Central access in neonates and infants

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HIGHLIGHTS WoCoVA 2016
10 MAY 2017

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.

ULTRASOUND GUIDANCE !

(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).

NIR TECHNOLOGY !

(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

INTRACAVITARY ECG !

(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

NO FLUOROSCOPY !

(4) the routine use of fluoroscopy and post-procedural chest x-ray as radiological methods for tip location should be discouraged

MORE ULTRASOUND !

(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).

Current Drug Targets, 2012, *13*, 961-969

Ultrasound Guided Central Vascular Access in Neonates, Infants and Children

Mauro Pittiruti*

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Table 1. Central Lines

• Umbelical catheters (Umbelical vein)*
• Epicutaneo-caval catheters (Superficial veins of limbs or scalp)*
• Central venous catheters: tunneled, non-tunnelled, ports (central veins of the neck and of the supra/infra-clavicular region)
• PICC, Peripherally Inserted Central Catheters (Deep veins of the arm)
• Inferior Vena Cava catheters (femoral and saphenous vein)

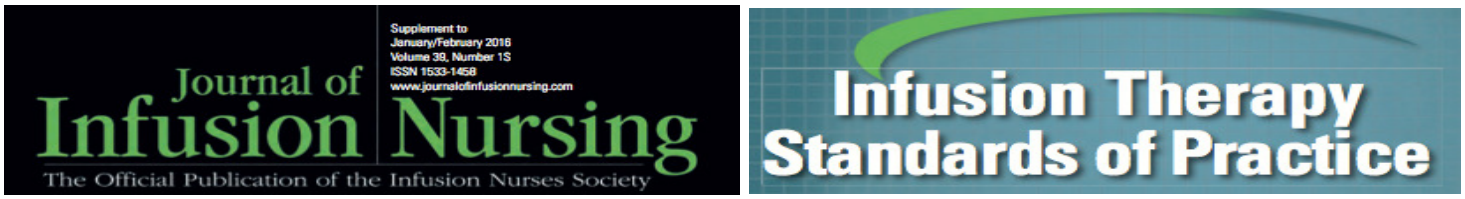
* = *only in neonates.*

Central lines in neonates, infants and children

Umbelical – **DIRECT INSERTION**
Epicutaneo-caval caths – **NIR TECHNOLOGY**
CICC, PICCs, etc. **ULTRASOUND GUIDANCE**

NIR TECHNOLOGY

Consider the use of near-infrared (nIR) light technology to aid in locating viable superficial peripheral venous sites and decreasing procedure time for short peripheral catheter insertion.



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1. Available technology includes hands-free devices that capture an image of the veins and reflect it back to the skin's surface or to a screen and transillumination projected to a screen. The clinician may choose to use a static process by imaging and marking the vein location on the skin or a dynamic process of using the image to guide catheter insertion. No studies have compared these various methods of device use, leaving this decision to the discretion of the clinician.[1,6,12]

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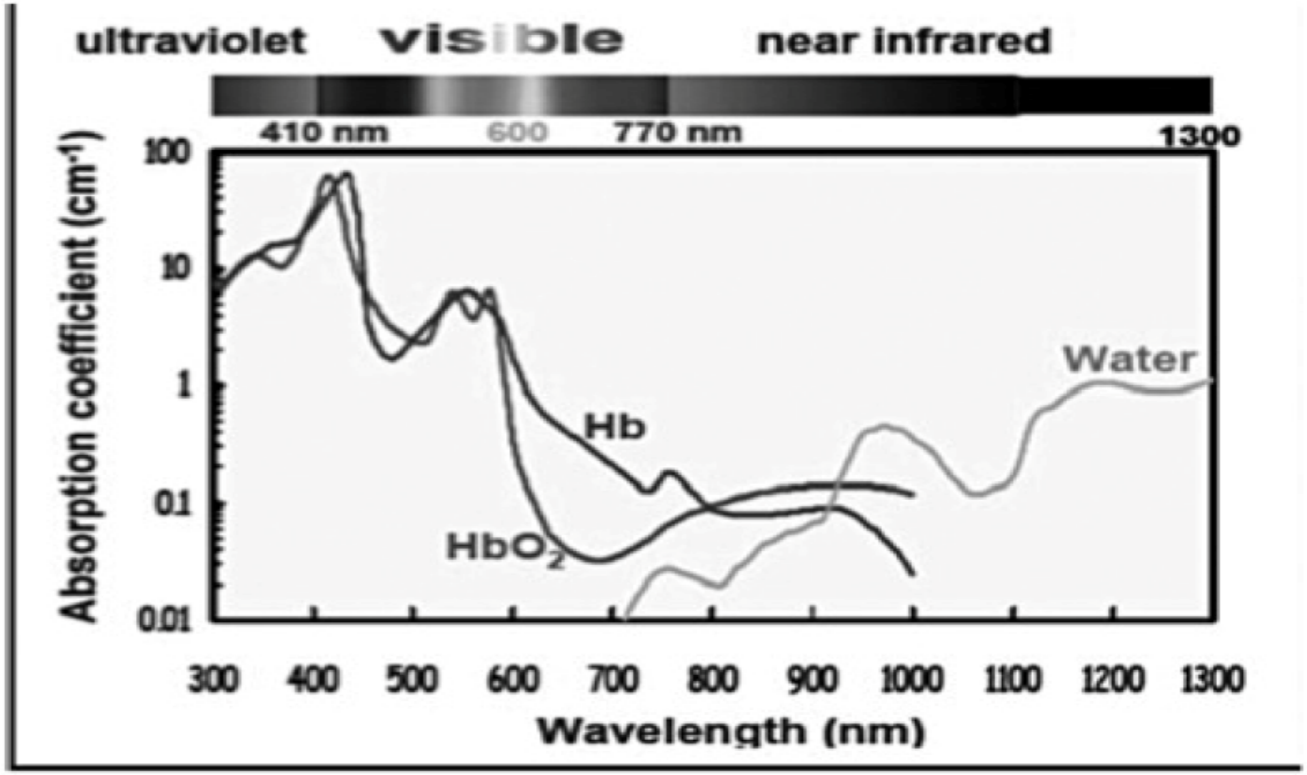
Consider nIR light technology to identify peripheral venous sites and facilitate more informed decisions about vein selection (ie, bifurcating veins, tortuosity of veins, palpable but nonvisible veins). Two nonrandomized studies have shown improvement in first-attempt success for peripheral catheter insertion using nIR; however, other studies have not shown this same outcome. Additional research is needed to address the reason(s), which could include differences in nIR devices, patient-related factors, and skill level of the inserters before using the nIR devices.[11-19] (I)


ultraviolet
visible
near infrared
410 nm
600
770 nm
1300
Absorption coefficient (cm-1)
100
10
1
0.1
0.01
Hb
HbO2
Water
300
400
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700
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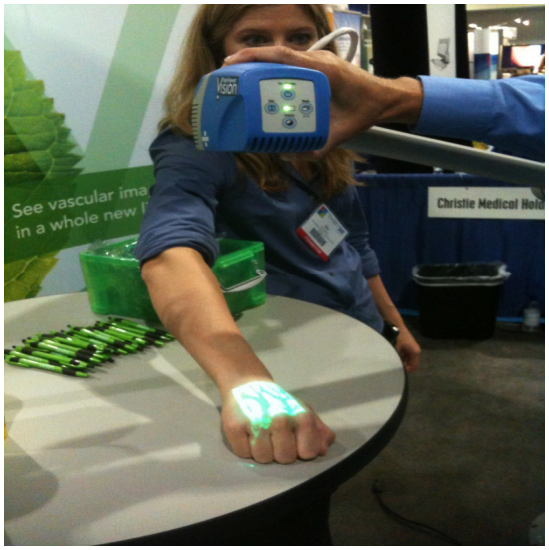
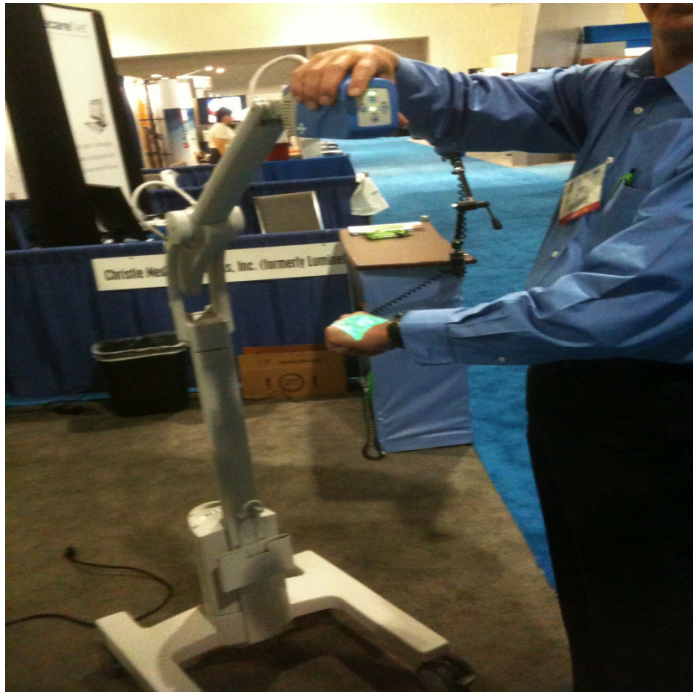
1000
1100
1200
1300
Wavelength (nm)

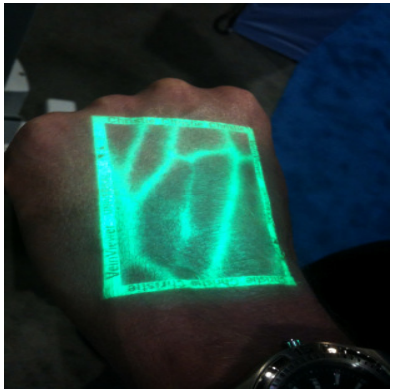
- VeinViewer

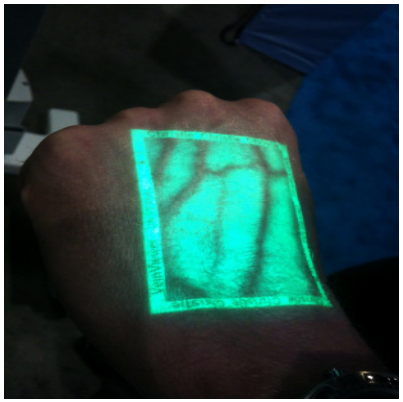
VeinViewer- Vision





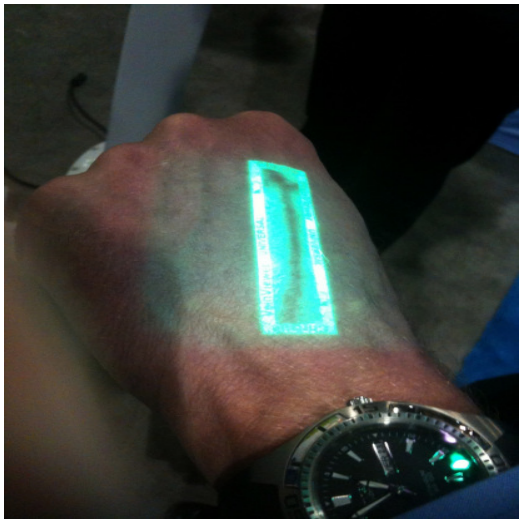
VeinViewer- Vision





VeinViewer- Vision





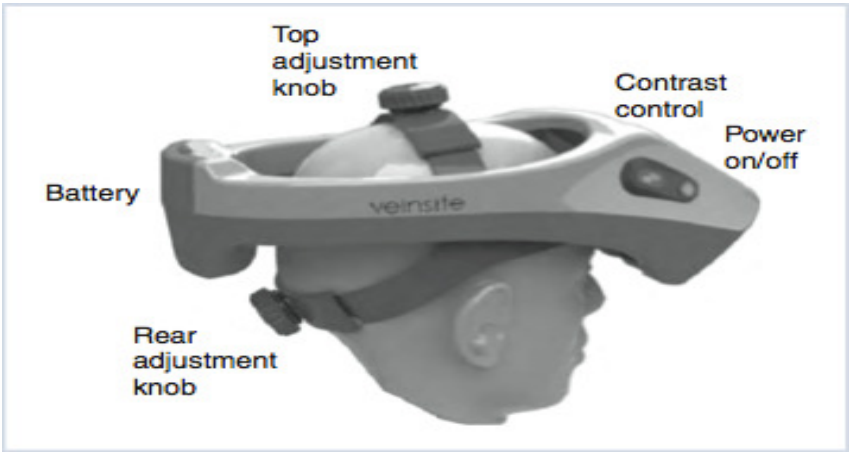
- AccuVein


Equipment
Imagine ho
you could
Now you c

- Vasculuminator

Veinsite


vuetek
vuetek
DELL


Top adjustment knob
Contrast control
Power on/off
Battery
veinsite
Rear adjustment knob


VueTek

Vein visualization: patient characteristic factors and efficacy of a new infrared vein finder technology†

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Editor's key points

- Factors contributing to difficult venous cannulation and the impact of new vein imaging technologies are important to safe and effective medical therapy.
- The numbers of potential i.v. cannulation sites were compared using the conventional visual method and a new infrared vein finding technology.
- Infrared vein visualization increased the number of potential cannulation sites in all subgroups.

Background. We investigated the patient characteristic factors that correlate with identification of i.v. cannulation sites with normal eyesight. We evaluated a new infrared vein finding (VF) technology device in identifying i.v. cannulation sites.

Methods. Each subject underwent two observations: one using the conventional method (CM) of normal, unassisted eyesight and the other with the infrared VF device, VueTek's Veinsite™ (VF). A power analysis for moderate effect size (β=0.95) required 54 samples for within-subject differences.

Results. Patient characteristic profiles were obtained from 384 subjects (768 observations). Our sample population exhibited an overall average of 5.8 [95% confidence interval (CI) 5.4–6.2] veins using CM. As a whole, CM vein visualization were less effective among obese [4.5 (95% CI 3.8–5.3)], African-American [4.6 (95% CI 3.6–5.5 veins)], and Asian [5.1 (95% CI 4.1–6.0)] subjects. Next, the VF technology identified an average of 9.1 (95% CI 8.6–9.5) possible cannulation sites compared with CM [average of 5.8 (95% CI 5.4–6.2)]. Seventy-six obese subjects had an average of 4.5 (95% CI 3.8–5.3) and 8.2 (95% CI 7.4–9.1) veins viewable by CM and VF, respectively. In dark skin subjects, 9.1 (95% CI 8.3–9.9) veins were visible by VF compared with 5.4 (95% CI 4.8–6.0) with CM.

Conclusions. African-American or Asian ethnicity, and obesity were associated with decreased vein visibility. The visibility of veins eligible for cannulation increased for all subgroups using a new infrared device.

Keywords: catheterization; veins

Accepted for publication: 21 December 2012

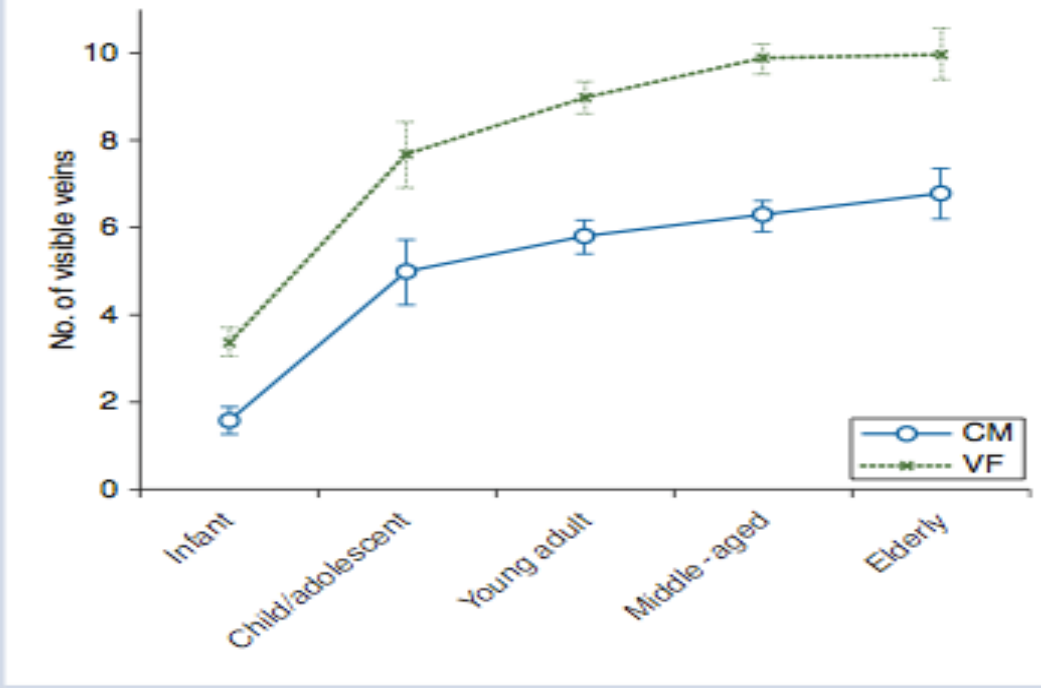

Fig 4 Comparison of VF and CM visible sites [mean (SE)] across age groups.

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BJA

CLINICAL PRACTICE

Vein visualization: patient characteristic factors and efficacy of a new infrared vein finder technology†

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EDITORIAL II

Difficult peripheral veins: turn on the lights

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There are three main unresolved issues regarding the use of NIR technology that makes its application still far from real life and clinical practice in our hospitals.

First: what about training? It is not clear how operators should be trained in the use of this new technology. Most of the studies do not report how many procedures the operators had to perform before being considered proficient with this new method. To define an operator proficient in a new technology or procedure, two main outcomes should be satisfied: goal achieved and time to success. Considering these devices, first-time successful cannulation should be considered the main goal and a learning curve should be calculated on this parameter;[12] this would suggest the average number of procedures required before obtaining a minimal training for getting proficiency.

Cannulation time is not less important, if we consider that these portable devices should also be used in the emergency room to obtain a prompt venous access. It is mandatory to define a training curriculum on the use of NIR devices, if we want to use them properly every time, those superficial veins are not easily visible, palpable, or both.

Second: cost-effectiveness. In other words, is this technology affordable in this period of international financial crisis? New technologies may be difficult to be accepted by our hospital managers, if not supported by a proper economical and clinical rationale. A budget impact analysis[13] of this technology should include not only the raw cost of the device (from $4500 up to $25 000) and the cost of training *vs* the time-saving benefit, but also the advantage of a convincing improvement in the quality of venous cannulation in terms of perception of pain by patients and handiness of the device by operators. Should the results of this analysis show a significant cost-effectiveness, the technique should be progressively introduced in the clinical practice, with the clinical goals of (i) preserving the peripheral vein patrimony of the patients and (ii) avoiding the risks associated with a potentially unnecessary central vein cannulation.[14]

Finally, there is a technical concern about vein visualization. Difficult venous cannulation may be related to the small diameter of the vein (as in infants) or to their deep location (as in obese patients) or to poor visibility or palpability due to other factors (oedema, pigmentation, etc.). It is still not clear whether NIR devices can be effective not only in venous visualization but also in venous cannulation; more specifically, since NIR technology does not provide a depth of field, accidental puncture of the posterior wall of the vein, and extravasation may easily occur. Ultrasound guidance has been proposed in recent years[15] [16] to improve the visualization of difficult superficial veins in paediatric patients, but the results of these studies are controversial in terms of improved success rate, first-time success, and overall time to cannulation.

