IX edizione

CRRT nursing

CORSO CRRT

L'accesso Vascolare

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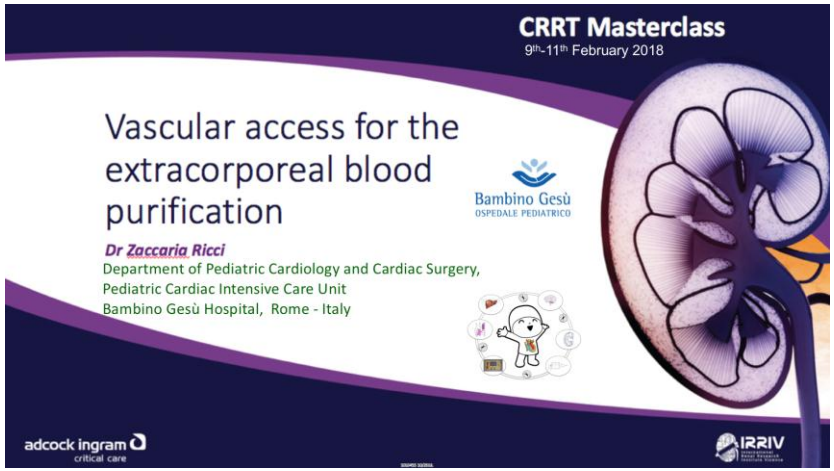
Agenda

- **L’accesso vascolare per CRRT**
- **Come gestire l’accesso vascolare, il suo corretto funzionamento, la prevenzione delle infezioni, il lock e le fasi di attacco.**

- **Il ruolo del nursing in questo importante aspetto**



Q:Is the catheter such a trouble spot?

- A: Yes, yes, yes! – It is the Achilles' heel of CRRT
- If the catheter is in the external iliac (flow at rest = 100-150 ml/min) and you ask for 200 ml/min with a side-hole catheter, the vessel wall will slam against the side holes and you will never get what you want.
- Flow will be chaotic. You need to sit close to the IVC

Determinants of catheter function

Position/site/technique

Composition/materials

Design/shape

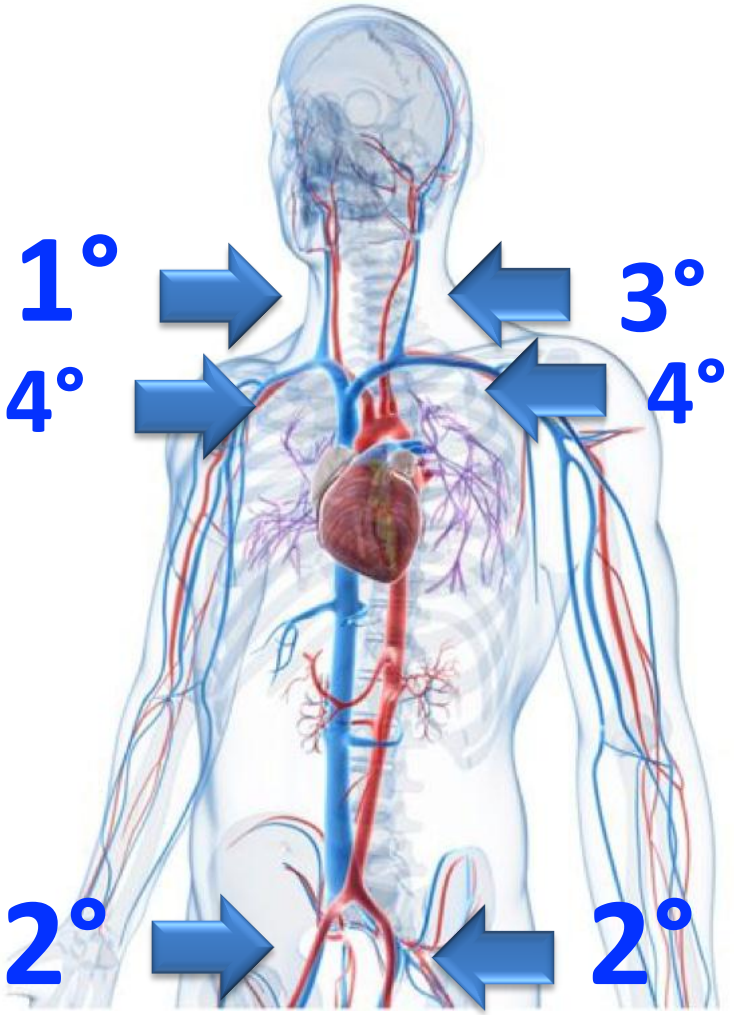
Maintenance

Position/site

Kidney Disease: Improving Global Outcomes (2012)

