

**TIP NAVIGATION: VECCHIE E NUOVE METODOLOGIE
A CONFRONTO IN TERMINI DI COSTO-EFFICACIA**

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In breve...

1. Cosa si intende per costo-efficacia

1. Quali fattori determinano la costo-efficacia
di una metodica o di una tecnica

1. Come ottimizzare la costo-efficacia
nell'ambito della tip navigation

Un presidio o una metodica è

efficace quando raggiunge l'obiettivo clinico per il
quale è usato

efficiente quando raggiunge l'obiettivo clinico
prefissato con le risorse minori o senza spreco di
risorse

costo-efficace quando offre un vantaggio in termini
di rapporto tra le risorse impiegate e l'obiettivo
clinico raggiunto

I nostri obiettivi:

(in ordine di priorità)

1. SICUREZZA del paziente
2. EFFICACIA clinica
3. EFFICIENZA aziendale

Attenzione:

E' errato comparare due metodiche soltanto
in termini del loro costo assoluto

Ciò non coincide con il reale 'costo' dell'impianto (che dipende da molti
altri fattori)

E non coincide con il reale 'costo' complessivo della metodica scelta

ma le SI DEVE valutare in termini di rapporto
tra le risorse impiegate e l'obiettivo clinico
raggiunto

Due ordini di fattori

- Risorse impiegate
 - Materiali, tempi, ambiente utilizzato,
apparecchiature, risorse umane impiegate,
etc.
- Costi delle complicanze 'attese' sia al
momento dell'impianto che durante la
gestione
 - Stimate sulla base del rischio % desunto dalla
letteratura

Esempio: risorse impiegate

Costo materiale e apparecchiature
ecografo, Fluoroscopia, ECG...

Costo risorse umane
infermiere, chirurgo, radiologo, anestesista...

Costo ambiente
bedside vs ambiente dedicato vs. angiografia

Tip Navigation

- Le tecniche di tip navigation, integrate con le tecniche di tip location, ragionevolmente, ne aumentano l'accuratezza riducendo le complicanze e i tempi dell'impianto soprattutto in alcune categorie di pazienti

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Complicanze

- **Malposizionamento primario (o secondario)** che comporta:
 - ritardo nella inizio della terapia e necessità di riprogrammazione per **sostituzione del presidio** a causa del malfunzionamento
 - aumento del rischio trombotico

Quindi...

I presidi e le metodiche che si associano a maggiore sicurezza del paziente riducono le complicanze (che costituiscono il vero 'costo' degli accessi venosi) e quindi aumentano in genere la costo-efficacia

Tip navigation vs Tip location

- Le tecniche di 'tip location' permettono di individuare la corretta posizione della punta del VAD se esso è stato fatto procedere nella giusta direzione
- Le tecniche di 'tip navigation' permettono di indirizzare correttamente la progressione del catetere la cui corretta posizione della punta sarà verificata con una tecnica di 'tip location' integrata

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Tip Navigation

- Le tecniche di tip navigation, in condizioni standard, non sostituiscono le tecniche di tip location.
- Le tecniche di tip navigation possono ridurre il rischio di malposizionamento in quelle particolari categorie di pazienti in cui non possono essere usate le tecniche di 'tip location' (es. ECG nei pazienti portatori di PM o con FA)

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Tecniche di 'Tip Navigation'

- Imaging-based
 - Fluoroscopia
 - Ecografia ed ecocardiografia
- Proiezione indiretta
 - Sherlock (Bard)
 - Navigator (Cordis)
 - Cath-finder (Elcam)
- Doppler-based
 - Vasonova (Teleflex)
- ECG-based
 - Delta (Romedex)

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LIMITI della fluoroscopia

Simultaneamente 'tip navigation' e 'tip location'
 Costosa
 Difficoltà logistiche e organizzative
 Limiti dei reperi radiologici

Inaffidabilità dei reperi radiologici comuni

- Incrocio tra silhouette cardiaca destra e linea mediastinica destra (vena cava superiore):
 - anatomia reale mal rappresentata dall'immagine proiettiva:
 - 1) nel 30% dei pazienti il profilo cardiaco destro radiologico è composto dalla spalla dell'atrio sinistro che sborda sull'immagine del destro nella sua porzione cranio-ventrale, con il risultato che la punta di cateteri ben posizionati appare sul radiogramma proiettata all'interno dell'ombra cardiaca (Asariy, Child 1988)

90% di cateteri venosi anteriori: implicazioni
 per cateteri venosi posteriori
 il 10% di cateteri venosi posteriori
 il 10% di cateteri venosi anteriori

- 2) la vena cava superiore si
 impara **dorsalmente** e
 non cranialmente sull'asse
 destro, tra terzo medio e
 terzo princ. dell'atrio destro
 e **tangenzialmente** ad esso
 (Tessier, Gelpy, Asariy)
 la punta di cateteri con
 punta ben posizionata
 all'interno di sede
 giustamente appare sul
 radiogramma proiettata
 all'interno dell'ombra
 cardiaca.