NIR TECHNOLOGY

Ideal for detection – puncture – cannulation of **superficial veins (< 7mm of depth)**

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EDITORIAL II

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ULTRASOUND

Ideal (mandatory !) for detection – puncture – cannulation of **deep veins (> 7mm of depth)**

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DOI 10.1007/s00134-012-2597-x

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International evidence-based recommendations on ultrasound-guided vascular access


SonoSite. MICROMAXX
2012

With the only exception of umbelical catheters and epicutaneo-caval catheters in neonates, ALL pediatric central venous access devices must be inserted by ultrasound guidance:

CICC – centrally inserted central catheters (cervico-thoracic approach)

- supraclavicular
- infraclavicular

PICC – peripherally inserted central catheters (upper arm)

FICC – femorally inserted central catheters (groin)

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
  - Trasparent dressing + glue
  - Tunneling
- Never a first option for medium-long term access
  - Only if CICC and PICC are contraindicated

Femoral line, tunneled

Of course, also for FICC:

Ultrasound guidance is mandatory

-No role for ‘blind’ venipuncture

-No role for venous cutdown

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

Not to be confused with other peripherally inserted central lines in neonates

Epicutaneo-caval caths

Neonates
Direct or NIR insertion
Superficial veins
Tip not always central
Caliber < 3Fr
Low flow
No blood sampling

US-guided PICCs

Infants and children
Ultrasound guidance
Deep vein of the arm
Tip must be at CAJ
Caliber 3 Fr or >
High flow (power injectable)
Ok for blood sampling

US guided PICCs

Patients:

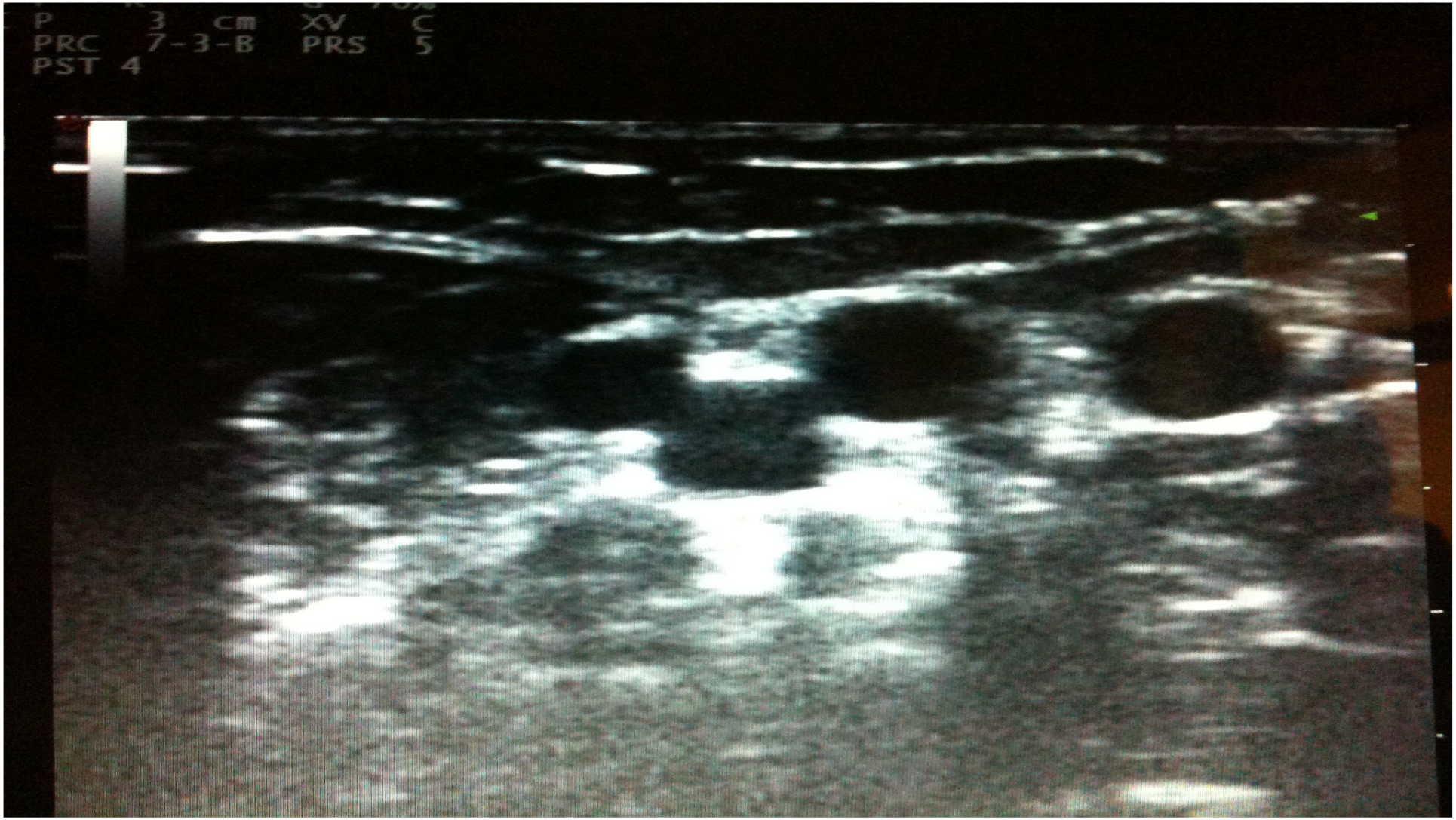
- pediatric intensive care unit
- pediatric surgery (perioperative access)
- pediatric parenteral nutrition
- pediatric oncology/haematology

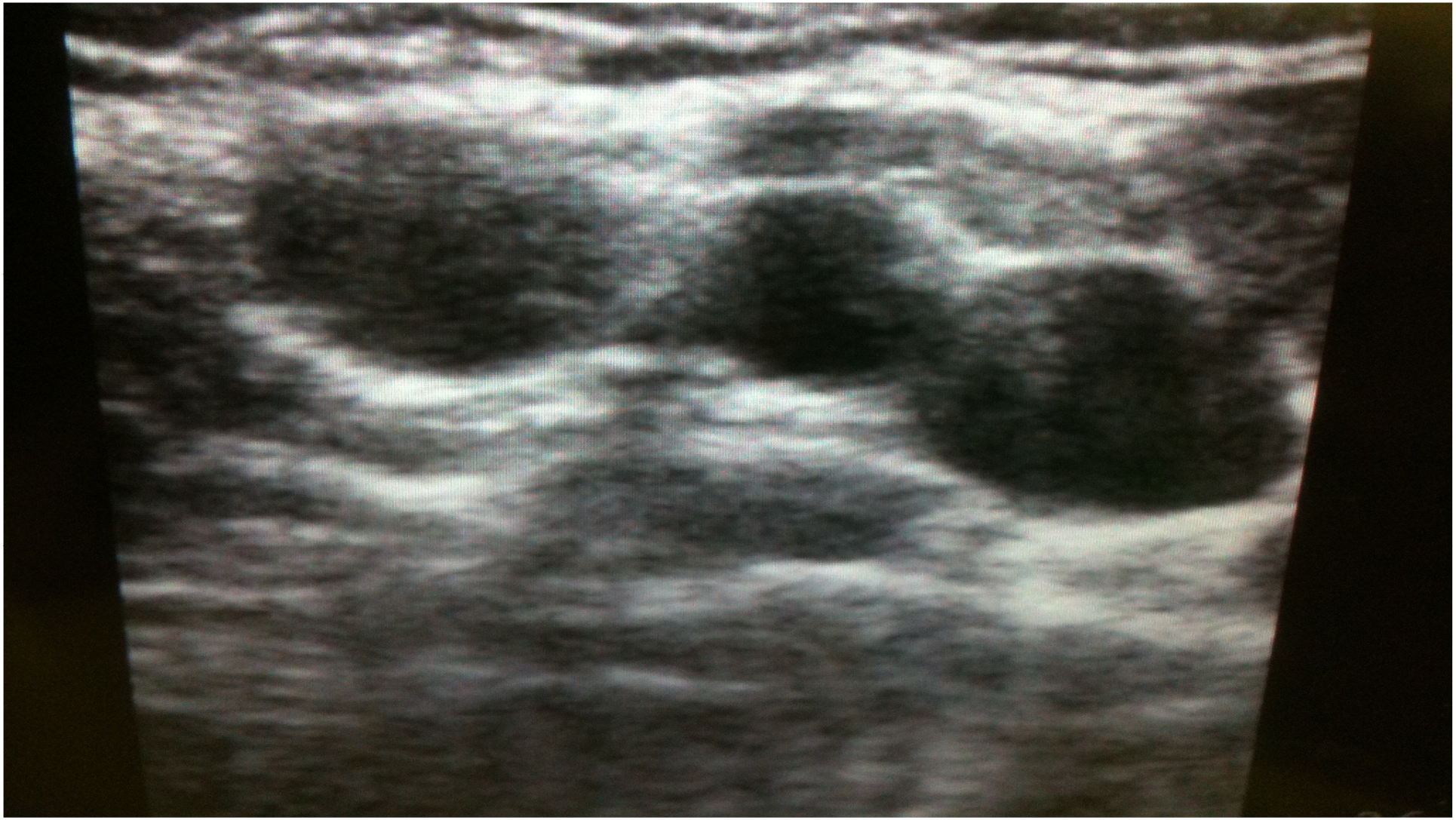
Catheter:

