Trombosi Venosa vs Guaina Fibroblastica

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EcoTIME
Ecografia in Terapia Intensiva e Medicina dell'Emergenza

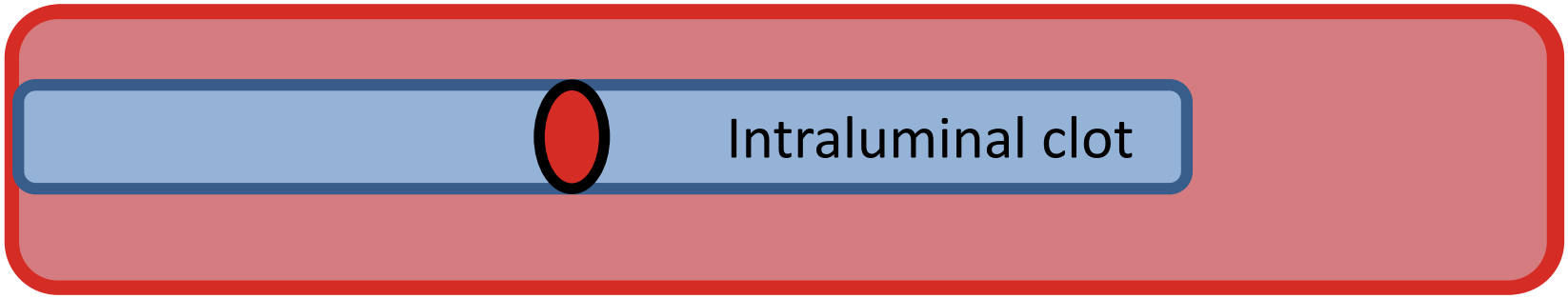
Guaina Fibroblastica

- Non si tratta di un evento trombotico!
  - dunque, non necessita di trattamento anticoagulante
- Tipo di reazione da "corpo estraneo" (catetere)
- Dipende dalla risposta dell'ospite
  - Non vi sono evidenze circa raccomandazioni o materiali in grado di evitarne la formazione
- Rilevanza Clinica
  - *Per lo più innocuo*
  - Stravaso (specie in caso di cateteri corti)
  - *Persistent Withdrawal Occlusion*
  - Colonizzazione batterica e possibile focolaio di batteriemia
  - Riduzione di lume e flusso residuo, possibile fattore di rischio per eventuale trombosi?

Trombosi Catetere-Correlata (CRT)

- Comparsa di un trombo sulla parete vascolare, più frequentemente dove l'endotelio è danneggiato
- Necessita di trattamento
- È ***prevedibile***!
  - Caratterisctihe cliniche innate o acquisite del paziente
- È ***prevenibile***!
  - Corretta scelta di tecniche e materiali, adozione sistematica di bundles per la prevenzione della CRT

Occlusione



Intraluminal clot is not CRT

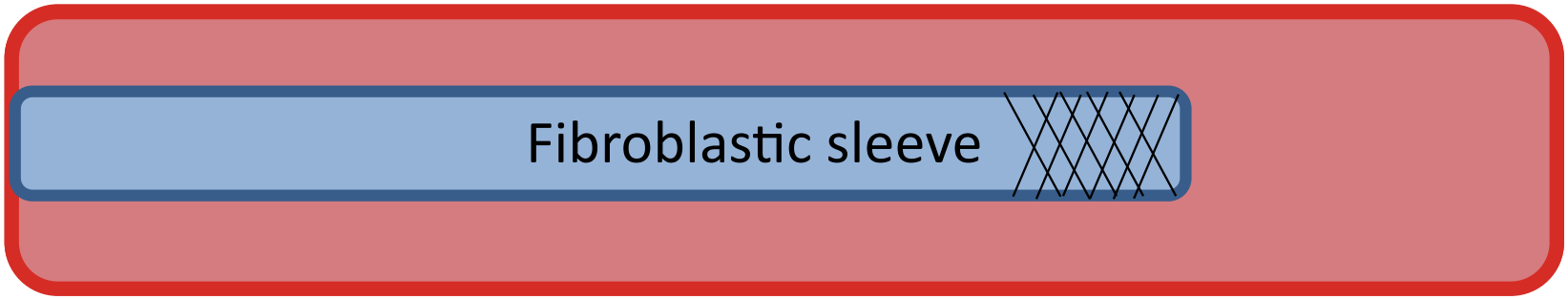
courtesy of Fulvio Pinelli

Baskin et al. Lancet. 2009 July 11; 374(9684): 159

Occlusione

- Reflusso di sangue all'interno del catetere = coagulo ('clot') misto a precipitati di farmaci, biofilm, etc.
- La occlusione intraluminale è un fenomeno potenzialmente prevenibile al 100%
    - Policy adeguata di flush/lock/etc.
- Determina malfunzionamento del catetere
- **Non causa embolia polmonare** ma il materiale occlusivo che va in circolo può causate brividi e/o febbre
- Può favorire la colonizzazione/infezione del catetere
- 'Worst scenario' = perdita del catetere

Guaina Fibroblastica: definizione



Fibroblastic sleeve is not CRT

courtesy of Fulvio Pinelli

Baskin et al. Lancet. 2009 July 11; 374(9684): 159

La guaina fibroblastica: definizione

- Negli ultimi 50 anni molti diversi termini sono stati utilizzati:
  «fibrin sleeve», «fibrin sheath», «catheter sleeve», «catheter-related sheath» , «fibroblastic sleeve», trombosi pericatetere
- Se il termine «sleeve» o «sheath» può essere accettabile (guaina, manicotto, che circonda il catetere), certamente non lo è «fibrin»

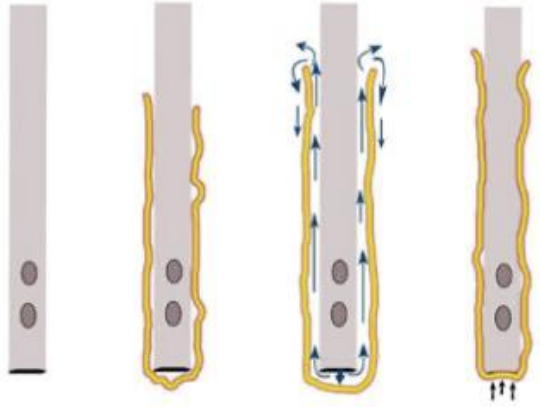
La guaina fibroblastica: istologia

- il materiale della guaina non è "fibrina», ma un tessuto cellulare strutturato, più specificamente un tessuto connettivo, costituito da fibroblasti e rivestito da endotelio;
- anche se la fibrina può inizialmente far parte di questo tessuto, il principale componente non cellulare della guaina matura è il collagene.

Patogenesi della guaina fibroblastica

- Tipo di **reazione da "corpo estraneo"** (catetere) del tessuto sanguigno
- Nella maggior parte dei cateteri che rimangono in posizione per più di 7 giorni
- FS si sviluppa **molto rapidamente**, anche 24 ore dopo l'inserimento del VAD e viene completata entro 2 settimane
- **Ipotesi 1**: superficie esterna del corpo estraneo (cioè il catetere) attira la fibronectina, che attrae macrofagi del sangue. Questi si attaccano al catetere e si differenziano in cellule muscolari lisce, iniziando la produzione di collagene, creando un tessuto connettivo che lentamente circonda il catetere.
- **Ipotesi 2**: il danno endoteliale potrebbe, indurre la proliferazione e la migrazione di fibroblasti e cellule muscolari lisce.

Guaina fibroblastica: rilevanza clinica

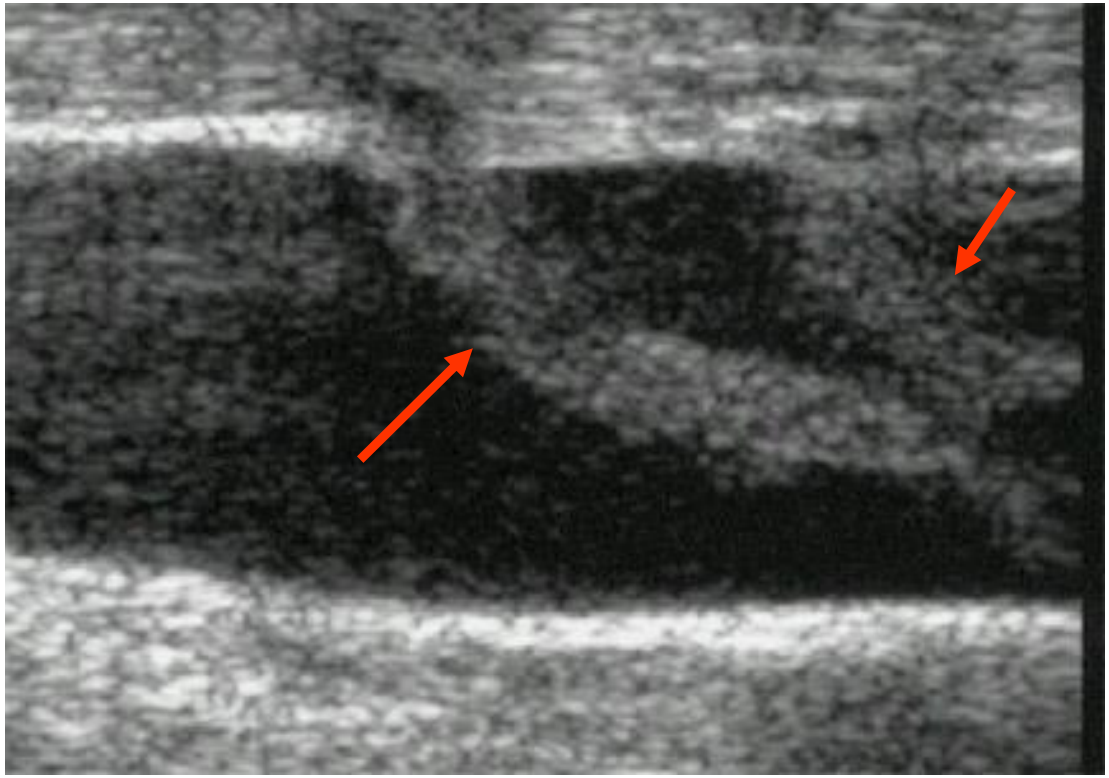


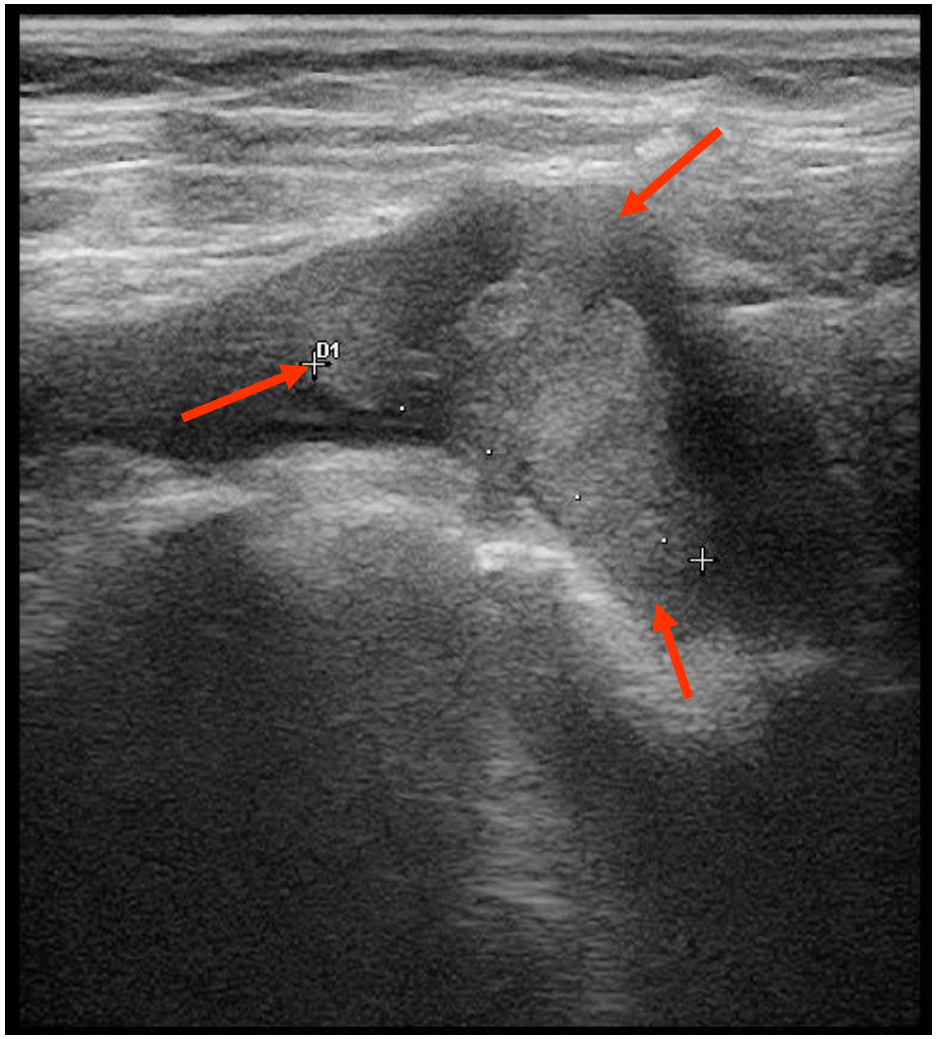
- Incidenza 10-56%
- Solitamente è un fenomeno fisiopatologico innocuo
- Clinicamente rilevante come potenziale motivo di malfunzionamento del VAD
  - impossibilità a prelevare sangue (withdrawal occlusion)
  - impossibilità di infondere
- Stravaso (specie se catetere corto)
  - in corrispondenza del sito di venipuntura
  - lungo il tunnel sottocutaneo
  - nella tasca del reservoir
- Colonizzazione batterica e possibile focolaio di batteriemia
- Riduzione di lume e flusso residuo, possibile fattore di rischio per eventuale trombosi?