5.4.2: When choosing a vein for insertion of a dialysis catheter in patients with AKI, consider these preferences (*Not Graded*):

- First choice: right jugular vein;
- Second choice: femoral vein;
- Third choice: left jugular vein;
- Last choice: subclavian vein with preference for the dominant side.

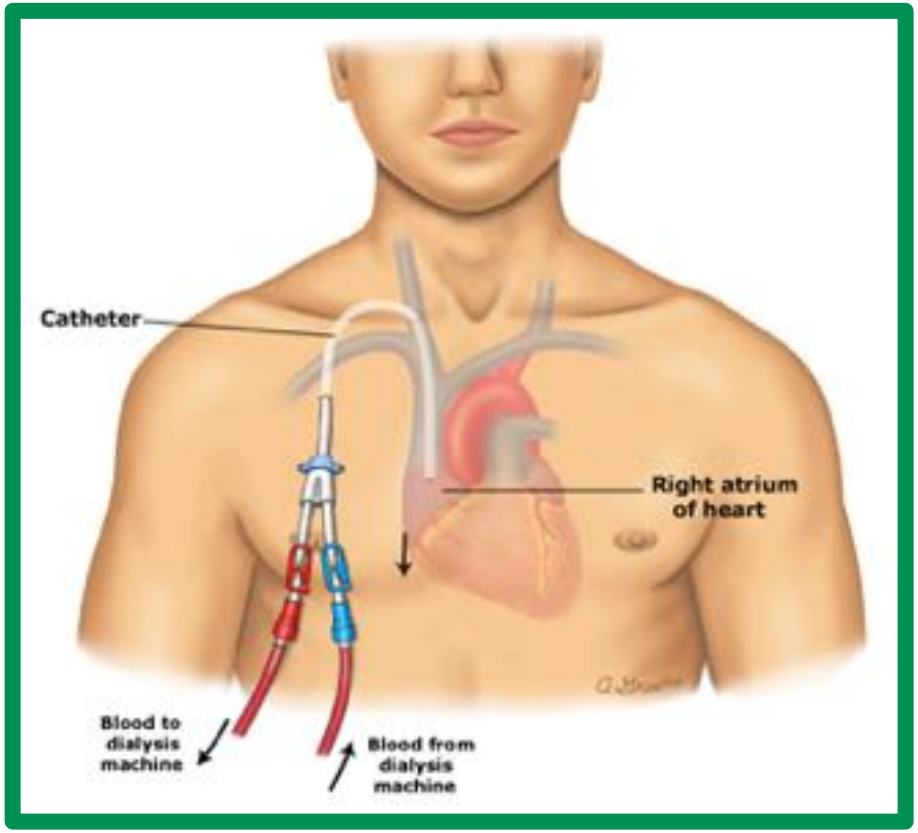


http://kdigo.org/home/guidelines/acute-kidney-injury/.

Position/site

The distal tip must be inserted in a **central venous territory** where the blood flow is maximal.

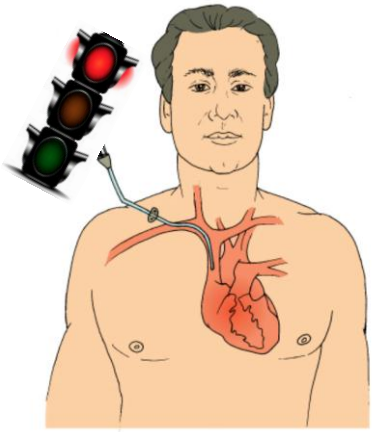
In the superior venous territory, the distal catheter tip should be located inside the superior vena cava at the junction with the right atrium.

