OPTIONS OF CENTRAL VENOUS ACCESS IN THE PICU

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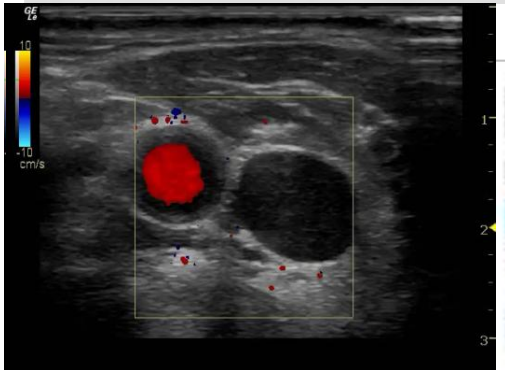
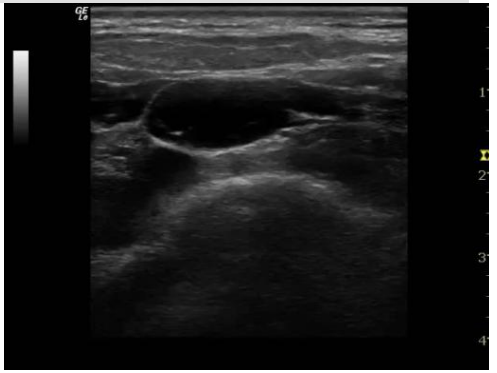
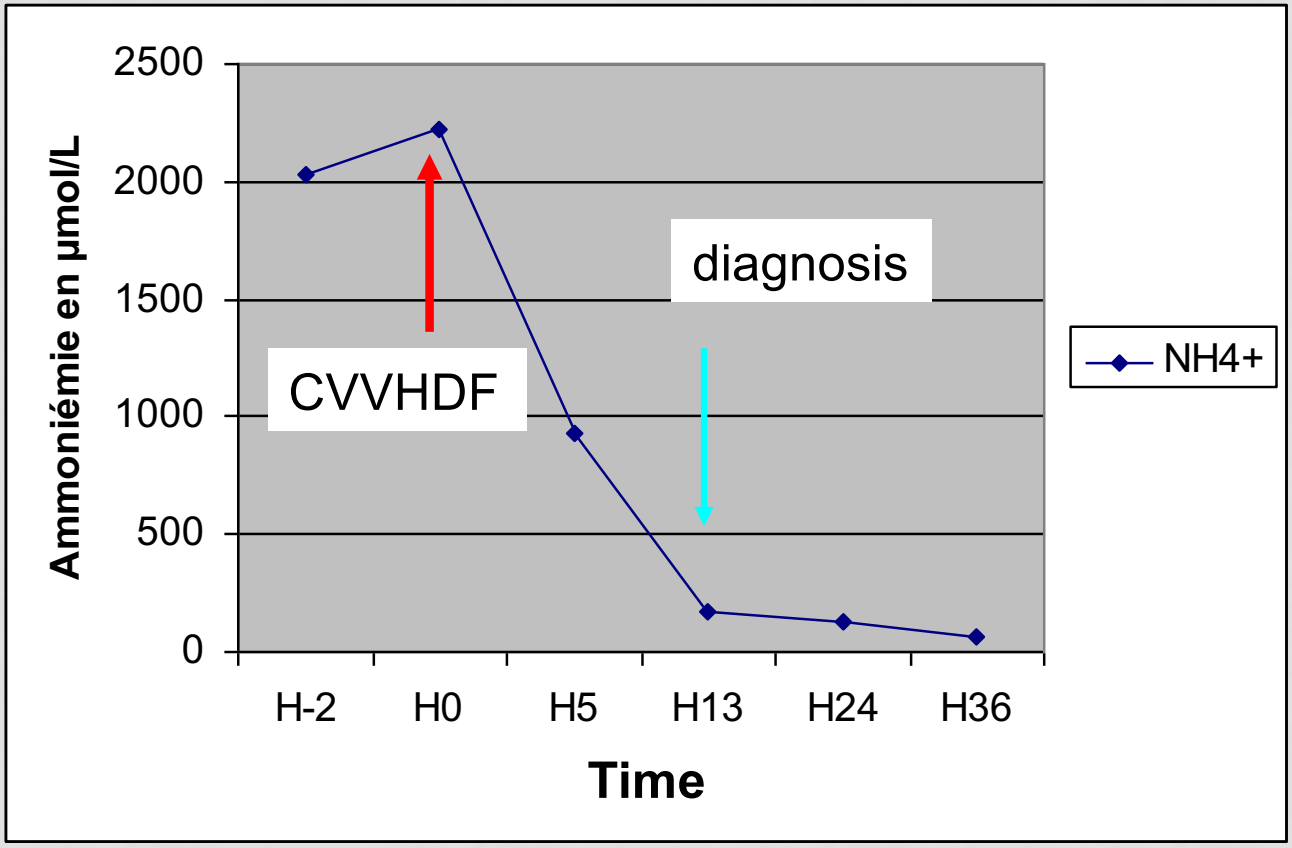




Respiratory arrest, day 5, in a 3.1Kg newborn
Hyperammonemia II propionic acidemia

Percutaneous 6 Fr Hickmann double lumen catheter
Continuous veno-venous hemodiafilatration
Blood flow 50mL/min
postdilution: 250mL/h, dialysate flow: 800mL/h

Patient size (kg)	Vascular access
2.5–10	6.5-FG dual-lumen (10 cm)
10–20	8-FG dual-lumen (15 cm)
>20	10.8-FG or larger dual-lumen (20 cm)