Doppio contorno

Stravaso prossimale

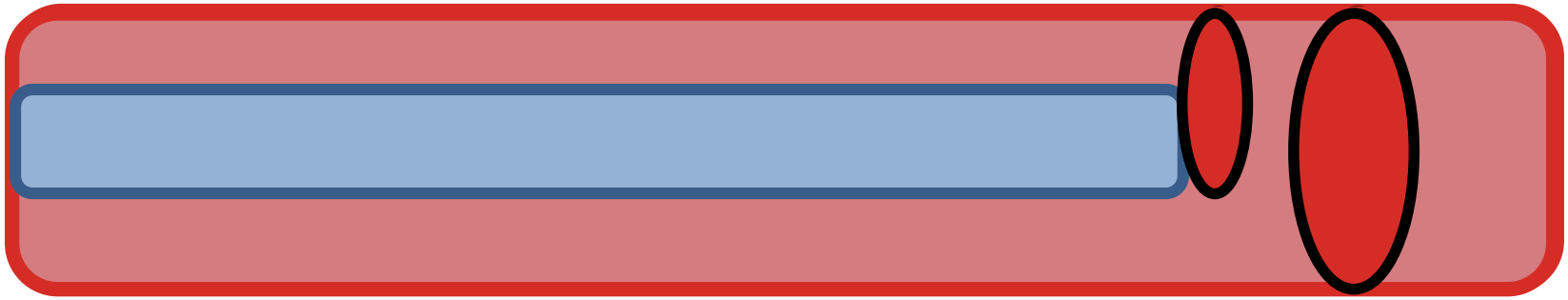
Opacizzazione del vaso tramite fenestratura della guaina





La Guaina Fibroblastica persiste spesso dopo la rimozione del catetere

Trombosi catetere-correlate (CRT): definizione



Mural and venous thrombosis are CRT

courtesy of Fulvio Pinelli

Baskin et al. Lancet. 2009 July 11; 374(9684): 159

Definizione della CRT

Il TROMBO PARIETALE è la tipica espressione della CRT e puo' avere differente estensione e rilevanza clinica

- < 50% del lume – spesso asintomatiche
- > 50% del lume – con o senza circolazione collaterale - sintomatica o non sintomatica
- 100% del lume (trombosi ostruttiva) – usualmente sintomatica

CRT

- La trombosi da catetere vera e propria nasce da un danno endoteliale
  - Nel punto di ingresso del catetere nella vena
  - In punti di frizione del catetere contro la vena
  - Là dove la punta del catetere urta la parete
  - Là dove sostanze vescicanti/irritanti vengono infuse contro la parete
  - ……

‘key points’ per prevenzione CRT

- Ultrasound study of deep veins
  - Catheter/vein ratio → 1/3
- US-guided venipuncture and cannulation
- Microintroducer kit
- Intraprocedural proper tip location
  - IC-EKG for verification of tip position
  - Intra-procedural US controls
- Tunneling
- Securement
  - glue + sutureless device + transparent dressing

Epidemiologia of CRT

Sintomatica: 0-28% (?)

Asintomatica : 12-66% (?)

L'incidenza varia a seconda degli studi dal 5 al 28% per le trombosi sintomatiche, dal 25 al 66% per quelle asintomatiche, per quanto riguarda i CVC in toto *(The Oncologist, 2008)*

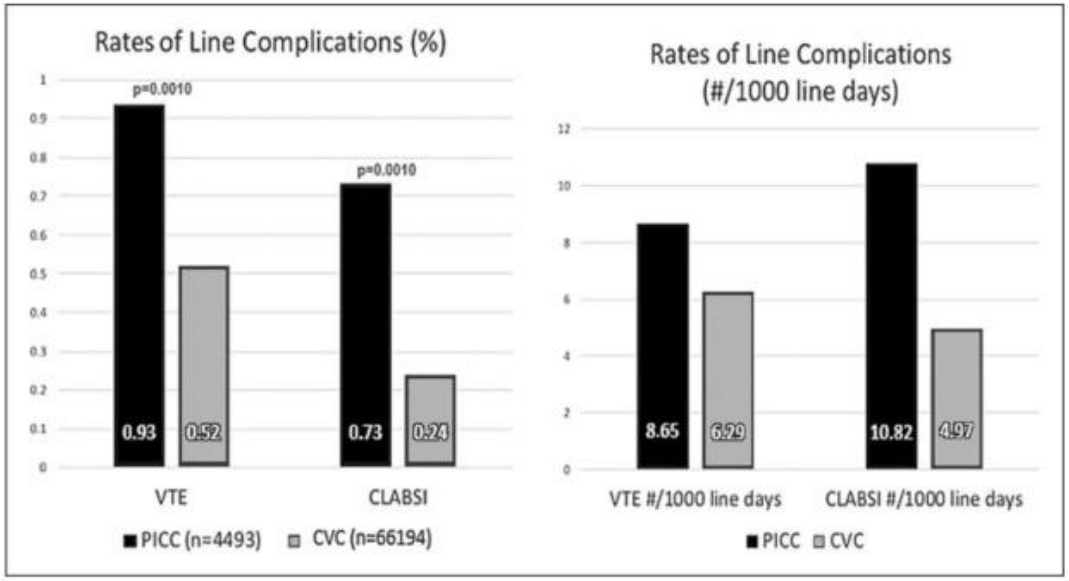
Incidenza

- Varia a seconda:
  - Che si consideri sintomatica vs. asintomatica
  - Del tipo di indagine diagnostica (eco vs. TC vs. flebo)
  - Della tipologia di pazienti
    - Neopl vs. non-neopl
    - Adulti vs. ped.
  - ***Del tipo di VAD considerati***
    - ***CICC vs. PICC vs. port vs. dialisi***
  - **Del protocollo di inserzione !!!**
  - ……

Pediatric Critical Care

Rates of Venous Thromboembolism and Central Line-Associated Bloodstream Infections Among Types of Central Venous Access Devices in Critically Ill Children*

Nital Patel, MD[1]; Tara L. Petersen, MD, MSEd[1]; Pippa M. Simpson, PhD[2]; Mingen Feng, MS[2]; Sheila J. Hanson, MD, MS[1]



Line Characteristics	Total First Lines (n = 74,196)	VTE (n = 410)	No VTE (n = 73,786)	Line Days As Covariate	
				OR (95% CI)	p
Line type, n (%)					
Peripherally inserted central catheter	4,493	42 (0.93)	4,451 (99.07)	Reference	
Central venous catheter	66,194	345 (0.52)	65,849 (99.48)	0.555 (0.402–0.766)	**0.0003**[e]
Hemodialysis/plasmapheresis	1,152	16 (1.39)	1,136 (98.61)	1.493 (0.836–2.665)	0.18
Broviac/Hickman	2,250	7 (0.31)	2,243 (99.69)	0.331 (0.148–0.737)	**0.0068**[e]
Sheath[a]	107	0	107 (100)		
Line days, median (interquartile range)	4 (1.94–7.90)	5.04 (2.56–9.83)	4 (1.94–7.89)	1.011 (1.004–1.018)	**0.0024**[e]
Present at admission, n (%)					
Yes	22,882	33 (0.14)	22,849 (99.86)	0.195 (0.137–0.279)	**< 0.0001**[e]
No	51,314	377 (0.73)	50,937 (99.27)	Reference	
Sidedness, n (%)					
Left	15,113	120 (0.79)	14,993 (99.21)	1.361 (1.086–1.706)	**0.0074**[e]
Midline[b]	15	0	15 (100)		
Right	35,238	206 (0.58)	35,032 (99.42)	Reference	
Missing	23,830				
Geographical location, n (%)					
Field/emergency department	629	7 (1.11)	622 (98.89)	1.401 (0.660–2.973)	0.38
ICU[c]	41,901	334 (0.80)	41,567 (99.20)	Reference	
Non-ICU[d]	31,257	67 (0.21)	31,190 (99.79)	0.267 (0.206–0.348)	**< 0.0001**[e]
Other	409	2 (0.49)	407 (99.51)	0.612 (0.152–2.464)	0.49
Anatomical location, n (%)					
Axillary vein	983	6 (0.61)	977 (99.39)	3.476 (1.489–8.112)	**0.0040**[e]
Femoral vein	28,740	280 (0.97)	28,460 (99.03)	5.568 (4.140–7.490)	**< 0.0001**[e]
Internal jugular vein	29,484	52 (0.18)	29,432 (99.82)	Reference	
Other vein	3,495	26 (0.74)	3,469 (99.26)	4.242 (2.646–6.801)	**< 0.0001**[e]
Saphenous vein	468	6 (1.28)	462 (98.72)	7.351 (3.142–17.199)	**< 0.0001**[e]
Subclavian vein	11,026	40 (0.36)	10,986 (99.64)	2.061 (1.364–3.114)	**0.0006**[e]

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Sintomatica o anche asintomatica?

VAD considerati troppo eterogenei

PICC o anche ECC???

<u>Quale protocollo di inserzione???</u>

.....

Line and Placement Characteristics[a]	Total First Lines[b] (*n* = 71,782)	VTE (*n* = 399)	No VTE (*n* = 71,383)	OR (95% CI)	*p*
Line type, *n* (%)					
Peripherally inserted central catheter	4,305	40 (0.93)	4,265 (99.07)	Reference	
Central venous catheter	64,316	337 (0.52)	63,979 (99.48)	0.569 (0.330–0.982)	**0.043**[e]
Hemodialysis/plasmapheresis	1,098	16 (1.46)	1,082 (98.54)	1.285 (0.620–2.662)	0.50
Broviac/Hickman	2,063	6 (0.29)	2,057 (99.71)	0.501 (0.195–1.289)	0.15
Present at admission, *n* (%)					
Yes	22,464	32 (0.14)	22,432 (99.86)	0.346 (0.215–0.557)	**< 0.0001**[e]
No	49,318	367 (0.74)	48,951 (99.26)	Reference	
Geographical location, *n* (%)					
Field/emergency department	596	7 (1.17)	589 (98.83)	3.355 (1.438–7.831)	**0.0051**[e]
ICU[c]	40,330	325 (0.81)	40,005 (99.19)	Reference	
Non-ICU[d]	30,461	66 (0.22)	30,395 (99.78)	0.732 (0.524–1.023)	0.068
Other	395	1 (0.25)	394 (99.75)	0.628 (0.086–4.559)	0.65
Anatomical location, *n* (%)					
Axillary vein	967	6 (0.62)	961 (99.38)	1.546 (0.577–4.141)	0.39
Femoral vein	27,545	274 (0.99)	27,271 (99.01)	3.931 (2.876–5.372)	**< 0.0001**[e]
Internal jugular vein	28,854	50 (0.17)	28,804 (99.83)	Reference	
Other vein	3,285	24 (0.73)	3,261 (99.27)	2.014 (1.035–3.917)	**0.039**[e]
Saphenous vein	453	6 (1.32)	447 (98.68)	3.630 (1.369–9.626)	**0.0096**[e]
Subclavian vein	10,678	39 (0.37)	10,639 (99.63)	1.744 (1.141–2.668)	**0.010**[e]
Freestanding children's hospital, *n* (%)					
Yes	44,272	222 (0.50)	44,050 (99.50)	0.728 (0.597–0.890)	**0.0019**[e]
No	27,510	177 (0.64)	27,333 (99.36)	Reference	

CRT

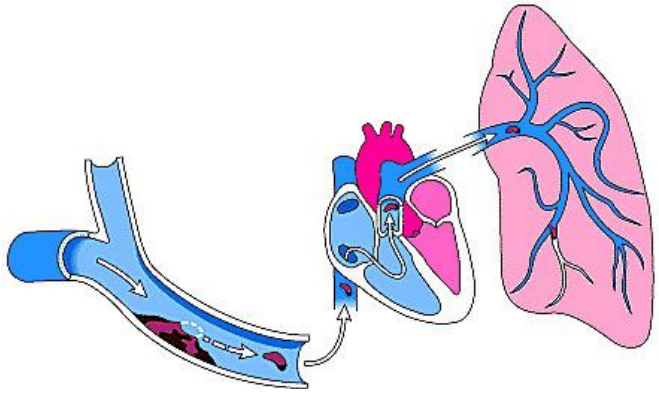
CRT sintomatica

edema o dolore arto/collo/testa

cefalea

parestesie/eritema delle estremità

turgore venoso, dolore mandibolare



Mediana gg tra inserzione CVC e trombosi :

16 – 23 gg

Classificazione della CRT

A seconda dell'estensione del trombo nella vena:

Trombosi murale (non-ostruttiva)

- Asintomatica o sintomatica or symptomatic
- Con o senza circoli collaterali

Trombosi completa (ostruttiva)

- Piu frequentemente sintomatica
- Con circoli collaterali

Classificazione della CRT

Secondo la localizzazione del trombo :

- Trombosi arto superiore (PICCs)
  - basilica, brachiael, cefalica, ascellare
- Trombosi centrale (PICCs and CICCs)
  - Ascellare, succlavia, giugulare, brachiocefalica, SVC
- Trombosi arti inferiori (FICCs)
  - Femorale, iliaca, IVC

Classificazione della CRT

Secondo al presunta patogenesi:

- CRT dovuta al danno endoteliale nel sito di venipuntura (danno meccanico)
  - tipicamente associata con una impianto traumatico
- CRT dovuta a un danno endoteliale alla punta del catetere (lesione meccanica/o chimica)
  - Tipicamente associata a una malposizione della punta

CRT da agocannula/midline

- Patogenesi multipla, sempre iatrogena
  - Frizione del catetere contro l'endotelio
    - Inappropriata stabilizzazione
  - Trauma del catetere all'ingresso nella vena
    - Tentativi ripetuti
    - Mancato uso dell'ecografo
  - Farmaci irritanti sull'endotelio
    - Uso inappropriato della via periferica
  - Diametro del catetere eccessivo rispetto al diametro della vena
    - Scelta di catetere troppo grosso

CRT da cateteri centrali (CICC, PICC, etc,)

- Patogenesi multipla, spesso iatrogena
  - Frizione del catetere contro l'endotelio
    - Inappropriata stabilizzazione
  - Trauma del catetere all'ingresso nella vena
    - Tentativi ripetuti
    - Mancato uso dell'ecografo
  - Trauma della punta
    - Malposizione
  - Diametro del catetere eccessivo rispetto al diametro della vena
    - Scelta di catetere troppo grosso

FATTORI DI RISCHIO

REVIEW ARTICLE

J Clin Oncol 21:3665-3675. © 2003 by American Society of Clinical Oncology.

Venous Thromboembolism Associated With Long-Term Use of Central Venous Catheters in Cancer Patients

By Melina Verso and Giancarlo Agnelli

Table 4. Risk Factors for Development of CVC-Related DVT

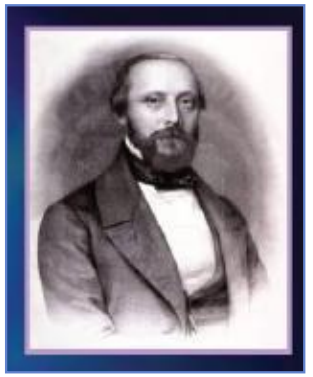
CVC Features	Patient Features
Chemical structure[94]	High platelet count[33]
Catheter diameter[57]	Cancer-related activation of coagulation cascade[109]
Numbers of lumens[42]	CVC-related activation of coagulation cascade[108]
Catheter tip positions[48,57,92,95,96,97]	Chemotherapy-related activation of coagulation cascade[110]
Side of insertion[37,80,95,100] **(Left thoracic, femoral)**	Thrombophilic molecular abnormalities[64,81,112-114] **(Deficit antitrombina III, fattore V Leiden)**
Insertion techniques[32,35,49,101-104]	
Previous CVC insertion[105]	
CVC-related infections[12,106-107]	

Abbreviations: CVC, central venous catheter; DVT, deep venous thrombosis.

