throughout to include people who do not identify as women but who are pregnant, in labour and in the postnatal period. The term breastfeeding is also used but should be taken to include those who term this method of feeding as chest or body feeding. Please always take time to make sure you are using the preferred pronouns and terminology of the patient and their support network.

The 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.

Glossary

ANTT®	Aseptic Non Touch Technique
AP	Anteroposterior
AXR	Abdominal X-ray
CLABSI	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

Scope

The principles within this framework apply to neonatal patients cared for within a neonatal unit. We recognise that neonatal patients cared for outside the neonatal unit will require CVAD insertion in certain clinical situations. In these situations, the insertion, imaging and ongoing use of CVADs should be in keeping with existing, applicable published guidance. If no such guidance exists, BAPM recommends the appropriate specialist group develop this and the principles within this framework are considered until such guidance exists. It is recognised that CVAD use in certain clinical situations, for example in cardiac surgical care, is beyond the remit of this framework.

The role of interventional radiology for the insertion of central venous access devices in neonates is not included within this framework. BAPM would support the development of evidence-based recommendations in this area by the appropriate subspecialty groups. CVAD use in the perioperative period, should where possible follow the principles of this framework, recognising there may be limitations due to the surgical environment. As soon as practical and where a CVAD remains in situ for longer term use in the neonatal unit, the recommendations in this framework should be applied.

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 venous access device complications.

To ensure thematic learning from all reported central venous access device 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) and Learning from Patient Safety Events (LfPSE) review of all central venous access device 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. Literature search was updated throughout the duration of framework development. 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™)

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). The catheter 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.

The working group recognises terminology used to describe central venous access devices in neonates varies internationally (van Rens 2024). Some classification systems distinguish epicutaneo-cava catheters (ECC) as smaller calibre devices (typically 1–2.7 Fr) commonly used in neonatal practice and reserve the term peripherally inserted central catheter (PICC) for larger calibre devices (>3 Fr) with different performance characteristics. However, within UK neonatal services, the term PICC remains widely understood and routinely used to describe centrally positioned catheters inserted via a peripheral vein, regardless of device calibre. For consistency with current UK neonatal practice the term PICC has therefore been retained throughout this framework. Readers should be aware of differences in nomenclature when interpreting the international literature.

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).

- POCUS can be used to guide UVC insertion.

- Principles of Aseptic Non Touch Technique (ANTT®) must be adhered to during the insertion of all CVADs.

- A correctly inserted CVAD should aspirate blood at the time of insertion, with the exception of the smallest PICCs where "flashback" should be confirmed.

Imaging and position

- All CVADs should be imaged in their final position, after any adjustment of length and before ongoing use on the neonatal unit. This does not apply to CVADs inserted during resuscitation where aspiration of blood is adequate prior to 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. If malposition is not suspected following first imaging, the UVC can be used routinely.

- 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.

- If lower limb PICC tip has not been identified in an optimal position by POCUS at the time of insertion, a contrast injection AXR should be performed.

- 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 catheter migration or dysfunction.

- Training in POCUS is essential for all practitioners before utilising as a method to confirm

CVAD tip position. Practitioner competence in POCUS must be considered when introducing the use of POCUS.

- POCUS is a complimentary imaging modality which can reduce the number of X-ray taken when a CVAD is in use.
- When a UVC tip lies at or below T10 it should only be used if essential and for a maximum of 24 hours.
- UVC tip should be positioned outside the cardiac chambers, near the level of the diaphragm.
- The tip of all CVAD <3Fr should lie outside the cardiac chambers.
- The tip of larger calibre (≥3Fr) CICC may in some circumstances be permitted within the right atrium. The decision to place the tip in the right atrium should be documented and rational provided.
- The junction between the SVC and right atrium can be estimated at 1.5 vertebral bodies below the carina. The thymus can obscure cardiac landmarks on an AP x-ray.

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.
- 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.

Care and maintenance

- Principles of ANTT® must be adhered to during care and maintenance of all CVADs.

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, imaging, maintenance 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 a number of CVADs commonly used in UK neonatal units. Practitioners should be familiar with the devices available in their own neonatal 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, skin cleaning and the required aseptic precautions, insertion technique, fixation method, imaging and maintenance protocols. All practitioners should have received education and training on local policies and equipment.

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. A dabbing technique is recommended rather than scrubbing to minimise skin trauma.

CVAD insertion should be undertaken using the Aseptic Non Touch Technique (ANTT®) approach, with the aim of achieving asepsis throughout the procedure. ANTT® provides a structured framework (ANTT Clinical Practice Framework 2024 can be requested at www.antt.org) to determine procedural complexity and staffing requirements based on factors that directly affect the ability to achieve and maintain asepsis. This risk assessment determines if Standard or Surgical-ANTT is required. Given the invasive nature of CVAD insertion, a Surgical-ANTT approach will be required, incorporating appropriate Critical Aseptic Fields with environment and protective measures. The procedure environment should be prepared to reduce contamination risk, and non-touch technique applied wherever possible to protect Key-Parts, defined by ANTT® as parts of the procedure equipment that come into contact with the Key-Site, the Key-Site being the CVAD insertion site. A consistent, structured approach to aseptic practice during insertion is essential to minimise the risk of catheter-related infection.

Although obtaining formal written consent is regarded as best practice, it is not currently a standard requirement for CVAD insertion in neonatal units. Best practice would include a documented discussion with parents or legally responsible guardian, outlining the indication for the procedure, associated risks, and available alternatives. In situations where CVAD insertion is required urgently and time does not permit, 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.

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

A correctly inserted CVAD should aspirate blood at the time of insertion, with the exception of the smallest PICCs where "flashback" should be confirmed. While awaiting imaging confirmation of tip placement, low risk infusions, such as 5% or 10% Glucose or 0.9% saline can be used to maintain CVAD patency.

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 any other (Akar 2020, Kieran 2016, Patel 2022).

UVC malposition is common with optimal positioning achieved between 28% and 71% of insertions 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 of their validity is limited. Ultrasound guided UVC insertion, where the path of the catheter is followed in real time during insertion, could identify malposition early, allowing a UVC to be repositioned at the time of first insertion (McNamara 2024). Evidence of improved catheter insertion success is variable (D’Andrea 2025, Ponin 2025, Mishra 2024) suggesting this method is operator dependant, emphasising the importance of training before adoption.

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

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.

Intracavitary 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.

Neonatal units should have a standard approach to fixation of PICC and CICC, recognising that suturing larger calibre CICC may be required to ensure risk of displacement is minimised. 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). One to two drops of cyanoacrylate glue only are required and any excess glue should be removed. Adhesive remover can be used to remove from the skin although natural debonding will occur over time (Hugill 2023).

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 (this information has been included in Appendix 2, Table 1 where available) and local policy. There is no evidence to determine the safety of shortening small calibre PICCs prior to 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 the 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 is 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.
        - Serial Number.
        - Cuffed/tunnelled.
        - Calibre, number of lumens.
        - For PICC/Untunnelled CICC.
            - Total catheter 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 device 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 device 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 for all CVAD insertions.
- 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.
- 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 until correct position has been confirmed definitively. If unable to confirm position, the CVAD should be removed.
- 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.
- 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).
- 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).

CVAD imaging and position

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 (IR(ME)R) in diagnostic and interventional radiology. Dose levels should be audited and Diagnostic Reference Levels (DRLs) should not be exceeded (IR(ME)R 2017).

Under IR(ME)R, 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. If used, intravenous contrast should be prescribed, prepared and administered in line with accepted practice for prescription only medicines.

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. Catheter malposition 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 or POCUS is performed for other indications while CVAD remains in situ.

Considerations in CVAD imaging

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 low UVC 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 UVC 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, Gronska 2025). 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 and preparation of the infant prior to image acquisition is essential to minimise exposure to repeat x-rays due to poor quality images. Appendix 4 Figure 1 and 2 illustrates the recommended infant positioning and preparation. If imaging using POCUS, movement of the catheter with changing limb position can be assessed.

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. If further attempts at obtaining a more optimally placed CVAD are unsuccessful the risk and benefit of repeated attempts should be considered and discussed with the parents. "Traffic light" systems which provide an illustration of accepted CVAD position, balancing the need for central access with the risks of malposition, have been published with the aim of improving consistency of practice (Pappa 2025).

Radiographic features of correct and incorrect device position

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 catheter should be imaged, noting that an initial downward displacement of the venous catheter indicates incorrect arterial placement.

On AP X-ray, the umbilical venous catheter 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.

A left upper limb PICC should cross the midline before descending to the SVC. If a left upper limb PICC descends to the left of the spine, consider arterial placement or persistent left SVC.

A PICC inserted into the left lower limb will cross the midline to enter the IVC. Injection of contrast into lower limb PICC at the time of insertion will assist in promptly identifying malposition in the paraspinal veins prior to PICC use. If the tip of a lower limb PICC cannot be confidently visualised on AP X-ray by both neonatologist and radiologist, the use of a lateral x-ray should be considered. 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. 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 (≥3Fr) CICCs can be positioned with their tip within the RA in some circumstances, 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). The decision to place a CICC tip in the RA should be documented and rational provided.

Practice points for CVAD imaging and position

- All CVADs should be imaged in their final position, after any adjustment of length and before ongoing use on the neonatal unit. This does not apply to CVADs inserted during resuscitation where aspiration of blood is adequate prior to 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-rays and POCUS and the tip position compared to previous known position.

- Training and competency 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.

