Visualization of superficial veins in neonates (RaSuVA protocol and NIR technology) and insertion of epicutaneo-cava catheters

Vito D’Andrea

Neonatal European Vascular Access Team

Insertion Bundle

- Optimise the manoeuvre by bringing all evidence-based strategies to minimise complications (immediate, early or late) that may be related to the insertion manoeuvre.
- Facilitate the implementation of such strategies in all neonatal centres.
- Standardise and facilitate training for the manoeuvre.

SIECC
Safe Insertion of Epicutaneo Cava Catheter

1. Preprocedural evaluation (including RaSuVa + NIR)
2. Prepackaged ECC trays.
3. Appropriate aseptic technique (hand hygiene, maximal barrier precautions, skin antisepsis with 2% chlorhexidine in 70% isopropilic alcohol)
4. Real time tip navigation and tip location using NeoECHO Tip protocol.
5. Securement and protection of the exit site (securement by sutureless device, cyanoacrylate glue, semipermeable transparent membrane)
6. Serial US assessment of the catheter tip (at 48 hours; every 7 days)
7. Consider removal within 2 weeks

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Rapid Superficial Vein Assessment (RaSuVA): A pre-procedural systematic evaluation of superficial veins to optimize venous catheterization in neonates

Vito D'Andrea[1], Giorgia Prontera[1], Lucilla Pezza[1], Giovanni Barone[2], Giovanni Vento[1] and Mauro Pittiruti[3]

The Journal of Vascular Access
1–5

DOI: 10.1177/11297298221098481
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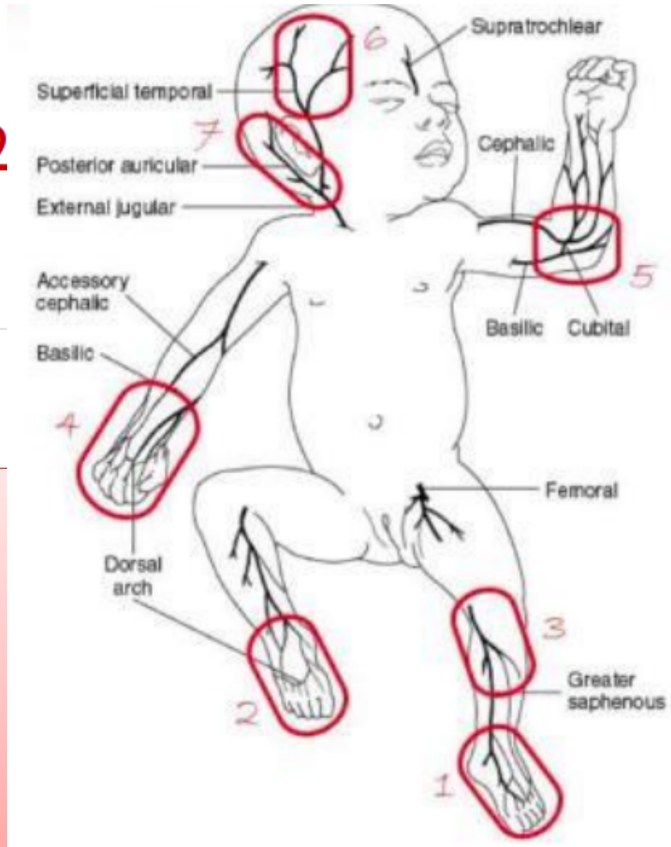
2022



RaSuVA protocol offers an accurate overview of:
– the patient's superficial vein pattern;
– the characteristics of each vein in terms of trajectory and flow;
– the expected difficulty of cannulation for each vein.

Techniques in vascular access

JVA The Journal of Vascular Access

Rapid Superficial Vein Assessment (RaSuVA): A pre-procedural systematic evaluation of superficial veins to optimize venous catheterization in neonates

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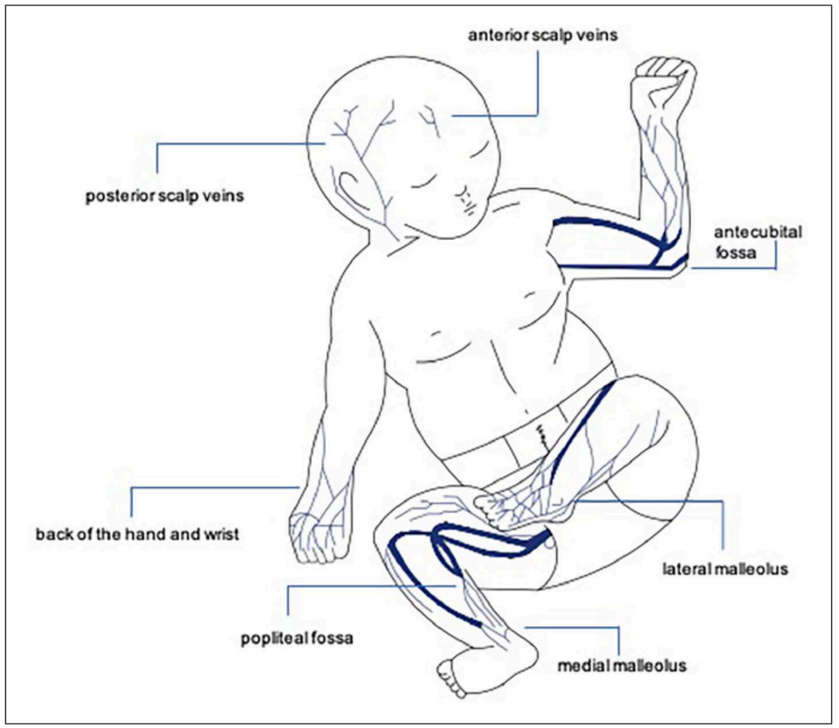
SAGE

Vito D'Andrea[1], Giorgia Prontera[1], Lucilla Pezza[1], Giovanni Barone[2], Giovanni Vento[1] and Mauro Pittiruti[3]

1. Medial malleolus
2. Lateral malleolus
3. Retro-popliteal fossa
4. Back of the hand and wrist
5. Antecubital fossa
6. Anterior scalp surface
7. Posterior scalp surface

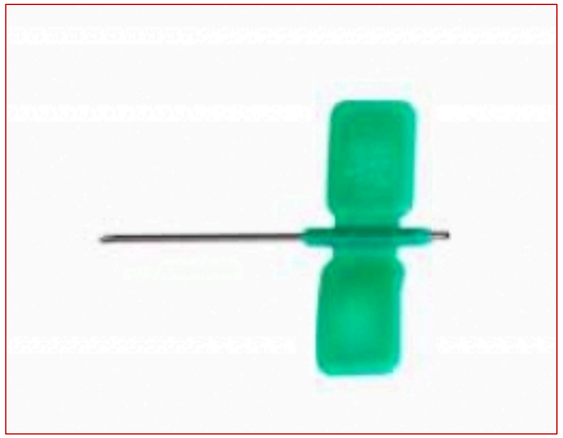
all possible venipuncture sites should be evaluated from feet to head with and without tourniquet, and with and without Near-Infrared technology.

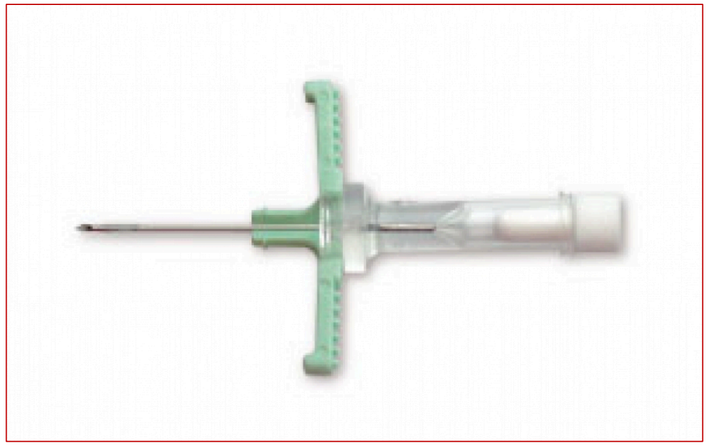


Considering the mean diameter of the veins of the upper and lower limbs, 2-Fr ECCs have a particularly high risk of thrombosis in infants <2,000 g.

Vein	All (n = 100)	500-1000g (n = 20)	1001-1500g (n = 20)	1501-2000g (n = 20)	2001-2500g (n = 20)	2501-3000g (n = 20)	ICC*
R IJV	3.1 ± 0.8 (1.8-6.0)	2.4 ± 0.5 (1.8-3.1)	2.8 ± 0.5 (2.0-3.3)	3.0 ± 0.6 (2.1-4.2)	3.2 ± 0.3 (2.8-3.6)	4.2 ± 0.7 (3.2-6.0)	0.85
L IJV	3.2 ± 0.8 (1.9-7.0)	2.5 ± 0.4 (1.9-3.1)	2.7 ± 0.5 (2.0-3.4)	3.2 ± 0.6 (2.2-4.4)	3.2 ± 0.2 (2.8-3.6)	4.4 ± 0.9 (3.3-7.0)	0.87
R BCV	3.6 ± 0.6 (2.6-5.7)	3.0 ± 0.3 (2.6-3.6)	3.3 ± 0.3 (2.7-3.7)	3.4 ± 0.3 (2.7-3.6)	3.8 ± 0.4 (3.1-4.2)	4.5 ± 0.6 (3.7-5.7)	0.96
L BCV	3.5 ± 0.8 (2.0-7.5)	3.0 ± 0.3 (2.2-3.3)	2.9 ± 0.4 (2.0-3.6)	3.4 ± 0.5 (2.4-4.2)	3.5 ± 0.3 (2.9-4.1)	4.6 ± 0.9 (3.5-6.5)	0.97
R SBV	1.8 ± 0.6 (0.8-3.0)	1.1 ± 0.3 (0.8-1.7)	1.5 ± 0.3 (1.2-2.2)	1.8 ± 0.3 (1.3-2.3)	2.0 ± 0.3 (1.5-2.4)	2.5 ± 0.4 (2.0-3.0)	0.91
L SBV	1.8 ± 0.6 (0.8-3.2)	1.1 ± 0.3 (0.8-1.6)	1.4 ± 0.3 (0.8-1.7)	1.8 ± 0.3 (1.3-2.2)	2.0 ± 0.3 (1.5-2.3)	2.5 ± 0.3 (1.9-3.2)	0.92
R EJV	1.3 ± 0.3 (0.8-2.2)	1.0 ± 0.2 (0.8-1.3)	1.3 ± 0.2 (0.9-1.5)	1.2 ± 0.2 (0.9-1.5)	1.3 ± 0.2 (1.0-1.5)	1.7 ± 0.3 (1.1-2.2)	0.89
L EJV	1.4 ± 0.4 (0.6-2.4)	0.9 ± 0.2 (0.6-1.2)	1.2 ± 0.3 (0.8-1.5)	1.4 ± 0.2 (1.1-1.7)	1.5 ± 0.2 (1.2-1.7)	1.8 ± 0.2 (1.5-2.4)	0.90
R AxVc	1.9 ± 0.5 (1.2-3.5)	1.5 ± 0.1 (1.2-2.0)	1.7 ± 0.4 (1.3-2.3)	1.8 ± 0.3 (1.3-2.2)	2.0 ± 0.3 (1.5-2.3)	2.5 ± 0.5 (1.9-3.5)	0.91
L AxVc	2.0 ± 0.4 (1.3-3.2)	1.6 ± 0.2 (1.3-1.9)	1.9 ± 0.5 (1.3-2.8)	2.0 ± 0.3 (1.4-2.2)	2.2 ± 0.2 (1.9-2.5)	2.5 ± 0.4 (2.0-3.2)	0.93
R AxVa	1.6 ± 0.4 (0.8-2.4)	1.2 ± 0.3 (0.8-1.5)	1.5 ± 0.3 (1.0-1.9)	1.5 ± 0.3 (1.1-2.1)	1.8 ± 0.3 (1.3-2.2)	2.1 ± 0.2 (1.5-2.4)	0.92
L AxVa	1.6 ± 0.4 (0.8-2.6)	1.2± 0.2 (0.8-1.7)	1.5 ± 0.4 (1.0-2.1)	1.7 ± 0.3 (1.0-2.1)	1.8 ± 0.2 (1.4-2.1)	2.0 ± 0.3 (1.6-2.6)	0.91
R BrV	1.0 ± 0.3 (0.5-2.1)	0.9 ± 0.2 (0.7-1.2)	0.8 ± 0.2 (0.5-1.0)	0.8 ± 0.2 (0.6-1.1)	1.1 ± 0.1 (0.9-1.3)	1.5 ± 0.2 (1.2-2.1)	0.89
L BrV	1.1 ± 0.4 (0.6-1.9)	0.9 ± 0.2 (0.7-1.3)	0.8 ± 0.2 (0.6-1.0)	1.0 ± 0.2 (0.7-1.3)	1.2 ± 0.1 (1.0-1.4)	1.6 ± 0.2 (1.3-1.9)	0.90
R BaV	1.0 ± 0.3 (0.5-1.5)	0.7 ± 0.2 (0.5-1.1)	1.0 ± 0.2 (0.7-1.2)	0.9 ± 0.2 (0.6-1.2)	1.2 ± 0.2 (0.7-1.4)	1.3 ± 0.1 (1.1-1.5)	0.91
L BaV	1.0 ± 0.3 (0.5-1.5)	0.7 ± 0.1 (0.5-1.0)	0.9 ± 0.1 (0.7-1.1)	0.9 ± 0.1 (0.6-1.1)	1.3 ± 0.2 (0.8-1.5)	1.3 ± 0.1 (1.1-1.5)	0.92
R FeV	2.3 ± 0.7 (1.1-3.5)	1.4 ± 0.2 (1.1-1.8)	2.1 ± 0.4 (1.3-2.7)	2.2 ± 0.3 (1.8-2.6)	2.8 ± 0.4 (2.1-3.4)	3.2 ± 0.2 (2.9-3.5)	0.89
L FeV	2.3 ± 0.7 (1.1-3.5)	1.4 ± 0.3 (1.1-1.9)	2.1 ± 0.5 (1.6-2.9)	2.0 ± 0.4 (1.4-2.6)	2.9 ± 0.2 (2.5-3.3)	3.1 ± 0.2 (2.9-3.5)	0.91
R SaV	1.3 ± 0.5 (0.5-2.3)	0.8 ± 0.2 (0.5-1.2)	1.0 ± 0.3 (0.7-1.8)	1.3 ± 0.2 (0.9-1.5)	1.7 ± 0.4 (1.2-2.3)	1.8 ± 0.3 (1.3-2.3)	0.88
L SaV	1.3 ± 0.5 (0.4-2.3)	0.8 ± 0.2 (0.4-1.1)	1.1 ± 0.2 (0.7-1.5)	1.2 ± 0.2 (0.8-1.4)	1.8 ± 0.3 (1.4-2.3)	1.8 ± 0.3 (1..4-2.3)	0.89

