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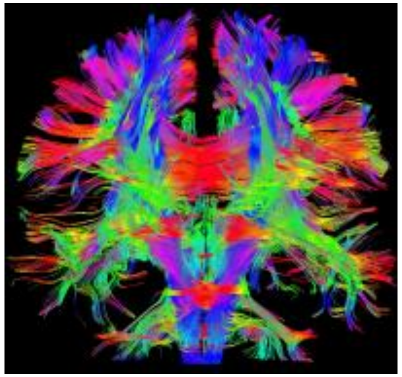

PICC, port e trombosi catetere-correlata: la prevenzione è legata alla tecnica di impianto

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Cleveland Clinic Lerner College of Medicine
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Disclosures

- No conflict of interest to declare related to this topic


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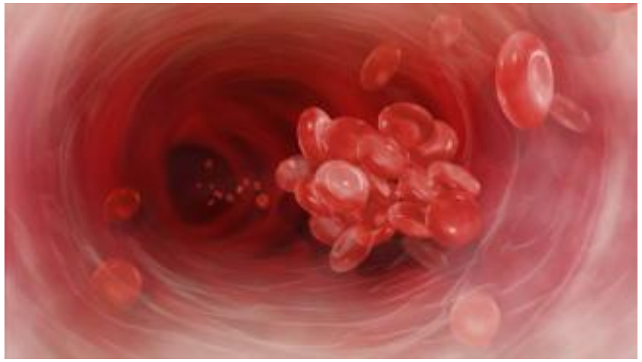
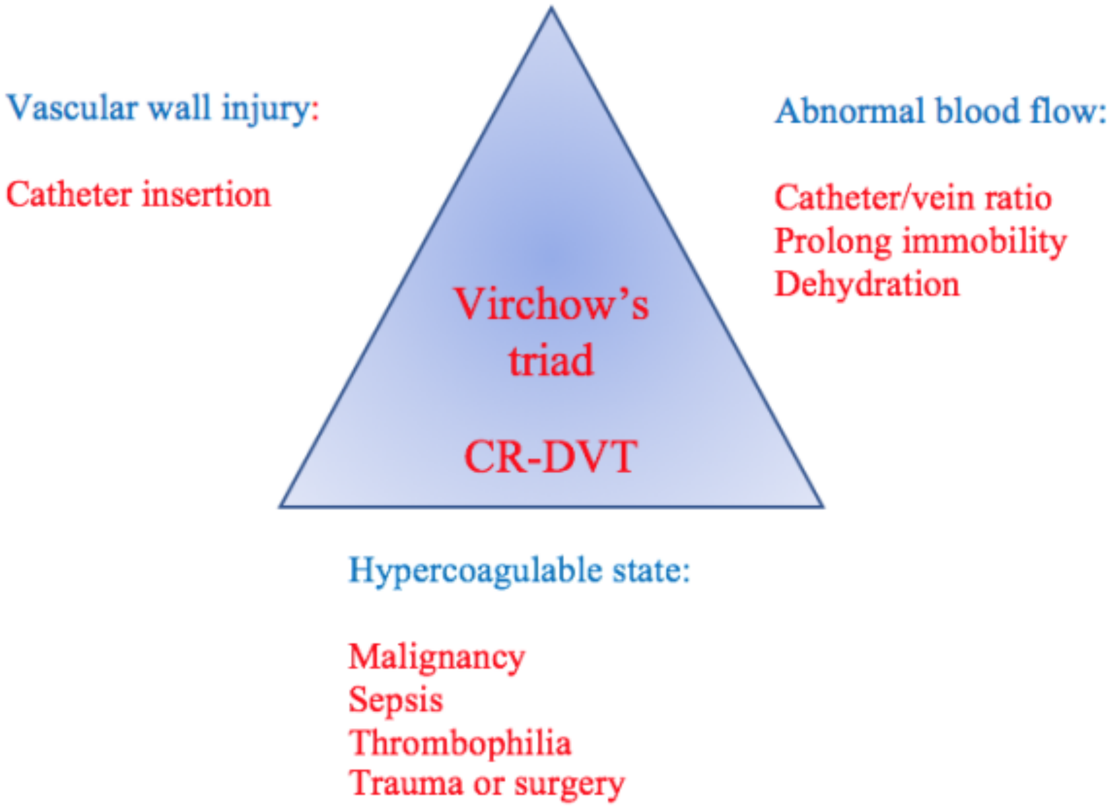
OPENING 11 NOVEMBER 2017

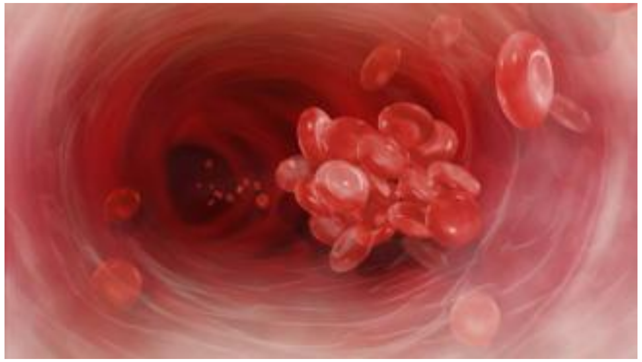
Q/A

- Pathophysiology of CR-DVT
- Is CR-DVT also catheter-type related?
- Can we avoid it?



CR-DVT


Vascular wall injury:
Catheter insertion
Abnormal blood flow:
Catheter/vein ratio
Prolong immobility
Dehydration
Virchow's triad
CR-DVT
Hypercoagulable state:
Malignancy
Sepsis
Thrombophilia
Trauma or surgery



CR-DVT

- All catheters, when introduced into the body, are progressively covered with plasma proteins and fibrin.
- Fibrin formation is a natural process that may occur soon after the insertion of a device or develop at any time during the intra-venous therapy.
- This is how the human body attempts to protect itself against a foreign body.

