

GAVePed

Primo Convegno Nazionale



Uso globale dell'ecografo nella procedura di accesso vascolare ecoguidato

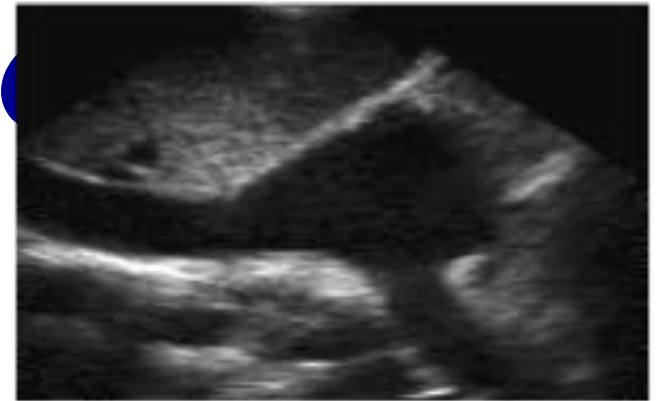
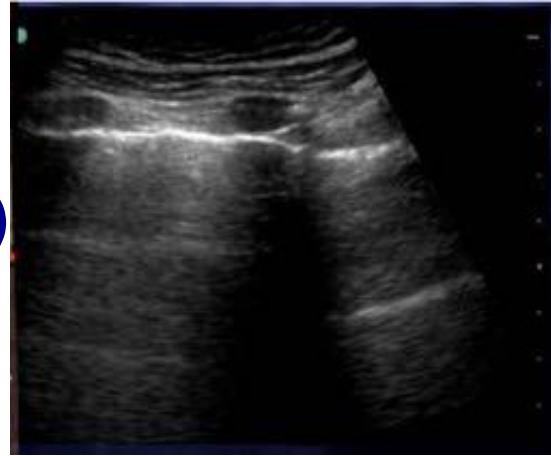
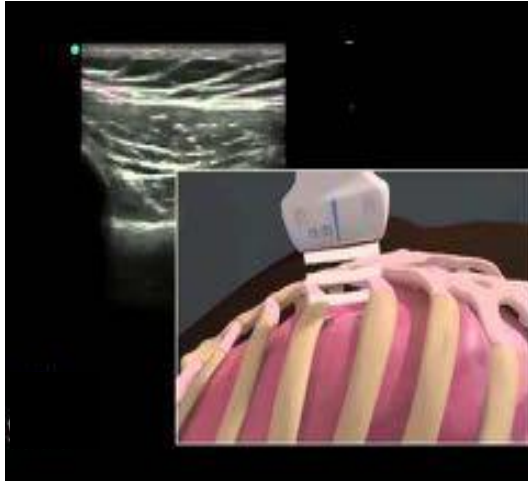
Daniele G. Biasucci

Gemelli



Fondazione Policlinico Universitario A. Gemelli
Università Cattolica del Sacro Cuore





**has become
disruptive innovation!**

CLINICALLY-INTEGRATED US in Critical Care

- Ultrasound Performed at the point of care
- Performed → Visualized on the screen
- Finally... INTERPRETED AT THAT TIME!



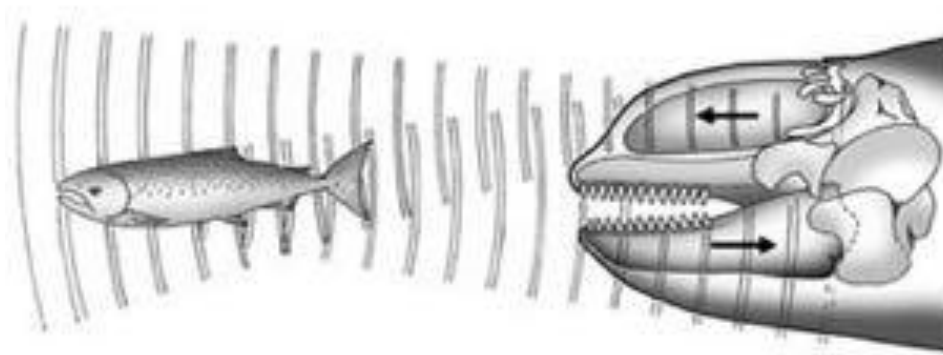
How an old technology has become a disruptive innovation

Resa Lewis, TEDMED Talks

1794 – Lazzaro Spallanzani



- Dimostrò che i pipistrelli, così come molti altri animali (es. i cetacei), usavano gli ultrasuoni per orientarsi



Ultrasuoni: prime applicazioni

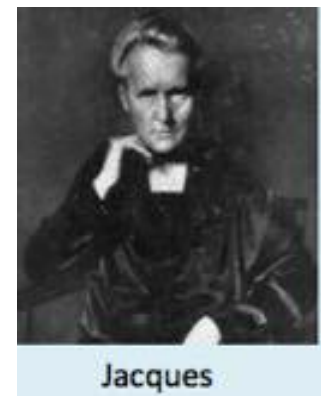
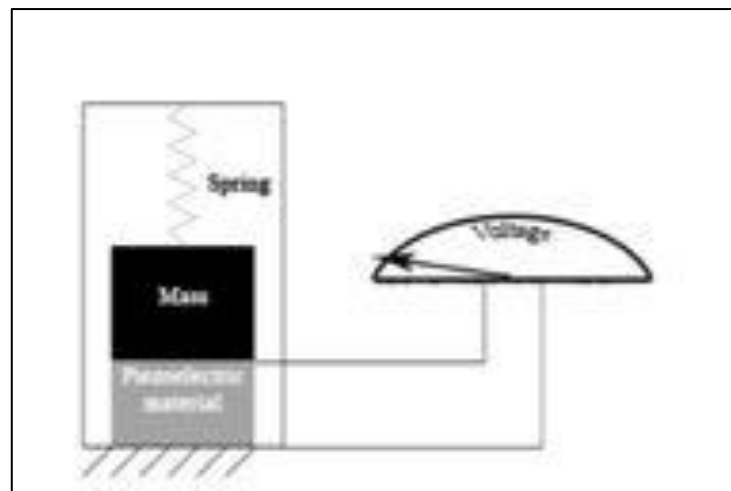
- Hanno riguardato inizialmente l'abito marittimo
- In pace le navi lo usavano per identificare ostacoli (es. icebergs)
 - Paul Langevin mette a punto il primo trasduttore dopo la tragedia del Titanic
- In guerra per identificare sottomarini o altre navi

1880 – The Curie Brothers

- Pierre e Jacques Curie scoprono l'effetto piezoelettrico
- Inventano il primo trasduttore di energia, da elettrica a meccanica ... ovvero... inventano la prima sonda ecografica della storia!



Pierre



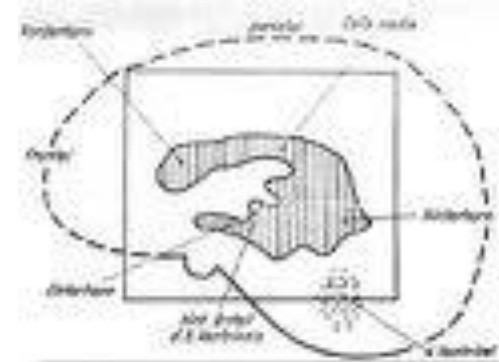
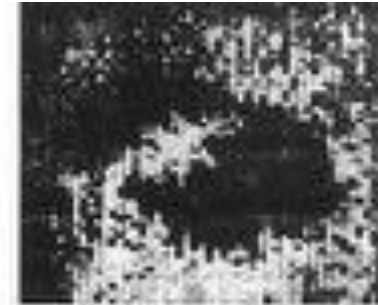
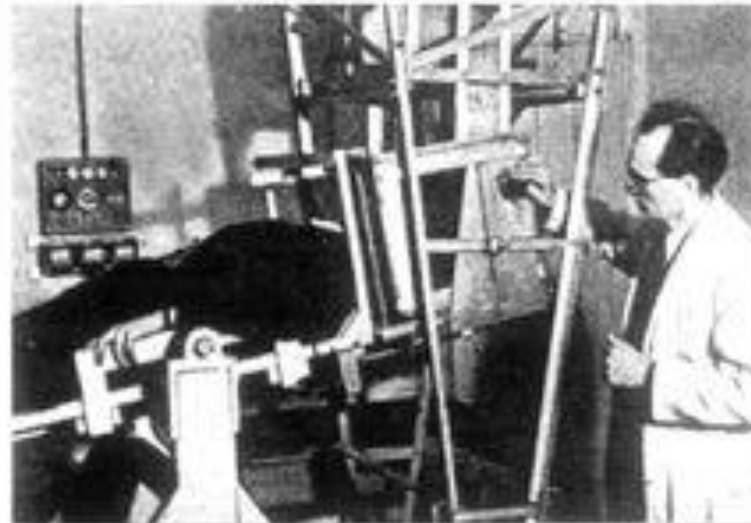
Jacques

1942 – Karl T. Dussik

- Prima applicazione in medicina: diagnosi di tumori cerebrali e valutazione dei ventricoli cerebrali



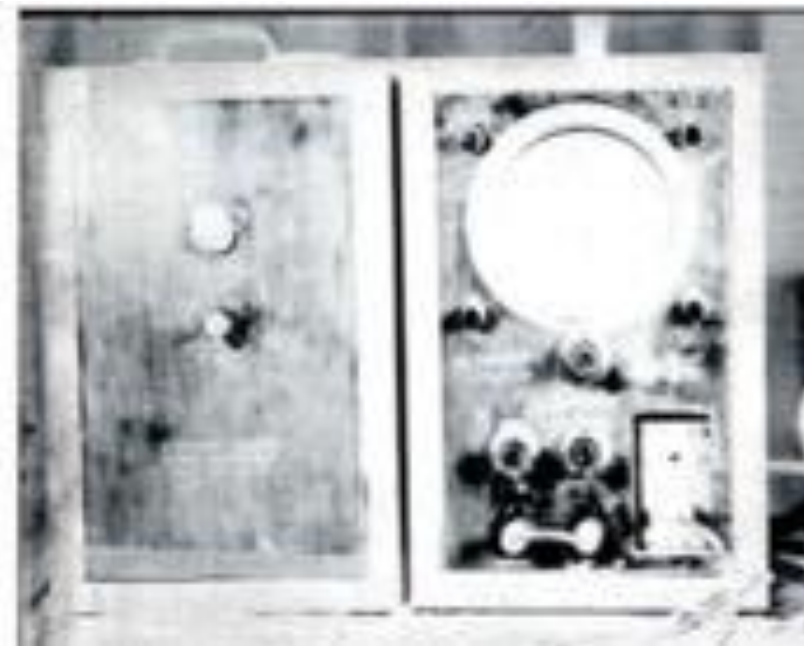
Karl Theo Dussik (9 January 1908 – 19 March 1968)



The hyperphonomogram was thought to depict the ventricles

1948 – George Ludwig

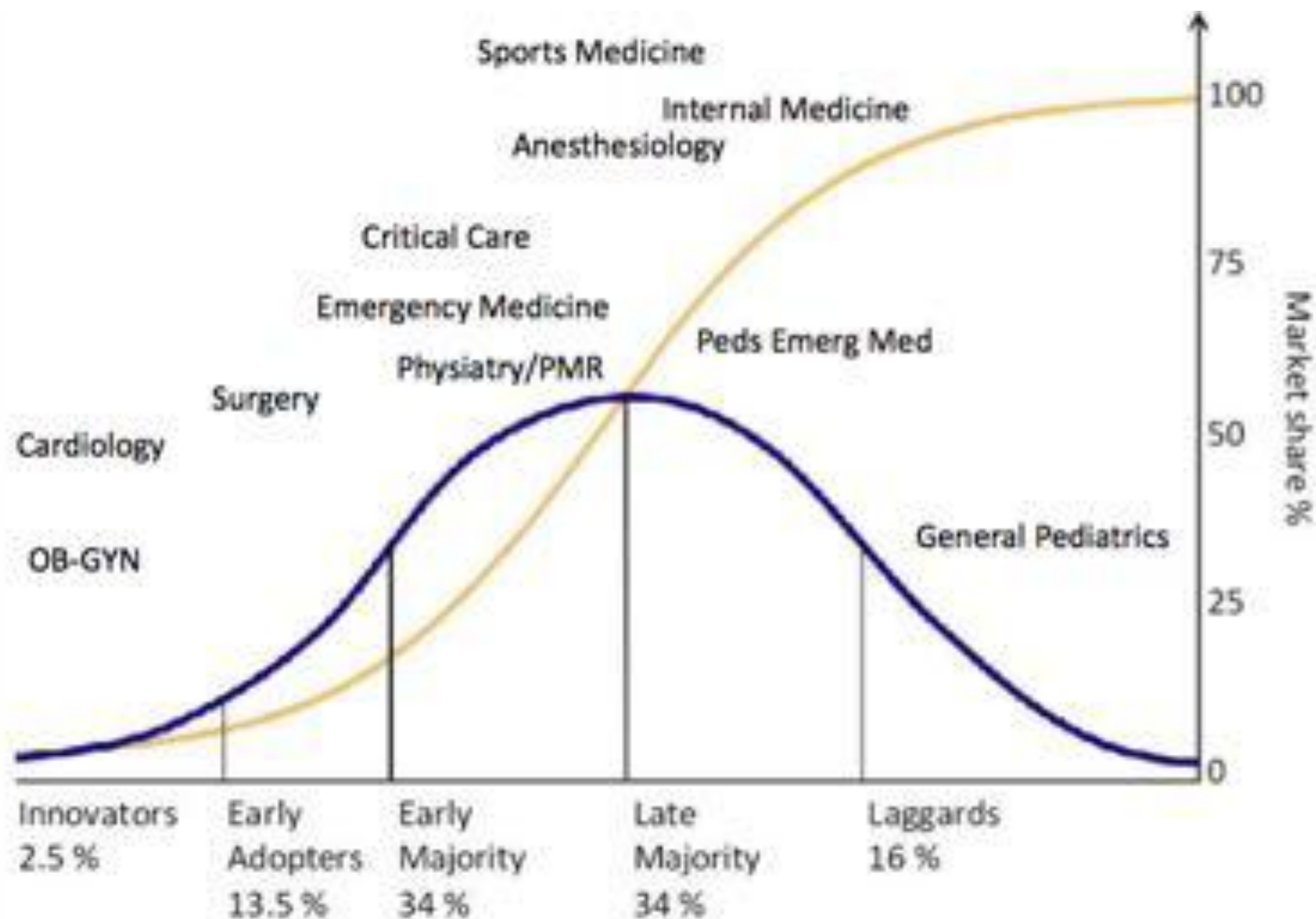
- Diagnosi ecografica di calcolosi della colecisti
- Individuazione di corpi estranei



1958 – Ian Donald

- Diffusione dell'ecografia in ambito ostetrico-ginecologico
- Prima pubblicazione su The Lancet



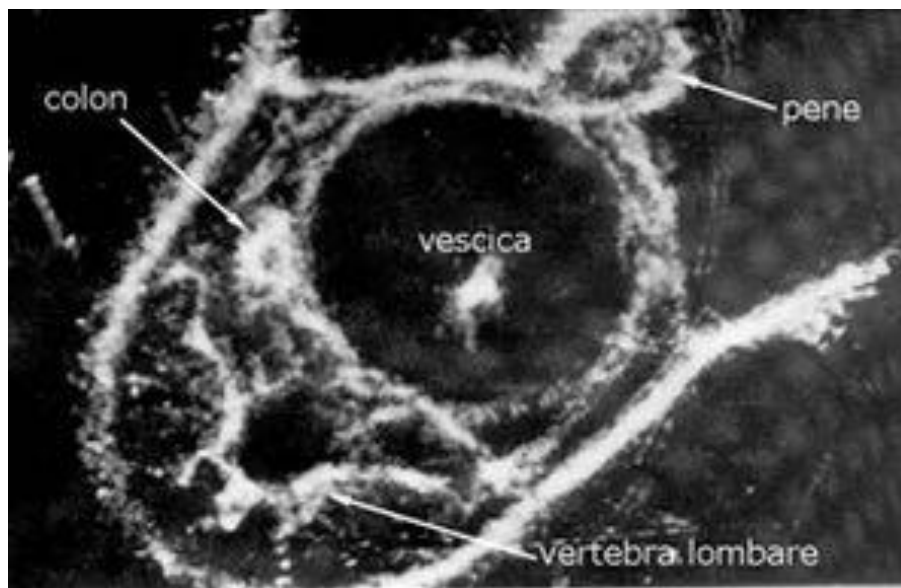




policy on privileging US

- (1) Ultrasound imaging is within the scope of practice of appropriately trained physicians;
- (2) [...] broad and diverse use and application of ultrasound imaging technologies exist in medical practice;
- (3) [...] each hospital medical staff should review and approve criteria for granting ultrasound privileges based upon background and training for the use of ultrasound technology and strongly recommends that these criteria are in accordance with recommended training and education standards developed by each physician's respective specialty.

Primi ecografi rudimentali



... evoluzione...







Portatili e dedicati... gli albori...







Ricordate il Tricorder?



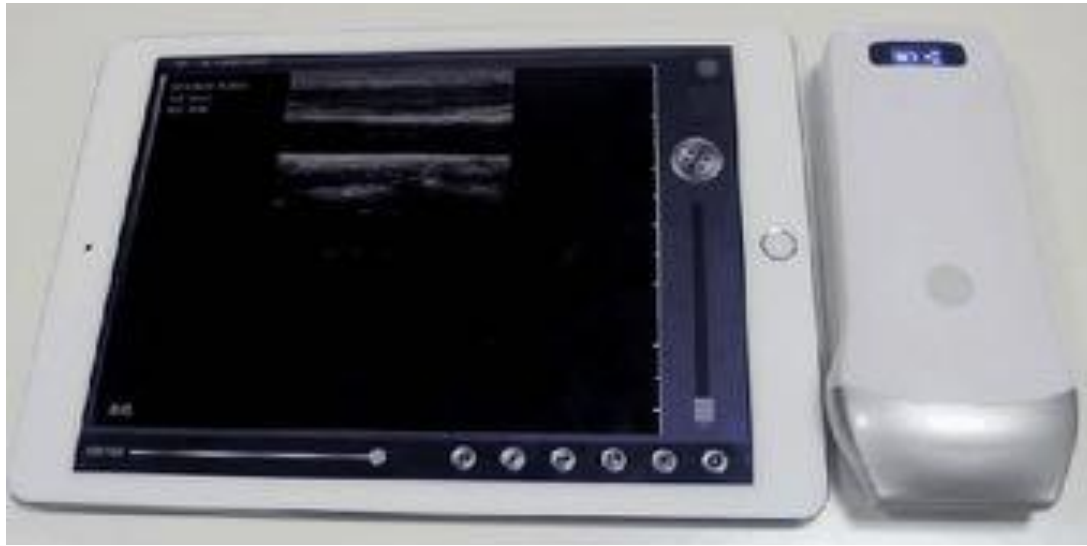
... on the scene...



...In-hospital...



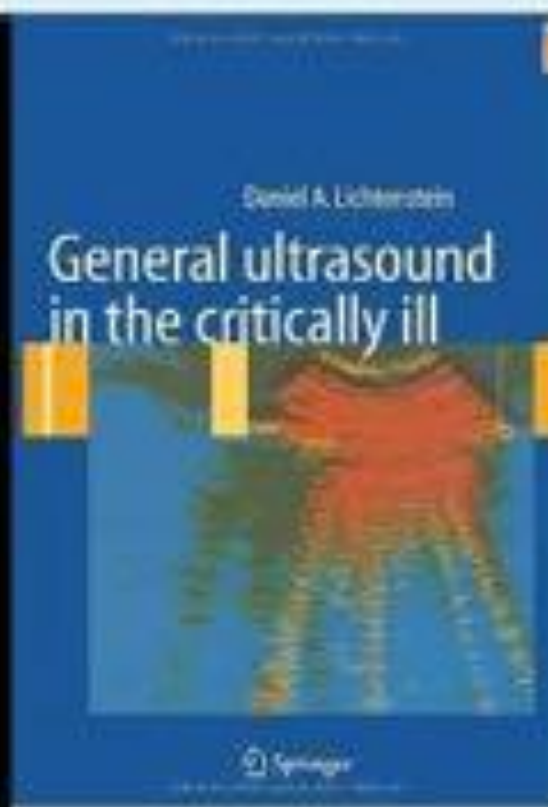
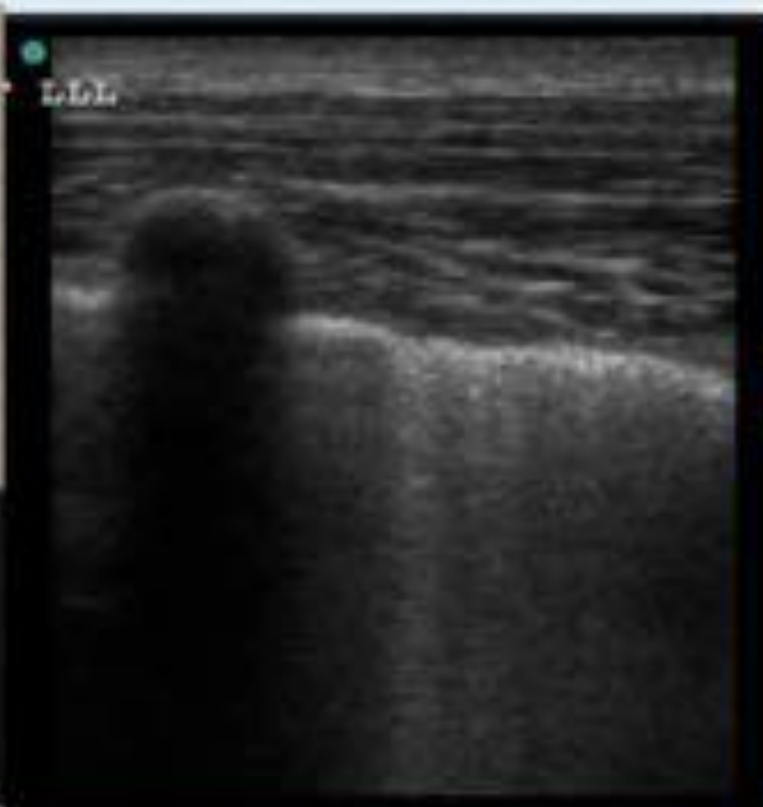






- Emergency ultrasound examinations are performed and interpreted by emergency physicians [...] in the setting of the ED or a non-ED emergency setting such as out-of-hospital, battlefield, space, clinic, or any remote setting.
- [...] may also be performed in other hospital settings if needed for emergent situations. Other medical specialties may wish to use this document if they perform emergency ultrasounds in the manner described above.
- [...] is a goal-directed focused ultrasound examination that answers brief and important clinical questions in an organ system or for a clinical symptom or sign involving multiple organ systems Emergency ultrasound is synonymous with the terms bedside, point-of-care, focused, clinical and physician performed. [...]
- [...] as described above uses a different paradigm than traditional, consultative ultrasound such as those ultrasound exams performed in US laboratories or departments
- Emergency ultrasound is an emergency medicine procedure, and should not be considered in conflict with exclusive “imaging” contracts seen with consultative ultrasound.