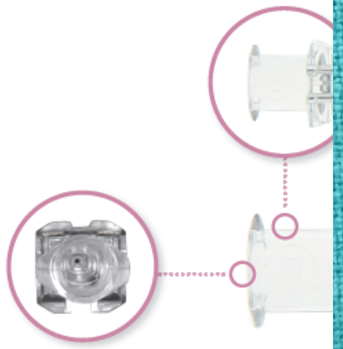
ECC





ECC

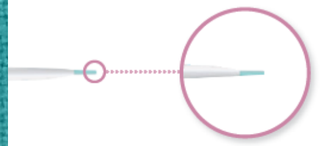
Puncture needle



Funnel entry:
Easy insertion of the guidewire

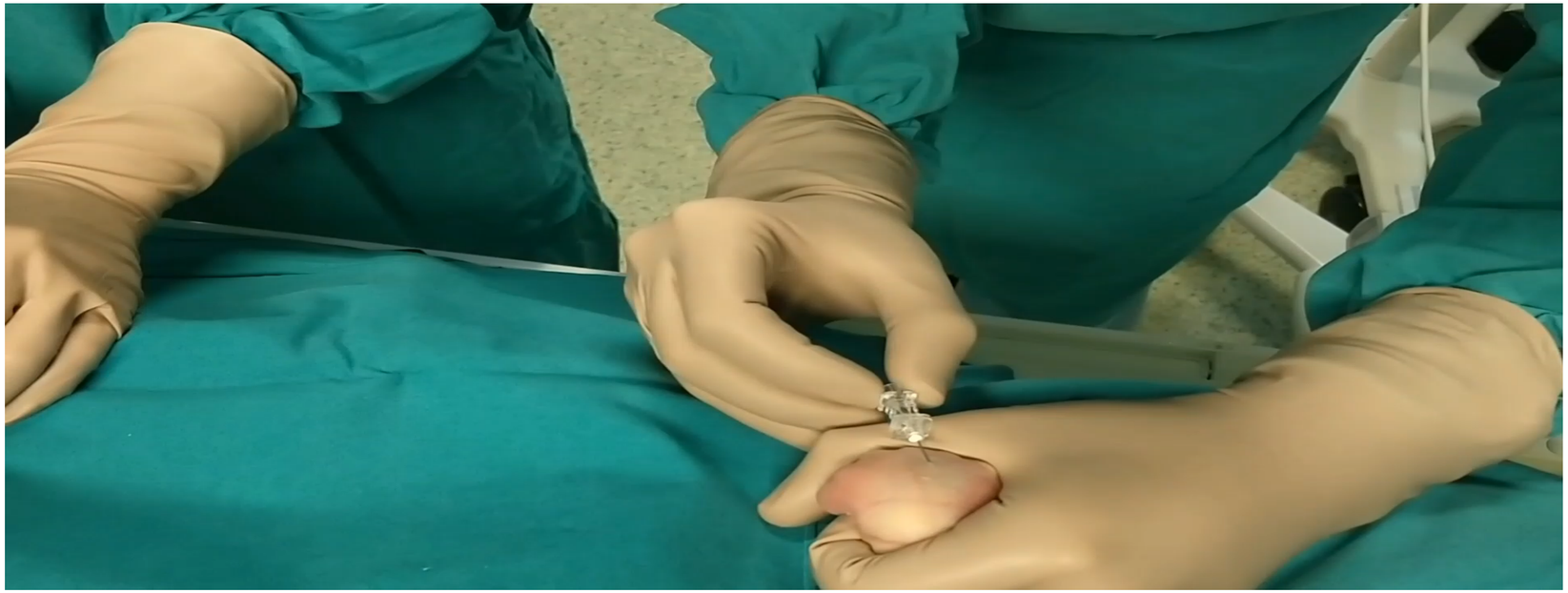
nmetrical tips:

18 mm / 20 G



Tapered tip:
Good skin penetration

th:



Modified seldinger technique for ECC

Original research article

JVA | The Journal of Vascular Access

Modified Seldinger technique for neonatal epicutaneo-caval catheter insertion: A non-randomised retrospective study

The Journal of Vascular Access
1–6

DOI: 10.1177/11297298211054637
journals.sagepub.com/home/jva
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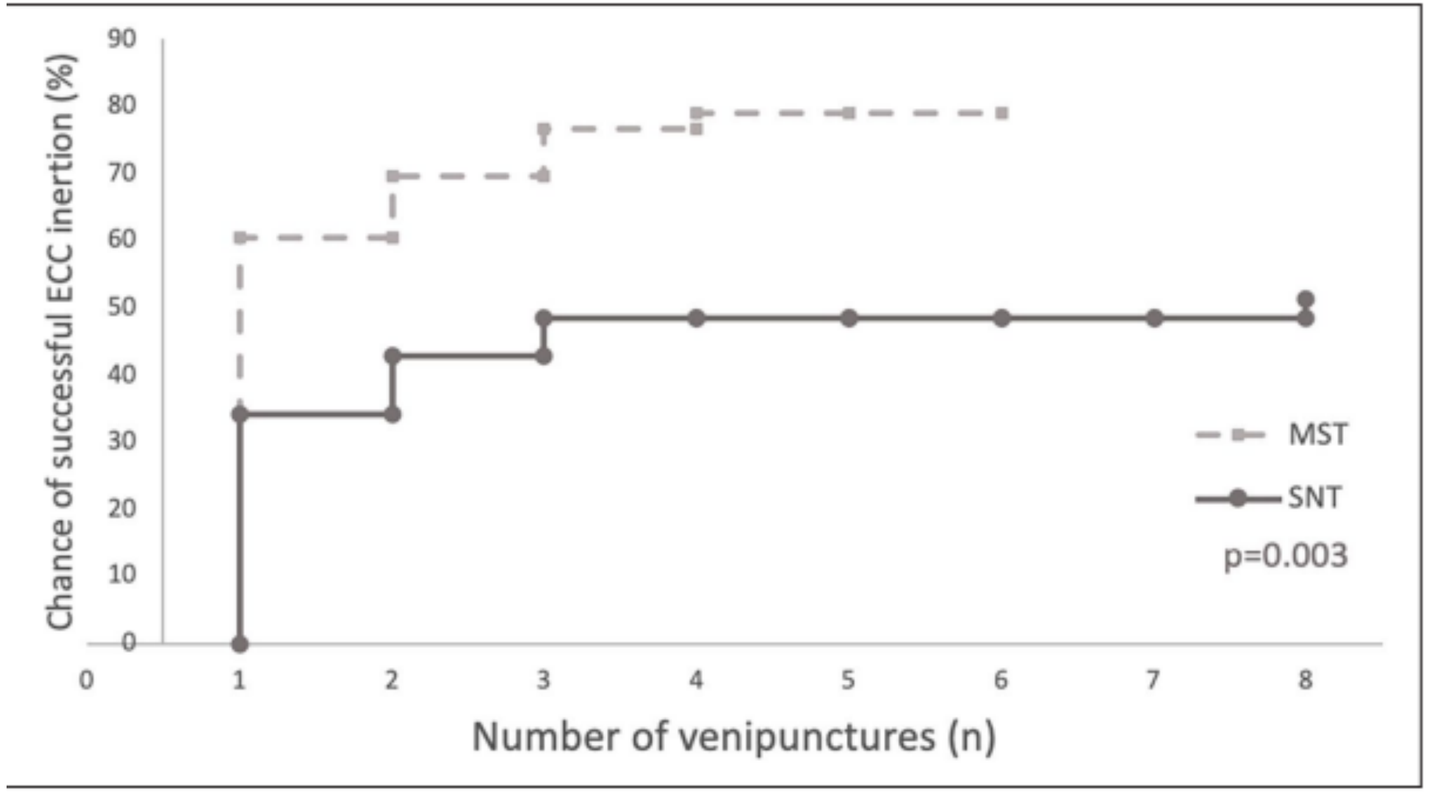
Jack JC Gibb[1*], Rachael MacLeod[2*], Liam Mahoney[2] and Ziju Elanjikal[2]

	MST		SNT	
Attempts (n)	43		35	
	1 Fr = 10	2 Fr = 33	1 Fr = 4	2 Fr = 31
Venipunctures (n)	76		78	
Successful ECCs (n (%))	31 (72)		14 (40)	
	1 Fr = 9	2 Fr = 22	1 Fr = 0	2 Fr = 14
First pass success (n (%))	23 (53)		9 (26)	
Venipunctures/ successful ECC	2.5		5.6	
Dwell time (days)*	7 (11.5–18.3)		10.5 (13.5–21.5)	

BW: birth weight; CI: confidence interval; Fr: French; GA: gestatior
split needle technique; GA: gestational age.
*Median (IQR)



DIVA score

Pediatr Emerg Care. 2008 Mar;24(3):143-7. doi: 10.1097/PEC.0b013e3181666f32.

Academic Emergency Medicine
Official Journal of the Society for Academic Emergency Medicine

ORIGINAL RESEARCH CONTRIBUTION

Validation and Refinement of the Difficult Intravenous Access Score: A Clinical Prediction Rule for Identifying Children With Difficult Intravenous Access

Michael W. Riker, MD, Chris Kennedy, MD, Brad S. Winfrey, RN, Kenneth Yen, MD, MS, and M. Denise Dowd, MD, MPH

Predictor Variable	Scores		
Visibility	Visible = 0		Not visible = 2
Palpability	Palpable = 0		Not palpable = 2
Age	≥36 months = 0	12–35 months = 1	< 12 months = 3
Prematurity	Not premature = 0		Premature = 3
Skin shade	Light = 0	Dark = 1	

Score ≥ 4, cut-off value for predicting failure

Turn on the lights in NICU!

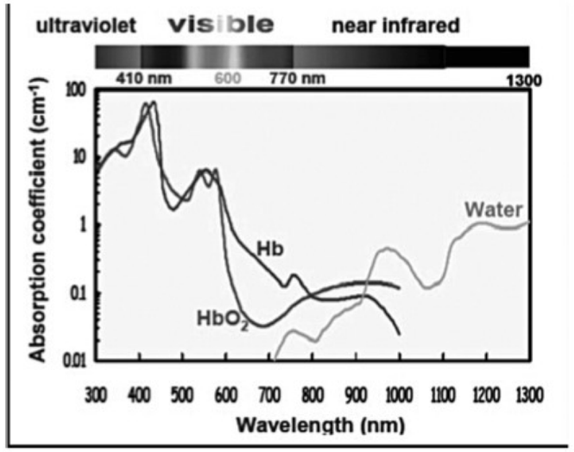
European recommendations on the proper indication and use of peripheral venous access devices (the ERPIUP consensus): A WoCoVA project

(5) Also, new technologies for insertion of peripheral VADs have been developed. The INS Standards of Practice[10] recommend considering the use of Near-Infra-Red technology (NIR) for insertion of peripheral VADs in superficial veins and the use of ultrasound (US) guidance for their insertion in deep veins. A vast scientific literature has recently been published on this subject, addressing the technical aspects, the indications, the advantages, and the limits of such imaging techniques.

Use near infrared (nIR) light technology to aid in locating viable superficial peripheral venous sites and decreasing procedure time for peripheral intravenous catheter (PIVC) insertion.

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.
2. Use nIR light technology to assess peripheral venous sites and facilitate more informed decisions about vein selection (ie, bifurcating veins, tortuosity of veins, palpable but nonvisible veins, location of venous valves). The use of nIR technology has been associated with enhanced first-time insertion success and decreased procedural time compared to traditional visual assessment and palpation in some populations, such as neonates.[12-14] (II)

NIR



- NIR technology is based on the selective adsorption of a specific wavelength of NIR rays (760 nm) by desaturated hemoglobin.
- NIR devices offer an accurate visualization of superficial veins (within 7 mm from the skin surface).
- NIR devices have no probe since the images are shown directly on patient's skin or on a helmet-viewer so that both hands of the clinician are free to perform the puncture.