CONFERENCE REPORTS AND EXPERT PANEL

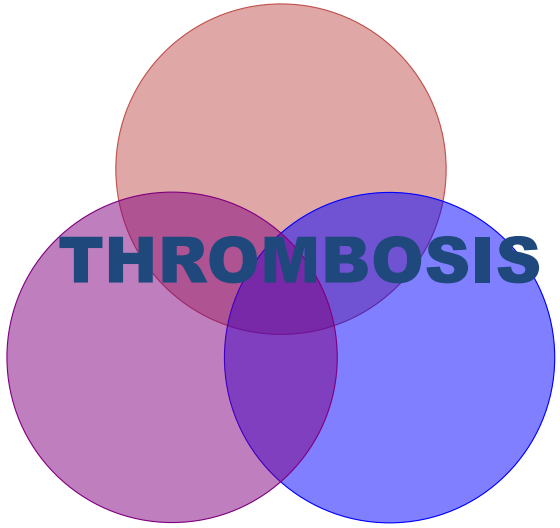
International evidence-based recommendations on ultrasound-guided vascular access

ICM 2012



Rudolph Virchow
1821 - 1902

HYPERCOAGULABILITY



VESSEL TRAUMA

VENOUS STASIS

Fattori di rischio

- Il paziente
- Patologia di base e comorbidità
- Tecnica di impianto
- Nursing e stabilizzazione del VAD
- VAD: materiali

Il paziente

- Trombofilia
  - ipercoagulabilità
- Ventilazione Meccanica
  - Stasi venosa
- Cardiopatie congenite con insufficienza cardiaca
  - Stasi venosa
- Paresi o plegie
  - Stasi venosa
- Immobilizzazione o allettamento
  - Stasi venosa

Patologia di base e comorbidità

- Trombosi paraneoplastica

- Comorbidità che determinano stasi venosa o altri stati di ipercoagulabilità

Tecnica d’Impianto

- Appropriata scelta della vena
- Tecnica di venipuntura appropriata
- Verifica della corretta posizione della punta
- Fissaggio e stabilizzazione appropriate

Appropriata scelta della vena

- Facilità di puntura
- Evitare vene già trombizzate o tributarie di vene trombizzate
- Catheter-vein ratio
- Exit site
- In caso di PICC evitare arti con plegie/paresi o immobilizzati per traumi/fratture

Key point

Check the diameter of the vein !

CHEST

Original Research

CRITICAL CARE

The Effect of Catheter to Vein Ratio on Blood Flow Rates in a Simulated Model of Peripherally Inserted Central Venous Catheters

Thomas P. Ntfong, MD; and Timothy J. McDevitt, PhD

Venous Catheters

Thomas P. Ntfong, MD; and Timothy J. McDevitt, PhD

Venous stasis

Catheter size relative to vein size

Vein	Initial Flow	2 Fr		4 Fr		6 Fr		8 Fr	
Cephalic (4 mm)	10	5	48%	3	28%	1.5	14%	0.5	0.5%
Brachial (5 mm)	25	13	53%	9	36%	6	22%	3	12%
Basilic (6 mm)	52	29	56%	21	41%	15	28%	9	18%
Axillary (8 mm)	164	100	61%	79	48%	62	38%	47	28%
Subclavian (10 mm)	400	256	64%	212	53%	175	44%	143	36%

Nifong TP & McDevitt T. CHEST Published online before print February 24, 2011

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

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International evidence-based recommendations on ultrasound-guided vascular access

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.

JVA
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J Vasc Access 2014; 00 (00): 000-000
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ORIGINAL ARTICLE

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

Alessandro Crocoli[1], Assunta Tornesello[2], Mauro Pittiruti[3], Angelica Barone[4], Paola Muggeo[5], Alessandro Inserra[1], Angelo Claudio Molinari[6], Valeria Grillenzoni[7], Viviana Durante[8], Maria Pia Cicalese[9], Giulio Andrea Zanazzo[10], Simone Cesaro[7]

Intensive Care Med
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International evidence-based recommendations on ultrasound-guided vascular access

- Catheter/Vein Ratio → 33% (1/3)

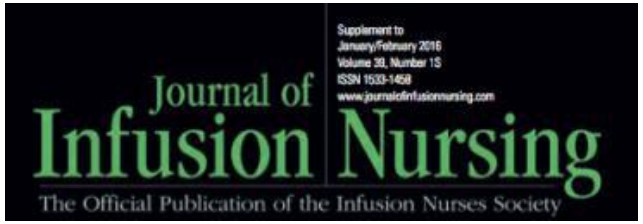
8TH EDITION

REVISED 2021

INFUSION NURSES SOCIETY

SETTING THE STANDARD FOR INFUSION CARE®

- Catheter/Vein Ratio → 45% (1/2)



EJA

Eur J Anaesthesiol 2020; **37**:344–376

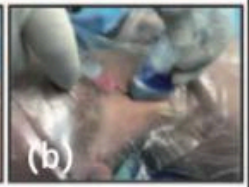
GUIDELINES

European Society of Anaesthesiology guidelines on peri-operative use of ultrasound-guided for vascular access (PERSEUS vascular access)

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

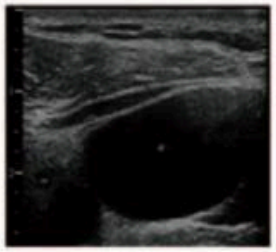
III. Use real-time US guidance for puncture of the vein

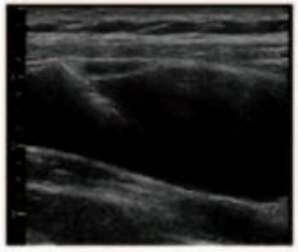
- Use an aseptic approach
- Use a short axis/out-of-plane (A) or a long axis/in-plane (B) approach
- Try to the tip of the needle during the needle approach to the vein and puncture of the vein



IV. Confirm needle position in vein

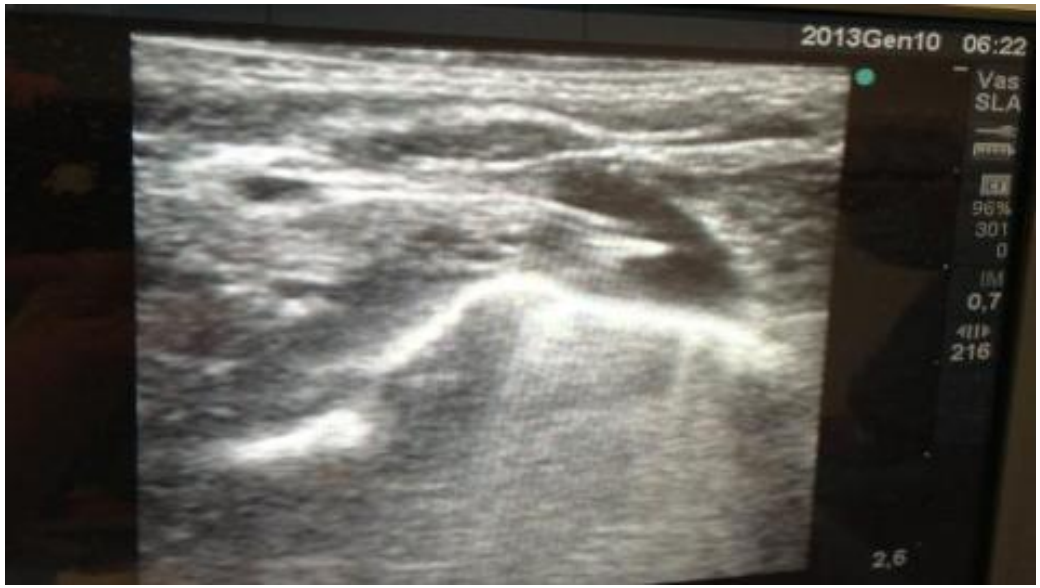
- Confirm that the needle tip is placed centrally in the vein before the guide wire





Needle

US guided venipuncture



Always keep an eye
on the tip of the needle

Use ultrasound

"… adoption of ultrasound guidance may have a significant favourable impact on the risk of catheter contamination and catheter related infection and on the risk of catheter related venous thrombosis"

(from SOR guidelines, 2008)

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

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International evidence-based recommendations on ultrasound-guided vascular access

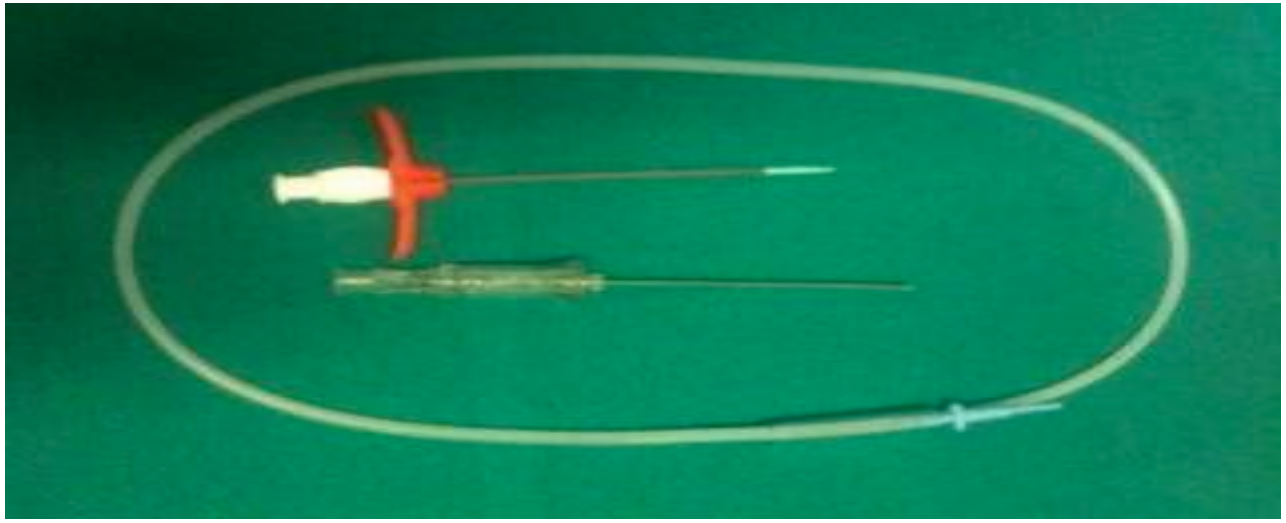
Use ultrasound !

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

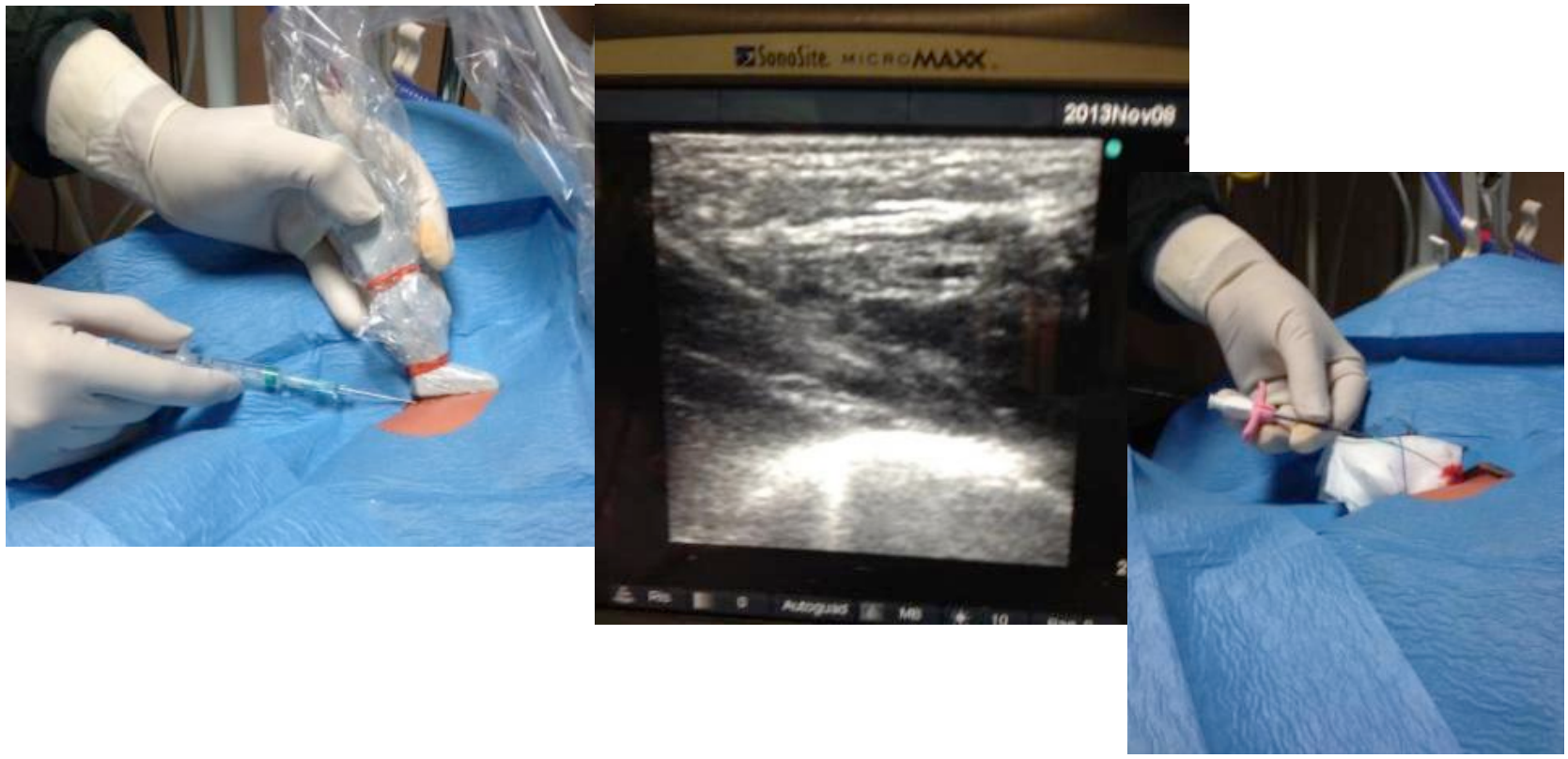
Domain code	Suggested definition	Level of evidence	Degree of consensus	Strength of recommendation
Sterility during ultrasound vascular procedures				
D8.S1	Sterile techniques should always be used during the placement of a vascular access device, including hand washing; sterile full body drapes; wearing 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	A multi-faceted strategy, including the use of 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

