Bedside procedure in children at the Catholic University Hospital in Rome

Mauro Pittiruti
Vascular access in pediatrics: a world rapidly changing

The world of pediatric central venous access is rapidly changing, as new methodologies of vein visualization and tip location have dramatically reduced the risks of complications as well as the costs associated with such procedures.
(1) the use of ultrasound guidance is mandatory for all central lines (PICC – CICC – FICC) in all pediatric patients, including neonates – with the only exception of umbilical catheters (UVC) and of small-bore epicutaneo-caval catheters (ECC).
(2) while access to deep veins (CICC, PICC, FICC) demands ultrasound, insertion of short peripheral cannulas or ECC in superficial veins can be performed considering the use of NIR technology
(3) the first option as a method for tip location should be the intracavitary ECG technique, which is applicable and feasible in neonates, infants and children in 99% of cases
(4) the routine use of fluoroscopy and post-procedural chest x-ray as radiological methods for tip location should be discouraged
(5) there is a growing evidence that ultrasound may be an accurate, inexpensive and non-invasive methodology for tip navigation (ultrasound scan of central veins during catheter progression), for tip location (echocardiographic visualization of the catheter tip) and for ruling out pleural complications after central vein puncture (ultrasound scan of pleural space).
A ‘global’ use of ultrasound

- US-based choice of the most appropriate vein
- US-guided venipuncture
- US-based r/o of puncture-related complications
- US-guided tip navigation
- Echocardiography for tip location
- US-based r/o of late non-infective complications
US-guided central venous access

Saphenous, femoral – INFERIOR VENA CAVA CATH. (FICC)

Axillary vein at the arm, basilica, brachial - PICC

Axillary vein at the chest – INFRACLAVICULAR CVC (CICC)

Brachio-cephalic, internal jugular, external jugular, subclavian – SUPRACLAVICULAR CVC (CICC)
Femoral vein = FICC
Femoral Lines

• May be difficult or not recommended in neonates and small infants
  – Vein too small (risk of thrombosis)
  – Difficult cannulation (sharp angle between femoral and iliac vein)
• Risk of infection due to extraluminal contamination should be reduced by appropriate strategies
  – Transparent dressing + glue
  – Tunneling
• Never a first option for medium-long term access
  – Only if CICC and PICC are contraindicated
Femoral line, tunneled
Axillary vein at the arm, basilica, brachial = PICC
Conventional use of US guided PICC lines in children:

- central lines via arm veins (brachial, basilic, axillary, cephalic)
- small caliber veins (3 mm or >)
- small caliber PICCs (3 Fr or >)
- no age limit: only limit is vein diameter
  - unlikely in neonates and in small infants
Double lumen power injectable PICC in 4 yr old
Though:

Conventional use of PICCs (US-guided venipuncture at midarm) is applicable to children and some infants, but not to neonates.

Limit (regardless of age/weight):

availability of a deep vein at arm (brachial, basilica or axillary) with diameter > 3 mm
Brachio-cephalic, internal jugular, external jugular, subclavian – SUPRACLAVICULAR CVC

Axillary vein at the chest – INFRACLAVICULAR CVC

CICC = centrally inserted central catheters
‘key points’ for an uneventful insertion of a CICC...

- Ultrasound study of deep veins (RaCeVA)
- US-guided venipuncture and cannulation
- IC-EKG and echocardo for verification of tip position
- Intra-procedural US control for r/o PNX
- Tunneling
- Securement and protection of the exit site
  - glue + sutureless device + transparent dressing
‘key points’ for an uneventful insertion of a CICC…

Ultrasound study of deep veins (RaCeVA)
US-guided venipuncture and cannulation
IC-EKG and echocardio for verification of tip position
Intra-procedural US control for r/o PNX
Tunneling
Securement and protection of the exit site
- glue + sutureless device + transparent dressing
The vein to puncture is chosen after careful ultrasound evaluation of central veins.