Thrombotic catheter-occlusions' types

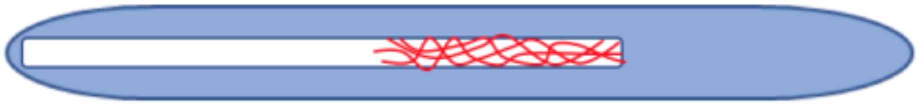
- **Fibrin tail or flap**: extends from the catheter tip but is drawn inward, blocking the opening of the catheter lumen on aspiration attempts. This results in an ability to infuse fluids but the inability to withdraw blood.

Thrombotic catheter-occlusions' types

- **Mural thrombus:** it starts where the catheter touches or "rubs" the vein's wall. Common sites are where this can happen are: the entry site, anywhere along the catheter path, and the catheter tip.

Thrombotic catheter-occlusions' types

- **Fibrin sheat:** it starts when fibrin adheres to the external catheter surface, often beginning at the entry site, and may encase all or part of the catheter like a sock. May completely cover the opening of the catheter tip creating difficulty in withdrawing the blood from the catheter.



Thrombotic catheter-occlusions' types

- **Intraluminal thrombus:** it occurs when blood refluxes inside the catheter lumen. Common causes of reflux include patient coughing, inadequate flushing after blood draws or after checking for blood return, or improper use of flush syringes.

Thrombotic catheter-occlusions' types

- **Venous thrombosis:** this type of thrombosis can be vessel-occlusive. It typically involves the superior vena cava and/or the innominate veins. When it is occlusive, it is associated with a superior cave syndrome.

Risk Factors for Catheter Related Thrombosis

Related to the **Patient**	Related to the **Catheter**	Related to the **Insertion**
Age >65 years [7]	Catheter diameter	Femoral > subclavian > jugular?
Malignancy	Multi lumen > single lumen	Left side > right side
Chemotherapy	Catheter/ vein ratio	
Systemic or catheter-related infection	Catheter tip location: proximal to SVC > lower third of SVC	
Acquired hypercoagulability	Time after insertion	
Patient managed in a critical care unit		
Previous catheter related thrombosis		
Diabetes		
Obesity		

Management of occlusion and thrombosis associated with long-term indwelling central venous catheters

Jacquelyn L Baskin, Ching-Hon Pui, Ulrike Reiss, Judith A Wilimas, Monika L Metzger, Raul C Ribeiro, Scott C Howard

Lancet 2009; 374: 159–69

	Diagnosis	Treatment	Level of evidence*
Mechanical obstruction			
Kink in catheter or tubing, tight suture, or clamp closed on external catheter[23–25]	Inspect catheter	Correct mechanical dysfunction	5
Port access needle dislodged or occluded in port[26–28]	Assess port access needle placement	Replace needle if necessary	5
Catheter tip blocked by vessel wall[23–25]	Reposition patient	Reposition patient	5
Pinch-off syndrome[26–28]	Fluoroscopy	Remove catheter if at risk for fracture	3b
Obstruction related to drug or parenteral nutrition			
Low pH (acidic)[23,24,29,30]	Review drug	Hydrochloric acid 0·1 mol/L†	4
High pH (basic)[23,24,29,31]	Review drug	Sodium hydroxide 0·1 mol/L or sodium bicarbonate 1·0 mol/L	4
Calcium phosphate precipitate[24,25,29,30,32]	Review drug	Hydrochloric acid 0·1 mol/L†	4
Lipid emulsion[24,25,29,33]	Review parenteral nutrition preparations	Ethanol 70%	4
Thrombotic obstruction			
Fibrin sheath or intraluminal clot[34,35]	Radiography after instillation of contrast into the catheter (linogram)	Intraluminal thrombolytic drugs	1b
Mural thrombus or venous thrombosis[34,35]	Ultrasound or venography	Anticoagulant treatment (rarely resolves with intraluminal thrombolytic drugs)	2c

*Levels of evidence as defined in Oxford Centre for Evidence Based Medicine.[36] †No longer used in some institutions because of concern about damage to the catheter wall.

Table 1: **Causes of central venous catheter occlusions[5] and recommendations for treatment**

Management of occlusion and thrombosis associated with long-term indwelling central venous catheters

Jacquelyn L Baskin, Ching-Hon Pui, Ulrike Reiss, Judith A Wilimas, Monika L Metzger, Raul C Ribeiro, Scott C Howard