- Care should be taken to correctly identify the cardiac chambers on AP CXR (Appendix 3, Figure 3).

- All tip of all CVAD <3Fr should lie outside the cardiac chambers.

- The tip of larger calibre (≥3Fr) CICC may in some circumstances be permitted within the right atrium. The decision to place the tip in the right atrium should be documented and rational provided.

Practice points for imaging umbilical venous catheters

- 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.

- 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.

- 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.
- Upper limb PICC should follow the expected course of the left or right subclavian vein, 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) to visualise the full course of the CVAD.
- 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.
- If Lower limb PICC tip has not been identified in an optimal position by POCUS at the time of insertion, an contrast injection AXR should be performed.
- Local guidance for imaging with contrast 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 0.9% sodium chloride.
- 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.
- A correctly positioned left lower limb PICC and FICC will cross the midline.

Practice points for imaging scalp PICC

- Scalp PICC should be imaged with a CXR to visualise the full course of the CVAD.
- A PICC placed in a superficial scalp vein should ultimately enter the internal or external jugular vein with the ideal location at the SVC/RA junction or in the SVC.

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.

CVAD care and maintenance

Appropriate care and maintenance of CVADs will reduce complication rates. Care and maintenance policies should be included in unit CVAD guidance with regular staff training and adherence to practice monitored. These policies should reflect the ANTT® Clinical Practice Framework. ANTT® is an evidence based clinical practice framework for aseptic practice which must be adhered to during the access and maintenance of all CVADs. A risk assessment to determine the appropriate ANTT® type (Surgical ANTT® versus Standard- ANTT®) should be performed, prior to CVAD use.

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.

PICC patency can be maintained with a continuous fluid infusion. Minimum flow rates are not typically specified by manufacturers. Heparin has not been found to have an advantage over sodium chloride in relation to CLABSI for “lock off” flushing of PICCs and “lock off” flushing with sterile 0.9% sodium chloride is recommended (WHO 2024). Additionally heparin was not found to have an advantage over sterile 0.9% sodium chloride in terms of CVAD occlusion rates in adults and therefore 0.9% sodium chloride can be safely used for CVAD maintenance (López-Briz 2022).

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.
- Principles of ANTT® must be adhered to during care and maintenance of all CVADs.
- 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.
- CVAD dressing change should be performed using an ANTT® risk assessed approach.
- 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% or 0.45% sodium chloride. Prefilled syringes are recommended.
- Sterile 0.9% Sodium Chloride can be used for “lock off” flushing of CVADs.
- 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.

CVAD 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). Complication rates increase with increasing CVAD dwell time. A UVC dwell time of more than 7 days predicts UVC migration (Gibson 2024) and increases CLABSI and thrombosis rates (Perme 2024). A maximum UVC dwell time of 7–10 days is recommended, with heightened monitoring for complications as the duration of catheter use increases.

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 catheter 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 is a common CVAD complication and can cause significant morbidity and mortality. Malposition at the time of insertion has been 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. Malposition of a lower limb PICC in the paraspinal vessels must be identified promptly as spinal injury can occur in a short timeframe and clinicians should be aware of the radiographic features which may suggest malposition.

Accidental arterial cannulation should be considered if a PICC takes an unusual course on X-ray. Indicators that accidental arterial cannulation may have occurred are a left upper limb PICC which does not cross the midline or a right upper limb PICC which does cross the midline and a lower limb PICC which ascends in front of the vertebrae. Particular care should be taken when interpreting X-rays when anatomy is influenced by patient pathology e.g congenital diaphragmatic hernia. Ultrasound is a useful additional imaging modality if arterial cannulation is suspected.

Migration and dislodgement of all CVADs can occur (Acun 2021, Franta 2016, Gibson 2024, Gupta 2016, Plooij-Lusthusz 2019, Stekhova 2023). 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).

Transport of the neonate with a CVAD in situ, either within or between neonatal units, could increase the risk of dislodgment or migration of the device. This should be considered and CVAD position reconfirmed if migration is suspected.

CVAD tip migration can lead to extravasation within a short timeframe i.e 1-4 days following device 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 of 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 catheter. If the catheter cannot be retrieved, consider early discussion with a NICU with onsite interventional radiology, cardiology and surgery to discuss management.

Risk of CVAD 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 discussion and referral to plastic surgery teams is recommended.

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 device 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.

- A maximum UVC dwell time of 7–10 days is recommended, with heightened monitoring for complications as the duration of catheter use increases.

- 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 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 access to training courses is a recognised barrier to wider use of ultrasound by neonatologists (Oulego- Erroz 2022) and the development of standardised training courses are recommended (McNamara 2024).

For clinicians from specialties where US guided insertion and imaging of CVADs is standard practice, it would be assumed that competence has been assessed in those areas and would be applicable to the neonatal population.

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.
- Information from national audit should be used to inform the development of clinical trials to reduce CVAD complications in neonates.
- 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) with inclusion of training within the paediatric curriculum.

Audit Standards

- All staff have completed CVAD training appropriate to their role and competency is assessed annually or during neonatal placement for rotational staff.
- All UVC have tip position 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

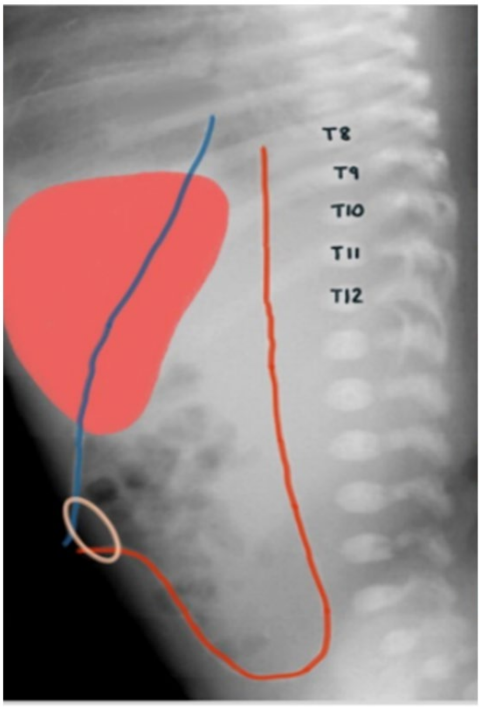
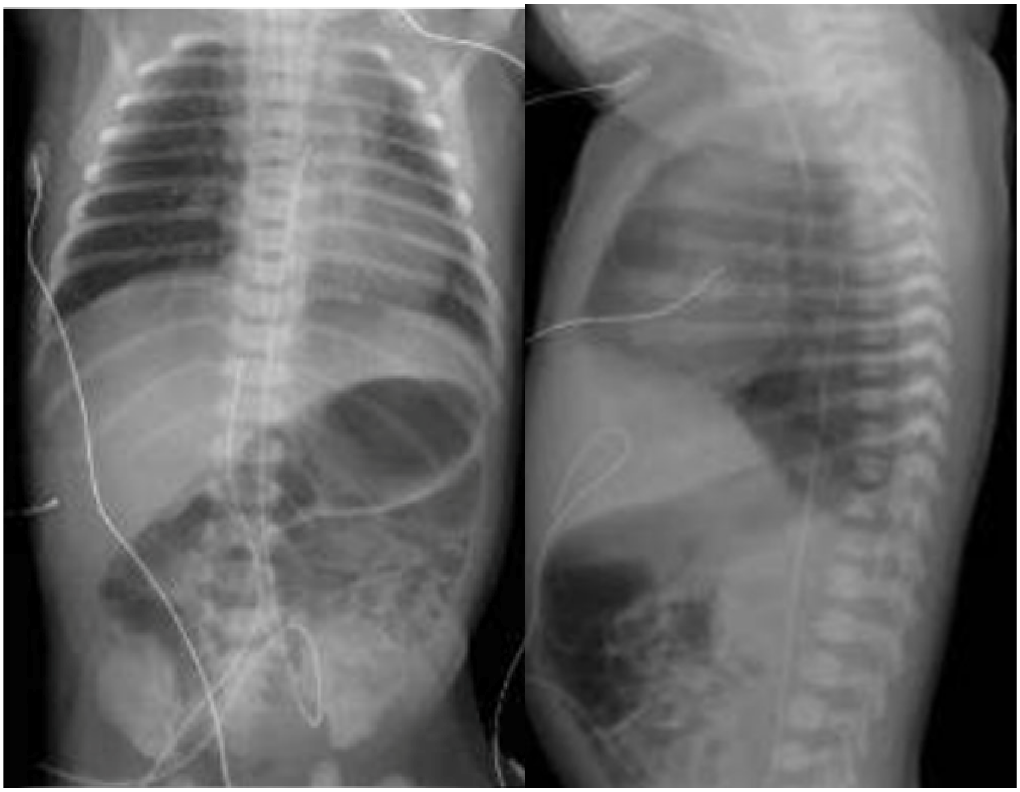


Image 2: Schematic of expected course of UVC (blue line) as seen on lateral X-ray