NIR Devices

VeinViewer

AccuVein

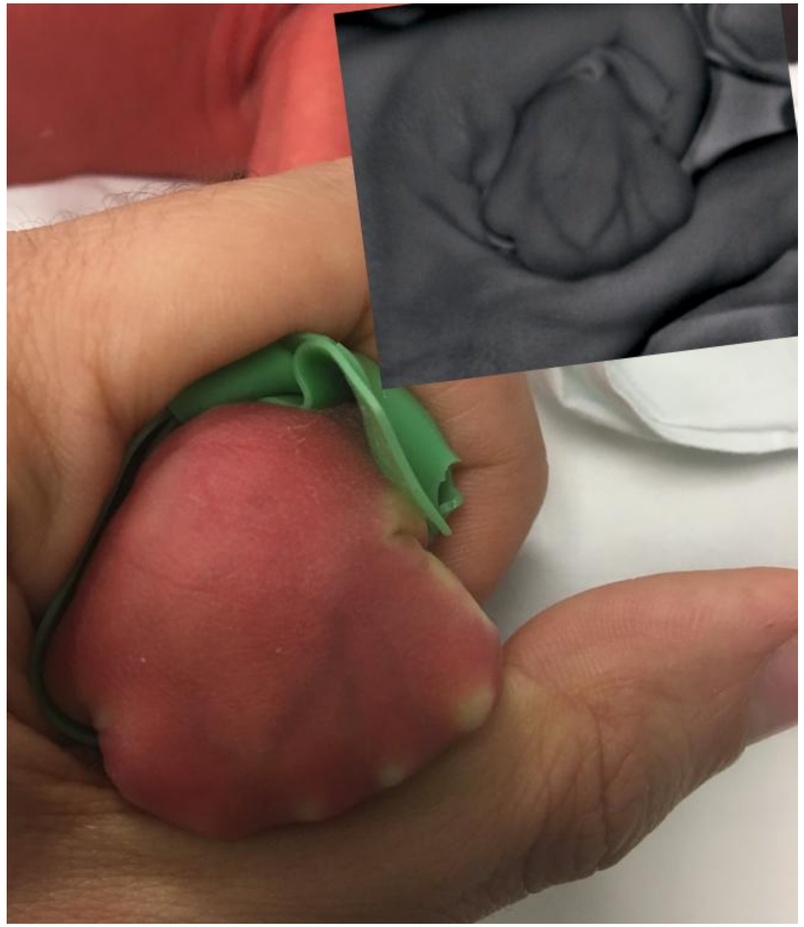
Vasculuminator

Veinsite

NIR

- It allows the visualization of veins which may not be visible with eyes because of skin pigmentation and/or skin edema, and/or poor light in the environment and/or limited visual acuity of the operator.
- It allows to evaluate the direction of the vein;
- It can unveil the patency of a vein lying inside or under a previous hematoma and it can discriminate between vein and artery, as well as between patent vein and obstructed vein.

Turn on the lights in NICU!



British Journal of Anaesthesia 110 (6): 966–71 (2013)
Advance Access publication 5 February 2013 · doi:10.1093/bja/aet003

BJA

CLINICAL PRACTICE

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

F. B. Chiao*, F. Resta-Flarer, J. Lesser, J. Ng, A. Ganz, D. Pino-Luey, H. Bennett, C. Perkins Jr and B. Witek

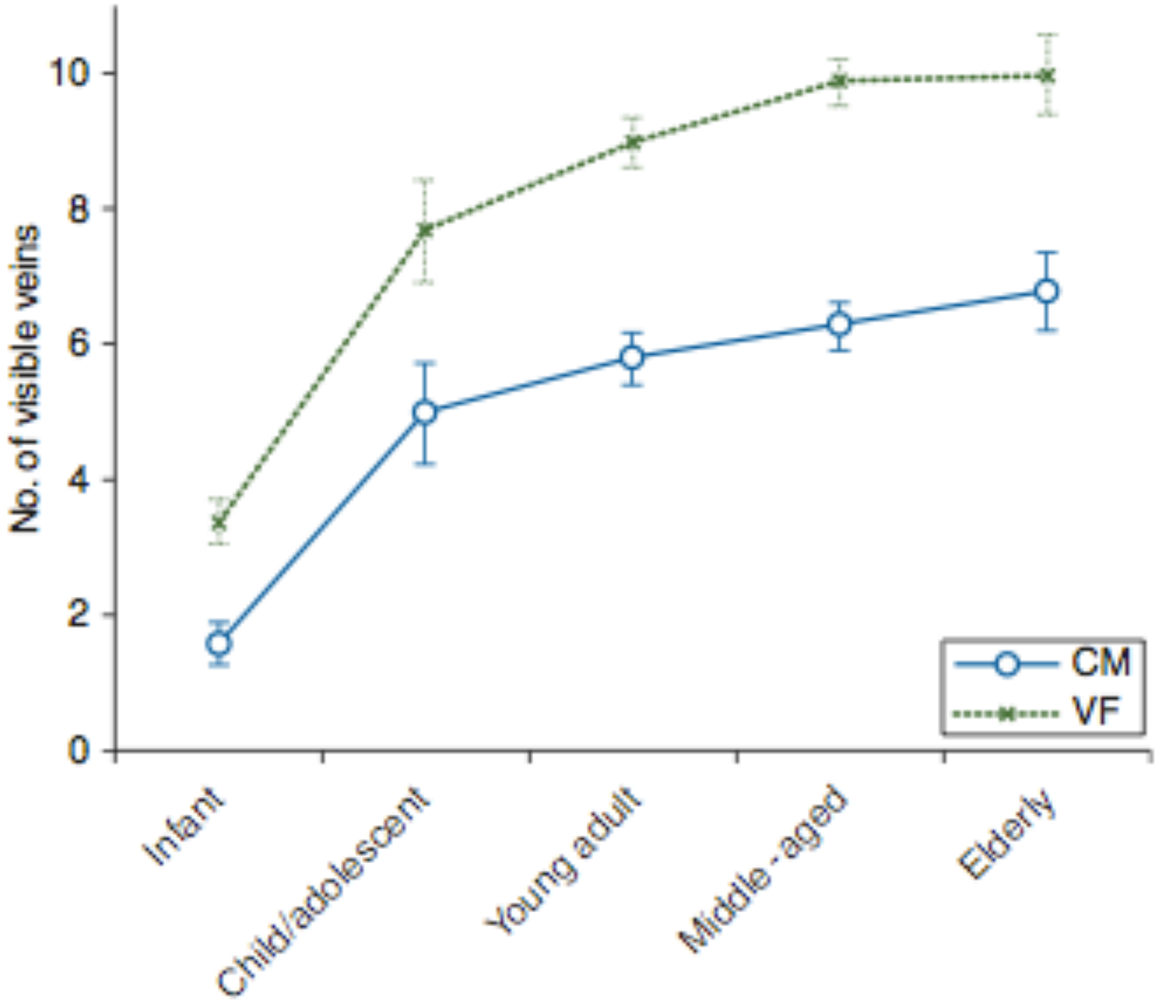


Fig 4 Comparison of VF and CM visible sites [mean (SE)] across age groups.

Journal of Perinatology (2012) 32, 498–501

www.nature.com/jp

ORIGINAL ARTICLE

A randomized trial of the Vein Viewer versus standard technique for placement of peripherally inserted central catheters (PICCs) in neonates

K Phipps, A Modic, MA O'Riordan and M Walsh

Division of Neonatology, Department of Pediatrics, Rainbow Babies and Children's Hospital, University Hospitals of Cleveland Case Medical Center, Cleveland, OH, USA

	Standard (N = 56)	*Vein Viewer (N = 59)*	P
Gestational age (weeks)	28.0 (23–40)	30.0 (23–40)	0.08
Birthweight (g)	1030 (320–4160)	1160 (300–4700)	0.06
Gender, male, *N* (%)	35 (62.5)	32 (54.2)	0.37
African American, *N* (%)	29 (51.8)	27 (45.8)	0.52

	Unadjusted odds ratio (95% CI)	*Adjusted odds ratio (95% CI)*
Success on first attempt	1.26 (0.59, 2.68)	1.57 (0.71, 3.50)
Any success	2.33 (0.90, 6.04)	3.05 (1.10, 8.42)

showed a trend to more successful placement 86 versus 75%; unadjusted odds ratio 2.33 (0.90, 6.04; $P = 0.08$). Infants randomized to the Vein Viewer were more mature (30 ± 2 weeks gestational age (GA) versus 28 ± 2 weeks GA; $P = 0.08$). After adjusting for GA, use of the Vein Viewer was significantly more likely to lead to successful line placement (adjusted odds ratio 3.05 (1.10, 1.82)).

European Journal of Pediatrics
https://doi.org/10.1007/s00431-022-04480-1

ORIGINAL ARTICLE

Near-infrared system's efficiency for peripheral intravenous cannulation in a level III neonatal intensive care unit: a cross-sectional study

Silvia Ferrario[1] · Gabriele Sorrentino[1] · Giacomo Cavallaro[1] · Ivan Cortinovis[2] · Silvia Traina[1] · Salvatore Muscolo[1] · Alessandro Agosteo[1] · Germana Santini[1] · Elisa Lagostina[1] · Fabio Mosca[1,3] · Laura Plevani[1]

- No differences in the proportion of successful cannulation attempts.
- NIR device may be advantageous for nurses with lesser experience performing cannulation for the first time.

	NIR group ($n = 124$)	Control group ($n = 101$)	p
Gestational age (weeks), median (Q1–Q3)	34.6 (33.8–35.2)	34.4 (34.6–36.2)	0.136
Birth weight (g), median (Q1–Q3)	2471 (2300–2641)	2624 (2440–2808)	0.229
Weight at the study (g), median (Q1–Q3)	3943 (3724–4162)	3668 (3504–3833)	0.058
Ethnic group (Caucasian), *n* (%)	102 (82.3)	87 (86.1)	0.8359
Drugs taken, *n* (%)	60 (48.4)	48 (47.5)	0.8975
Years of nurses' experience, *n* (%)			0.4124
<1 year	22 (17.7)	13 (12.9)	
1–5 years	35 (28.2)	25 (24.7)	
>5 years	67 (54.1)	63 (62.4)	
Proportion of one attempt (CI 95%)	64.5 (56.1; 72.9)	55.5 (45.8; 65.1)	0.2136
Proportion of one attempt based on the nurses' years of experience (CI 95%)			
<1 year	72.7 (54.1; 91.3)	23.1 (0.2; 46.0)	*0.0125*
1–5 years	60.0 (43.8; 76.2)	52.0 (32.4; 71.6)	0.7246
>5 years	64.2 (52.7; 75.7)	63.5 (51.6; 75.4)	0.9206
Average pain score (CI 95%)	5.5 (4.9–6.1)	4.9 (4.3–5.4)	0.147
Average pain score based on the nurses' years of experience (CI 95%)			
<1 year	5.8 (4.0; 7.8)	4.1 (2.4; 5.7)	0.191
1–5 years	5.6 (4.7; 6.4)	5.3 (3.8; 6.9)	0.756
>5 years	5.3 (4.8; 6.2)	4.8 (4.2; 5.2)	0.366

Journal of Perinatology (2020) 40:581–588
https://doi.org/10.1038/s41372-019-0575-7

ARTICLE

Risk factors for peripherally inserted central catheter complications in neonates

Gillian C. Pet[1] · Jens C. Eickhoff[2] · Kate E. McNevin[3] · Julie Do[3] · Ryan M. McAdams[4]

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	Upper extremity *n*/total (%)	Lower extremity *n* (%)	OR of complication with UE compared with LE PICC (95% CI) *p* value
Any complications	210/524 (40.1%)	215/710 (30.3%)	1.54 (1.22–1.94) <0.001
Nonelective line removal	183/524 (34.9%)	168/710 (23.7%)	1.73 (1.35–2.21) <0.001
Associated with PICC clot	18/524 (3.4%)	40/710 (5.6%)	0.6 (0.33–1.06) NS
Malposition in 1st 72 h	33/524 (6.3%)	17/710 (2.4%)	2.74 (1.51–4.97) <0.001
Malposition over time	35/524 (6.7%)	14/710 (2.0%)	3.56 (1.89–6.71) <0.001
Dislodgement	20/524 (3.8%)	17/710 (2.4%)	1.62 (0.83–3.16) NS
Crack/Broken/Fracture	23/524 (4.4%)	39/710 (5.4%)	0.79 (0.47–1.34) NS
Extravasation/Infiltration	13/524 (2.5%)	4/710 (0.6%)	4.49 (1.44–13.96) 0.001
Phlebitis/Edema/ Erythema/Perfusion changes	18/524 (3.4%)	44/710 (6.2%)	0.54 (0.31–0.93) 0.03
Malfunction/Occlusion	37/524 (7.1%)	40/710 (5.6%)	1.27 (0.8–2.01) NS
Failed insertion	35/524 (6.7%)	25/710 (2.3%)	1.96 (1.19–3.24) 0.009
Infection	11/524 (2.0%)	7/710 (1.0%)	2.15 (0.8–5.79) NS

Research Article

Risk Factors Related to Peripherally Inserted Central Venous Catheter Nonselective Removal in Neonates

Xiaohe Yu, Shaojie Yue, Mingjie Wang, Chuanding Cao, Zhengchang Liao, Ying Ding, Jia Huang, and Wen Li

We aimed to investigate the incidence and risk factors associated with nonselective removal of peripherally inserted central venous catheter (PICC) in neonates. In this prospective cohort study, neonates who underwent PICC placement at neonatal intensive care units (NICUs) in China from October 2012 to November 2015 were included. The patient demographics, catheter characteristics, catheter duration, PICC insertion site, indication for PICC insertion, infuscate composition, PICC tip location, and catheter complications were recorded in a computerized database. Risk factors for nonselective removal were analyzed. A total of 497 PICCs were placed in 496 neonates. Nonselective removal occurred in 9.3% of PICCs during 10,540 catheter-days (4.6 nonselective removals per 1,000 catheter-days). These included occlusion (3%), infection (1.4%), leakage (2.0%), phlebitis (0.6%), displacement (1%), pleural effusion(0.6%), and breaks (0.6%). Noncentral tip position was independently associated with an increased risk of nonselective removal (odds ratio 2.621; 95% confidence interval, 1.258-5.461) after adjusting for gestational age, sex, birth weight, and PICC dwell time. No significant differences in the rate of complications occurred between silastic and polyurethane PICC or different insertion sites. Noncentral PICC tip position was the only independent risk factor for nonselective removal of PICC.