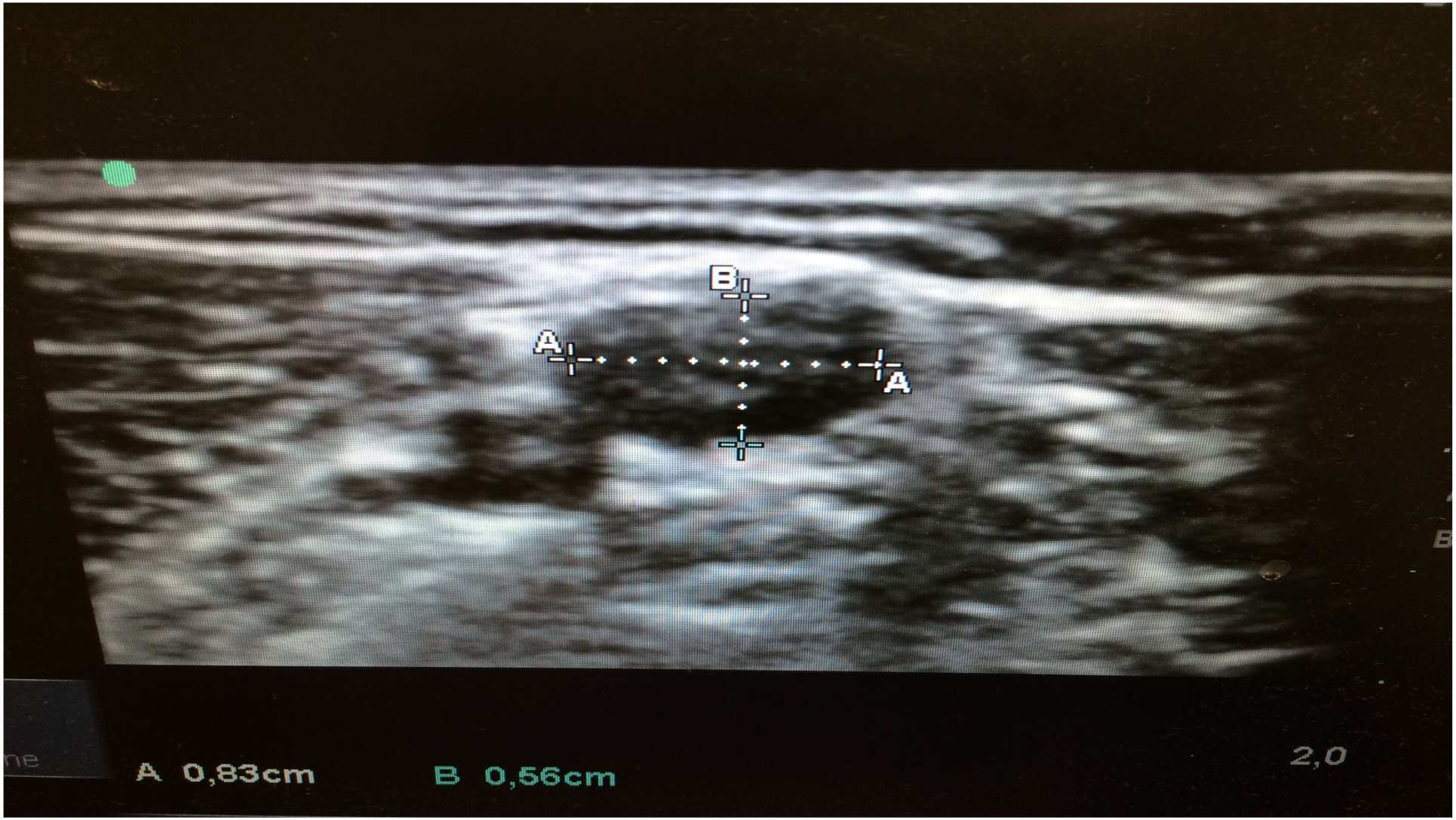
- power injectable polyurethane

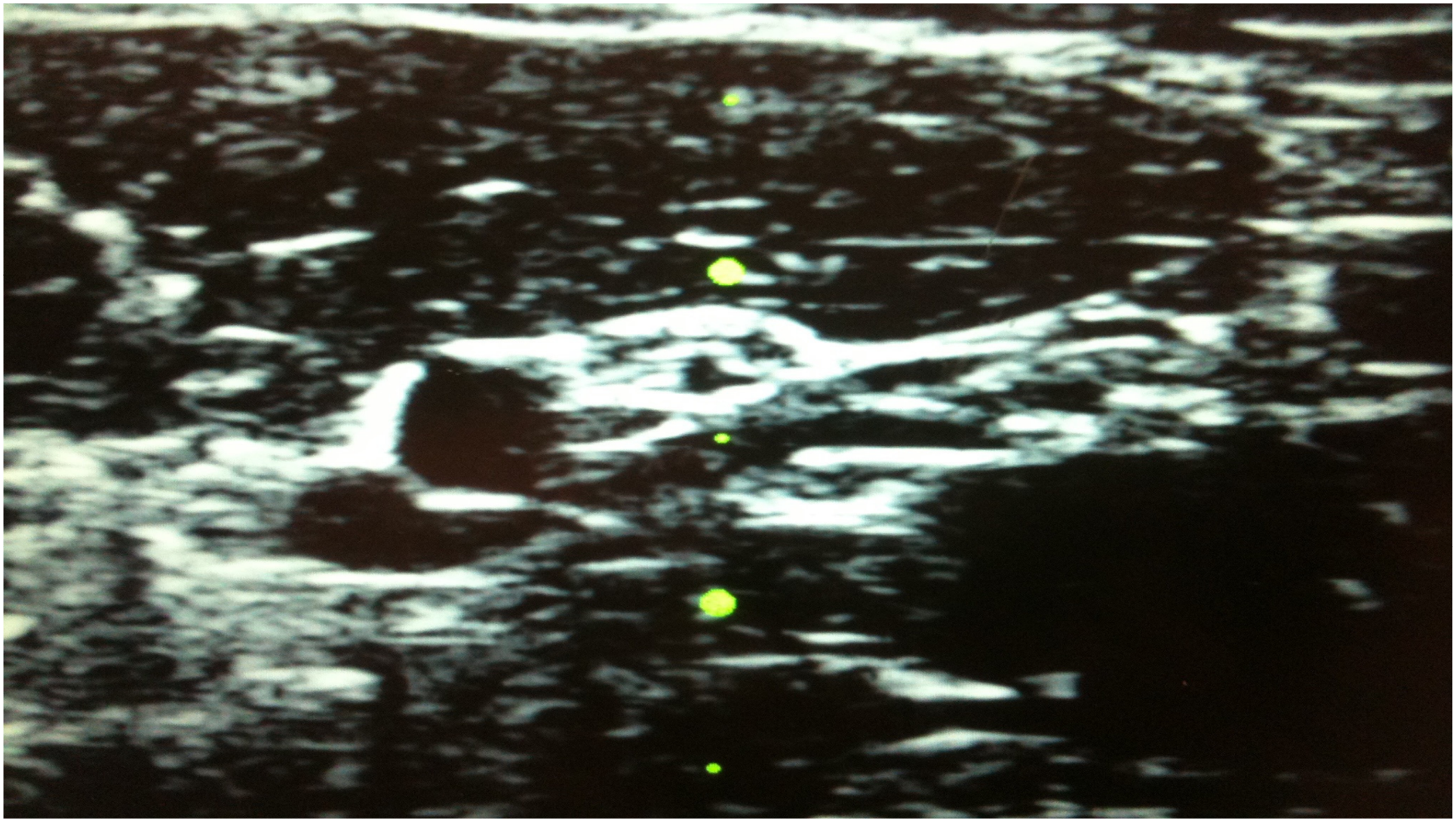
RaPeVA

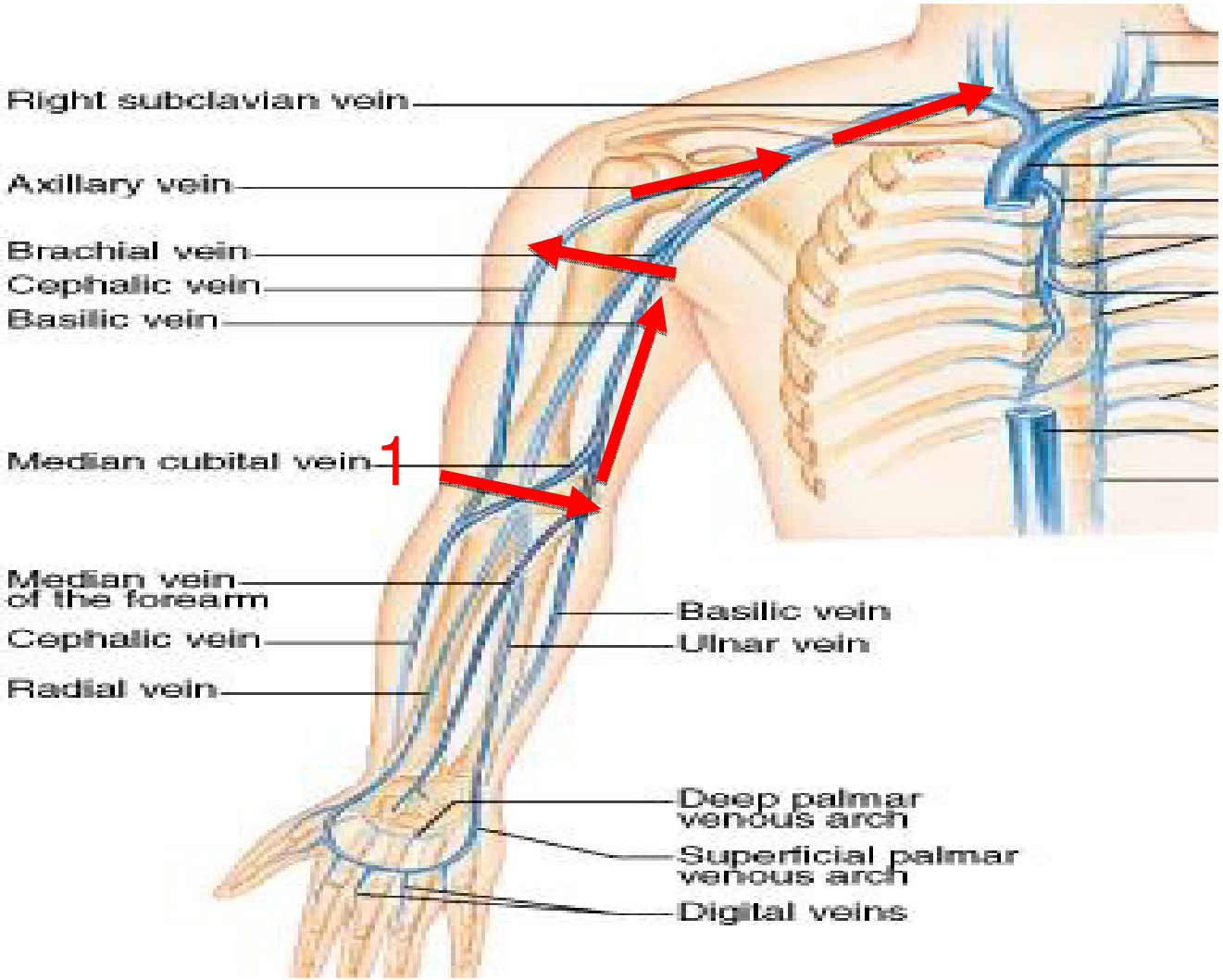
Rapid Peripheral Vein Assessment


P 3 cm XV C
PRC 7-3-B PRS 5
PST 4



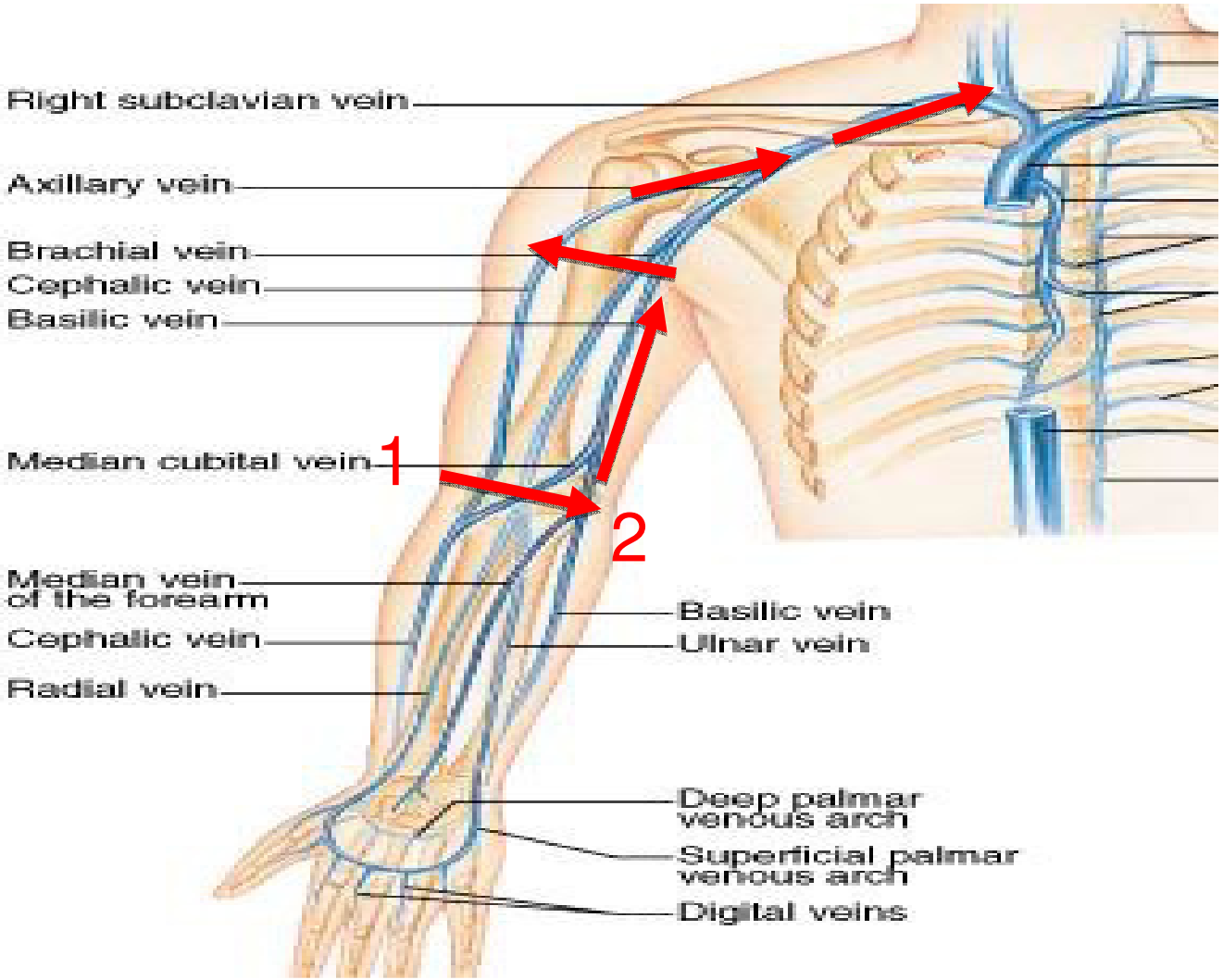

B
A
A
A 0,83cm
B 0,56cm
2,0





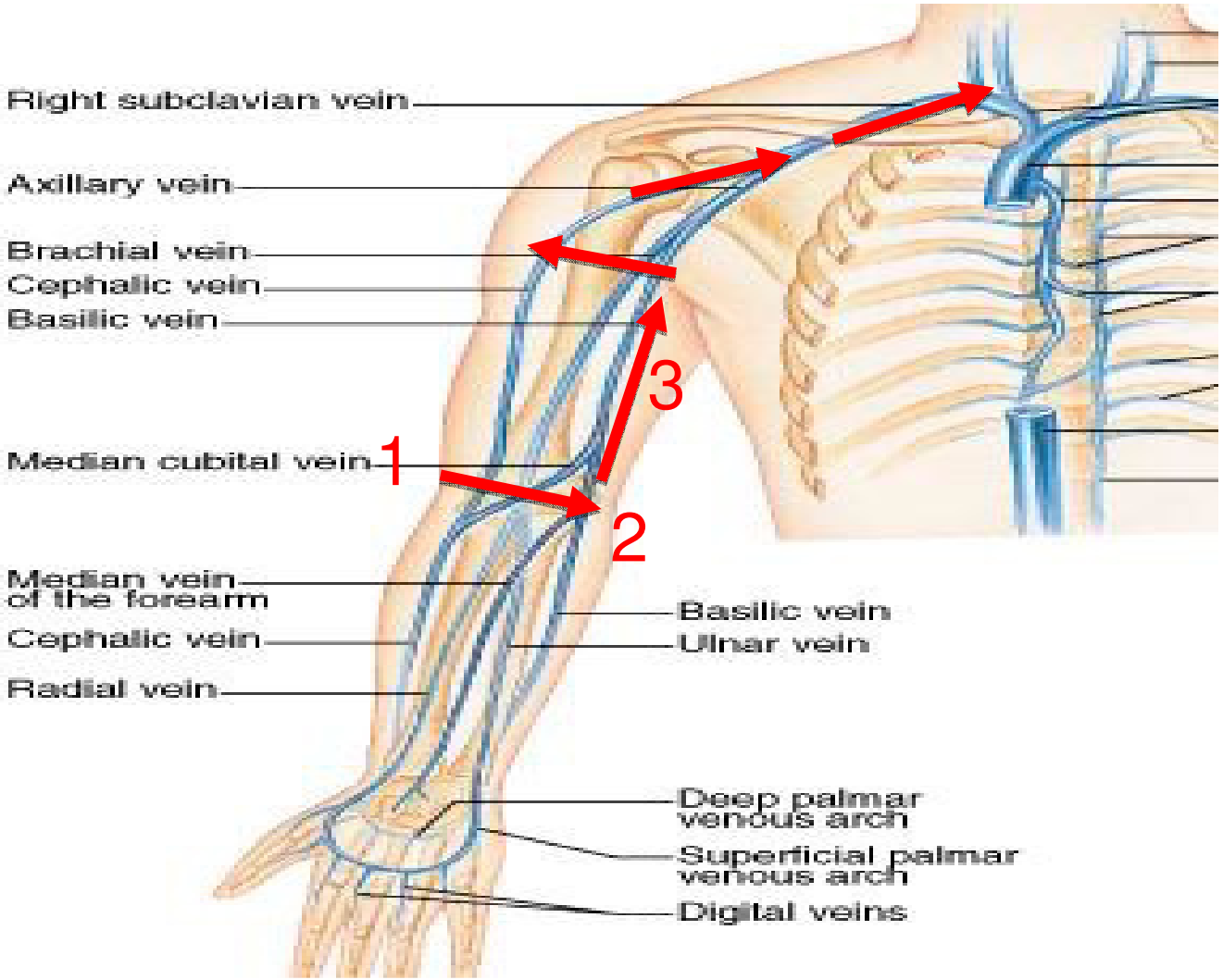
1

Cephalic vein



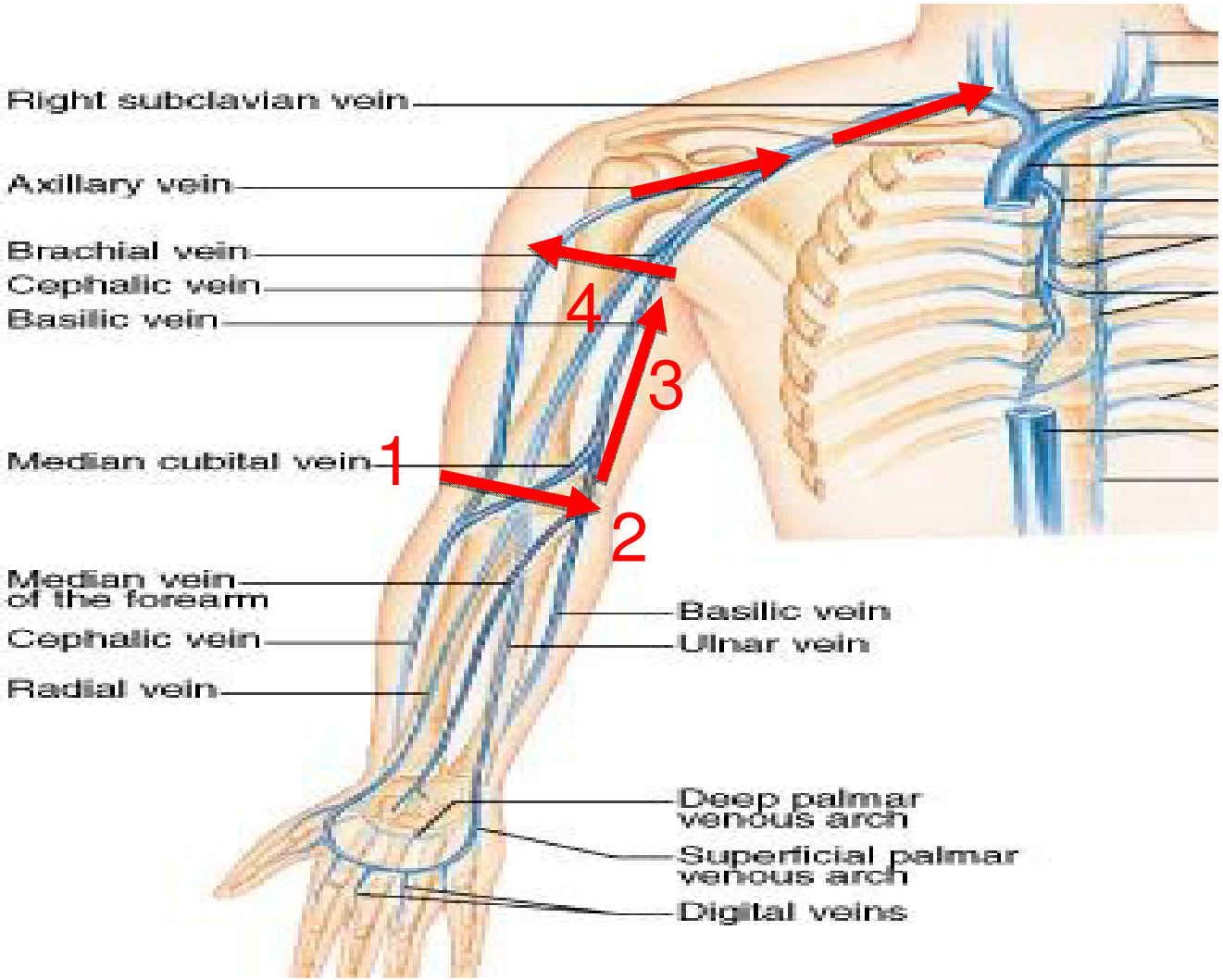
2

Brachial a & vv


Right subclavian vein
Axillary vein
Brachial vein
Cephalic vein
Basilic vein
Median cubital vein
Median vein of the forearm
Cephalic vein
Radial vein
Basilic vein
Ulnar vein
Deep palmar venous arch
Superficial palmar venous arch
Digital veins
1
2
3

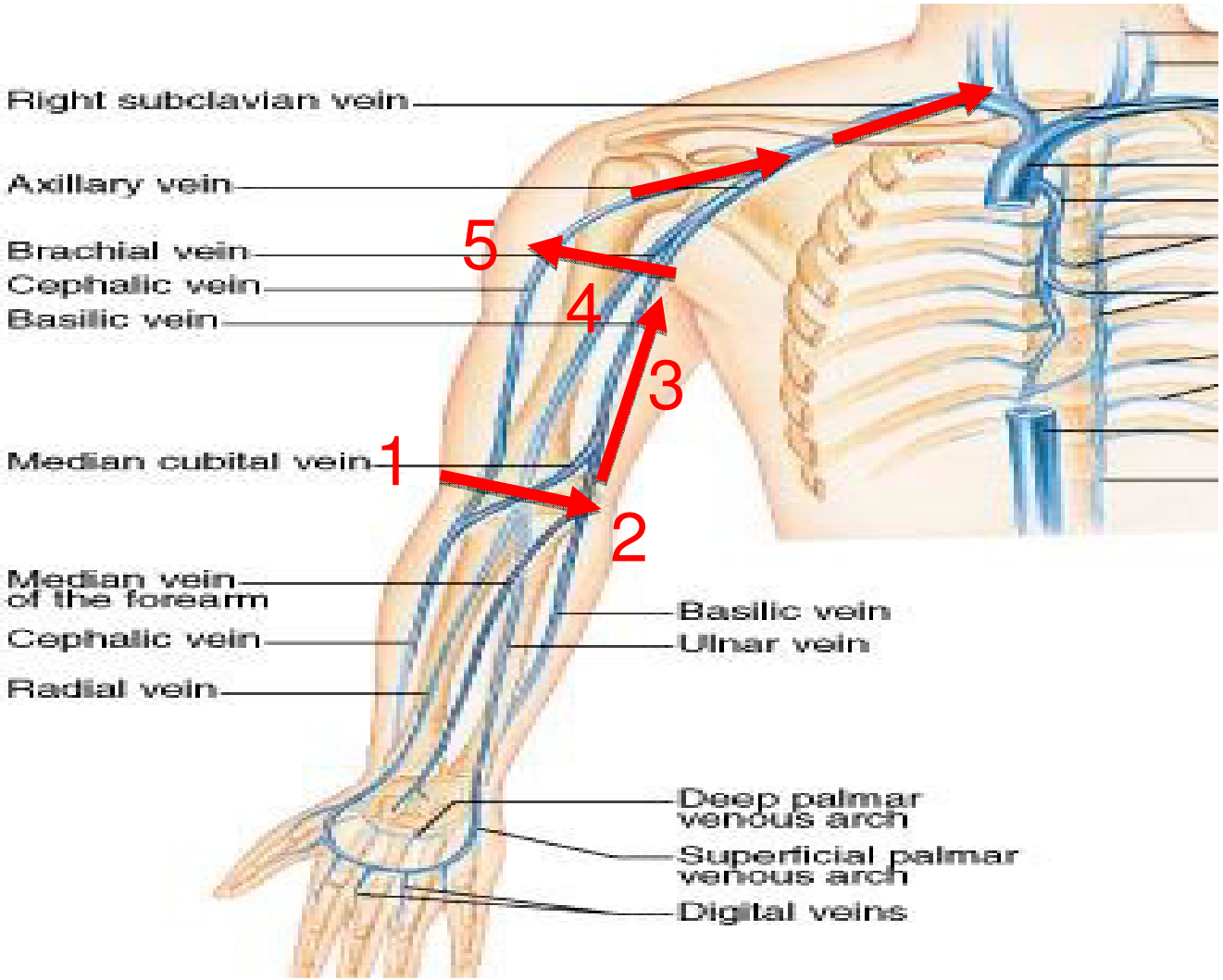
3

Basilic v



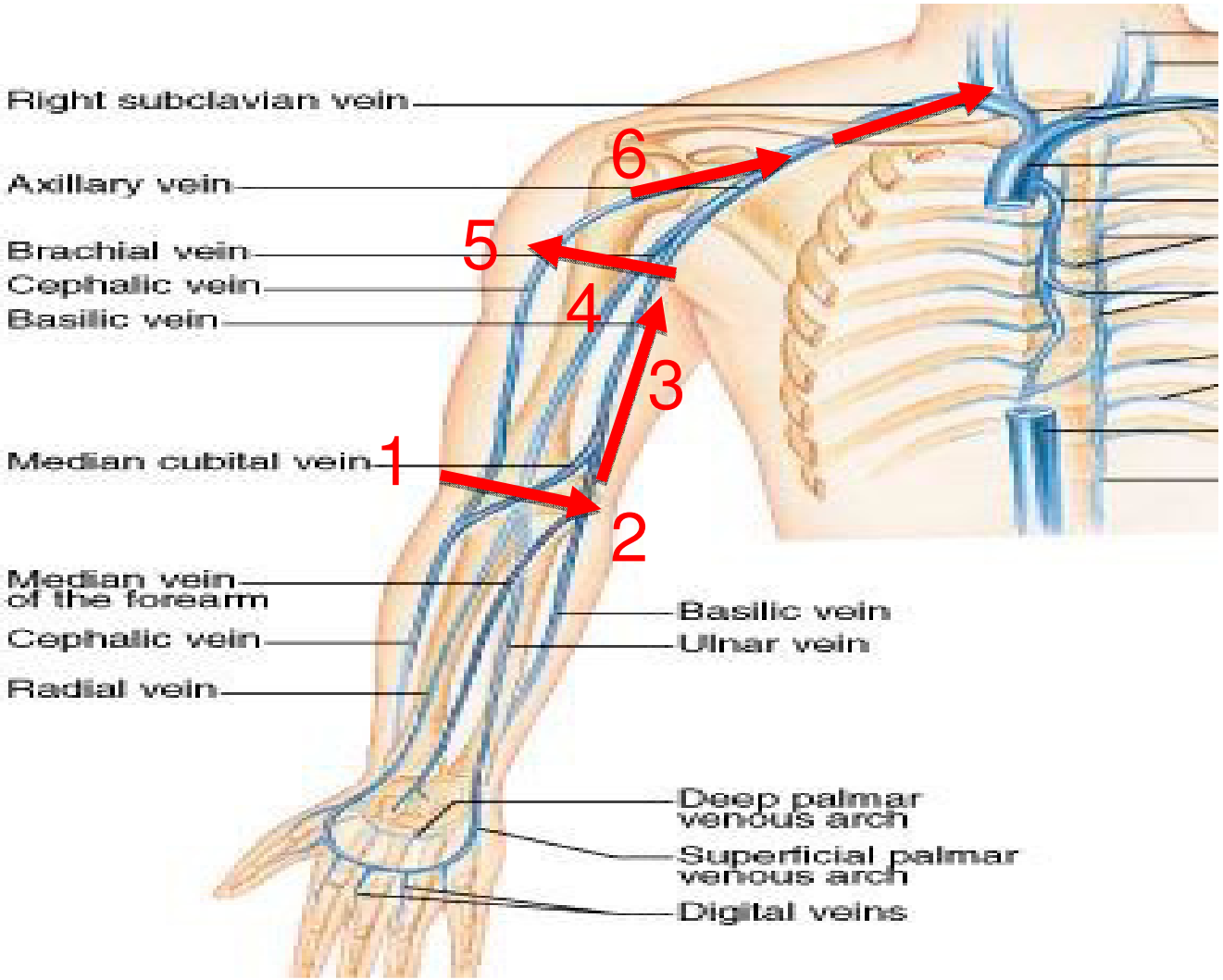
4

Brachial
a & vv.
at midarm



5

Cephalic v at midarm


Right subclavian vein
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Cephalic vein
Radial vein
Basilic vein
Ulnar vein
Deep palmar venous arch
Superficial palmar venous arch
Digital veins
6
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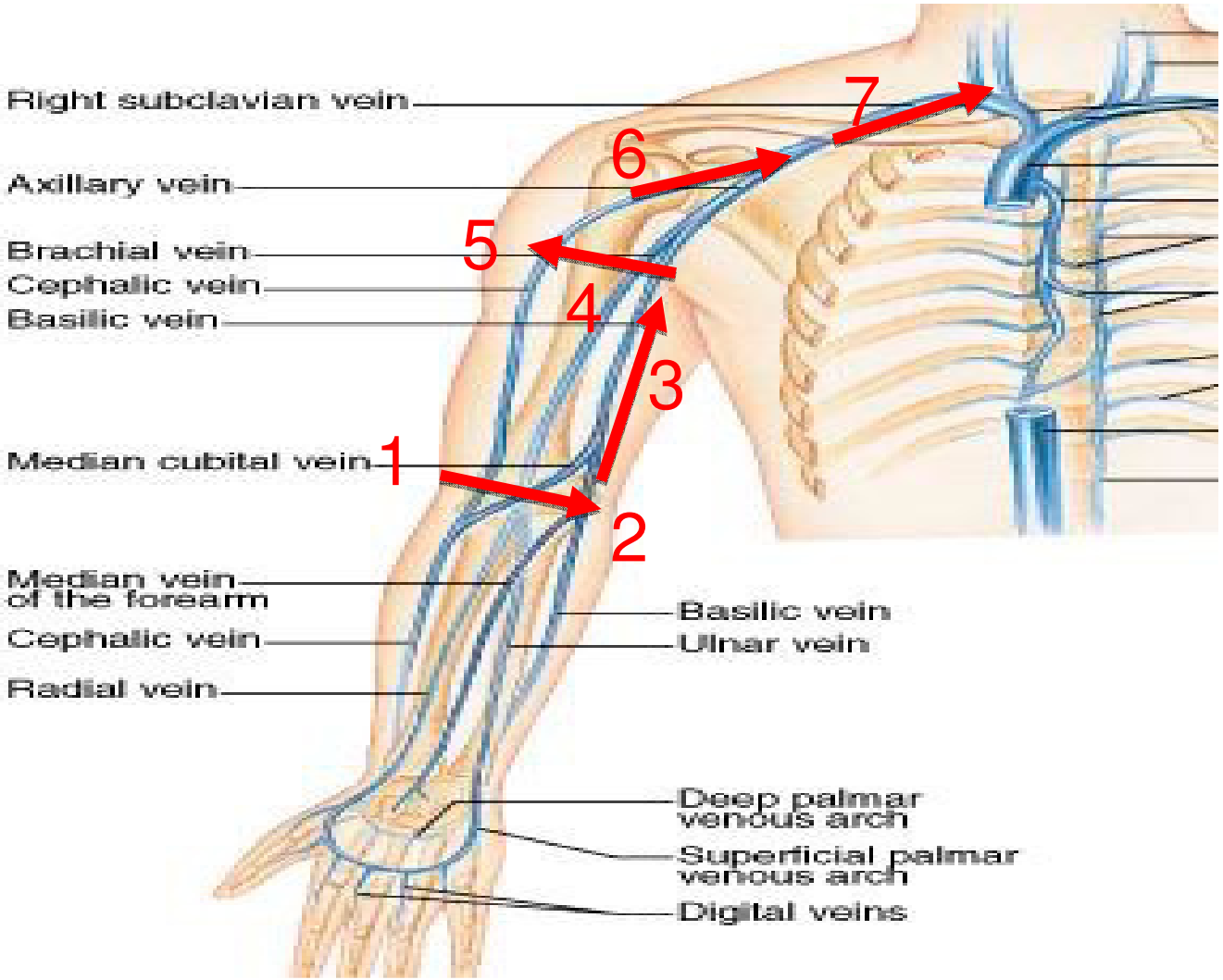
axillary v



7

Supraclav. veins

100% success at insertion

Consistent adoption of **SIP protocol** as proposed by GAVeCeLT since 2010:

1 – hand washing, maximal barrier protection, 2% chlorhexidine
2 – US scan of all veins before starting the procedure (RaPeVA)
3 – choice of vein matched with cath diameter (3:1)
4 – individuation of brachial artery and median nerve
5 – US-guided puncture and cannulation
6 – tip navigation by US
7 – tip verification by intracavitary EKG
8 – securement with glue + sutureless device + transparent membrane

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

Non-conventional use of PICCs as CICCs

PICCs = ideal as CICC in neonates and small infants

- optimal micro-introducer
- echogenic 21G needle
- nitinol guidewire
- adjustable length (tunneling, etc.)
- power injectable polyurethane

Ideal choice for neonates/infants

- Best material: power injectable PUR
- Best microintroducer kit
- Best technique: ultrasound
- Best vein available (usually: brachio-cephalic)

‘key points’ for an uneventful insertion of a CICC…

Ultrasound study of deep veins (RaCeVA)

US-guided venipuncture and cannulation

IC-EKG for verification of tip position

Intra-procedural US controls

- r/o PNX + further verification of tip position by TEE

Tunneling

Securement

- glue + sutureless device + transparent dressing

‘key points’ for an uneventful insertion…

Ultrasound study of deep veins (RaCeVA)

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Ultrasound Guided Central Vascular Access in Neonates, Infants and Children

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Table 2. Ultrasound-Guided Venipuncture

• At neck – Internal jugular vein (*out of plane*)
• In the supra-clavicular area – Internal and external jugular, subclavian, brachio-cephalic vein (*in plane*)
• In the infraclavicular area – Axillary, cephalic vein (*out of plane/in plane*)
• At mid-arm – Basilic vein, brachial veins (*out of plane*)
• At the groin – Femoral, saphenous vein (*out of plane*)

- Ultrasound guided venipuncture is rapidly becoming the standard technique for achieving a central line in neonates, infants and children.
- Ultrasound gives the possibility of choosing the most appropriate and safest venous access, as well as performing a 100% safe procedure.