Lancet 2009; 374: 159–69

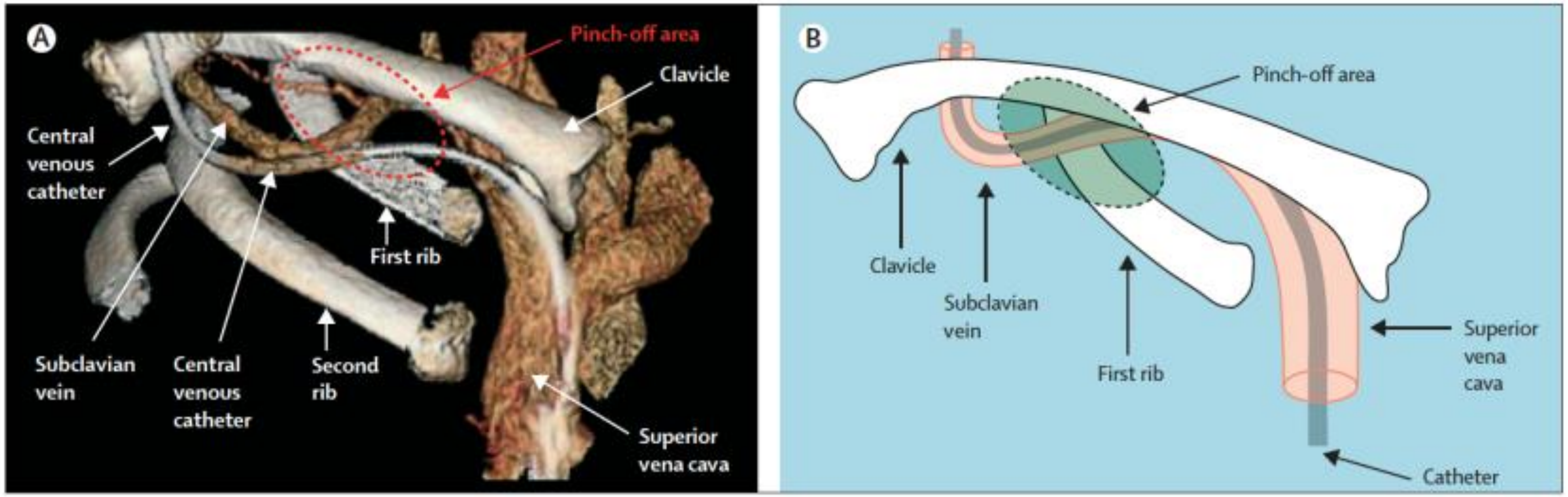


Figure **1: The pinch-off syndrome**

The catheter passes through the narrow angle between the first rib and the lateral portion of the clavicle (the pinch-off area), placing it at risk for compression or transection. In panel A (a three-dimensional CT image), the catheter passes through the pinch-off area parallel to the subclavian vein then inserts into the superior vena cava. In panel B, the catheter inserts into the subclavian vein and is intravenous when it passes through the pinch-off area. Catheters that are external to the subclavian vein when they pass through the pinch-off area, as in panel A, have a greater risk of pinch-off syndrome and fracture.[1]

Can we avoid CR-DVT?

5STEPS

- Sonography – both 2D and Doppler
- Tip – central
- EKG
- Power injectability
- Size – measurement and choice of the catheter

S- Sonography

- Pre-scanning: RACEVA- RAPEVA
- Ultrasound-guided cannulation: puncture– guidewire- catheter in site
- Doppler mode in case of low venous flow in small veins

S- Sonography

G Model
ACCPM-12; No. of Pages 5
ARTICLE IN PRESS
Anaesth Crit Care Pain Med xxx (2015) xxx–xxx

ELSEVIER

SFAR
Société Française d'Anesthésie et de Réanimation

Recommendations

Guidelines on the use of ultrasound guidance for vascular access

Hervé Bouaziz[a,*], Paul J. Zetlaoui[b], Sébastien Pierre[c], Eric Desruennes[d], Nicolas Fritsch[e], Denis Jochum[f], Frédéric Lapostolle[g], Thierry Pirotte[h], Stéphane Villiers[i]

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Practice Guidelines for Central Venous Access

A Report by the American Society of Anesthesiologists Task Force on Central Venous Access

Anaesthesia 2016, 71, 573–585 doi:10.1111/anae.13360

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. Mclure[10] and S. Q. M. Tighe[11]

GUIDELINES AND STANDARDS

Guidelines for Performing Ultrasound Guided Vascular Cannulation: Recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists

Christopher A. Troianos, MD, Gregg S. Hartman, MD, Kathryn E. Glas, MD, MBA, FASE, Nikolaos J. Skubas, MD, FASE, Robert T. Eberhardt, MD, Jennifer D. Walker, MD, and Scott T. Reeves, MD, MBA, FASE, for the Councils on Intraoperative Echocardiography and Vascular Ultrasound of the American Society of Echocardiography, *Pittsburgh, Pennsylvania; Lebanon, New Hampshire; Atlanta, Georgia; New York, New York; Boston, Massachusetts; and Charleston, South Carolina*

(J Am Soc Echocardiogr 2011;24:1291-318.)

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

CONFERENCE REPORTS AND EXPERT PANEL

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Jack LeDonne
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Roberto Biffi
Eric Desruennes
Lawrence A. Melniker
Susan T. Verghese

International evidence-based recommendations on ultrasound-guided vascular access