■ ■ 1989: Daniel Lichtenstein pioneers point-of-care lung ultrasound in the ICU
“Ultrasound is the real stethoscope”



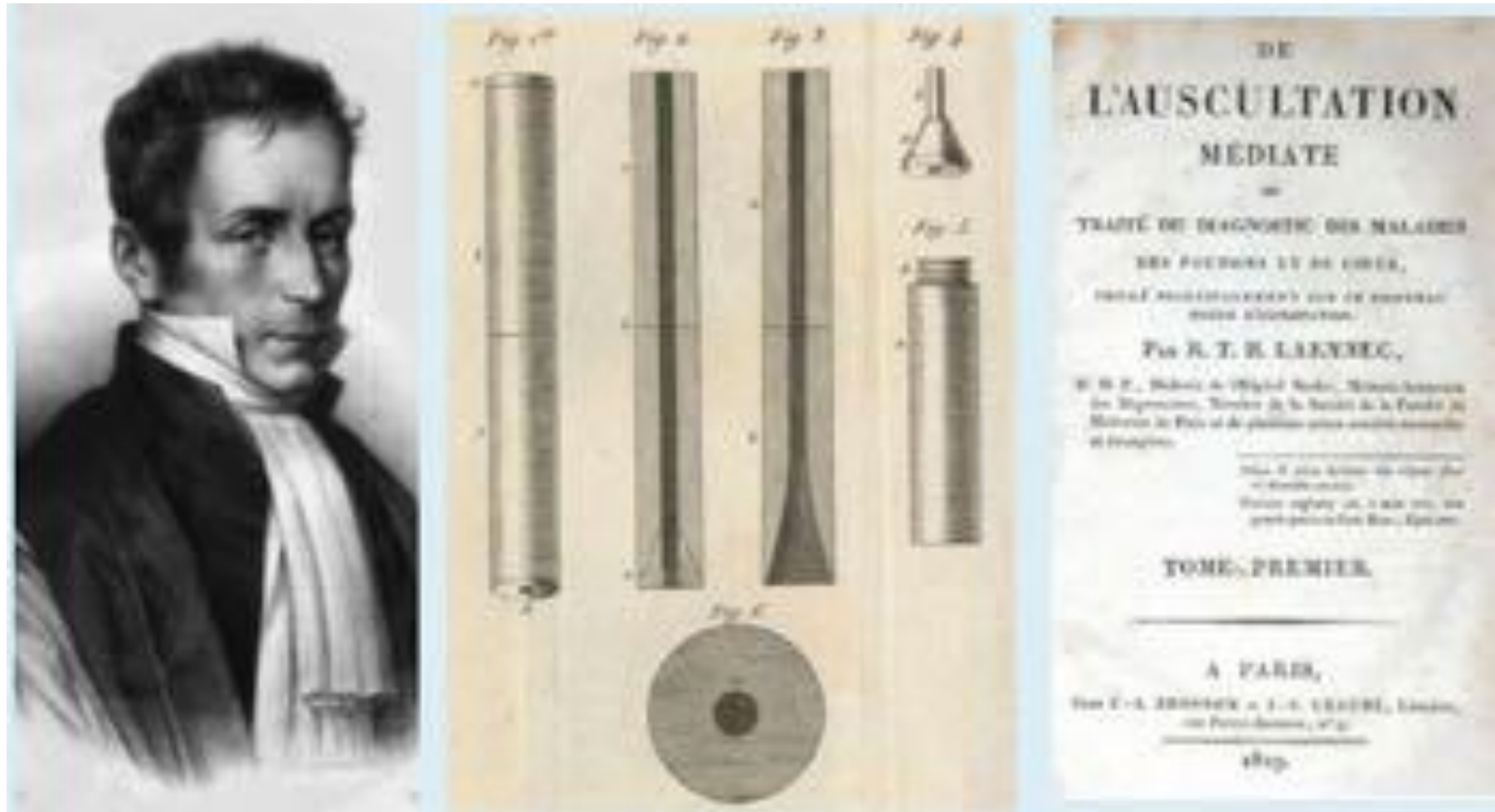
Ecografia pleuro-polmonare

- The lung has always been considered off-limits for ultrasound, «because ultrasound energy is rapidly dissipated by air, ultrasound imaging is not useful for the evaluation of the pulmonary parenchyma»

(Harrison's Principles of Internal Medicine, 2008)

1816-1819: René T.H. Laennec

- Inventore dello stetoscopio...

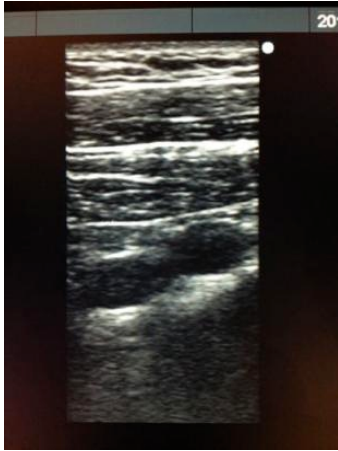


“That it will ever come into general practice, I am extremely doubtful; because its beneficial application requires much time and gives a good bit of trouble both to the patient and the practitioner”

J. Forbes, 1823

Preface to the First English Edition of Laennec’s “Treatise”

Ecografia e Accessi Vascolari

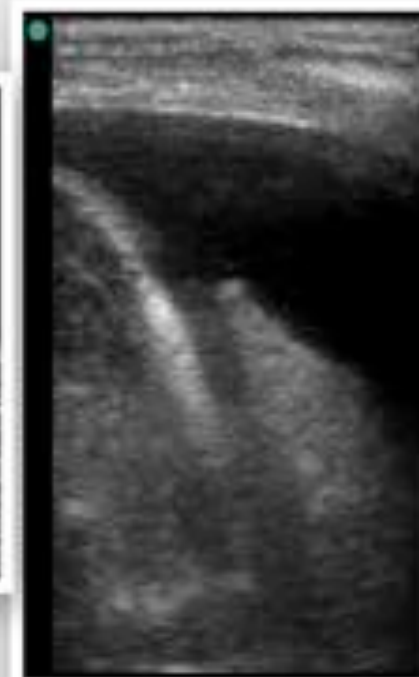
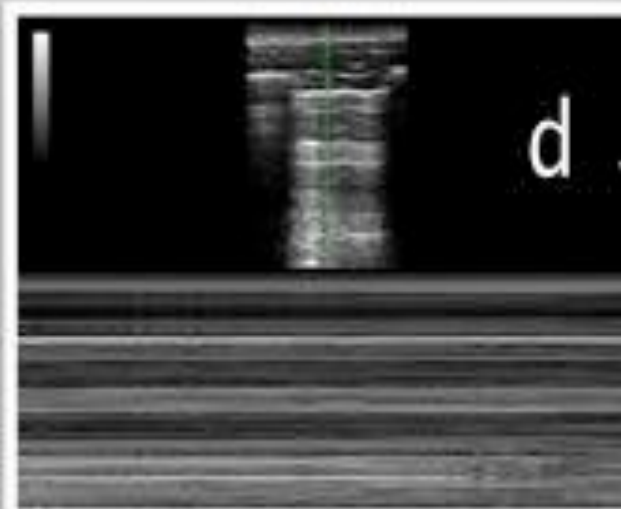
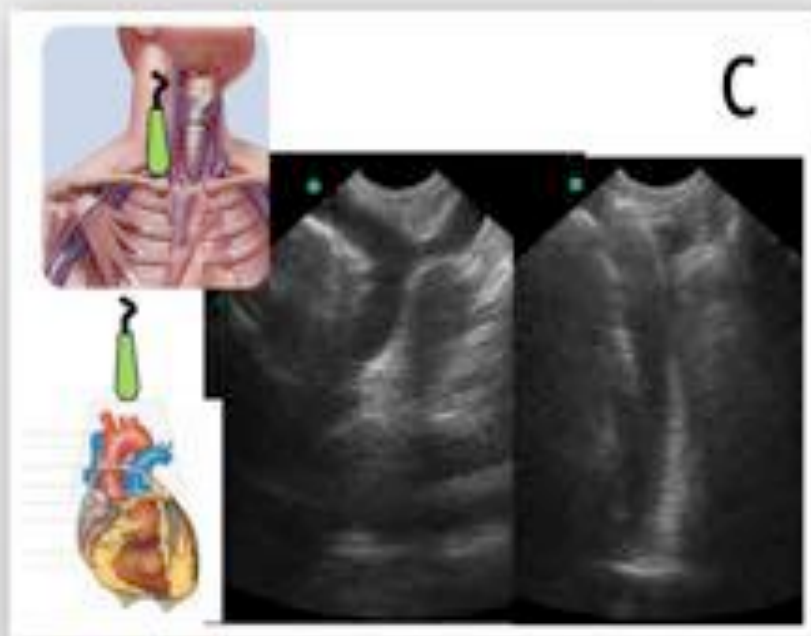
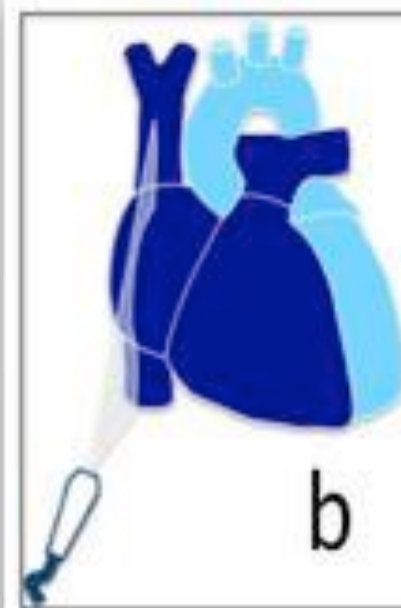
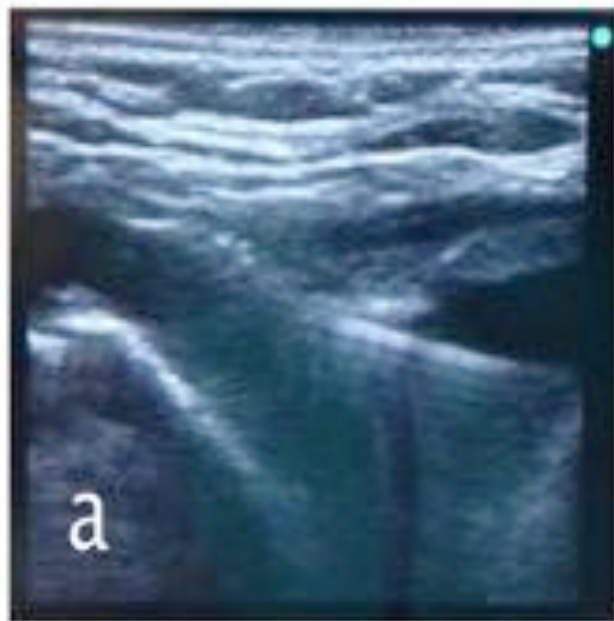


Valutazione Ecografica Preliminare

Puntura ecoguidata



Controllo della punta
Diagnosi/Esclusione PNX/Emotorace



... era il 1978 quando...

118

Clinical Reports

Vol. 57, Jan.-Feb. 1978
Anesth. Analg.

Internal Jugular Vein Location with the Ultrasound Doppler Blood Flow Detector

JAMES I. ULLMAN, MD*
ROBERT K. STOELTING, MD†
Indianapolis, Indiana‡

Anesthesia & Analgesia

... 1983 ...

CLINICAL REPORTS

481

Anesthesiology
60:481-482, 1984

Doppler Localization of the Internal Jugular Vein Facilitates Central Venous Cannulation

DWIGHT LEGLER, M.D.,* AND MICHAEL NUGENT, M.D.†

cannulation attempts.^{6,7} To avoid multiple needle probes and hopefully reduce the incidence of complications, we investigated the use of an ultrasonic Doppler to locate the IJ prior to its catheterization.⁸

- *Anesthesiology*

...alcuni anni più tardi...

Anesthesiology
64:350-351, 1986

Real-time Ultrasonic Guidance for Percutaneous Puncture of the Internal Jugular Vein

To the Editor:—Anatomical landmarks¹ and ultrasound Doppler flowmetry² have been employed for the location of the internal jugular vein (IJV). We have used transcutaneous ultrasonographic scanning to determine the precise location of the IJV and to observe the procedures of venous puncture and catheterization. An ultrasonographic scanner (Echo® Camera, Model SSD-256, Aloka, Japan) equipped with a 5 MHz ultrasound transducer was used to obtain the real-time ultrasound images. With the head rotated approximately 45 degrees contralateral to the side of the puncture, povidone iodine gel was used as the acoustic coupling medium. The probe was sterilized with ethylene oxide and applied longitudinally to the neck (fig. 1). The carotid artery is the only observable structure that bears a fixed relationship to the IJV at the level scanned.³ Both the IJV and carotid artery are identified as echo-free band images on the oscilloscope (fig. 2). Dur-



FIG. 1. Puncture of the right internal jugular vein. T-shaped probe is positioned in right internal jugular vein.

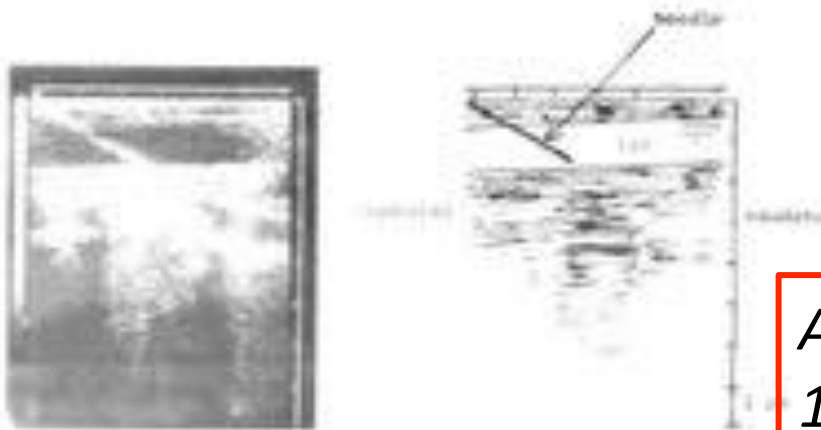


FIG. 2. The longitudinal ultrasound image of the internal jugular vein with the puncture needle in place. The internal jugular vein is observed as an echo-free band.

Anesthesiology,
1986

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Le evidenze pubblicate

- Cfr le meta-analisi disponibili in letteratura
 - Randolph 1996
 - Keenan 2002
 - Calvert 2003
 - Cochrane 2015
- Tutte dimostrano che la ecoguida si associa a
 - Maggiore % successi al primo tentativo
 - Minore % di complicanze
 - Minor numero di punture ripetute
 - Minor costo
 - Minor tempo

Calvert 2003: analisi economica

‘Economic modeling indicates that US is likely to save NHS resources as well as improve failure and complication rates’

‘For every 1000 procedures, a resource saving of 2000 pounds is suggested’

Le prime esperienze...

- Vena giugulare interna
 - Approccio 'out of plane', in asse corto



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Review (33)

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Text availability

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Free full text (137)

Full text (563)

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Page 1 of 36 Next > Last >>

- ☐ 1. [Airway compromise during central venous cannulation in an undiagnosed tubercular retropharyngeal abscess: A case report.](#)

Samanta S, Samanta S, Aggarwal R, Sori KD.

Ann Card Anaesth. 2015 Oct-Dec;18(4):596-8. doi: 10.4103/0971-9784.166483.

PMID: 26440253

[Similar articles](#)

- ☐ 2. [The effectiveness of trendelenburg positioning on the cross-sectional area of the right internal jugular vein in obese patients.](#)

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Pak J Med Sci. 2015 Jul-Aug;31(4):770-4. doi: 10.12669/pjms.314.7326.

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- ☐ 3. [Emergency percutaneous, bicaval double-lumen, ECMO cannulation in neonates and infants: insights from three consecutive cases.](#)

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Int J Artif Organs. 2015 Sep 29;0. doi: 10.5301/ija.5000432. [Epub ahead of print]

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PMC Images search for internal jugular vein cannulation and ultrasound



Puntura ecoguidata della VGI

- 439 studi
- 29 RCTs; 2 QRCTs; 2 non chiaro se RCT
- 33 solo VGI
- 2 VGI + SV (?)
- 29 solo Eco
- 6 solo doppler
- 2 Eco-color-doppler

Problemi

- Doppler o Eco-doppler
- Eco-assistenza
 - Alderson PJ, BJA 1992
- Ecoguida real-time
- Solo VGI
 - In-plane + “Asse Lungo”
 - Out-of-plane + “Asse Corto”
- Tecniche non standardizzate e/o non ben descritte nei lavori

Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization (Review)

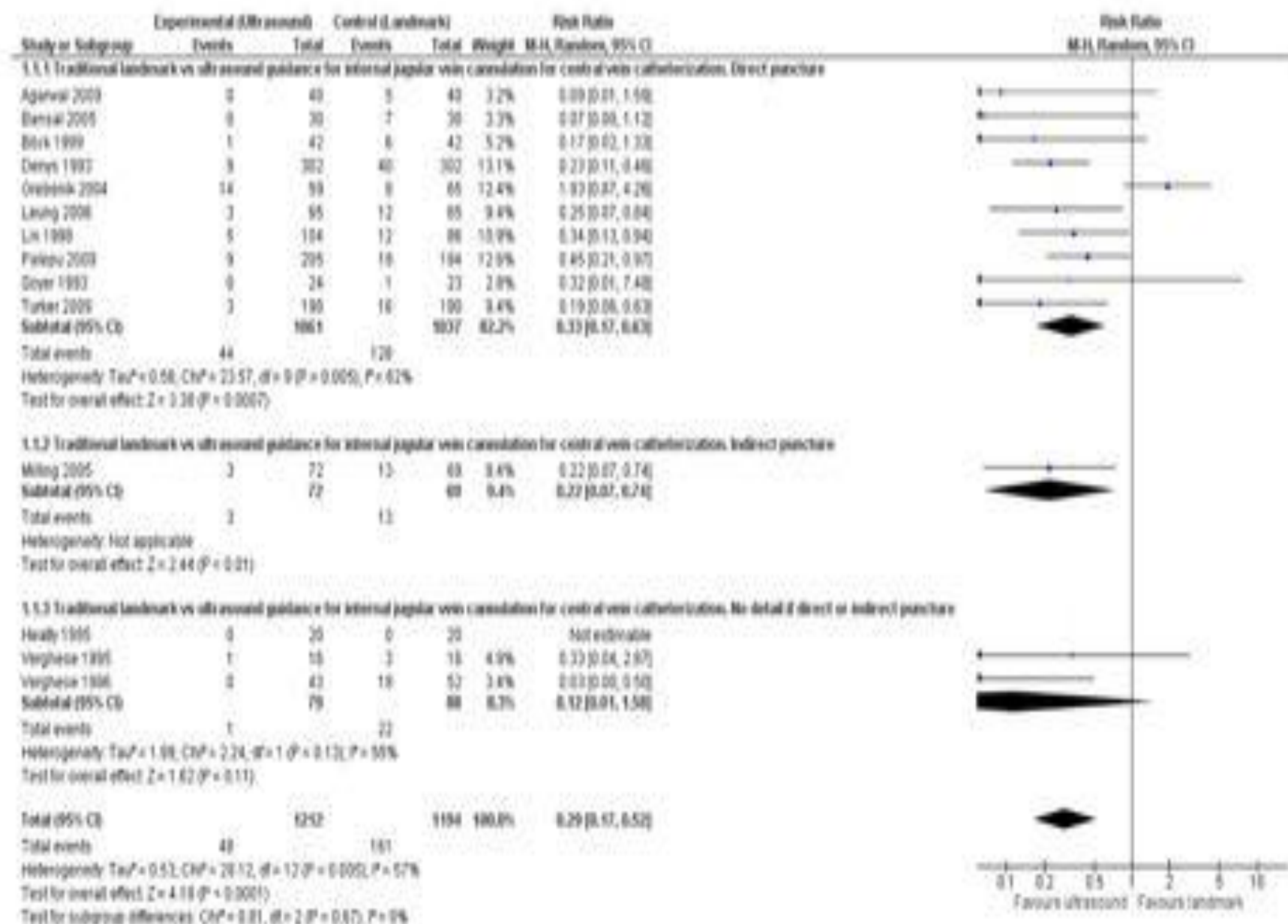
Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF



2015

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Figure 4. Forest plot of comparison: I Traditional landmark versus ultrasound guidance for internal jugular vein cannulation for central vein catheterization, outcome: I.I Complication rate total.