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Giancarlo Scoppettuolo
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Wolfram Schummer
Roberto Biffi
Eric Desruennes
Lawrence A. Melniker
Susan T. Verghese

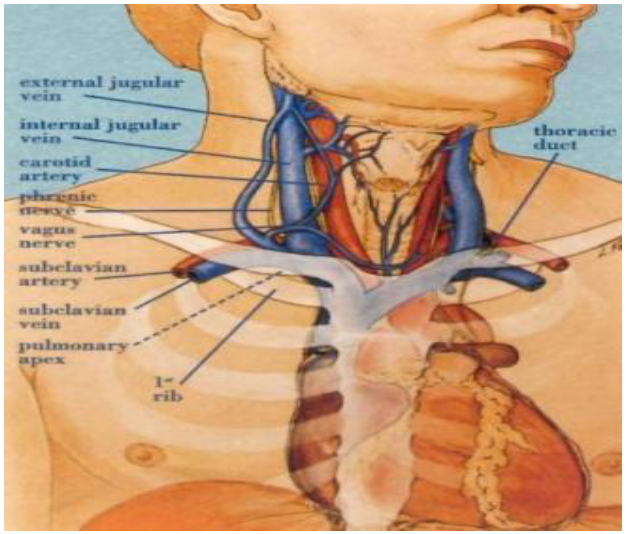
International evidence-based recommendations on ultrasound-guided vascular access

Table 3 Recommendations on ultrasound vascular access in neonates and children

Ultrasound vascular access in neonates and children		
Domain code	Suggested definition	Level evider
D4.SD1.S1–2	Ultrasound guidance should be routinely used for short- and long-term central venous access in children and neonates	A
D4.SD1.S3	Ultrasound vessel imaging with ultrasound assistance as "a minimum" should be routinely performed before internal jugular vein puncture in neonates	A
D4.SD1.S4	In neonates, ultrasound screening should be used before subclavian vein puncture. Ultrasound-guided puncture should be considered for catheterization using the supra-clavicular route, but this technique requires experienced operators	C
D4.SD1.S5	Ultrasound vessel screening should be routinely used before femoral vein puncture. Ultrasound-guided femoral puncture is recommended to decrease inadvertent arterial puncture	B
D4.SD1.S6	Ultrasound guidance can be considered when difficult peripheral venous access is required in areas such as the antecubital fossa and ankle. Blind deep antecubital fossa puncture should disappear	C
D4.SD1.S7	Ultrasound-guided arterial catheterization improves first-pass success and should be used routinely in children and neonates	A
D4.SD1.S8	After central venous catheter placement in paediatric patients including neonates, the ultrasound equipment should remain easily accessible at the patient's bedside to detect early life-threatening catheter-related complications such as pneumothorax, cardiac tamponade and hemothorax	B
D4.SD1.S9	There is no ideal site for cannulation in children; the best site should be determined after ultrasound examination	A

D4.SD1.S9 There is no ideal site for cannulation in children; the best site should be determined after ultrasound examination A

- Though much of the initial experience in this field has been carried out with **internal jugular** vein and **subclavian** vein, in neonates and in small children the largest and easiest vein to access is the **brachio-cephalic** vein.



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'

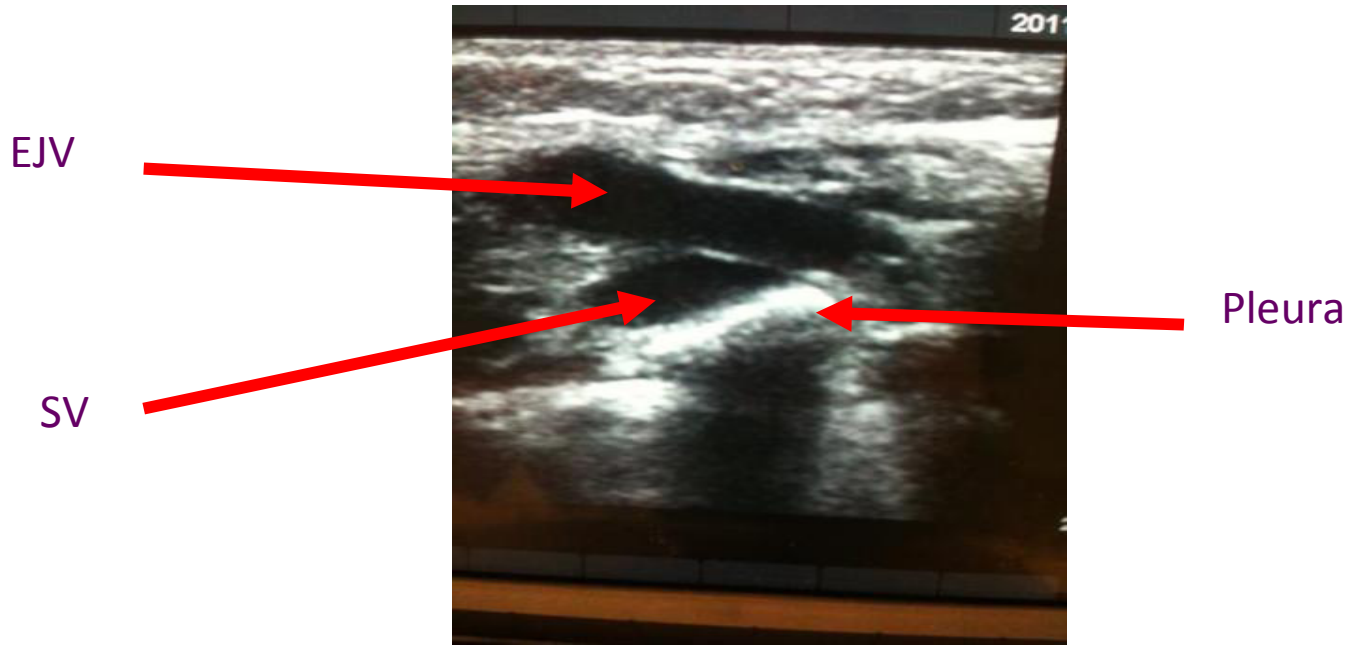
RaCeVA in 4 mo. old in PICU

IJV

SA

BCV


201
SV
BCV


EJV
SV
Pleura


AA
VA

The choice: BCV

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

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…

Ultrasound study of deep veins (RaCeVA)

US-guided venipuncture and cannulation

IC-EKG for verification of tip position

Intra-procedural US controls

- r/o PNX + further verification of tip position by TEE

Tunneling

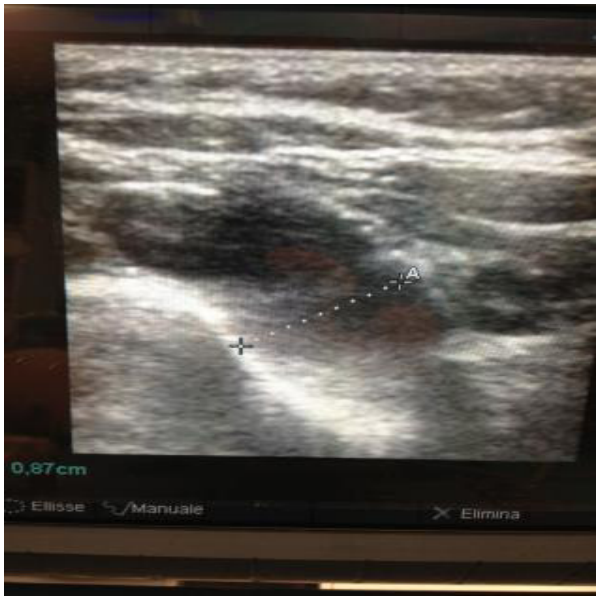
Securement

- 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)

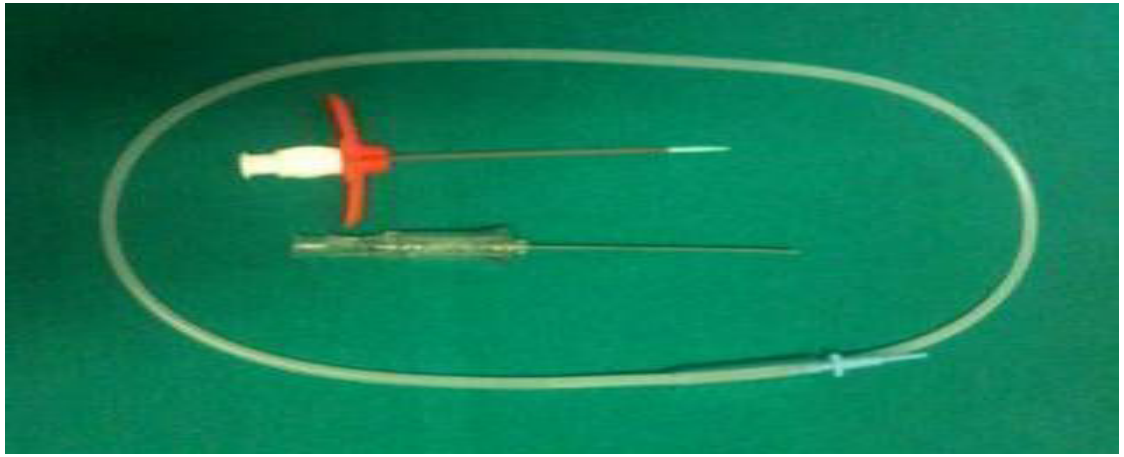
Key point

Check the diameter of the vein !



Kits for micro-introduction :

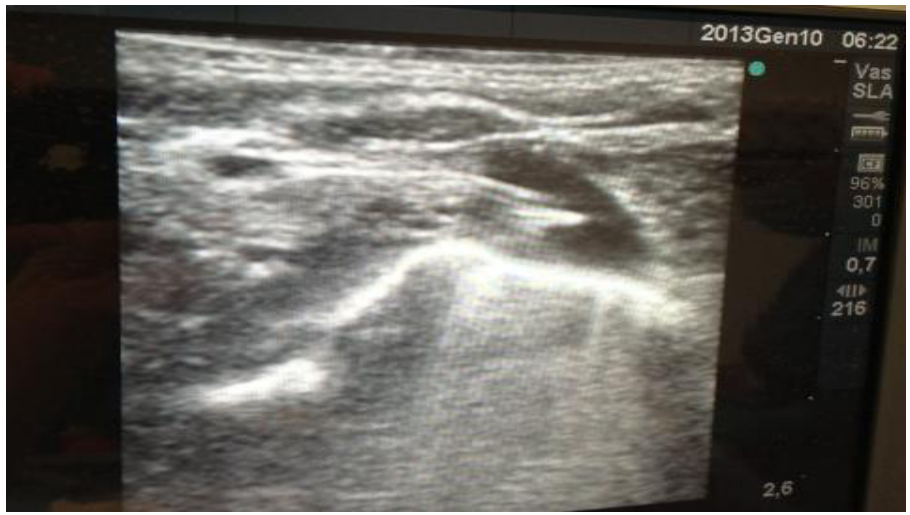
- 21 G echogenic needles
- soft straight tip 0.018’’ guide-wire
- 3,5 or 4,5 Fr micro-introducer-dilator



- All catheters should be inserted by real time ultrasound guidance, by the ‘in-plane’ approach.

Needle

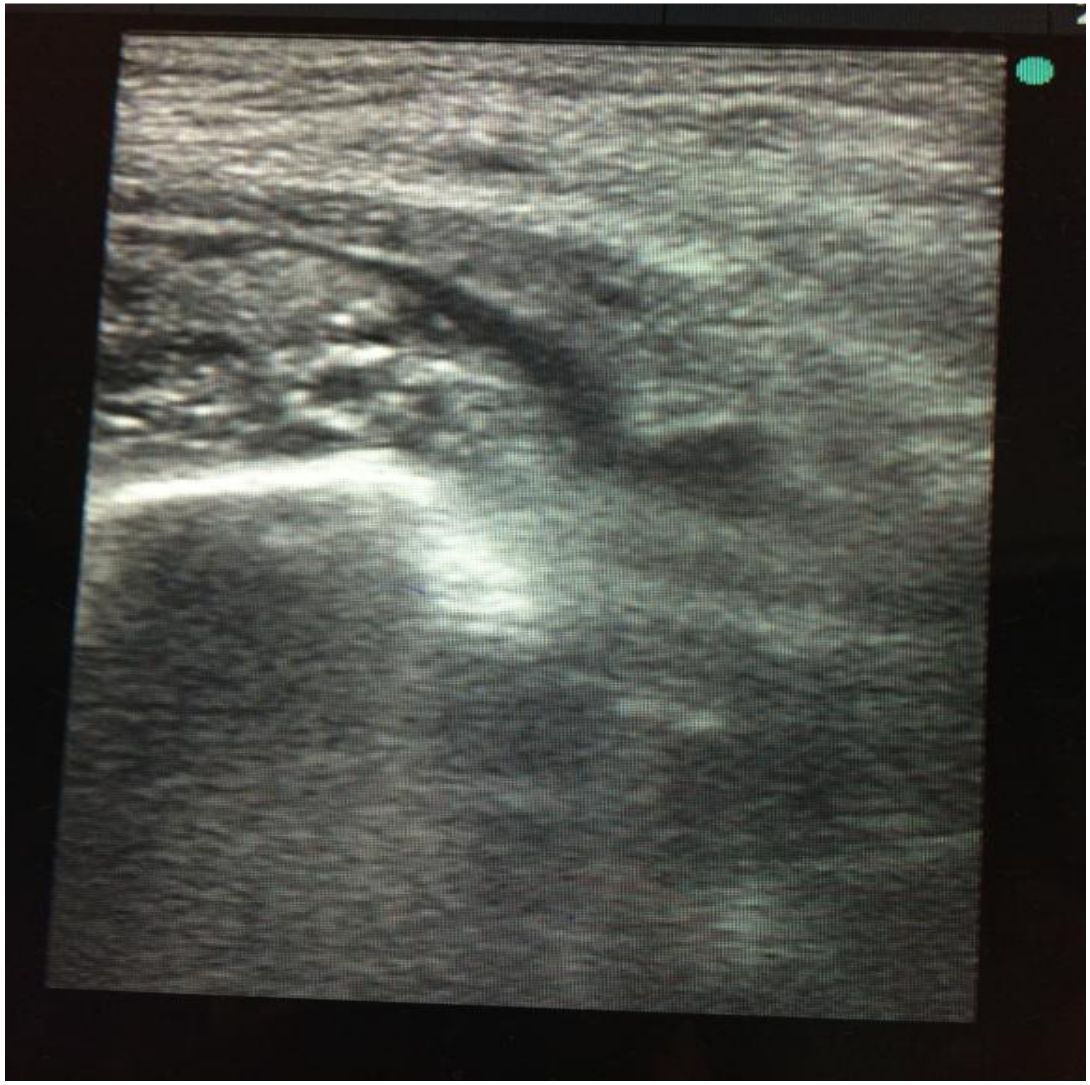
US guided venipuncture



Always keep an eye
on the tip of the needle

Easy puncture…

Easy puncture…



Not so easy!
(800 gr)

Choice of the vein

A careful **ultrasound** assessment of the child before CVC insertion allows a rationale choice of the vein apparently most appropriate in terms of caliber, depth and potential risk of pleural or arterial damage.

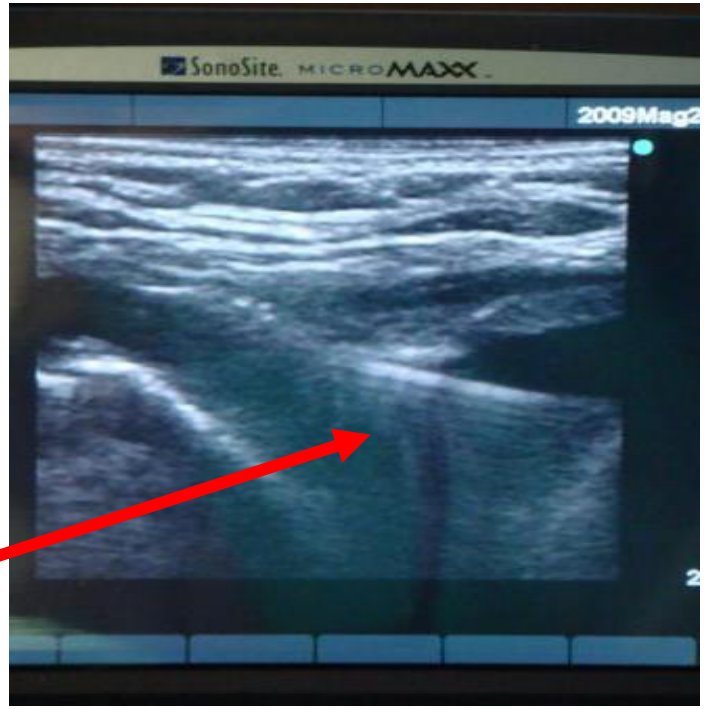
In our experience, in the vast majority of patients < 6 years, **the brachiocephalic vein** is the vein with the largest caliber and the easiest to puncture.

US guided puncture of the brachio-cephalic vein

In neonates/infants > 750 g
(our experience)
In neonates/infants > 600 g
(C.Breschan, Klagenfurt)
In neonates/infants > 450 g
(J.Bennett, Birmingham)

Tip location

- Ultrasound is constantly used to assess the direction of the guidewire, soon after its insertion in the needle



Wrong direction !

guidewire

Micro introducer

Catheter

Tip navigation by US

- US is not just for puncture !
- US control of the direction of guidewire and/or catheter (tip navigation by US) is particularly easy in neonates and infants
- Tip navigation by US should be implemented also in UVC and ECC !!

‘key points’ for an uneventful insertion…

Ultrasound study of deep veins (RaCeVA)

US-guided venipuncture and cannulation

IC-EKG for verification of tip position

Intra-procedural US controls

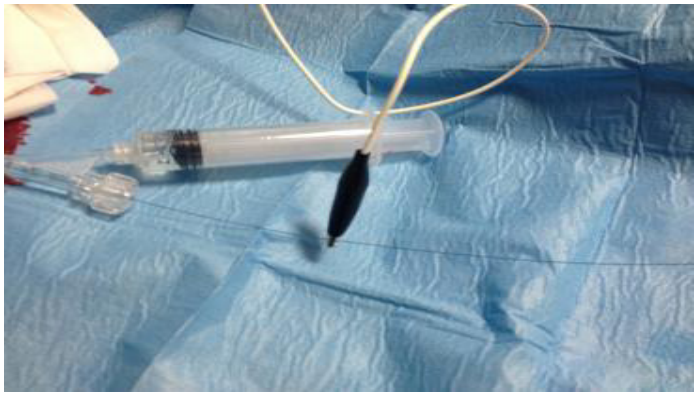
- r/o PNX + further verification of tip position by TEE

Tunneling

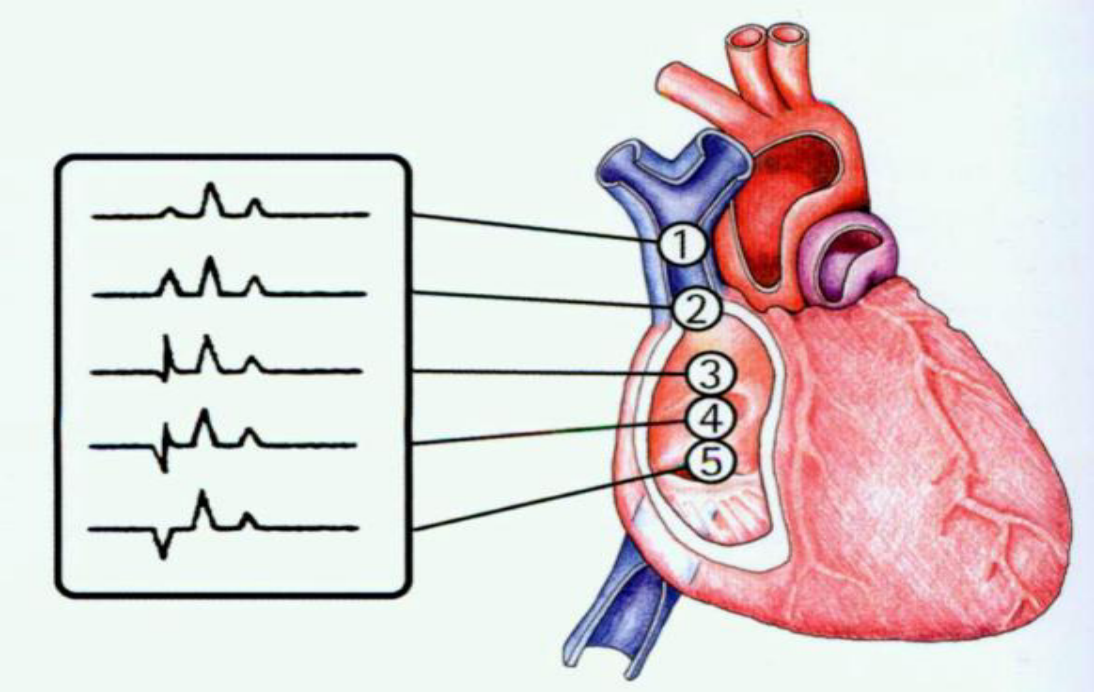
Securement

- glue + sutureless device + transparent dressing

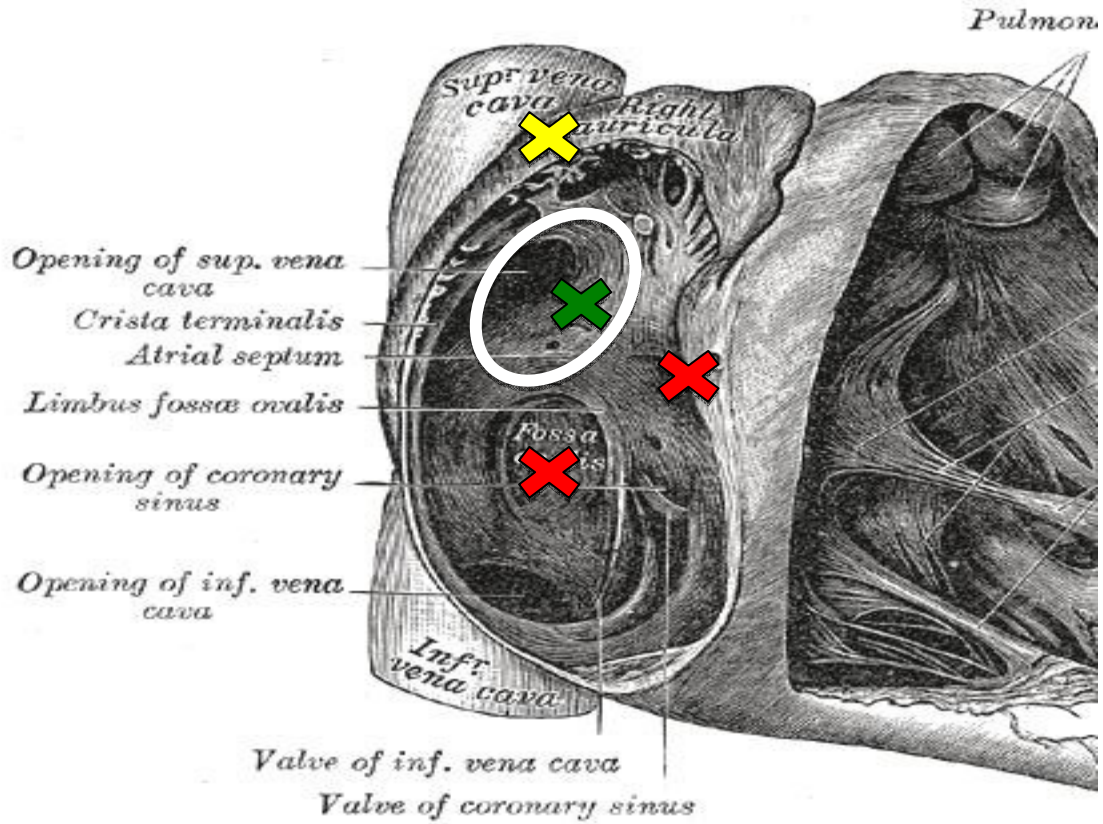
- The correct position of the tip must be verified during the procedure via the intracavitary ECG method