**RaCeVa** = Rapid Central Vein Assessment

**Linear probe**
10-14 Mhz
‘hockey stick’
Measure the veins!
In neonates and small infants

- **Infraclavicular** approaches (axillary vein) are unlikely
- Among the **supraclavicular** veins, the **brachiocephalic vein** is usually the easiest and safest approach
In children

• **Infraclavicular** approaches (axillary vein) are possible

• Among the **supraclavicular** veins, the **brachiocephalic vein** is usually the easiest and safest approach, but also the **internal jugular** and the **subclavian** can be punctured
Axillary vein at the chest

- Atypical (CICC or PICC ?)
- Rare (ma possible) in neonates
- Most likely to be feasible in infants and children
‘key points’ for an uneventful insertion of a CICC…

Ultrasound study of deep veins (RaCeVA)
**US-guided venipuncture and cannulation**
IC-EKG and echocardoio for verification of tip position
Intra-procedural US control for r/o PNX
Tunneling
Securement and protection of the exit site
- glue + sutureless device + transparent dressing
• Different PICCs can be used (silicon, polyurethane, power injectable polyurethane), single and double lumen
• The calibre - 3Fr or 4Fr or 5Fr - is chosen considering the diameter of the vein (vein mm = or > cath Fr)
Key point

Check the diameter of the vein!
Kits for micro-introduction:
- 21 G echogenic needles
- soft straight tip 0.018” guide-wire
- 3,5 or 4,5 Fr micro-introducer-dilator
• All catheters are inserted by real time ultrasound guidance, preferably by the ‘in-plane’ approach.
Easy puncture...
Not so easy!
(800 gr)
US guided puncture of the brachio-cephalic vein

In neonates/infants > 420 g (our experience)
In neonates/infants > 590 g (C. Breschan, Klagenfurt)
In neonates/infants > 450 g (J. Bennett, Birmingham)
Tip navigation

- Ultrasound is constantly used to assess the direction of the guidewire, soon after its insertion in the needle.
‘key points’ for an uneventful insertion of a CICC…

Ultrasound study of deep veins (RaCeVA)
US-guided venipuncture and cannulation
**IC-EKG and echocardio for verification of tip position**
Intra-procedural US control for r/o PNX
Tunneling
Securement and protection of the exit site
  - glue + sutureless device + transparent dressing
• The correct position of the tip must be verified during the procedure via the intracavitary ECG method
• In the pediatric patient, the correct position of the tip can also be verified by echocardiography (TTE)
Echocardiography (TTE)

- It is particularly easy in neonates and infants
- It is safe and inexpensive but requires some training
- It should be implemented also with UVC and ECC
Echocardiography (TTE)

- Two options are available:
  - Subcostal ‘bicaval’ view:
    - direct visualization of the tip in the SVC
  - Apical view:
    - Indirect visualization of the tip in the SVC (injection of saline: appearance in the RA in one second)
    - The tip is visualized in the RA and withdrawn
We do not need routine x-ray

**Tip position** can be verified during the procedure with IC-EKG and/or echocardiography.

These methods are easier, safer, faster and more accurate than fluoroscopy or chest x-ray.
‘key points’ for an uneventful insertion of a CICC…

- Ultrasound study of deep veins (RaCeVA)
- US-guided venipuncture and cannulation
- IC-EKG and echocardoio for verification of tip position
- **Intra-procedural US control for r/o PNX**
- Tunneling
- Securement and protection of the exit site
  - glue + sutureless device + transparent dressing
After the puncture, the possible presence of pneumothorax or other pleura-pulmonary damage is excluded by ultrasound scan of the intercostal spaces.
Table 2: Summary of sensitivity and specificity for included studies

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Ultrasound of the pediatric chest

Andrew Mong · Monica Epelman · Kassa Darge

Pediatric chest ultrasound versus conventional radiology: experimental evidence first

Francesco Raimondi · Luigi Cattarossi · Roberto Copetti
Sliding Sign = No PNX

B - mode

M - mode: seashore sign
No Sliding Sign: PNX!