T- Tip must be in a central venous location

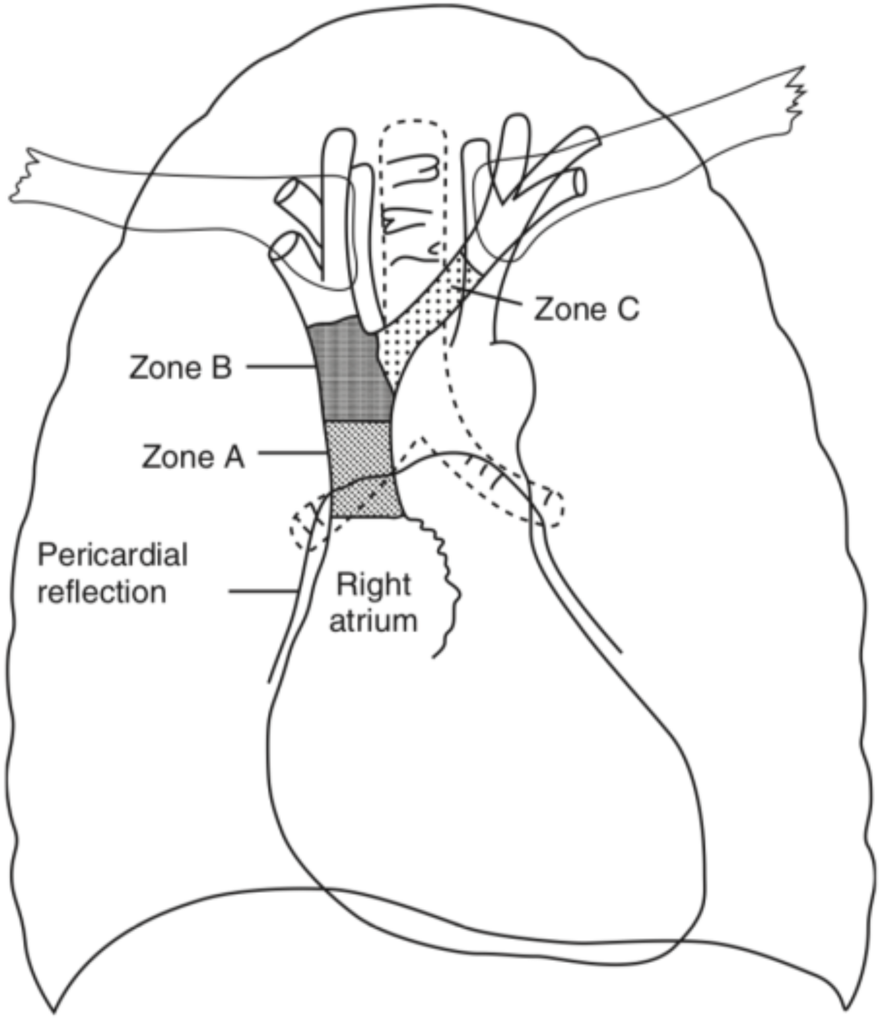
British Journal of Anaesthesia **96** (**3**): 335–40 (2006)
doi:10.1093/bja/aei310 Advance Access publication January 16, 2006

BJA

The carina as a radiological landmark for central venous catheter tip position

P. A. Stonelake and A. R. Bodenham*

T- Tip must be in a central venous location



T- Tip must be in a central venous location

TTE : trans-thoracic echocardiography

- Accuracy depending on the method used and on the operator

- Widely used in Europe more than in USA

- Ideal in neonates and children

- May be difficult in some adult patients

T- Tip must be in a central venous location

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

AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 164 2001

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

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

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

T- Tip must be in a central venous location

- TTE: Apical four chamber view

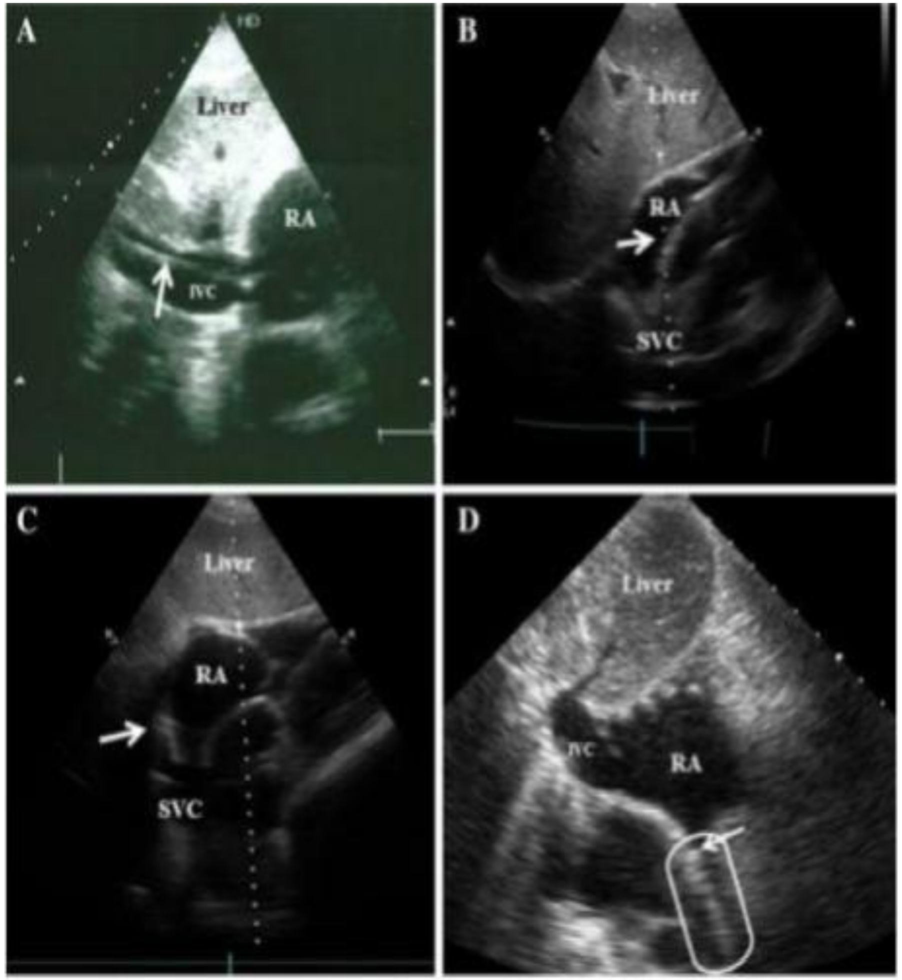
- Easy to perform

- Visualization of the tip only if it is inside the right atrium

- Indirect visualization by CEUS (evidence of contrast flow within 1-2 sec after injection = tip is in the lower 1/3 of SVC)

T- Tip must be in a central venous location

- TTE: Subcostal 'bi-caval' view
- Requires training
- Direct visualization of the tip in RA, SVC or IVC
- May be difficult or impossible in some conditions (obesity, COPD, abdominal surgery)