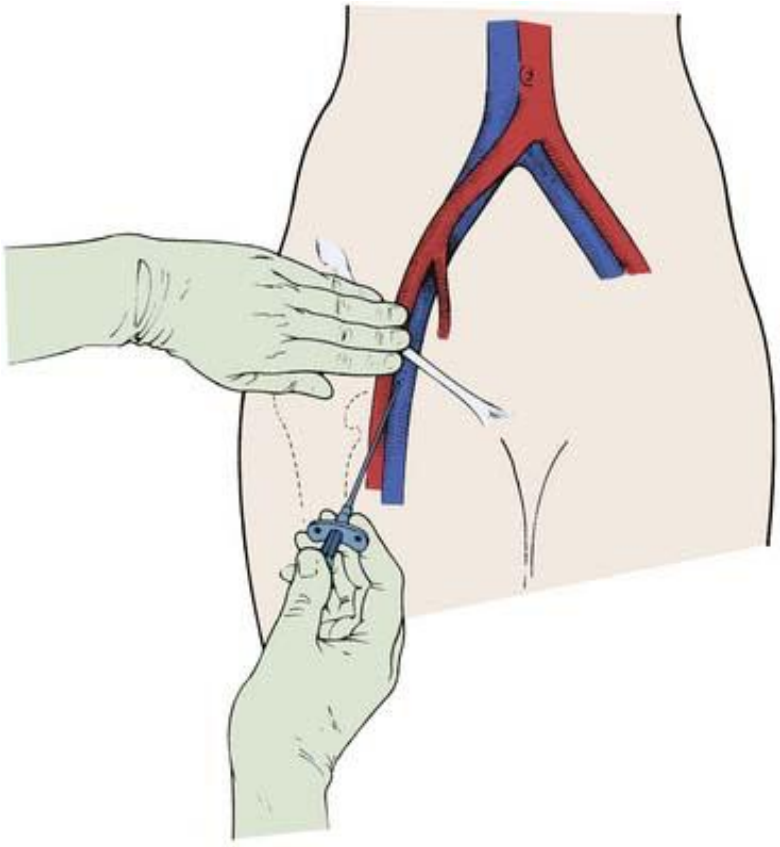


Huriaux L et al. Anaesth Crit Care Pain Med. 2017 Oct;36(5):313-319.

Position/site

The **femoral** (and **jugular**) sites are the preferred localizations.





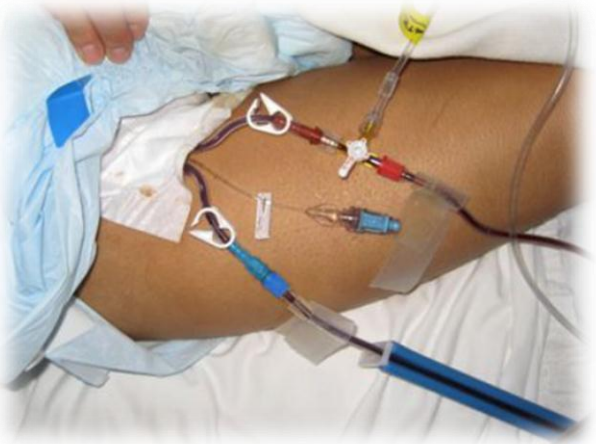
- A recent randomized trial demonstrated that the **femoral position was as efficient as the jugular site** in terms of catheter failures and dialysis performance in ICU patients

  Parienti JJ et al. Crit Care Med 2010; 38:1118–1125

Meersch M & Zarbock A. Curr Opin Critical Care 2018

In the **femoral** location, catheters **shorter than 25cm** or with lower flow capacity may predispose to **catheter dysfunction**.