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ultrasound guided central venous access AND children

Summary, 20 per page, Sorted by Recently Added

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RCTs

Study	Number Patients	Ultrasound Technique	Operator	Percent Central Venous Catheter Success		Arterial Puncture	
				Landmark	Ultrasound	Landmark	Ultrasound
Alderson et al (52)	40	Prelocation	Cardiac anesthesia attending	80%	100%	6%	12%
Verghese et al (56)	95	Real time	Anesthesia fellow	77%	100%	25%	0%
Verghese et al (50)	32	Real time	Anesthesia fellow	81%	94%	19%	6%
Grebenik et al (57)	124	Real time	Cardiac anesthesia attending	89%	80%	6%	12%
Chaun et al (55)	62	Prelocation	Anesthesiologist	80%	100%	27%	3%

Paediatr Anaesth. 2009 Dec;19(12):1199-206. doi: 10.1111/j.1460-9592.2009.03171.x. Epub 2009 Oct 23.

Ultrasound guided internal jugular vein access in children and infant: a meta-analysis of published studies.

Sigaut S, Skhiri A, Stany I, Golmar J, Nivoche Y, Constant I, Murat I, Dahmani S.

- Limiti
 - Numero pazienti arruolati
 - Solo VGI
 - Eco assistenza e Eco Guida

J Am Coll Surg. 2013 May;216(5):939-43. doi: 10.1016/j.jamcollsurg.2013.01.054. Epub 2013 Mar 7.

A prospective randomized trial of ultrasound- vs landmark-guided central venous access in the pediatric population.

Bruzoni M, Slater BJ, Wall J, St Peter SD, Dutta S.

- RCT
- 150 pts < 18 anni
- Outcome primario: N° tentativi
- Outcome secondario: tempo, puntura arteriosa, altre complicanze
- Solo VGI

RESULTS: There were 150 patients enrolled between April 2008 and September 2011. There was no difference when comparing demographic data. Success at first attempt was achieved in 65% of patients in the ultrasound group vs 45% in the landmark group (p = 0.021). Success within 3 attempts was achieved in 95% of ultrasound group vs 74% of landmark group (p = 0.0001).

CONCLUSIONS: Ultrasound reduced the number of cannulation attempts necessary for venous access. This indicates a potential to reduce complications when ultrasound is used by pediatric surgeons.

Linee guida internazionali di riferimento

- ☐ Raccomandazioni AHRQ
- ☐ Linee guida NICE
- ☐ Linee guida pediatriche ESPEN
- ☐ Linee guida BCSH
- ☐ Position Statement AVA 2008
- ☐ Position Statement ACS 2008
- ☐ Linee guida ESPEN
- ☐ Linee guida CDC Atlanta 2011
- ☐ Linee Guida SHEA 2014
- ☐ Linee Guida EPIC 3

AHRQ Recommendations



2001

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. Haugom, 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

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Jiang L, Zhang M, Ma Y.

Crit Care Med. 2015 Oct 43(10):e474-5. doi: 10.1097/CCM.0000000000001071. No abstract available.

PMID: 26376279

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Ultrasound guidance versus anatomical landmarks for subclavian or femoral vein catheterization (Review)

Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF



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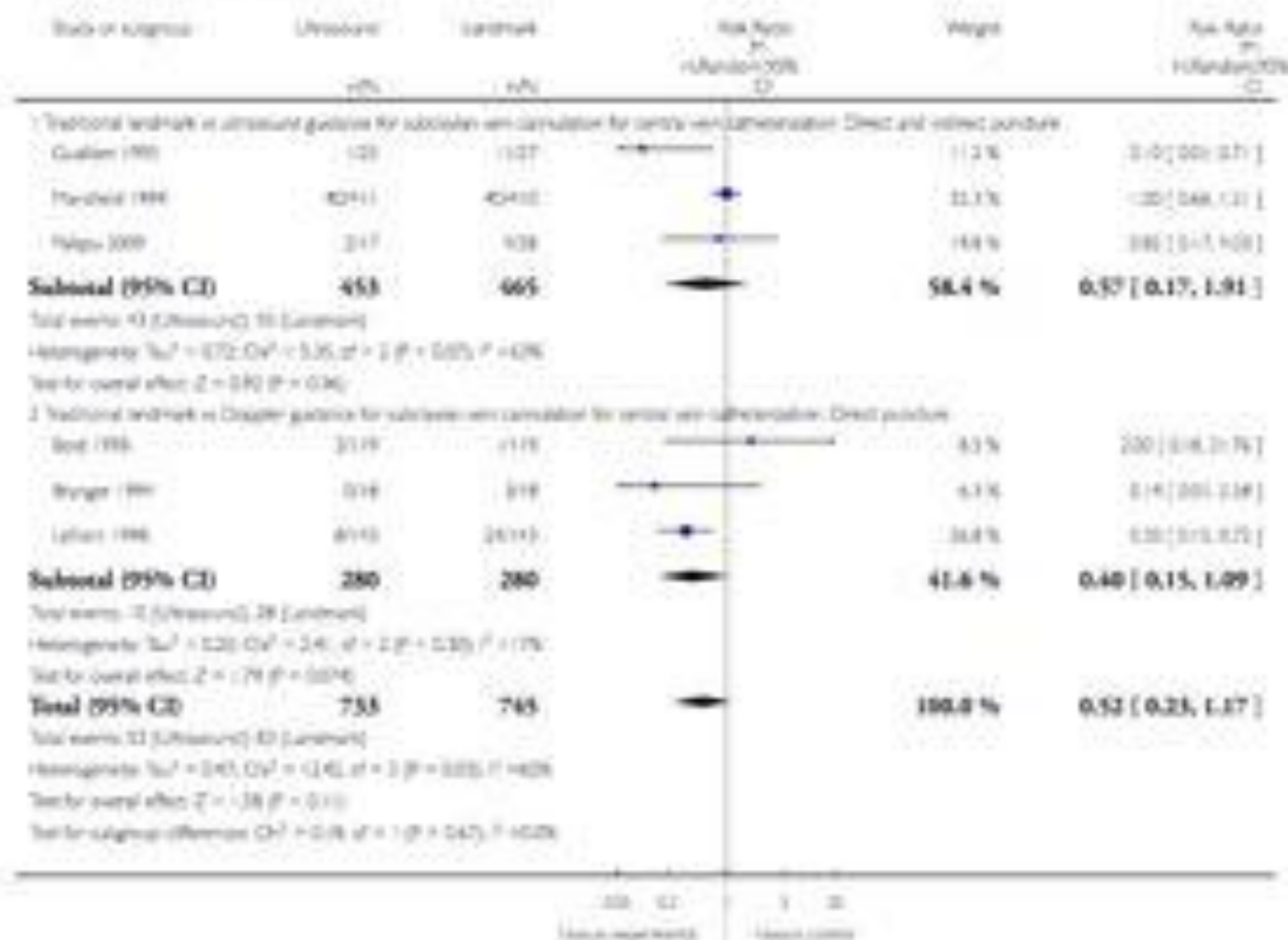
- 10 studi
- 6 RCTs, 1 QRCT, 3 non ben determinato
- 6 Eco B-mode
 - 1 puntura eco-assistita
- 4 Eco B-mode + Eco-doppler

Analysis 1.1. Comparison 1 Ultrasound or Doppler guidance vs anatomical landmarks for subclavian vein cannulation for central vein catheterization, Outcome 1 Complication rate total.

Review: Ultrasound guidance versus anatomical landmarks for subclavian vein cannulation

Comparison: 1 Ultrasound or Doppler guidance vs anatomical landmarks for subclavian vein cannulation for central vein catheterization

Outcome: 1 Complication rate total



Confusione terminologica

- La puntura eco-guidata della vena succlavia è SOVRACLAVEARE
- La puntura eco-guidata in regione sottoclaveare consiste nella puntura di:
 - Vena Ascellare
 - Vena Cefalica al torace

Ultrasound-Guided Subclavian Vein Catheterization: A Systematic Review and Metaanalysis

Manoj M. Lalu, MD, PhD, FRCPC^{1,2}; Ashraf Fayad, MD, FRCPC^{1,2}; Osman Ahmed, MD³;

TABLE 2. Characteristics of Ultrasound Technology and Technique Used in Individual Studies

Study	Ultrasound Technique	Ultrasound Machine	Transducer	Patient Positioning	Approach for Imaging	Axis of Imaging	Approach for Needle	Landmark Technique Approach
Oh et al (27)	Dynamic 2D	SonoSite S-nerve (SonoSite, Bothell, WA)	T5-MHz high-resolution	Trendelenburg	NR	Longitudinal	NR	Infraclavicular
Campbell et al (20)	Dynamic 2D	NR	NR	NR	Infraclavicular	NR	NR	NR
Fragou et al (26)	Dynamic 2D	HD11 XE ultrasound Machine (Philips, Andover, MA)	T5-MHz high-resolution	Trendelenburg	Infraclavicular	Longitudinal	In plane	Infraclavicular
Alic et al (19), 2009	Dynamic 2D	GE Logiq Book XP	5–13 MHz transducer	NR	NR	Longitudinal	In plane	NR
Palepu et al (26)	Dynamic 2D	SonoSite (Bothell, WA)	6–13 MHz, 38-mm linear-array transducer	Trendelenburg	Infraclavicular→middle third of the clavicle	Transverse	NR	Infraclavicular
Gustien et al (23)	Dynamic 2D	Sie Roe (Dymec Corporation, Pittsburgh, PA)	T5 MHz	Trendelenburg	Infraclavicular→lateral aspect of clavicle	Transverse	NR	Infraclavicular
Mansfield et al (3)	Static 2D	Model 6330-Hitachi Aloka, Wallingford, CT)	T5-MHz linear array	Trendelenburg	Infraclavicular	NR	NR	Infraclavicular
Bold et al (22)	Dynamic Doppler	Smart Needle (Peripheral Systems Group, Mountain View, CA)	14-MHz continuous-wave	NR	NR	NA	NR	Infraclavicular
Lehrant et al (21)	Dynamic Doppler	Pulsed Doppler system (Medical Biophysics Laboratory, Faculty of Medicine, Tours, France)	4-MHz pulsed single, circular	Trendelenburg	Infraclavicular	NA	Through probe indentation	Infraclavicular
Branger et al (24)	Dynamic Doppler	Pulsed Doppler system (Medical Biophysics Laboratory, Faculty of Medicine, Tours, France)	4 MHz pulsed, circular	Trendelenburg	Infraclavicular	NA	30° angulation to body of probe	Infraclavicular

NR = not reported, NA = not applicable.

Ultrasound-Guided Subclavian Vein Cannulation in Low Birth Weight Neonates

Ulrik Lausten-Thomsen, MD, PhD¹; Zied Merchaoui, MD¹; Cécile Dubois, MD^{1,2};
Sergio Eleni Dit Trolli, MD^{1,3}; Nolwenn Le Saché, MD¹; Mostafa Mokhtari, MD^{1,4};
Pierre Tissières, MD, PhD¹⁻³

www.pccmjournal.org

February 2017 • Volume 18 • Number 2



- 97.2% success rate
- Three failed attempts due to hematomas from venous bleeding

Guidelines

Association of Anaesthetists of Great Britain and Ireland* Safe vascular access 2016

A. Bodenham (Chair),¹ S. Babu,² J. Bennett,³ R. Binks,⁴ P. Fee,⁵ B. Fox,⁶ A. J. Johnston,⁷ A. A. Klein,⁸
J. A. Langton,⁹ H. McLure¹⁰ and S. Q. M. Tighe¹¹

This has been well covered in the literature. Recent consensus is that where the technology is affordable (e.g. in the UK), it should be used routinely for internal jugular CVCs (unless in emergency or other unusual situations), and early in other procedures (arterial and peripheral venous), if difficult [36]. Ultrasound makes many steps safer including: evaluation of puncture site; recognition of local pathology; avoidance of the use of seeker needles; needle guidance; verification of guidewire/catheters in a vessel; information on central tip position and recognition of complications.

Two recent Cochrane analyses [55, 56] concluded a benefit for using ultrasound for CVCs by the internal jugular vein, but not femoral or axillary/subclavian routes. The Working Party believe the latter is likely to relate to a lack of adequate studies, rather than an inherent failure of ultrasound at other sites, and recommends that ultrasound guidance should be used for

all routes of access where the vessel cannot be seen directly or palpated.

Operators need to be adequately trained and experienced, and use a high-resolution device. It takes considerable time and practice to become fully competent in such techniques, and national guidance on training has not quantified this [53].

PubMed : **ultrasound guided axillary vein cannulation**[Create RSS](#) [Create alert](#) [Advanced](#)

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- ☐ [1. Infraclavicular axillary vein cannulation using ultrasound in a mechanically ventilated general intensive care population.](#)

Glen H, Lang I, Christie L.

Anaesth Intensive Care. 2015 Sep;43(5):635-40.

PMID: 26310415

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- ☐ [2. Real-time, ultrasound-guided infraclavicular axillary vein cannulation for renal replacement therapy in the critical care unit—A prospective intervention study.](#)

Czarnik T, Gawda R, Nowotarski J.

J Crit Care. 2015 Jun;30(3):624-8. doi: 10.1016/j.jcc.2015.01.002. Epub 2015 Jan 8.

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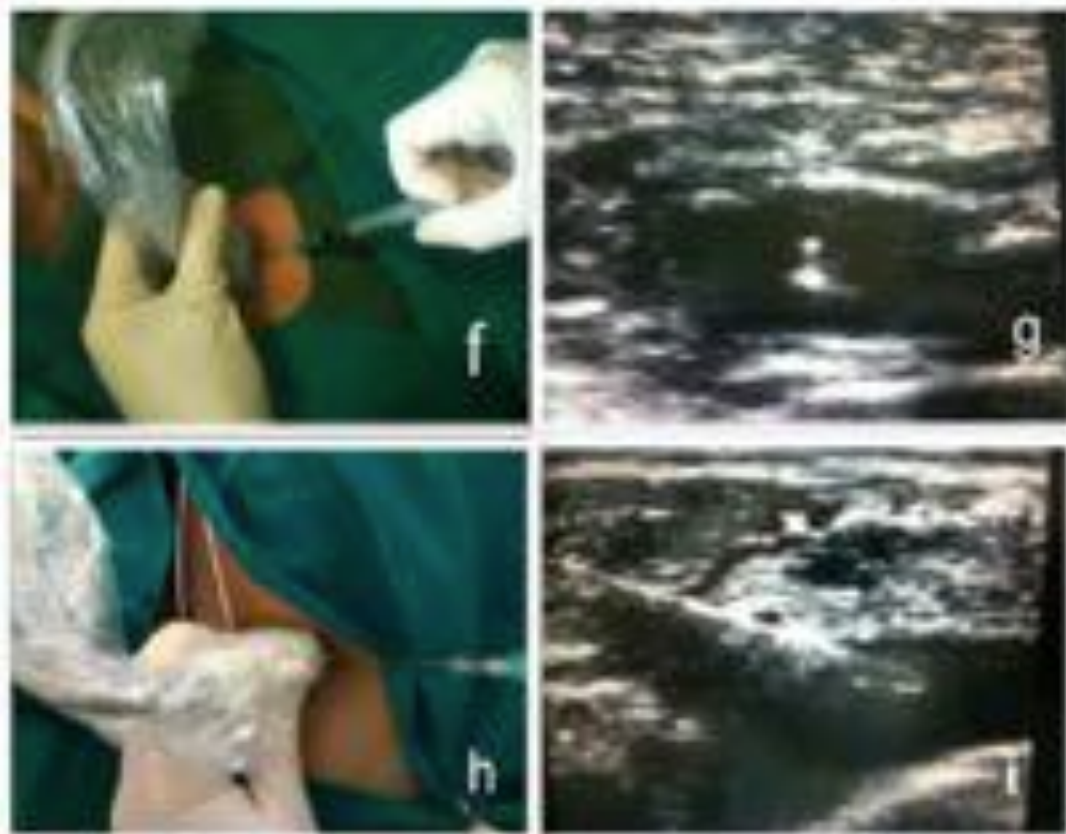
Ultrasound-guided infraclavicular axillary vein cannulation: a useful alternative to the internal jugular vein†

R. O'Leary, S. M. Ahmed, H. McLure, J. Oram, A. Mallick, B. Bhambra and A. R. Bodenham*

Department of Anaesthesia, Critical Care and Pain, Leeds Teaching Hospitals NHS Trust, Great George Street, Leeds LS1 3EX, UK

Editor's key points

- Cannulation of the axillary vein (AxV) provides a potential alternative to subclavian vein cannulation that is more amenable to ultrasound (US) guidance.
- A retrospective analysis evaluated the success and complications reported in a large prospectively collected database of central vein catheterization at a large UK centre.
- US-guided internal jugular and AxV catheterization were both effective and relatively safe.



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[\[Ultrasound-guided cannulation of the brachiocephalic vein in neonates and infants\].](#) Oulego-Eroz I et al. An Pediatr (Barc). (2015)

[Ultrasound-guided left brachiocephalic vein cannulation in children with underlying bleeding disorders: a retrospective analysis.](#) Di Nardo M et al. Pediatr Crit Care Med. (2014)

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- ☐ [Ultrasound-guided supraclavicular cannulation of the right brachiocephalic vein in small infants: a consecutive, prospective case series.](#)

1. Breschan C, Graf G, Jost R, Stettner H, Feigl G, Goessler A, Neuwersch S, Koestenberger M, Likar R.

Paediatr Anaesth. 2015 Sep;25(9):943-9. doi: 10.1111/pan.12700. Epub 2015 Jun 17.

PMID: 26083730

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- ☐ [Ultrasound-guided brachiocephalic vein catheterization in infants weighing less than five kilograms.](#)

2. Aytekin C, Özyer U, Harman A, Boyvat F.

J Vasc Access. 2015 May 30;0(0):0. doi: 10.5301/jva.5000385. [Epub ahead of print]

PMID: 26044899

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REGIONAL ANAESTHESIA

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

C. Breschan^{1*}, M. Platzer¹, R. Jost², H. Stettner³, A.-S. Beyer³, G. Feigl⁴ and R. Likar¹



Commentary

Can you justify not using ultrasound guidance for central venous access?

Andrew R Bodenham

Department of Anaesthesia, Leeds General Infirmary, Leeds, LS1 3EX, UK

Corresponding author: A R Bodenham, Andy.Bodenham@leedsth.nhs.uk

Published: 22 November 2006

Critical Care 2006, 10:175 (doi:10.1186/cc5079)

- *“... It is my belief that there is enough evidence now ... to support routine use of ultrasound in all situations...”*

Massimo Lamperti
Andrew R. Bodenham
Mauro Pittiruti
Michael Blaivas
John G. Augoustides
Mahmoud Elbarbary
Thierry Pirotte
Dimitrios Karakitsos
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Eric Desruennes
Lawrence A. Melniker
Susan T. Verghese

International evidence-based recommendations on ultrasound-guided vascular access

JVA
ISSN 1129-7298

J Vasc Access 2014; 00 (00): 000-000
DOI: 10.5301/jva.5000314

ORIGINAL ARTICLE

Central venous access devices in pediatric malignancies: a position paper of Italian Association of Pediatric Hematology and Oncology

Alessandro Crocchi¹, Assunta Tornesello¹, Mauro Pittiruti¹, Angelica Barone⁴, Paola Muggeo⁵, Alessandro Inserra¹,
Angelo Claudio Molinari⁶, Valeria Grillenzoni⁷, Viviana Durante⁸, Maria Pia Cicalese⁹, Giulio Andrea Zanazzo¹⁰, Simone Cesaro⁷

Massimo Lamperti
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**International evidence-based
recommendations on ultrasound-guided
vascular access**

Intensive Care Med. 2012 Jul;38(7):1105-17.

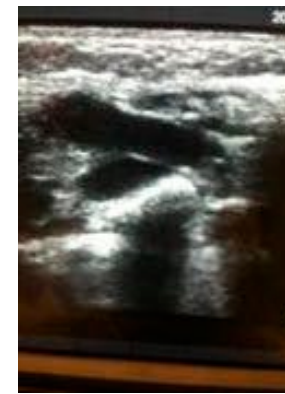
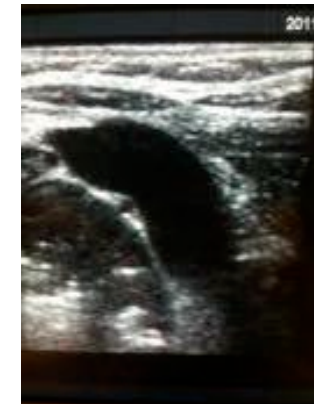


Valutazione Ecografica Preliminare

Non esiste un sito ideale per il posizionamento di cateteri venosi centrali ma esso deve essere stabilito sulla base dell'integrazione (a) dell'esame ecografico preliminare, (b) del tipo di catetere e (c) della clinica

**VALUTAZIONE ECOGRAFICA
PRELIMINARE**

RaCeVA – Rapid Central Vein Assessment



Rapid Central Vein Assessment (RaCeVA): A systematic, standardized approach for ultrasound assessment before central venous catheterization

The Journal of Vascular Access
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Timothy R Spencer¹ and Mauro Pittiruti²

Table 2. Criteria for choosing the vein.