A Study of the Relationship of the Superior
 Vena Cava to the Right Atrium: Implications for
 Magnetic Guidance Systems

Journal of Vascular Medicine and Biology, 1999, 11(1), 1-7

Altri limiti della radiologia tradizionale

- Obesità
- Slargamenti mediastinici
- Deformità scheletriche
- Altre anomalie anatomiche

*Tali limitazioni rendono la fluoroscopia una
 metodica poco accurata*

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Costi dell'impianto di un PICC

Dati presentati da M. Smith (Wisconsin) al
 congresso DIVLD – Parigi, 2011

	operatori	ambulatorio	ambulatorio	altri usi
\$ 5000	clinico	Sala operatoria	fluoroscopia	territo
\$ 2000	radiologo	Sala radiologica	fluoroscopia	territo rad.
\$ 1000	anestesiologo	Podiale	no fluor.	
\$ 875	infermiere	Podiale	no fluor.	

Annals of Internal Medicine

Supplement

Working Together Can Make
a Difference
Improving Respiratory
Health: A Guide
for Health Care Providers

SUPPLEMENT

[illegible]

Strongly encouraged

Bundles that include checklists to prevent central line-associated bloodstream infections

Resides that include head-of-bed elevation, isolation precautions, and care with disinfection, and subglottic suctioning endotracheal tubes to prevent ventilator-associated pneumonia

The do-not-use list for hazardous abbreviations.

Earlier precautions to prevent health care-associated infections

Use of real time ultrasonography for control line placement

REFERENCES

Multi-component interventions to reduce falls

Use of clinical pharmacists to reduce adverse drug events

Documentation of patient preferences for life-sustaining treatment

Obtaining informed consent to improve patients' understanding of the potential risks of procedures

Team training

Medication reconciliation

Strategies to reduce radiative exposure from fluoroscopy and CT

The use of surgical outcome measurements and report cards, such as those from ACS NSQIP

Rapid-response systems

Use of complementary methods for detecting adverse events or medical

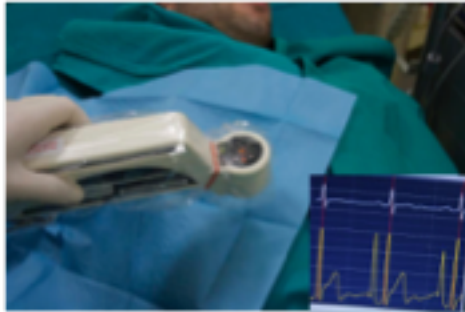
errors to monitor for patient safety problems.

Computerized provider order entry

Use of simulation exercises in patient safety efforts



Puerta in Vena Auricular controlateral



Tip at the cavo-atrial junction

Sherlock II Tip Location System



Lebes V, Kumar A, Shukla PA, Contractor S, Ratan T. Analysis of the Sherlock II tip location system for inserting peripherally inserted central venous catheters. *Clin Imaging* 2013 Sep-Oct; 37(5): 477-2

- Efficaci come tecniche di 'tip navigation'
- Non accurati come tecniche di 'tip location'
- Necessità di essere integrati da tecniche di 'tip location' (es. ECG)

A Study of the Relationship of the Superior Vena Cava to the Bony Landmarks of the Sternum in the Supine Adult: Implications for Magnetic Guidance Systems

Sharma A, Choudhary R, Sharma P, and Sharma P (2013)

JAVA | Vol 2 No 3 | 2013

Sherlock + Sapiens = Sherlock 3CG



Johnston AJ, Holder A, Bishop SM, See TC, Shearer CT. Evaluation of the Sherlock 3CG Tip Confirmation System on peripherally inserted central catheter malposition rates. *Anaesthesia* 2014 Jul 18; doi: 10.1111/anae.12788. [Epub ahead of print]

Vasonova: ECG + Doppler



Gingardi et al. Successfully Eliminating Chest Radiography by Replacing it with Dual Vector Technology and an Algorithm for PICC Placement (JAVA, June 2014)

Tuttavia...