B - Mode

M - mode: barecode sign
Linee B
Lung Point
‘key points’ for an uneventful insertion of a CICC...

Ultrasound study of deep veins (RaCeVA)
US-guided venipuncture and cannulation
IC-EKG and echocardo for verification of tip position
Intra-procedural US control for r/o PNX

**Tunneling**
Securement and protection of the exit site
  - glue + sutureless device + transparent dressing
• In most cases, the catheter is tunneled to the infra-clavicular area, so to achieve a more favourable exit site.
Comments

Tunnelling of central lines is a simple technique that allows us to achieve simultaneously:

- **an optimal site for venepuncture** (which minimizes the risk of puncture-related complications)
- **and an optimal exit site** (which reduces the risk of late complications).
‘key points’ for an uneventful insertion of a CICC...

Ultrasound study of deep veins (RaCeVA)
US-guided venipuncture and cannulation
IC-EKG and echocadio for verification of tip position
Intra-procedural US control for r/o PNX
Tunneling

Securement and protection of the exit site
- glue + sutureless device + transparent dressing
• All catheters are secured by sutureless devices; the puncture site and the exit site are sealed with cyano-acrylate glue and covered with transparent dressing
Glue + sutureless device + transparent dressing
The best securement
Our Insertion Bundle for CICC-PICC-FICC in pediatric patients

(1) ultrasound choice of the vein (RaCeVA - RaPeVA);
(2) hand washing + maximal barrier precautions + skin antisepsis with 2% chlorhexidine;
(3) Use of ultrasound for venipuncture, for tip navigation and for ruling out PNX and other puncture-related complications;
(4) Tip navigation by US + tip location by intracavitary ECG and/or echocardio;
(5) tunnelling of the catheter so to obtain an exit site in the most favourable area;
(6) sealing of the exit site with glue;
(7) securement with sutureless device + transparent semipermeable dressing.
What do we need?

• Catheter kits and insertion packs
• Ultrasound devices
• ECG monitor
• Sedation/anesthesia equipment
Something we DO NOT need...

- Operating room
- Fluoroscopy
- Post-procedural chest x-ray
- Sedation/anesthesia equipment
Maximal cost-effectiveness

To perform ALL procedures in a dedicated procedural room of the Pediatric Intensive Care Unit
- For children in PICU
- But also for children in other pediatric wards
Our procedural room

• Located in the PICU
• Close to the Pediatric Emergency Room
Oxygen/Sevo outlet
Anesthesia equipment
ECG monitor
Portable ultrasound device with 3 probes

- Linear (hockey stick)
- Micro-convex
- Sectorial
Gloves

Chlorhexidine

Subcutaneous anchored securement

Insertion packs
Sedation/anesthesia

- Drugs
- Devices
Catheter kits
- 3Fr single lumen
- 4Fr single lumen
- 4Fr double lumen
- 5Fr double lumen
- 5Fr triple lumen

Tunnelers
Pediatric insertions in PICU

• All US-guided peripheral VADs and central VADs in pediatric patients are performed in this dedicated ‘procedure room’
  – US guided long peripheral cannulas and midlines
  – US guided PICCs, CICCs and FICCs (most of them: tunneled, non cuffed)

• Insertion is performed by VAT members specifically trained in pediatric VADs (two nurses, one physicians)
Request from pediatric ward

Child is taken to PICU

Evaluation by VAT member (physician or nurse)

Collaboration with the intensivists of the PICU for sedation/anesthesia

Performance of the task

Child gets back to ward
Insertion of a tunneled central venous catheter in PICU
(3Fr power injectable polyurethane)
Who needs the operating room...?! 