-
1. Size of the vein (internal diameter/caliber)
 2. Depth of the vein (depth of target vessel from skin surface)
 3. Respiratory variations (influence of respiratory cycle on vein diameter)
 4. Compression by artery (influence of arterial pulsation on vein diameter)
 5. Proximity to non-venous structures which must not be damaged (pleura, nerve, and artery)
 6. Exit site location—convenience/appropriateness in terms for best care and maintenance
-

...nel bambino e nel neonato

Ultrasound vascular access in neonates and children

Domain code	Suggested definition
-------------	----------------------

D4.SD1.S1-2	Ultrasound guidance should be used for central venous access	A
-------------	--	---

D4.SD1.S3	Ultrasound guidance should be used for central venous access	A
-----------	--	---

D4.SD1.S4	Ultrasound guidance should be used for central venous access	A
-----------	--	---

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

D4.SD1.S7	Ultrasound guidance should be used for central venous access	A
-----------	--	---

D4.SD1.S8	Ultrasound guidance should be used for central venous access	A
-----------	--	---

There is no ideal site for cannulation in children; the best site should be determined after ultrasound examination

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

Central venous access devices in pediatric malignancies: a position paper of Italian Association of Pediatric Hematology and Oncology

Alessandro Crocchi¹, Assunta Tornesello¹, Mauro Pittiruti¹, Angelica Barone⁴, Paola Muggeo⁵, Alessandro Insema¹, Angelo Claudio Molinari⁶, Valeria Grillenzoni⁷, Viviana Durante⁸, Maria Pia Cicalese⁹, Giulio Andrea Zanazzo¹⁰, Simone Cesaro⁷

Introduction: Treatment of pediatric malignancies is becoming progressively more complex, implying the adoption of multimodal therapies. A reliable, long-lasting venous access represents one of the critical requirements for the success of those treatments. Recent technical innovations—such as minimally invasive procedures for placement, new devices and novel materials—have rapidly spread for clinical use in adult patients, but are still not consistently used in the pediatric population.

Methods: The Supportive Therapy Working Group of Italian Association of Hematology and Oncology (AIEOP) reviewed medical literature focusing on new aspects of central venous access devices (VADs) in pediatric patients affected by oncohematological diseases.

Results: Appropriate recommendations for clinical use in these patients have been discussed and formulated.

Conclusions: The importance of the correct choice, management and use of VADs in pediatric oncohematological patients is a necessary prerequisite for an adequate standard of care, also considering the increased chances of cure and the longer life expectancy of those patients with modern therapies.

Ultrasound should be used for diagnosis of local pathologic conditions before the procedure and for diagnosis of procedure-related complications.

Ultrasound is necessary to assess vein patency before the procedure and to choose the vein most appropriate in terms of caliber, depth and position.

The internal diameter of the vein to be cannulated—as assessed by ultrasound—should be at least three times the external diameter of the catheter, so as to reduce the risk of venous thrombosis.

Ultrasound-guided venipuncture should be adopted, so as to reduce the risk of early and late complications.

Venous cannulation by surgical cutdown should be avoided.

“Blind” percutaneous puncture of central veins (“landmark” venipuncture) should be avoided.

In newborn and infants, internal jugular vein and brachio-cephalic vein are usually the first options for ultrasound-guided central venous access.

Soon after procedures potentially associated with pleural damage, pneumothorax should be excluded by ultrasound scan of the inter-costal space.

EUROPEAN GUIDELINES ON PERIOPERATIVE USE OF **ULTRASOUND** (PERSEUS): VASCULAR ACCESS

Massimo Lamperti, Daniele Guerino Biasucci, Nicola Oliva, Mauro Pittiruti, Christian Breschan, Davide Vallati, Matteo Subert, Emmanuel Boselli, Vilma Traškaitė, Andrius Macas, Jean-Pierre Estebe, Regis Fuzier, and Philipp Hopkins



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Anche effetto su **infezioni**:

Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients

D. Karakitsos et al - *Critical Care* 2006, **10**:R162

Table 2

Outcome measures in the ultrasound group versus the landmark group of patients

Outcome measures	Ultrasound group (<i>n</i> = 450)	Landmark group (<i>n</i> = 450)
Access time (seconds)	17.1 ± 16.5 (11.5 to 41.4) ^a	44 ± 95.4 (33.2 to 77.5)
Success rate	450 (100%) ^a	425 (94.4%)
Carotid puncture	5 (1.1%) ^a	48 (10.6%)
Haematoma	2 (0.4%) ^a	38 (8.4%)
Haemothorax	0 (0%) ^a	8 (1.7%)
Pneumothorax	0 (0%) ^a	11 (2.4%)
Average number of attempts	1.1 ± 0.6 (1.1 to 1.9) ^a	2.6 ± 2.9 (1.5 to 6.3)
CVC-BSI	47 (10.4%) ^a	72 (16%)

^aComparison of the outcome measures between the ultrasound group and the landmark group of patients (*p* < 0.001). Access time and average number of attempts are expressed as mean ± standard deviation (95% confidence interval). Success rate, carotid puncture, haematoma, haemothorax, pneumothorax, and CVC-BSI are expressed as the absolute number of patients and percentage of their group. CVC-BSI, central venous catheter-associated blood stream infection.

CDC 2011

7. Usare la guida ecografica per posizionare i cateteri venosi centrali (ovunque questa tecnologia sia disponibile) così da ridurre il numero di tentativi di incannulamento e le complicanze meccaniche da venipuntura. La guida ecografica dovrebbe essere utilizzata da personale pienamente addestrato nell'utilizzo di questa tecnica. [60–64]. Categoria 1B



Linee Guida EPIC 2014

“... L'uso dell'ecografia può indirettamente ridurre il rischio di infezione facilitando il posizionamento del catetere venoso centrale...”

Journal of Hospital Infection 86S1 (2014) S1-S70



epic3: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England

H.P. Loveday^{a*}, J.A. Wilson^a, R.J. Pratt^a, M. Golsorkhi^a, A. Tingle^a, A. Bak^a, J. Browne^a, J. Prieto^b, M. Wilcox^c

^a Richard Wells Research Centre, College of Nursing, Midwifery and Healthcare, University of West London (London).

^b Faculty of Health Sciences, University of Southampton (Southampton).

^c Microbiology and Infection Control, Leeds Teaching Hospitals and University of Leeds (Leeds).

SHEA/IDSA PRACTICE RECOMMENDATION

Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals: 2014 Update

Jonas Marschall, MD;^{1,2*} Leonard A. Mermel, DO, ScM;^{3*} Mohamad Fakih, MD, MPH;⁴
Lynn Hadaway, MEd, RN, BC, CRNI;⁵ Alexander Kallen, MD, MPH;⁶ Naomi P. O'Grady, MD;⁷
Ann Marie Pettis, RN, BSN, CIC;⁸ Mark E. Rupp, MD;⁹ Thomas Sandora, MD, MPH;¹⁰
Lisa L. Maragakis, MD, MPH;¹¹ Deborah S. Yokoe, MD, MPH¹²

5. Use ultrasound guidance for internal jugular catheter insertion (quality of evidence: II).⁹⁹
 - a. Ultrasound-guided internal jugular vein catheterization reduces the risk of CLABSI and of non-infectious complications of CVC placement.¹⁰⁰

Consensus 2012

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

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**International evidence-based
recommendations on ultrasound-guided
vascular access**

Table 6 Recommendations regarding sterility using ultrasound guidance and prevention of infectious and mechanical complications using ultrasound-guided cannulation

Sterility during ultrasound vascular procedures

Domain code	Suggested definition	Level of evidence	Degree of consensus	Strength of recommendation
D8.S1	Sterile techniques should always be used during the placement of a vascular access device, including hand washing; sterile full body drapes; wearing of sterile gowns, gloves, caps and masks covering both the mouth and nose. Probe and cable sterility have to be maintained using sterile gel and appropriate probe and cable shields	A	Very good	Strong
Prevention of infectious and mechanical complications with ultrasound-guided cannulation				
D8.S2	Ultrasound guidance should be used in order to decrease the rate of CRBSI in adults and children	C	Very good	Strong
D8.S3–4	Ultrasound guidance with specific preventive and educational measures and the promotion of good practices applied by both medical and nursing staff, is suggested in order to reduce the incidence of CRBSI	B	Good	Strong
D8.S5	Ultrasound guidance should be used to avoid cannulation of thrombotic sites	A	Very good	Strong
D8.S6	Ultrasound guidance, by reducing puncture attempts, technical failure rates and mechanical complications, has to be preferred because of a reduced incidence of catheter-related thrombosis	A	Very good	Strong



Targeting zero catheter-related bloodstream infections in pediatric intensive care unit: a retrospective matched case-control study

Daniele G. Biasucci¹, Mauro Pittiruti², Alessandra Taddei³, Enzo Picconi¹, Alessandro Pizza¹, Davide Celentano¹, Marco Piastra¹, Giancarlo Scoppettuolo⁴, Giorgio Conti¹

Insertion and maintenance bundle

1. Hand washing and maximal barrier precautions
 2. Skin antiseptics with 2% chlorhexidine
 3. Ultrasound pre-puncture evaluation through RaCeVA
 4. Ultrasound guided venipuncture
 5. Tunneling of the catheter so to obtain an exit site in the infraclavicular area
 6. Sealing of the exit site with glue
 7. Securement with sutureless device
 8. Coverage with transparent semi permeable dressing
 9. Chlorhexidine-impregnated sponges
 10. Use of neutral NFC and port protectors
 11. Simulation-based standardized training program
-

RaCeVA = rapid central vein assessment; NFC = needle free connectors.

JVA

Targeting zero catheter-related bloodstream infections in pediatric intensive care unit: a retrospective matched case-control study

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TABLE III - Punctured veins at different sites

Veins	Cases	Controls
Right internal jugular vein at mid-neck, n (%)	0 (0%)	40 (62.5%)
Low lateral right internal jugular vein, n (%)	2 (3.12%)	11 (17.2%)
Left internal jugular vein at mid-neck, n (%)	0 (0%)	13 (20.3%)
Left brachiocephalic vein, n (%)	2 (3.12%)	0 (0%)
Right brachiocephalic vein, n (%)	52 (81.25%)	0 (0%)
Right axillary vein, n (%)	4 (6.25%)	0 (0%)
Left subclavian vein, n (%)	2 (3.12%)	0 (0%)
Right external jugular vein, n (%)	2 (3.12%)	0 (0%)

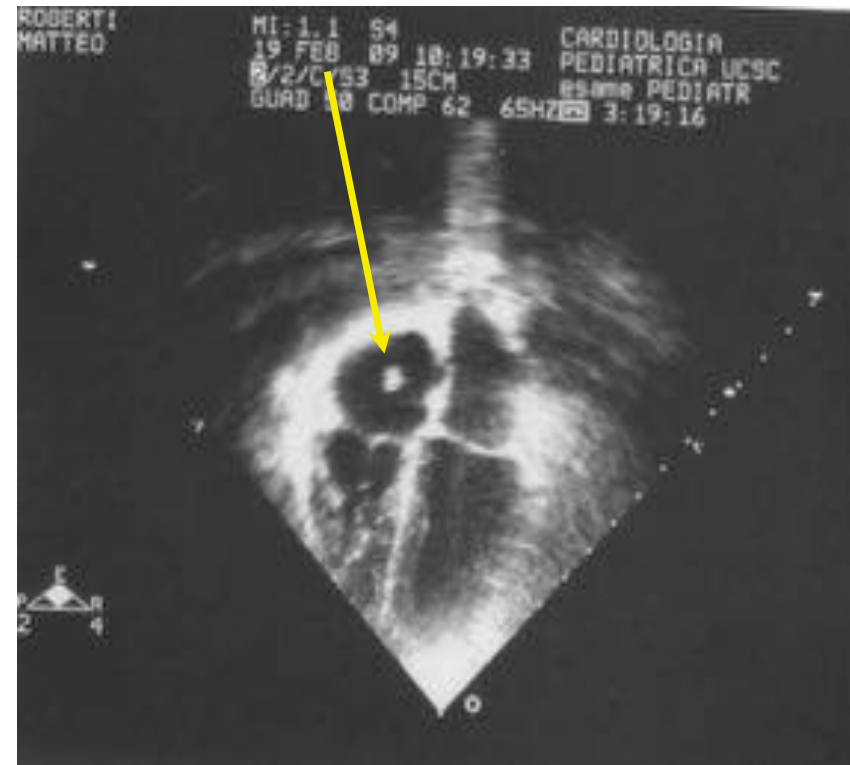
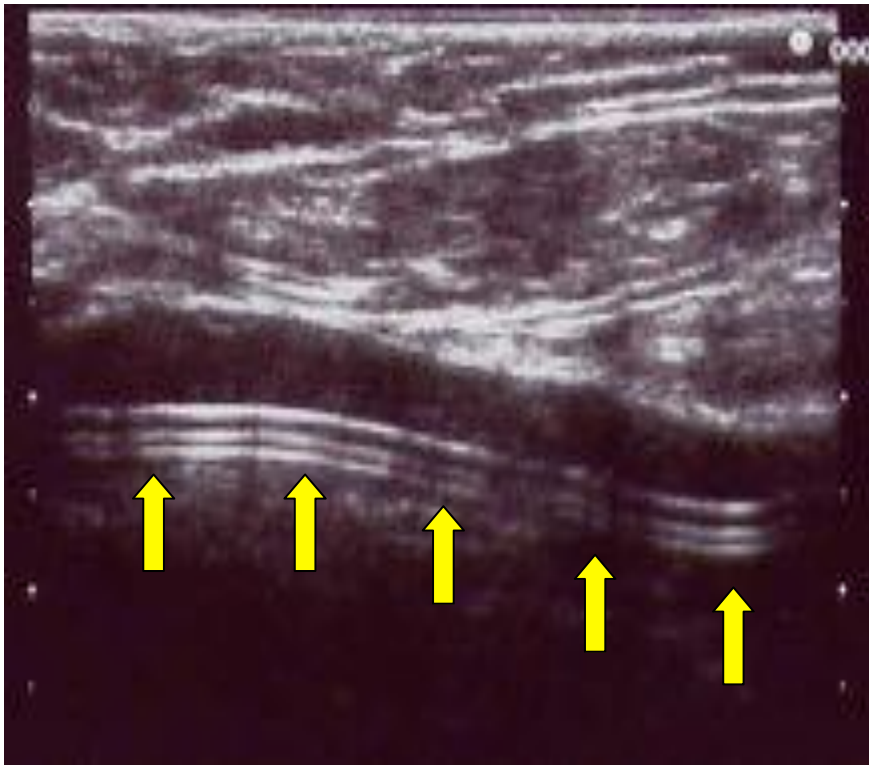
Targeting zero catheter-related bloodstream infections in pediatric intensive care unit: a retrospective matched case-control study

Daniele G. Biasucci¹, Mauro Pittiruti², Alessandra Taddei³, Enzo Picconi¹, Alessandro Pizza¹, Davide Celentano¹, Marco Piastra¹, Giancarlo Scoppettuolo⁴, Giorgio Conti¹

		Cases	Controls
Indwelling time (d)	Total	648	503
	Mean ($\pm$ SD)	9.7 $\pm$ 3.1	7.5 $\pm$ 3.5
CR-BSI	No	1	8
	per 1000 catheter days	1.5	15
CR-DVT	No	0	1
Accidental dislodgements	No	0	3

CR-BSI = catheter-related bloodstream infections; CR-DVT = catheter-related deep vein thrombosis; PICU = pediatric intensive care unit; SD = standard deviation.

Clinical Question...



Massimo Lamperti
Andrew R. Bodenham
Mauro Pittiruti
Michael Blaivas
John G. Augoustides
Mahmoud Elbarbary
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**

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

Ultrasound vascular access in adults

Domain code	Suggested definition	Level	Quality of evidence	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 midline with ultrasound guidance using micro introducer	A	Very good	Strong
D4.SD2.S4	Use of ultrasound guidance should be considered for any kind of peripheral venous access if difficult access is anticipated	B	Very good	Strong
D4.SD2.S5	Ultrasound-guided vascular access improves first-pass success rate in adults	A	Very good	Strong
D4.SD2.S6	Ultrasound-guided vascular access reduces the risk of pneumothorax and should be used for central venous catheter cannulation	B	Very good	Strong
D4.SD2.S7	Contrast-enhanced ultrasound (CEUS) is a valid method for detecting a central venous catheter tip in the right atrium	B	Very good	Strong
Cost	the use of ultrasound for vascular cannulation	A	Very good	Strong
D5	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

CEUS (contrast-enhanced ultrasound) is a valid method for detecting a central venous catheter tip in the right atrium

...nel bambino e nel neonato

Ultrasound vascular access in neonates and children		
Domain code	Suggested definition	
D4.SD1.S1-2	Ultrasound guidance should be used for central venous access	A
D4.SD1.S3	Ultrasound guidance should be used for arterial puncture in neonates	A
D4.SD1.S4	Ultrasound guidance should be used before subclavian vein puncture in neonates	C
D4.SD1.S5	Ultrasound guidance should be considered for arterial puncture in neonates	C
D4.SD1.S6	Ultrasound-guided femoral puncture is recommended to avoid inadvertent arterial puncture	B
D4.SD1.S7	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.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

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

Use caution with ultrasound for CVAD tip location, as its use in replacing chest radiographs is controversial in all ages due to small sample sizes in available studies and lack of standardized techniques. Consider use in neonates and in emergency departments when immediate knowledge of the CVAD tip location is beneficial.

- 🚩 Generally speaking, suggest caution with the use of US to detect tip location
- 🚩 Recommend to consider US to detect tip location in neonates and in emergency condition when immediate knowledge of the CVAD tip location is beneficial.

Association of Anaesthetists of Great Britain and Ireland*

Safe vascular access 2016

A. Bodenham (Chair),¹ S. Babu,² J. Bennett,³ R. Binks,⁴ P. Fee,⁵ B. Fox,⁶ A. J. Johnston,⁷ A. A. Klein,⁸
J. A. Langton,⁹ H. Mclure¹⁰ and S. Q. M. Tighe¹¹

Anaesthesia 2016

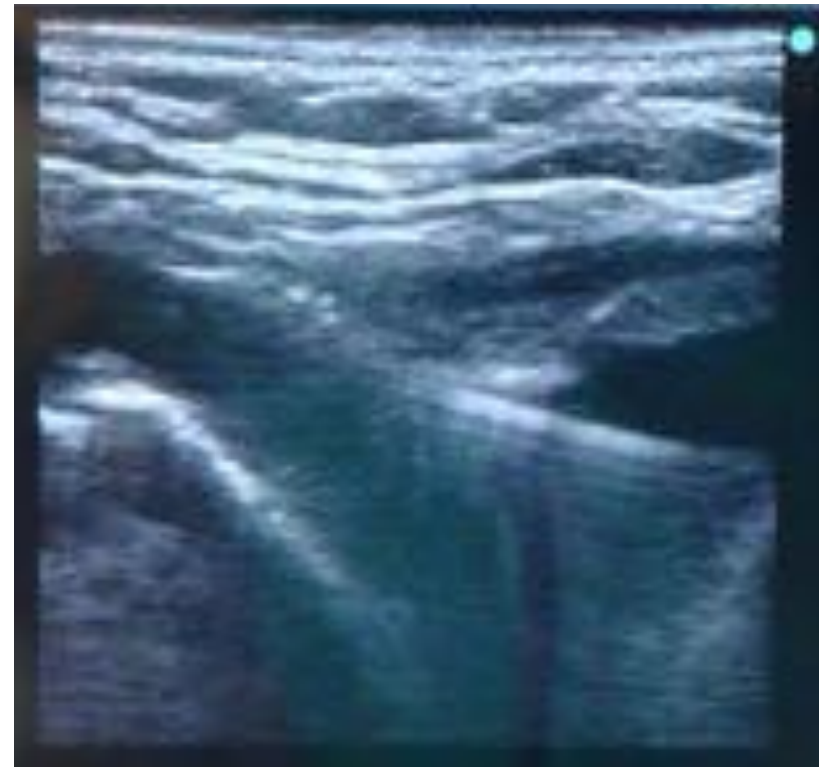
 Ultrasound can confirm catheter position with:

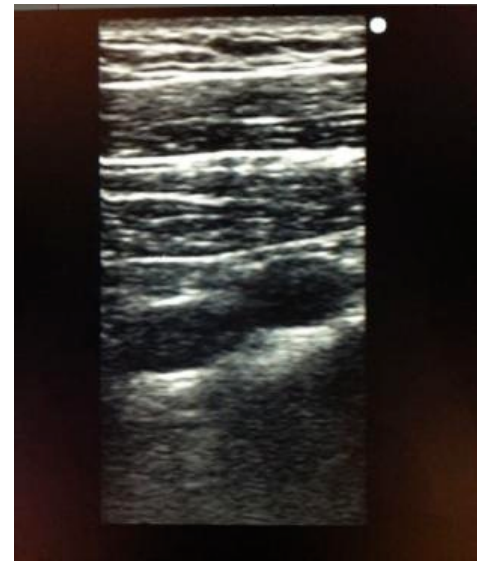
- Supraclavicular views
- Transthoracic echocardiographic views
- Transoesophageal echocardiographic views