- Si tratta di dispositivi che hanno un costo
- Di tali metodiche integrate resta da dimostrare la costo-efficacia rispetto alla sola metodica ECG
- Sono necessari studi per provarne la costo-efficacia

ECG Navigation



Ecografia e Accessi Vascolari

Valutazione Ecografica
Preliminare

Puntura ecoguidata

Controllo della punta
Diagnosi/Esclusione PNx/
Emotorace

AMA policy on privileging US

- (1) Ultrasound imaging is within the scope of practice of appropriately trained physicians;
- (1) [...] broad and diverse use and application of ultrasound imaging technologies exist in medical practice;
- (1) [...] 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;

American College of Emergency Physicians POLICY STATEMENT

- 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 term 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.

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

CONSENSUS REPORTS AND EXPERT PANEL

International evidence-based recommendations on ultrasound-guided vascular access

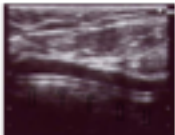
Members: Longwell, Andrew B. Boudreau, Mauro Pittet, Michael Walter, John G. Argente, Mahmoud Elbarbary, Steven Pinsky, Christine Karkhanavala, Seth LeFrere, Stephanie Dargatzis, Giuseppe Nappi, David Fisher-Siegel, William Schumacher, Roberto Belli, Eric Therasse, Lawrence A. Molloy, Susan T. Yorgensen

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

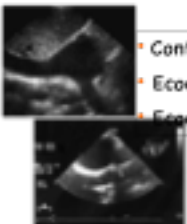
Table 4 Recommendations on ultrasound vascular access in adults and paediatrics

Recommendation	Suggested definition	Level of evidence	Grade of recommendation	Strength of recommendation
DR-001-01	Ultrasound guidance should be routinely used for the insertion of central venous access in adults	A	Very good	Strong
DR-001-02	Ultrasound guidance should be routinely used for the insertion of central venous access in adults	A	Very good	Strong
DR-001-03	PICO should be routinely inserted at and use level by ultrasound guidance using video-integrated technique	A	Very good	Strong
DR-001-04	Use of ultrasound guidance should be taken into consideration for the kind of peripheral intravenous line when difficult access is anticipated	B	Very good	Strong
DR-001-05	Ultrasound guided arterial catheterisation improves flow rate success rate should be used routinely in adults	A	Very good	Strong
DR-001-06	Ultrasound can potentially detect, prevent and avoid complications performed after central venous catheterisation	B	Very good	Strong
DR-001-07	Ultrasound guided peripheral intravenous catheterisation improves flow rate success rate should be used routinely in adults	B	Very good	Strong
DR-001-08	Ultrasound guided peripheral intravenous catheterisation improves flow rate success rate should be used routinely in adults	A	Very good	Strong

- Controllo indiretto
- Ecografia Vascolare



- Controllo diretto
- Ecocardiografia transtoracica
- Ecocardiografia transesofagea



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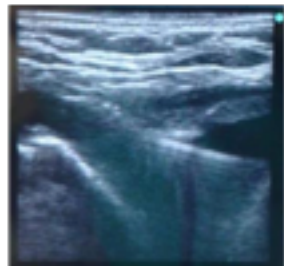
Ecografia Vascolare

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Ultrasound detection of guidewire position during central venous catheterization

Michael B. Stone MD, RDMS^{1,2}, Arun Nigam MD³,
Michael C. Murphy MD¹, Craig A. Simon MD¹