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

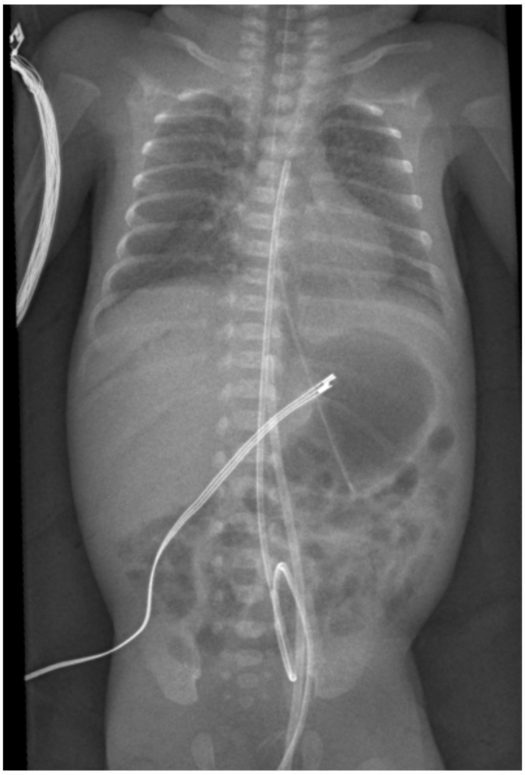


Image 6: AP X-ray. UVC tip in midline at T11. UAC T3/4

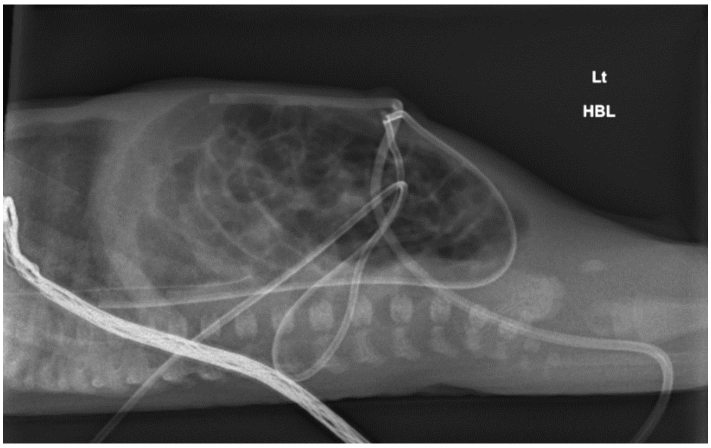
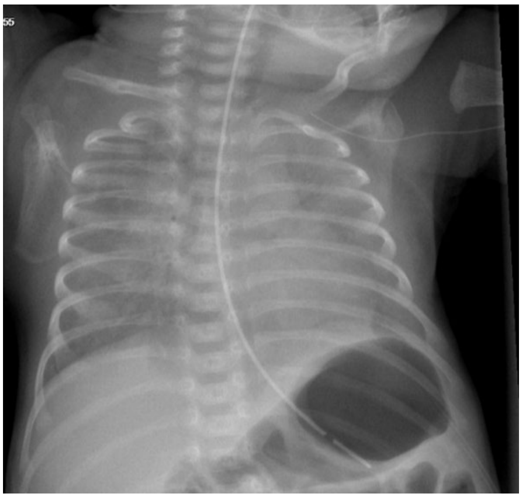
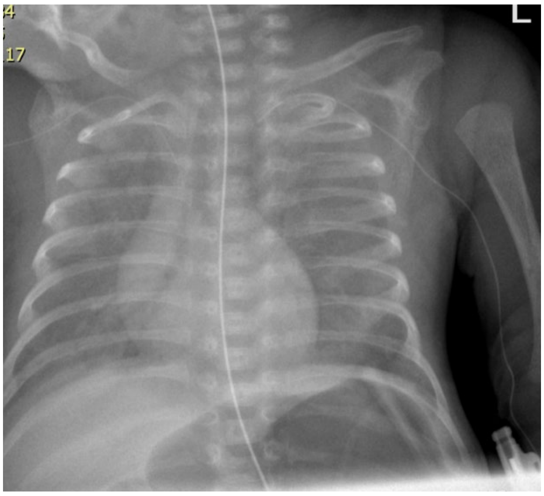


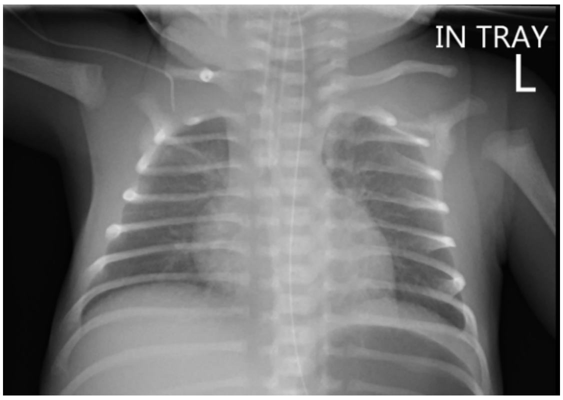
Image7: Lateral X-ray of UVC shown in image 6 demonstrating malposition with UVC running close to abdominal wall rather than taking posterior course. This UVC was intra-abdominal

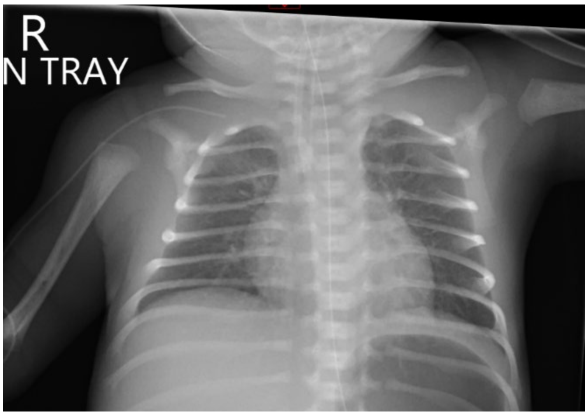
Upper limb PICC



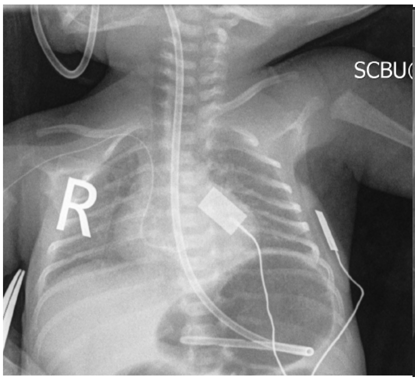


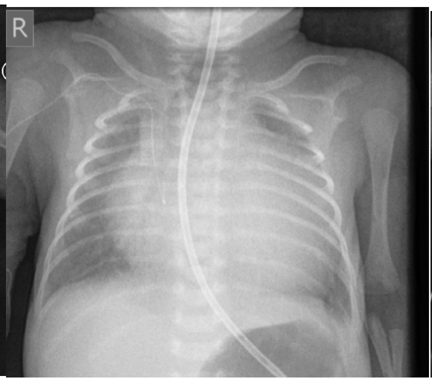
Images 8 and 9: Movement of left upper limb PICC with change in arm position. Images taken 12hr apart with no apparent change in external PICC position

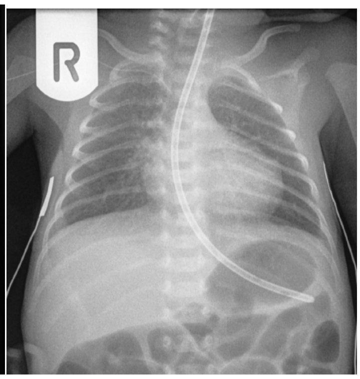




Images 10 and 11: Movement of right upper limb PICC with change in arm position. Images taken 15 minutes apart with no apparent change in external PICC position







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

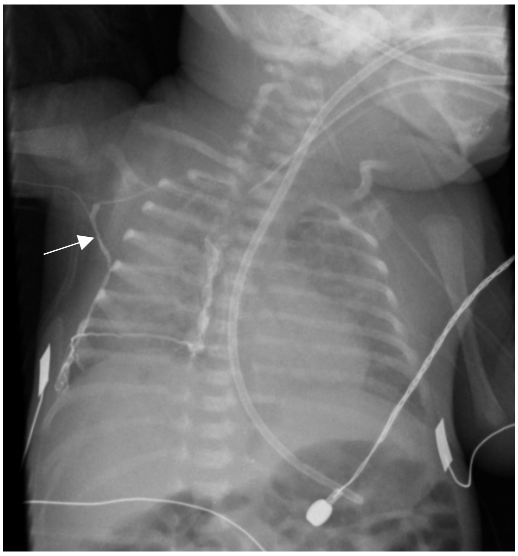


Image 15: Right upper limb PICC. Tip in axilla and draining via an intercostal vein into azygos vein outlined by contrast