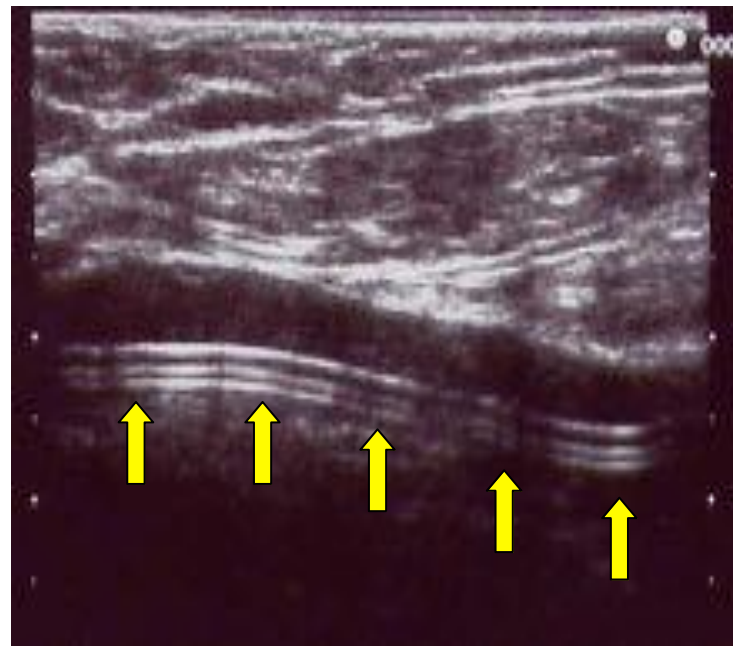
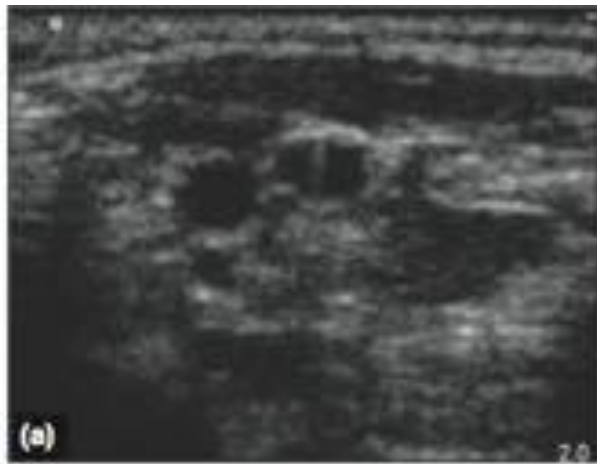
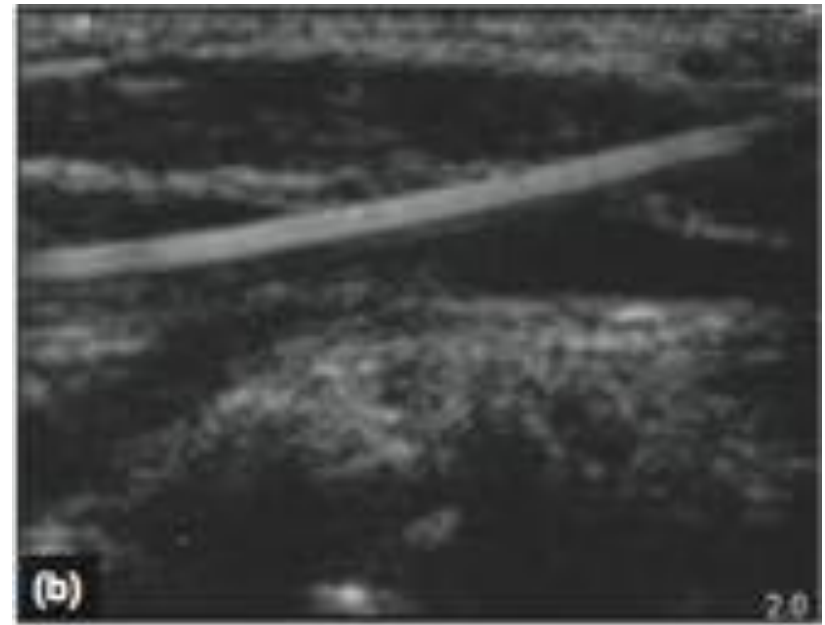
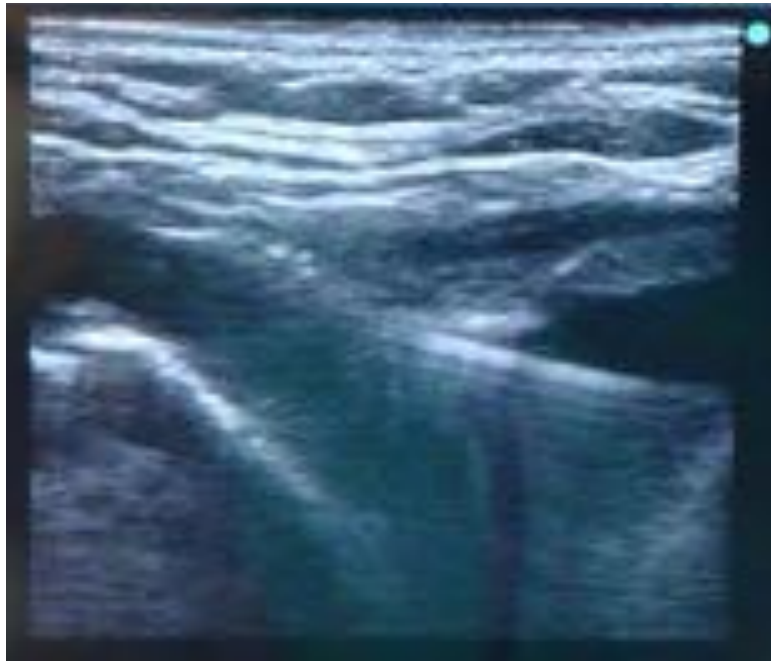
Prevention of primary malposition

🏠 In regard to the prevention of primary malposition US may play two roles:

- As a „tip navigation“ technique
- As a „tip location“ technique







TEE

- TEE is the most accurate method for tip location (gold standard), but it is expensive and invasive.

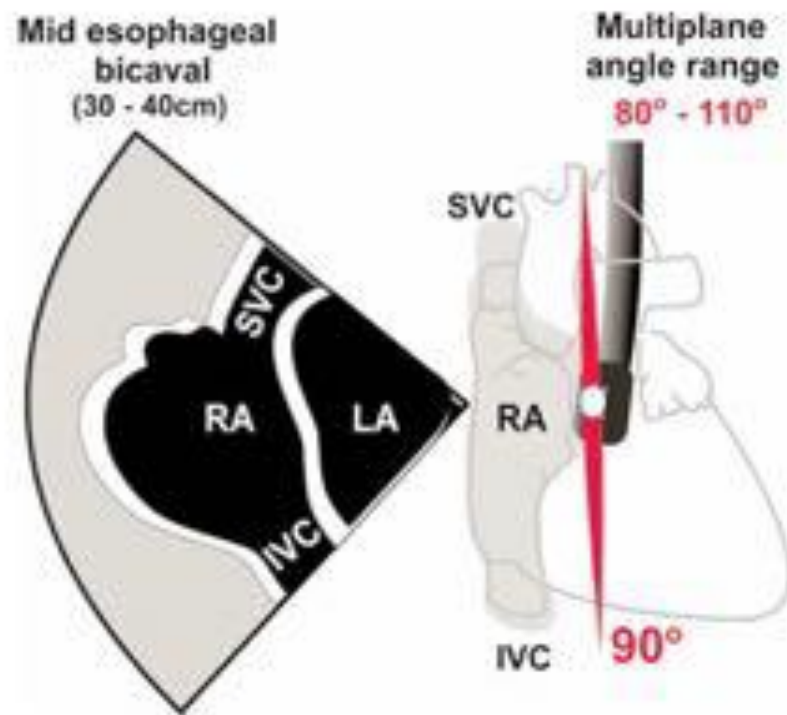
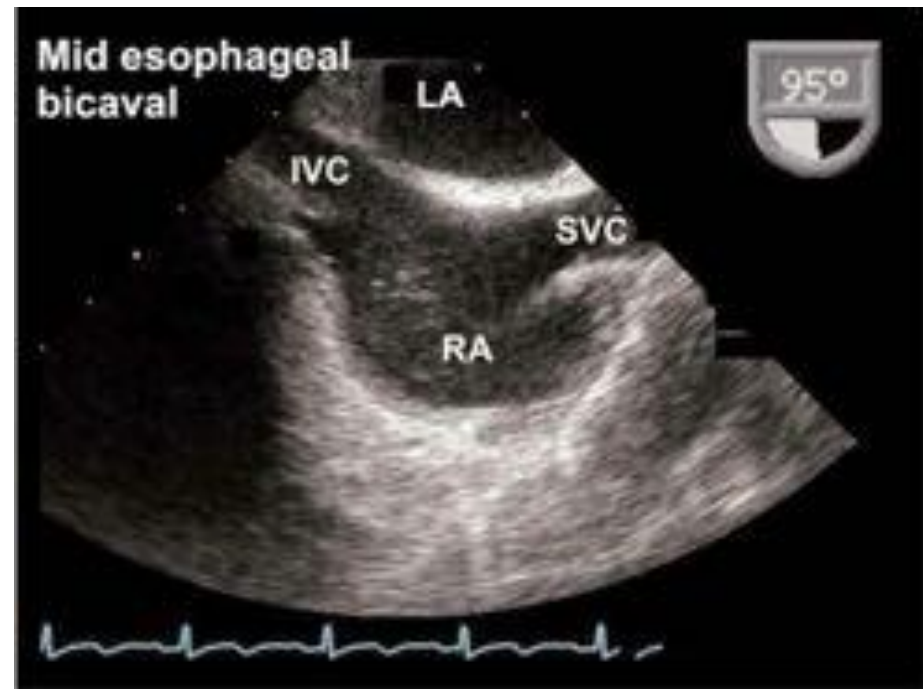
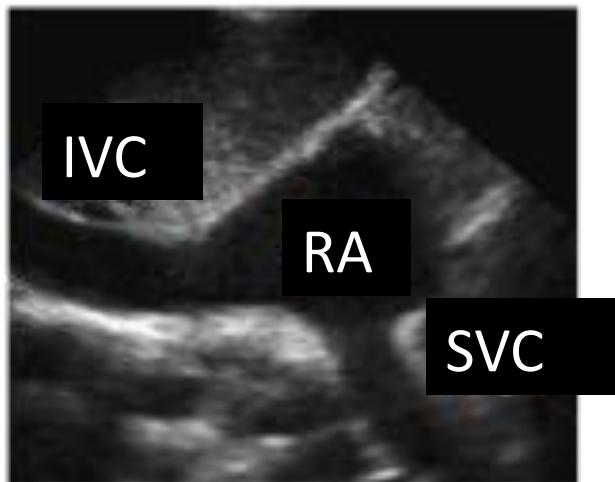


Fig. 19. Midesophageal bicaval (L).

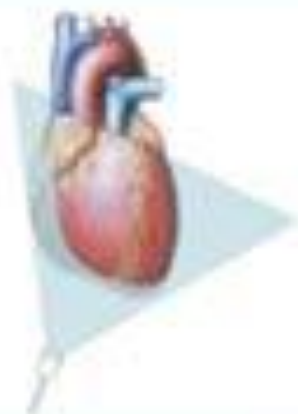


US based “tip location” technique

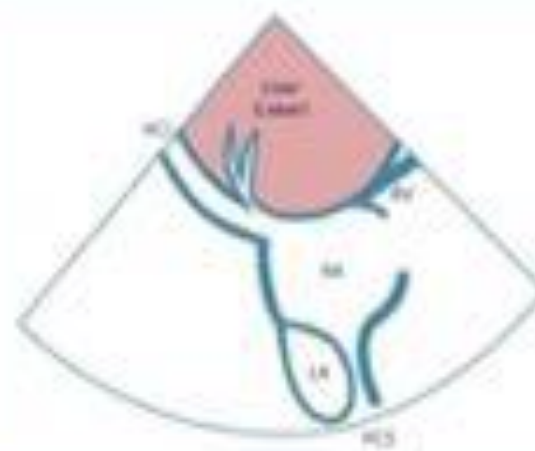
- As a ‘tip location’ technique, TTE allows direct or indirect visualization of the catheter tip or J-guidewire at the CAJ or in the lower SVC by means of a subcostal bicaval view.



Subcostal Views



Subcostal 4 chamber view



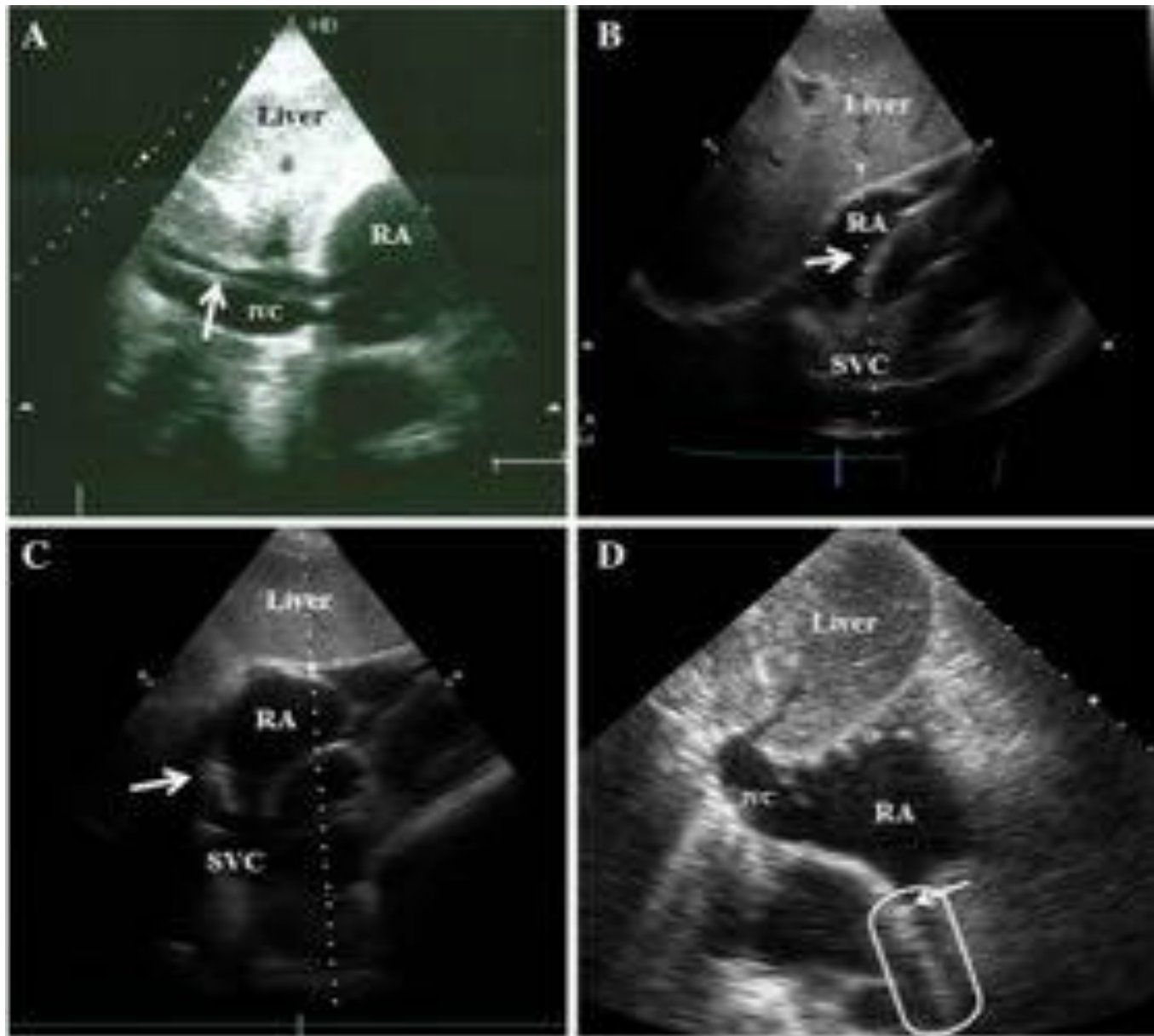
Vena cava inferior view

Apical Views

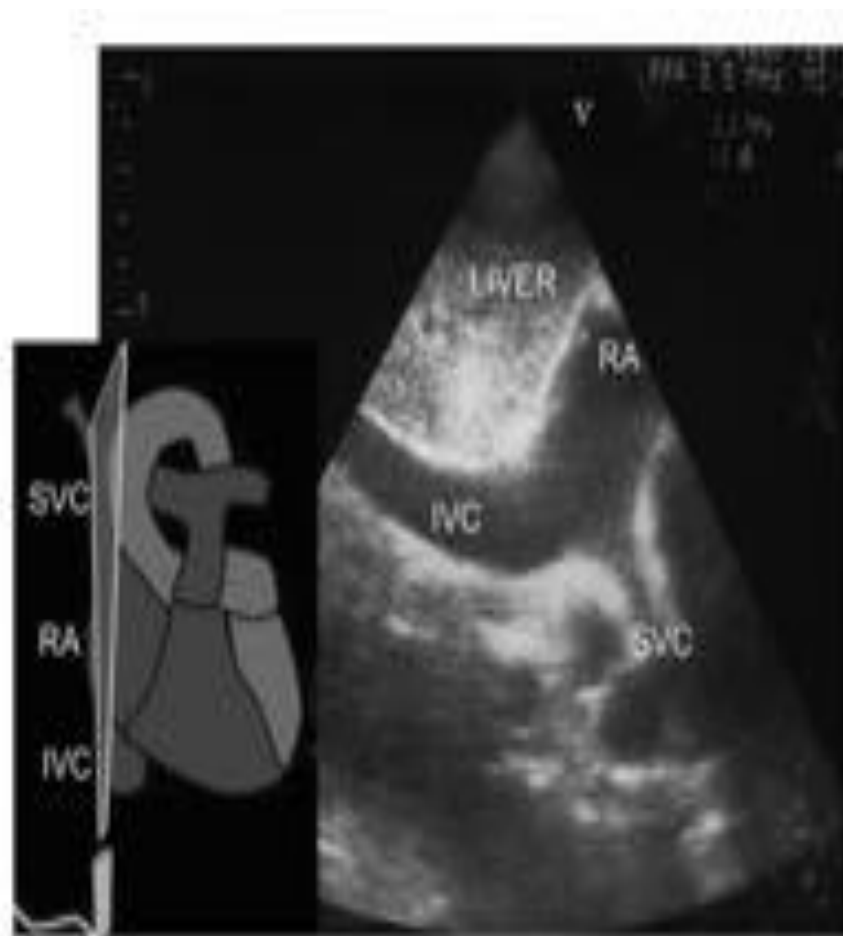


4 chamber view





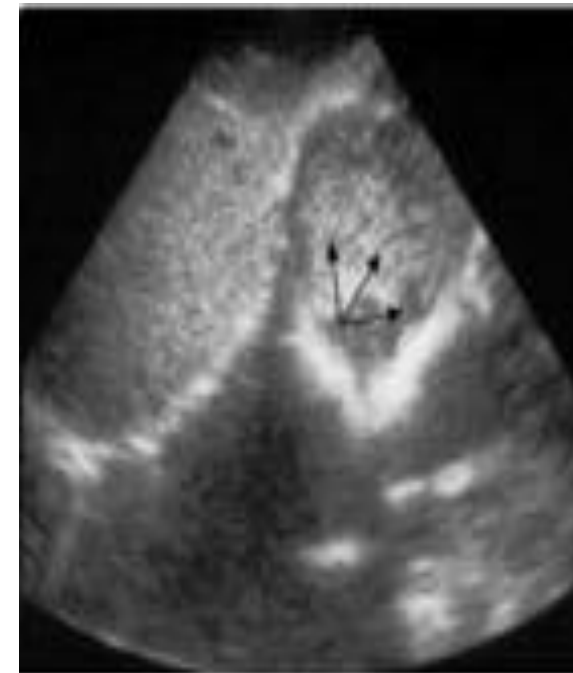
Bedel et al. Intensive Care Med (2013) 39:1932–1937

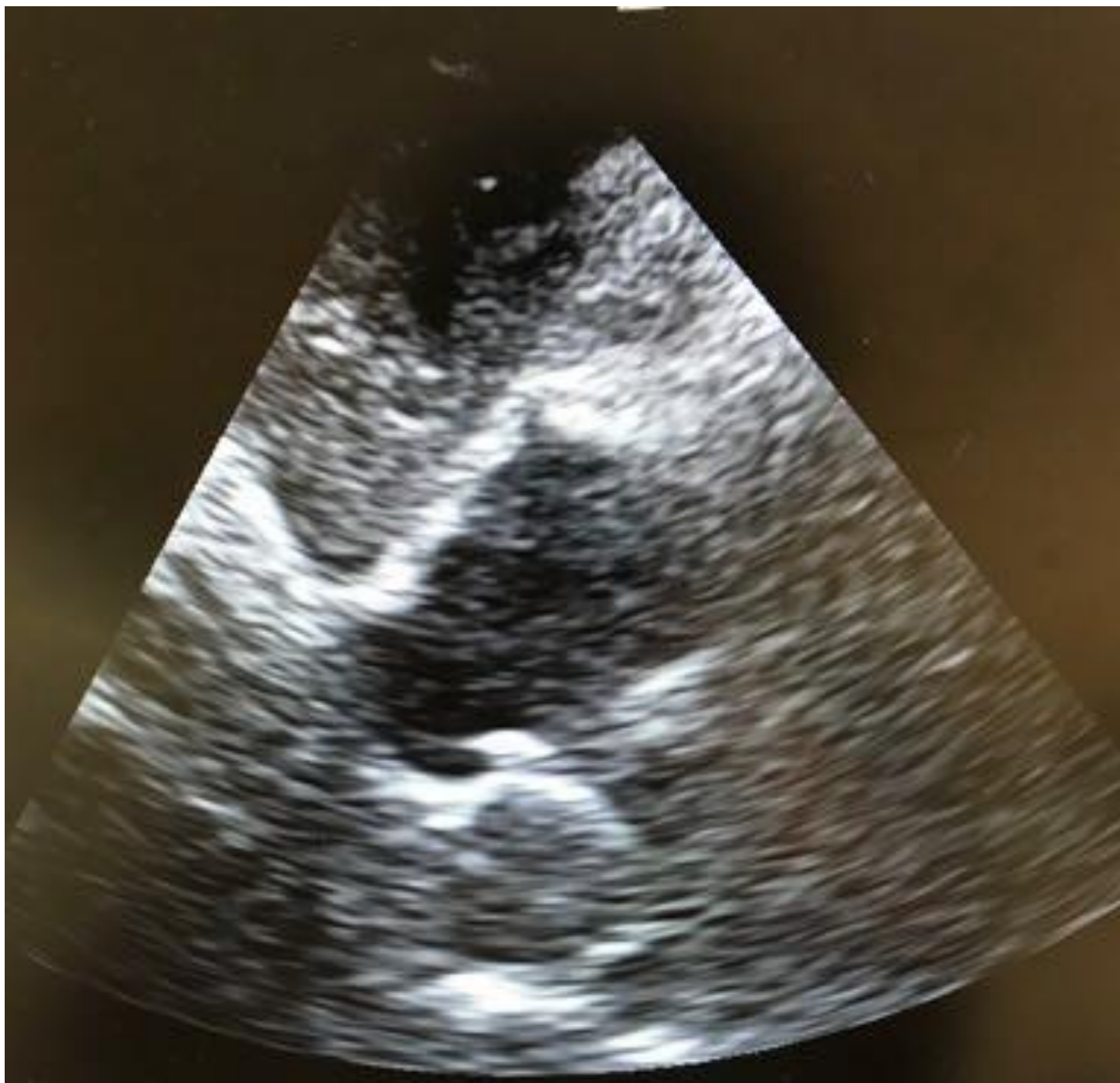


Ultrasound localization of central vein catheter and detection of postprocedural pneumothorax: An alternative to chest radiography*

Antonella Vezzani, MD; Claudia Brusasco, MD; Salvatore Palermo, MD; Claudio Launo, MD; Mario Mergoni, MD; Francesco Corradi, MD, PhD

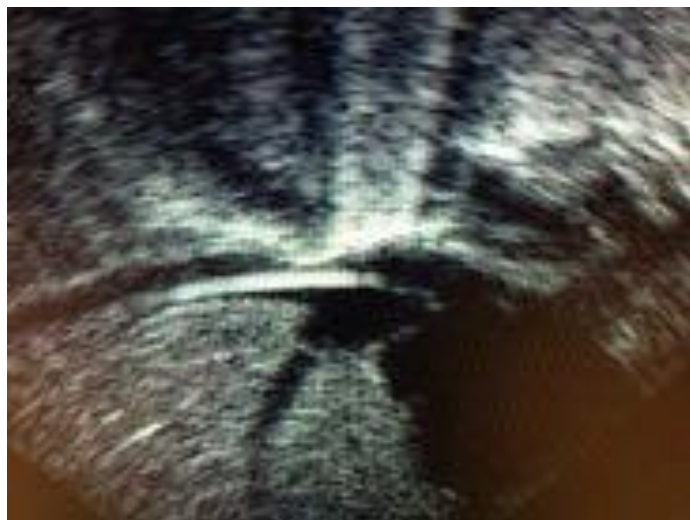
Crit Care Med 2010 Vol. 38, No. 2







Ideale nei neonati...