Parenti JJ et al. Crit Care Med 2010; 38:1118–1125
Bellomo R et al. Blood Purif 2016; 41:11–17



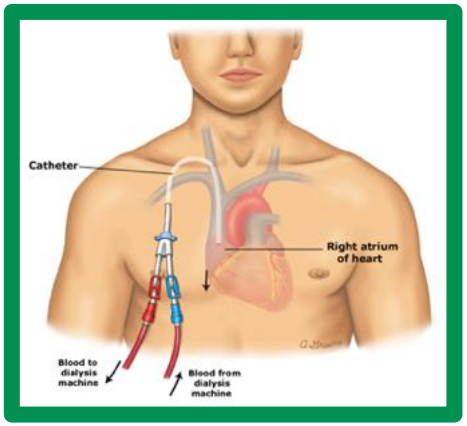
- The recommended femoral catheter length is therefore just **above 24 cm**

  KDIGO 2012; Dugué AE et al. Clin J Am Soc Nephrol CJASN 2012;7:70–7

Position/site & Catheter Related BloodStream Infection (CRBSI)

The internal jugular vein access should be considered for patients with a body mass index above **28 kg/m²** to avoid maceration and bacterial colonization at the femoral vascular access site.

Parienti JJ et al. JAMA J Am Med Assoc 2008;299:2413–22



Patients with **higher BMI** showed higher incidence of catheter-tip colonization in the **femoral** position.

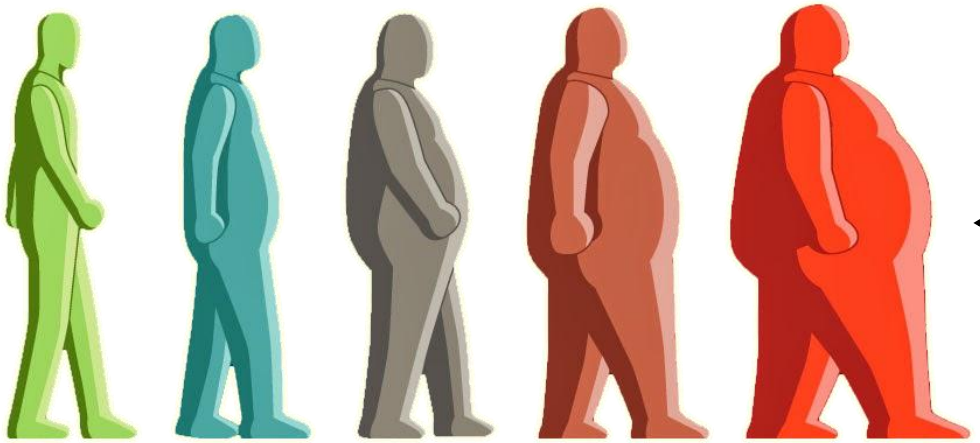
Parienti JJ et al. Crit Care Med 2010; 38:1118–1125

Position/site and CRBSI

Kidney Disease: Improving Global Outcomes (2012)

When stratified according to body mass index (BMI), those within the lowest BMI tertile had a higher incidence of **colonization with the jugular site**, whereas those within the highest BMI tertile had the highest **colonization rate with femoral catheters**.

Parienti JJ et al. JAMA J Am Med Assoc 2008;299:2413–22

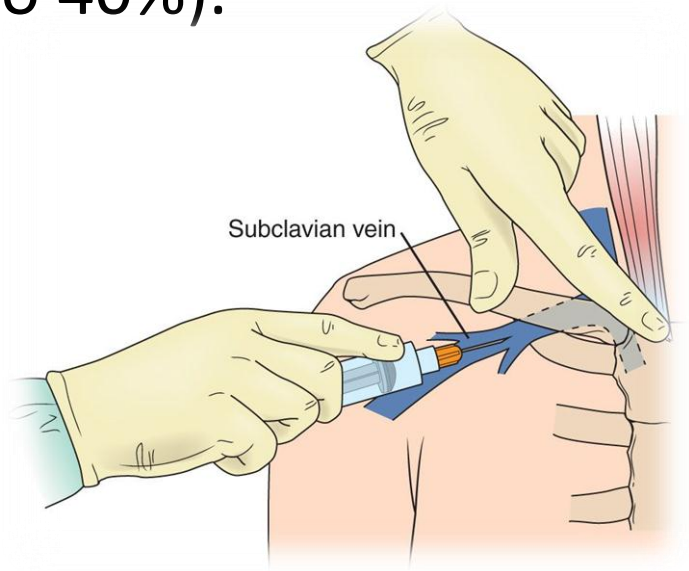


http://kdigo.org/home/guidelines/acute-kidney-injury/.