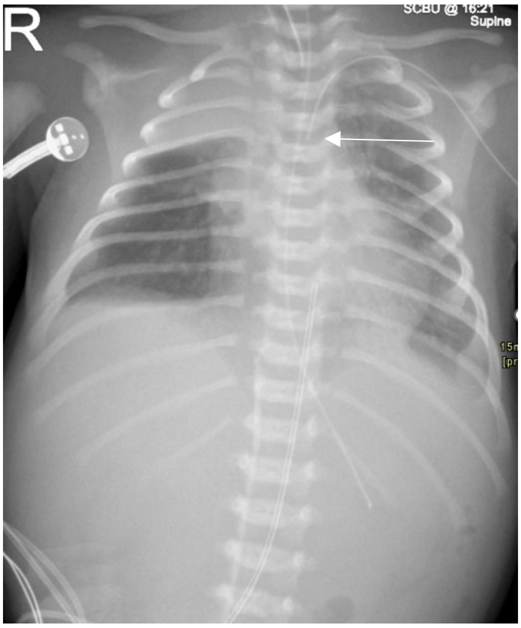
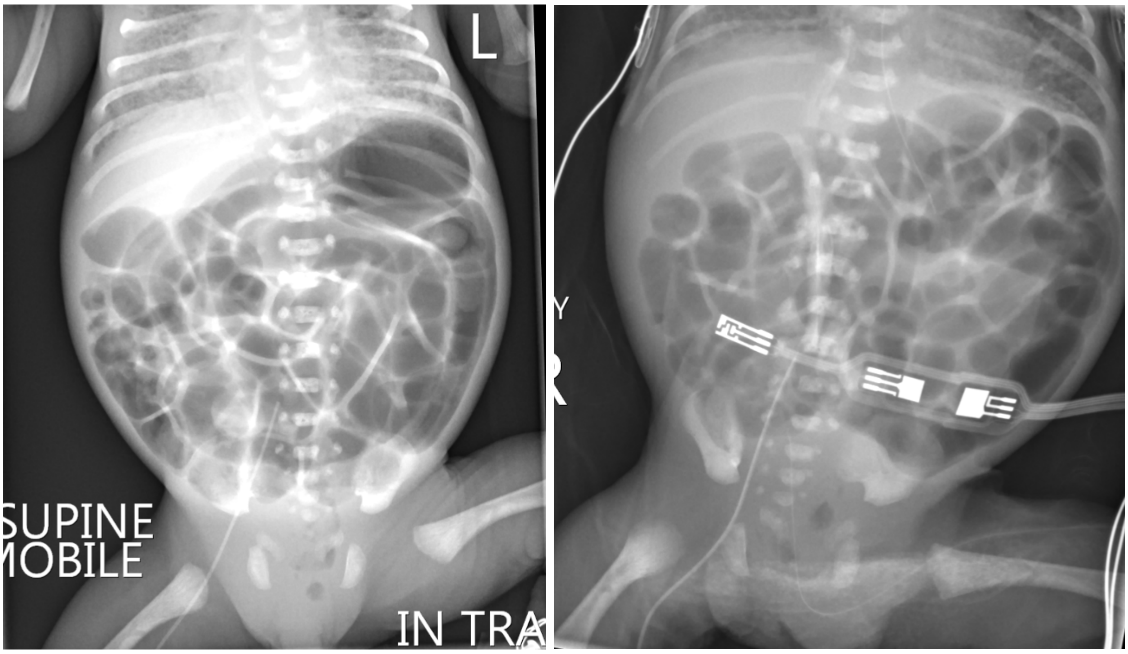


Image 16: Left upper limb PICC, not crossing midline showing arterial malposition

Lower limb PICC



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

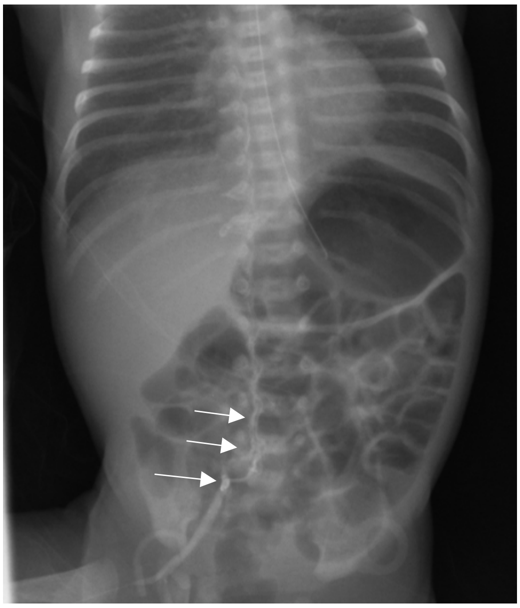
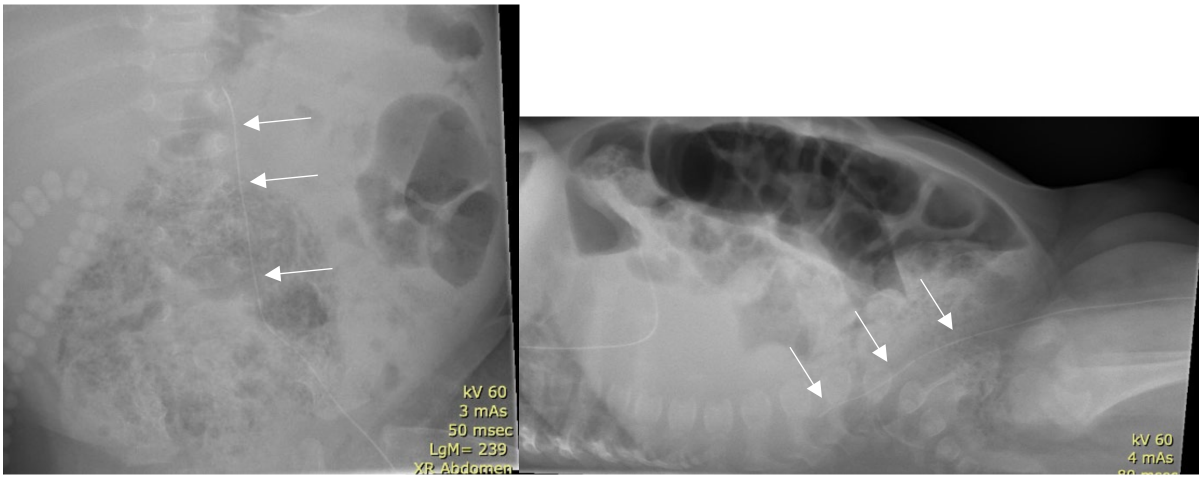
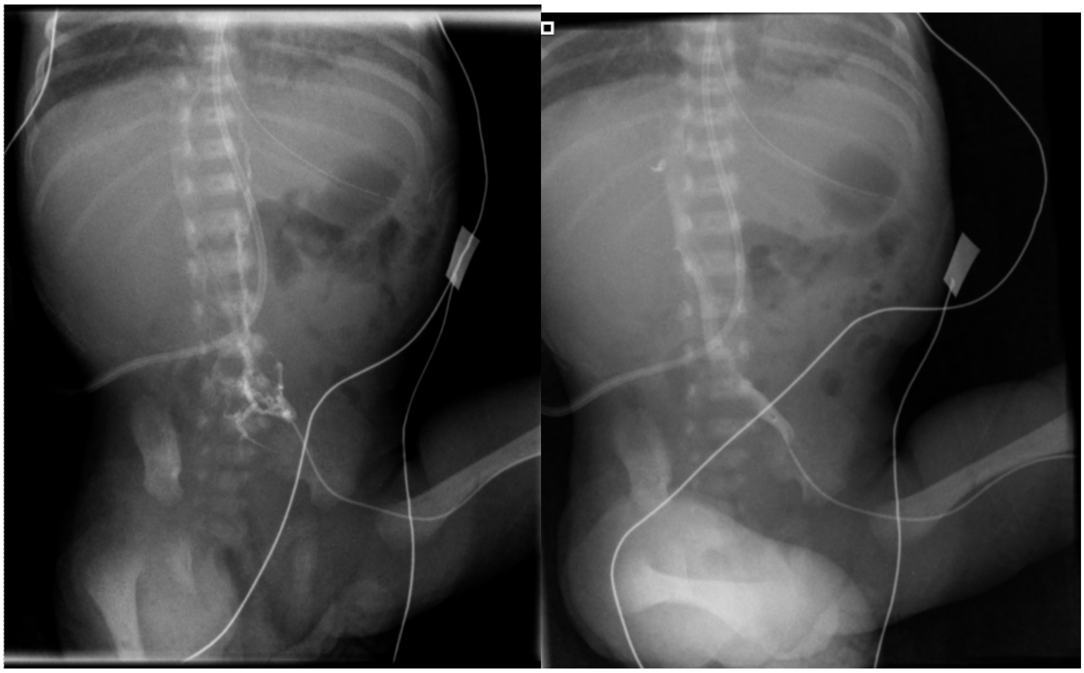


Image 19: Right lower limb PICC, with the contrast jet outlining the paraspinal veins. Note the wavy course medial to the vertebral pedicles, inside the bony spinal canal



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

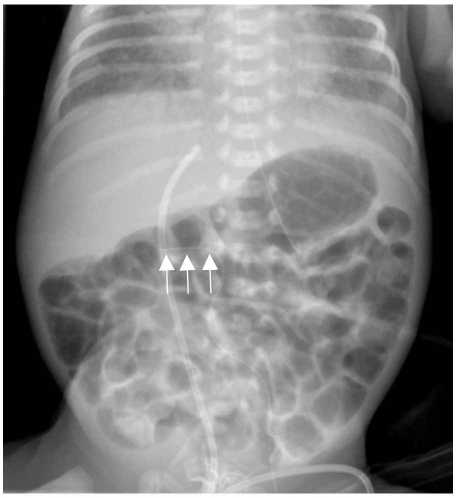


Image 24: Left lower limb PICC inserted. The tip is sharply deviating to the right, likely within the right renal vein. Low lying UVC