Ideal after FICC insertion...



Ultrasonic Examination

An Alternative to Chest Radiography after Central Venous Catheter Insertion?

ERIC MAURY, JEAN GUGLIELMINOTTI, MARC ALZIEU, BERTRAND GUIDET, and GEORGES OFFENSTADT

Service de Réanimation Médicale, Hôpital Saint-Antoine, Assistance Publique-Hôpitaux de Paris, Paris, France

Jerome Bedel
Fabrice Vallée
Arnaud Mari
Beatrice Riu
Benjamin Planquette
Thomas Geeraerts
Michèle Gènestal
Vincent Minville
Olivier Fourcade

Guidewire localization by transthoracic echocardiography during central venous catheter insertion: a periprocedural method to evaluate catheter placement

Ultrasound localization of central vein catheter and detection of postprocedural pneumothorax: An alternative to chest radiography*

Antonella Vezzani, MD; Claudia Brusasco, MD; Salvatore Palermo, MD; Claudio Launo, MD; Mario Mergoni, MD; Francesco Corradi, MD, PhD

Brief Report

American Journal of Emergency Medicine 32 (2014) 78–81

Contrast enhanced ultrasound vs chest X-ray to determine correct central venous catheter position

Francesca Cortellaro, MD ^{a,*}, Luca Mellace, MD ^a, Stefano Paglia, MD ^a, Giorgio Costantino, MD ^c, Sara Sher, MD ^b, Daniele Coen, MD ^a

Location of the Central Venous Catheter Tip With Bedside Ultrasound in Young Children: Can We Eliminate the Need for Chest Radiography?*

Alonso-Quintela, Paula MD^{1,2}; Oulego-Erroz, Ignacio MD^{1,2}; Rodriguez-Blanco, Silvia MD¹; Muñoz-Fontan, Manoel MD¹; Lapeña-López-de Armentia, Santiago MD, PhD^{1,2}; Rodriguez-Núñez, Antonio MD, PhD^{3,4}

Pediatric Critical Care Medicine: November 2015 - Volume 16 - Issue 9 - p e340–e345

Pediatric Anesthesia

Pediatric Anesthesia ISSN 1155-5648

ORIGINAL ARTICLE

Transthoracic echocardiographic guidance for obtaining an optimal insertion length of internal jugular venous catheters in infants

Yong-Hee Park¹, Ji-Hyun Lee², Hyo-Jin Byon³, Hee-Soo Kim² & Jin-Tae Kim²

Ultrasound-Guided Placement of Central Venous Port Systems via the Right Internal Jugular Vein: Are Chest X-Ray and/or Fluoroscopy Needed to Confirm the Correct Placement of the Device?

World Journal of Surgery

October 2016, Volume 40, Issue 10, pp 2353–2358 | Cite as

• Michelangelo Miccini (1) Email author

Bedside Ultrasound can Safely Eliminate the Need for Chest Radiographs after Central Venous Catheter Placement: CVC Sono in the Surgical ICU (SICU)¹

Kazuhide Matsushima, M.D.,² and Heidi L. Frankel, M.D., F.A.C.S., F.C.C.M.

Confirmation of correct central venous catheter position in the preoperative setting by echocardiographic “bubble-test”

M. MEGGIOLARO¹, A. SCATTO¹, A. ZORZI², E. ROMAN-POGNOUZ¹
A. LAURO³, C. PASSARELLA¹, G. BONACCORSO¹

The use of ultrasound during and after central venous catheter insertion versus conventional chest X-ray after insertion of a central venous catheter

M.J. Blans^a, H. Endeman^a, F.H. Bosch¹

Verification of correct central venous catheter placement in the emergency department: comparison between ultrasonography and chest radiography

Maurizio Zanobetti · Alessandro Coppa · Federico Bulletti · Serena Piazza · Peyman Nazerian
Alberto Conti · Francesca Innocenti · Stefano Ponchietti · Sofia Bigiarini · Aurelia Guzzo ·
Claudio Poggioni · Beatrice Del Taglia · Yuri Mariannini · Riccardo Pini

US based tip location & tip navigation: EBM

Author (year)	Study design (period)	Setting (country)	Patients (CVCs, n)	Ultrasound protocol	Reference (n/total)	Primary outcome (secondary outcomes)
Kilzer et al. (2010) [45]	Prospective pilot study	Surgical ICU (United States)	3 (3)	Suprasternal ultrasound [†]	CR	Misposition time advancement guidelines
Kim et al. (2015) [46]	Prospective pilot study (Jul 2012–Oct 2013)	Operating theaters (Germany)	51 (10)	Suprasternal ultrasound [†]	CR/TTE	Misposition time unit confirmation
Kim et al. (2016) [47]	Prospective pilot study (Jun 2014–Aug 2014)	Operating theaters (Germany)	20 (30)	Suprasternal ultrasound [†]	CR	Misposition time advancement guidelines
Benkari et al. (2012) [48]	Prospective study (Apr 2011–Jan 2014)	Surgical ICU (India)	25 (20)	TTE and CUS [†]	CR	Time unit confirmation (misposition)
Comellas et al. (2014) [49]	Prospective study	Emergency department (Italy)	71 (25)	TTE and CUS [†]	CR	Misposition time unit confirmation
Duan-Gehring et al. (2010) [50]	Prospective study (Dec 2010–Nov 2011)	Emergency department (United States)	30 (30)	TTE and CUS [†]	CR	Time unit confirmation (misposition, pneumothorax)
Galle et al. (2010) [51]	Prospective study (Dec 2010–Mar 2014)	Emergency department (United States)	81 (81)	TTE and CUS [†]	CR	Misposition pneumothorax
Kamalipour et al. (2010) [52]	Prospective study (Aug 2011–Jan 2014)	Operating theaters (Iran)	115 (114)			
Lewis et al. (2009) [53]	Prospective study (Nov 2004–Sep 2009)	Pediatric ICU (Canada)	107 (107)			

Smit et al. Critical Care (2018) 22:65
<https://doi.org/10.1186/s13054-018-1989-x>

Critical Care

REVIEW

Open Access



Bedside ultrasound to detect central venous catheter misplacement and associated iatrogenic complications: a systematic review and meta-analysis

Jasper M. Smit^{1,2*}, Reinder Raadsen^{1,2}, Michiel J. Blans³, Manfred Petjak⁴, Peter M. Van de Ven⁵ and Pieter R. Tuinman^{1,2}

REVIEW

Open Access



Bedside ultrasound to detect central venous catheter misplacement and associated iatrogenic complications: a systematic review and meta-analysis

Jasper M. Smit^{1,2*}, Reinder Raadsen^{1,2}, Michiel J. Blans³, Manfred Petjak⁴, Peter M. Van de Ven⁵ and Pieter R. Tuinman^{1,2}

Salmi et al. ² (2011) [17]	Prospective study	Nephrology department (Fin)	82 (82)	TTE and CLUS [†]	OR	Misposition, pneumothorax
Santarelli et al. (2000) [54]	Prospective study	Nephrology department (Italy)	134 (134)	TTE and CLUS [†]	OR	Misposition
Weekes et al. (2014) [13]	Prospective study (Jan 2013–Apr 2013)	Emergency department and ICU	147 (132)	TTE and CLUS [†]	OR	Misposition
Weekes et al. (2016) [14]	Prospective study (Nov 2013–Mar 2015)	Emergency department and ICU	136 (136)	TTE and CLUS [†]	OR	Misposition, pneumothorax (time until confirmation)
Wen et al. (2014) [15]	Retrospective study (Jun 2011–Jul 2013)	Nephrology department (Germany)	203 (219)	TTE and CLUS [†]	OR	Misposition (time until confirmation)
Alonso-Gonzalez et al. (2011) [18]	Prospective study (Jan 2012–Jan 2014)	Pediatric ICU (Spain)	40 (51)	Vascular ultrasound and TTE [†]	OR	Misposition (time until confirmation)
Maurly et al. (2001) [16]	Prospective study (Mar 1999–Sep 1999)	ICU (France)	81 (81)	Vascular ultrasound and TTE [†]	OR	Misposition, pneumothorax (time until confirmation)

Author (year)	Study design (period)	Setting (country)	Patients (ICU)	Ultrasound protocol	Reference standard	Primary outcome (secondary outcome)
Morini et al. (2014) [46]	Prospective study (Jan 2010-Dec 2014)	Operating theatres (Italy)	101 (101)	Wascular ultrasound and TTE*	V/CXR	Misposition, pneumothorax
Park et al. (2014) [47]	Prospective study	Pediatric ICU (United States)	108 (108)	Wascular ultrasound and TTE*	O/E	Misposition, insertion depth (VO)
Ardians et al. (2014) [27]	Prospective study	Operating theatres (Canada)	100 (100)	Wascular ultrasound and TTE*	TTE	Misposition
Sedel et al. (2011) [48]	Prospective study (Jan 2010-Nov 2010)	ICU (France)	88 (88)	Wascular ultrasound and TTE*	O/E	Misposition (pneumothorax, time until confirmation)
Rans et al. (2016) [49]	Prospective study (Jan 2011-Sep 2013)	ICU (The Netherlands)	53 (53)	Wascular ultrasound, TTE and CTUS*	O/E	Misposition, pneumothorax (time until confirmation)
Matsushima and Fender (2013) [38]	Prospective study (Nov 2004-Sep 2009)	Surgical ICU (United States)	48 (48)	Wascular ultrasound, TTE and CTUS*	O/E	Misposition, pneumothorax (time until confirmation)
Meggs et al. (2011) [32]	Prospective study (Jan 2011-Sep 2013)	Operating theatres (Italy)	101 (101)	Wascular ultrasound, TTE and CTUS*	O/E	Misposition, pneumothorax (ring bubble test, time until confirmation)
Verrini et al. (2013) [31]	Prospective study (Apr 2008-Aug 2008)	ICU (Italy)	111 (111)	Wascular ultrasound, TTE and CTUS*	O/E	Misposition, pneumothorax (time until confirmation, cost analysis)
Zandotti et al. (2011) [50]	Prospective study (Jan 2009-Dec 2011)	Emergency department (Italy)	210 (210)	Wascular ultrasound, TTE and CTUS*	O/E	Misposition, pneumothorax (time until confirmation)

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Critical Care

REVIEW

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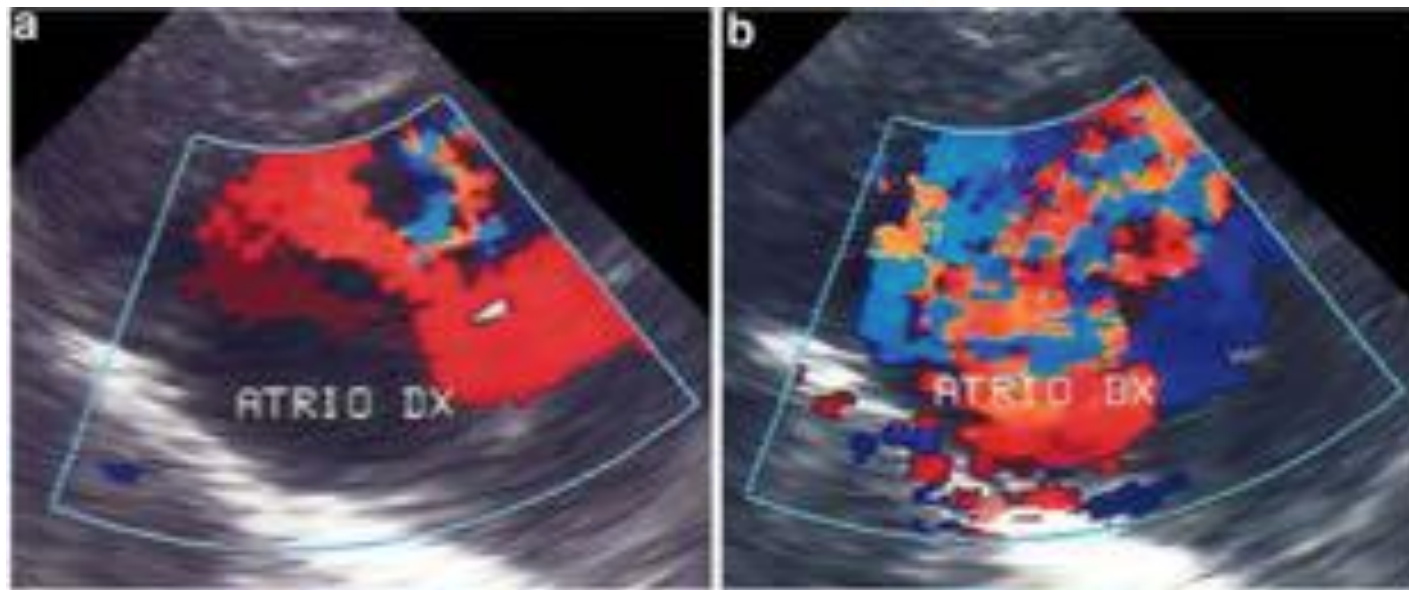


Bedside ultrasound to detect central venous catheter misplacement and associated iatrogenic complications: a systematic review and meta-analysis

Jasper M. Smit^{1,2*}, Reinder Raadsen^{1,2}, Michiel J. Blans³, Manfred Petjak⁴, Peter M. Van de Ven⁵ and Pieter R. Tuinman^{1,2}

Cecilia Lanza · Marco Russo · Giancarlo Fabrizzi

Central venous cannulation: are routine chest radiographs necessary after B-mode and colour Doppler sonography check?



- Color Doppler signals in the superior vena cava.
- Increased colour signal due to turbulent flow during infusion of saline solution

ORIGINAL ARTICLE

Transthoracic echocardiographic guidance for obtaining an optimal insertion length of internal jugular venous catheters in infants

Yong-Hee Park¹, Ji-Hyun Lee², Hyo-Jin Byon³, Hee-Soo Kim² & Jin-Tae Kim²

¹ Department of Anesthesiology and Pain Medicine, Chung-Ang University Hospital, Seoul, Korea

² Department of Anesthesiology and Pain Medicine, Seoul National University Hospital, Seoul, Korea

³ Department of Anesthesiology and Pain Medicine, In-Ha University Hospital, Incheon, Korea

Results: Among 106 cases, positioning of the CVC tip under TTE guidance failed in four patients; thus, the success rate was 96.2%. The mean distance from the CVC tip to the level of the carina was different for positioning using the TTE method (-3.8 ± 8.2 mm; 95% confidence interval, -5.5 to -2.2 mm) and that using the height-based formula (6.1 ± 9.6 mm; 95% CI, 4.2 to 8.0 mm; $P = 0.001$). The distance was consistent regardless of the height when the insertion length was determined using TTE ($r = -0.048$, $P > 0.05$).

Conclusions: Transthoracic echocardiography is a practical method for the correct placement of the CVC tip with less variability compared to the height-based method.

Pediatric Anesthesia

Pediatric Anesthesia ISSN 1155-5645



High specificity but low sensitivity

- 📺 32 studies on US detection of CVC malposition
 - 11 studies in which Vascular US was coupled with TTE +/- CEUS
 - In 6 studies advancement of the guidewire was assessed by US
 - In the remaining 26 studies the CVC was visualized by US directly after placement.
- 📺 US to detect CVC malposition is feasible in 96.8% of cases
- 📺 US to detect CVC malposition as a tip location technique has an overall pooled specificity of 98.9 (95% CI: 97.8–99.5) and sensitivity of 68.2 (95% CI: 54.4–79.4)

Low sensitivity: why?

- 📊 The limited sensitivity of US to detect CVC malposition can be explained by the small a priori chance of primary malposition
- 📊 Given the small incidence of primary malposition in these studies, they were certainly underpowered
- 📊 Therefore, small changes in the number of false negatives could eventually cause dramatic changes in the sensitivity

Low sensitivity: why?

Imperfect reference standard!

- Excepting for 2 studies in which the reference standard was TEE, in the remaining studies the reference was the CXR which should not be considered always a reliable and accurate diagnostic method for tip location

There is a large inter-observer variability among radiologists in identifying the cavo-atrial junction on CXRs; therefore, reading of a bedside CXR alone may not be sufficiently accurate to identify tip position

Low sensitivity: why?



Lack of informations about training

- Operators' experience and proficiency
- What to teach?
- How to teach it?



Lack of standardization of the technique

- Subcostal bicaval view
- Right Parasternal view
- Supraclavicular view
- ...

TTE + CEUS

- ❖ In cases where CEUS was implemented in the study protocol an overall lower sensitivity was noted
 - This may be due to the high inter-observer and intra-observer variability in interpreting the appearance of microbubbles and its shape
- ❖ It has been debated whether the ***threshold of 2 s*** in appearance of microbubbles is an accurate indicator of correct CVC position
- ❖ More likely, the delay in appearance of microbubbles is dependent on the length of CVC
- ❖ Meggiolaro et al. suggested a cut- off value of ***500 ms***

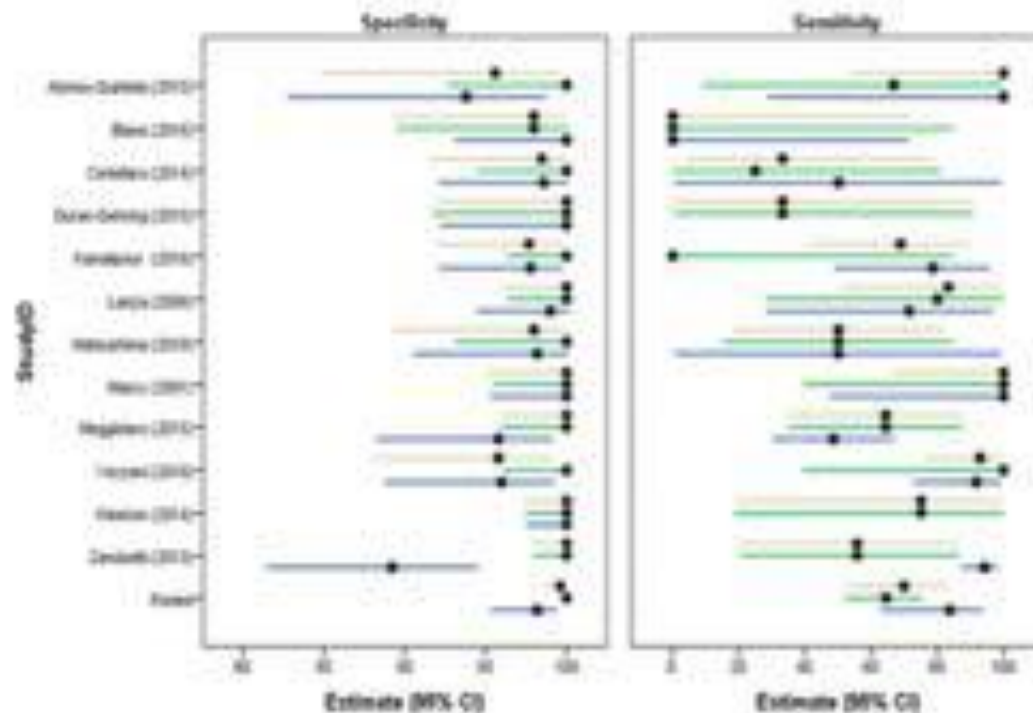
REVIEW

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Bedside ultrasound to detect central venous catheter misplacement and associated iatrogenic complications: a systematic review and meta-analysis

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- “...CVC position, according to our meta-analysis, is best verified by vascular US combined with TTE...”
- Theoretically, the best protocol is an US method incorporating a scan of the central vessels bilaterally (if needed) and visualizing the migration of the CVC tip into the heart through CEUS



Recently, Kim et al. proposed the use of a microconvex probe to visualize catheter passage into the SVC after US guided central vein puncture