T- Tip must be in a central venous location

Standardization of TTE for tip location

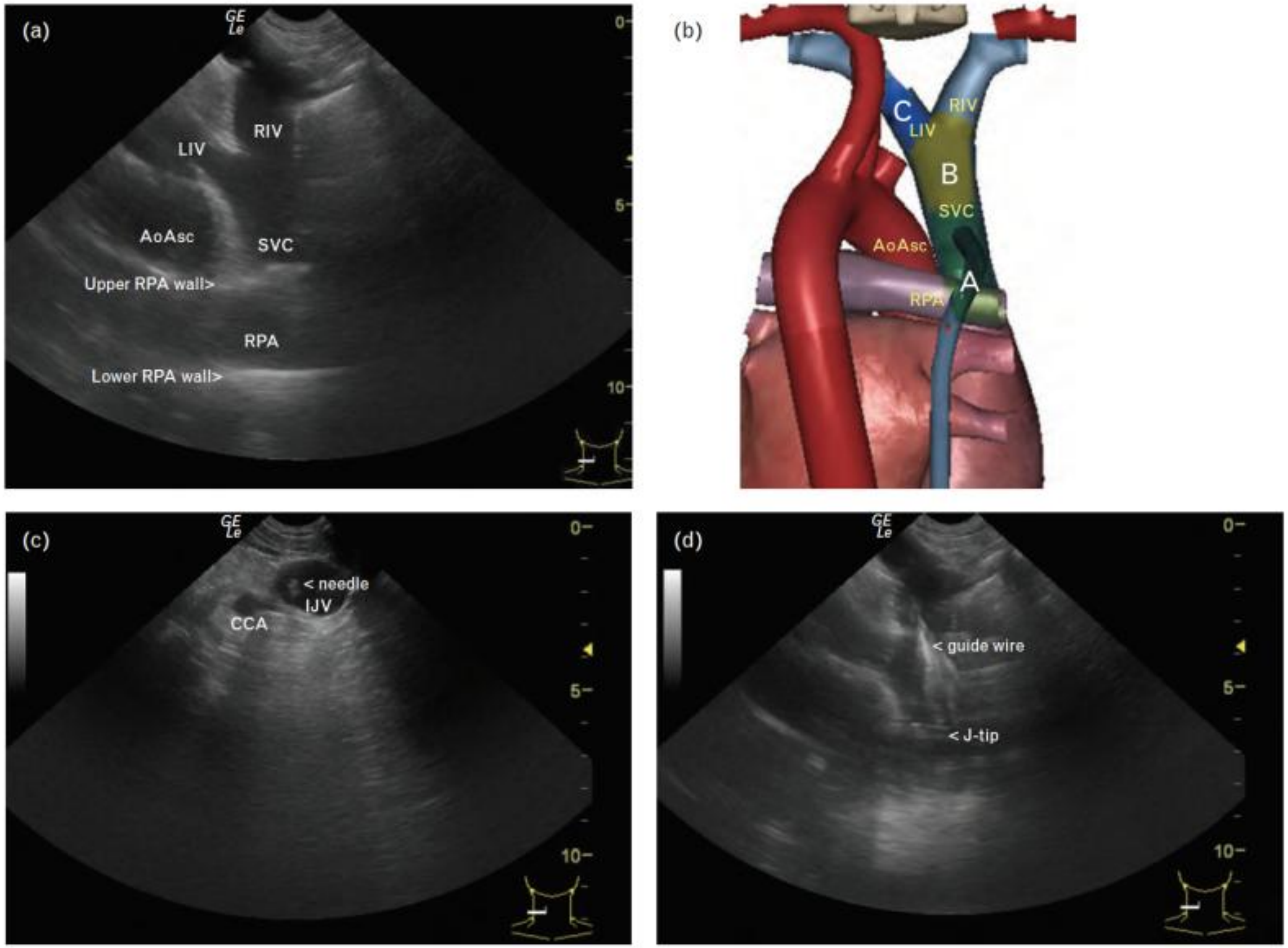
-Tip to be placed in lower 1/3 of SVC

- Subcostal view: direct tip visualization in SVC
- Apical view: RA visualization + echo-contrast infusion (contrast appearing in RA within 1-2 sec) or saline infusion (color doppler changes in RA within 1-2 sec)
- Apical view: direct tip visualization in RA + pulling back the catheter until tip disappears

-Tip to be placed in RA

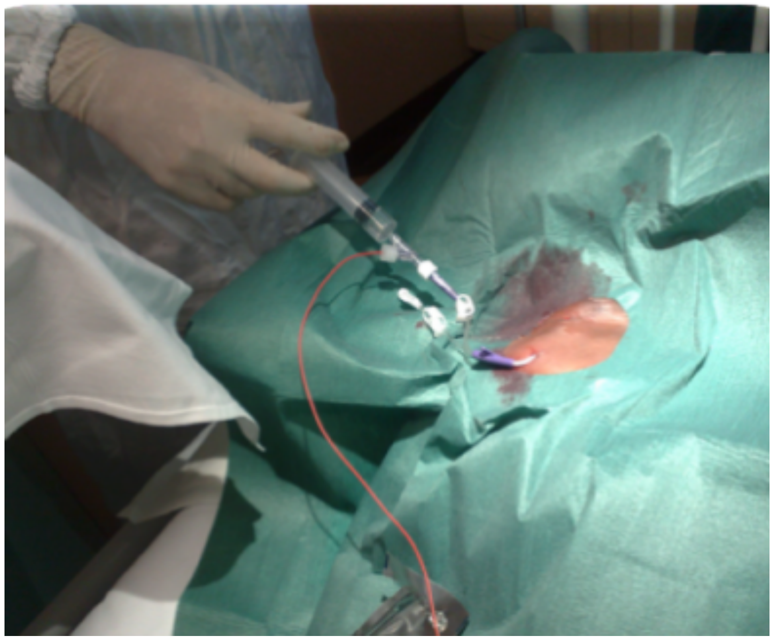
- Apical view: direct tip visualization in RA