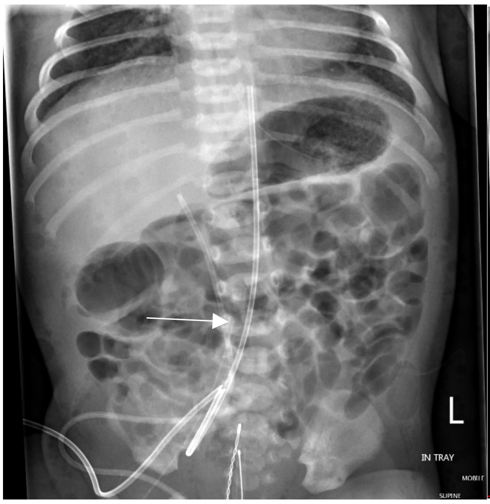


Image 25: Low UVC in situ. Right lower limb PICC inserted. Hip extended. Tip at L4 (see arrow)
Image 26: UVC removed. PICC position unchanged. Reimaged with contrast and hip flexed. Tip at T12 (see arrow)

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: Overview of CVAD types, insertion and fixation devices

MANUFACTURER	DEVICE NAME	TYPE	SIZE	GAUGE	LENGTH	FEATURES	INTENDED USE (AS STATED BY MANUFACTURER)
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	
VYGON UK	Expert Umbilical Catheter	UVC	2.5Fr/3.5Fr/4Fr/5Fr/8Fr		30cm/40cm	Single & double lumen, Integrated antimicrobial technology	
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	Lifecath XS-CT PICC™ Maestro	PICC	3Fr		30cm	Polyurethane	
MED-COMP®	Vascu-PICC® TLS	PICC	1.9 Fr, 2.6Fr		20cm, 50cm	Single and double lumen, Polyurethane	
MED-COMP®	Pro-PICC®	PICC	3Fr/4Fr/5Fr/6Fr		55cm/60cm	Single, dual and triple lumen, Polyurethane	
VYGON UK	Nutricath (s)	CICC		18	35cm/58cm	Tunnelled, Silicone, subcutaneous cuff	Long term (days not specified)
BARD ACCESS SYSTEMS	Groshong ™	CICC	4Fr			Silicone, 3-way valve, trimmable proximally, available as double lumen (not trimmable)	
BARD ACCESS SYSTEMS	PowerGroshong ™ PICC	CICC	5Fr			Silicone, 3-way valve, increased flow rate over single lumen PICC, non trimmable	
BD	Hickman™ Broviac™	CICC	2.7Fr/4.2Fr	24/22	71cm	Tunnelled, Silicone, cuffed	
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-Line®	CICC	3Fr, 4Fr, 5Fr		60cm	Single and double lumen, cuffed	

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
GALT™	Tearaway Introducer Kits & Sets	2Fr and 3Fr introducers available
FIXATION DEVICES		
COOK MEDICAL	FlexGRIP®	Catheter cushion and stabilisation device suitable for 5Fr
VYGON UK	Grip-Lok	Fixation device for PICC catheter fixation. Various sizes available
VYGON UK	Securacath®	Securement device for PICC and CICC. Available for 3Fr and upward

Table 1: Overview of CVAD types, insertion and fixation devices available in the UK

Appendix 3: Anatomy

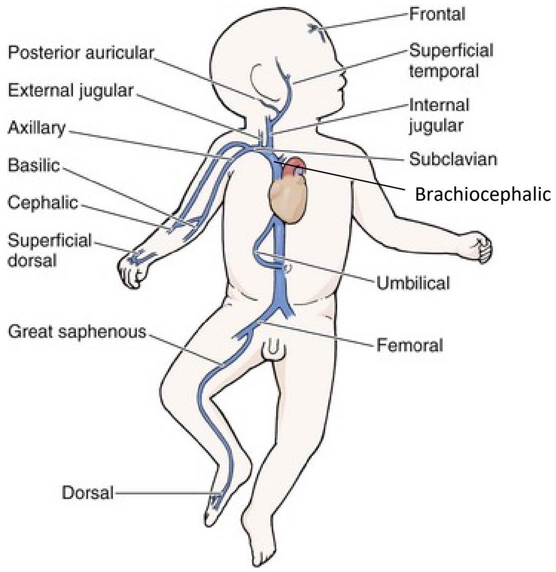


Figure 1: Venous system anatomy

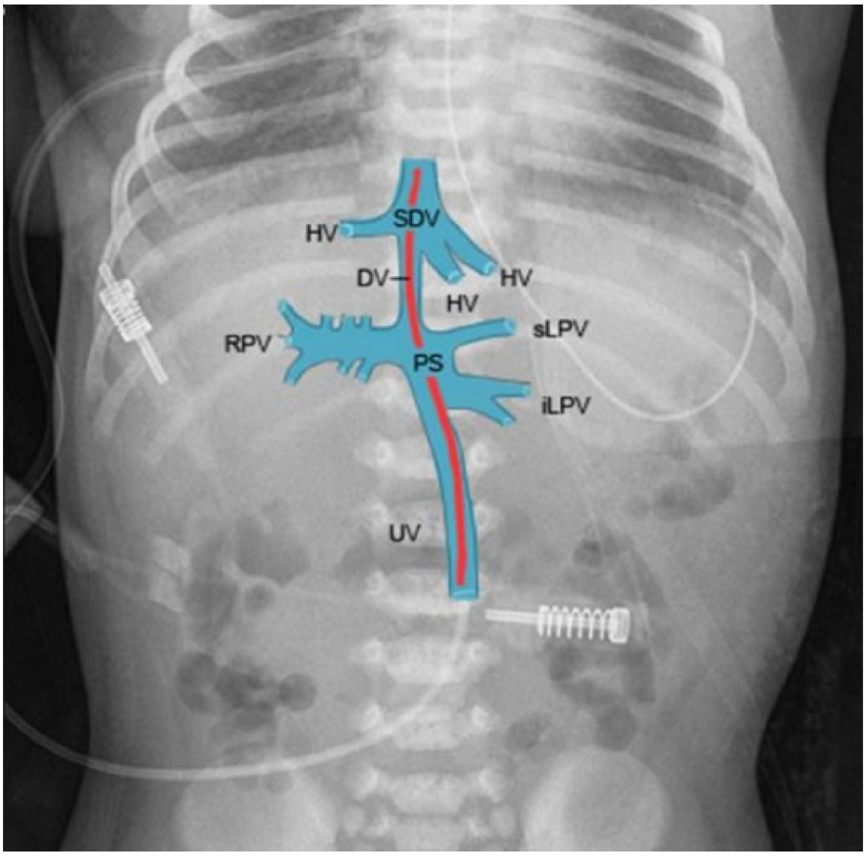


Figure 2: Umbilical vein, hepatic and portal venous anatomy. UV, umbilical vein, PS, portal sinus, iLPV inferior left portal vein, sLPV, superior left portal vein, RPV, right portal vein, DV, ductus venosus, HV, Hepatic Vein, SDV, subdiaphragmatic vestibulum

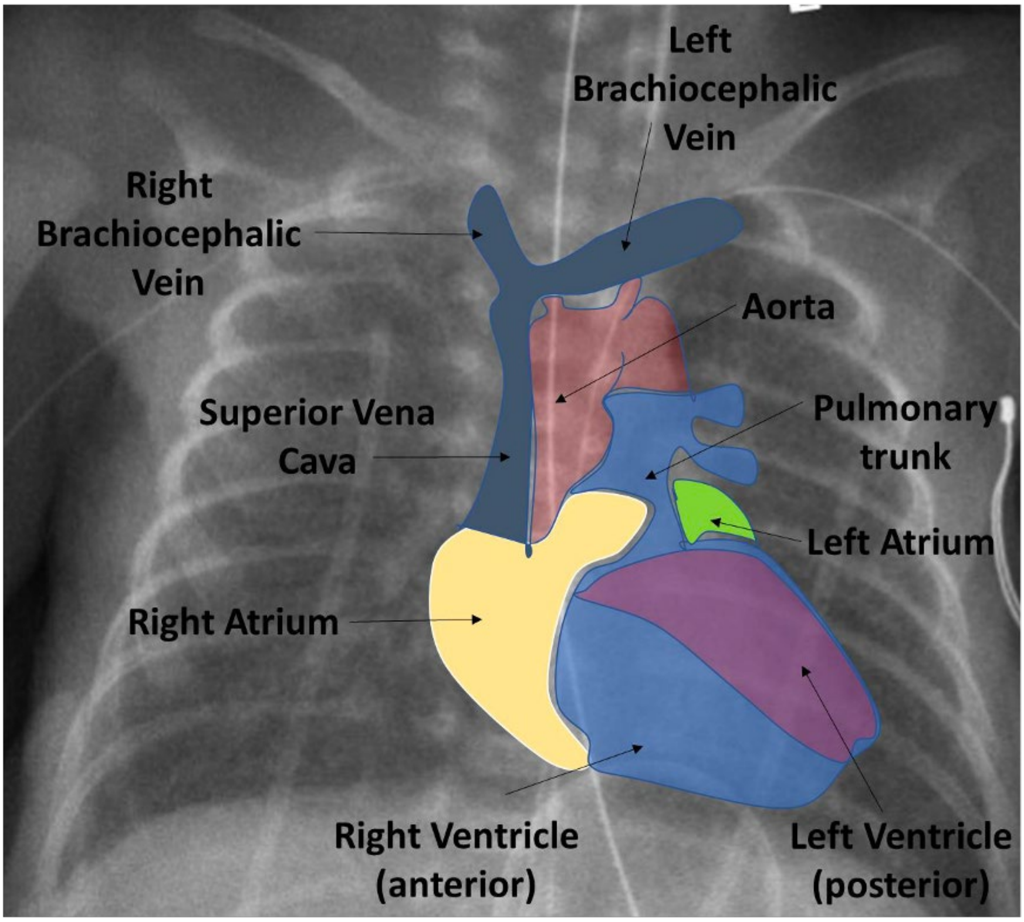


Figure 3: Schematic showing the position of the cardiac chambers and related structures on AP chest X-ray
Note in this X-ray a left upper limb PICC has been sited. This did not cross the midline before traveling downwards, indicating arterial malposition. Anatomical variants should also be considered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