Kits for micro-introduction :

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



US-guided venipuncture + micro-introducer technique

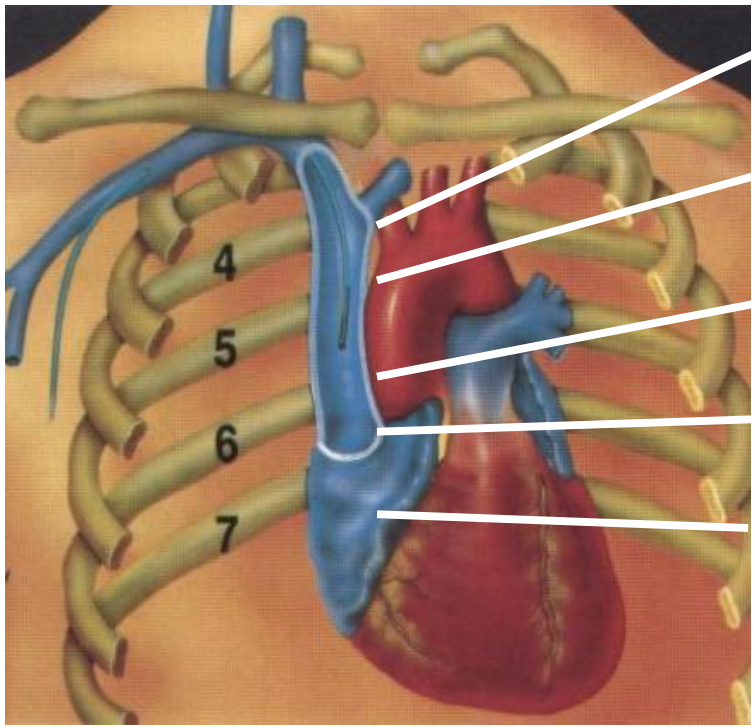


Support Care Cancer (2005) 13:325–331
DOI 10.1007/s00520-004-0723-1

ORIGINAL ARTICLE

Jo Caers
Christel Fontaine
Vincent Vinh-Hung
Johan De Mey
Gerrit Ponnet

Catheter tip position as a risk factor for thrombosis associated with the use of subcutaneous infusion ports



45.2 %

19 %

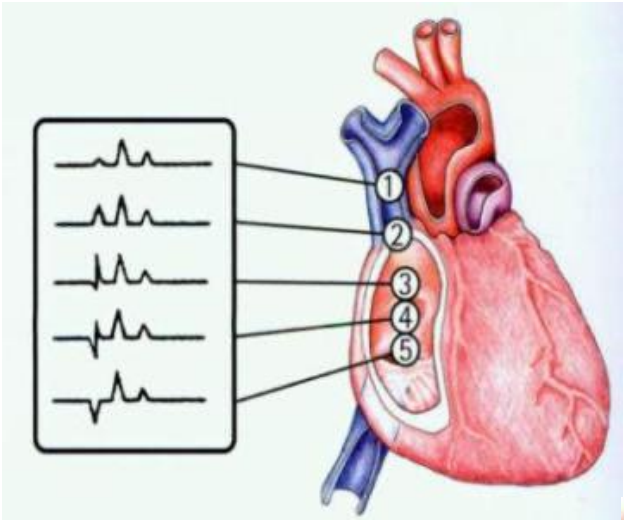
4.2 %

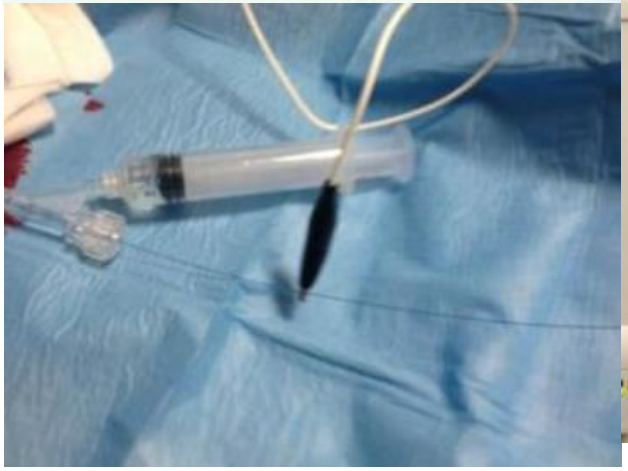
1.5 %

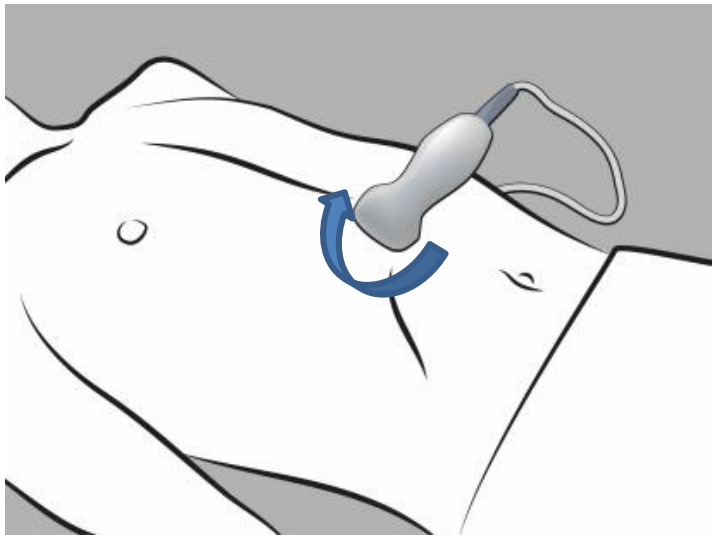
5.6 %

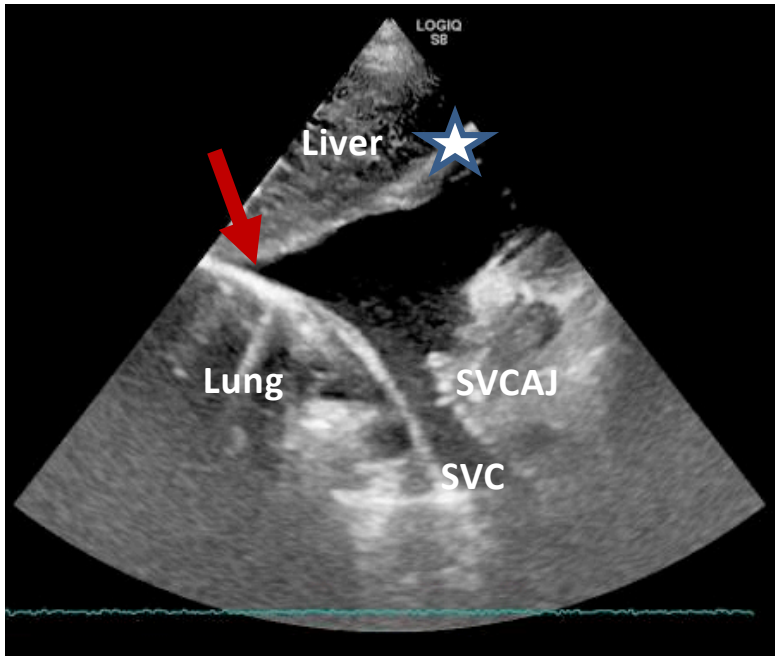
Petersen Am J Surg 1999
Luciani, Radiology 2001
Puel, Cancer 2003
Melina Verso, J Clin Oncol 2003
Caers, Support Care Cancer 2005

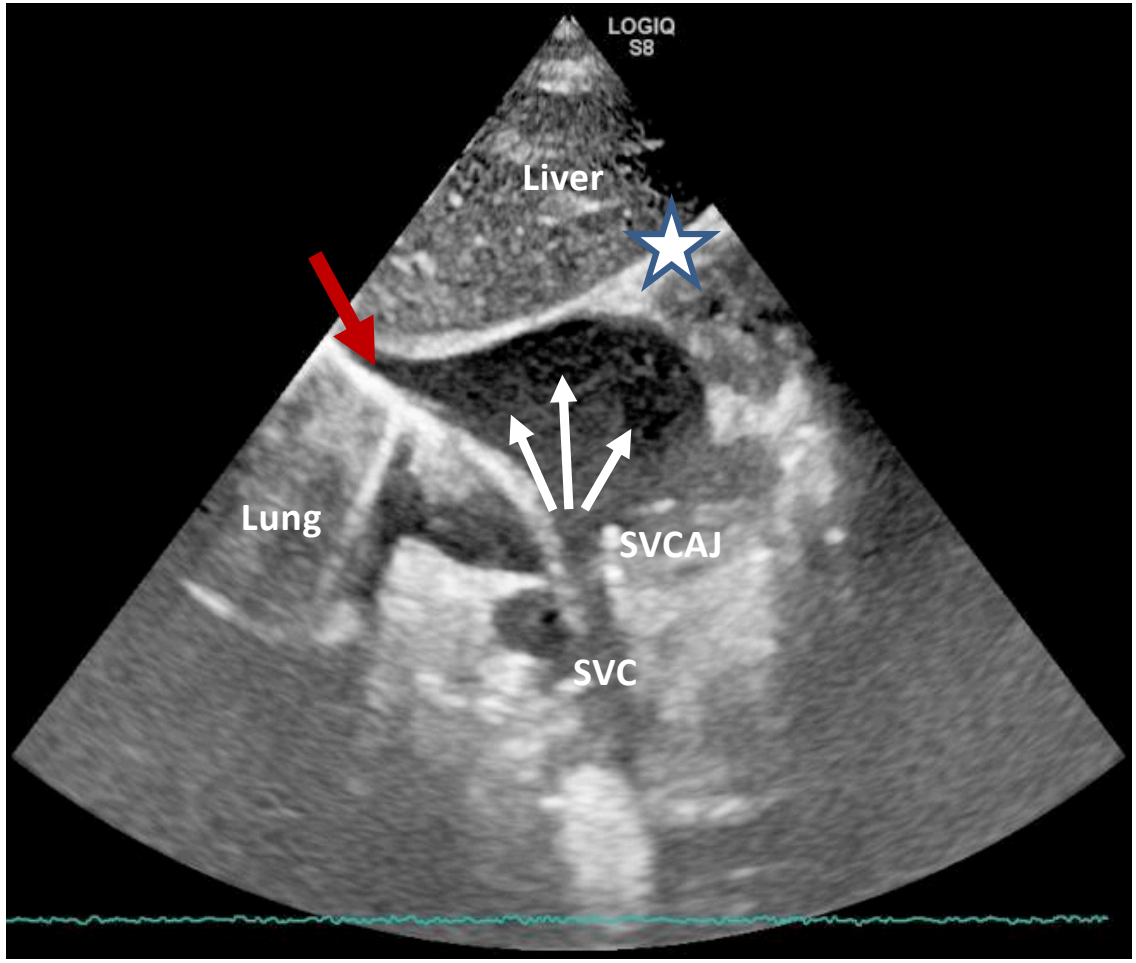
Intracavitary EKG !








LOGIQ
S8
Liver
Lung
SVCAJ
SVC


LOGIQ
S8
Liver
Lung
SVCAJ
SVC

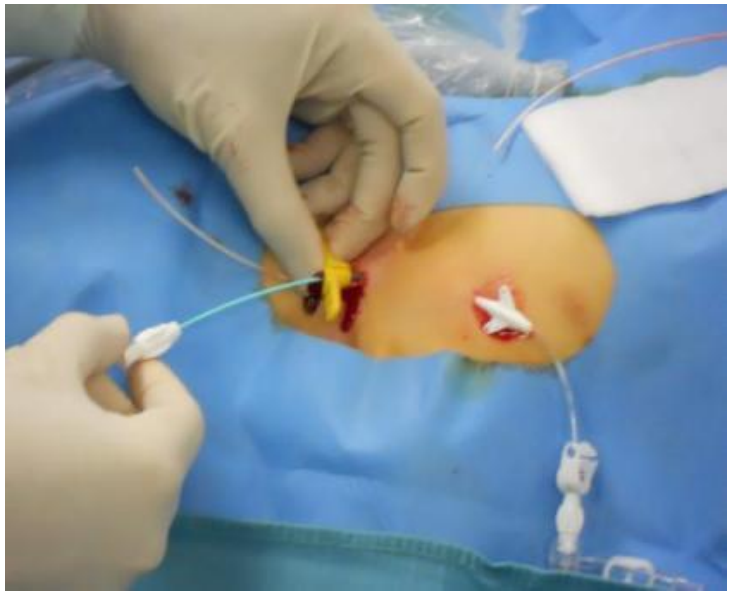
Proper securement = multimodal

1. Proper choice of the exit site
2. Glue at the exit site
3. Sutureless device
    - Adhesive to skin
    - Anchored subcutaneously
4. Transparent dressing

Exit Site....!

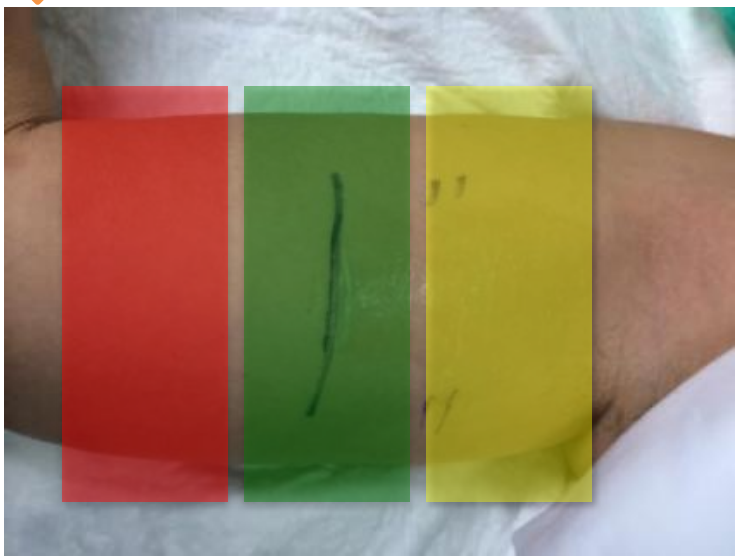
Please, avoid exit site at the neck ....!