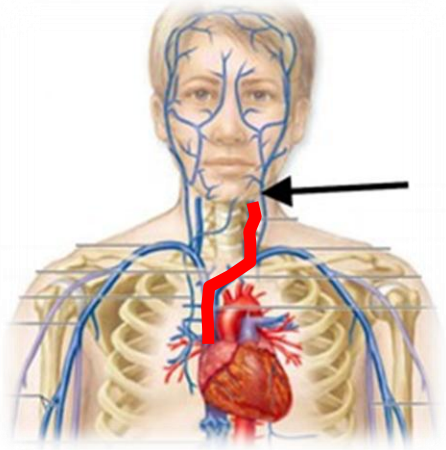
Position/site – subclavian – left IJV

Subclavian sites should be avoided because of a predisposition to venous stenosis (up to 40%).

Schillinger F, et al. Nephrol Dial Transplant 1991;6:722–4.



As AKI is strongly associated with end-stage kidney disease and consequently with the need for permanent vascular access, it is recommended to **preserve the subclavian sites**.



In the jugular location, access via the **left internal jugular vein** is be related to a higher degree of **catheter dysfunction** because of anatomical reasons.

An upper extremity venous access permits patient **mobilization** while promoting their rehabilitation.

Right Internal Jugular Vein

- Best flow
- No limitation to mobilization
- **Risk** on insertion (PNX, carotid puncture)

Left Internal Jugular Vein

- Limited flow do to **kinking**
- No limitation to mobilization
- **Risk** on insertion (PNX, carotid puncture)

Femoral Vein

- Good flow if adequate **length**
- **Easy** and fast to insert
- Limitation to mobilization

Subclavian Vein

- Good flow if adequate length
- Enhanced risk of **kinking** and **stenosis**
- **Difficult** insertion

Position/site – technique

Kidney Disease: Improving Global Outcomes (2012)

5.4.3: We recommend using ultrasound guidance for dialysis catheter insertion. (*1A*)

Ultrasound reduces the risk of placement failure, arterial puncture, and rates of complication.

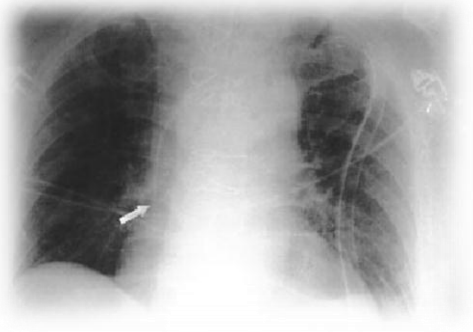
Rabindranath KS, et al. Am J Kidney Dis 2011; 58:964–970.

http://kdigo.org/home/guidelines/acute-kidney-injury/.