IC-EKG method



- Intracavitary ECG (lead II)
- The intracavitary electrode is the tip of the catheter
- Based on changes of P wave during the progression of the catheter into the central veins
- CAVO-ATRIAL JUNCTION: maximal peak of the P wave (Stas, Yeon, Schummer, Pittiruti/La Greca, etc,) (= CRISTA TERMINALIS)



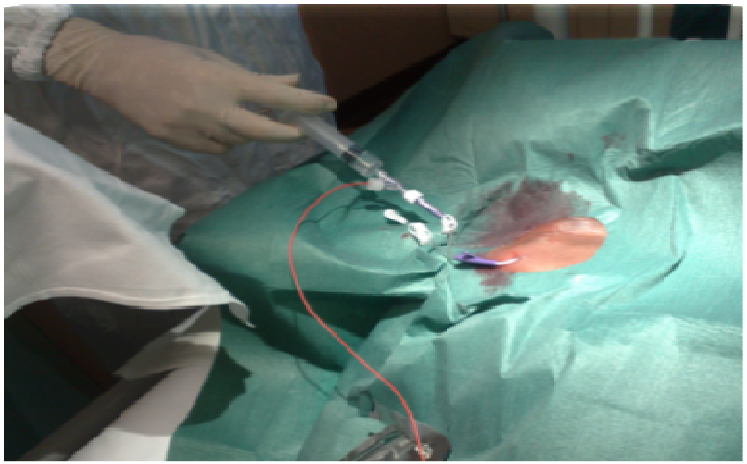
P increasing

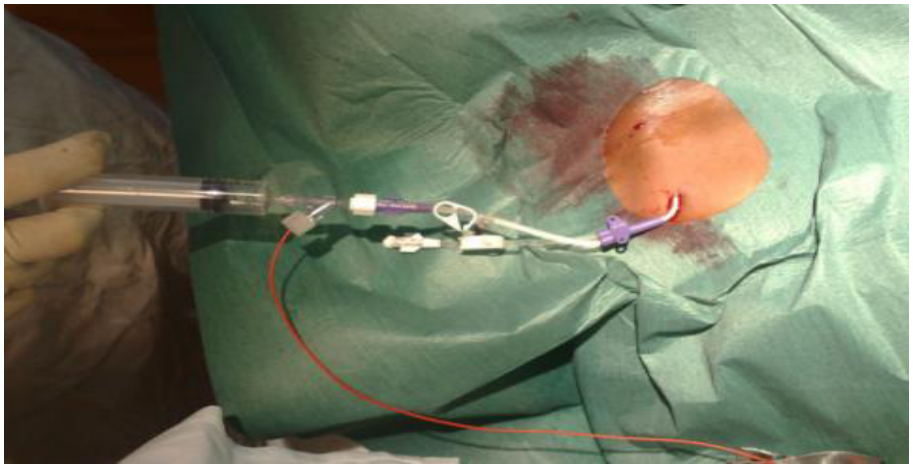
Maximal P

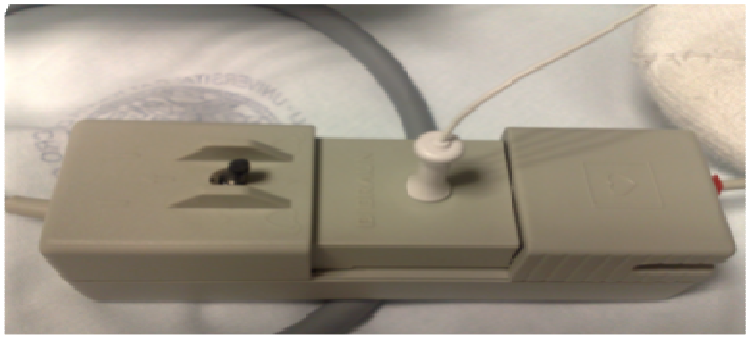
P decreasing and/or diphasic

IC-EKG in children/neonates: does it work ?

- Yes, it works
- Rationale:
  - Surface landmark = unreliable in children
  - Chest X-Ray = more difficult to interpretate
  - Repositioning because of malposition = more expensive
- Critical issues:
  - Never use IC-EKG with guidewire technique (risky)
  - P changes are faster and occur in shorter space
  - X-Ray criteria for CAJ are unclear

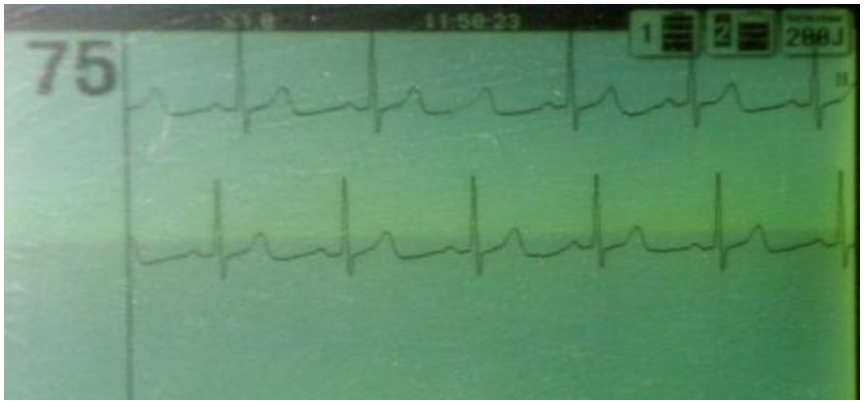


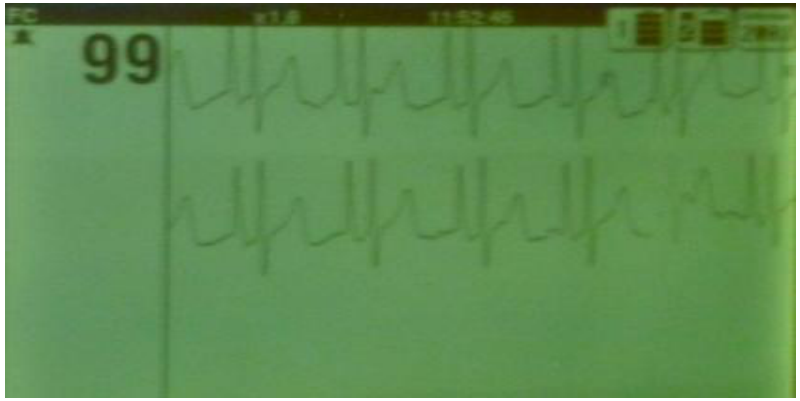





HR
91
PM OFF
SpO2
100
91
ART
80
150
54
43


PAJUNK
MEDIZINTECHNOLOGIE


75


99

GAVeCeLT pediatric ECG Study

JVA
ISSN 1129-7298

J Vasc Access 2014; 00 (00): 000-000
DOI: 10.5301/jva.5000281

ORIGINAL ARTICLE

The intracavitary ECG method for positioning the tip of central venous access devices in pediatric patients: results of an Italian multicenter study

Francesca Rossetti[1], Mauro Pittiruti[2], Massimo Lamperti[3], Ugo Graziano[4], Davide Celentano[5], Giuseppe Capozzoli[6]

[1] Department of Anesthesia, Children's Hospital 'Meyer', Firenze - Italy
[2] Department of Surgery, Catholic University Hospital, Roma - Italy
[3] Department of Neuroanesthesia, Neurological Institute 'Besta', Milano - Italy
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[5] Pediatric Intensive Care Unit, Catholic University Hospital, Roma - Italy
[6] Department of Anesthesia and Intensive Care, Ospedale Civile di Bolzano, Bolzano - Italy

Applicability

99.4 %

- In **2** children out of **309**, the P wave was not identified on the surface ECG, so that IC-ECG was not performed
  - One child 2 mo. old
  - One child 5 yr old

Feasibility

99.4 %

- In **2** cases out of **307** no elevation of the P wave could be identified:
  - One child 1 mo. old
  - One child 2 yr old

Accuracy

95.8%

- Gr. A 96.2%
- Gr. B 95%
- Gr. C 96.8%

In all cases of mismatch but one, tip position as estimated with IC-EKG was too low as estimated by radiological criteria (from +1cm to +5cm).

In the **95** cases performed with a dedicated ECG monitor (Nautilus) accuracy was **98.8%**

Safety

100%

- No complication directly or indirectly related to the IC-EKG method

- In the pediatric population, the IC-EKG method is applicable and feasible in almost all patients (**> 99%**)
- As compared with the radiological methods, the accuracy of the IC-EKG method is very high **95.8%**, and even higher if performed with a dedicated monitor such as Nautilus (**98.8%**)
- The IC-EKG method is **100%** safe also in children

What about IC-EKG in neonates ?

- Preliminary personal experience (**47** cases, not included in the multicenter study)
  - Saline technique
  - Caths >3Fr, central insertion, US-guidance
  - Age 3hrs – 29 days; weight > 950 gr

  RESULTS
  - Applicability **100%**
  - Feasibility : 45 cases out of 47 (**96%**)
  - Accuracy: **100%** (check by x-ray and/or echocardio.)

AHRQ recommendations

2013

Annals of Internal Medicine | SUPPLEMENT

The Top Patient Safety Strategies That Can Be Encouraged for Adoption Now

Paul G. Shekelle, MD, PhD; Peter J. Pronovost, MD, PhD; Robert M. Wachter, MD; Kathryn M. McDonald, MM; Karen Schoelles, MD, SM; Sydney M. Dy, MD, MSc; Kaveh Shojania, MD; James T. Reston, PhD, MPH; Alyce S. Adams, PhD; Peter B. Angood, MD; David W. Bates, MD, MSc; Leonard Bickman, PhD; Pascale Carayon, PhD; Sir Liam Donaldson, MBChB, MSc, MD; Naihua Duan, PhD; Donna O. Farley, PhD, MPH; Trisha Greenhalgh, BM BCH; John L. Haughom, MD; Eileen Lake, PhD, RN; Richard Lilford, PhD; Kathleen N. Lohr, PhD, MA, MPhil; Gregg S. Meyer, MD, MSc; Marlene R. Miller, MD, MSc; Duncan V. Neuhauser, PhD, MBA, MHA; Gery Ryan, PhD; Sanjay Saint, MD, MPH; Stephen M. Shortell, PhD, MPH, MBA; David P. Stevens, MD; and Kieran Walshe, PhD

Table 2. **Patient Safety Strategies Ready for Adoption Now**

Strongly encouraged

- Preoperative checklists and anesthesia checklists to prevent operative and postoperative events
- Bundles that include checklists to prevent central line–associated bloodstream infections
- Interventions to reduce urinary catheter use, including catheter reminders, stop orders, or nurse-initiated removal protocols
- Bundles that include head-of-bed elevation, sedation vacations, oral care with chlorhexidine, and subglottic suctioning endotracheal tubes to prevent ventilator-associated pneumonia
- Hand hygiene
- The do-not-use list for hazardous abbreviations
- Multicomponent interventions to reduce pressure ulcers
- Barrier precautions to prevent health care–associated infections
- Use of real-time ultrasonography for central line placement
- Interventions to improve prophylaxis for venous thromboembolisms

Encouraged

- Multicomponent interventions to reduce falls
- Use of clinical pharmacists to reduce adverse drug events
- Documentation of patient preferences for life-sustaining treatment
- Obtaining informed consent to improve patients' understanding of the potential risks of procedures
- Team training
- Medication reconciliation
- Practices to reduce radiation exposure from fluoroscopy and CT
- The use of surgical outcome measurements and report cards, such as those from ACS NSQIP
- Rapid-response systems
- Use of complementary methods for detecting adverse events or medical errors to monitor for patient safety problems
- Computerized provider order entry
- Use of simulation exercises in patient safety efforts

‘key points’ for an uneventful insertion…

Ultrasound study of deep veins (RaCeVA)

US-guided venipuncture and cannulation

IC-EKG for verification of tip position

Intra-procedural US controls

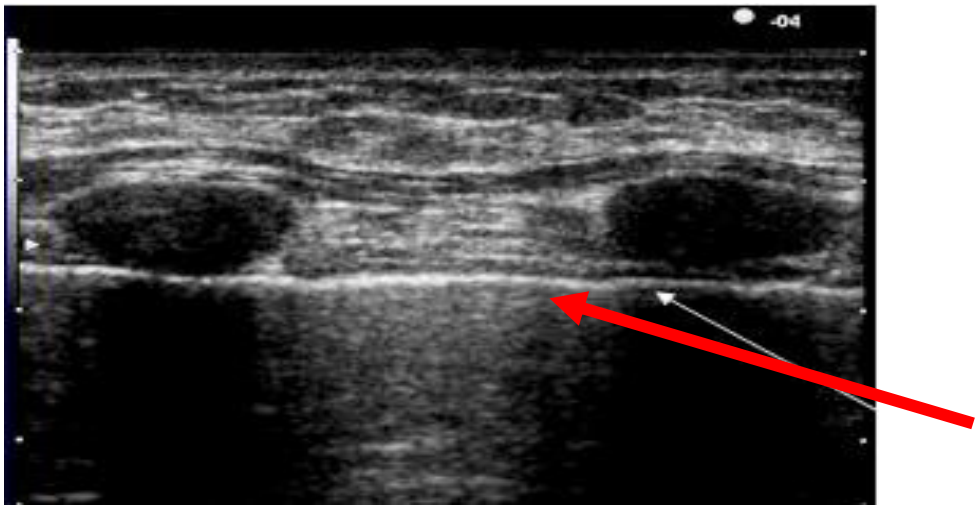
- r/o PNX + further verification of tip position by TEE

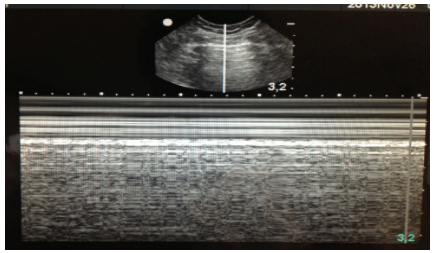
Tunneling

Securement

- 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.





CHEST

Official publication of the American College of Chest Physicians

Test Characteristics of Ultrasonography for the Detection of Pneumothorax: A Systematic Review and Meta-analysis

Khaled Alrajhi, Michael Y. Woo, and Christian Vaillancourt

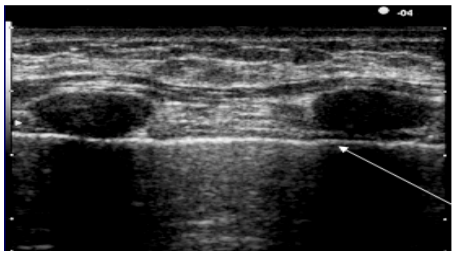


Table 2: Summary of sensitivity and specificity for included studies

Author	N	Ultrasonography		Chest X-ray	
		Sensitivity	Specificity	Sensitivity	Specificity
Blaivas[14]	176	98.1%	99.2%	75.5%	100.0%
Chung[15]	97	88.2%	89.3%	47.1%	94.0%
Garofalo[13]	184	95.7%	100%	-	-
Kirkpatrick[11]	133	48.8%	98.7%	20.9%	99.6%
Rowan[16]	27	100%	93.8%	36.4%	100.0%
Soldati[17]	186	98.2%	100%	53.6%	100.0%
Soldati[18]	109	92.0%	99.5%	52.0%	100.0%
Zhang[19]	135	86.2%	97.2%	27.6%	100.0%

Pediatr Radiol (2012) 42:1287–1297
DOI 10.1007/s00247-012-2401-7

REVIEW

Ultrasound of the pediatric chest

Andrew Mong · Monica Epelman · Kassa Darge

Pediatr Radiol
DOI 10.1007/s00247-014-2930-3

LETTER TO THE EDITOR

Pediatric chest ultrasound versus conventional radiology: experimental evidence first

Francesco Raimondi · Luigi Cattarossi · Roberto Copetti

Intensive Care Med (2012) 38:577–591
DOI 10.1007/s00134-012-2513-4

CONFERENCE REPORTS AND EXPERT PANEL

International evidence-based recommendations for point-of-care lung ultrasound

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Mahmoud Elbarbary
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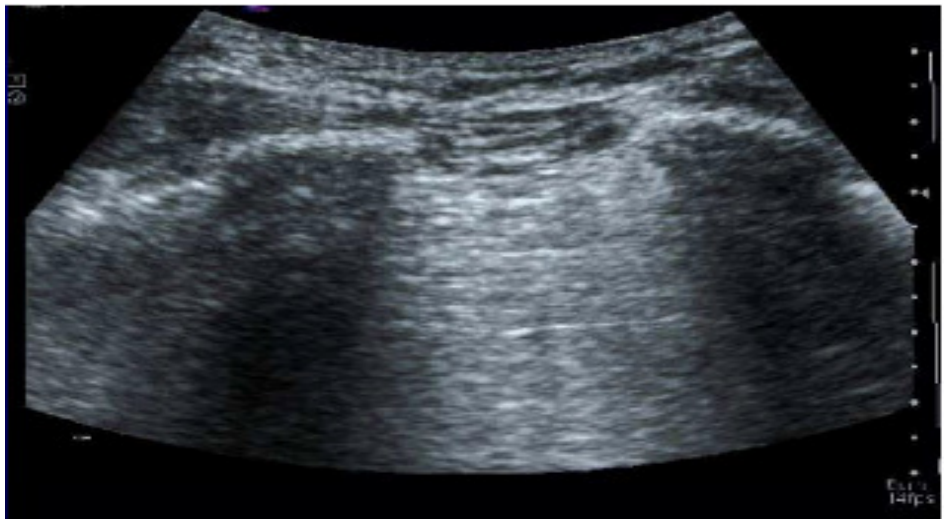
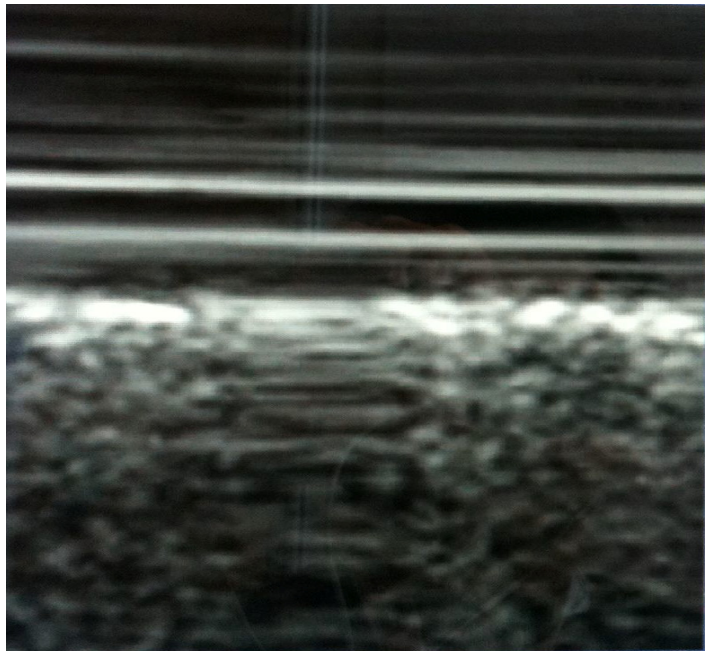
Armin Seibel
Luca Neri
Enrico Storti
Tomislav Petrovic
International Liaison Committee on Lung Ultrasound
(ILC-LUS) for the International
Consensus Conference on Lung Ultrasound (ICC-LUS)

Sliding Sign = No PNX

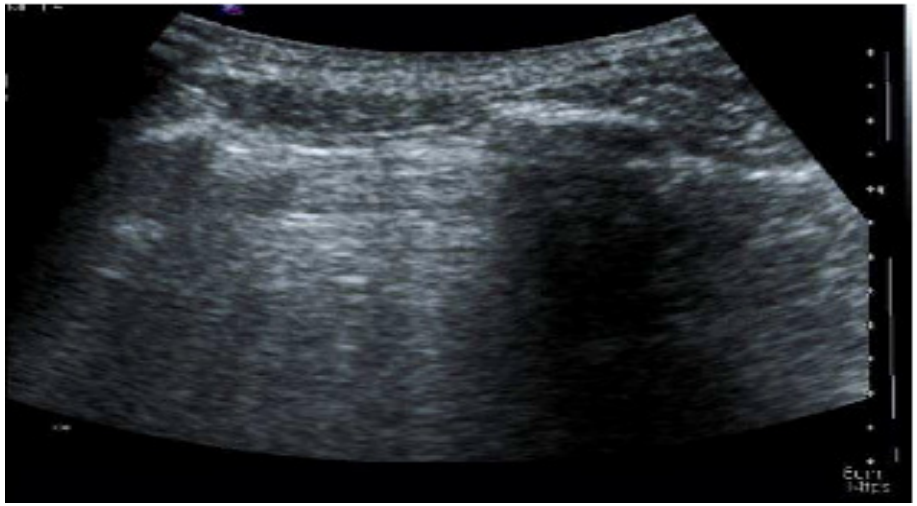


B - mode

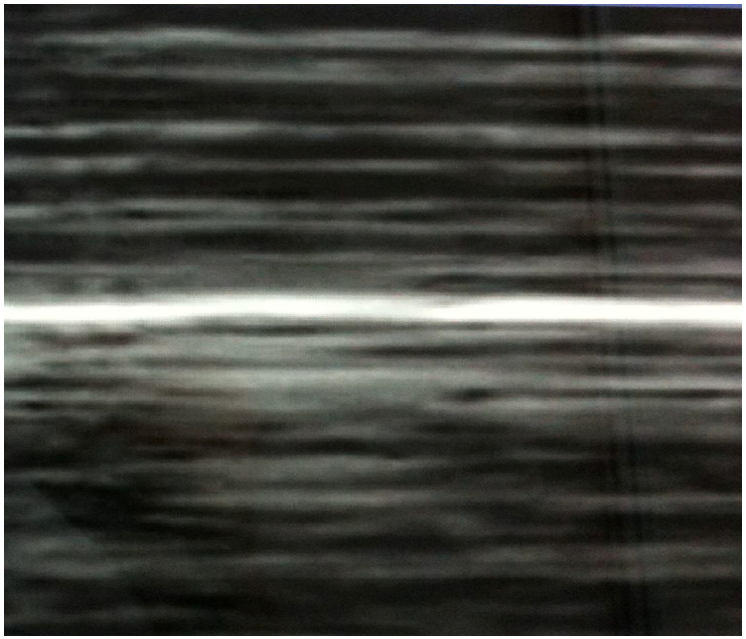


M - mode: seashore sign

No Sliding Sign: PNX!