Appendix 4: CVAD imaging positioning and preparation guidance

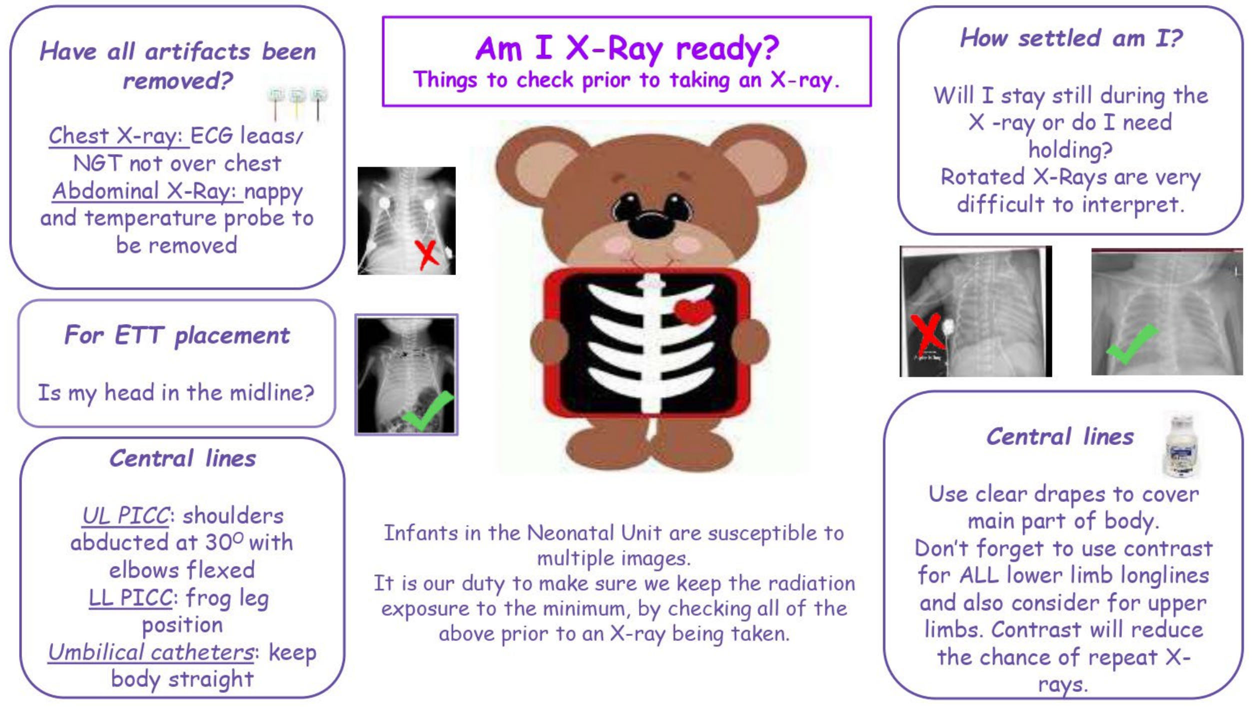


Figure 1: "Am I X-Ray Ready?" QIP poster
'A lifeline: enhancing neonatal central venous catheters safety'
Credit: https://doi.org/10.1136/archdischild-2024-326977

Figure 2: Suggested infant position at time of image acquisition for CVAD tip placement

References

Acun C, Baker A, Brown LS, et al. Peripherally inserted central cathether migration in neonates: Incidence, timing and risk factors. J Neonatal Perinatal Med. 2021;14(3):411-7. https://libkey.io/10.3233/NPM-200684

Akar S, Varan C. Evaluation of the distance between the xiphoid process and the umbilicus: Is it appropriate for the measurement of the umbilical venous catheter length? J Clin Neonatol. 2020;9(4):276-9 https://libkey.io/10.4103/jcn.JCN_85_20

Akar S, Dincer E, Topcuoglu S, et al. Determination of Accurate Position of Umbilical Venous Catheters in Premature Infants. Am J Perinatol. 2022;39(4):369-72. https://libkey.io/10.1055/s-0040-1716405

Balasundaram P, Lucena MH, Jiang L, et al. Unveiling Peripherally Inserted Central Catheter Fractures and Related Complications in the Neonatal Intensive Care Unit: A Concise Review. Cureus. 2023;15(10):e47572. https://libkey.io/10.7759/cureus.47572

Barone G, D'Andrea V, Vento G, et al. A Systematic Ultrasound Evaluation of the Diameter of Deep Veins in the Newborn: Results and Implications for Clinical Practice. Neonatology. 2019;115(4):335-40 https://libkey.io/10.1159/000496848

Baskin K M, Jimenez R M, Cahill A M, Jawad A F, Towbin R B. Cavoatrial junction and central venous anatomy: implications for central venous access tip position. J Vasc Interv Radiol 2008 Mar;19(3):359-65. DOI: 10.1016/j.jvir.2007.09.005

Berger TD, Gavri A, Jesin S, Strauss T, Weiss B. Hepatic extravasation of total parenteral nutrition following umbilical venous catheter insertion: A rare complication. JPNG Reports. Vol.5 Issue 1, pp 83-85, 2024 https://doi.org/10.1002/jpr3.12031

Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. Cochrane Database of Systematic Reviews 2015 DOI: 10.1002/14651858.CD006962.pub2

Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for subclavian or femoral vein catheterization. Cochrane Database of Systematic Reviews 2015 DOI: 10.1002/14651858.CD011447

Brusciano V, Lecce M. Advantages of the use of ultrasound in newborn vascular access: a systematic review. J Ultrasound. 2024 Jun;27(2):203-207. doi: 10.1007/s40477-023-00832-1

Catho G, Rosa Mangeret F, Sauvan V, et al. Risk of catheter-associated bloodstream infection by catheter type in a neonatal intensive care unit: a large cohort study of more than 1100 intravascular catheters. J Hosp Infect. 2023;139:6-10. https://libkey.io/10.1016/j.jhin.2023.06.011

Chan KM, Chau JPC, Choi KC, et al. Clinical practice guideline on the prevention and management of neonatal extravasation injury: a before-and-after study design. BMC Pediatr. 2020;20(1):445 https://libkey.io/10.1186/s12887-020-02346-9

Chen HJ, Chao H C, Chiang M C, Chu S M/ Hepatic extravasation complicated by umbilical venous catheterization in neonates: A 5-year, single-center experience. Pediatrics and Neonatology (2020)

61, 16-24. https://doi.org/10.1016/j.pedneo.2019.05.004

Connolly, B., Amaral, J., Walsh, S. et al. Influence of arm movement on central tip location of peripherally inserted central catheters (PICCs). Pediatr Radiol 36, 845–850 (2006) https://doi.org/10.1007/s00247-006-0172-8

D'Andrea V, Cascini V, Russo R, et al. The Role of Ultrasound in Epicutaneo-Caval Catheter Insertion in Neonates: Systematic Review, Meta-Analysis and Future Perspectives. Diagn. 2023;13(17) https://libkey.io/10.3390/diagnostics13172850

D'Andrea V, Prontera G, Pinna G et all. Securement of umbilical venous catheter using cyanoacrylate glue: A Randomised Controlled Trail. J Pediatr 2023;260:113517 https://doi.org/10.1016/j.jpeds.2023.113517

D'Andrea V; Prontera G; Cota F at al. Real-time Ultrasound tip location reduces malposition and radiation exposure during umbilical venous catheter placement in neonates: A retrospective, Observational Study. Neonatology. 122(1):32-37, 2025 (Abstract) https://doi.org/10.1159/000538905

D'Andrea V, Pittiruti M, Prontera G, et al. The SIECC protocol: A novel insertion bundle to minimize the complications related to epicutaneo-cava catheters in neonates. Journal of Vascular Access. 2024 https://libkey.io/10.1177/11297298241239699

Department of Health. Technical report. Review of the Deaths of Four Babies due to cardiac Tamponade associated with the presence of a central Venous catheter. June 2001

Dubbink-Verheij GH, Visser R, Tan RNGB, et al. Inadvertent Migration of Umbilical Venous Catheters Often Leads to Malposition. Neonatology. 2019;115(3):205-10 https://libkey.io/10.1159/000494369

Dubbink-Verheij GH, Pelsma ICM, van Ommen CH, et al. Femoral Vein Catheter is an Important Risk Factor for Catheter-related Thrombosis in (Near-)term Neonates. J Pediatr Hematol Oncol. 2018;40(2):e64-8. https://libkey.io/10.1097/MPH.0000000000000978

Eifinger F, Fuchs Z, Koerber F, et al. Investigation of umbilical venous vessels anatomy and diameters as a guideline for catheter placement in newborns. Clin Anat. 2018;31(2):269-74 https://libkey.io/10.1002/ca.22998

Franta J, Harabor A, Soraisham AS. Ultrasound assessment of umbilical venous catheter migration in preterm infants: A prospective study. Arch Dis Child Fetal Neonatal Ed 2017;102:F251–F255 https://libkey.io/10.1136/archdischild-2016-311202