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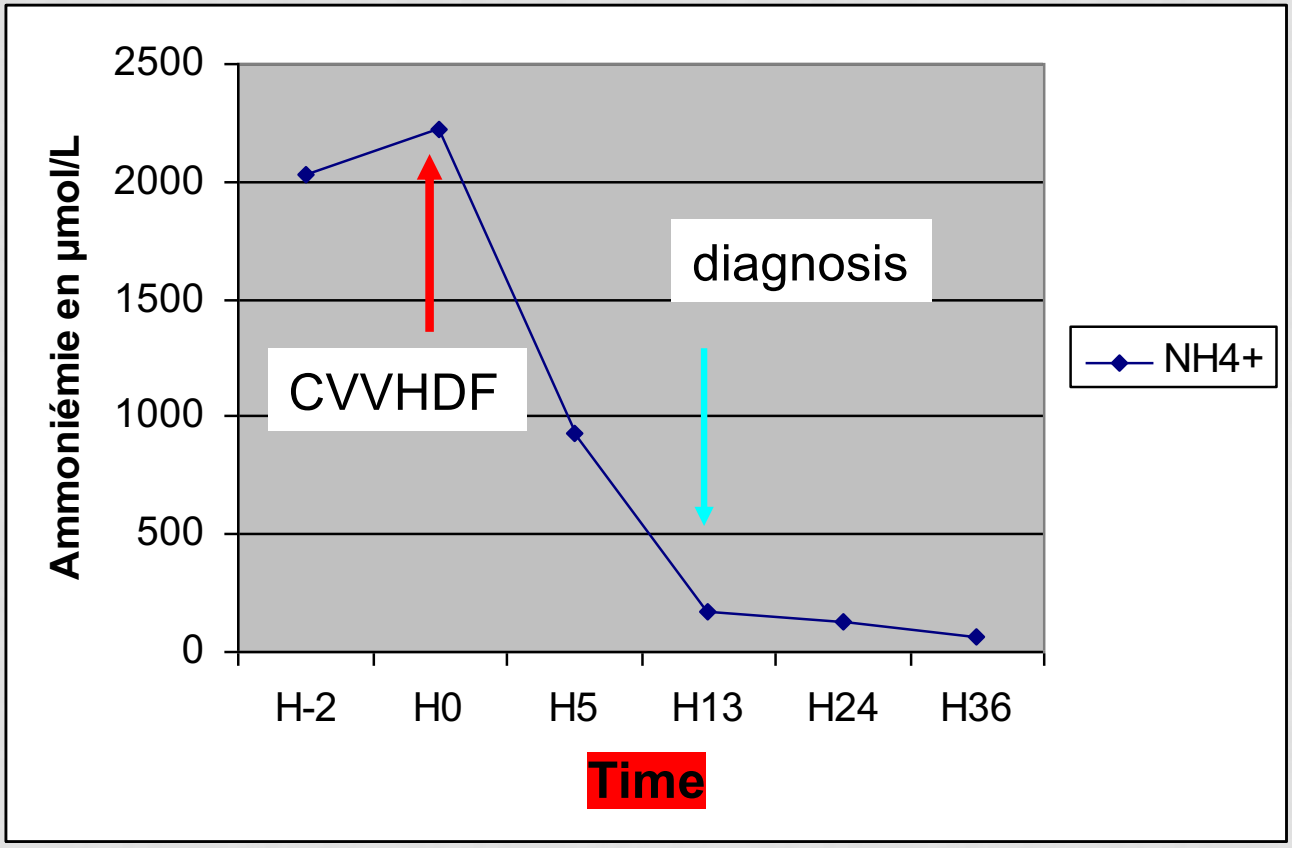


WHAT SHOULD WE CONSIDER IN THE PEDIATRIC CRITICALLY ILL CHILD ?

- **Age**: Patient's weight range from 400g to >70 Kg !!
- **Anatomy**: short neck, small vessel (IJV diameter in a term infant is 3mm)
- **Flow limitation**: Inferior Veina Cava flow limitation in children <10Kg
- **Critical conditions**: hypovolemia, high intrathoracic pressure swings (ie. extrathoracic venous collapse), prone positioning (ie. cutaneous compression), increased in intraabdominal pressure, urgent vascular access, (hemostasis abnormalities),

A. EVALUATE THE CONTEXT:

- **EMERGENCY / RESSUCITATION**
- **EMERGENT DIALYSIS/APHERESIS**
- **EMERGENT VASCULAR ACCESS**
- **ACCESS TO THE SVC-ATRIA (ScvO2, …)**
- **LONG TERM EXPECTED (PVA, NPVA, TCC, …)**
- **AWAKE / SEDATION**

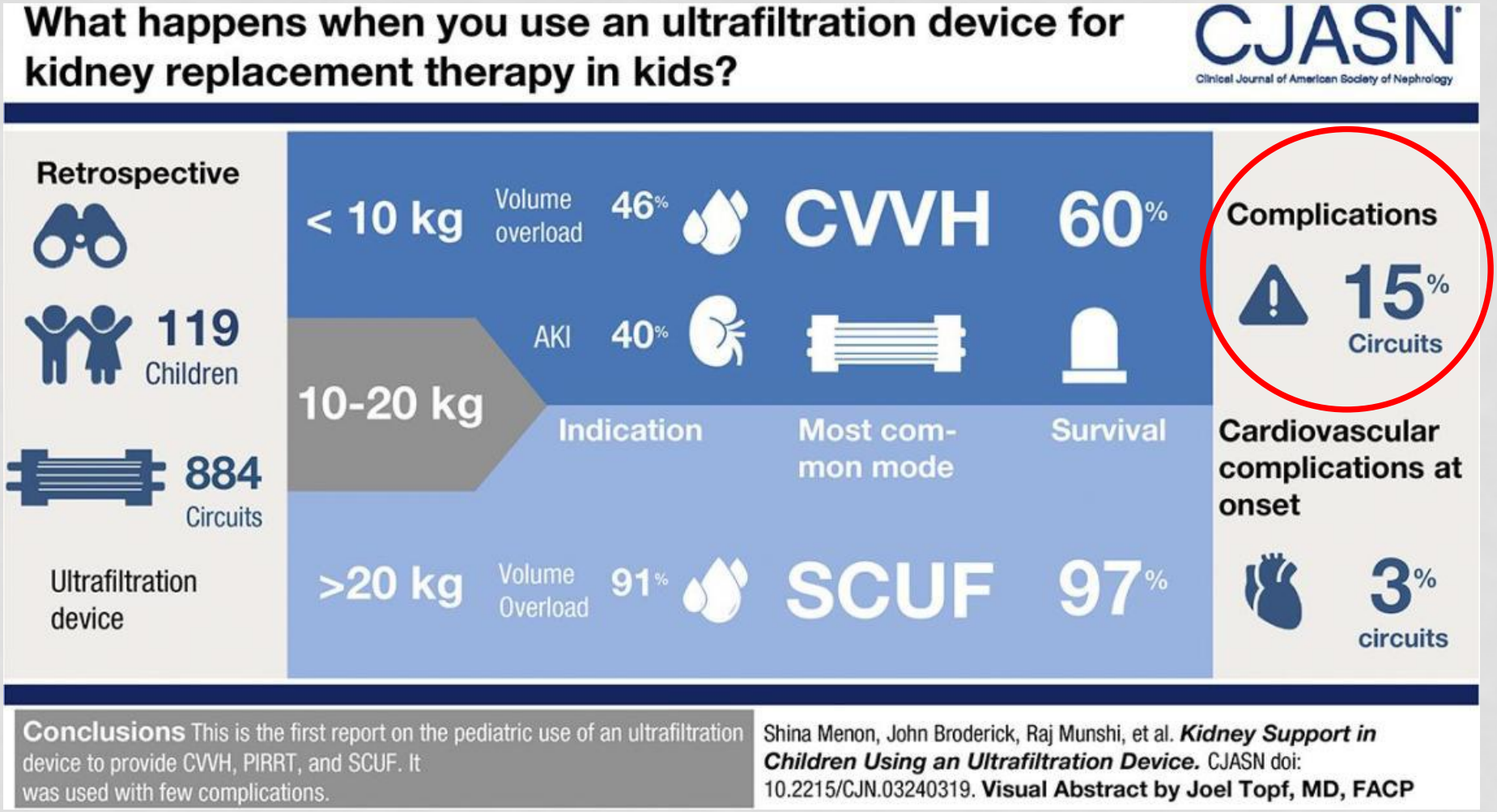
B. EXPECT COMPLICATIONS

1) **Precedural complications**: prematurity, agitation/sedation, bleeding, vascular puncture, vascular trauma/effraction (ie. Hemothorax, hemopericardium)