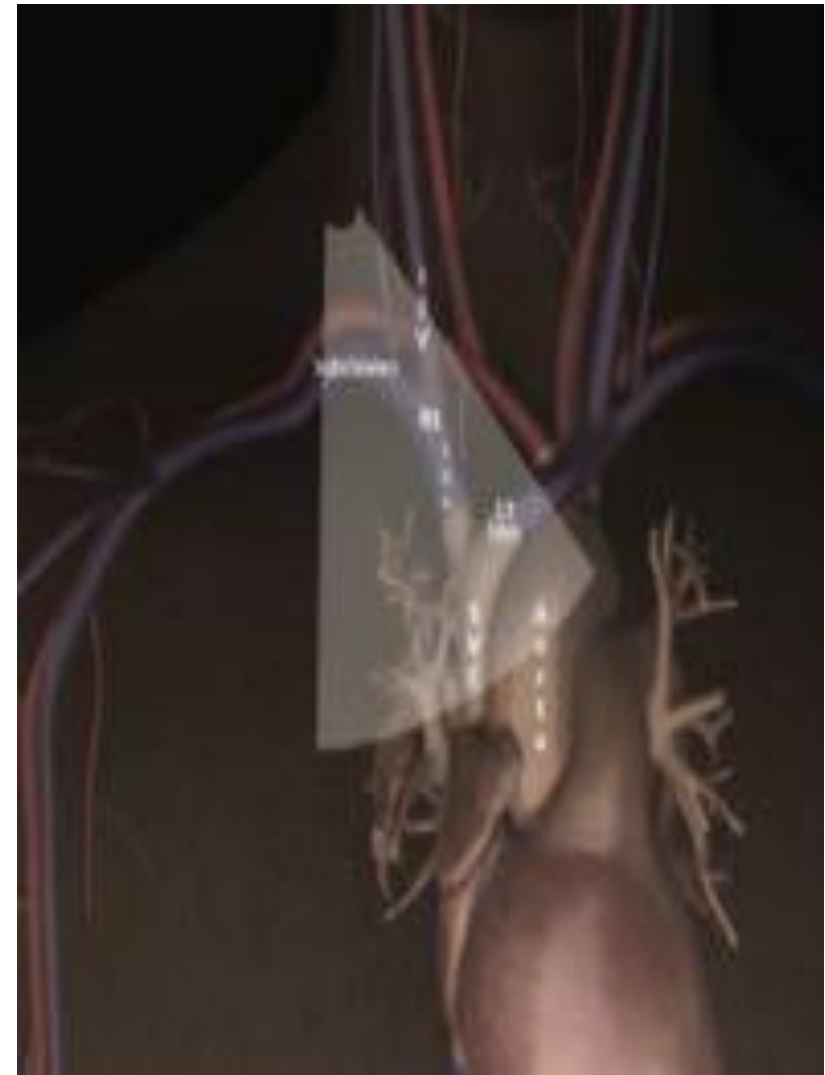
Microconvex probe allows to visualize deeper structures



Transducer Type	Applications	Footprint	Frequency	Field of Vision	Advantages	Disadvantages
Linear	Peripheral vascular, small parts, musculoskeletal	42 × 7 mm	5-13 MHz	39 mm	Higher axial resolution	Less tissue penetration; large footprint, difficult to fit in the suprasternal area
Microconvex	Pediatric applications, vascular, abdominal	26 × 10 mm	4-11 MHz	133°	Deeper tissue penetration; smaller footprint can fit in the suprasternal area	Less axial resolution; specialty transducer, less commonly used



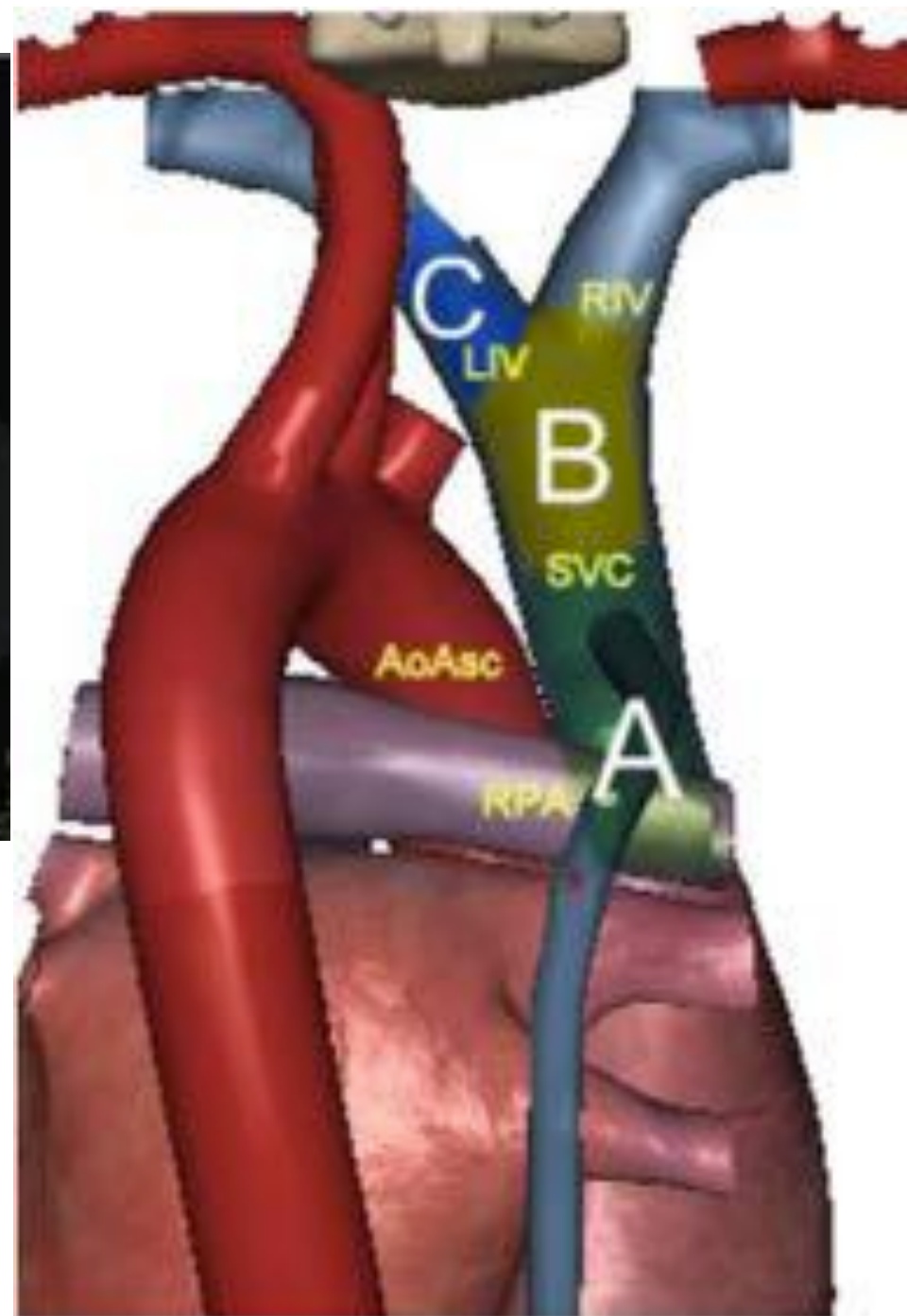
-  A supraclavicular US obtained with this probe offers a longitudinal view of the SVC to its crossing with the right pulmonary artery in front of which the CAJ lies, allowing both catheter tip navigation and location at the same time



Using Ultrasound to Identify the Central Venous Catheter Tip in the Superior Vena Cava

ICU DIRECTOR

Keith Killu, MD, Alton Parker, MD, Victor Coba, MD, Mathilda Horst, MD, and Scott Dulchavsky, MD, PhD



EJA

Eur J Anaesthesiol 2015; **32**:29–36

ORIGINAL ARTICLE

Ultrasound confirmation of central venous catheter position via a right supraclavicular fossa view using a microconvex probe

An observational pilot study

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Improving the “global use” of ultrasound for central venous access: a new supraclavicular scan by microconvex probe

Critical Ultrasound Journal

A La Greca^{1*}, DG Biasucci², A Emoli³, M Pittiruti¹

a SpringerOpen Journal

From 7th WINFOCUS Italian Congress on Ultrasound in Emergency, Anaesthesiology and Critical Care
Lodi, Italy. 26-29 March 2014



Ultrasound-guided supraclavicular central venous catheter tip positioning via the right subclavian vein using a microconvex probe

Se-Chan Kim¹, Ingo Gräff², Alexandra Sommer³, Andreas Hoeft¹, Stefan Weber¹

Electrocardiography-controlled central venous catheter tip positioning in patients with atrial fibrillation

Folkert Steinhagen¹, Maximilian Kanthak¹, Guido Kukuk², Christian Bode¹, Andreas Hoeft¹, Stefan Weber³ and Se-Chan Kim^{1,4}



Using Ultrasound to Identify the Central Venous Catheter Tip in the Superior Vena Cava

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Supraclavicular Ultrasound (SCU)

- 🏠 SCU has been proved to have the highest specificity of 100% (95% CI: 94.4–100) but ***due to absent cases of malposition in the published studies the sensitivity could not be calculated***
- 🏠 SCU is a promising protocol which could potentially be the best since it is performed during the procedure allowing both tip navigation and, in most patients, tip location
- 🏠 Primary malpositions may be almost completely prevented!

SCU - limitations



Operator dependent

- inter- and intra- variability



Patient dependent

- poor echogenic window due to high acoustic impedance of the chest

Objective

Ruling out pulmonary complications

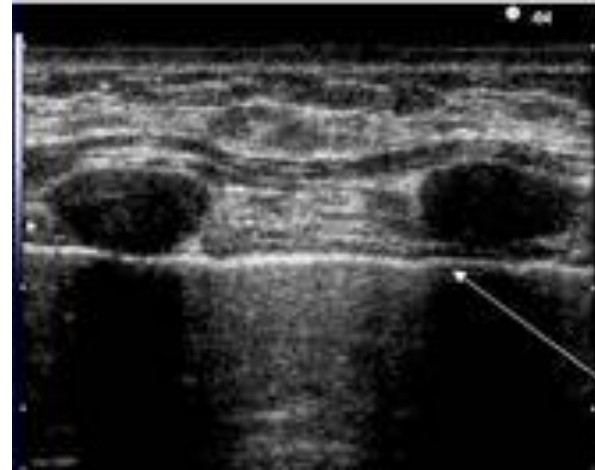


Table 4 Recommendations on ultrasound vascular access in adults and cost-effectiveness

Ultrasound vascular access in adults

Domain code	Suggested definition	Grade of evidence	Strength of recommendation
D4.SD2.S1	Ultrasound guidance should be used for central venous access in adults	A	Very good Strong
D4.SD2.S2	Ultrasound guidance should be used for central venous access in adults	A	Very good Strong
D4.SD2.S3	PICCs should be inserted under ultrasound guidance	A	Very good Strong
D4.SD2.S4	Ultrasound should be taken into consideration for central venous line when difficult access is required	B	Very good Strong
D4.SD2.S5	Arterial catheterization improves first-pass cannulation and should be used routinely in adults	A	Very good Strong
D4.SD2.S6	<u>Ultrasound can accurately detect pneumothorax and should be routinely performed after central venous catheter cannulation when the pleura could have been damaged</u>	B	Very good Strong
D4.SD2.S7	<u>CEUS (contrast-enhanced ultrasound) is a valid method for detecting a central venous catheter tip in the right atrium</u>	B	Very good Strong
D5.S1-3	Cost-effectiveness of the use of ultrasound for vascular cannulation 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

Ultrasound can accurately detect pneumothorax and should be routinely performed after central venous catheter cannulation when the pleura could have been damaged

...nel bambino e nel neonato

Ultrasound vascular access in neonates and children		
Domain code	Suggested definition	
D4.SD1.S1-2	Ultrasound guidance should be used for central venous access	A
D4.SD1.S3	Ultrasound guidance should be used for arterial puncture in neonates	A
D4.SD1.S4	Ultrasound guidance should be used for subclavian vein puncture in neonates	C
D4.SD1.S5	Ultrasound guidance should be used for femoral vein puncture in neonates	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

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

Central venous access devices in pediatric malignancies: a position paper of Italian Association of Pediatric Hematology and Oncology

Alessandro Crocchi¹, Assunta Tornesello¹, Mauro Pittiruti¹, Angelica Barone⁴, Paola Muggeo⁵, Alessandro Inerra¹, Angelo Claudio Molinari⁶, Valeria Grillenzoni⁷, Viviana Durante⁸, Maria Pia Cicalese⁹, Giulio Andrea Zanazzo¹⁰, Simone Cesaro⁷

Introduction: Treatment of pediatric malignancies is becoming progressively more complex, implying the adoption of multimodal therapies. A reliable, long-lasting venous access represents one of the critical requirements for the success of those treatments. Recent technical innovations—such as minimally invasive procedures for placement, new devices and novel materials—have rapidly spread for clinical use in adult patients, but are still not consistently used in the pediatric population.

Methods: The Supportive Therapy Working Group of Italian Association of Hematology and Oncology (AIEOP) reviewed medical literature focusing on new aspects of central venous access devices (VADs) in pediatric patients affected by oncohematological diseases.

Results: Appropriate recommendations for clinical use in these patients have been discussed and formulated.

Conclusions: The importance of the correct choice, management and use of VADs in pediatric oncohematological patients is a necessary prerequisite for an adequate standard of care, also considering the increased chances of cure and the longer life expectancy of those patients with modern therapies.

Ultrasound should be used for diagnosis of local pathologic conditions before the procedure and for diagnosis of procedure-related complications.

Ultrasound is necessary to assess vein patency before the procedure and to choose the vein most appropriate in terms of caliber, depth and position.

The internal diameter of the vein to be cannulated—as assessed by ultrasound—should be at least three times the external diameter of the catheter, so as to reduce the risk of venous thrombosis.

Ultrasound-guided venipuncture should be adopted, so as to reduce the risk of early and late complications.

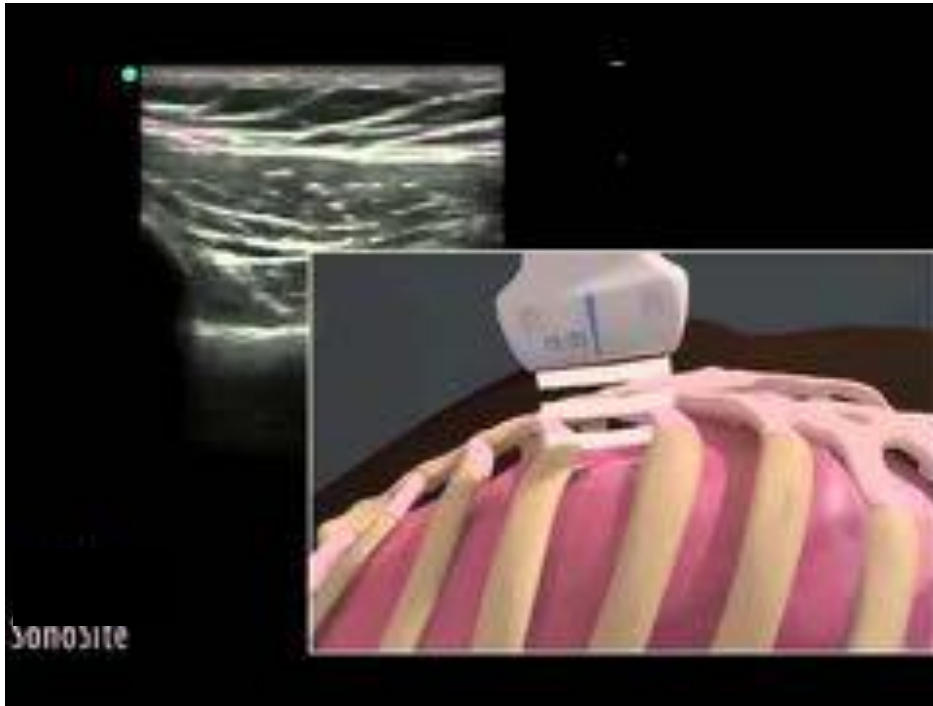
Venous cannulation by surgical cutdown should be avoided.

“Blind” percutaneous puncture of central veins (“landmark” venipuncture) should be avoided.

In newborn and infants, internal jugular vein and brachio-cephalic vein are usually the first options for ultrasound-guided central venous access.

Soon after procedures potentially associated with pleural damage, pneumothorax should be excluded by ultrasound scan of the inter-costal space.

The scanning technique

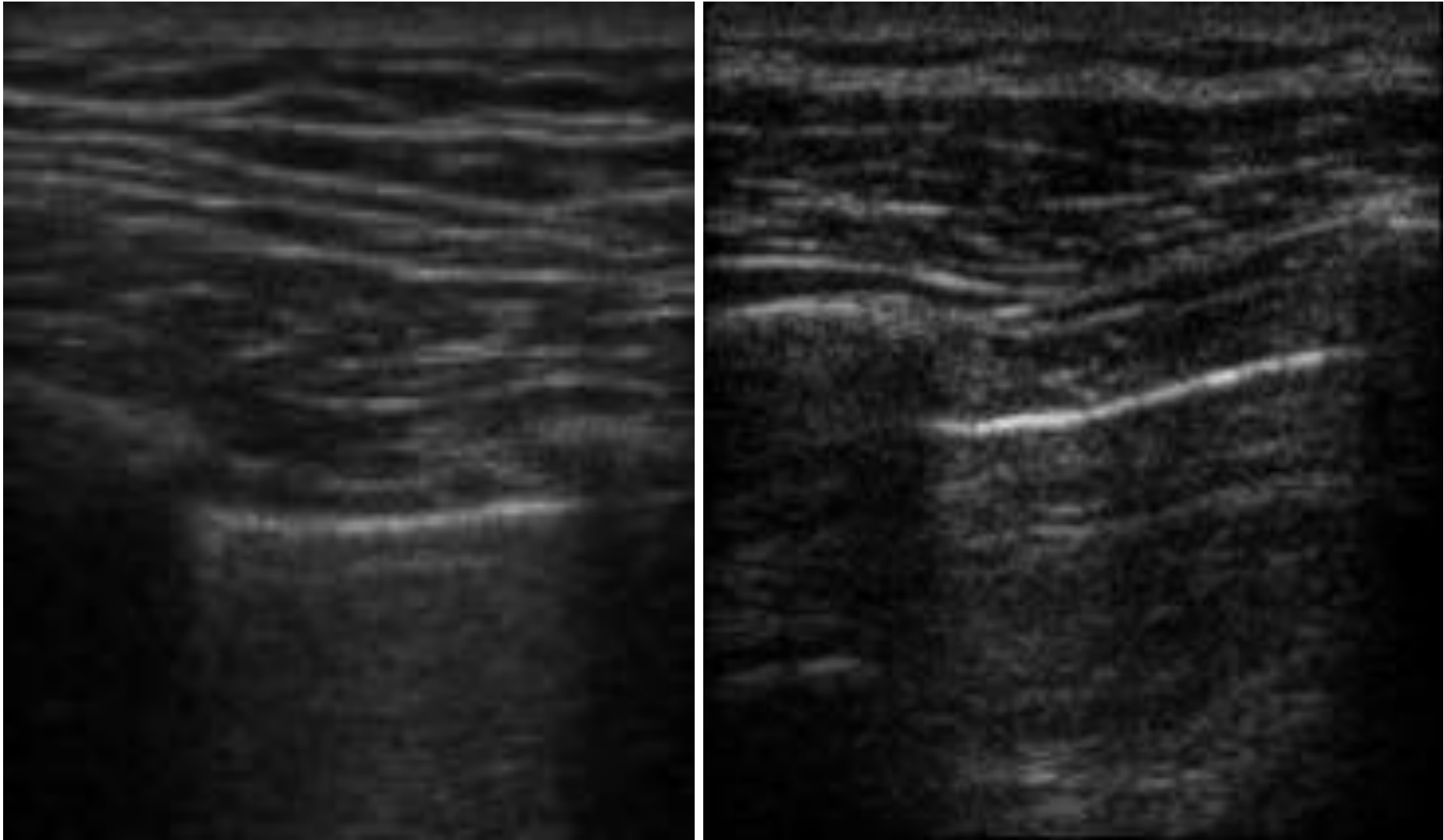


- The probe can be positioned longitudinally, perpendicular to two (or more) consecutive ribs

The scanning technique

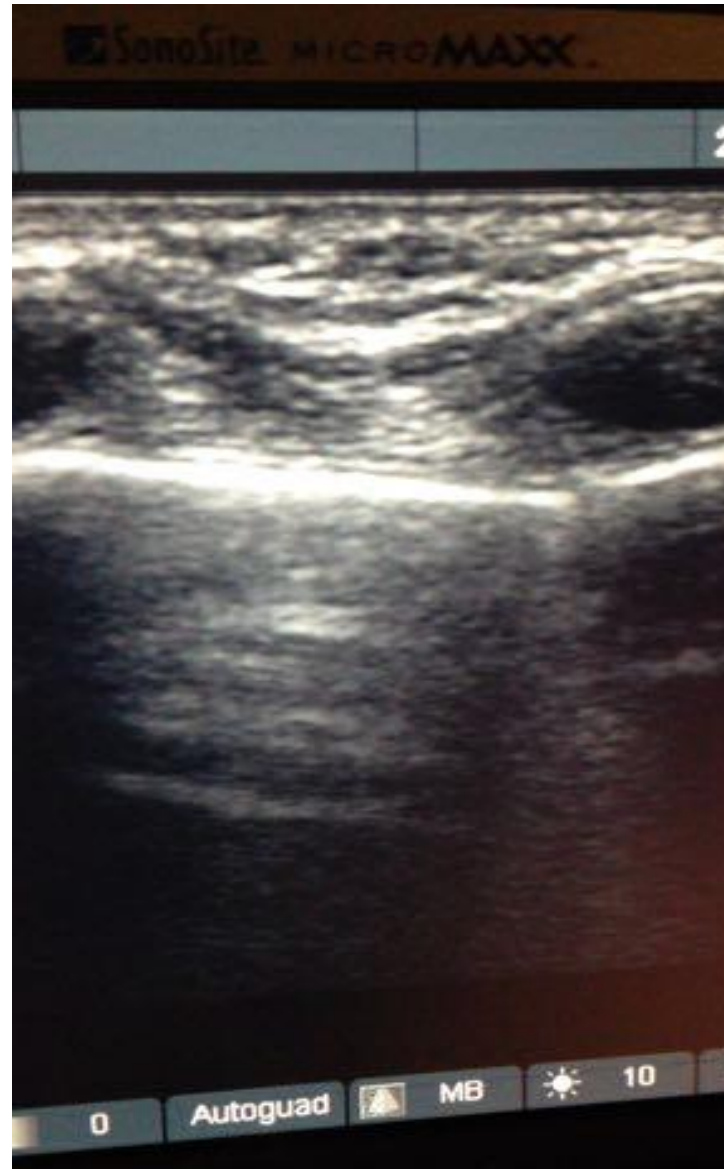


- Most exam must include, at a minimum, the anterior, anterolateral and postero-lateral portions of the chest wall evaluated in a clinically integrated goal-directed manner based on patient's clinical presentation