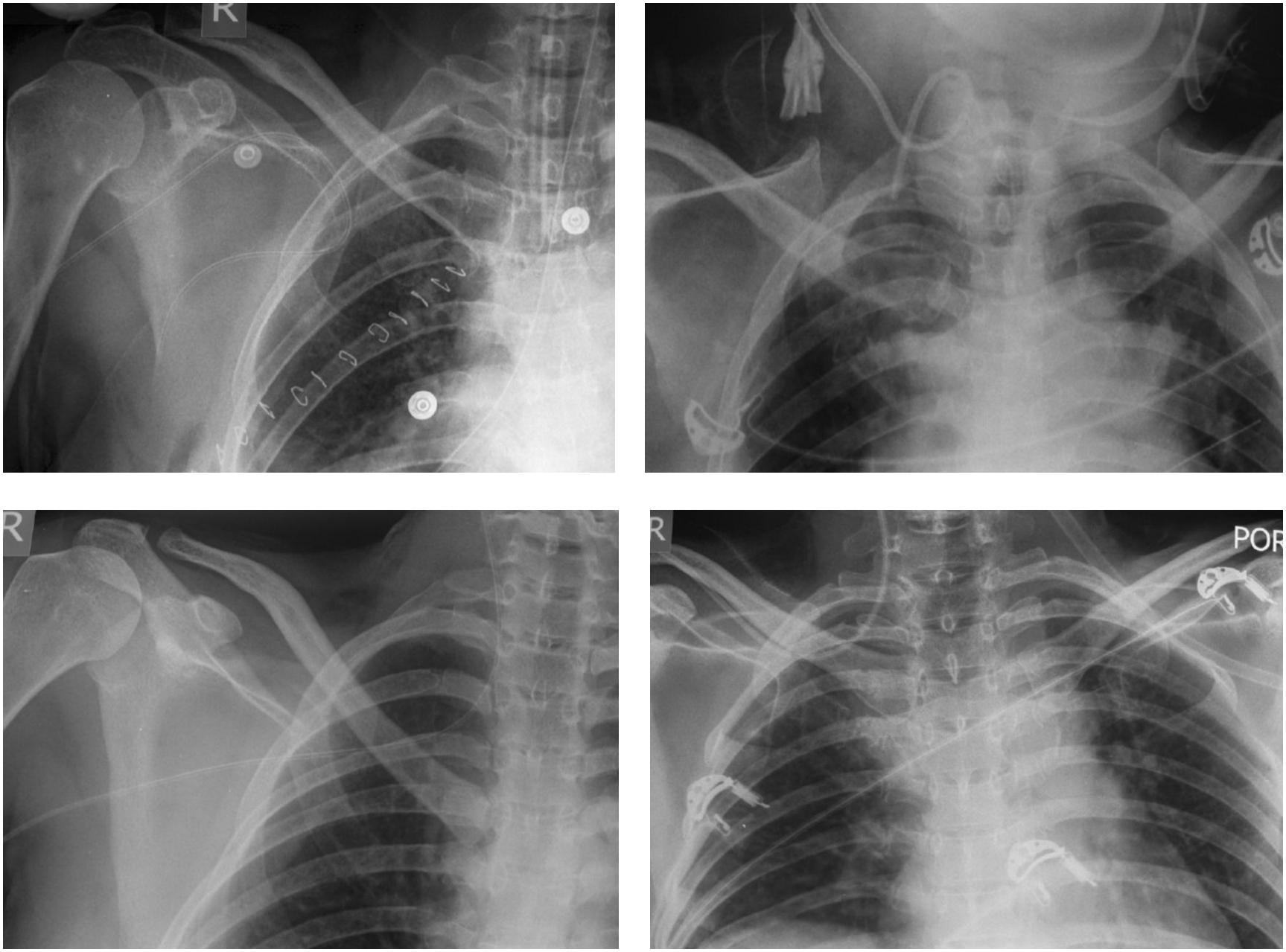
Position/site – technique

- The operator needs to follow a surgical **asepsis** process.
- The catheter must be inserted according to the **Seldinger** method.
- Venous anatomic variations are detected by the mandatory **ultrasound** guidance, which logically reduces the number of venous puncture failures and mechanical complications.