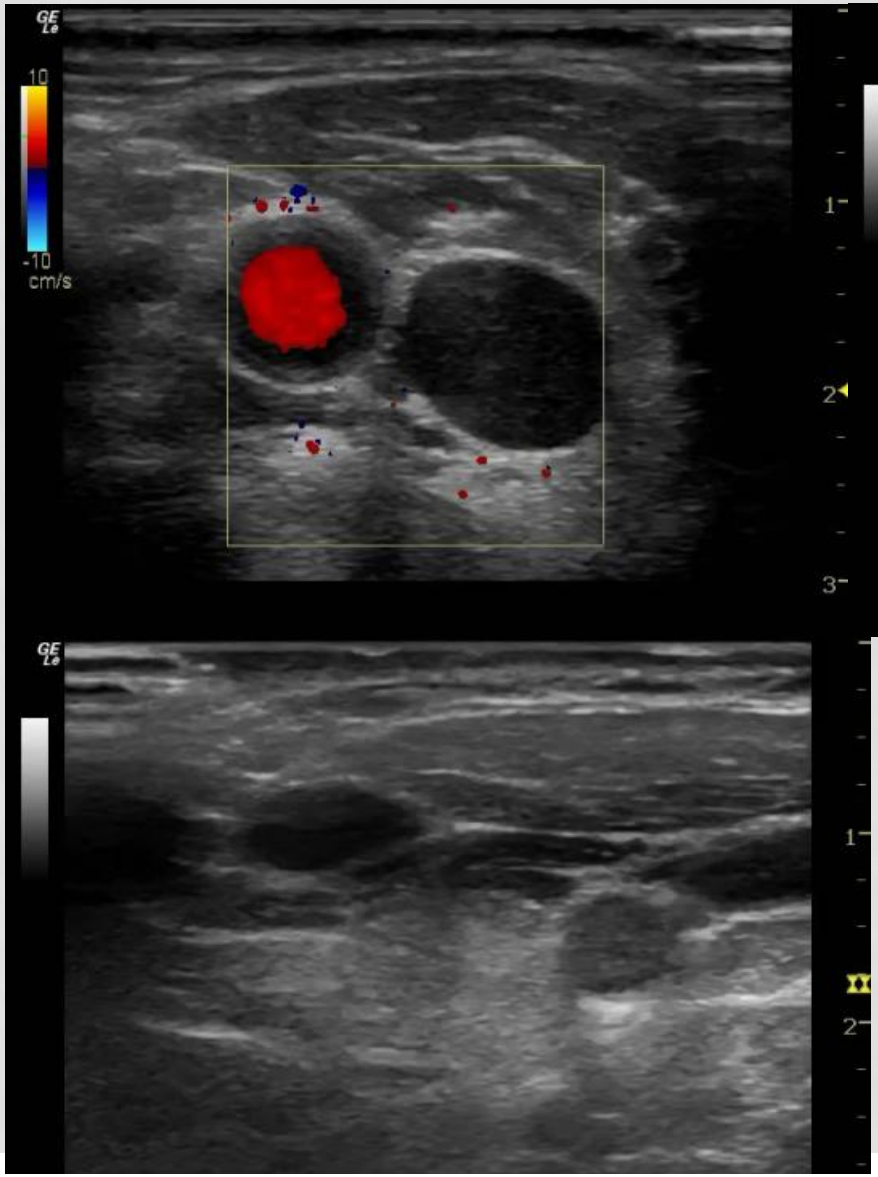
2) **Technical limitations** – match the vessel with the therapy: CVVH will need sufficient entry flow (!!!), cath extremity in special position (Avalon bilumen-bicaval), adapted material (wire, guide)

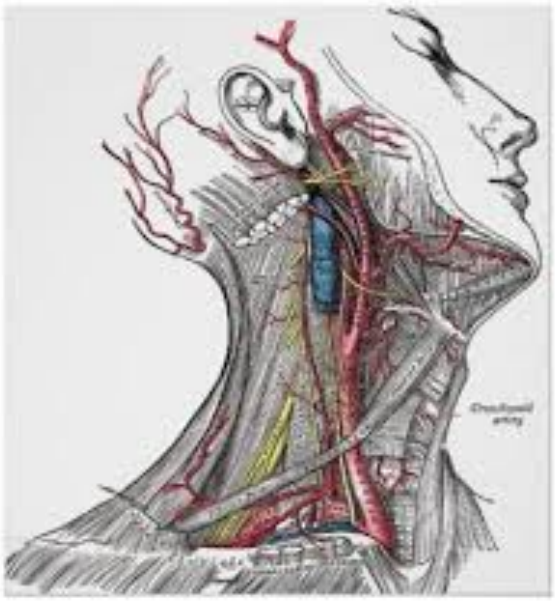
3) **CVC complications**: venous thrombosis (non-occulsive/occulisve), infection, accidentel removal