The American Journal of Emergency Medicine

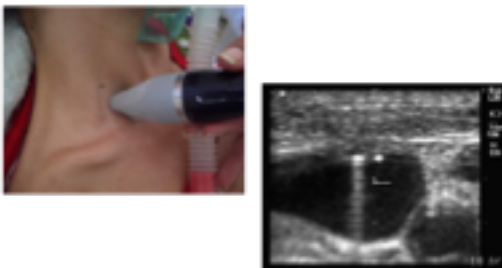


Controllo indiretto della guida

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Assessment Negativo

- Ecografia vasi venosi



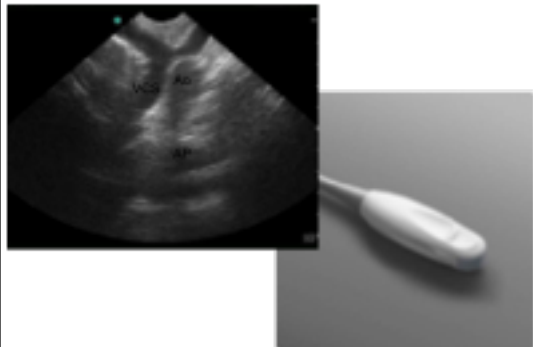
40

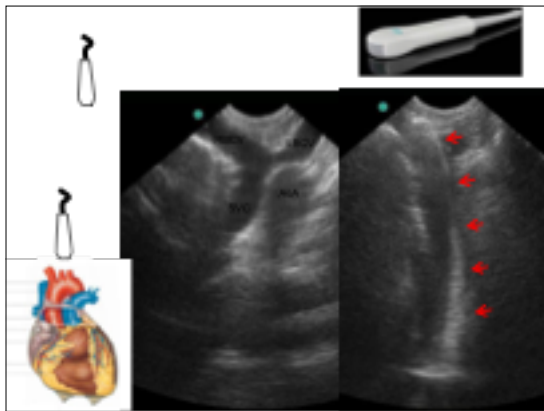
Assessment Negativo

- * Facile ed a basso costo
- * E' possibile utilizzare la stessa sonda della venipuntura
- * Riduce le malposizioni in VGI in caso di puntura dell'ascellare o di accessi brachiali
- * Non previene e non permette di rilevare altri tipi di malposizionamento (punta nel tronco brachiocefalico ipsilaterale o contralaterale; punta 'troppo alta' in VCS o 'troppo bassa' in atrio dx)

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Sonda Microconvex





Ecocardiografia Transtoracica

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* Proiezione Apicale 4 Camere

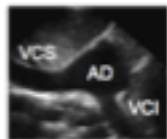
- Facile esecuzione
- Visualizzazione diretta della punta
 - Solo se la punta è in atrio dx
- Visualizzazione indiretta della punta
 - Solo se la punta è prossima alla giunzione seno-atriale



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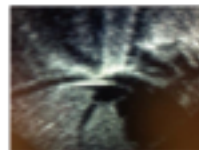
* Proiezione Sottocostale Bicavale o Asse corto

- Permette di visualizzare atrio dx e vene cave sup e inf
- Limitazioni: meteorismo intestinale o chirurgia addominale sottodiaframmica; pazienti obesi o affetti da grave BPCO
- IMPORTANTE: piccoli movimenti di tilting dello scudo
- Permette la visualizzazione diretta della punta anche se in VCS



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Anche nei neonati...



Ecocardiografia Transesofagea

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- * Il metodo più accurato
- * Dispendioso, invasivo, richiede molto training

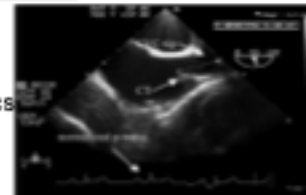


Punta in giunzione cavo - atriale

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Punta al 1/3 distale di VCS



Punta al 1/3 medio di VCS

Ultrasonic Examination

An Alternative to Chest Radiography after Central Venous Catheter Insertion?

ERIC HAURY, JEAN-LOUIS GILBERT, MARC ALBERT, ROYALD GAGNON, and GEORGES D'AMARANT
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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*

Antonio Vassini, MD; Claude Brasseur, MD; Salvatore Pateris, MD; Claude Laroche, MD; Marc Merges, MD; Francesco Carati, MD, PhD

Brief Report

American Journal of Emergency Medicine 32 (2014) 76–81

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

Francesco Corbelli, MD^{1,*}, Luca Willem, MD^{1,*}, Stefano Pagli, MD^{1,*}, Giorgio Comarini, MD^{1,*}, Sara Sisti, MD^{1,*}, Daniele Cook, MD^{1,*}

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AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 164 2001

Procedures

1. US of IJV and SVC → Negative Assessment
 2. Visualization of right atrium and ventricle and the inferior vena cava through the subcostal acoustic window → Negative Assessment
 3. Pneumothorax detection us- ing both lung-sliding and comet-tail artifact
- US was interpretable in all cases except for one heart examination in a severely obese patient in whom heart visualization was impossible.
 - Only two distal placements were recognized by echographic examination (TTT)
 - Only one pneumothorax occurred after subclavian insertion and was identified by ultrasound. This pneumothorax required chest tube drainage.
 - While performing heart and vein examination and pneumothorax research, ultrasound did not give any false-positive result.