SIEMENS




PED
DimAir

Dawson's Zone Insertion Method



- Evitare la zona rossa
- Se si è scelta la zona gialla è necessario tunnellizzare

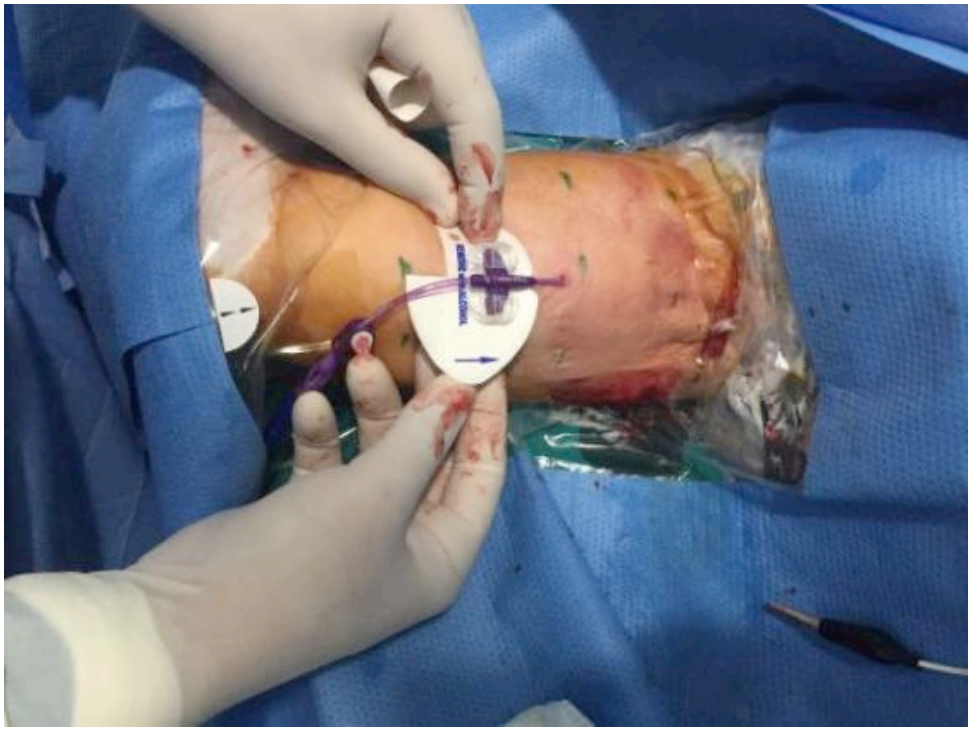
Zona Rossa

Zona Verde – Zona Ideale

Glue !!!!

Sutureless devices

- Skin adhesion



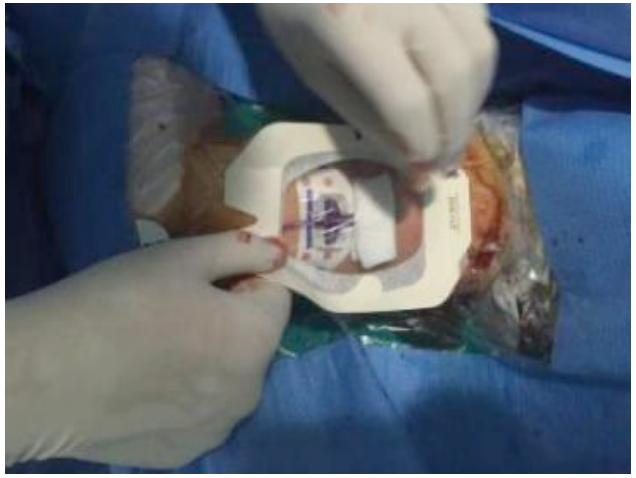
Sutureless devices

- Anchored subcutaneously

Transparent dressing

- Transparent dressings are to be preferred not only because protective against bacterial contamination, but also because of the catheter securement they offer

  (see EPIC guidelines 2014)



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

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevierhealth.com/journals/jhin

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]

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

Daniele G. Biasucci[1], Mauro Pittiruti[2], Alessandra Taddei[3], Enzo Picconi[1], Alessandro Pizza[1], Davide Celentano[1], Marco Piastra[1], Giancarlo Scoppettuolo[4], Giorgio Conti[1]

Insertion and maintenance bundle

1. Hand washing and maximal barrier precautions
2. Skin antisepsis 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 semipermeable 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

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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%)

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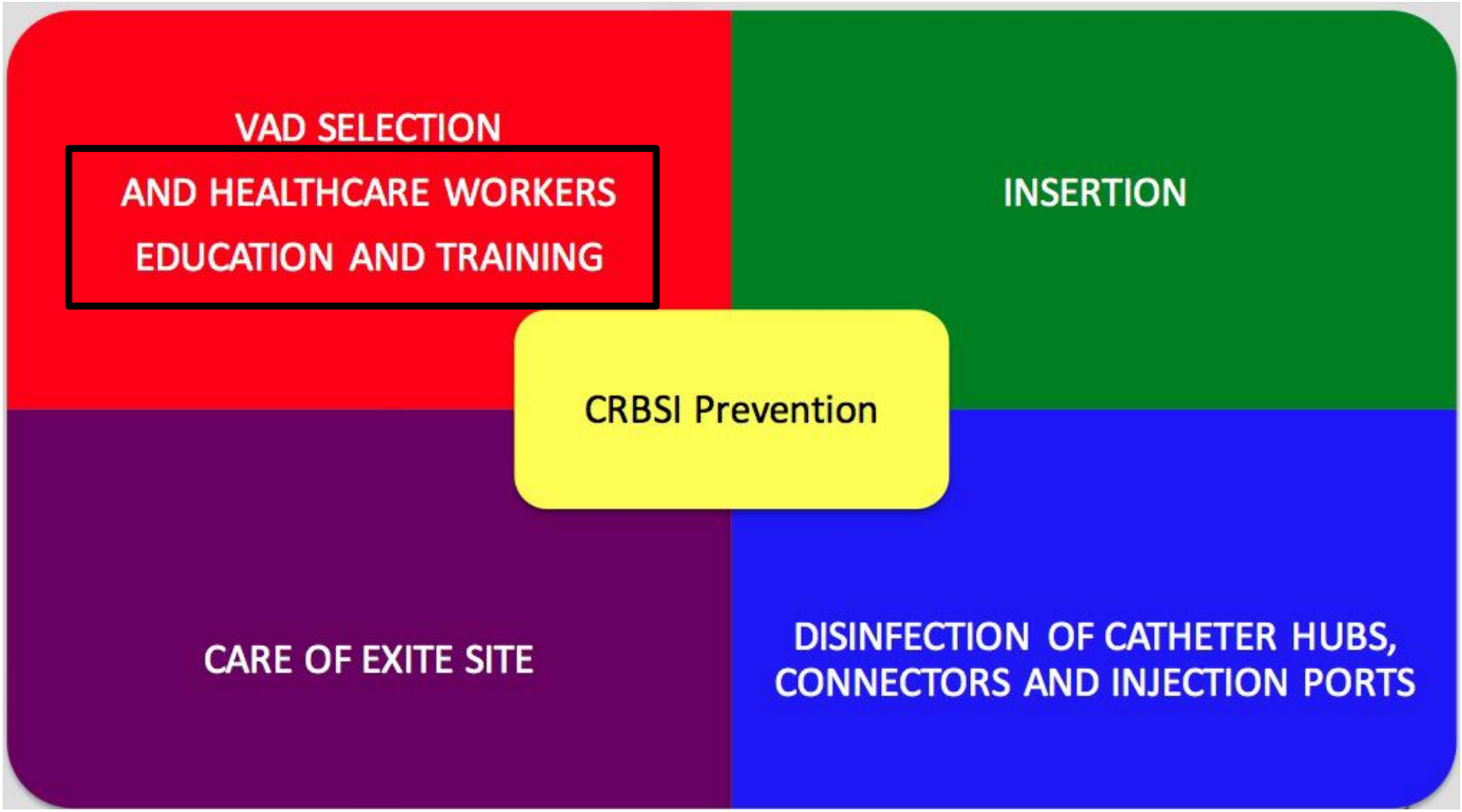
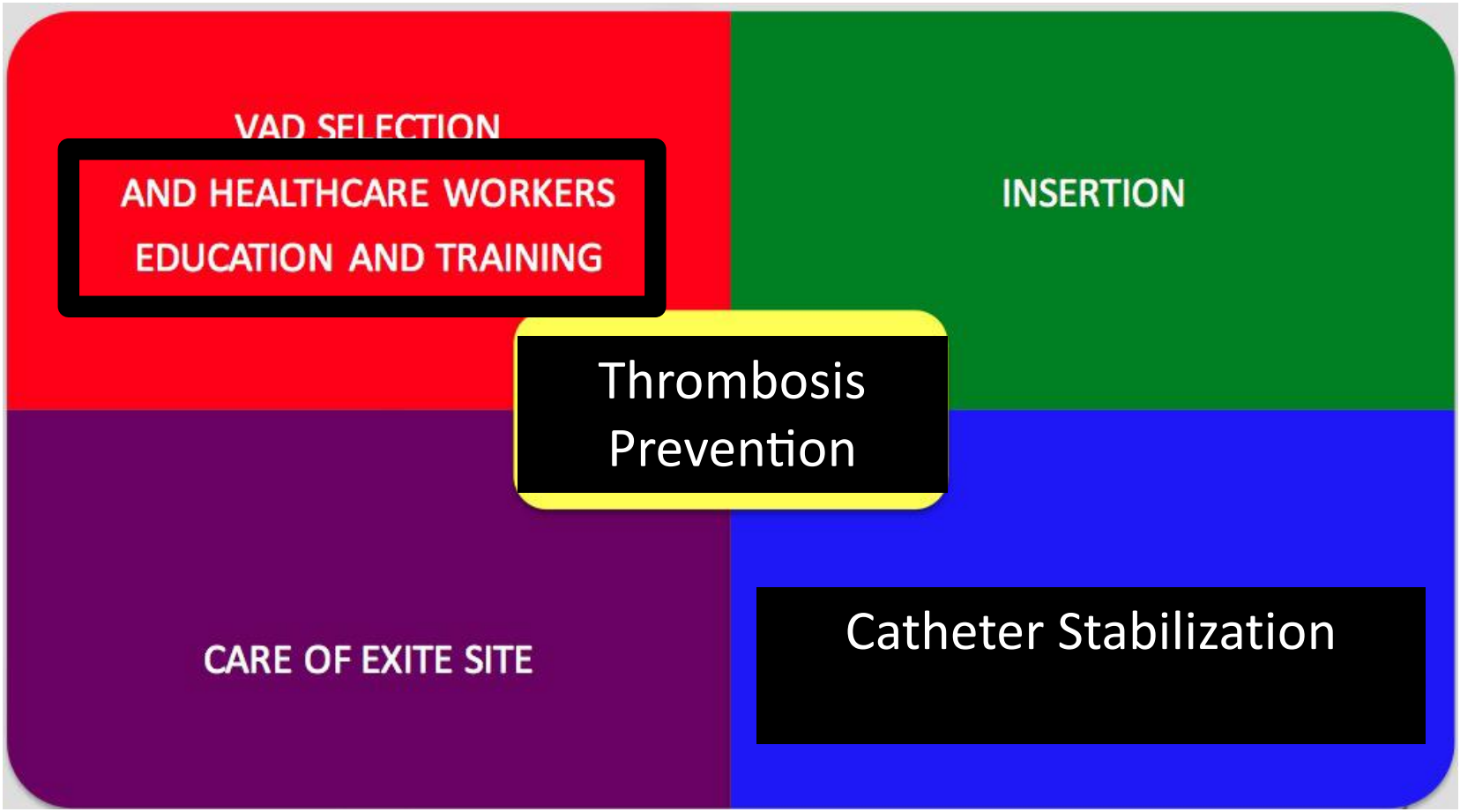
		Cases	Controls
Indwelling time (d)	Total	648	503
	Mean (±SD)	9.7 ± 3.1	7.5 ± 3.5
CR-BSI	No	1	8
	per 1000 catheter days	1.5	15
CR-DVT	No	0	1
Accidental dislodgements	No	0	3

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


VAD SELECTION
AND HEALTHCARE WORKERS
EDUCATION AND TRAINING
INSERTION
CRBSI Prevention
CARE OF EXITE SITE
DISINFECTION OF CATHETER HUBS,
CONNECTORS AND INJECTION PORTS


VAD SELECTION
AND HEALTHCARE WORKERS
EDUCATION AND TRAINING
INSERTION
Thrombosis
Prevention
CARE OF EXITE SITE
Catheter Stabilization

THE BIOFLO TECHNOLOGY

The BioFlo technology's thromboresistant character is achieved by intimately combining the Endexo polymer with the base Carbothane polymer via thermoplastic extrusion processes. Unlike coatings that are superficial and impregnated agents that are transient, the BioFlo technology is an integral, non-eluting polymer technology that imparts thromboresistant properties to the indwelling catheter (Figure 2).

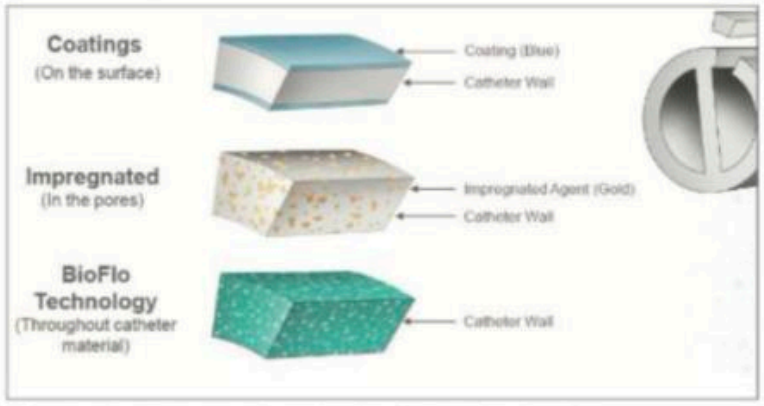


Figure 2. Comparison of BioFlo to Other Technologies

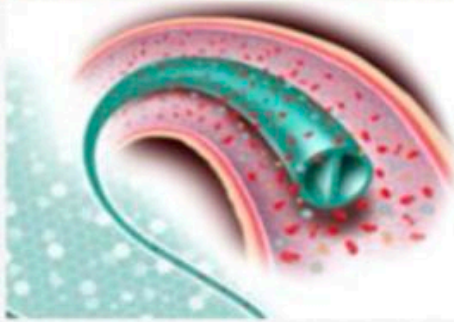
'…resistant to the accumulation of blood components…'

'….less thrombus accumulation on its surface…'

?

FEATURES

BioFlo Endexo Technology



BENEFITS

- Provides a catheter material that is more resistant to the accumulation of blood components. In-vitro studies show an 87% reduction in thrombus accumulation on catheter surfaces, when compared to other commonly-used PICCs, reducing the risk of thrombosis and Occlusion.
- Unlike other technologies that are superficial and/or transient, like coatings and or impregnations, the BioFlo material is designed to be both integral and non-eluting.