Use of peripherally inserted central catheters (PICC) via scalp veins in neonates

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Doi: 10.3109/14767058.2016.1139567

Abstract

Objective To describe the use and complications of peripherally inserted central catheters (PICC) via scalp veins in neonates.

Methods A retrospective review of neonates who had PICCs inserted, between January 2010 and June 2013, in the NICU at Childreńs and Womeńs Health Centre of British Columbia.

Results During the study period, 689 PICCs were inserted over a total of 46728 NICU patient days. The PICC insertion sites were: scalp veins (69), upper limb veins (471) and lower limb veins (149). The mean catheter durations were 17 days, 19 days and 18 days for PICCs inserted through scalp, upper limb and lower limb veins, respectively. The complication rates were 23%, 23% and 15% for insertion via scalp, upper and lower limb veins, respectively. Centrally placed PICCs at the time of insertion were more likely to remain in situ for longer than one week ($p < 0.001$). The incidence of central line-associated blood stream infection was 4.4, 6.4 and 3.4 per 1000 catheter days, respectively, for scalp, upper and lower limb PICCs.

Insertion Site	Scalp	Upper limb	Lower limb
No. of PICCs (% of total PICCs)	69 (10%)	471 (68%)	149 (22%)
End of therapy	40 (58%)	296 (63%)	94 (63%)
*Death or transferred to other NICUs	9 (13%)	45 (10%)	18 (12%)
Infectious complications	5 (8%)	56 (13%)	8 (6%)
	- CoNS. [1] - Unidentified Staph. [1] - Enterococcus [1] - Group B Strep. [1] - E Coli [1]	- CoNS. [42] - Enterococcus [3] - E Coli [3] - Kleb. pneumoniae [2] - Unidentified Staph. [2] - Candida lustiniae [1] - Klebsiella oxytoca [1]	- CoNS. [3] - Enterococcus [3] - E Coli [1] - Staph. Aureus [1]

ORIGINAL ARTICLE

Increased frequency of peripheral venipunctures raises the risk of central-line associated bloodstream infection in neonates with peripherally inserted central venous catheters

Hao-Yuan Cheng [a], Chun-Yi Lu [a], Li-Min Huang [a], Ping-Ing Lee [a], Jong-Min Chen [b], Luan-Yin Chang [a,*]

Background/Purpose: Central-line associated bloodstream infection (CLA-BSI), which is mostly caused by coagulase-negative staphylococcus, is an important morbidity in neonatal intensive care units. Our study is aimed to identify the risk factors of CLA-BSI in neonates with peripherally inserted central venous catheters (PICCs).

Methods: A retrospective cohort study of neonatal intensive care unit patients with a PICC insertion between January 1, 2011 and December 31, 2012 was conducted. We performed univariate and multivariate analyses with a logistic regression model to investigate the risk factors and the association between increased frequency of peripheral venipunctures during PICC use and the risk of CLA-BSI while adjusting for other variables.

Results: There were 123 neonates included in our study. Thirteen CLA-BSIs were recorded within the follow-up period. The incidence of PICC-associated CLA-BSI was 4.99 per 1000 catheter-days. There was no statistically significant association between the risk of CLA-BSI and gestational age, birth weight, chronological age, or other comorbidities. However, the odds of CLS-BSI increased to 12 times if the patient received six or more venipunctures within the period without concurrent antibiotic use [odds ratio (OR), 11.94; $p < 0.001$]. The OR of CLA-BSIs increased by 16% per venipuncture during PICC use (OR, 1.14; $p = 0.003$).

SIECC
Safe Insertion of Epicutaneo Cava Catheter

1. Preprocedural evaluation (including US, RaSuVa + NIR)
2. Prepackaged ECC trays.
3. Appropriate aseptic technique (hand hygiene, maximal barrier precautions, skin antisepsis with 2% chlorhexidine in 70% isopropilic alcohol)
4. Real time tip navigation and tip location using NeoECHO Tip protocol.
5. Securement and protection of the exit site (securement by sutureless device, cyanoacrylate glue, semipermeable transparent membrane)
6. Serial US assessment of the catheter tip (at 48 hours; every 7 days)
7. Consider removal within 2 weeks

33. VASCULAR ACCESS SITE PREPARATION AND DEVICE PLACEMENT

III. Central Vascular Access Device (CVAD)

A. Implement the central line bundle when placing CVADs, which includes the following interventions:

hand hygiene; skin antisepsis using >0.5% chlorhexidine in alcohol solution; maximal sterile barrier precautions; and avoidance of the femoral vein in obese adult patients during placement under planned and controlled conditions.[3,15,16,33] (I)

Ensure adherence to proper technique through use of and completion of a standardized checklist completed by an educated health care clinician and empower the clinician to stop the procedure for any breaches in aseptic technique. Completion of a checklist should be done by someone other than the CVAD inserter.[15,34]

Use a standardized supply cart or kit that contains all necessary components for the insertion of a CVAD.[15] (IV)

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SHEA

SHEA/IDSA/APIC Practice Recommendation

Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 Update

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Essential Practices

Before insertion

1. Provide easy access to an evidence-based list of indications for CVC use to minimize unnecessary CVC placement (Quality of Evidence: LOW)
2. Require education and competency assessment of HCP involved in insertion, care, and maintenance of CVCs about CLABSI prevention (Quality of Evidence: MODERATE)[74–78]
3. Bathe ICU patients aged >2 months with a chlorhexidine preparation on a daily basis (Quality of Evidence: HIGH)[86–90]

At insertion

1. In ICU and non-ICU settings, a facility should have a process in place, such as a checklist, to ensure adherence to infection prevention practices at the time of CVC insertion (Quality of Evidence: MODERATE)[101]
2. Perform hand hygiene prior to catheter insertion or manipulation (Quality of Evidence: MODERATE)[102–107]
3. The subclavian site is preferred to reduce infectious complications when the catheter is placed in the ICU setting (Quality of Evidence: HIGH)[33,37,108–110]
4. Use an all-inclusive catheter cart or kit (Quality of Evidence: MODERATE)[118]
5. Use ultrasound guidance for catheter insertion (Quality of Evidence: HIGH)[119,120]
6. Use maximum sterile barrier precautions during CVC insertion (Quality of Evidence: MODERATE)[123–128]
7. Use an alcoholic chlorhexidine antiseptic for skin preparation (Quality of Evidence: HIGH)[42,129–134]

After insertion

1. Ensure appropriate nurse-to-patient ratio and limit use of float nurses in ICUs (Quality of Evidence: HIGH)[34,35]
2. Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age (Quality of Evidence: HIGH)[45,135–142]
3. For non-tunneled CVCs in adults and children, change transparent dressings and perform site care with a chlorhexidine-based antiseptic at least every 7 days or immediately if the dressing is soiled, loose, or damp. Change gauze dressings every 2 days or earlier if the dressing is soiled, loose, or damp (Quality of Evidence: MODERATE)[145–148]
4. Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter (Quality of Evidence: MODERATE)[150–154]
5. Remove nonessential catheters (Quality of Evidence: MODERATE)
6. Routine replacement of administration sets not used for blood, blood products, or lipid formulations can be performed at intervals up to 7 days (Quality of Evidence: HIGH)[164]
7. Perform surveillance for CLABSI in ICU and non-ICU settings (Quality of Evidence: HIGH)[13,165,166]


CUSTOMIZE
Macro


CUSTOM
Design
Your
Own
PRODUCTS

“Instruction for use..”

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5. Securement and protection of the exit site (securement by sutureless device, cyanoacrylate glue, semipermeable transparent membrane)
6. Serial US assessment of the catheter tip (at 48 hours; every 7 days)
7. Consider removal within 2 weeks

1. **In ICU and non-ICU settings, a facility should have a process in place, such as a checklist, to ensure adherence to infection prevention practices at the time of CVC insertion** (Quality of Evidence: MODERATE)[101]
    a. Ensure and document adherence to aseptic technique
        i. Checklists have been suggested to ensure optimal insertion practices. If used, the documentation should be done by someone other than the inserter.
        ii. Observation of CVC insertion should be done by a nurse, physician, or other HCP who has received appropriate education (see above) to ensure that aseptic technique is maintained.
        iii. HCP should be empowered to stop the procedure if breaches in aseptic technique are observed.
2. **Perform hand hygiene prior to catheter insertion or manipulation** (Quality of Evidence: MODERATE)[102–107]
    a. Use an alcohol-based waterless product or soap and water.
        i. Use of gloves does not obviate hand hygiene.

6. **Use maximum sterile barrier precautions during CVC insertion** (Quality of Evidence: MODERATE)[123–128]
   a. Use maximum sterile barrier precautions:
      i. A mask, cap, sterile gown, and sterile gloves are to be worn by all HCP involved in the catheter insertion procedure.
      ii. The patient is to be covered with a large ("full-body") sterile drape during catheter insertion.
   b. These measures should also be followed when exchanging a catheter over a guidewire.

7. **Use an alcoholic chlorhexidine antiseptic for skin preparation** (Quality of Evidence: HIGH)[42,129–134]
   a. Before catheter insertion, apply an alcoholic chlorhexidine solution containing at least 2% chlorhexidine gluconate to the insertion site.
      i. The antiseptic solution must be allowed to dry before making the skin puncture.
      ii. Alcoholic chlorhexidine for skin antisepsis to prevent CLABSI in NICU patients should be used when the benefits are judged to outweigh potential risk.

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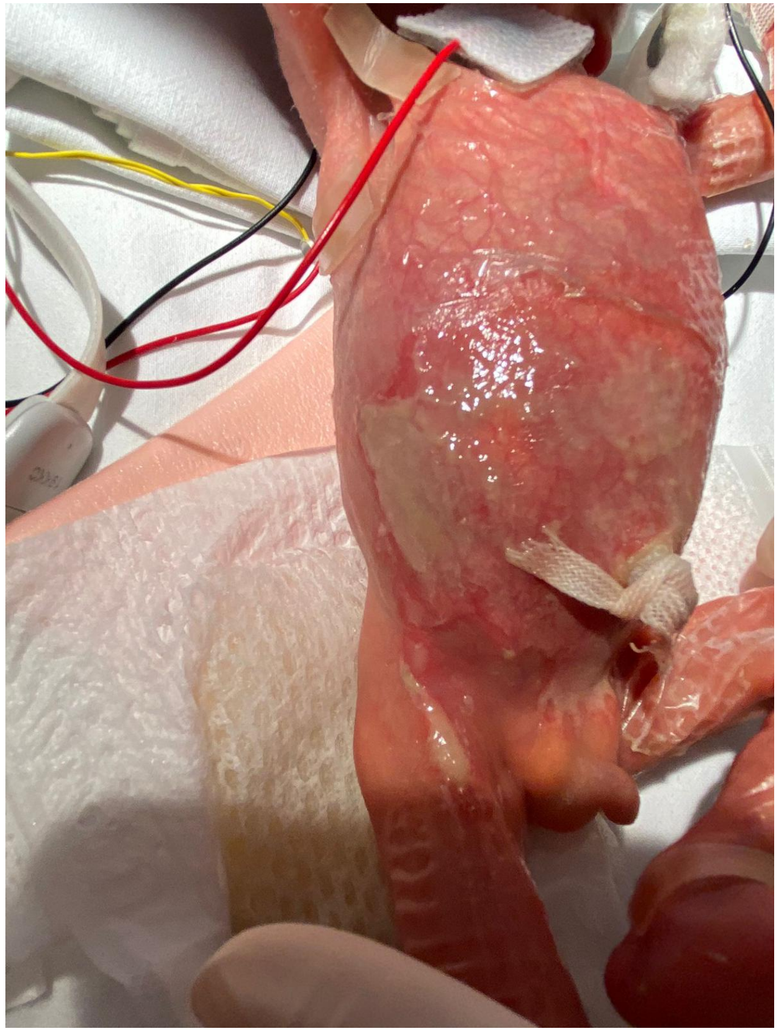
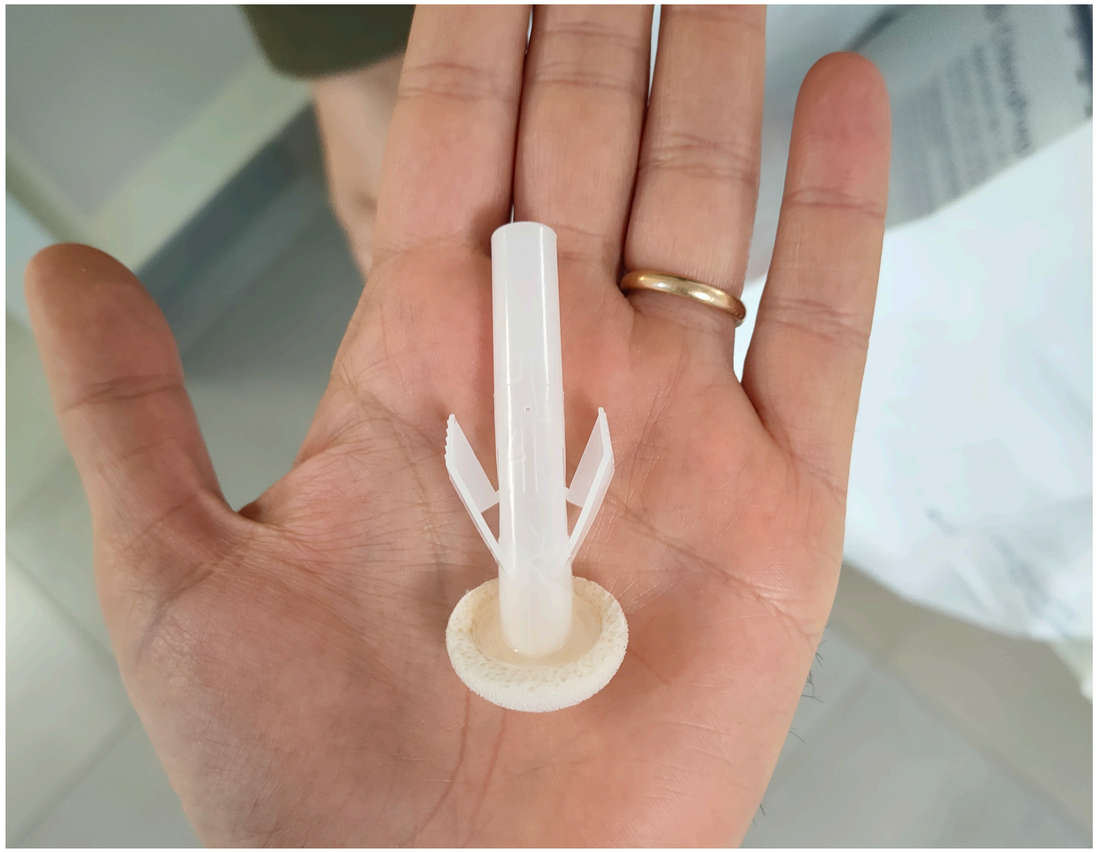
Skin Injuries and Chlorhexidine Gluconate-Based Antisepsis in Early Premature Infants