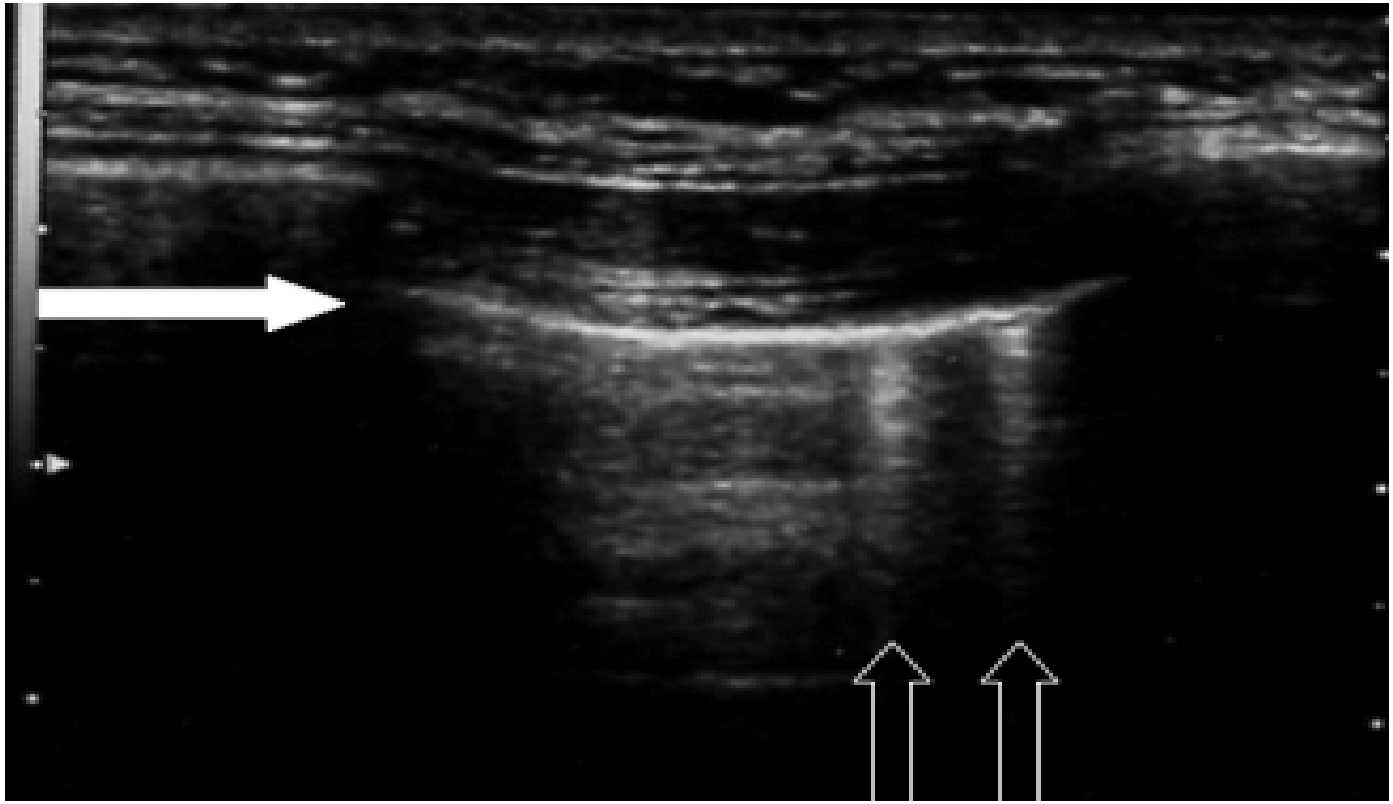


B - Mode

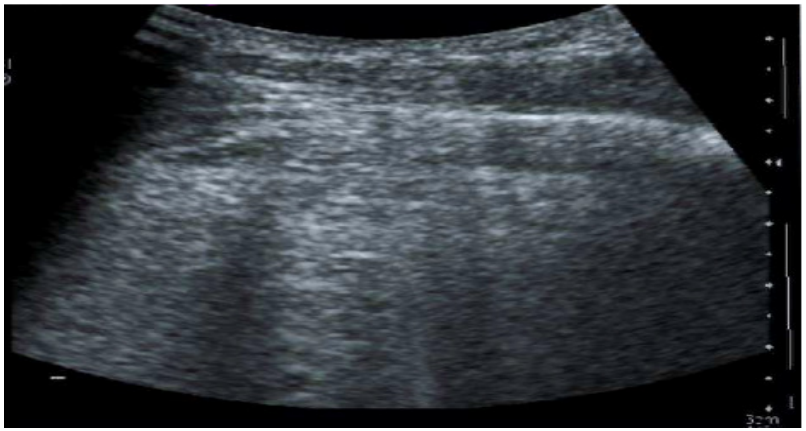


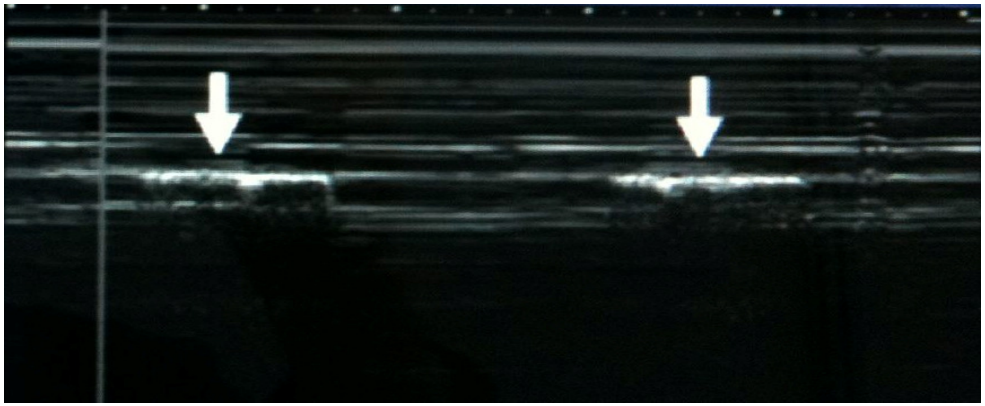
M - mode: barecode sign

Linee B



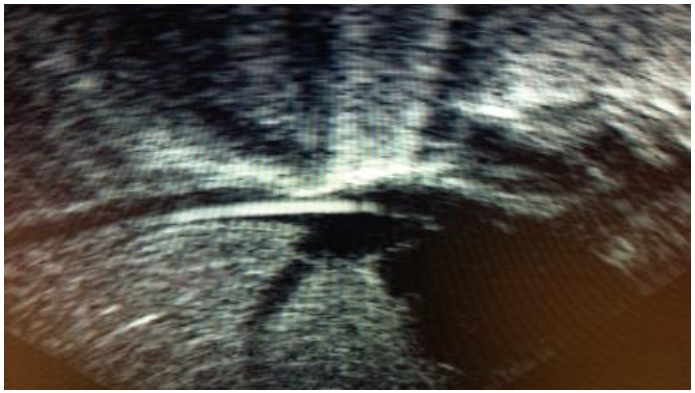
Lung Point





- After the IC-ECG tip location, the correct position of the tip can also be verified by echocardiography (TTE)

TTE = best choice in neonates



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

Intensive Care Med
DOI 10.1007/s00134-012-2597-x

CONFERENCE REPORTS AND EXPERT PANEL

Massimo Lamperti
Andrew R. Bodenham
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Thierry Pirotte
Dimitrios Karakitsos
Jack LeDonne
Stephanie Doniger
Giancarlo Scoppettuolo
David Feller-Kopman
Wolfram Schummer
Roberto Biffi
Eric Desruennes
Lawrence A. Melniker
Susan T. Verghese

International evidence-based recommendations on ultrasound-guided vascular access

WoCoVA-GAVeCeLT Consensus,
Intensive Care Medicine 2012

Table 4 Recommendations on ultrasound vascular access in adults and cost-effectiveness

Ultrasound vascular access in adults

Domain code	Suggested definition	Level of evidence	Degree of consensus	Strength of recommendation
D4.SD2.S1	Ultrasound guidance should be routinely used for short-term central venous access in adults	A	Very good	Strong
D4.SD2.S2	Ultrasound guidance should be routinely used for long-term central venous access in adults	A	Very good	Strong
D4.SD2.S3	PICCs should be routinely inserted at mid arm level by ultrasound guidance using micro introducer technique	A	Very good	Strong
D4.SD2.S4	Use of ultrasound guidance should be taken into consideration for any kind of peripheral intravenous line when difficult access is anticipated	B	Very good	Strong
D4.SD2.S5	Ultrasound-guided arterial catheterization improves first-pass success and should be used routinely in adults	A	Very good	Strong
D4.SD2.S6	Ultrasound can accurately detect pneumothorax and should be routinely performed after central venous catheter cannulation when the pleura could have been damaged	B	Very good	Strong
D4.SD2.S7	CEUS (contrast-enhanced ultrasound) is a valid method for detecting a central venous catheter tip in the right atrium	B	Very good	Strong
Cost-effectiveness of the use of ultrasound for vascular cannulation				
D5.S1–3	Ultrasound-guided vascular access has to be used because it results in clinical benefits and reduced overall costs of care makes it cost-effective	A	Very good	Strong

WoCoVA-GAVeCeLT Consensus, Intensive Care Medicine 2012

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…

Ultrasound study of deep veins (RaCeVA)

US-guided venipuncture and cannulation

IC-EKG for verification of tip position

Intra-procedural US controls

- r/o PNX + further verification of tip position by TEE

Tunneling

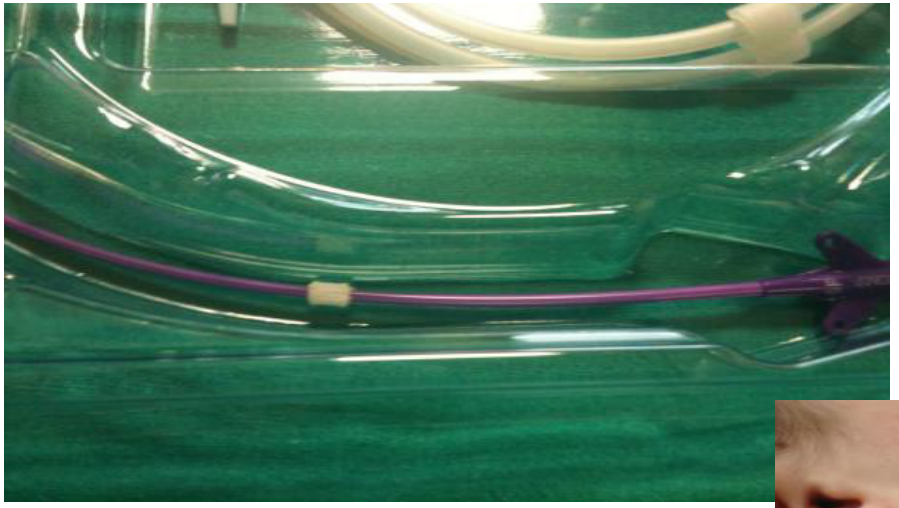
Securement

- 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

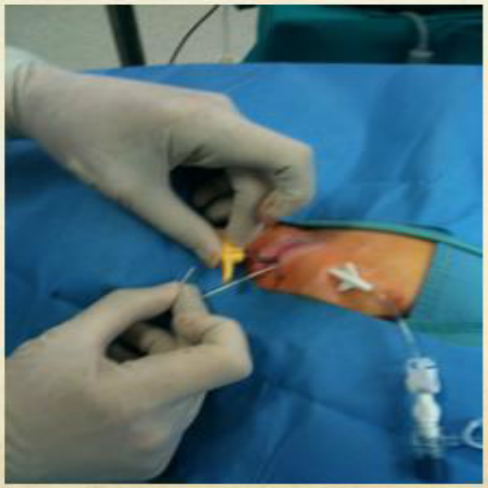



PED
DimAir

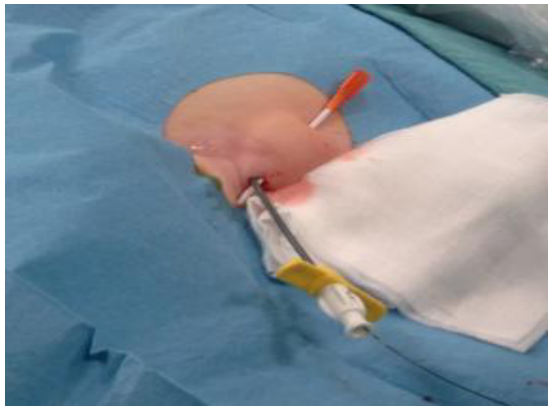


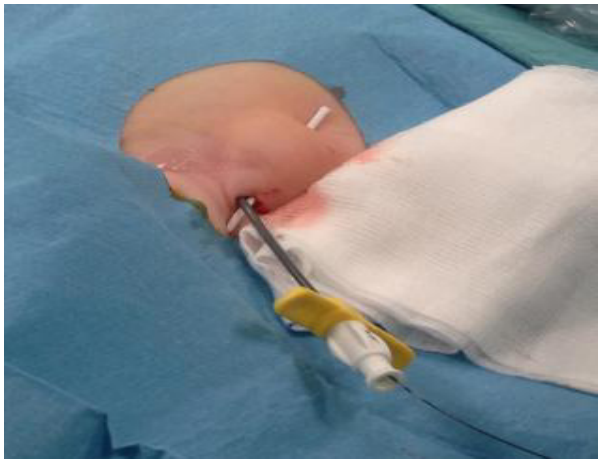

A 0.66cm

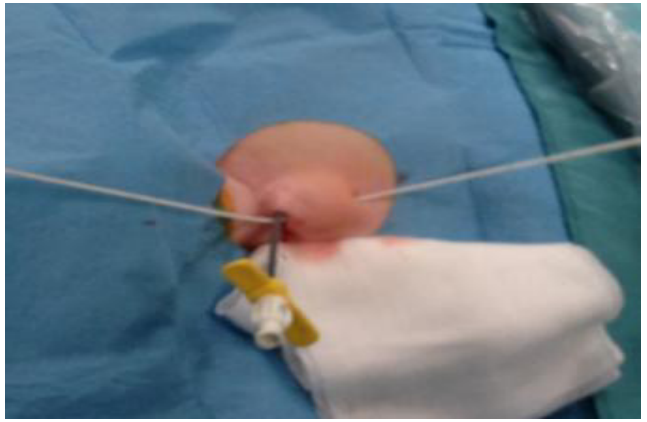


How to tunnel ?








SIEMENS
CE

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).

Please, avoid exit site at the neck ....!

Please, avoid exit site at the neck ....!

‘key points’ for an uneventful insertion…

Ultrasound study of deep veins (RaCeVA)

US-guided venipuncture and cannulation

IC-EKG for verification of tip position

Intra-procedural US controls

- r/o PNX + further verification of tip position by TEE

Tunneling

Securement

- 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

Glue !!!!

Comments

Glue is a simple, safe, inexpensive tool for closing the skin at the puncture site and sealing the skin around the catheter at the exit site.