MOST COMPLICATIONS ARE VASCULAR ACCESS RELATED

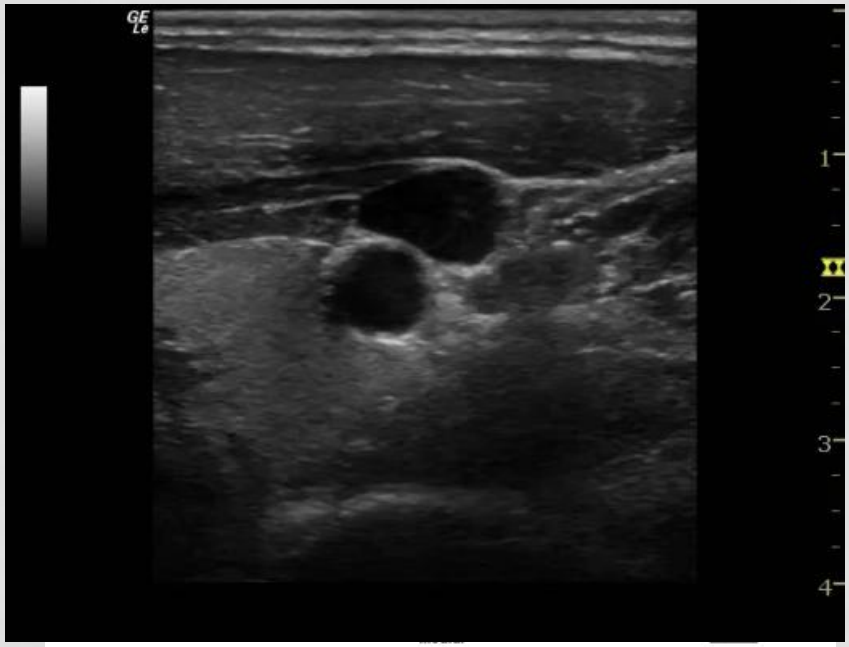


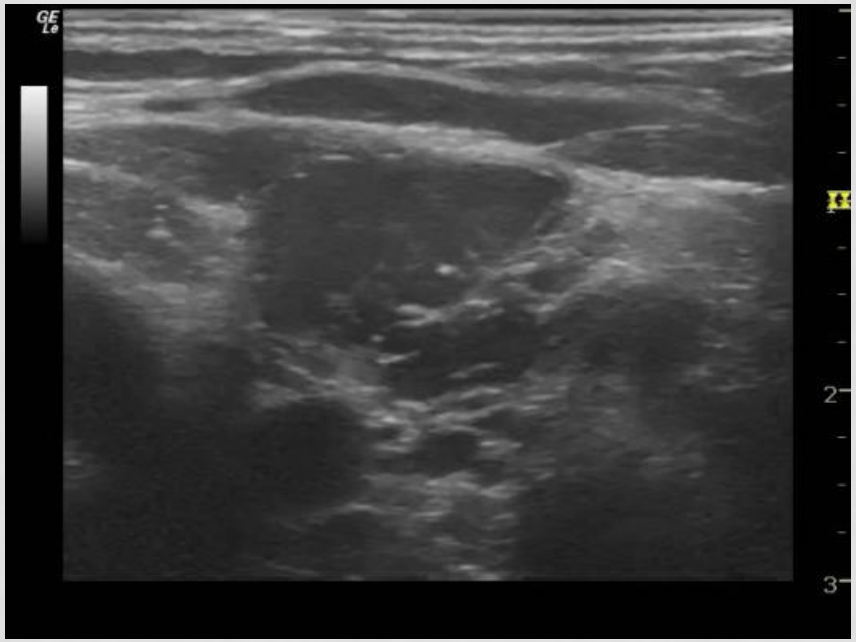
IJV … LANDMARK ! , WHAT ELSE ?..?

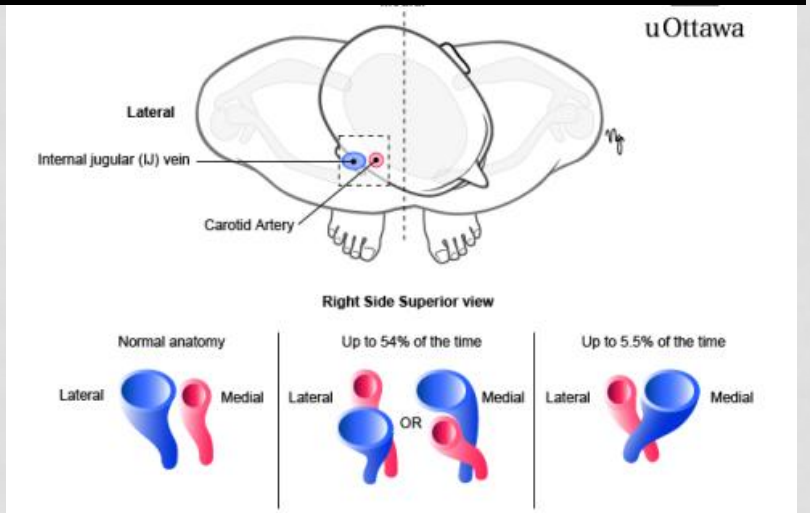




IJV … LANDMARK ? , NO !







In half cases carotid artery is either in front or behind the IJV !!!

IJV AND FV ARE ASSOCIATED WITH SIGNIFICANT VENOUS THROMBOSIS

Incidence of and risk factors for venous thrombosis in children with percutaneous non-tunnelled central venous catheters

Åsa Östlund[1,2], Urban Fläring[1,2], Åke Norberg[3,4], Ann Dahlberg[1], Jonas Berner[1,2], Sylvie Kaiser[5], Lena Vermin[5], Anna Svenningsson[6], Tony Frisk[7], Peter Larsson[1,2] and Andreas Andersson[1,2,*,*]

Table 4 Predictors of central venous catheter-related venous thrombosis in children (n=211) by stepwise backward multivariate logistic regression. Only variables with a P value <0.2 in the univariate analysis were included in the multivariate analysis. Venous thrombosis is the dependent variable in the multivariate analysis. OR, odds ratio; CI, confidence interval; CVC, central venous catheter.

Variable	Regression coefficient, β	OR (95% CI)	P-value
Intercept	−1.207		
Lumina (>1)	0.535	1.71 (1.19–2.45)	0.002
CVC insertion site (upper)	0.362	1.44 (1.03–1.99)	0.028
Male sex	0.319	1.38 (1.00–1.90)	0.049

Variable	All VT n=64	ANO n=49 (76.6%)	SO n=15 (23.4%)	P-value
CVC insertion site				
Internal jugular vein, n (%)	45 (70.3)	42 (85.7)	3 (20.0)	<0.001†
Femoral vein, n (%)	19 (29.7)	7 (14.3)	12 (80.0)	
CVC/vein diameter >0.33 (n=54), n (%)	10 (18.5)	4 (9.5)	6 (50.0)	0.005†

British Journal of Anaesthesia, 123 (3): 316–324 (2019)

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THE GOOD INSERTION SITE FOR THE RIGHT PATIENT

Intensive Care Med
https://doi.org/10.1007/s00134-019-05564-7

REVIEW

Ultrasound-guided vascular access in critical illness

G. A. Schmidt[1*], M. Blaivas[2], S. A. Conrad[3], F. Corradi[4,5], S. Koenig[6], M. Lamperti[7], B. Saugel[8], W. Schummer[9,10] and M. Slama[11]

Intensive Care Med. 2019;45(4):434–446.