NICU Tips

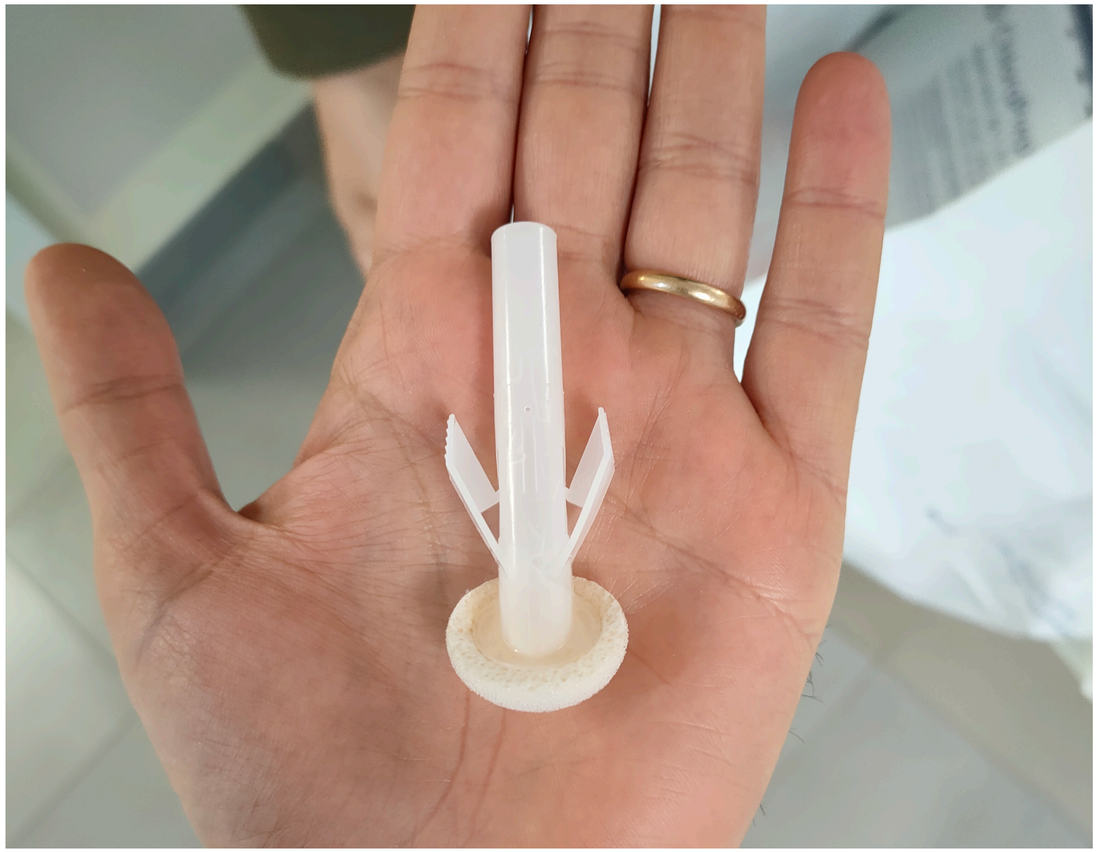
- Correct amounts for the area to be disinfected
- Single sterile applicator
- No pooling
- Rewash with sterile saline
- No scrubbing

- 0.67 ml: 5 cm x 8 cm
- 1 ml: 8 cm x 10 cm
- 1.5 ml: 10 cm x 13 cm
- 3 ml: 15 cm x 15 cm



Instructions for using ChloraPrep® applicators.

- 0.67 ml: [illegible] cm x 8 cm
- 1 ml: 8 cm x 10 cm
- 1.5 ml: 10 cm x 13 cm
- 3 ml: 15 cm x 15 cm



Instructions for using ChloraPrep® applicators.

Table 1 Patient demographics

	CHX–IA (n=148)	PI (n=156)	p Value
Gestational age (weeks)*	27 (2)	27 (2)	0.558
Birth weight (g)*	1017 (289)	1014 (326)	0.92
Skin damage from IMP*	3 (2)	2 (1.3)	0.677
Raised TSH on screening*	0 (0)	12 (7.7)	<0.001
Raised TSH in serum*	0 (0)	10 (6.4)	0.002
Treatment with thyroxine*	0 (0)	8 (5.1)	0.003

0.2% chlorhexidine acetate as skin disinfectant prevents skin lesions in extremely preterm infants: a preliminary report. ADC 2017
2% chlorhexidine–70% isopropyl alcohol versus 10% povidone–iodine for insertion site cleaning before central line insertion in preterm infants: a randomised trial. ADC 2017
Healthcare Infection Control Practices Advisory Committee. Guidelines for the prevention of intravascular catheter-related infections. Am J Infect Control 2011;39:S1–S34.

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7. Consider removal within 2 weeks

Please avoid x-ray

It is relatively inaccurate. As x-rays do not allow the direct visualization of the veins, the location of the catheter tip is assessed indirectly, i.e., using radiological landmarks such as the vertebral bodies, the cardiac silhouette, the diaphragmatic contour, etc.

It is consistently a post-procedural methodology, since fluoroscopy is not considered appropriate in NICU.

It is not harmless, since it exposes the neonate to ionizing radiation, which may ultimately be associated with long term damage

Please use Neo-ECHOTIP

- Neo-ECHOTIP protocol is **stepwise and standardized procedure**, potentially useful to perform both ultrasound based **tip navigation and tip location**, in all central venous access devices currently used in NICU
- **It's based on evidences from many published clinical studies**.
- Some of these maneuvers are easy and require only a minimal training, while some others imply a well trained operator.
- Current evidence and common sense suggest that ultrasound-based tip location will have an **increasingly important role for CVAD in NICU**, considering its many advantages in terms of accuracy, cost-effectiveness and safety

Table 1. Summary of Neo-ECHO tip.

Catheter	Protocol	Probe	Windows
UVC	Tip navigation	Small sectorial probe, 7–8 MHz	Low subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
ECCs inserted via veins of the scalp or of the upper limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA and RaPeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
ECCs inserted via veins of the lower limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Short and long axis view of the femoral vein
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
CICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
FICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz and small sectorial probe	Short and long axis view of the femoral vein and subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view

UVC: umbilical venous catheter; ECC: epicutaneo-caval catheter; RaCeVA: rapid central vein assessment; RaPeVA: rapid peripheral vein assessment; CICC: centrally inserted central catheter; FICC: femoral inserted central catheter.

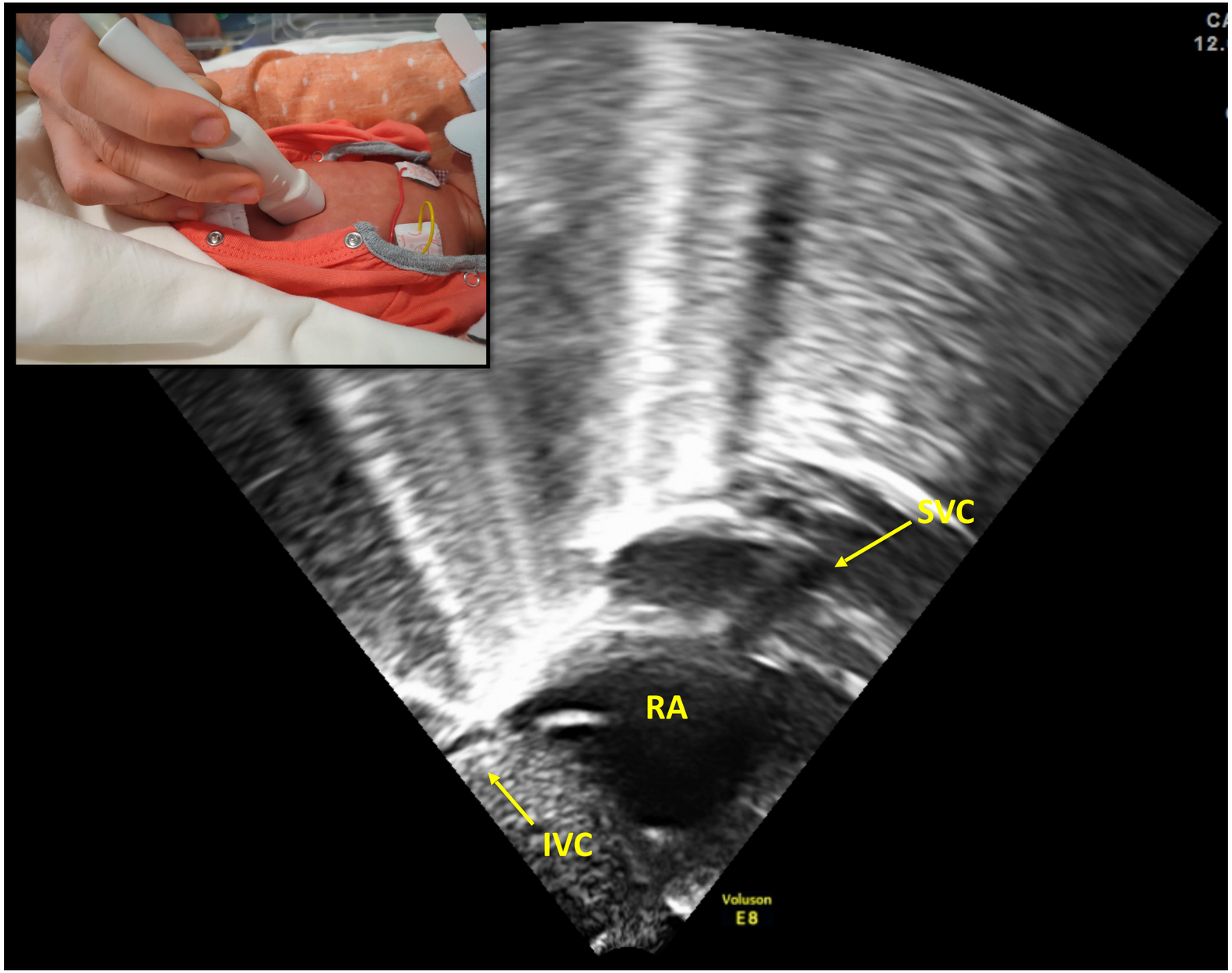
Neo-ECHOTIP for ECC inserted via veins of the upper limb

Tip location protocol:

Probe: Small sectorial probe, 7-8 MHz.

Acoustic windows: At least three different windows have been used to locate the catheter tip. The most useful ones are the subcostal longitudinal view (‘bi-caval’ view); the four-chamber apical view; the parasternal, long axis view of SVC.

Procedure**:** the catheter tip is followed until it reaches the target zone, i.e., the transition between SVC and RA. A small flush of normal saline (0.5-1 ml) may help visualizing the tip.