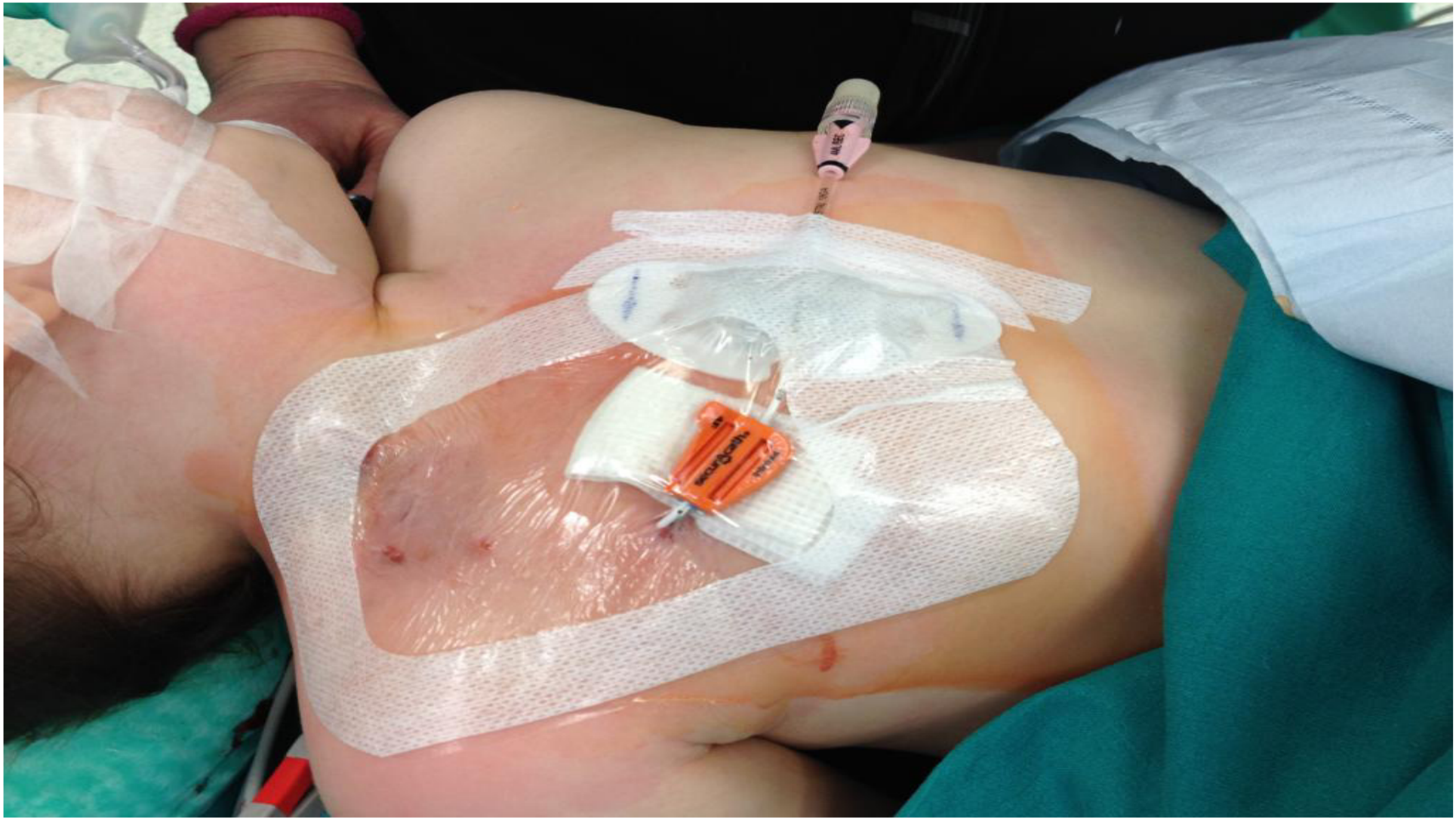
-**Stops extraluminal contamination**

-**Stops bleeding/oozing at the exit site**

-**Secures the catheter for 7-10 days**

Use of glue should be implemented also in ECC

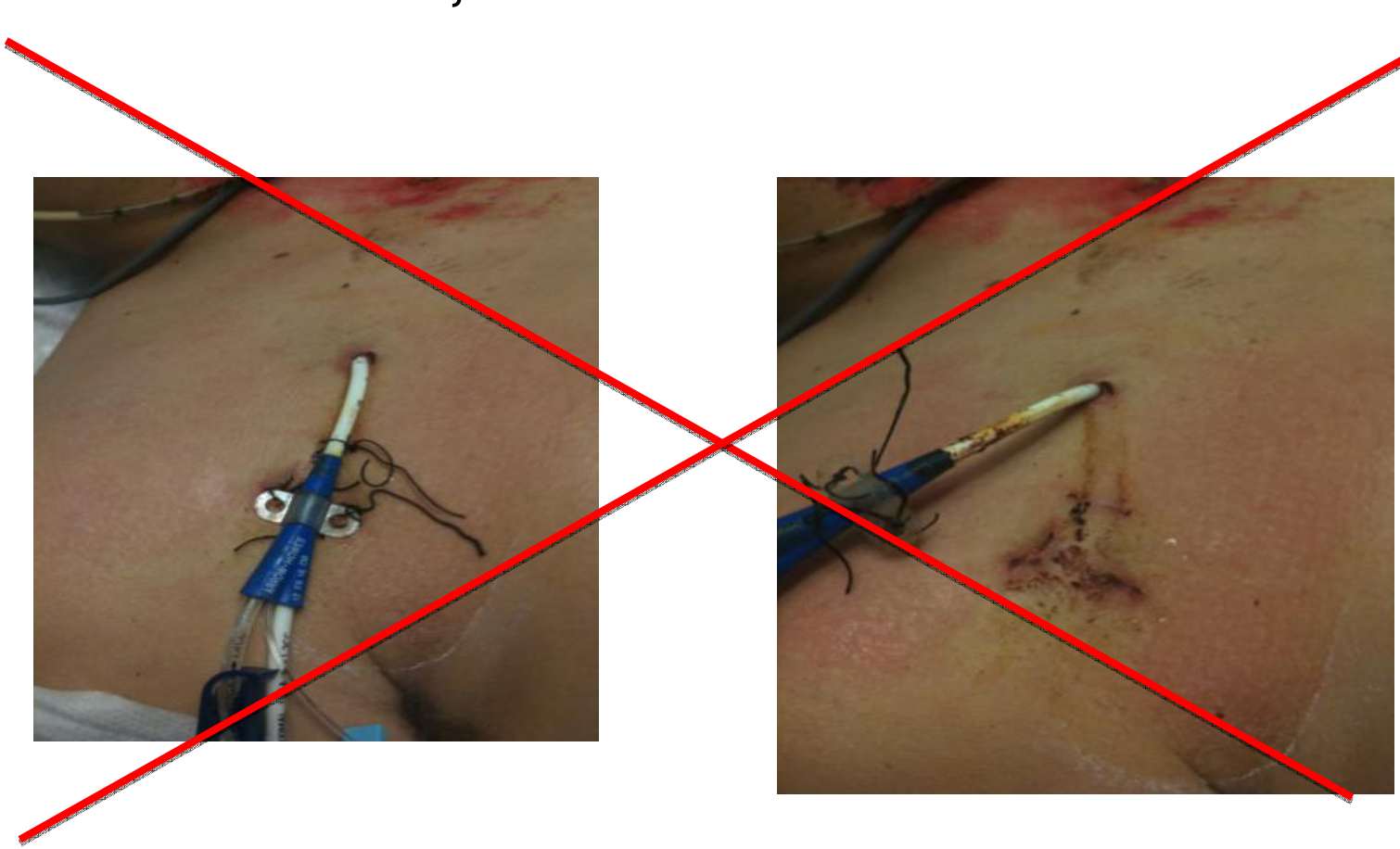
The best securement




securacath
LIFT
4F
HOLD

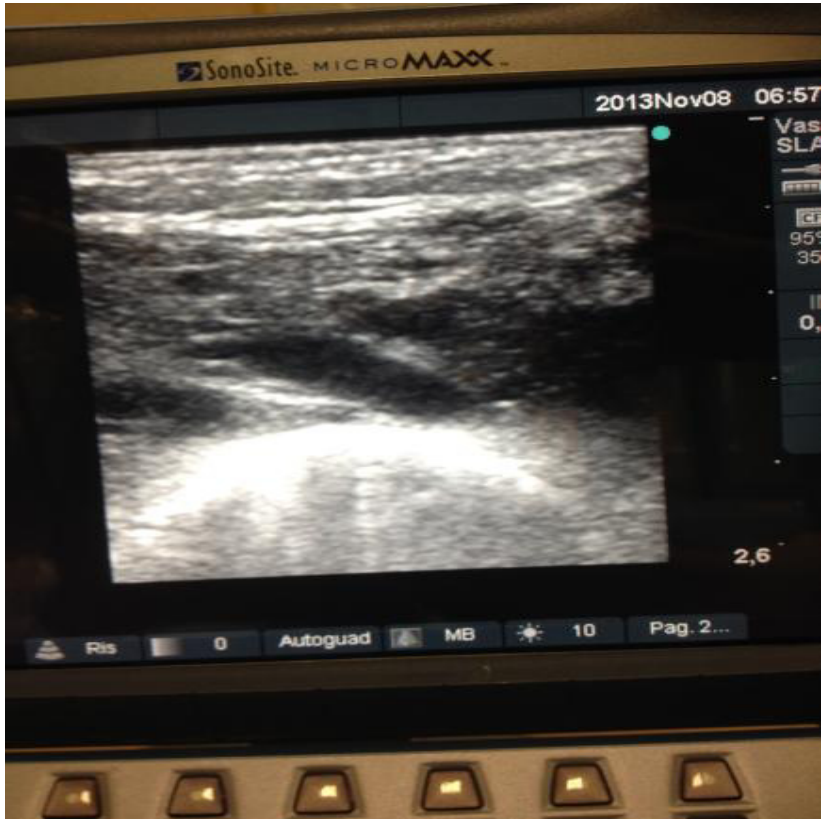
Please, avoid sutures….

Please, avoid sutures….



Insertion of a tunneled central venous catheter in a neonate

(3Fr power injectable polyurethane)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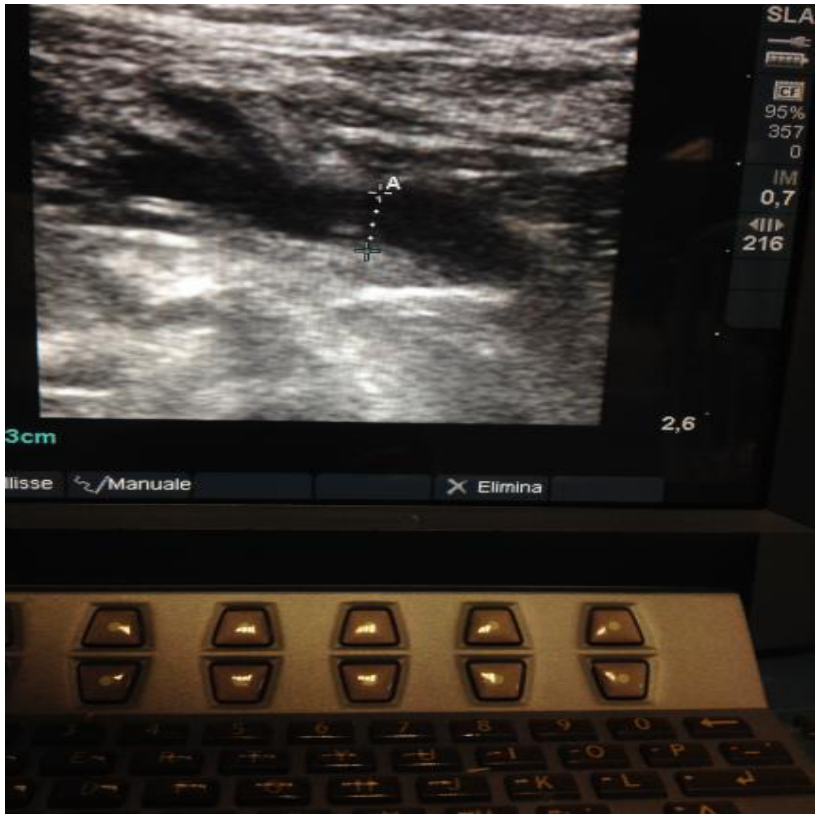
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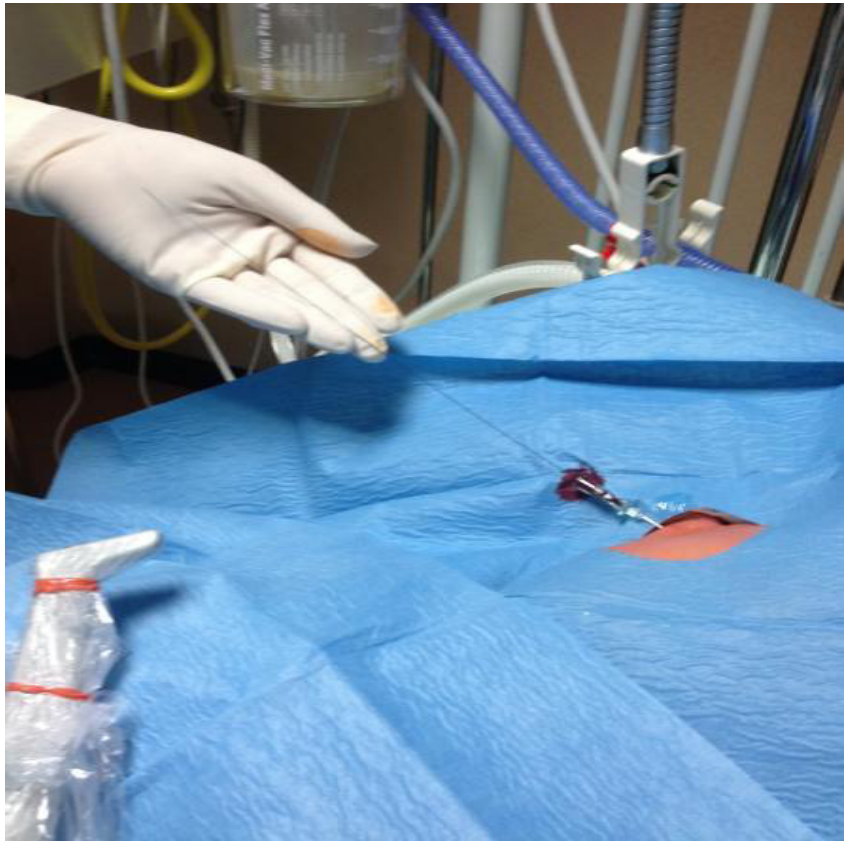