Effect of treated PUR ?

- PICC with endexo-treatment – reduction in CRT ?
  - Kleidon 2018 (3% vs 7%) - pediatrics
- PICC with CHG-treatment – no effect on CRT
  - Storey 2016 (1.3% vs 2.2%)
- PICC with CHG-treatment – reduction of fibroblastic sleeve?
  - Sylvia 2018 (experimental study)

J Hosp Med. 2018 Aug 1;13(8):517-525. doi: 10.12788/jhm.2911. Epub 2018 Feb 8.

How Does Your PICCOMPARE? A Pilot Randomized Controlled Trial Comparing Various PICC Materials in Pediatrics.

Kleidon T[1,2], Ullman AJ[2,3], Zhang L[2], Mihala G[2,4,5], Chaseling B[6,7], Schoutrop J[6,7], Rickard CM[2,3].

Author information

2018

Abstract

BACKGROUND: Despite the popularity of peripherally inserted central catheters (PICCs), recent literature highlights their potential injurious complications. Innovative PICC materials have been developed to prevent thrombosis and infection formation (Endexo®) and antireflux valves to prevent occlusion (pressure-activated safety valve®). No large randomized controlled trial has assessed these technologies. Our primary aim was to evaluate the feasibility of a large randomized controlled efficacy trial of PICC materials and design to reduce PICC complication in pediatrics.

METHODS: A randomized controlled feasibility trial was undertaken at the Lady Cilento Children's Hospital in South Brisbane, Australia, between March 2016 and November 2016. Consecutive recruitment of 150 pediatric participants were randomly assigned to receive either (1) polyurethane PICC with a clamp or (2) BioFlo® PICC (AngioDynamics Inc, Queensbury, NY). Primary outcomes were trial feasibility, including PICC failure (thrombosis, occlusion, infection, breakage, or dislodgement). Secondary outcomes were PICC complications during use.

RESULTS: Protocol feasibility was established, including staff and patient acceptability, timely recruitment, no missing primary outcome data, and 0% attrition. PICC failure was 22% (16 of 74, standard care) and 11% (8 of 72, BioFlo®) corresponding to 12.6 and 7.3 failures per 1000 hours (risk ratio 0.58; 95% confidence interval, 0.21-1.43; P = .172). PICC failures were primarily due to thrombosis (standard care 7% versus BioFlo® 3%) and complete occlusion (standard care 7% versus BioFlo® 1%). No blood stream infections occurred. Significantly fewer patients with BioFlo® had PICC complications during use (15% vs 34%; P = .009).

CONCLUSIONS: BioFlo® PICCs appear potentially safer for pediatrics than traditional standard care PICCs with a clamp. Further research is required to definitively identify clinical, cost-effective methods to prevent PICC failure and improve reliability.

PMID: 29649341 DOI: 10.12788/jhm.2911

Clinical randomized study
Non-valved PUR vs. Valved Endexo PUR (?)
Apparent effect on both occlusion and thombosis
CRT: 7% vs. 3% (?)

CRT e guaina fibroblastica diagnosi e diagnosi differenziale

- CT scan
- Venografia
- Eco-color Doppler

EJA

Eur J Anaesthesiol 2020; **37**:344–376

GUIDELINES

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

Grade of Recommendation	Clarity of risk/benefit
1A. Strong recommendation, high quality evidence	Benefits clearly outweigh risk and burdens, or vice versa.
1B. Strong recommendation, moderate quality evidence	Benefits clearly outweigh risk and burdens, or vice versa.
1C. Strong recommendation, low quality evidence	Benefits appear to outweigh risk and burdens, or vice versa.
2A. Weak recommendation, high quality evidence	Benefits closely balanced with risks and burdens.
2B. Weak recommendation, moderate quality evidence	Benefits closely balanced with risks and burdens, some uncertainly in the estimates of benefits, risks and burdens.
2C. Weak recommendation, low quality evidence	Uncertainty in the estimates of benefits, risks, and burdens; benefits may be closely balanced with risks and burdens.

Should ultrasound be used for verification of immediate postprocedural life-threatening complications after central venous catheterisation?

Recommendations

(1) The quality of evidence on which to base recommendations is generally weak, with prospective cohort studies with a high degree of heterogeneity.

(2) We recommend performing PLUS to rule out potential pleural-pulmonary complications (mainly pneumothorax) soon after the procedure in any difficult puncture of the subclavian or axillary vein and, particularly, if the patient complains of shortness of breath or discomfort that worsens after catheter placement **(1B).**

(3) We recommend using PLUS to monitor the development of a confirmed pleural-pulmonary complication or for follow-up of treatment **(1B).**

(4) We recommend ultrasound for diagnosis and follow-up of catheter-related thrombosis **(1C).**

Sonda Lineare

Caratteristiche anatomiche delle vene

- Prossimali e distali rispetto al cuore e non al senso del flusso sanguigno, sopra e sotto la linea articolare del ginocchio
- Superficiali e profonde (al di sotto o al di sopra della fascia muscolare)
- Diametro (in genere è leggermente maggiore rispetto alla arteria adiacente; se è assai maggiore sospettare una trombosi!)

✓ scompenso cardiaco congestizio
✓ reflusso da incontinenza valvolare
✓ ostruzione venosa prossimale al tratto esaminato

Importante la variazione del flusso con le inspirazioni profonde o con la manovra di Valsalva

Diagnosi ecografica di CRT

La diagnosi ecografica di TVP si basa principalmente sulla **mancata compressione della vena.**

1. **CUS (Compression UltraSonography)**

- ✓ **CUS semplice (sCUS):** compressione diretta della vena punta per l'inserzione del catetere
- ✓ **CUS completa (cCUS):** compressione anche delle vene prossimali e distali per valutare l'eventuale estensione del trombo

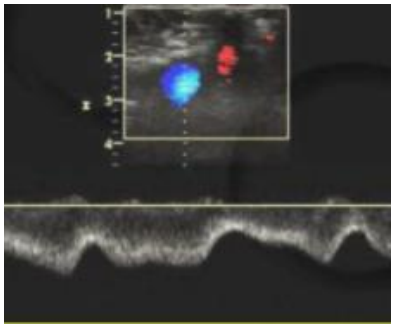
Diagnosi ecografica di CRT

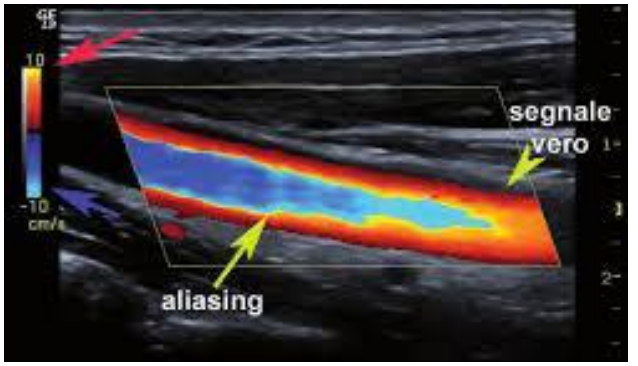
2. Studio completo EcocolorDoppler

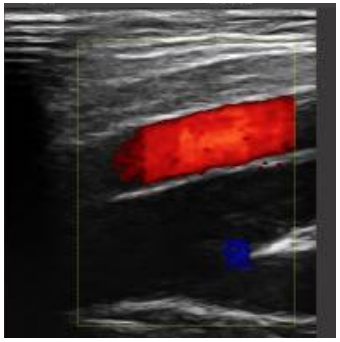
Studio morfologico e funzionale sistematico delle vene iliache e degli arti inferiori, in cui il **color** e il **doppler pulsato** forniscono ulteriori preziose informazioni, riguardanti particolarmente la valutazione del flusso (test standard di riferimento in caso di sospetto clinico

Caratteristiche del flusso sanguigno nelle vene

1. **E’ spontaneo:** normalmente presente nelle vene
2. **E’ fasico:** la velocità si modifica con gli atti del respiro (aumenta di intensità durante la espirazione e si riduce durante la inspirazione, per aumento della pressione intraddominale)
3. **Si arresta con la manovra di Valsalva:** essa aumenta bruscamente le pressioni intratoraciche; se il flusso nelle vene si arresta il sistema è pervio
4. **Aumenta con la compressione dei distretti a monte**
5. **E’ unidirezionale:** per la presenza delle valvole il sangue va dalla periferia al centro; il movimento in senso opposto spontaneo o indotto da compressione prossimale o da manovra di Valsalva è indice di incontinenza valvolare



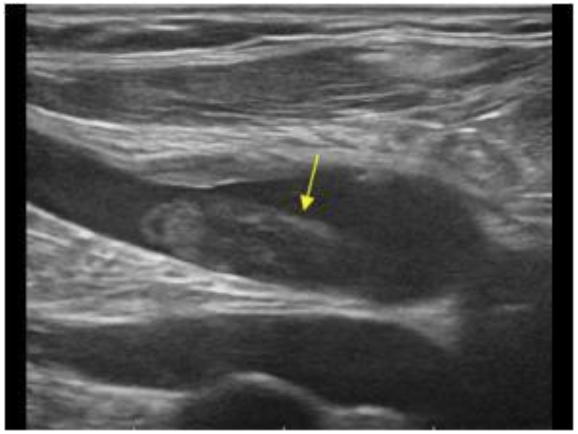


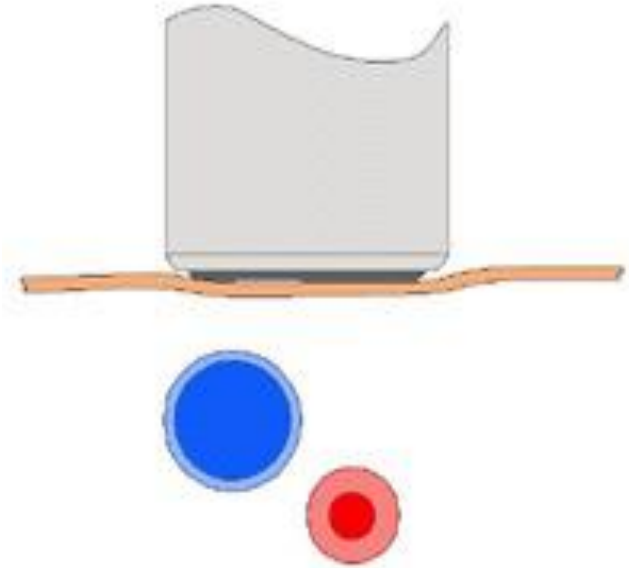


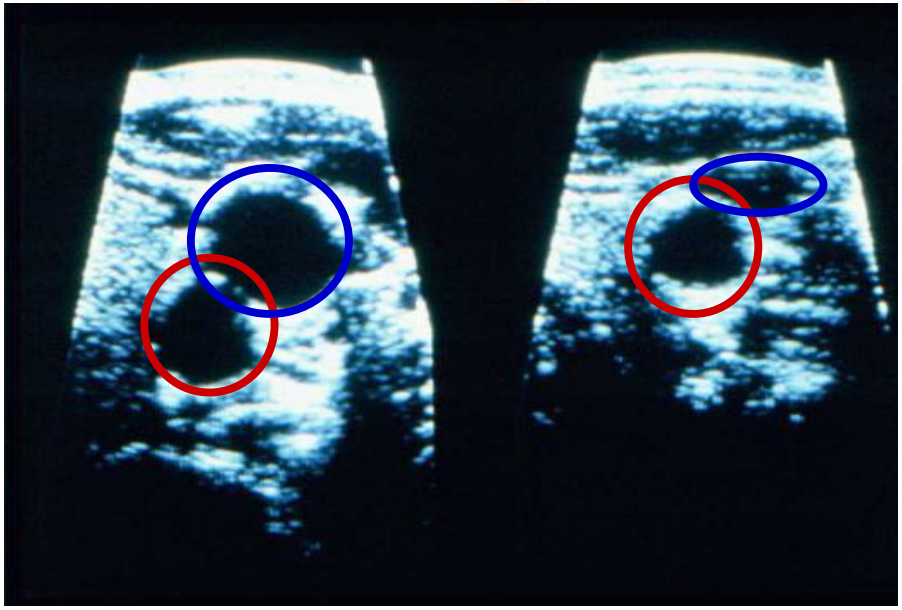
Diagnosi Ecografica di CRT

Criteri diretti

- visualizzazione del trombo
  - massa anecogena, poi ipoecogena;
- vena non comprimibile alla Compression Ultrasound (CUS);
- occupazione parziale o totale del lume.



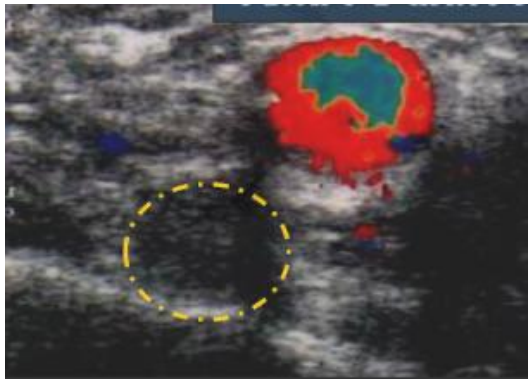




CUS (Compression UltraSonography)

Età della trombosi: il trombo 'fresco' genera echi molto deboli, è quasi completamente ecoprivo o debolmente iperecogeno.

Con il passare del tempo l'ecogenicità aumenta, anche se è difficile stabilire l'esatta età del trombo.