Gibson K, Smith A, Sharp R, et al. Adverse events associated with umbilical vascular catheters in the neonatal intensive care unit: A retrospective cohort study. Australian Critical Care. 2024 https://libkey.io/10.1016/j.aucc.2024.01.013

Grasso F, Capasso A, Pacella D, et al. Ultrasound Guided Catheter Tip Location in Neonates: A Prospective Cohort Study. J Pediatr. 2022;244:86,91.e2. https://libkey.io/10.1016/j.jpeds.2021.12.059

Gronska A, Tolentino D, Duffy D, Shetty S, Richards J, Kulkarni A M. Movement of peripherally inserted central catheters in relation to limb movement in neonates: a prospective observational study. Arch Dis Child Fetal Neonatal Ed 2025;0:F1. https://doi.org/10.1136/archdischild-2025-328992

Guimaraes AFM, Souza AACGd, Bouzada MCF, et al. Accuracy of chest radiography for positioning of the umbilical venous catheter. J Pediatr (Rio J). 2017;93(2):172-8. https://libkey.io/10.1016/j.jped.2016.05.004

Gupta R, Drendel AL, Hoffmann RG, et al. Migration of Central Venous Catheters in Neonates: A Radiographic Assessment. Am J Perinatol. 2016;33(6):600-4 https://libkey.io/10.1055/s-0035-1570341

Hargitai B, Toldi G, Marton T, et al. Pathophysiological Mechanism of Extravasation via Umbilical Venous Catheters. Pediatr Dev Pathol. 2019;22(4):340-3 https://doi.org/10.1177/1093526619826714

Hollingsworth C, Clarke P, Sharma A, Upton M. National Survey of umbilical venous catheterisation practices in the wake of two deaths. Arch Dis Child Fetal Neonatal Ed 2015: 100:F371-F372 https://doi.org/10.1136/archdischild-2015-308327

Huang H, Su L, Liu Y, et al. The role of ultrasonography for detecting tip location of percutaneous central venous catheters in neonates-a single-center, prospective cohort study. Pediatr neonatol. 2021;62(3):265-70. https://libkey.io/10.1016/j.pedneo.2021.01.006

Hugill K, van Rens MFPT, Alderman A, Kaczmarek L, Lund C, Paradis A. Safe and effective removal of cyanoacrylate vascular access catheter securement adhesive in neonates. Front Pediatr. 2023 Aug 25;11:1237648. https://pmc.ncbi.nlm.nih.gov/articles/PMC10492643/

Ionising Radiation (Medical Exposre) Regulations 2017: guidance. Ionising Radiation (Medical Exposure) Regulations 2017: guidance - GOV.UK

Jacob R. Hirschl, Samir K. Gadepalli, Brian A. Derstine, Sven A. Holcombe, Ethan A. Smith, Stewart C. Wang, Peter F. Ehrlich, Marcus D. Jarboe. CT validation of SVCRA junction location for pediatric central. Pediatric Surgery International (2020) 36:1055–1060. https://doi.org/10.1007/s00383-020-04712-1

Jahagirdar D, Featherstone R. Trimmed Peripherally Inserted Central Catheters for Hospitalized Neonatal Patients: A Review of Safety and Guidelines. Canadian Agency for Drugs and Technologies in Health. 2019. https://www.ncbi.nlm.nih.gov/books/NBK550559/

Jain A, McNamara PJ, Ng E, et al. The use of targeted neonatal echocardiography to confirm placement of peripherally inserted central catheters in neonates. Am J Perinatol. 2012;29(2):101-6. https://libkey.io/10.1055/s-0031-1295649

Johnson KN, Thomas T, Grove J, et al. Insertion of peripherally inserted central catheters in neonates less than 1.5 kg using ultrasound guidance. Pediatr Surg Int. 2016;32(11):1053-7 https://libkey.io/10.1007/s00383-016-3959-1

Kieran EA, Laffan EE, O'Donnell CPF. Estimating umbilical catheter insertion depth in newborns using weight or body measurement: A randomised trial. Arch Dis Child Fetal Neonatal Ed 2016 Jan;101(1):F10-5 https://libkey.io/10.1136/archdischild-2014-307668

Kishigami M, Shimokaze T, Enomoto M, et al. Ultrasound-Guided Umbilical Venous Catheter Insertion With Alignment of the Umbilical Vein and Ductus Venosus. J Ultrasound Med.

2020;39(2):379-83. https://libkey.io/10.1002/jum.15106

Kisa P, Ting J, Callejas A, et al. Major thrombotic complications with lower limb PICCs in surgical neonates. J Pediatr Surg. 2015;50(5):786-9 https://libkey.io/10.1016/j.jpedsurg.2015.02.043

Kumar S, Jain S. Minimally Invasive Technique of Direct Central Venous Access in Micro Preemies-a Case Series. SN Compr Clin Med. 2020;2(1):111-4 https://libkey.io/10.1007/s42399-019-00191-1

Levit OL, Shabanova V, Bizzarro MJ. Umbilical catheter-associated complications in a level IV neonatal intensive care unit. J Perinatol. 2020;40(4):573-80. https://libkey.io/10.1055/s-0040-1715117

Levit O, Shabanova V, Bizzarro M. Impact of a dedicated nursing team on central line-related complications in neonatal intensive care unit. J Matern Fetal Neonatal Med. 2020;33(15):2618-22. https://libkey.io/10.1080/14767058.2018.1555814

Liu X, Tao X, Xu Y, Zhang X, Chen Y and Wu L (2022) Comparison of bedside ultrasonography and bedside chest radiography in neonatal peripherally inserted central catheters: A before and after self-control study. Front. Pediatr. 10:976826. doi: 10.3389/fped.2022.976826

López-Briz E, Ruiz Garcia V, Cabello JB, Bort-Martí S, Carbonell Sanchis R. Heparin versus 0.9% sodium chloride locking for prevention of occlusion in central venous catheters in adults. Cochrane Database of Systematic Reviews 2022, Issue 7. Art. No.: CD008462.
DOI: 10.1002/14651858.CD008462.pub4.

McNamara PJ, Jain A, El-Khuffash A, et al. Guidelines and Recommendations for Targeted Neonatal Echocardiography and Cardiac Point-of-Care Ultrasound in the Neonatal Intensive Care Unit: An Update from the American Society of Echocardiography. J Am Soc Echocardiogr. 2024;37(2):171-215.
https://libkey.io/10.1016/j.echo.2023.11.016

Mishra P, Mohanty P K, Som T K, Sahoo T, Devi U, Bag N D. Comparison of Ultrasound-Guided Umbilical Venous Catheter Insertion with Blind Method: A Randomised Controlled Trial. Biomed Hub 2024;9:1-8. https://doi.org/10.1159/000535096

Mutlu M, Aslan Y, Kul S, et al. Umbilical venous catheter complications in newborns: a 6-year single-center experience. J Matern Fetal Neonatal Med. 2016;29(17):2817-22
https://libkey.io/10.3109/14767058.2015.1105952

Nadroo A M, Glass R B, Lin J, Green R S Holzman I R. Changes in upper extremity position cause migration of peripherally inserted central catheters in neonates. Pediatrics 2002 Jul;110(1 Pt 1) 131-6 https://doi.org/10.1542/peds.110.1.131

National Child Mortality Database (NCMD) . Critical central venous line complications in neonates-February 2025

National Institute for Health and Care Excellence. Guidance on the use of ultrasound locating devices for placing central venous catheters. Technology appraisal guidance. TA 49. NICE Oct 2002.
https://www.nice.org.uk/guidance/ta49

National Neonatal Audit Programme. England & Wales NNAP Line Data 2016-2023. Unpublished data. Personal communication 15th May 2024

Neonatal and Paediatric Pharmacists Group. Use of chlorhexidine for skin cleansing in neonates. Nov

2024. www.nppg.org.uk/chlorhesidine-for-neonates/

NHS England Patient Safety Team NRLS analysis summary. Neonatal cardiac tamponade associated with long line insertion. Aug 2023

NHS England Patient Safety Team. NRLS analysis summary. Complications associated with neonatal central catheters. March 2025

Oulego-Erroz I, Alonso-Quintela P, Terroba-Seara S, et al. Ultrasound-Guided Cannulation of the Brachiocephalic Vein in Neonates and Preterm Infants: A Prospective Observational Study. Am J Perinatol. 2018;35(5):503-8 https://libkey.io/10.1055/s-0037-1608803

Oulego-Erroz I, Alonso-Ojembarrena A, Aldecoa-Bilbao V, et al. Ultrasound-guided vascular access in the neonatal intensive care unit: a nationwide survey. Eur J Pediatr. 2022;181(6):2441-51. https://libkey.io/10.1007/s00431-022-04400-3

Pappa O, Lynn M, Davey N, Mullins N. A lifeline:enhancing neonatal central venous catheter safety. Arch Dis Child Educ Pract Ed. 2025;110:192-196. https://doi.org/10.1136/archdischild-2024-326977

Patel S, Shannon D, Eldridge W, et al. Understanding umbilical venous catheter insertion practices through a prospective multicenter observational study. J Matern Fetal Neonatal Med. 2022;35(25):5043-8 https://libkey.io/10.1080/14767058.2021.1874908

Perme T. Central Lines and Their Complications in Neonates: A Case Report and Literature Review. Children 2024; 11 (1) 26. https://libkey.io/10.3390/children11010026