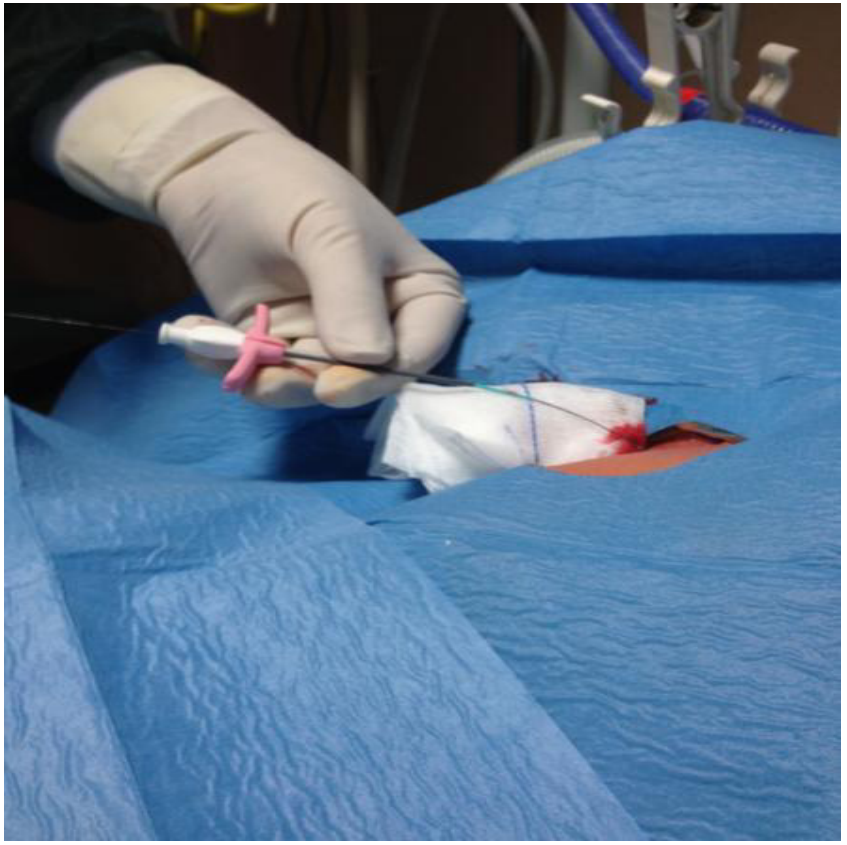

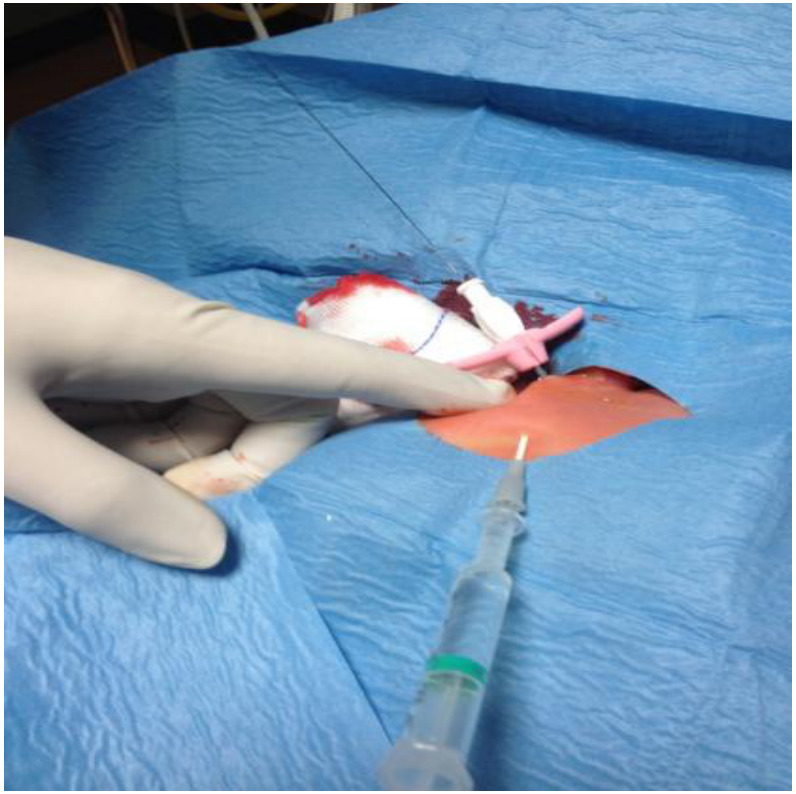

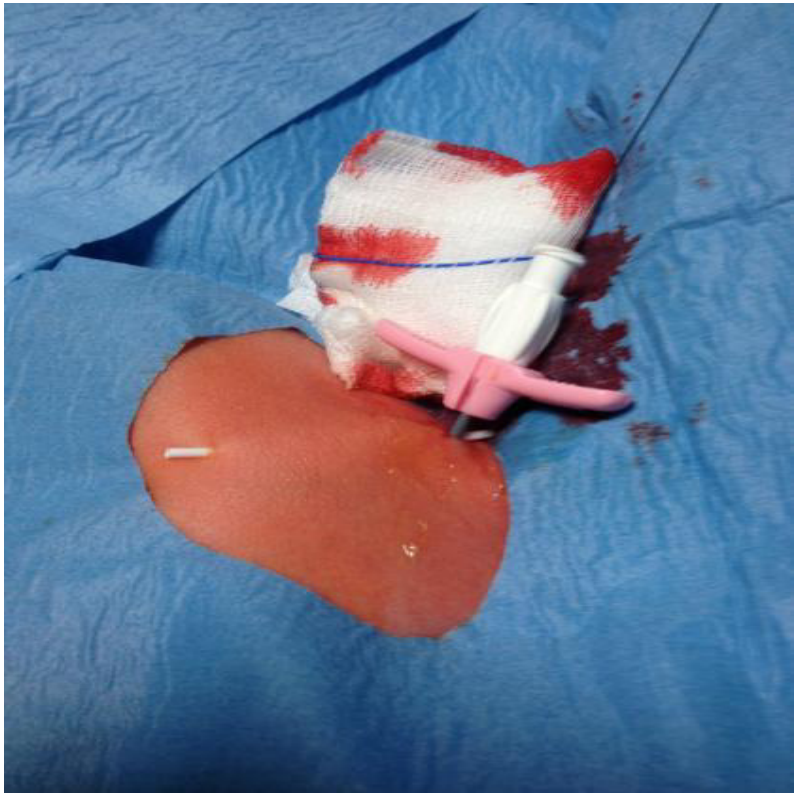

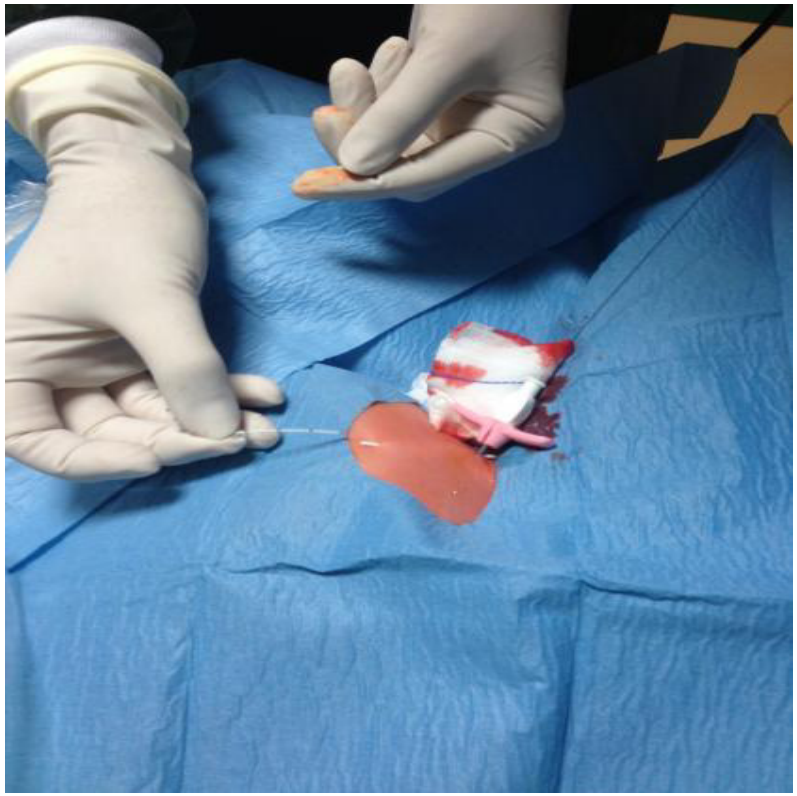

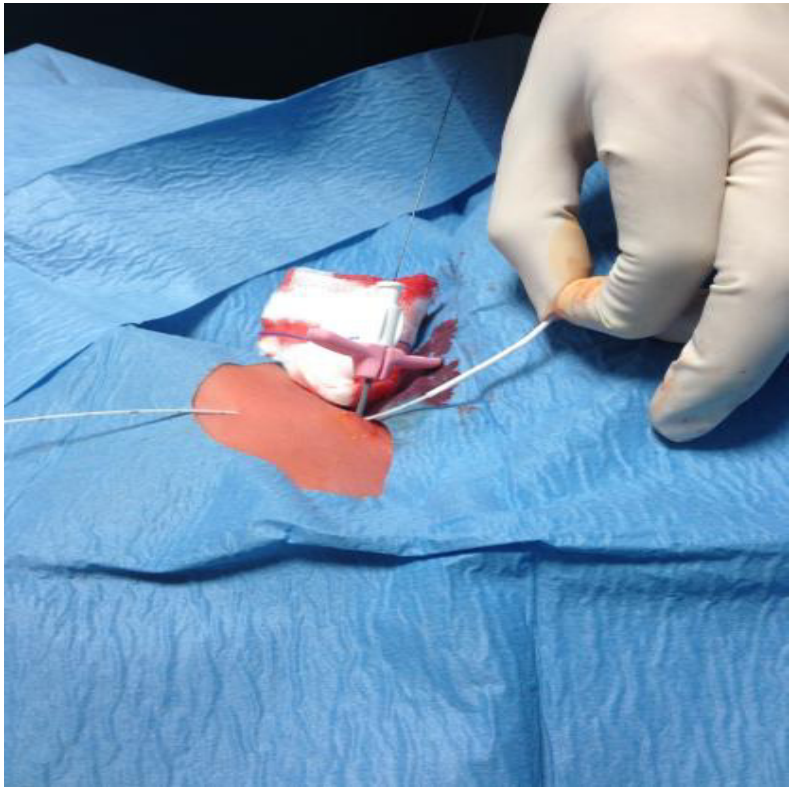

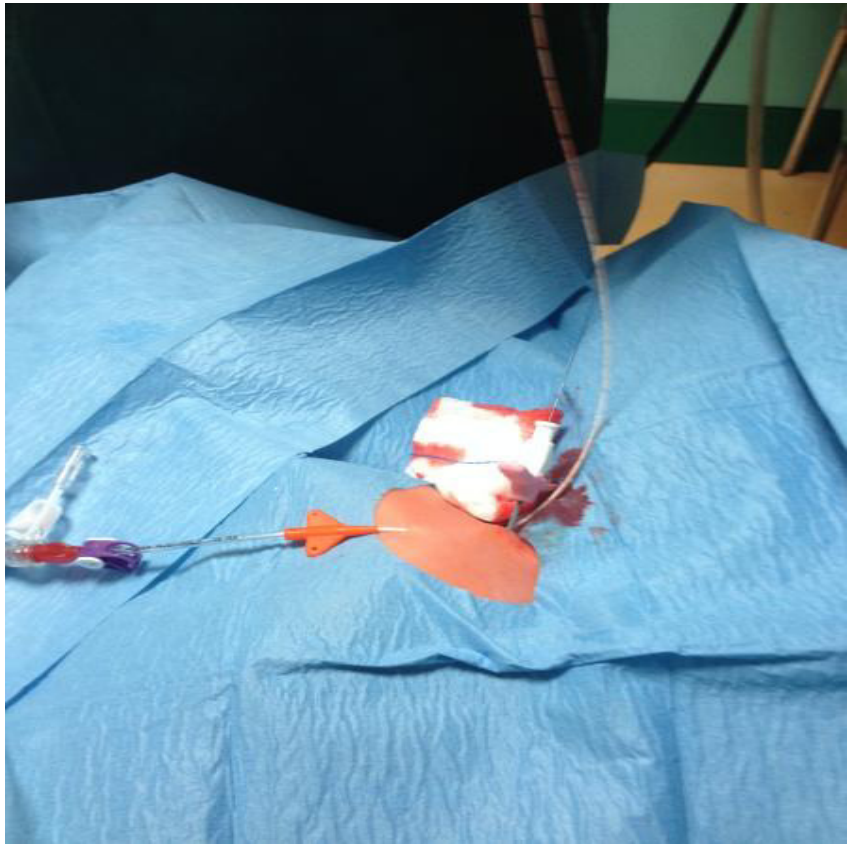

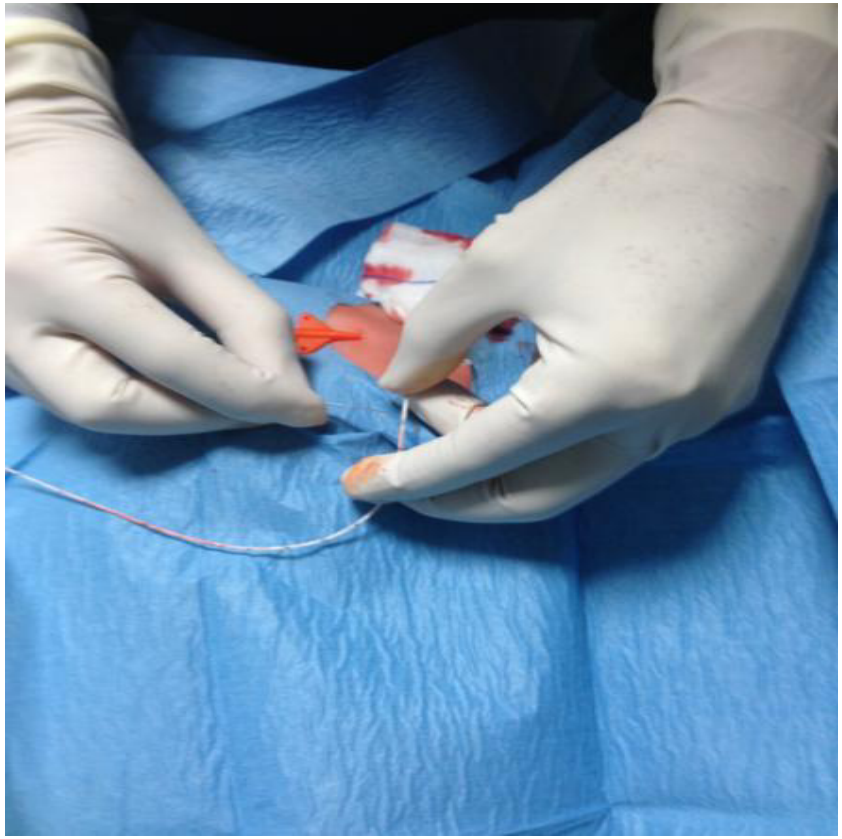

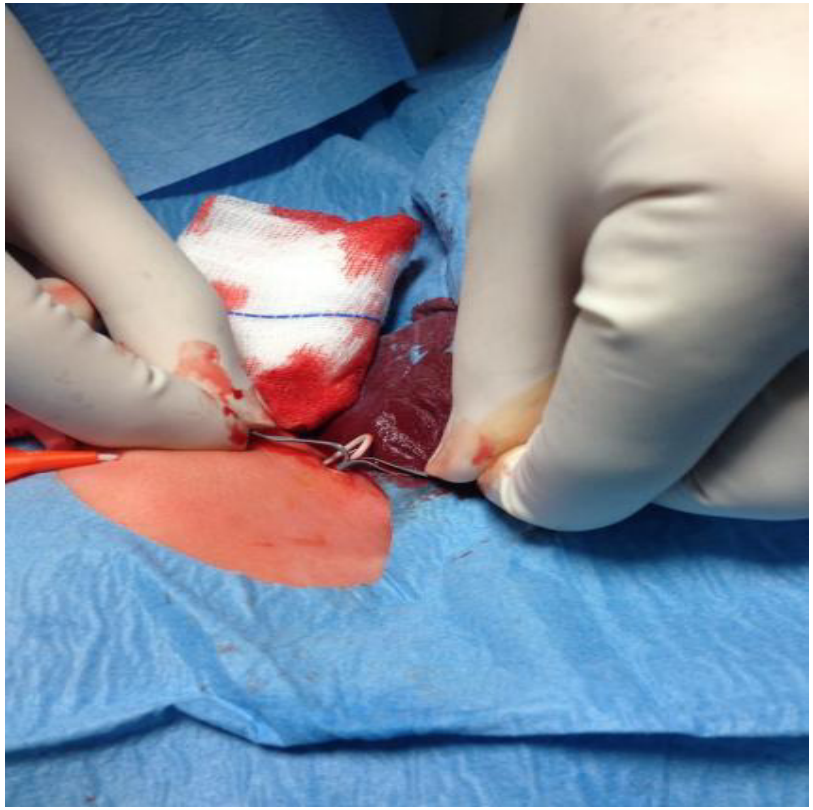

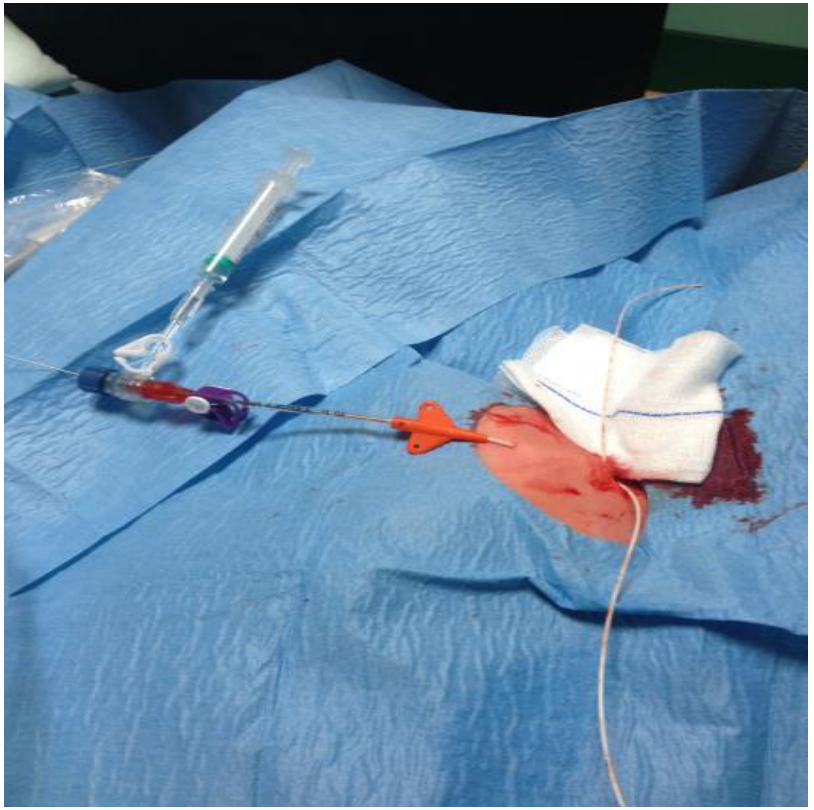

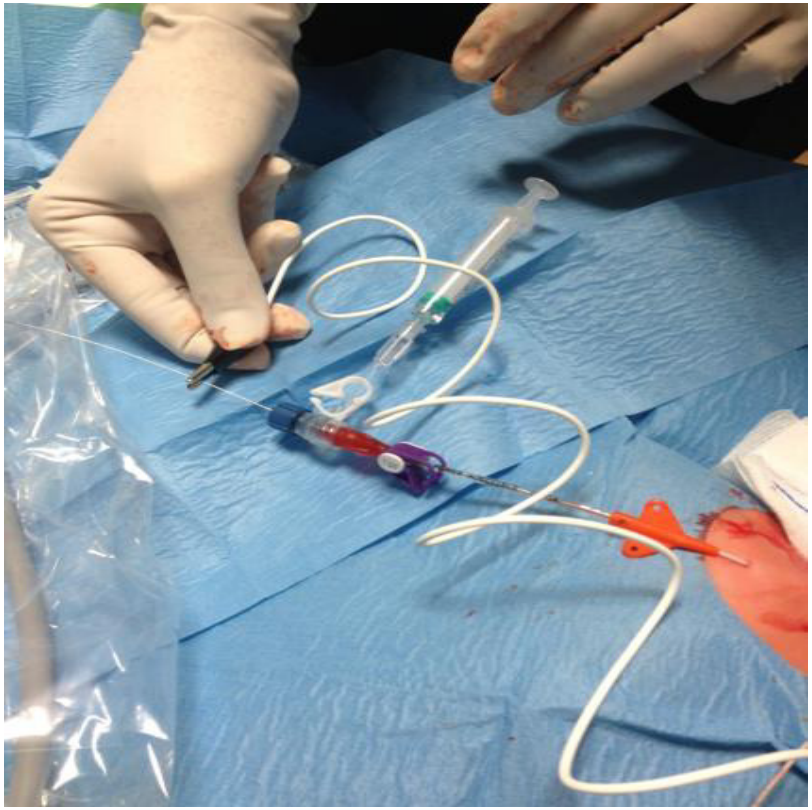

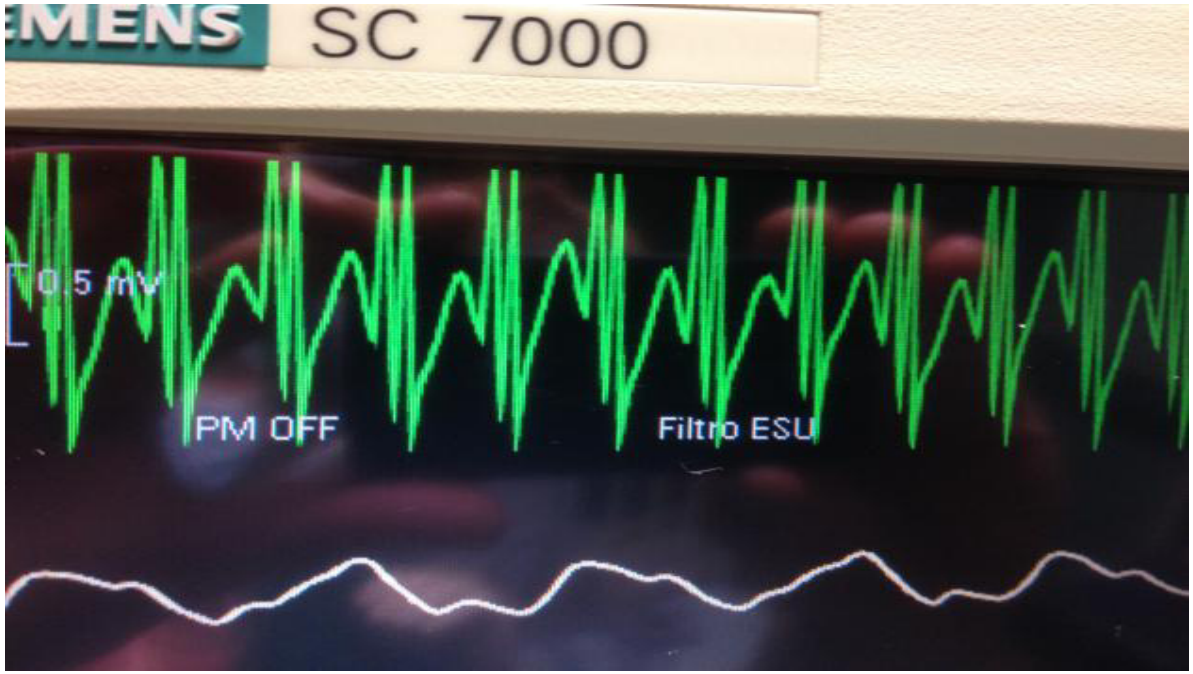
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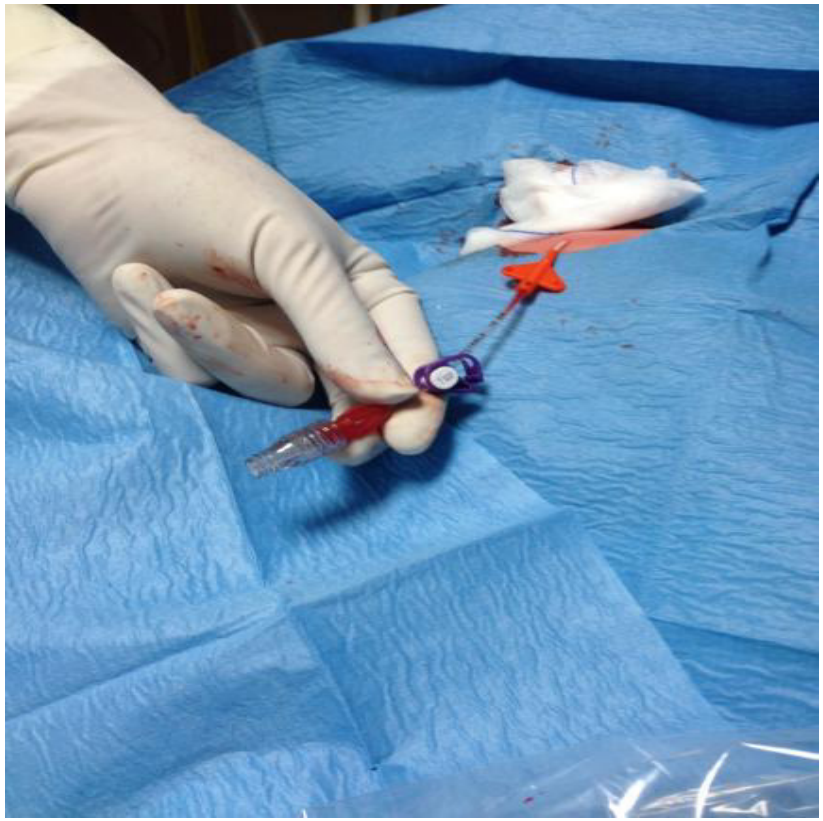

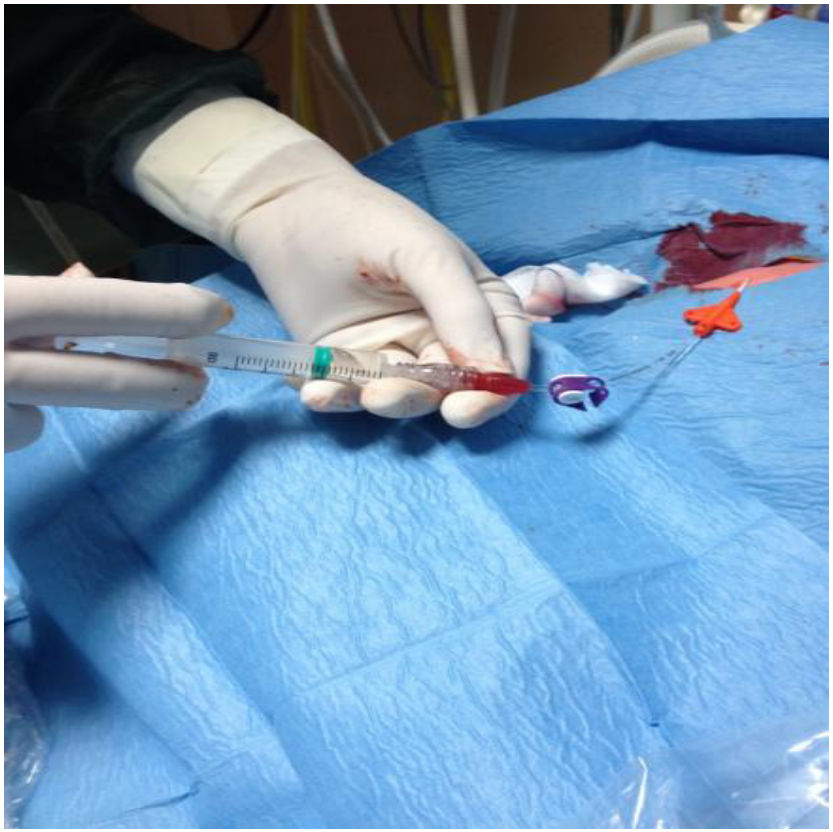

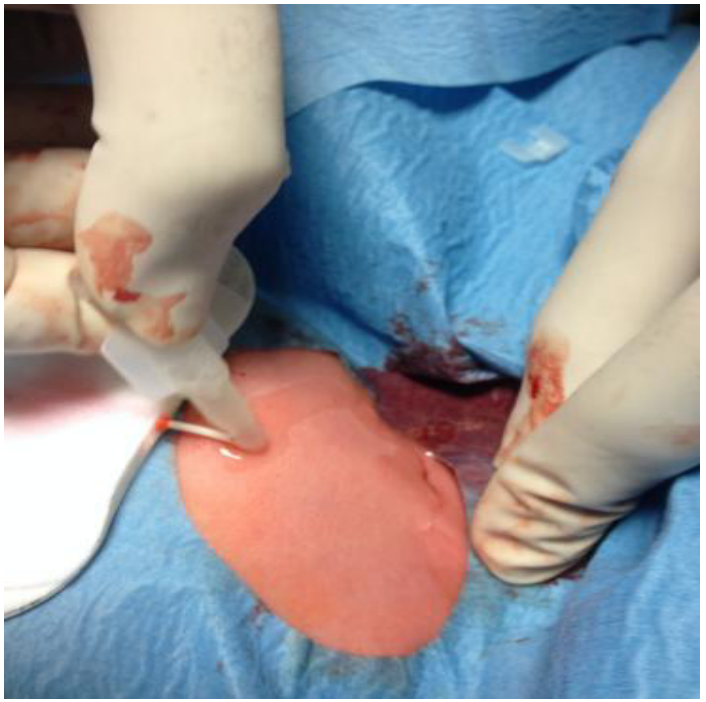

Our Insertion Bundle for CICCs in neonates and infants

(1) ultrasound choice of the vein (RaCeVA);

(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;

(4) tunnelling of the catheter so to obtain an exit site in the infraclavicular area;

(5) Tip location by intracavitary ECG and/or echocardio;

(6) sealing of the exit site with glue;

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

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INS Infusion Nurses Society
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Wolters Kluwer

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)

CONCLUSION

The soft revolution

Pediatric Vascular Access Practice: Time for Evolution or Revolution?

By Amanda J Ullman RN, MAppSci, PhD, Centaur Fellow, Director-at-Large;
Association for Vascular Access Pediatric Special Interest Group, Senior Lecturer;
Alliance for Vascular Access Teaching and Research (AVATAR) Group, Griffith University

1. **We need to <u>improve central venous access in the neonates</u>, the main issues being:**

- Define the role of ultrasound (US) -guided central venous catheters (3Fr, PUR, power injectable, high performance) in premature newborns if compared to the use of epicutaneo-caval catheters (ECC) (1-2.7Fr, silicone or PUR, non-power, low performance)
- Verify the cost-effectiveness and the indication of Near Infra Red Technology in visualizing and cannulating the superficial veins for insertion of ECC
- Improve the training of health care specialists so to implement the use of new technology for insertion (US, NIR) and for tip location (echocardio, intracavitary EKG) of central access in neonates

By Amanda J Ullman RN, MAppSci, PhD, Centaur Fellow, Director-at-Large;
Association for Vascular Access Pediatric Special Interest Group, Senior Lecturer;
Alliance for Vascular Access Teaching and Research (AVATAR) Group, Griffith University

2. **The world of <u>pediatric central venous access needs an update</u>, by implementing materials and methods which have become (or are becoming) the standard of care in adults:**

- Consistent adoption of US-guidance for all central venous access devices (PICC, CICC, FICC, ports)
- Adoption of tip location by intracavitary EKG and/or echocardio
- Shift to power injectable polyurethane for all external catheters (the reason for still using fragile silicon catheters like Broviac and Hickman is mysterious)
- Increased use of PICCs as first option central line in all children
- Increased adoption of tunneling for all external catheters (even if non-cuffed)

3. **<u>Eliminate the problem of dislodgment</u> (the main cause of loss of the central line in pediatrics) by an extensive use of subcutaneously anchored securement devices.**

ZERO COMPLICATIONS is possible

If we only want it

If we make the ‘right’ choices in terms of methodologies and materials

Who is the ‘expert’ ?

Who is the expert ?

To have ‘experience’ is not enough

The expert is the one who knows when/how to use the most appropriate materials and the most appropriate methodology.

Thank you for your attention

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