Trombo fresco

Con il passare del tempo, spontaneamente o con farmaci anticoagulanti:

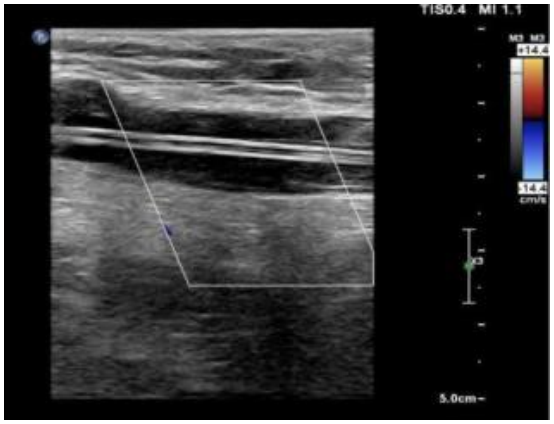
1. *Ricanalizzazione del trombo* (dapprima parziale con 'lacune di colore' all'intero del trombo)
2. *Trasformazione in cicatrice fibrosa* (lume della vena uguale o inferiore a quello prima della trombosi, completamente privo di flusso, occupato da materiale iperecogeno – fibrosi cicatriziale a carattere retraente)

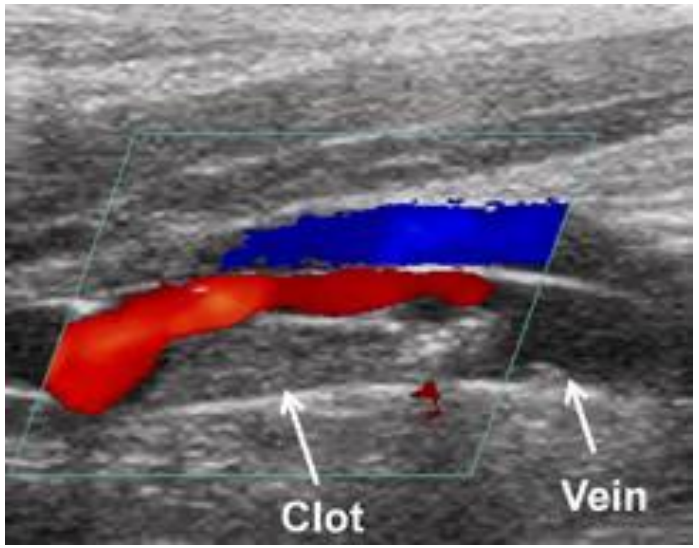
Trombo di vecchia data

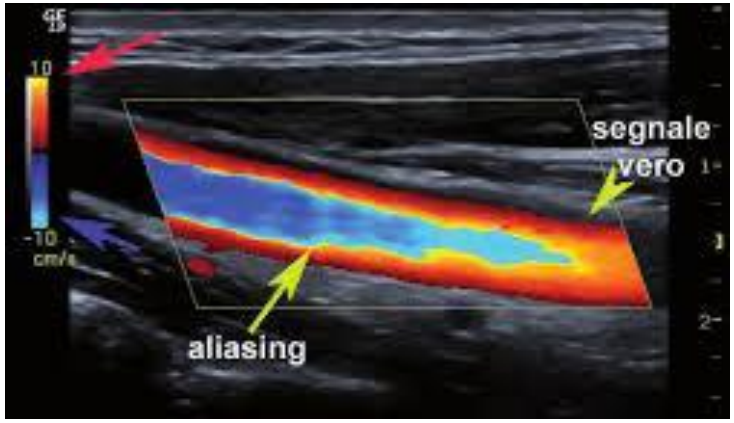
Criteri Indiretti

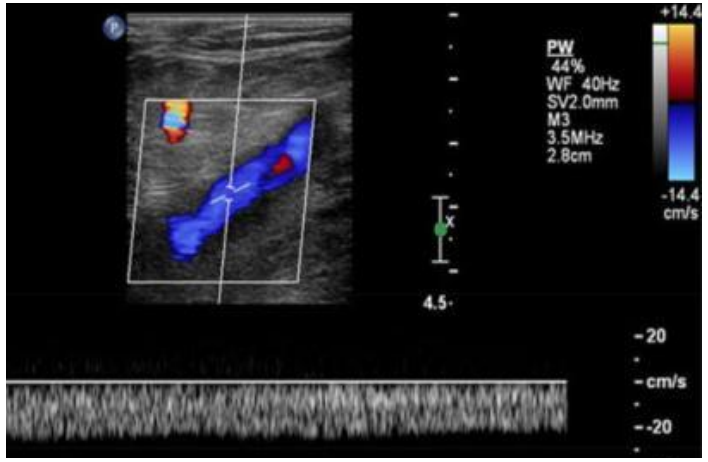
- Flusso assente
- Flusso marginale
- Collaterali
- Demodulazione del flusso

  (riduzione della variabilità delle velocità di flusso con il respiro, al PWD)



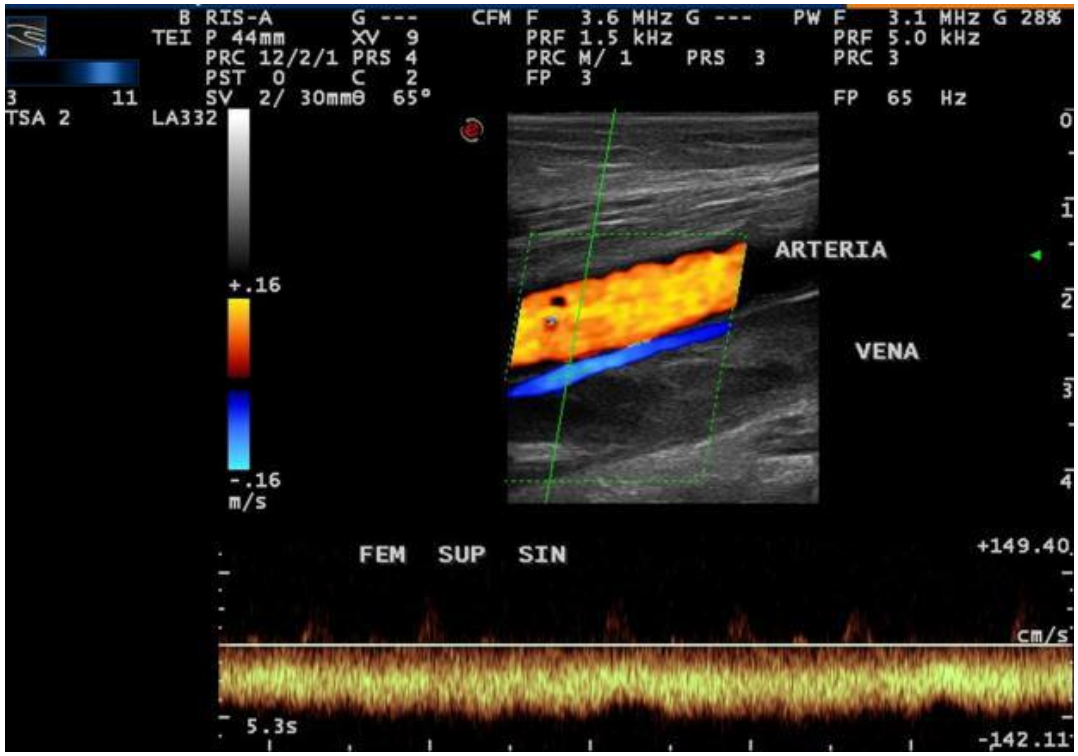






CUS (Compression UltraSonography)

- Trombosi completa o incompleta: il lume risulta disteso e non comprimibile; il color in aggiunta ci fornisce una immagine di ‘vuoto di colore’. Il segnale doppler tende a perdere la sua fasicità, a diventare continuo e a non rispondere alle manovre di provocazione.



Attenzione!

US non forniscono informazioni nei distretti non esplorabili!

(es: vena cava superiore)

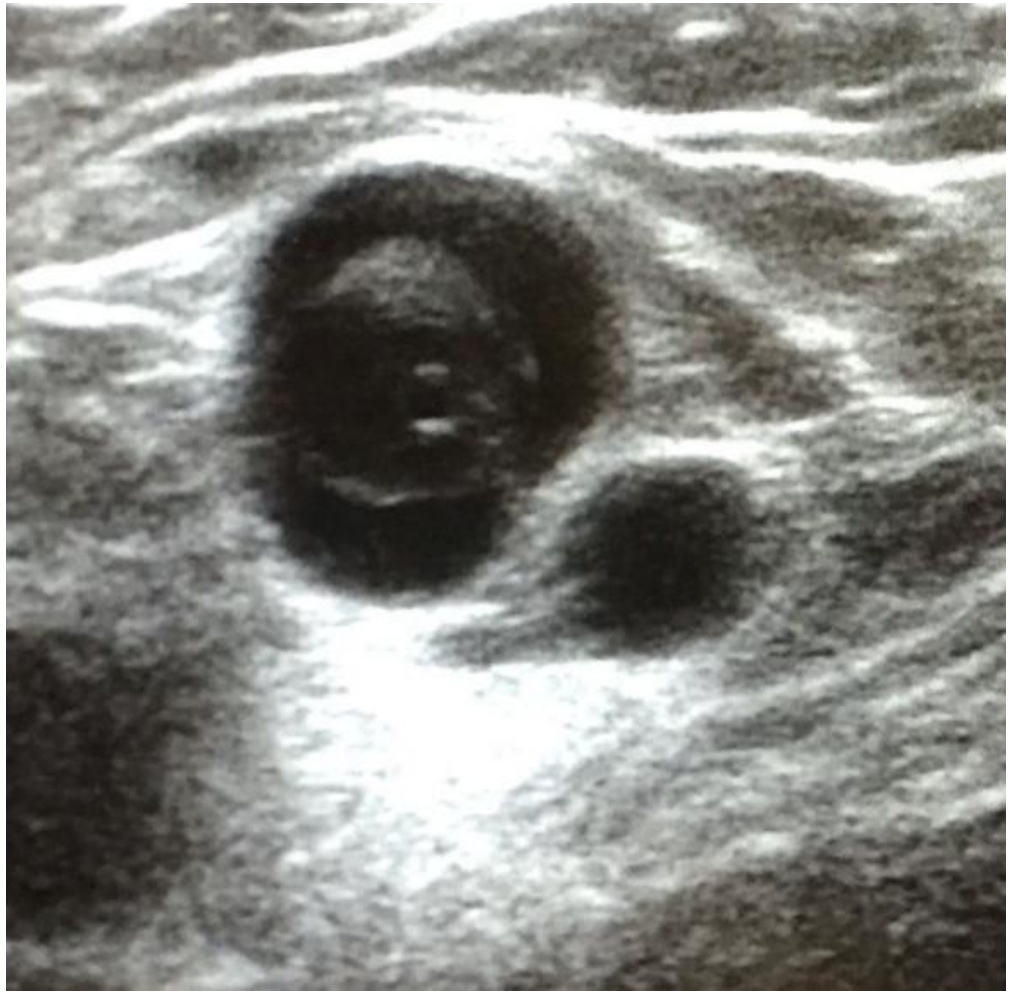
Ecocardiografia per valutare la punta del catetere

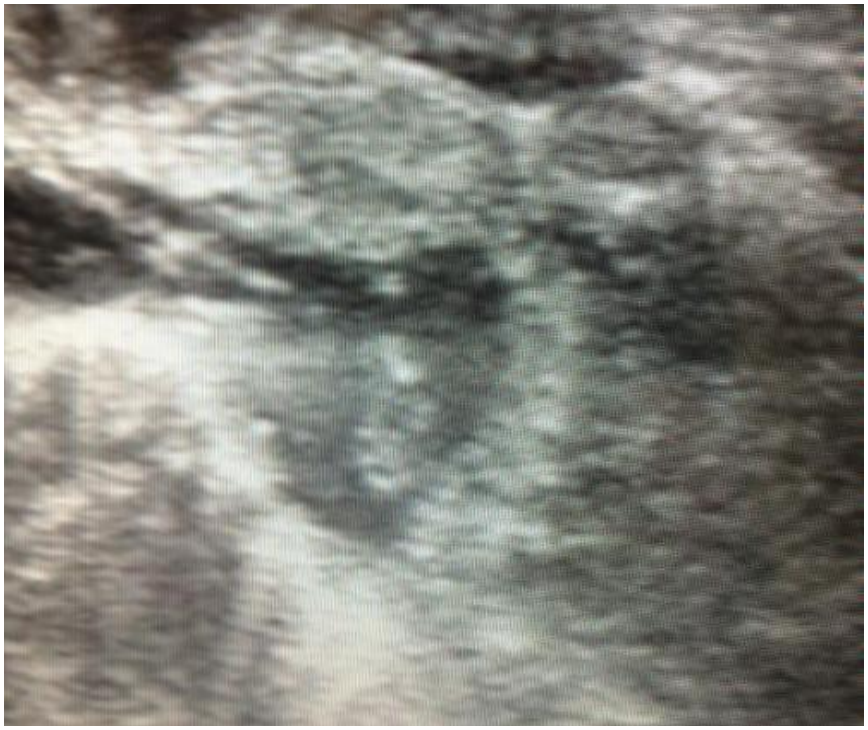
Considerare esecuzione TEE

DIAGNOSI ECOGRAFICA DI FS

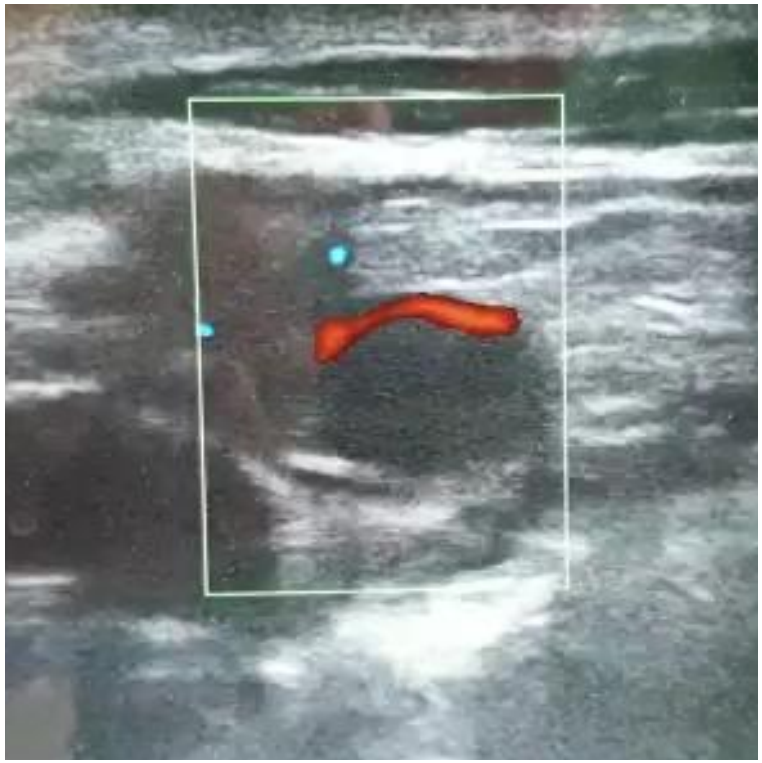
- FS è uno **strato sottile (>1mm)** di materiale ecogenico situato **intorno alla parete** del catetere, come una sorta di manica;
- superficie regolare e **poca o nessuna relazione con la parete** vene;
- FS può essere rilevato in **qualsiasi tratto del catetere**, e a volte può essere così lungo da **coprire completamente il catetere** in tutta la sua lunghezza.
- Contrariamente alla trombosi venosa, FS non ha aderenze coerenti con la parete venosa, anche se ci possono essere **alcuni "ponti" tra le due strutture.**
- Il **grado di ecogenicità di FS è molto variabile** e può cambiare nel corso del tempo: ipo/iper ecogenicità anche nei primi giorni
  - CRT, invece, nelle prime fasi è anecogena o ipoecogena