SVC
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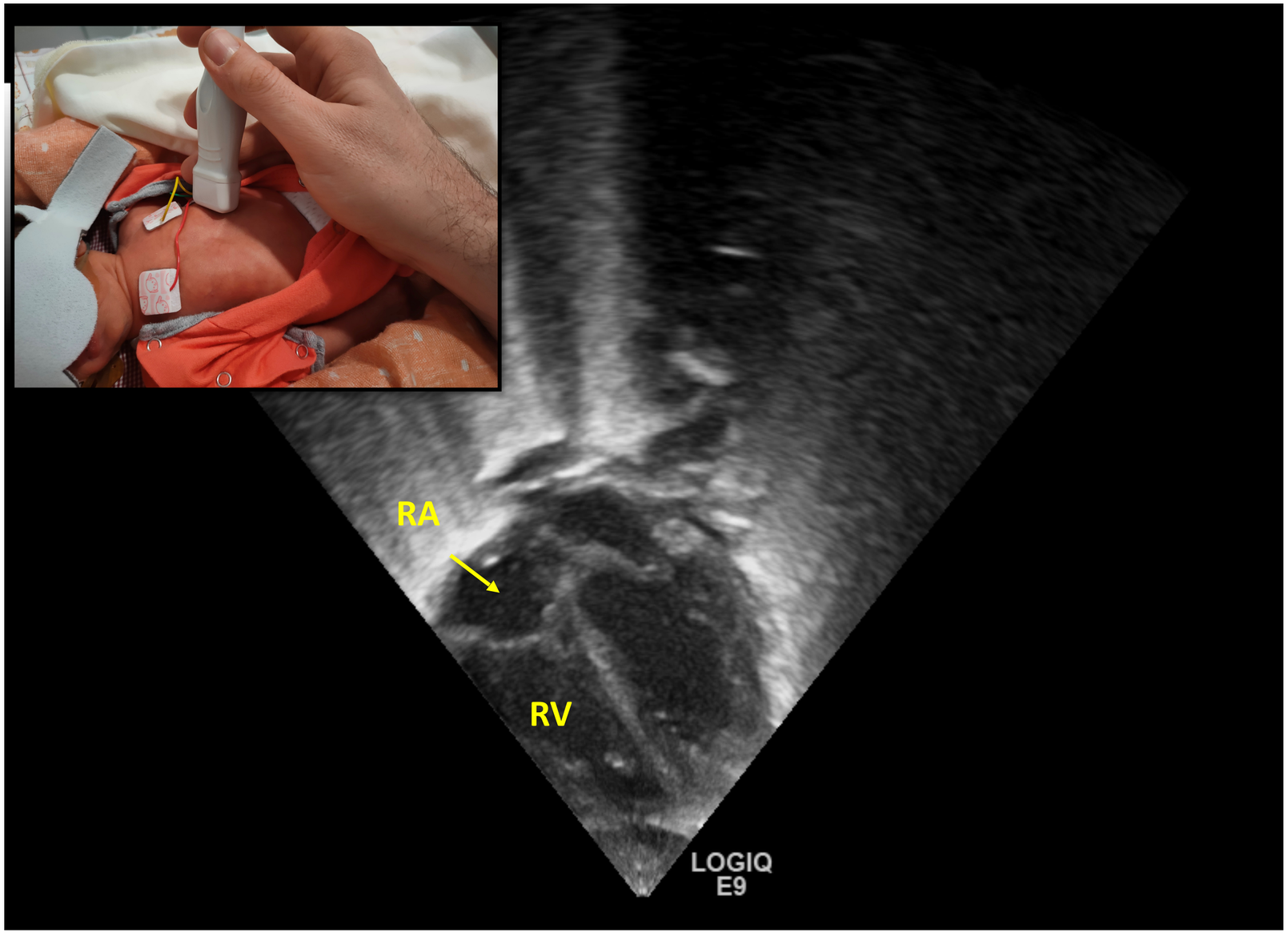
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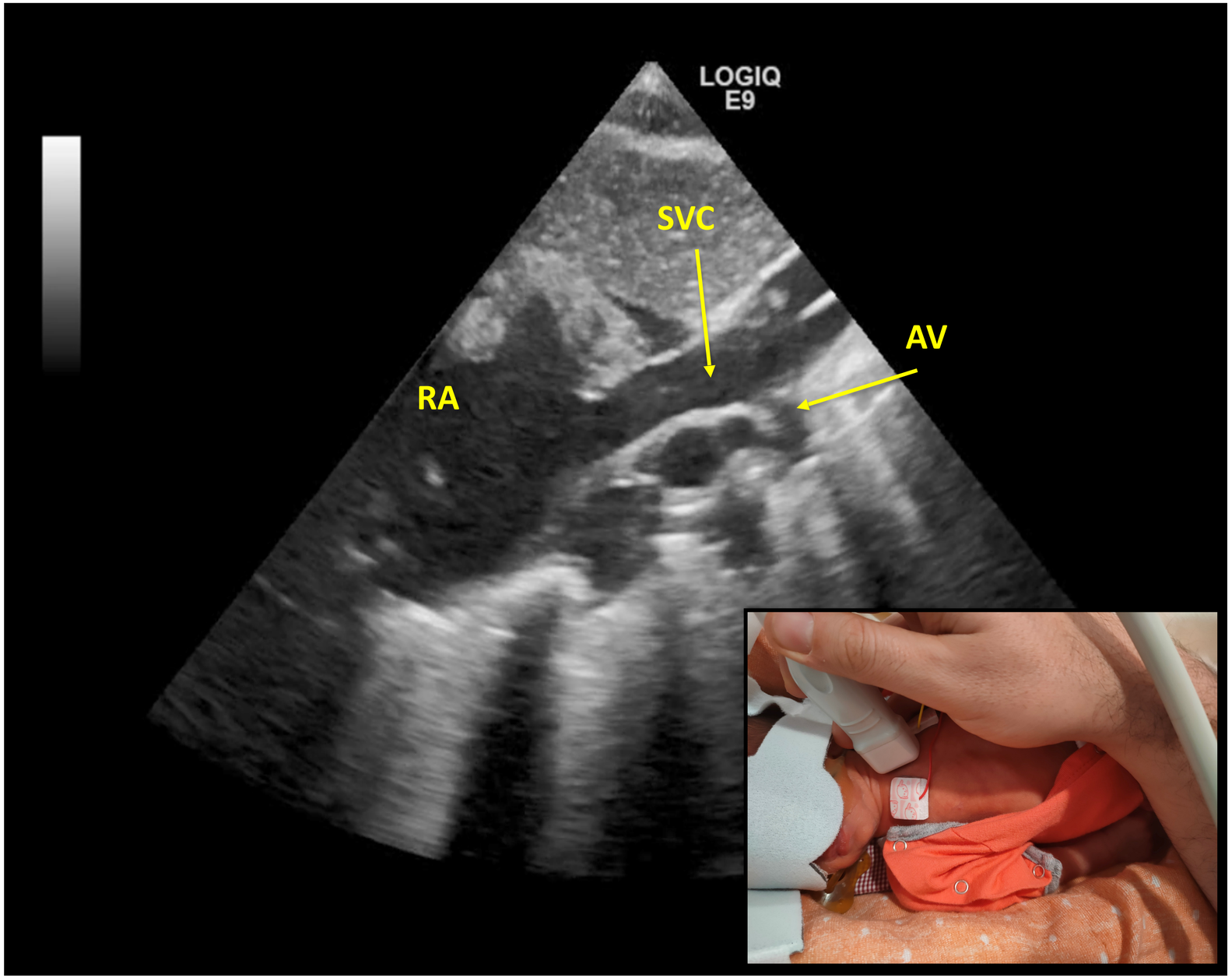
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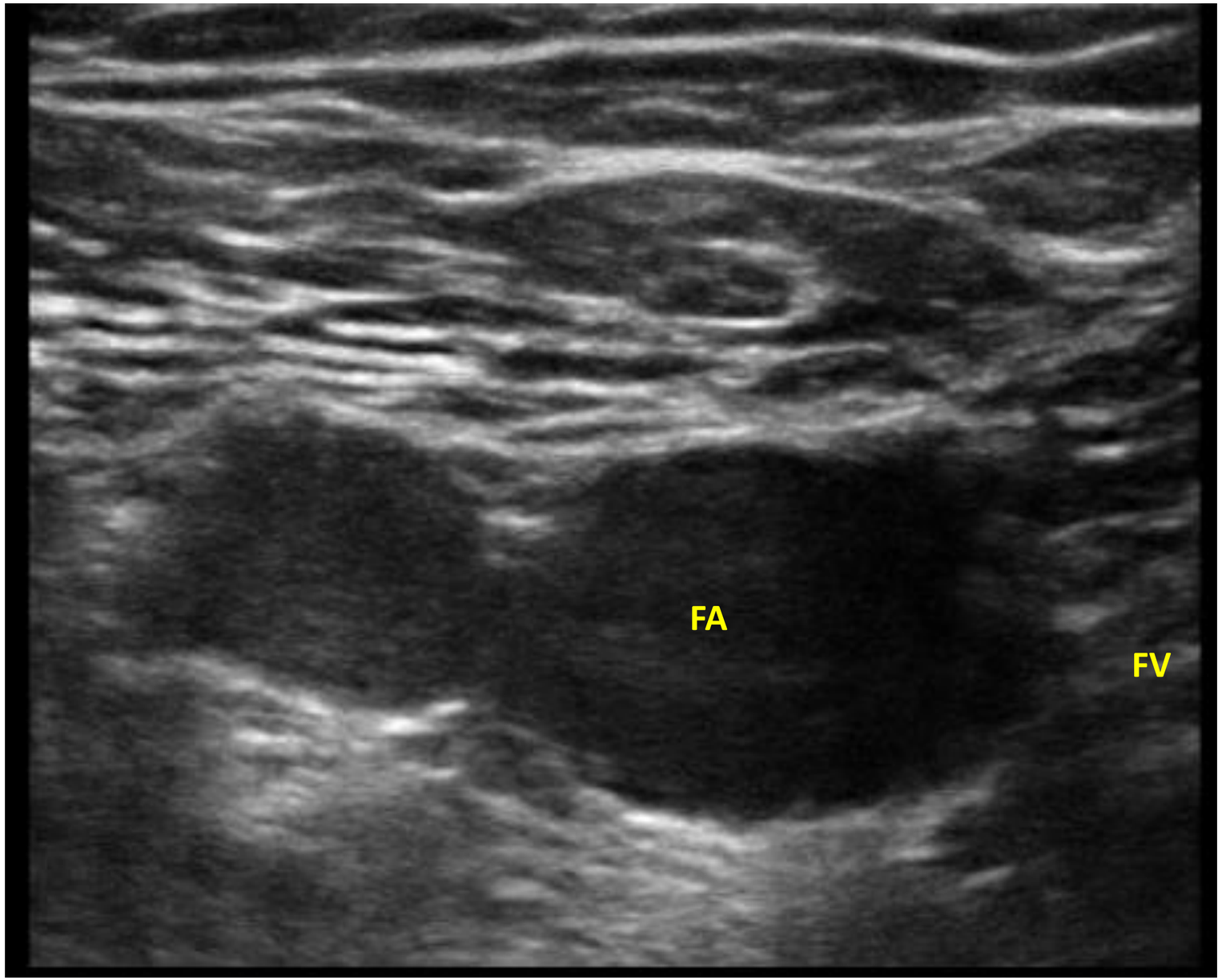
Protocol for ECCs inserted via veins of the lower limbs

Tip location protocol:

Probe: Small sectorial probe, 7-8 MHz

Acoustic window: subcostal longitudinal view. This view allows visualization of IVC and RA.