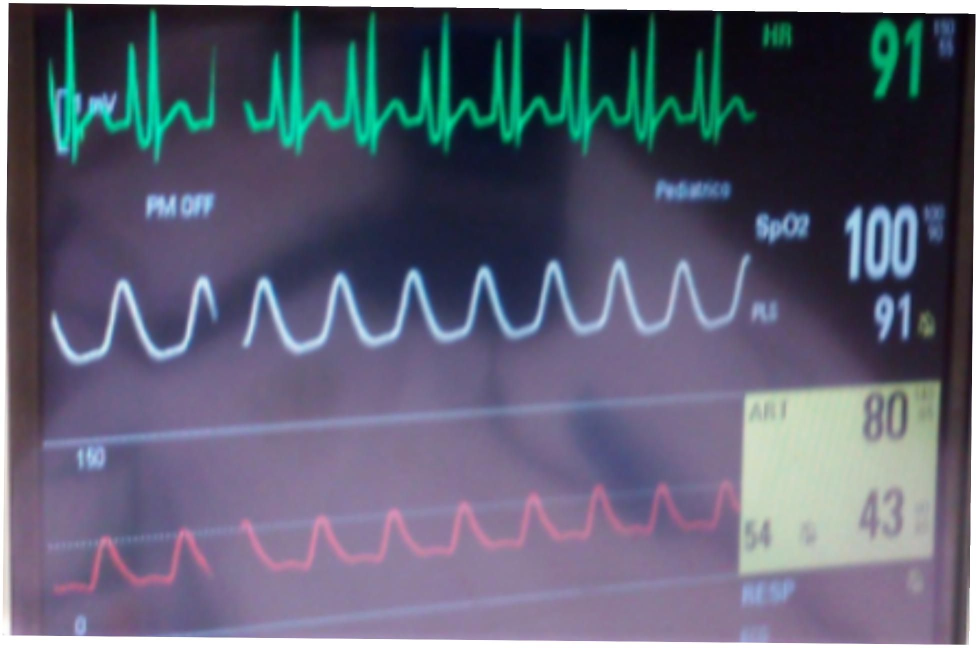
T- Tip must be in a central venous location



Ekg- verification

- Whenever possible, the correct position of the tip is verified during the procedure via the intracavitary Ekg method





Ekg- verification

J Vasc Access. 2012 Jul-Sep;13(3):357-65. doi: 10.5301/JVA.2012.9020.

The intracavitary ECG method for positioning the tip of central venous catheters: results of an Italian multicenter study.

Pittiruti M[1], Bertollo D, Briglia E, Buononato M, Capozzoli G, De Simone L, La Greca A, Pelagatti C, Sette P.

J Vasc Access. 2012 Jul-Sep;13(3):393-6. doi: 10.5301/jva.5000065.

Intra-cavitary ECG is an effective method for correct positioning the tip of tunneled Groshong catheters.

Capozzoli G[1], Accinelli G, Fabbro L, Pedrazzoli R, Auricchio F.

Ekg- verification

Ekg- verification

Encouraged

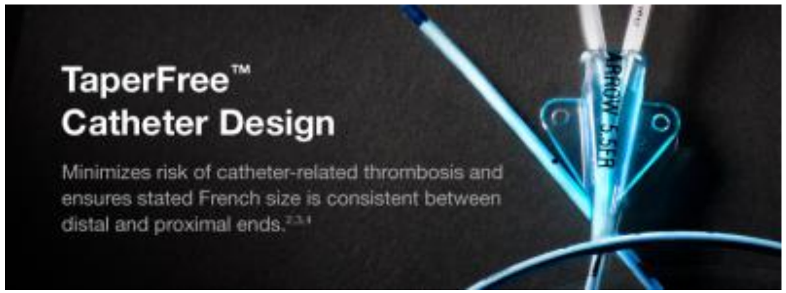
- Multicomponent interventions to reduce falls
- Use of clinical pharmacists to reduce adverse drug events
- Documentation of patient preferences for life-sustaining treatment
- Obtaining informed consent to improve patients' understanding of the potential risks of procedures
- Team training
- Medication reconciliation
- Practices to reduce radiation 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

P-ower injectability

- Allows rapid infusion of high volumes
- Allows high PSI (up to 300)
- Allows small calibre
- Allows high flexibility

P-ower injectability

P-ower injectability



P-ower injectability

Pittiruti *et al. Critical Care* 2012, **16**:R21
http://ccforum.com/content/16/1/R21

CRITICAL CARE

RESEARCH Open Access

Clinical experience with power-injectable PICCs in intensive care patients

Mauro Pittiruti[1*], Alberto Brutti[2], Davide Celentano[2], Massimiliano Pomponi[2], Daniele G Biasucci[2], Maria Giuseppina Annetta[2] and Giancarlo Scoppettuolo[3]

- Ultra-resistant polyurethane-made power-injectable catheters seems to reduce the rate of occlusion and thrombosis in ICU patients

P-ower injectability

J Comput Assist Tomogr. 2001 Nov-Dec;25(6):932-7.

Assessing the adequacy of peripherally inserted central catheters for power injection of intravenous contrast agents for CT.

Williamson EE[1], McKinney JM.