Table 2 Approaches to CVC insertion

Vein	Visualization	Cannulation	Advantages	Disadvantages
Internal jugular vein	Longitudinal Transversal Oblique	In-plane (especially if the carotid artery is under) Out-of-plane	Easy to visualize Easily compressible Usually large cross-sectional diameter Less respiratory variations	Increased risk for infections Increased risk for thrombosis Not ideal in case of tracheostomy Not ideal in infants
Brachiocephalic vein	Longitudinal	In-plane	Easy to visualize Not dependent on respiratory variations Large cross-sectional diameter	Less visible and accessible in obese patients Requires advanced training
Subclavian vein (supraclavicular approach)	Longitudinal	In-plane	Not dependent on respiratory variations	Can be overlapped by subclavian artery Near to pleura Requires advanced training Risk for pneumothorax
Axillary vein	Longitudinal Transversal	In-plane Out-of-plane	↓ risk for infections ↓ risk for thrombosis	Dependent on respiratory variations Deep position Requires advanced training Risk for pneumothorax
Femoral vein	Transverse (longitudinal)	Out-of-plane	Easily visible Ideal for emergency situations or when the head and neck area are not accessible	High risk for infections High risk for accidental removal Catheter tip will not be centrally placed Not ideal in infants

Adapted table for infants and young children

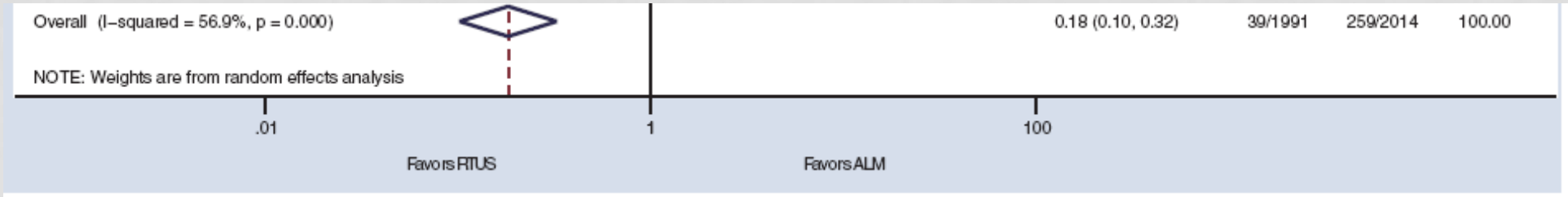
…BUT THE GOOD WAY !

Real-time Two-dimensional Ultrasound Guidance for Central Venous Cannulation

A Meta-analysis

Shao-yong Wu, M.D.,* Quan Ling, M.D.,† Long-hui Cao, M.D., Ph.D.,‡ Jian Wang, M.D., § Mei-xi Xu, M.D.,‡ Wei-an Zeng, M.D., Ph.D.‖

Anesthesiology 2013



Less arterial puncture
Less hematoma
Less pneumothoraces
Less hemthoraces

NHS
National Institute for Clinical Excellence

1. Guidance

1.1 Two-dimensional (2-D) imaging ultrasound guidance is recommended as the preferred method for insertion of central venous catheters (CVCs) into the internal jugular vein (IJV) in adults and children in elective situations.

1.2 The use of two-dimensional (2-D) imaging ultrasound guidance should be considered in most clinical circumstances where CVC insertion is necessary either electively or in an emergency situation.

http://www.nice.org.uk/nicemedia/live/11474/32461/32461.pdf

A Prospective Randomized Trial of Ultrasound- vs Landmark-Guided Central Venous Access in the Pediatric Population

J Am Coll Surg 2013

Matias Bruzoni, MD, Bethany J Slater, MD, James Wall, MD, Shawn D St Peter, MD, Sanjeev Dutta, MD, FACS

Table 2. Overall Success and Complication Rates Between the Two Groups

Variable	Ultrasound-guided (n = 66)	Landmark (n = 84)	p Value
Success at first attempt, %	65	45	0.021
Success within 3 attempts, %	95	74	0.0001
Arterial puncture, %*	4.5	8.3	–
Complications, %*	4.5	4.7	–
Cannulation time, s*	35	43	–

*Secondary outcomes.

Ultrasounds and CVC

- Pediatric literature

Ultrasound-guided central venous catheter placement decreases complications and decreases placement attempts compared with the landmark technique in patients in a pediatric intensive care unit*

Curt D. Froehlich, MD; Mark R. Rigby, MD, PhD, FAAP; Eli S. Rosenberg, BS; Ruosha Li, BS; Pei-Ling J. Roerig, BS, CCRC; Kirk A. Easley, MS; Jana A. Stockwell, MD, FAAP, FCCM

Crit Care Med 2009 Vol. 37, No. 3

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J Am Coll Surg Vol. 216, No. 5, May 2013

Ultrasound for vascular access in pediatric patients

Ehrenfried Schindler[1], Gregory J. Schears[2], Stuart R. Hall[3] & Tomohiro Yamamoto[1]

Pediatric Anesthesia **22** (2012) 1002–1007

Ultrasound-guided percutaneous insertion of Hickman lines in children. Prospective study of 500 consecutive procedures☆

G. Suren Arul*, Nicola Lewis, Peter Bromley, James Bennett

Journal of Pediatric Surgery (2009) **44**, 1371–1376

ULTRASOUNDS AND CVC

- Internal jugular vein and femoral vein : more described….
- **The "not so new" subclavicular approach technique: brachiocephalic vein catheterization**

Ultrasound-guided subclavian vein cannulation in infants: supraclavicular approach

Ossam Rhondali[1], Rachid Attof[1], Sylvie Combet[1], Dominique Chassard[2] & Mathilde de Queiroz Siqueira[1]

Pediatric Anesthesia 21 (2011) 1136–1141

Consecutive, prospective case series of a new method for ultrasound-guided supraclavicular approach to the brachiocephalic vein in children

C. Breschan[1*], M. Platzer[1], R. Jost[2], H. Stettner[3], A.-S. Beyer[3], G. Feigl[4] and R. Likar[1]

British Journal of Anaesthesia **106** (5): 732–7 (2011)

Supraclavicular Ultrasound-Guided Catheterization of the Subclavian Vein in Pediatric and Neonatal ICU: A Feasibility Study

Anne-Sophie Guilbert, MD[1]; Lorenço Xavier, MD[1]; Clément Ammouche, MD[1]; Philippe Desprez, MD[1]; Dominique Astruc, MD[2]; Pierre Diemunsch, PhD[3]; Jocelyne Bientz, MD[1]

Pediatr Crit Care Med. 2013 May;14(4):351-5

Table 1: summary of overall results form studies published on US-guided SCV cannulations in pediatric populations