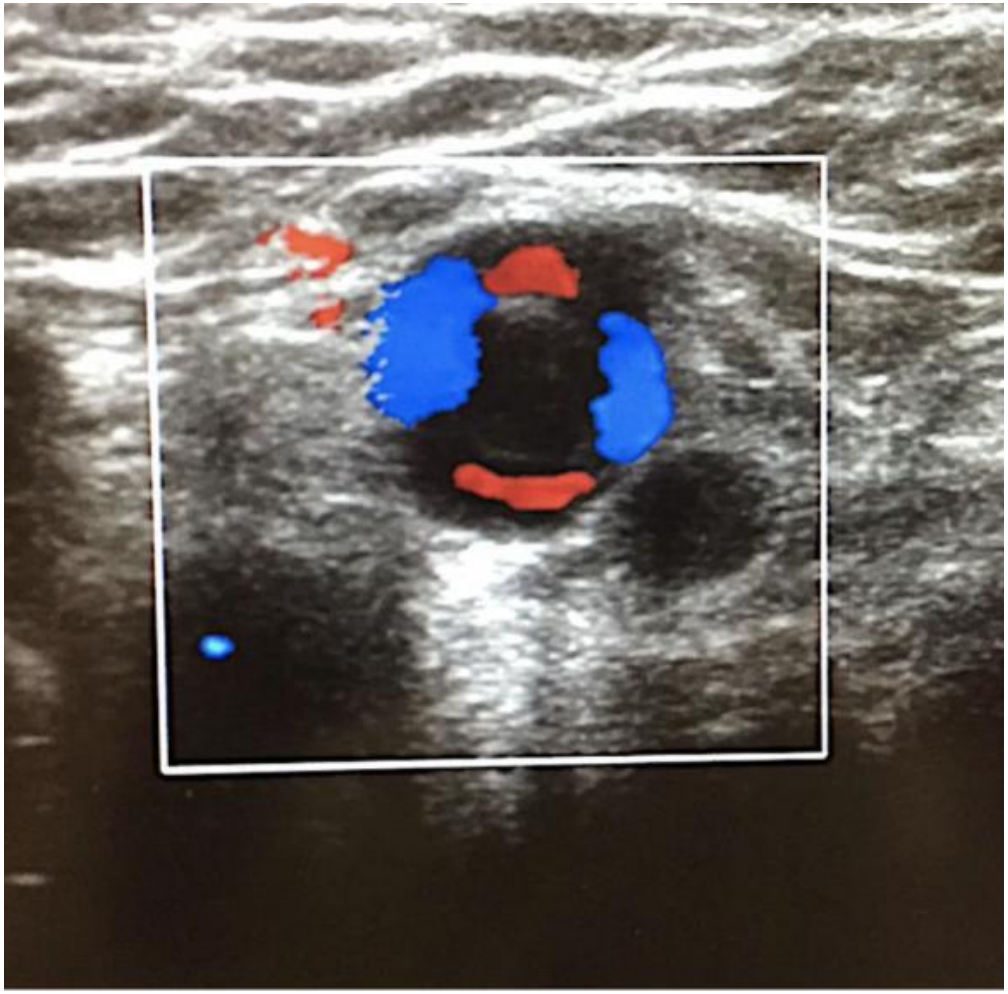
FS con aree ipo- e iper-ecogene, che circondano completamente il catetere.



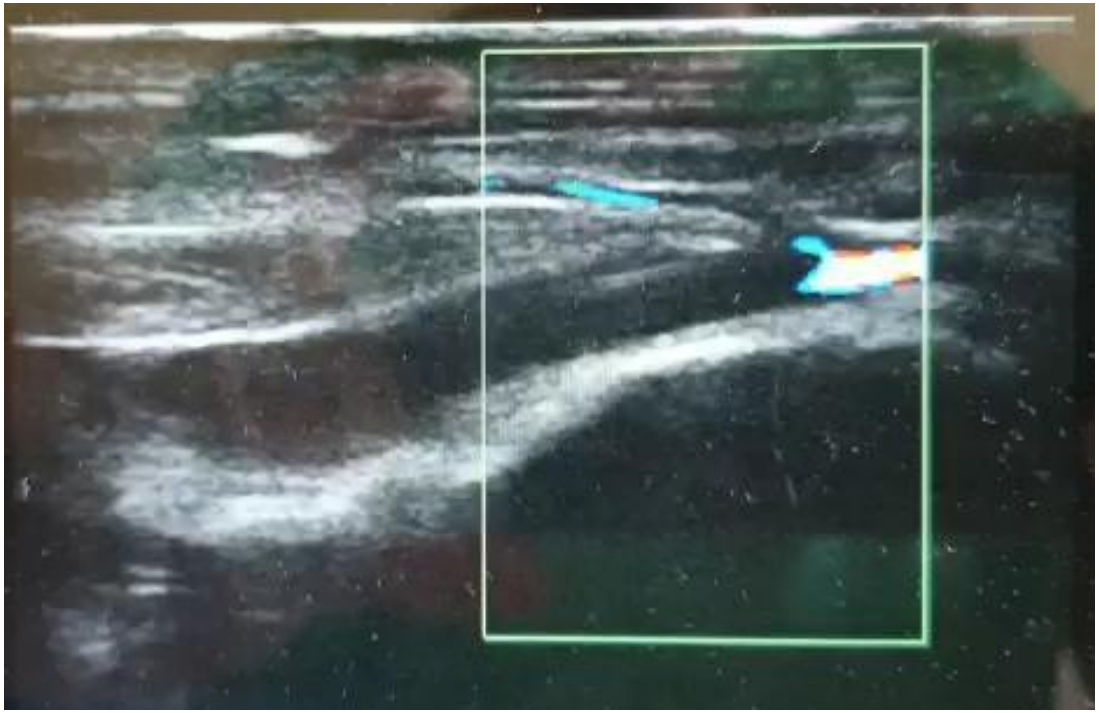


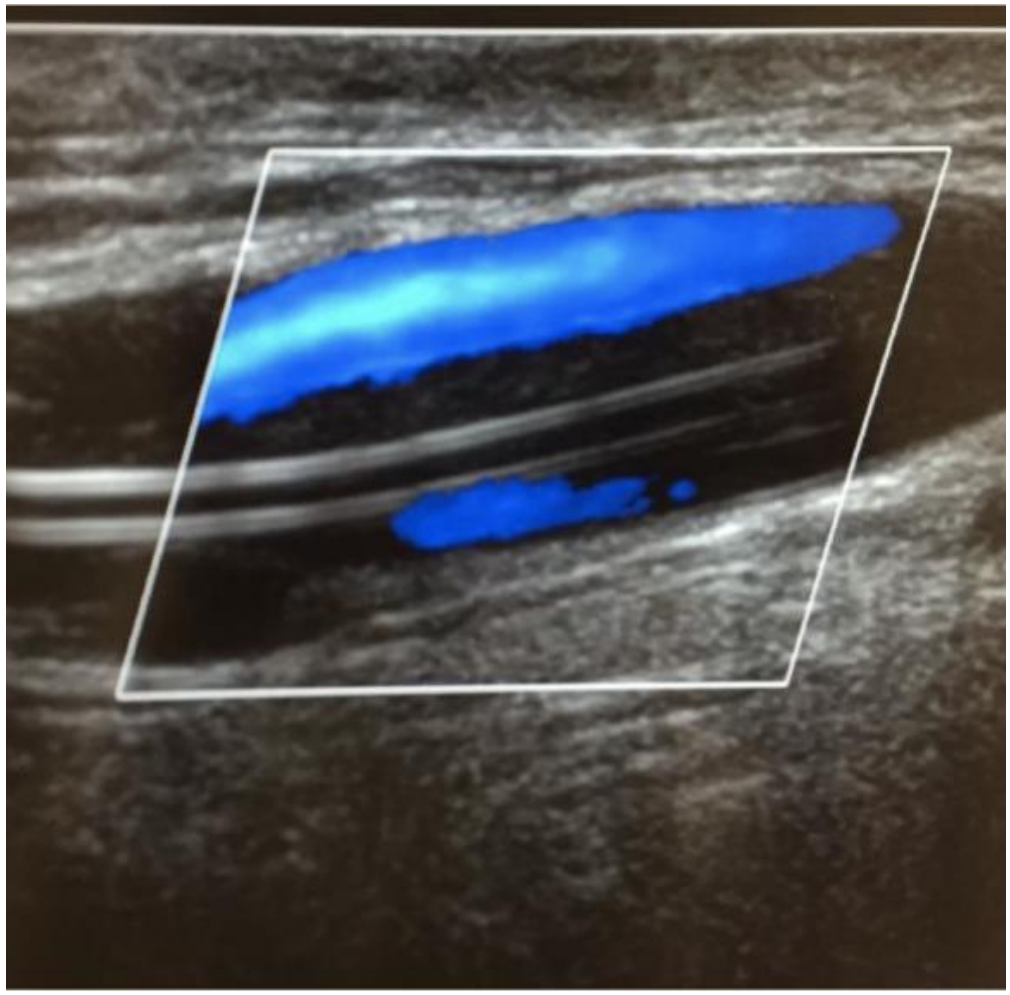
Visione trasversale dell'FS ipoecogenico, con flusso sanguigno (a colori) tra FS e parete vene (il cosiddetto "segno circolare").



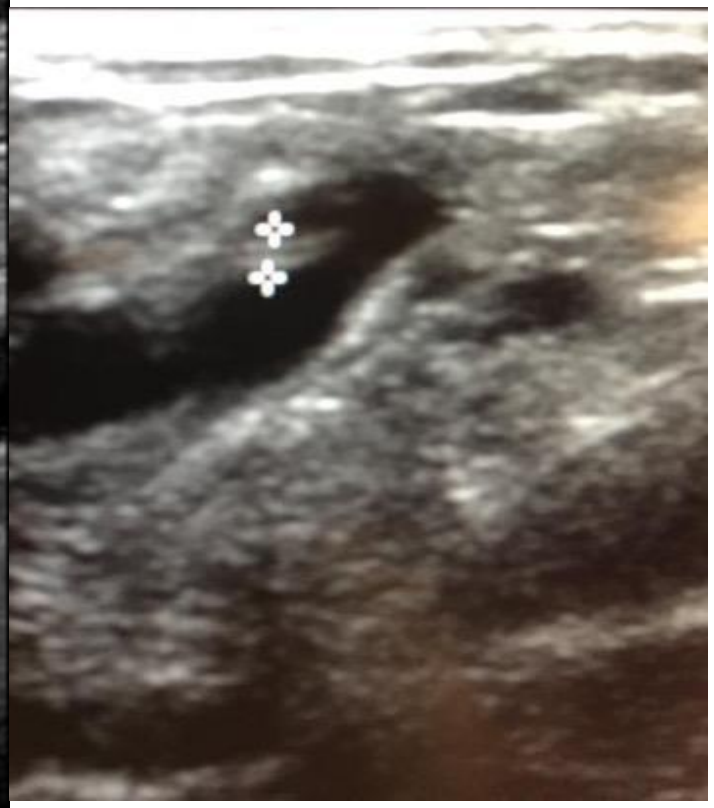


Vista longitudinale di FS ipo-ecogenico, con flusso sanguigno (a colori) tra FS e parete vene.





FS residuo, dopo la rimozione del catetere



Sleeve + Trombo

Principali differenze tra CRT e FS

	CRT	FS
Etiopathogenesis	Endothelial damage	Foreign body reaction
Molecular trigger	Tissue thromboplastin	Fibronectin
Type of tissue	Thrombus	Connective tissue
Location	At the site of vein wall damage	Around the catheter
Evolution	Fibrosis/reabsorption	Reabsorption (?)
US imaging	Mass obstructing the vein Anechoic, and then hypo-echoic Mainly attached to the vein wall	Sleeve all around the catheter Hypo- or hyper-echoic Mainly attached to the catheter
Clinical manifestation	Signs and symptoms of venous obstruction + risk of catheter malfunction	Catheter malfunction
Risk of pulmonary embolism	Yes	No
Need for VAD removal	Rare (not responsive to therapy)	Rare (irreversible catheter malfunctio
Preventable with anticoagulants	Yes (not consistently)	No
Sensitive to thrombolysis	Yes (in the initial phase)	No
Pharmacological management	LMW heparin	None

Passaro JVA 2020

Trattamento CRT

Editor's Choice – European Society for Vascular Surgery (ESVS) 2021 Clinical Practice Guidelines on the Management of Venous Thrombosis☆

Stavros K. Kakkos [*,a,†], Manjit Gohel [a,†], Niels Baekgaard [a], Rupert Bauersachs [a], Sergi Bellmunt-Montoya [a], Stephen A. Black [a], Arina J. ten Cate-Hoek [a], Ismail Elalamy [a], Florian K. Enzmann [a], George Geroulakos [a], Anders Gottsäter [a], Beverley J. Hunt [a], Armando Mansilha [a], Andrew N. Nicolaides [a], Per Morten Sandset [a], Gerard Stansby [a]

ESVS Guidelines Committee [b], Gert J. de Borst, Frederico Bastos Gonçalves, Nabil Chakfé, Robert Hinchliffe, Philippe Kolh, Igor Koncar, Jes S. Lindholt, Riikka Tulamo, Christopher P. Twine, Frank Vermassen, Anders Wanhainen

Recommendation 58

For patients with catheter related thrombosis, anticoagulation with low molecular weight heparin or low molecular weight heparin followed by vitamin K antagonists should be considered for a minimum of three months.

Class	Level	References
IIa	C	Debourdeau *et al.* (2013),[295] Barco *et al.* (2017)[296]

Recommendation 57

For patients with catheter related thrombosis, catheter removal should be considered, when (1) it is not needed; (2) it is not functional; (3) anticoagulation is contraindicated; (4) symptoms are not resolving with anticoagulation; or (5) the thrombosis is limb or life threatening.

Class	Level	Reference
IIa	C	Baumann Kreuziger *et al.* (2015)[327]

Recommendation 59

The management of children with deep vein thrombosis should be guided by clinicians with specific expertise in paediatric thrombosis and haemostasis.

Class	Level	References
I	C	Monagle *et al.* (2012),[335] Monagle *et al.* (2020)[336]

CONCLUSIONI

- CRT e FS sono due condizioni distinte dal punto di vista eziopatogenetico, istologico, clinico e terapeutico
- FS non evolve verso la trombosi
- FS non va trattata con anticoagulanti
- L'ecografia è il Gold Standard per la diagnosi differenziale:
  - CRT: massa che ostruisce la vena, anecoica, e poi ipo-ecoica, principalmente attaccata alla parete della vena
  - FS: manicotto intorno al catetere ipo- o iper-ecoico, principalmente attaccato al catetere

Grazie