Procedure: the tip is followed until it reaches the target zone, i.e. the transition between IVC and RA. A small flush of normal saline (0.5-1 ml) may help visualizing the tip.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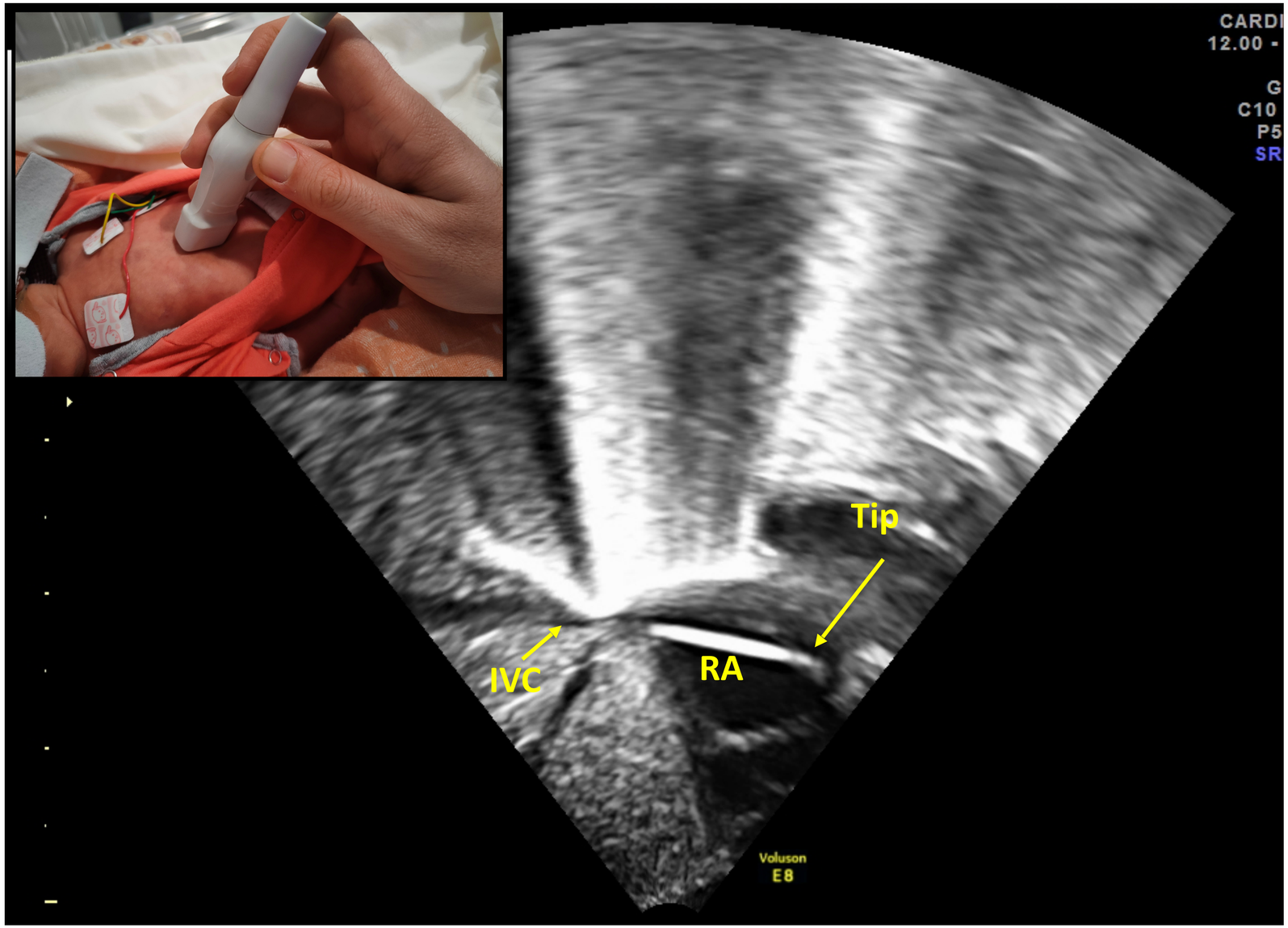
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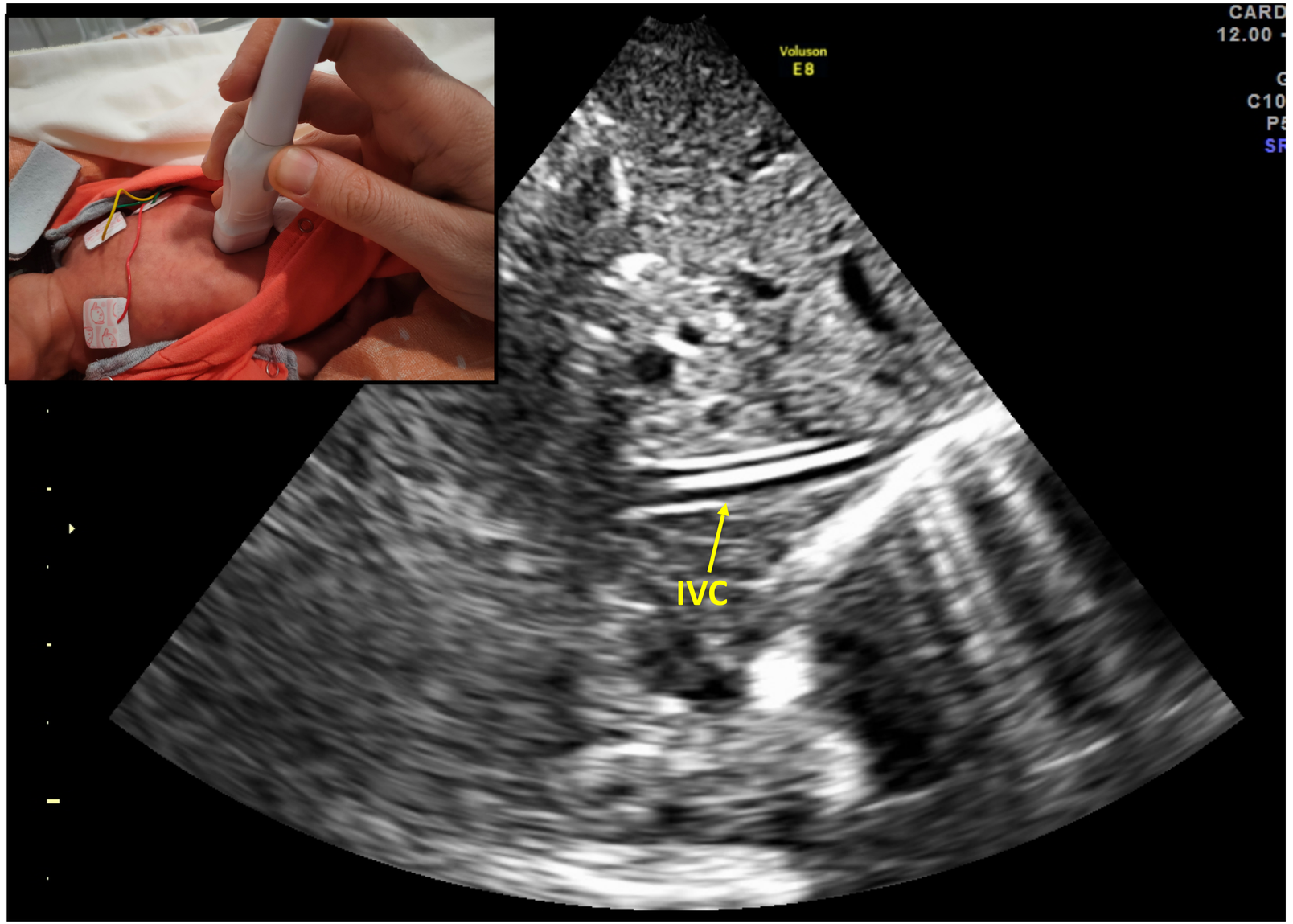
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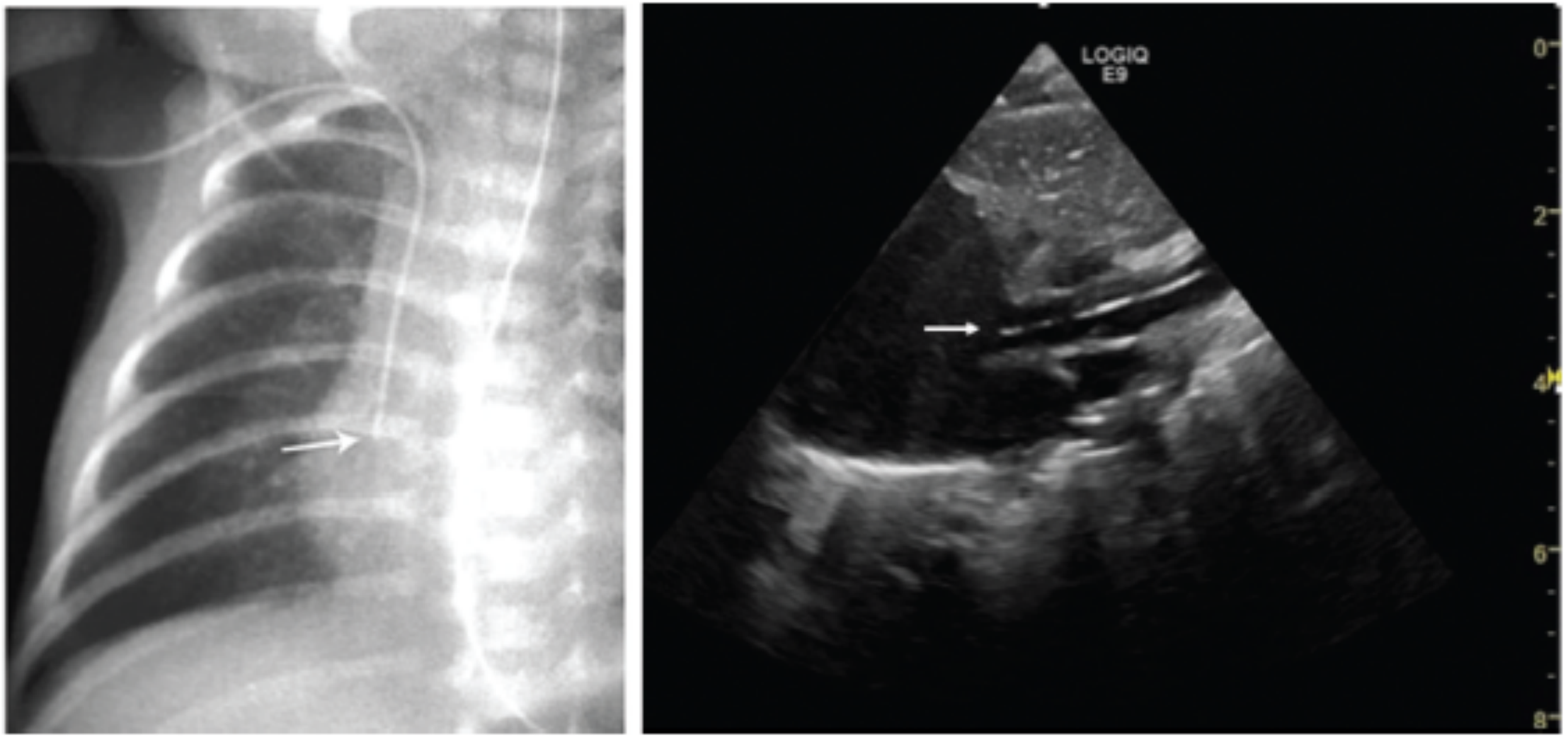
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Real-Time Ultrasound Tip Location Reduces Malposition and Radiation Exposure during Epicutaneo-Caval Catheter Placement in Neonates

	X-ray	RT-US	*p*-Value
Primary malposition	107 (65.4%)	11 (13.25%)	<0.001
Single repositioning	79 (47.88%)	10 (12.5%)	<0.001
Multiple repositioning	28 (16.97%)	1 (1.2%)	<0.001
Removal reason			
Dislocation	4 (2.4%)	–	0.304
Phlebitis	10 (6.1%)	5 (6%)	1
Infection	20 (12.1%)	15 (18.1%)	0.246
Malposition	7 (4.2%)	–	0.099
Occlusion	6 (3.6%)	4 (4.8%)	0.736
Rupture	15 (9.1%)	3 (3.6%)	0.193
Extravasation	7 (4.2%)	1 (1.2%)	0.274
Cardiac tamponade	1 (0.6%)	1 (1.2%)	1

Table 2 Ultrasonography after catheter insertion

	Population	*n*	US operator	Probe	Technique	Tips visualized by US	Clinical utility
Madar and Deshpande (1996)[17]	BW: 1,210 (640–3,530) g GA: 28 (23–40) wk	18 UACs, 3 UVCs, 19 PICCs	Not specified	7.5 MHz	Suprasternal, subcostal, and parasternal SAX views	95%	US detected two venous catheters passed through the foramen ovale which was not evident on XR
Ohki et al (2000)[7]	"Neonates"	57 PICCs	Not specified	10 and 12 MHz	Not specified	95%	US could detect 78% of cases of catheter tip dislodgement by changes in extremity position
Jain et al (2012)[6]	BW: 833 (710–1,930) g GA: 26.5 (25.4–28.8) weeks.	22 PICCs	Neonatologists	10 MHz	UE: Subcostal, parasternal LAX, high parasternal, and apical views. LE: subcostal sagittal view. Saline contrast used	100%	XR incorrectly deemed 4 of 11 malpositioned tips in good position, and 5 of 11 well-positioned tips in bad position. In nine infants, a second XR was avoided with US-guided manipulation
Tauzin et al (2013)[8]	BW: < 1,800 g Weight: ~1,130 (828–1,452) g CGA: 27–33 weeks.	109 PICCs	"US specialist"	12 MHz	Subcostal, apical, parasternal LAX, high parasternal, and abdominal parasternal views	100%	US evaluation determined 25% of PICCs extended into the heart even though deemed to be in good position by XR. 21% PICCs repositioned after US evaluation without complications

Abbreviations: BW, birth weight; CGA, corrected gestational age; GA, gestational age; LAX, long axis; LE, lower extremity; PICC, peripherally inserted central catheter; SAX, short axis; UAC, umbilical artery catheter; UE, upper extremity; US, ultrasound; UVC, umbilical venous catheter; XR, radiograph.
Note: Population expressed as ranges, means ± standard deviation, and median (range).

Training issue

Training issues. Even though US-based tip location of ECC has been proved to be effective and safe, many neonatologists still consider chest X-rays as the gold standard for this purpose. This is partly explained by the advanced training necessary to complete this maneuver with RT-US.

To the best of our knowledge, few data are available about the training needed for performing ultrasound-based tip location of ECCs. Clinical studies on RT-US for tip location of ECCs show a direct correlation between the level of expertise of the clinician and the percentage of successful tip visualization.[45]

In our experience, the minimum training requirements for ultrasound-based tip navigation and tip location of ECCs should include:

1. Basic knowledge of targeted neonatal echocardiography and advanced vascular ultrasound assessment (in particular, the RaCeVA, RaPeVA, and RaFeVA protocols).
2. Advanced theoretical training, including the evaluation of several clinical case scenarios (at least 12 h).
3. Practical training supervised by a neonatologist with expertise in ultrasound-based tip location of ECCs (at least 50 cases).

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7. Consider removal within 2 weeks

38. VASCULAR ACCESS DEVICE SECUREMENT

KEY DEFINITIONS

Adhesive securement device (ASD): an adhesive-backed device that adheres to the skin with a mechanism to hold the VAD in place; a separate dressing is placed over the ASD. Both the dressing and ASD must be removed and replaced at specific intervals during the VAD dwell time.

Integrated securement device (ISD): a device that combines a dressing with securement functions; includes transparent, semipermeable window and a bordered fabric collar with built-in securement technology.

Subcutaneous anchor securement system (SASS): a securement device that anchors the VAD in place via flexible feet/posts that are placed just beneath the skin; these act to stabilize the catheter right at the point of insertion. A separate dressing is placed over the SASS. The SASS does not need to be changed at regular intervals when the dressing is changed; it can remain in place if there are no associated complications.

Tissue adhesive (TA): a medical-grade cyanoacrylate glue that can seal the insertion site and temporarily bond the catheter to the skin at the point of insertion and under the catheter hub. TA should be reapplied at each dressing change.

Advantages of Semipermeable Transparent Dressing

- Visibility of insertion site
- Better stabilization of catheter, avoiding “in and out” movements
- Better protection against secretions
- Longer time between dressing changes (7 days vs 2 days)

Use the TA!

Assess the benefits of TA as an adjunct to the primary method of dressing and securement as it provides immediate hemostasis at the insertion site and prolongs the interval between VAD insertion and the first dressing change. The application of TA at the catheter insertion site has been demonstrated in in vivo trials, animal studies, and some small clinical trials to provide a barrier to microorganism growth on the catheter tip.

- Stabilizing and securing VADs to reduce dislodgement and device failure
- Sealing the insertion site creating a barrier to microorganism growth
- Reducing the risk of catheter-associated infection
- Providing immediate hemostasis at the insertion site to reduce dressing changes

Infusion therapy standard of practice. Journal of infusion nursing

Techniques in vascular access

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Use of cyanoacrylate glue for the sutureless securement of epicutaneo-caval catheters in neonates

The Journal of Vascular Access
1–4

DOI: 10.1177/1129729821008103
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Table 1. Demographics population and Epicutaneo-Caval Catheters caratteristics.