Author	Patients (n)	Weight (kg) range median	Left vs. right sided catheters	Position of the operator	Probe	Results	Complications
Pirotte et al 2007	23 (25 catheters)	2.2-27.0 (6.1)	67% left sided 33% right sided	Not specified	10MHz, 2.5 cm 'Hockey Stick' probe	Success rate 100% First attempt 84%	No major complications
Brechan et al (2011)	35 (42 catheters)	0.9-21.0 (6.8)	83.3% left sided 16.7% right sided	At the child's head	13-6 MHz, 2.5cm linear probe	Success rate 100% First attempt 7[illegible]	No major complications
Kulkarni et al (2012)	150	2.7-35.0 (median not reported)	6.5% left sided 93.5% right sided	At the child's head	Not described	Su[illegible]	1.33% (2) arterial puncture 0.67% (1) pneumothorax
Brechan et al (2012)	136 (183 catheters)	0.7-10 (3.7)	92.9% left sided 7.1% right sided	At the child's head			major plications
Rhondali et al (2011)	37	4.1 (range not reported)	73% left si[illegible] 27%				or plications
Guilbert et al (2013)	42	2-70				[illegible]ate [illegible]% First attempt not reported	1 arterial puncture 1 pneumothorax
Byon et al (2013)	49	2.6-17. (mean			[illegible]0MHz linear 'hokey-stick' probe	Success rate 100% First attempt 93.9%	No major complication
Park et al (2012)	11	2.6-12.4 (4.	[illegible] sided	Not specified	25mm and 40 mm 6-18 MHz linear probe	Success rate 100% First attempt 90.9%	No major complication
Nardi et al (2016)	615	1.2 – 94 (14.0)	45.2% left sided 54.8% right sided	At the patients side	10MHz and 18 MHz linear 'hokey-stick' probe	Success rate 98.1% First attempt 79.8%	0.8% arterial puncture 0.3% hematoma 1.8% guide-wire malposition
Lausten-Thomsen et al (2016)	105 (107 catheters)	0.7-4.8 (2.8)	93.5% left sided 6.5% right sided	At the patients side	8-18 MHz Probe	Success rate 97.3% First attempt not reported	No major complications

Success rate 93-100%
First attempt 73-94%
No complications …

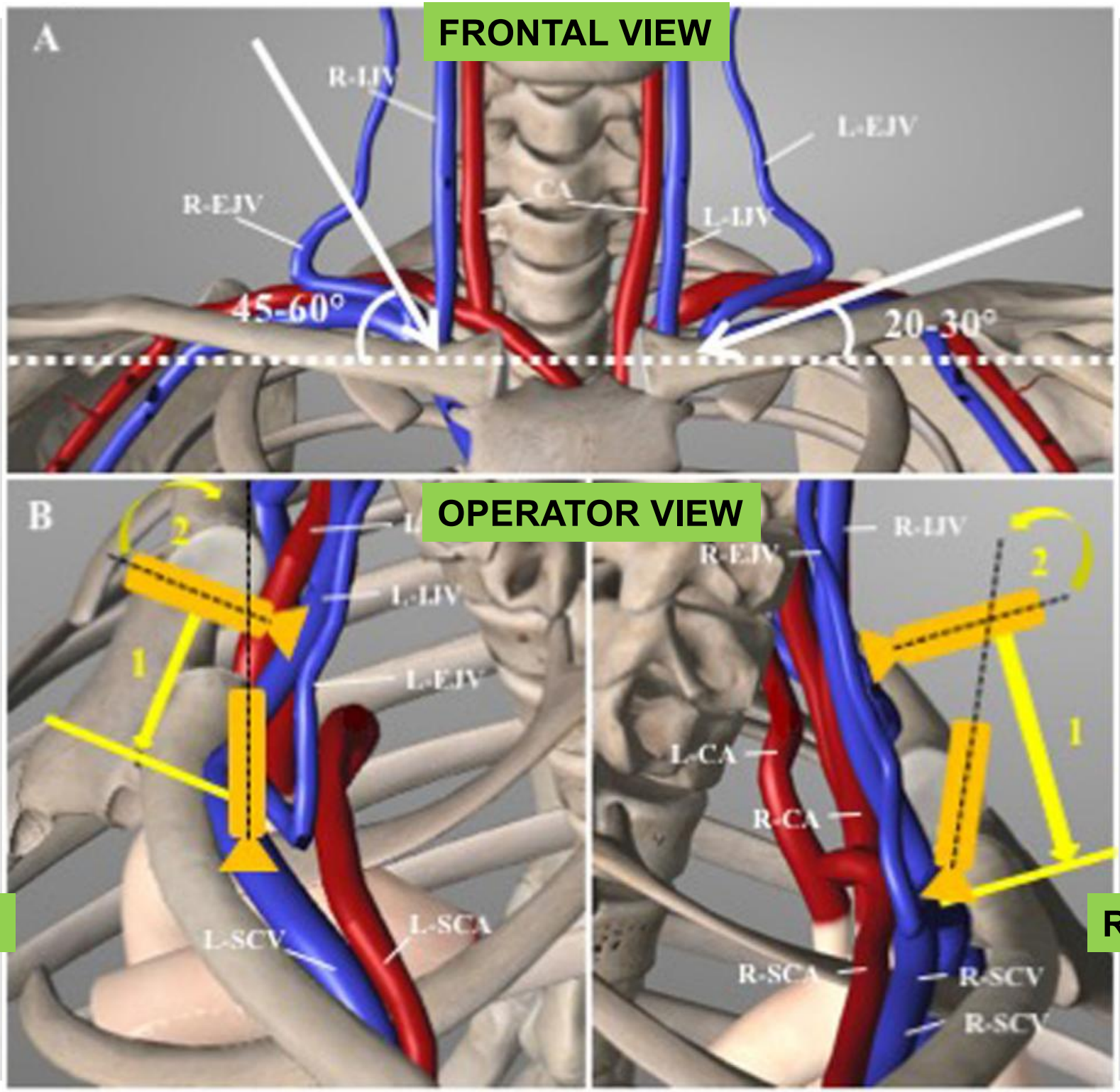
Ultrasound-guided subclavian vein cannulation in low birth weight neonates – Bicêtre P/NICU

- January 2013 - July 2015, 107 subclavian cvc
- 97.3% success rate, no complications