Piersigilli F, Iacona G, Yazami S, et al. Cyanoacrylate glue as part of a new bundle to decrease neonatal PICC-related complications. Eur J Pediatr. 2023;182(12):5607-13 https://libkey.io/10.1007/s00431-023-05253-0

Pittiruti M, Celentano D, Barone G, et al. A GAVeCeLT bundle for central venous catheterization in neonates and children: A prospective clinical study on 729 cases. J vasc access. 2023;24(6):1477-88**.** https://libkey.io/10.1177/11297298221074472

Pittiruti M, Annetta MG, D'andrea V. Point-of-care ultrasound for vascular access in neonates and children. Eur J Pediatr. 2024;183(3):1073-8**.** https://libkey.io/10.1007/s00431-023-05378-2

Plooij-Lusthusz AM, van Vreeswijk N, van Stuijvenberg M, et al. Migration of Umbilical Venous Catheters. Am J Perinatol. 2019;36(13):1377-81. https://libkey.io/10.1055/s-0038-1677016

Ponin, L., Ruangkit, C., Ruangwattanapaisarn, N. et al. Real-time ultrasound to assess the umbilical catheter position in neonates: a randomized, controlled trial. J Perinatol 45, 235–241 (2025). https://doi.org/10.1038/s41372-024-02128-6

Ren XL, Wang M, Wei YR, et al. Ultrasound to guided epicutaneo-caval catheter insertion in newborn infants. Front Pediatr. Vol 10 2022 https://doi.org/10.3389/fped.2022.1022796

Rossi S, Jogeesvaran KH, Matu E, et al. Point-of-care ultrasound for neonatal central catheter positioning: impact on X-rays and line tip position accuracy. Eur J Pediatr. 2022;181(5):2097-108. https://libkey.io/10.1007/s00431-022-04412-z

Russo A, Patane V, Faggioni L, et al. Conventional Radiology Evaluation of Neonatal Intravascular Devices (NIVDs): A Case Series. Diagnostics. 2024;14(2) https://libkey.io/10.3390/diagnostics14020157

Saha A, Fernandez R. Audit on Optimal Positioning of Peripherally Inserted Central Catheters in Neonates Arch Dis Child. Vol 98 Issue Suppl 1 https://doi.org/10.1136/archdischild-2013-304107.067

Seigel A, Evans N, Lutz T. Use of clinician-performed ultrasound in the assessment of safe umbilical venous catheter tip placement. J Paediatr Child Health. 2020;56(3):439-43. https://libkey.io/10.1111/jpc.14658

Shabeer MP, Abiramalatha T, Gibikote S, et al. Bedside sonography performed by neonatology residents to confirm central vascular catheter position in neonates - A Prospective Diagnostic Evaluation study. J Neonatal Perinatal Med. 2021;14(1):101-7 https://libkey.io/10.3233/NPM-200409

Shahroor M, Maarouf AM, Yang J, et al. Complications Associated with Low Position versus Good Position Umbilical Venous Catheters in Neonates of <=32 Weeks' Gestation. Am J Perinatol. 2022;39(3):259-64. https://libkey.io/10.1055/s-0040-1715117

Shalygin, N, Kim, J. 59 Determination of range of movement of peripherally inserted central catheters in lower extremities of neonates by ultrasound. J Investig Med. 2018;66(1):A86-A87. https://dx.doi.org/10.1136/jim-2017-000663.59

Singh Y et al International evidence-based guidelines on Point of Care Ultrasound (POCUS) for critically ill neonates and children issued by the POCUS Working Group of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC). Critical Care (2020) 24:65 https://doi.org/10.1186/s13054-020-2787-9

Soares BN, Pissarra S, Rouxinol-Dias AL, et al. Complications of central lines in neonates admitted to a level III Neonatal Intensive Care Unit. J Matern Fetal Neonatal Med. 2018;31(20):2770-6. https://libkey.io/10.1080/14767058.2017.1355902

Sobczak A, Dudzik A, Kruczek P, et al. Ultrasound Monitoring of Umbilical Catheters in the Neonatal Intensive Care Unit-A Prospective Observational Study. Front Pediatr. 2021 https://libkey.io/10.3389/fped.2021.665214

Soonsawad S, Kieran EA, Ting JY, et al. Factors Associated with Umbilical Venous Catheter Malposition in Newborns: A Tertiary Center Experience. Am J Perinatol. 2022;39(16):1805-11 https://libkey.io/10.1055/s-0041-1726385

Sulemanji M, Vakili K, Zurakowski D, et al. Umbilical Venous Catheter Malposition Is Associated with Necrotizing Enterocolitis in Premature Infants. Neonatology. 2017;111(4):337-43 https://libkey.io/10.1159/000451022

Stekhova Y, Kodur V, Lowe G, et al. Role of a radiopaque agent and surveillance radiographs for peripherally inserted central catheters in newborn infants. Pediatr Radiol. 2023;53(11):2235-44. https://libkey.io/10.1007/s00247-023-05705-7

Thakur A, Kumar V, Modi M, et al. Use of Point of Care Ultrasound for Confirming Central Line Tip Position in Neonates. Indian Pediatr. 2020;57(9):805-7

Torres Del Pino M, Gomez Santos E, Dominguez Quintero ML, et al. Steps to improve umbilical vein catheterization in neonatal care. An Pediatr (Engl Ed). 2023;99(3):155-61 https://libkey.io/10.1016/j.anpede.2023.08.006

Van Rens M (Roland), van der Lee R, Spencer TR, et al. The NAVIGATE project: A GloVANet–WoCoVA position statement on the nomenclature for vascular access devices. The Journal of Vascular Access. 2024;0(0). doi:10.1177/11297298241291248

Weil BR, Ladd AP, Yoder K. Pericardial effusion and cardiac tamponade associated with central venous catheters in children: an uncommon but serious and treatable condition. J Pediatr Surg. 2010;45(8):1687-92. https://libkey.io/10.1016/j.jpedsurg.2009.11.006

Wen J, Yu Q, Chen H, et al. Peripherally inserted central venous catheter-associated complications exert negative effects on body weight gain in neonatal intensive care units. Asia Pac J Clin Nutr. 2017;26(1):1-5 https://libkey.io/10.6133/apjcn.112015.07

World Health Organization. Guidelines for the prevention of bloodstream infections and other infections associated with the use of intravascular catheters. Part I: peripheral catheters. Geneva: World Health Organization; 2024. https://www.who.int/publications/b/74189

Wu Y, Yan J, Tang M, et al. A review of neonatal peripherally inserted central venous catheters in extremely or very low birthweight infants based on a 3-year clinical practice: Complication incidences and risk factors. Front pediatr. 2022;10:987512 https://libkey.io/10.3389/fped.2022.987512

Yazdani N, Badfar G, Pourarian S. Evaluation of Umbilical Vein Catheter Position in Neonates by Thoraco-Abdominal Radiography Versus Echocardiography.Inn J Pediatr.2020;30(4):e101658. https://doi.org/10.5812/ijp.101658.

Yeoh M, Erickson J, Desai S, et al. Are multiple projections necessary when assessing umbilical venous catheter placement in neonates? A retrospective study. J Med Imaging Radiat Oncol. 2024;68(3):243-9. https://libkey.io/10.1111/1754-9485.13632

Yousef N, Singh Y, De Luca D. “Playing it SAFE in the NICU” SAFE-R: a targeted diagnostic ultrasound protocol for the suddenly decompensating infant in the NICU. Eur J Pediatr 2022 Jan;181(1):393-398. DOI: 10.1007/s00431-021-04186-w

Yeung C. Complications of umbilical venous catheters in neonates: A safety reappraisal. Pediatr neonatol. 2020;61(1):1-2 https://libkey.io/10.1016/j.pedneo.2020.01.001

Xie HQ, Xie CX, Liao JF, et al. Point-of-care ultrasound for monitoring catheter tip location during umbilical vein catheterization in neonates: a prospective study. Front Pediatr. 2023 https://libkey.io/10.3389/fped.2023.1225087

Zhang S, Zhu Y, Du Y, et al. The positioning of the catheter tip with an intracavitary electrocardiogram in epicutaneo-caval catheter placement via lower limbs in newborns: A retrospective study. J vasc access. 2024;25(1):119-24 https://libkey.io/10.1177/11297298221100174

Zhang Y, Li S, Li Y, et al. Analysis and risk factors of deep vein catheterization-related bloodstream infections in neonates. Medicine (Baltimore). 2024;103(12):e37184. https://libkey.io/10.1097/MD.0000000000037184

Zini T, Corso L, Mazzi C, et al. Ultrasound-Guided Centrally Inserted Central Catheter (CICC) Placement in Newborns: A Safe Clinical Training Program in a Neonatal Intensive Care Unit. Children. 2024;11(4) https://libkey.io/10.3390/children11040395

BAPM

Leading Excellence in Perinatal Care

This document was produced by the British Association of Perinatal Medicine (BAPM).

BAPM is a membership organisation that is here to support all those involved in perinatal care to optimise their skills and knowledge, deliver and share high-quality safe and innovative practice, undertake research, and speak out for babies and their families.

We are a professional association of neonatologists, paediatricians, obstetricians, nurses, midwives, trainees, network managers and other health professionals dedicated to shaping the delivery and improving the standard of perinatal care in the UK.

Our vision is for every baby and their family to receive the highest standard of perinatal care. Join us today.

www.bapm.org/join

British Association of Perinatal Medicine (BAPM)
is registered in England & Wales
under charity number 1199712 at
5-11 Theobalds Road, London, WC1X 8SH