	Intervention	Control	
Infants (*n*)	92	80	
Gestational age weeks	29	29	
Birth weigth grams	1280	1200	
Catheters (*n*)	134	124	
Day of life at the insertion	6	6	
Weight at insertion gramms	1230 (520–3000)	1180 (480–3270)	
Days ECC in place	10.4	11	
Elective ECC removal *n* (%)	95 (70.8)	89 (71.7)	
Dislodgement *n* (%)	1 (0.7)	14 (11.3)	0.0003

SIECC
Safe Insertion of Epicutaneo Cava Catheter

1. Preprocedural evaluation (including US, RaSuVa + NIR)
2. Prepackaged ECC trays.
3. Appropriate aseptic technique (hand hygiene, maximal barrier precautions, skin antisepsis with 2% chlorhexidine in 70% isopropilic alcohol)
4. Real time tip navigation and tip location using NeoECHO Tip protocol.
5. Securement and protection of the exit site (securement by sutureless device, cyanoacrylate glue, semipermeable transparent membrane)
6. Serial US assessment of the catheter tip (at 48 hours; every 7 days)
7. Consider removal within 2 weeks

Table 1 Ultrasound findings of catheter tip position

	First ultrasound, n=65	Second ultrasound, n=52	Third ultrasound, n=42	Fourth ultrasound, n=24
Good position, n (%)	25 (38.5)	40 (77)	24 (57)	13 (54.2)
Malposition, n (%)	40 (61.5)	12 (23)	18 (43)	11 (45.8)
Right atrium, n (%)	17 (26.2)	6 (11.5)	9 (21)	1 (4.2)
Foramen ovale, n (%)	6 (9.2)	1 (2)	2 (5)	2 (8.3)
Left atrium, n (%)	15 (23.1)	3 (5.7)	–	1 (4.2)
Hepatic vessels, n (%)	2 (3)	2 (3.8)	7 (17)	7 (29.1)
Migration rate, n (%)	–	9 (17)	13 (31)	7 (29.1)

Franta J, *et al*. *Arch Dis Child Fetal Neonatal Ed* 2017;**102**:F251–F255. doi:10.1136/archdischild-2016-311202

Line type	*N*	Migration 1 h	Migration 24 h
		% (*n*) (95% CI)	% (*n*) (95% CI)
UVC	41	36% (15) (21–51%)	23% (9) (9–36%)
PICC (total)	63	23% (15) (12–33%)	11% (7) (3–18%)
UE PICC	25	28% (7) (10–46%)	28% (7) (10–46%)
LE PICC	38	21% (8) (7–38%)	0

Infusion Therapy Standards of Practice

Change transparent semipermeable membrane (TSM) dressings at least every 7 days (except neonatal patients) or immediately if dressing integrity is disrupted (eg, lifted/detached on any border edge or within transparent portion of dressing; visibly soiled; presence of moisture, drainage, or blood) or compromised skin integrity is present under the dressing.[2,4,5,8-10] (III)

1. In neonatal patients, perform dressing change as needed per patient or clinical indications due to risk of catheter dislodgement, patient discomfort, or skin injury.[10-14] (V)

	N°	Non elective remuv
Central catheters	413	7.5%
Non central cathet.	83	18.1%

Xiaohe Yu,Bio Med Research Intern, 2018

	N°	Complications	Duration
Central catheters	97	19%	17.7 gg
Non central cathet.	79	49%	11.4 gg

Goldwasser, Pediatr Radiol 2017

	N°	Complications	Non elective remuv
Central catheters	203	29%	27%
Non central cathet.	116	47%	45%

Jain, J of Perinatology, 2013

	N°	Complications
Central catheters	889	15.9 per 1000 line days
Non central cathet.	91	51.7 per 1000 line days

Colacchio, J of Perinatology, 2012

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TABLE 4 Risk Factors for CLA-BSIs in NICU Patients With PICCs

Risk Factor	Univariate			Multivariable	
				95% CI	*P*
Gestational age, w					
<32					
≥32				.08–3.18	.46
Birth weight, g					
<1500					
≥1500				.17–5.18	.94
Chronological age					
≤7					
>7				.56–3.25	.51
Days since PICC in					
<19				.04–1.25	<.01

TABLE 3 Incidence of CLA-BSIs Over 10-Day Time I

	Days 1–10	Days 11–20
No. of events	6	8
No. of catheters[a]	315	192
No. of catheter-days[b]	5563	2883
Incidence rate per 1000 catheter-days	1.08	2.77

[a] Number of catheters at the end of the time bin.

[b] Catheter-days for catheters extending beyond 60 days are

Catheter Duration and Risk of CLA-BSI in Neonates With PICCs. Pediatrics 2009

TABLE 4 Unadjusted and Adjusted Risk Factors for CLABSIs in Neonates With PICCs

Variable	CLABSI, *n* = 149, *n* (%)	No CLABSI, *n* = 4648, *n* (%)	Unadjusted IRR (95% CI)	*P* Value	aIRR[a] (95% CI)
Age at line insertion, d			1.00 (0.99–1.00)	.19	1.00 (0.99–1.00)
Birth weight, 100 g			0.98 (0.96–0.99)	.006	0.97 (0.95–0.99)
Concurrent PICCs					
No	134 (89.9)		) (reference)		1.0 (reference)
Yes	15 (10.1)		; (0.97–2.84)	.06	2.04 (1.12–3.71)
CLABSI from previous PICC					
No	143 (96.0)		) (reference)		1.0 (reference)
Yes	6 (4.0)		(1.00–4.90)	.05	1.66 (0.69–3.98)
Catheter dwell time					
≤7 d	25 (16.6)	1071 (25.0)	1.0 (reference)		—
8–13 d	32 (21.2)	1257 (27.1)	2.02 (1.21–3.38)	.007	—
14–22 d	39 (25.8)	1090 (23.5)	3.27 (2.04–5.24)	<.001	—

DISCUSSION

These data confirm that the daily risk of infection is higher in PICCs that have been in place for >2 weeks as compared with those that have been in place for <2 weeks. However, we found no

Catheter Dwell Time and CLABSIs in Neonates With PICCs: A Multicenter Cohort Study Pediatrics 2013

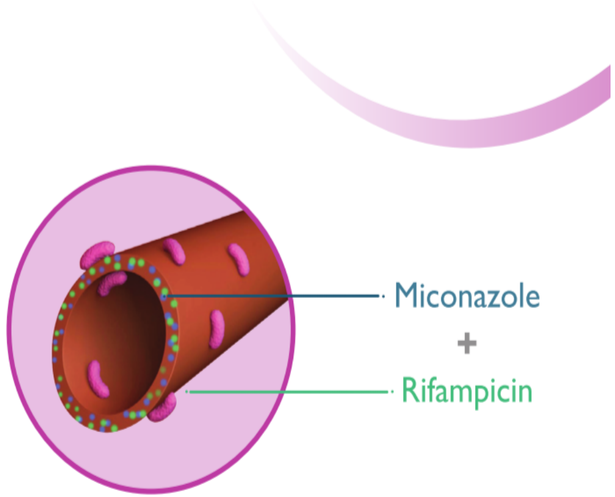
ECC...a new device?

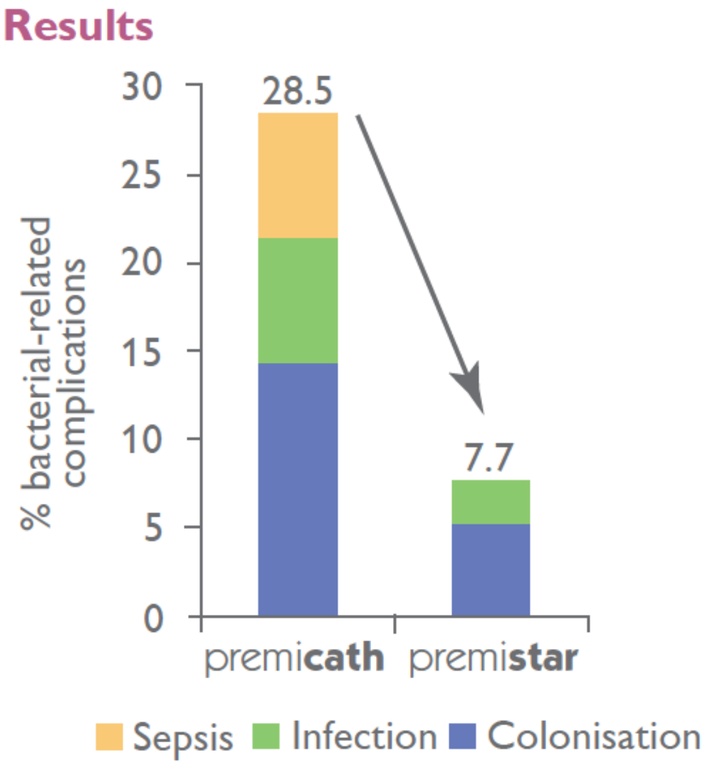
premistar

premistar is the only impregnated 1Fr PICC, especially developed to fight against CBRSI in NICU.

The Star Technology is the innovative combination of two active substances, Rifampicin and Miconazole, chosen for their synergic properties:

- overlapping spectrum of efficacy on gram+, gram- & fungi, [10, 11]
- multiple level of action on the bacteria,
- low risk of bacterial resistance development[11].





Pectin-abstract 31 1 2016
AS-2

Very promising...but

Antimicrobial-impregnated central venous catheters for prevention of neonatal bloodstream infection (PREVAIL): an open-label, parallel-group, pragmatic, randomised controlled trial

*Ruth Gilbert, Michaela Brown, Naomi Rainford, Chloe Donohue, Caroline Fraser, Ajay Sinha, Jon Dorling, Jim Gray, William McGuire, Carrol Gamble, Sam J Oddie, on behalf of the PREVAIL trial team**

	Antimicrobial-impregnated PICC (n=430)	Standard PICC (n=431)	HR (95% CI), rate ratio (95% CI), or RR (95% CI)*	p value
Primary outcome				
Time to first bloodstream infection†	46 (11%)	44 (10%)	1·11 (0·73–1·67)	0·63
Secondary outcomes				
Rate of bloodstream infection, per 1000 days with PICC	13·15	10·87	1·21 (0·78–1·88)	0·40
Rate of catheter-related bloodstream infection, per 1000 days with PICC	1·84	2·35	0·78 (0·27–2·25)	0·65
Rifampicin resistance from PICC tip culture	14 (3%)	4 (1%)	3·51 (1·16–10·57)	0·018

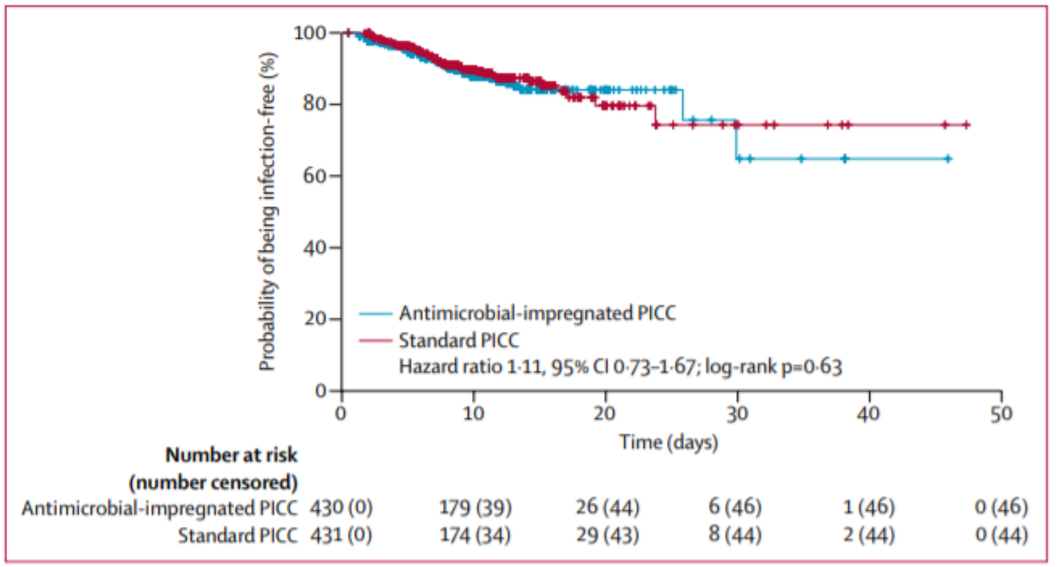


Figure 2: **Time to first bloodstream infection for newborn babies randomised to antimicrobial-impregnated PICC or standard PICC**

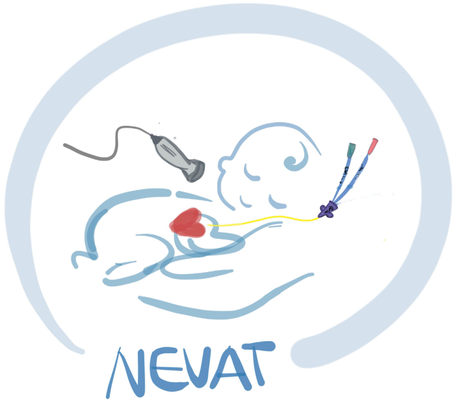
PICC=peripherally inserted central venous catheter.

THM

- Choose best vein
- Choose 2% chlorhexidine in 70% isopropilic alcohol
- Choose RT-US
- Choose "secure and protect" philosophy
- Choose the bundle

When you are still doing a medical procedure exactly the way you used to do it 20 years ago, something is going wrong
(Jack LeDonne)

Thank you



https://neonat.org