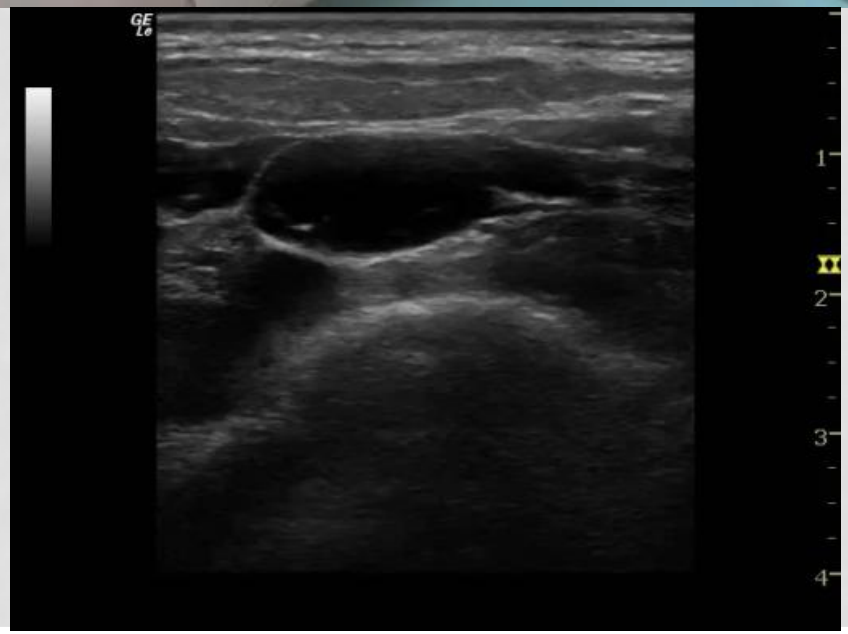
	<1500g n=10	1500-2499g n=30	2500-4999g n=67	total n=107
At birth				
GA, birth, median (range)	26+2 (25+2 – 30+6)	34+1 (25+3 – 39+5)	38+3 (26+4 – 41+1)	37+1 (25+2 – 41+1)
Birth weight (grams) median (range)	847.5 (590-1506)	1947.5 (655-2450)	3060 (820-4170)	2630 (590-4170)
Sex (male:female)	6:4	13:17	41:26	60:47
At catheter placement				
Chronologic age (days) median (range)	17.5 (0-56)	11 (0-90)	4 (0-89)	6 (0-90)
Weight (grams), median (range)	1130 (705-1495)	2180 (1570-2470)	3160 2500-4800)	2770 (705-4800)
Corrected GA (days) median (range)	213 (190-237)	250 (224-281)	281 (241;329)	269 (190-329)
left:right catheter	10:0	28:2	62:5	100:7

Lausten-Thomsen , Merchaoui, PCCM 2016

BRACHIOCEPHALIC VEIN BY SUPRACAVICULAR WAY


FRONTAL VIEW
A
R-IJV
L-EJV
R-EJV
CA
L-IJV
45-60°
20-30°
OPERATOR VIEW
B
L-IJV
L-EJV
L-SCV
L-SCA
R-IJV
R-EJV
L-CA
R-CA
R-SCA
R-SCV
R-SCV
1
2
LEFT
RIGHT

Perpendicular scaning and anterior tilt



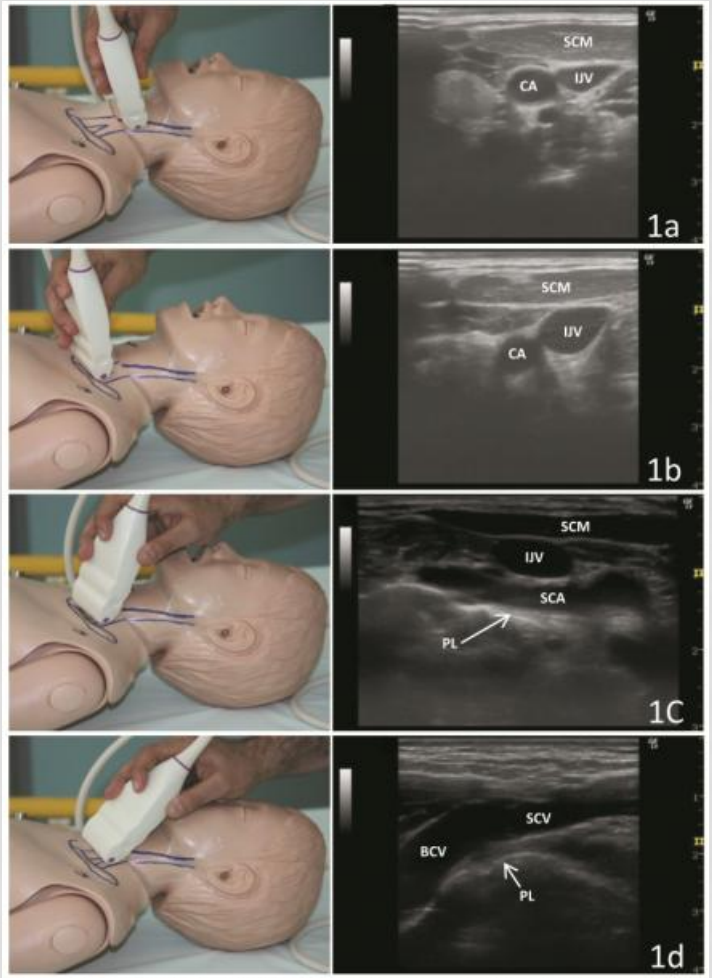
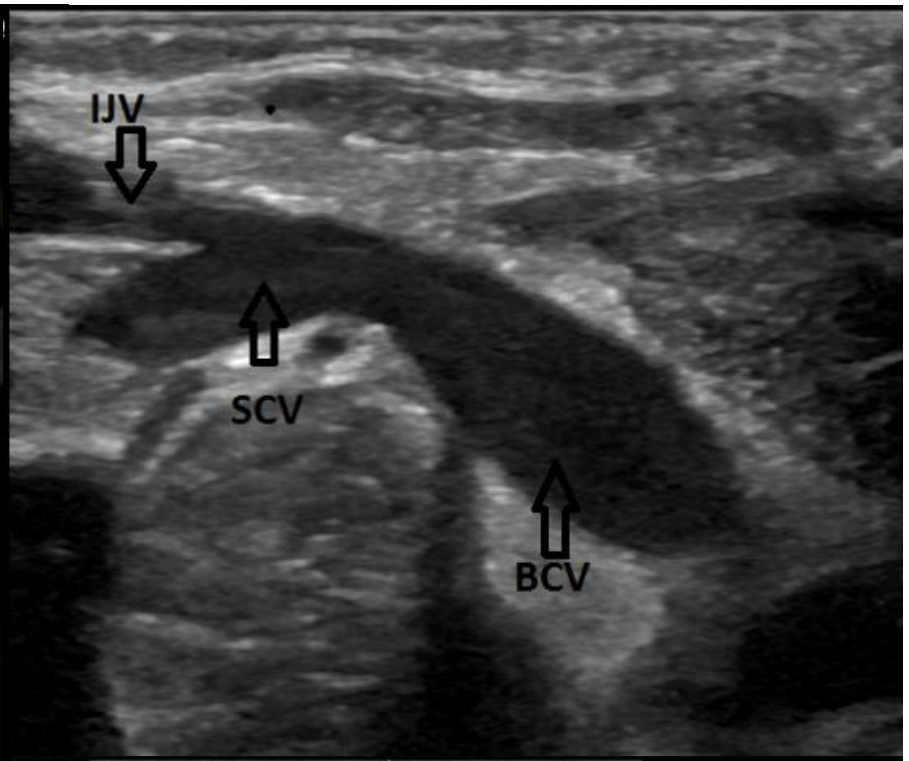
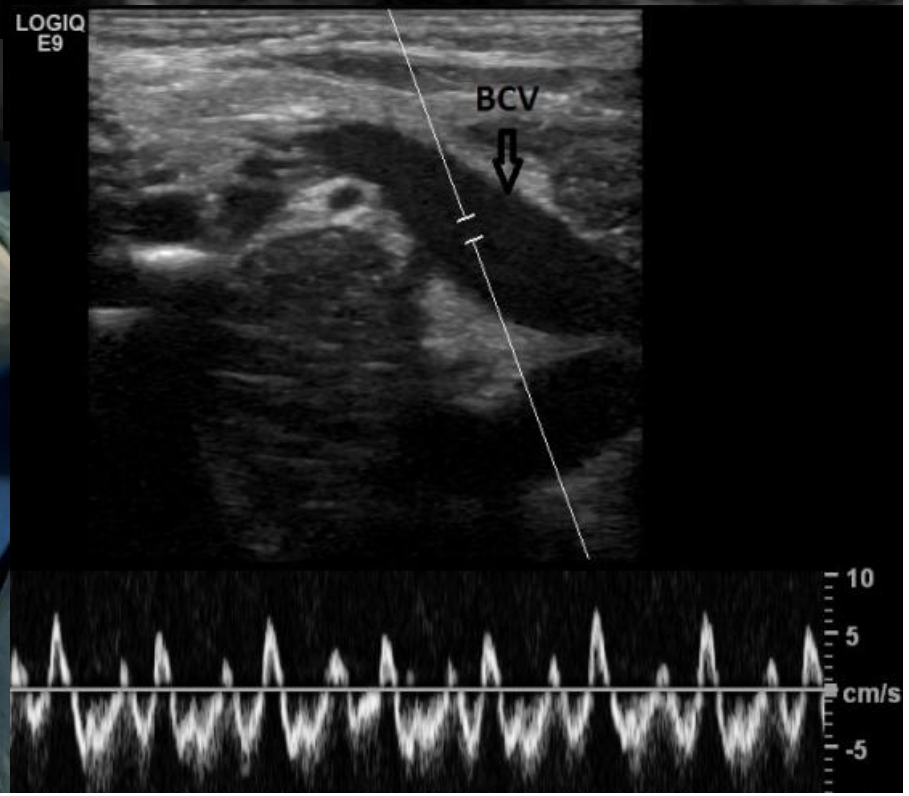