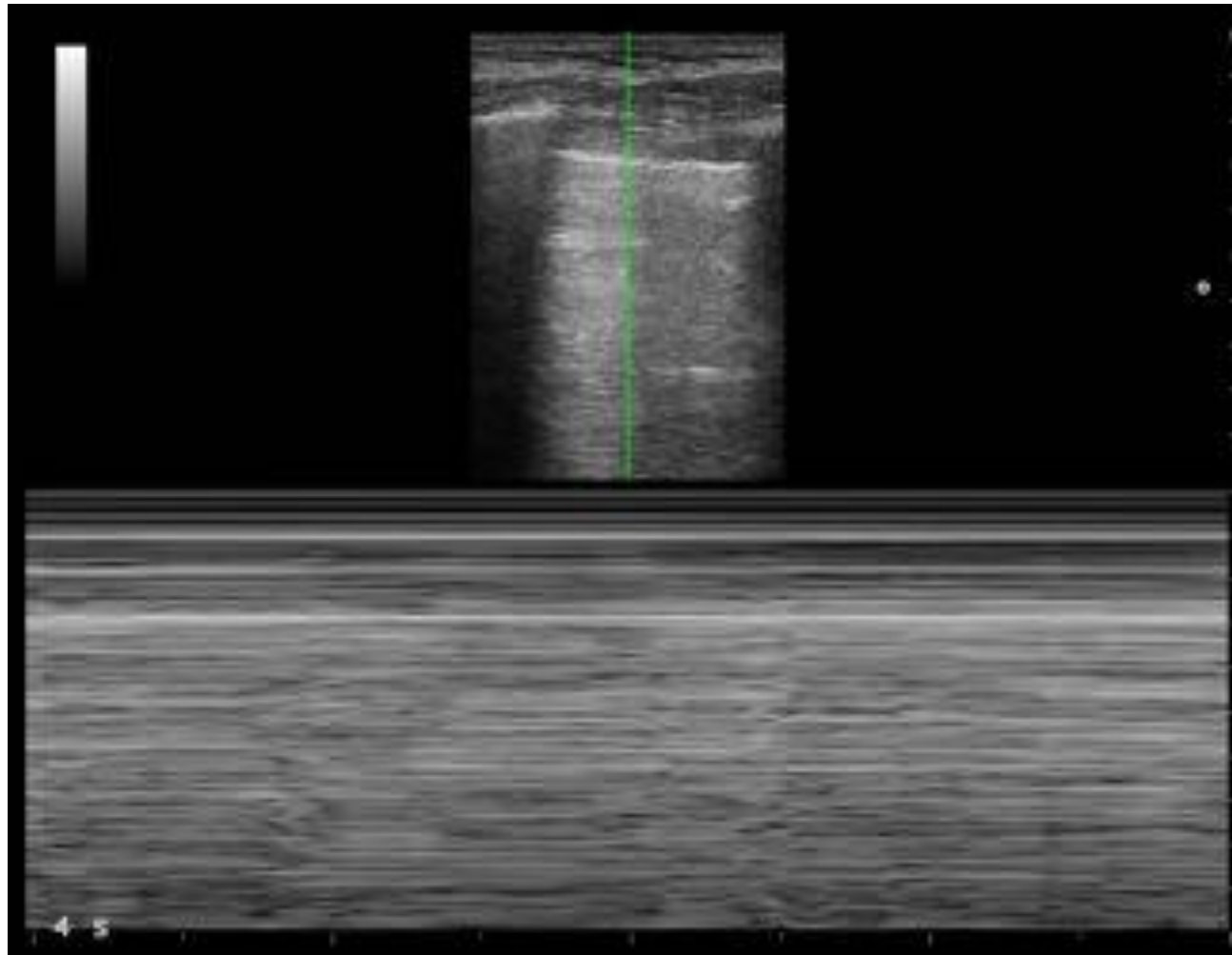


- The presence of air, between the chest wall and the lung causes a change of the sonographic dynamic image of the lung
- In PNX lung sliding is absent, due to the presence of air between the two pleural layers

M-Mode



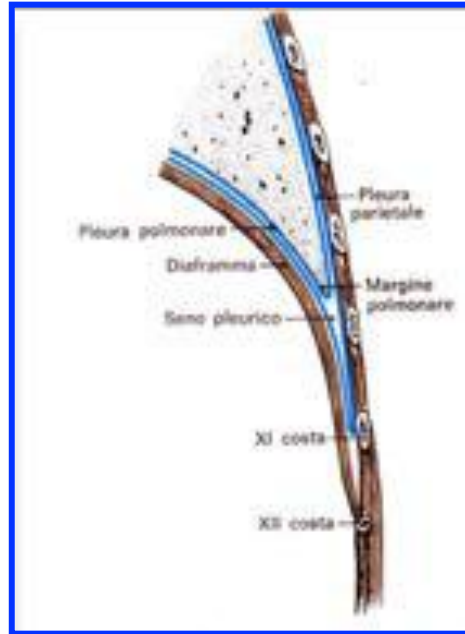
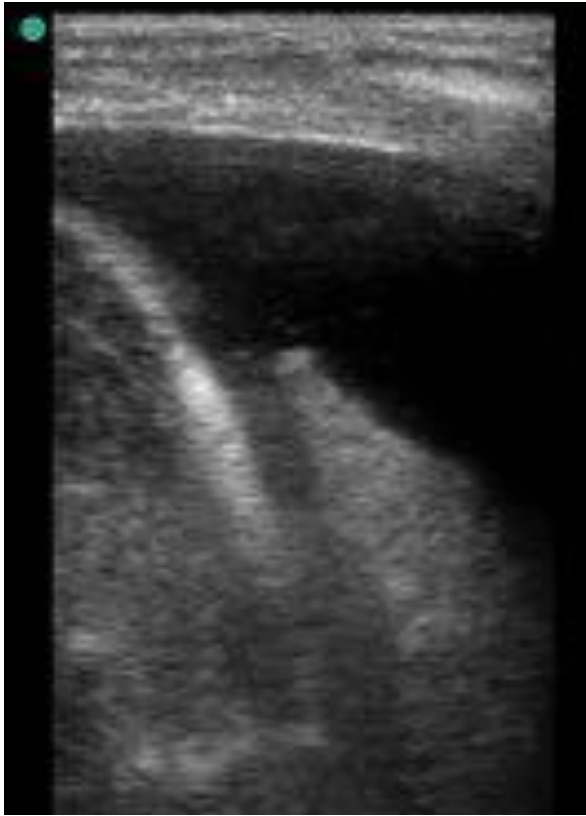
M - MODE



- **Stratosphere sign** is the typical PNX m-mode pattern



- This phenomenon creates vertical artefacts known as B-lines
- B-lines belong to the family of the comet-tail artifacts
- B-lines are vertical hyperechoic lines arising from pleural line extending downward to the edge of the ultrasound screen
- B-lines move synchronously with lung sliding



- The presence of fluid between the two pleural layers can be easily detected using ultrasound as an anechoic fluid mass
- Complicated effusions may have multiple internal echoes
- LUS allows to determine the characteristics of the effusion, such as being free, loculated or corpuscolated

Curtain Sign



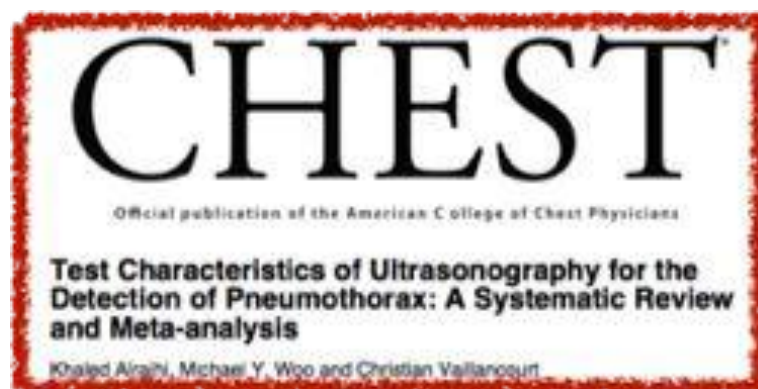
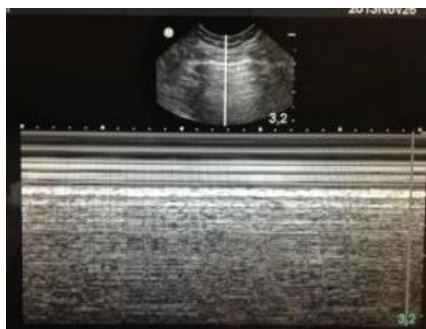


Table 2: Summary of sensitivity and specificity for included studies

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%

PNX

- *PNX Sonographic Signs

- *Sliding Sign

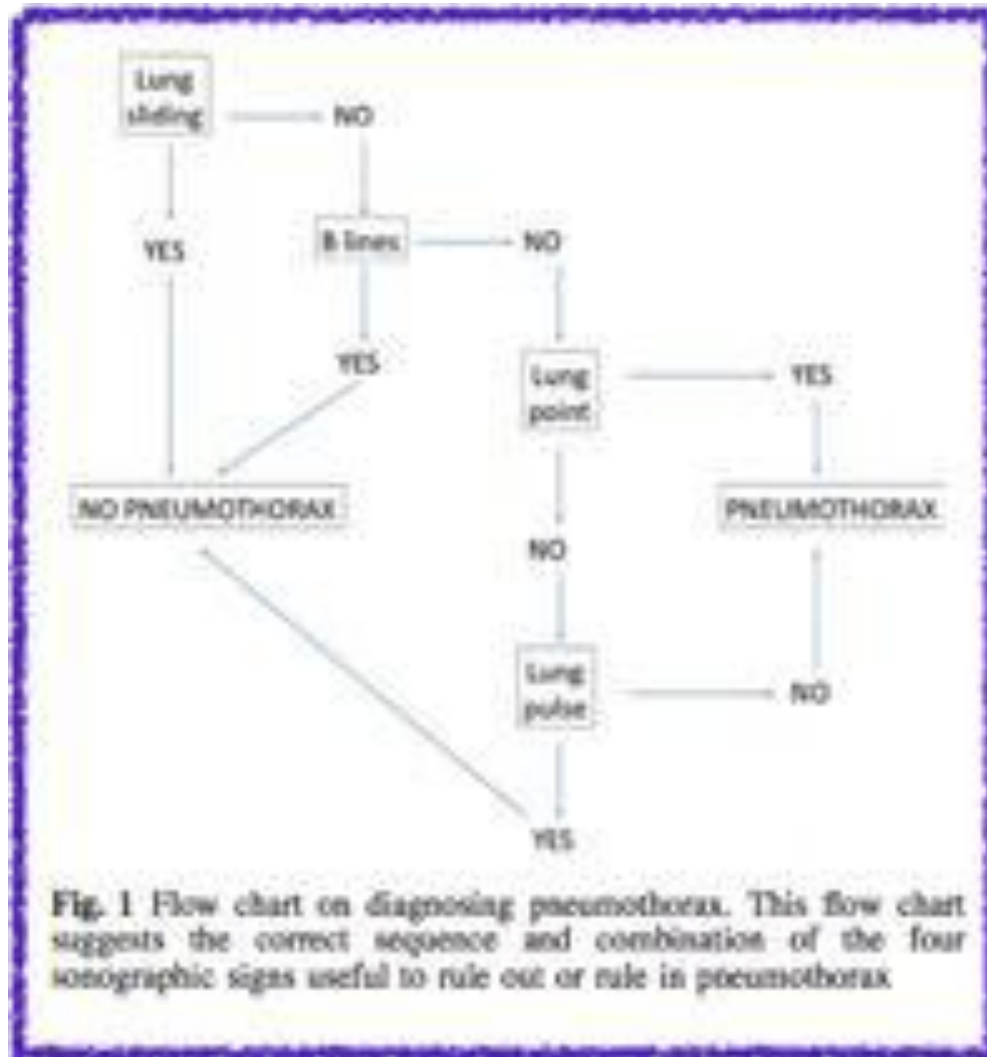
- *B - lines

- *Lung Pulse

- *Lung Point

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

Pneumothorax

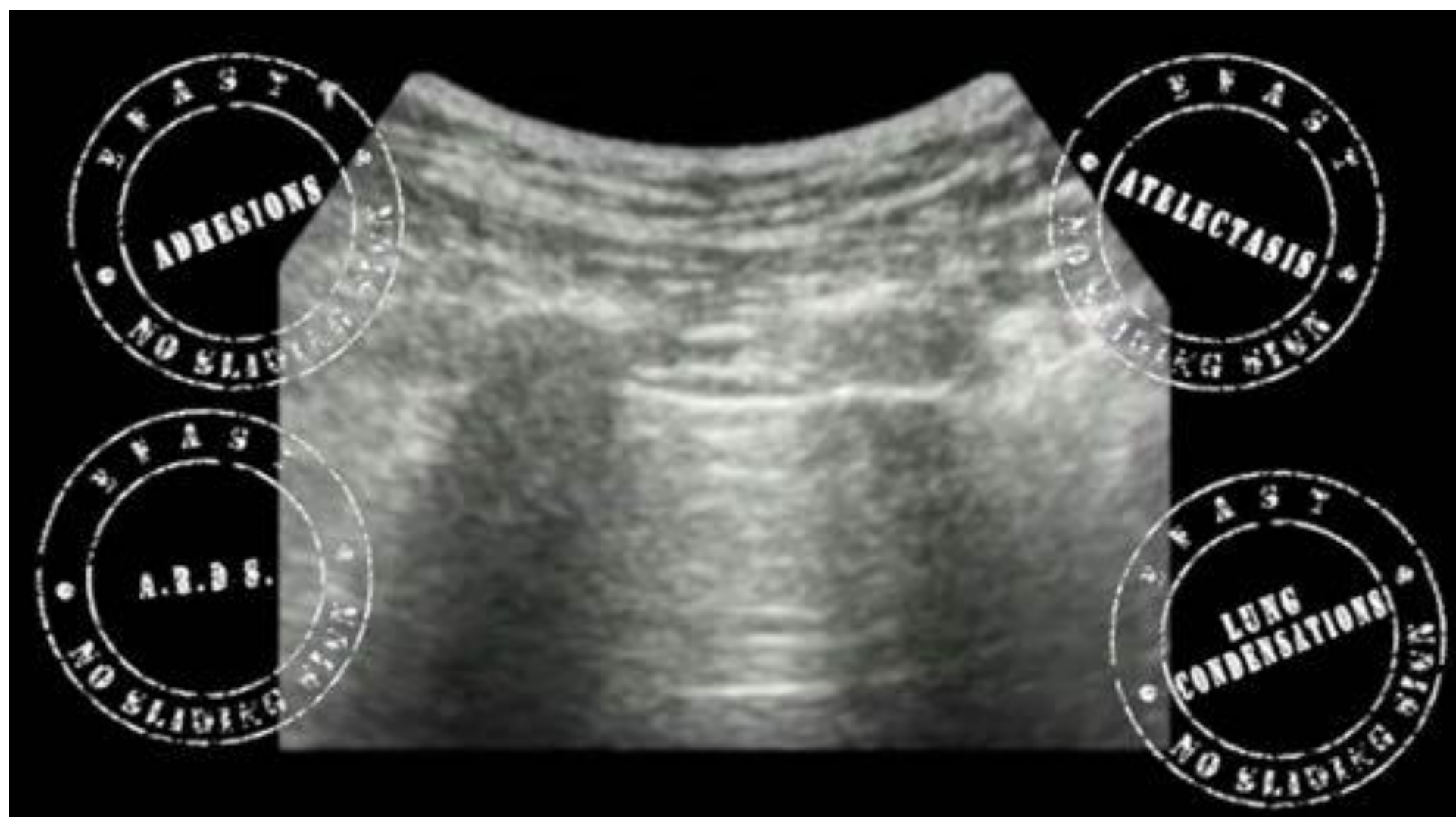


- PNX US signs:
 - Absence of lung sliding
 - Absence of B-lines
 - Absence of Lung Pulse
 - Presence of Lung Point

CONFERENCE REPORTS AND EXPERT PANEL

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

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



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Profond.

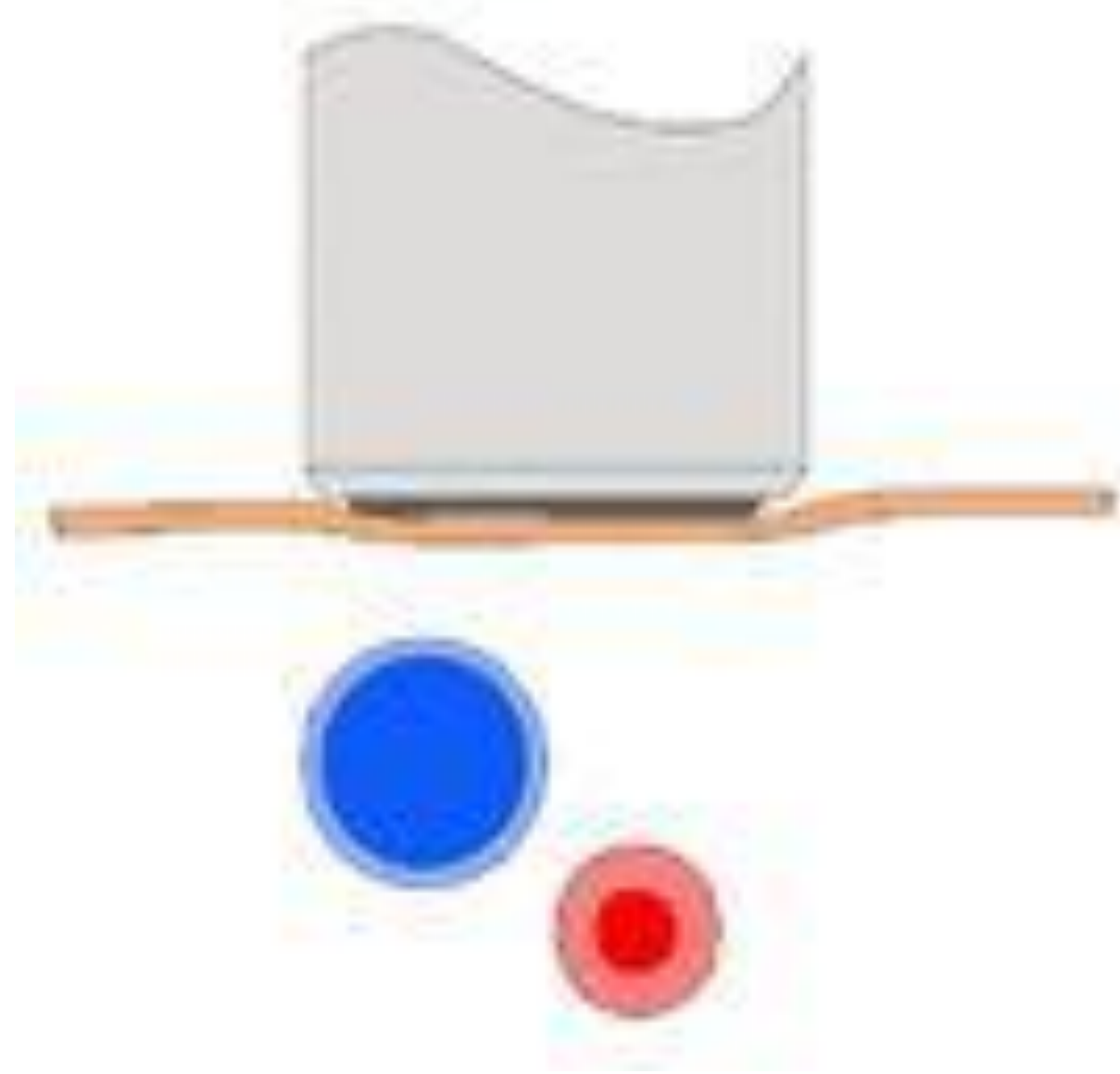
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**ANCHE PER LA GESTIONE
POST - IMPIANTO**

Il nuovo concetto che emerge è:

- USO '**CLINICO - INTEGRATO**'
DELL'ECOGRAFO

- Per la scelta della vena
- Per la venipuntura
- Per la corretta direzione della guida metallica e del catetere
- Per la esclusione di complicanze da venipuntura:
 - Puntura arteriosa; Ematoma; PNX; Emotorace
- Per la verifica della posizione della punta
- Diagnosi di complicanze tardive non infettive: es. trombosi

Domande?



Ecografia in Terapia Intensiva e Medicina dell'Emergenza

Corso di Perfezionamento in

**ECOGRAFIA CLINICA-INTEGRATA
PER L'INTENSIVISTA:
DALL'EMERGENZA MEDICO-CHIRURGICA
AI REPARTI DI TERAPIA INTENSIVA**

Anno Accademico 2018-2019



INFO E CONTATTI

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