• The operating room does not increase the safety of the maneuver
  – The minimization of mechanical complications is based on the wise use of micro-introducer kits, ultrasound and ECG
  – The minimization of infective complications is based on hand hygiene, 2% CHG for skin antisepsis and maximal barrier precautions

• The operating room is expensive
  – € 500/hr (OR) vs. € 100/hr (procedure room)

• The operating room is not always readily available
Who needs the operating room…?! 

- Pediatric central venous access in OR:
  - higher incidence of general anesthesia with tracheal intubation vs. sedation/anesthesia with spontaneous breathing
  - no advantages in terms of early and late complications
  - longer waiting list
  - increased costs
Clinical results
Our Insertion Bundle for CICC-PICC-FICC in pediatric patients

(1) ultrasound choice of the vein (RaCeVA - RaPeVA);
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(4) Tip navigation by US + tip location by intracavitary ECG and/or echocardio;
(5) tunnelling of the catheter so to obtain an exit site in the most favourable area;
(6) sealing of the exit site with glue;
(7) securement with sutureless device + transparent semipermeable dressing.
Infusion Therapy Standards of Practice

Funded by an educational grant from BD Medical
INS 2016: recommendations for the insertion of any central venous access device

- Skin antisepsis with 2% chlorhexidine
- Consistent adoption of maximal barrier precautions
- Always adopt real-time ultrasound guidance
- Avoid fluoroscopy if not absolutely necessary
- Intraprocedural tip location with intracavitary ECG whenever possible
- Do not use stitches: secure with sutureless devices (skin-adhesive or subcutaneously anchored)
ISAC Ped

1) ultrasound choice of the vein (RaCeVA - RaPeVA);
ISAC Ped

2) hand washing + maximal barrier precautions + skin antisepsis with 2% chlorhexidine;
3) Use of ultrasound for venipuncture, for tip navigation and for ruling out PNX and other puncture-related complications;
ISAC Ped

4) Tip navigation by US + tip location by intracavitary ECG and/or echocardiography;
ISAC Ped

5) tunnelling of the catheter so to obtain an exit site in the most favourable area;
ISAC Ped

6) sealing of the exit site with glue;
ISAC Ped

7) securement with sutureless device + transparent semipermeable dressing.
Thus

The ISAC-Ped protocol is designed so to minimize all the complications possibly related to the insertion:

- early
- late
Our recent experience

729 central lines in pediatric patients
• 68 in neonates (0-30 days)
• 173 in infants (1-12 months)
• 488 in children (1 – 18 anni)

All inserted by a small team of specifically trained operators (one surgeon – un nurse – two neonatologists)
All inserted bedside, in PICU or NICU
<table>
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<th>FICC</th>
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Neonates

- **67 CICC** (mostly: right brachiocephalic vein)
- **1 FICC**

100% Ultrasound for puncture and tip navigation
100% IC-ECG for Tip location
33% Echocardio for tip location
100% tunnelled
### Age

1 - 12 months

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Infants

- **155 CICC** (mostly: brachiocephalic veins)
- **18 FICC**

100% Ultrasound for puncture and tip navigation
100% IC-ECG for Tip location
33% Echocardio for tip location
95% tunnelled
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<td>Triluminal</td>
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Children

- 279 PICC
- 196 CICC (mostly: brachiocephalic vein)
- 13 FICC

100% Ultrasound for puncture and tip navigation
100% IC-ECG for Tip location
25% Echocardio for tip location
70% Tunnelled
729 central lines

NO accidental arterial puncture
NO hemothorax
NO pneumothorax
NO primary malposition of the tip
2 catheter-related venous thrombosis
NO early catheter related infections (< 1 week)
729 central lines

All inserted bedside in NICU or PICU
- No operating room
- No fluoroscopy
- No post-procedural chest x-ray
- Minimal staff
- Low cost
- High efficiency (no waiting list)
- Maximal cost-effectiveness
Thank you for your attention

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