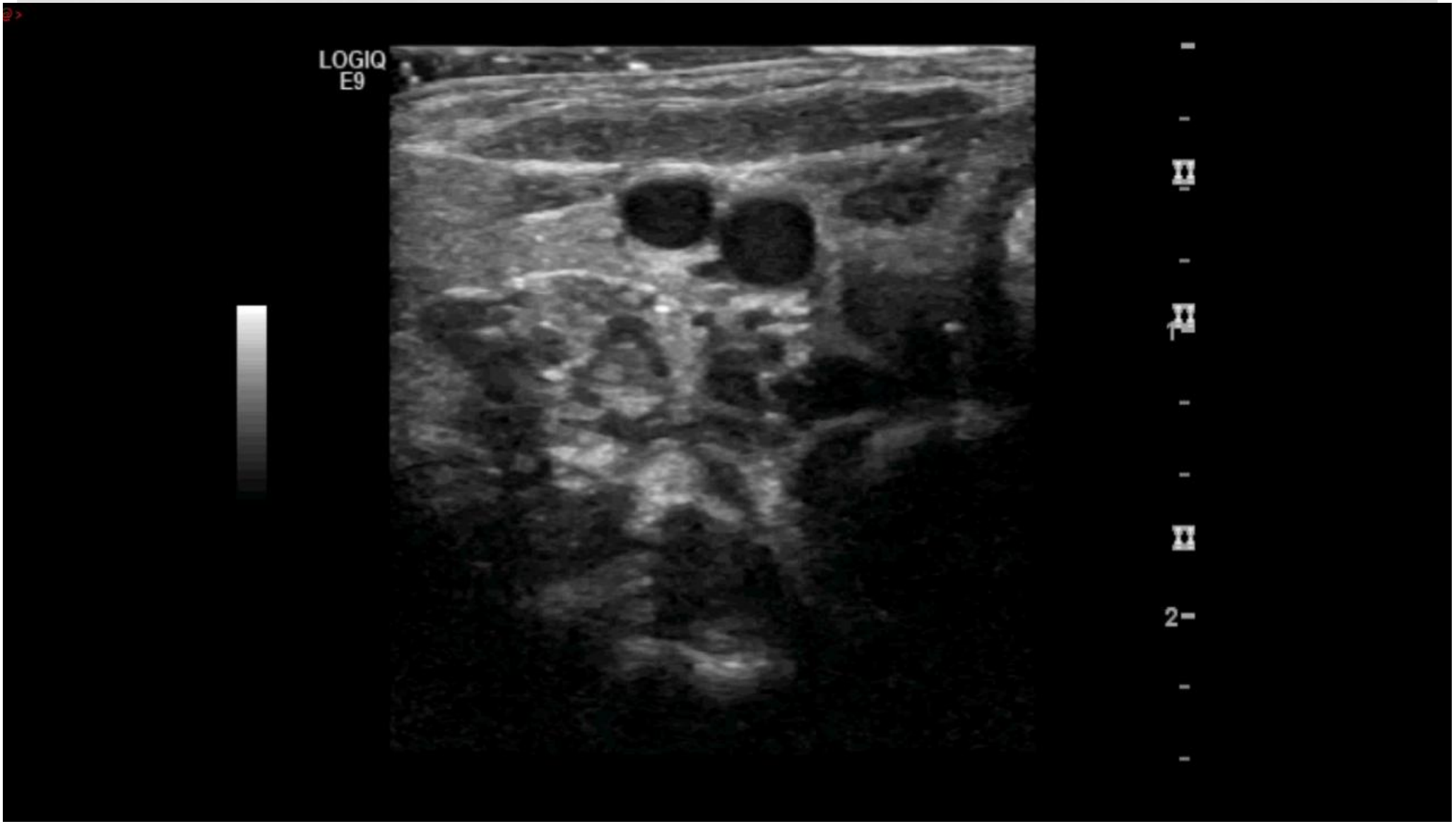
Figure 1 . Puncture method using a manikin. The probe is placed at the level of thyroid cartilage (1a), then translated down to the clavicule (1b). When it abuts against the clavicle, a progressive movement of angulation of the probe is made up : SCA then BCV and SCV appears (1c, 1d).
SCM : sternocleido mastoid muscle ; IJV : internal jugular vein ; CA : carotid artery ; SCA : subclavian artery ; SCV : subcalvian vein ; BCV : brachiocephalic vein ; PL : pleura

Guilbert et al PCCM 2013


IJV
SCV
BCV


LOGIQ
E9
BCV
10
5
cm/s
-5

THE 25 SECONDS PUNCTURE



GRAZIE, MERCI, THANK YOU

espnic

European Society of Paediatric and Neonatal Intensive Care