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

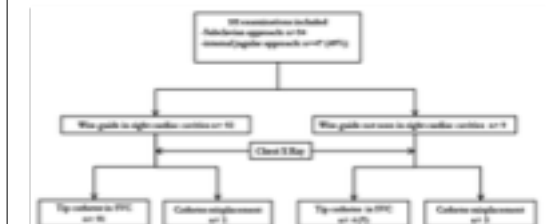
Intensive Care Med (2013) 39:1932–1937

- Before dilator introduction, the guidewire was slowly removed under echographic control until its extremity (metallic loop) disappeared from the upper RA
- Using this procedure, the authors were able to estimate the distance between the SVC-RA junction and the skin
- Bicaudal subcostal view
- Four patients presented very poor echogenicity (heart not seen), so ultrasound examination was not performed.

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

Intensive Care Med (2013) 39:1932–1937



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

Antonio Vezzani, MD; Claudio Brusaporci, MD; Salvatore Palermo, MD; Claudio Ianni, MD; Mario Mergani, MD; Francesco Caracci, MD, PhD

Crit Care Med 2010 Vol. 38, No. 2

- After CVC insertion, both B-mode ultrasound and CEUS were performed.
- Conventional B-mode ultrasound to examine both SV and IJV.
- Right atrium and ventricle, SVC and inferior vena cava were excluded through the apical and subcostal acoustic windows along the short heart axis allowing to see both cava veins and right atrium at the same time confirming catheter placement.
- The catheter tip identification in the right atrium was confirmed by CEUS, using a standard technique: 5 ml of a saline-air mixture (prepared with two 10-ml syringes containing one 9 ml of saline and the other 1 ml of air) were injected rapidly as a bolus through the catheter so that a stream of microbubbles could be seen through the tip, to assure positioning.
- ultrasound examination of the lung for detection of PNX

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Crit Care Med 2010 Vol. 38, No. 2

Table 3. Classification and interpretation of microbubbling test

Characteristics	Interpretation
No bubbles	Negative test: an absent or too distal tip position must be considered. Test to be repeated. If confirmed, possible misplacement (probably in the IV or IJV). Negative test, false atrial positioning.
Free bubbles or appearance time >2 sec	
Numerous bubbles indistinguishable separately	Positive test: CVC tip correctly placed in the SVC.
Isolated flow coming from atrium within 2 sec	
Numerous bubbles indistinguishable separately	
Isolated flow coming from superior vena cava within 2 sec	

SV, subclavian vein; IJV, internal jugular vein; CVC, central venous catheter; SVC, superior vena cava.

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Crit Care Med 2010 Vol. 38, No. 2

Table 3. Complication detection after central venous catheter insertion in 99 patients

Variable	US	CEUS	CEUS + CXR	CXR
Internal jugular vein	4	—	4	4
Intracardiac (atrial) position	20	0	20	24
Inferior vena cava	0	0	0	0
Pneumothorax	4	—	4	2
Vein thrombosis	2	—	2	0

US, ultrasound examination; CEUS, contrast enhanced ultrasound; CXR, chest radiograph.

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

- SC or apical acoustic windows when the SC window was not obtainable
- Direct visualization of superior vena cava (SVC), right atrium (RA) and right ventricle (RV)
- CEUS: 10 mL syringe containing 9 mL of saline solution and 1 mL of air
- Tip misplacement:
 - right atrium or right ventricle (intra-cardiac misplacement);
 - contralateral neck veins;
 - homolateral opposite veins;
 - brachiocephalic veins

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- CXR identified 6 tip misplacements
 - 4 intravascular
 - 2 in the brachiocephalic vein
 - 1 in the SC vein
 - 1 in the IJV
 - 2 in the RA
- CEUS identified only 3 misplacements
 - 1 intravascular
 - 2 intracardiac in the RA

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- CEUS Vs CXR
 - Sensitivity: 33% (95% CI, 0%-71%)
 - Specificity: 98% (95% CI, 95%-100%)
 - Negative predictive value: 94% (95% CI, 89%-100%)
 - Positive predictive value 67% (95% CI, 13%-100%)

CEUS by itself cannot substitute CXR or serve as a triage test.

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Conclusioni



"Ultra-advanced" algorithm