Author information

Abstract

PURPOSE: The purpose of this work was to determine the tolerance of silicone peripherally inserted central catheters (PICCs) of different sizes and lengths to power injection of contrast materials at flow rates suitable for CT studies.

METHOD: Fifty silicone PICCs in three single-lumen sizes (3 to 5F) and two double-lumen sizes (6 and 7F) were cut to two lengths (35 and 45 cm), and a uniform volume of 74% ioversol was injected into each at increasing rates of flow by a power injector. The flow rate, volume, and peak pressure were recorded for each injection.

RESULTS: The respective tolerated flows for the 35 and 45 cm PICCs were 0.65 ml/s at 125 psi and 0.56 ml/s at 125 psi for the 3F catheters, 1.58 ml/s at 150 psi and 1.04 ml/s at 150 psi for the 4F catheters, 4.20 ml/s at 200 psi and 3.02 ml/s at 170 psi for the 5F catheters, 1.50 ml/s at 145 psi and 0.88 ml/s at 150 psi for the 6F catheters, and 9.52 ml/s at 350 psi and 8.78 ml/s at 330 psi for the 7F catheters.

CONCLUSION: The 3F catheters were unsuitable for power injection for CT studies because they could not accommodate adequate flow rates. The 4F single-lumen and 6F double-lumen catheters withstood flow rates that were marginally adequate for CT studies. The 5F single-lumen and 7F double-lumen PICCs tolerated peak flows and pressures well within the range necessary to allow power injection of contrast materials for CT studies. For each size of PICC, the 35 cm length withstood higher flow rates than the 45 cm length before failure.

S-ize

- C/V must not exceed 30% of cross-sectional diameter of the vein

- Catheter area should not exceed 20% or Vein CSA

S-ize

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

Thomas P. Nifong and Timothy J. McDevitt

Chest 2011;140;48-53; Prepublished online February 24, 2011;
DOI 10.1378/chest.10-2637

Table 1—*Experimental Results Using Combinations of Three Outer Tube (Cylinder) Diameters and Four Inner Wire (Catheter) Diameters*

Measure	Unobstructed	Inner Wire 0.67 mm (2F)	Inner Wire 1.33 mm (4F)	Inner Wire 2.0 mm (6F)	Inner Wire 2.6 mm (8F)
Outer tube, 4 mm					
D_{cath}/D_{cyl}	0	0.16	0.32	0.48	0.64
Average flow, mL/min	17	12	6.7	3.4	1.2
Relative flow, %	100	69	40	20	6.9
SD, mL/min	0.42	0.11	0.15	0.034	0.016
P value[a]	…	3.7×10^{-6}	6.8×10^{-11}	3.8×10^{-7}	3.6×10^{-11}
Outer tube, 5 mm					
D_{cath}/D_{cyl}	0	0.13	0.25	0.38	0.51
Average flow, mL/min	41	33	25	17	10
Relative flow, %	100	81	60	42	25
SD, mL/min	0.15	0.75	0.70	0.16	0.092
P value[a]	…	1.0×10^{-5}	8.5×10^{-8}	9.0×10^{-6}	5.3×10^{-11}
Outer tube, 6 mm					
D_{cath}/D_{cyl}	0	0.11	0.21	0.32	0.42
Average flow, mL/min	81	52	47	39	29
Relative flow, %	100	64	58	49	36
SD, mL/min	0.98	0.58	0.40	2.7	0.75
P value[a]	…	5.3×10^{-10}	1.0×10^{-6}	.0028	6.7×10^{-4}

D_{cath} = diameter of the catheter; D_{cyl} = diameter of the cylinder.
[a]Compared with the next smallest catheter size.

S-ize

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

Thomas P. Nifong and Timothy J. McDevitt

Chest 2011;140;48-53; Prepublished online February 24, 2011;
DOI 10.1378/chest.10-2637

- There are several alterations that occur under conditions of low shear rate. Intravascular foreign substances evoke inflammatory reactions and provide surfaces for protein deposition.

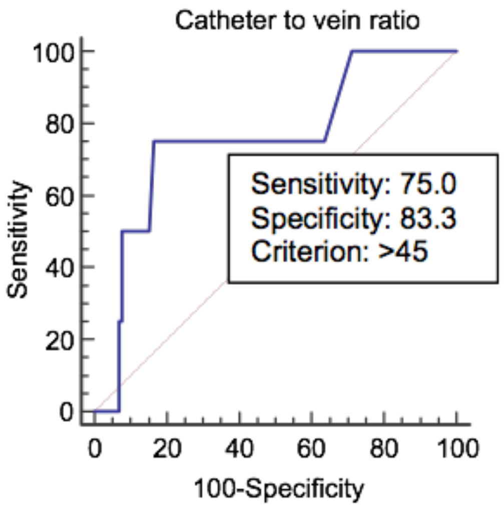
- The insertion of a catheter may decrease shear stress along the endothelial lining to levels that produce increased viscosity and even further reductions in blood flow.

S-ize

The catheter to vein ratio and rates of symptomatic venous thromboembolism in patients with a peripherally inserted central catheter (PICC): A prospective cohort study Sharp R, et al. Int J Nursing Studies 2014

- Prospective cohort; n=136, 1 site, Australia

- Association between catheter#vein#VTE



Recommended minimum vein diameter for PICC insertion.

French size	PICC outer diameter (mm)	Minimum vein diameter (mm)
4	1.332	3
5	1.665	3.75
6	1.998	4.5

Patients with a C:V ratio > 45%
RR 13.0 (1.44-122.7) for DVT compared to those <45%
(adjusted for co-morbidities, meds)

S-ize

Journal of Thrombosis and Thrombolysis

Reducing catheter-related thrombosis using a risk reduction tool centered on catheter to vessel ratio

- **Catheter to vessel ratio (CVR)** may be defined as the "indwelling space or area consumed or occupied by an intravascular device inserted and positioned within a venous or arterial blood vessel."

- The authors suggest to calculate the real area of the vein occupied by the catheter

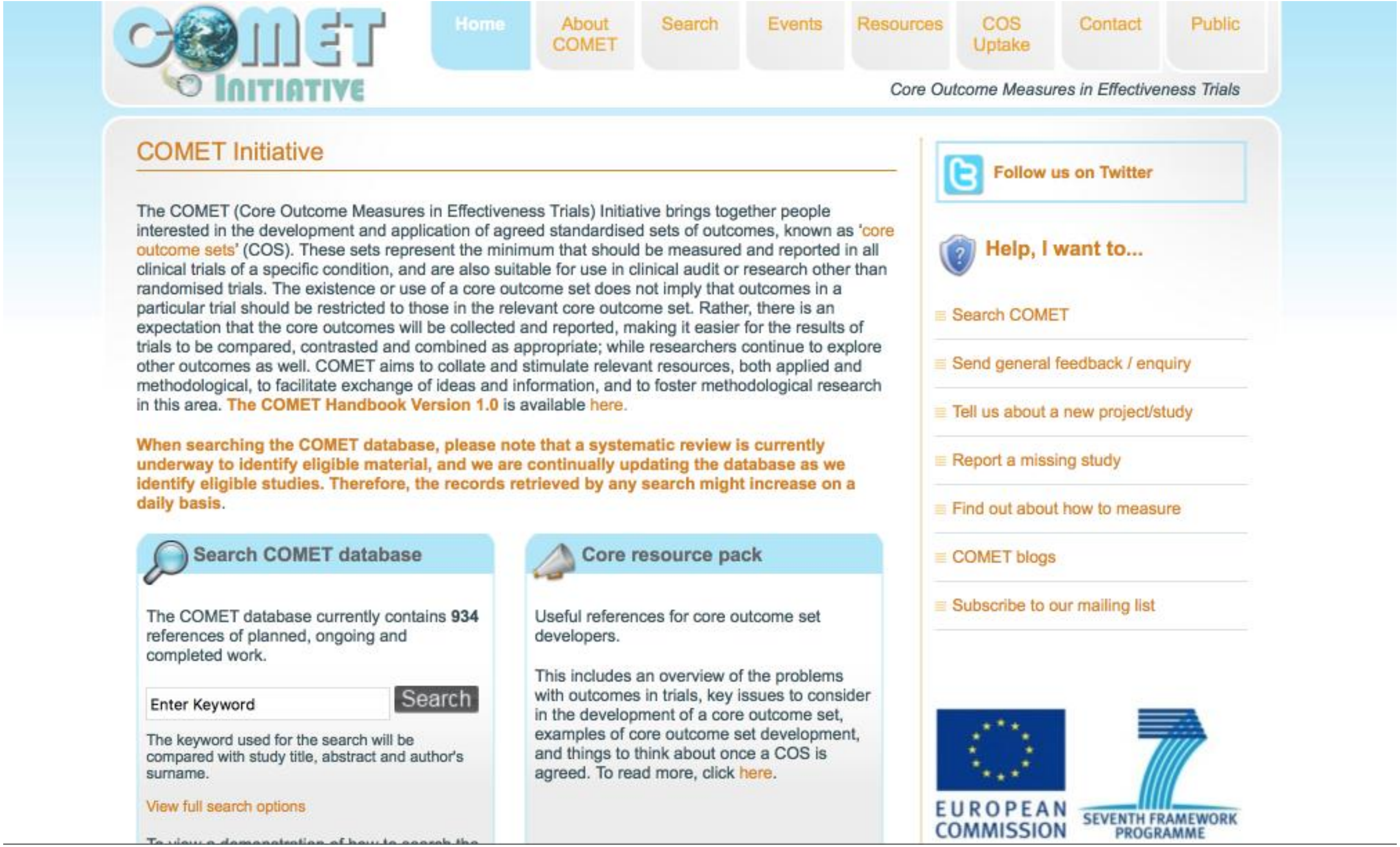
- They suggest **three zones**: GREEN 33% or less - safe

  YELLOW 34-44% -caution

  RED 45% above – high risk

Keynotes

- CRT is an unseen danger in patients receiving short as long-term central venous access
- CRT can be minimize
- The introduction of a BUNDLE seems to be more effective than single manoeuvres or preferences
- There is still a big debate related to the standardization of outcome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COMET Initiative
The COMET (Core Outcome Measures in Effectiveness Trials) Initiative brings together people interested in the development and application of agreed standardised sets of outcomes, known as 'core outcome sets' (COS). These sets represent the minimum that should be measured and reported in all clinical trials of a specific condition, and are also suitable for use in clinical audit or research other than randomised trials. The existence or use of a core outcome set does not imply that outcomes in a particular trial should be restricted to those in the relevant core outcome set. Rather, there is an expectation that the core outcomes will be collected and reported, making it easier for the results of trials to be compared, contrasted and combined as appropriate; while researchers continue to explore other outcomes as well. COMET aims to collate and stimulate relevant resources, both applied and methodological, to facilitate exchange of ideas and information, and to foster methodological research in this area. The COMET Handbook Version 1.0 is available here.
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Core resource pack
Useful references for core outcome set developers.
This includes an overview of the problems with outcomes in trials, key issues to consider in the development of a core outcome set, examples of core outcome set development, and things to think about once a COS is agreed. To read more, click here.
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