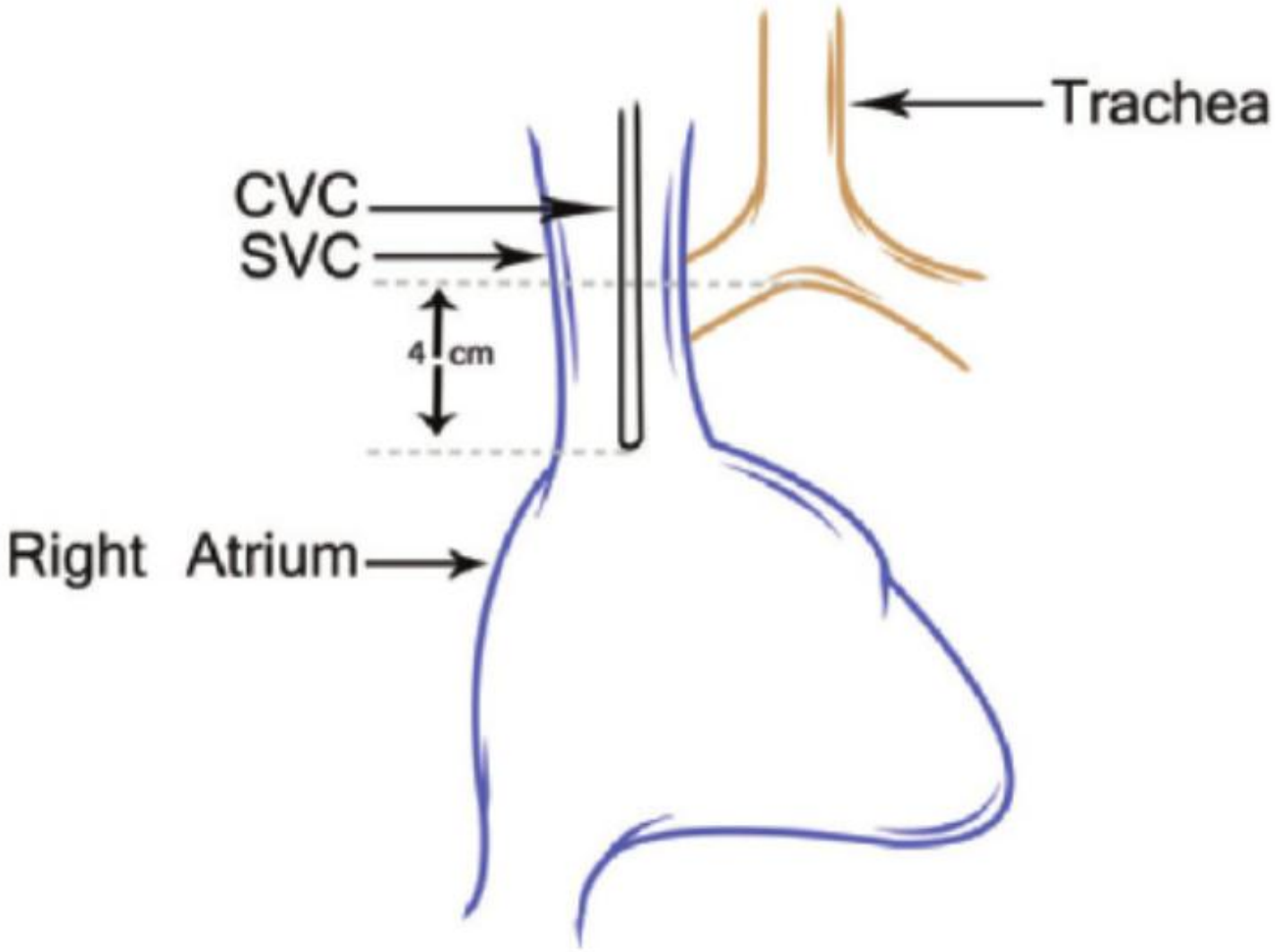
Rabindranath KS et al.Am J Kidney Dis 2011;58:964–70.
Prabhu MV et al. Clin J Am Soc Nephrol CJASN 2010; 5:235–9.



- **Chest radiography** is mandatory for verifying the correct position of the catheter distal tip in the superior vena cava territory before the initiation of the RRT.



Venugopal AN et al. J Anaesthesiol Clin Pharmacol. 2013 Jul-Sep; 29(3): 397–400.

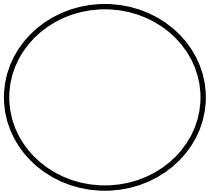


The junction of the SVC and right atrium lies about 4 cm below the level of the carina.

Composition/materials

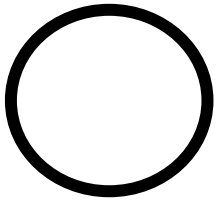
Haemodialysis catheters are made of **polyurethane** or **silicon**.

- Thin **polyurethane** catheter wall → larger internal diameter for a constant external diameter.



- Its **rigidity** makes insertion easier.
- Increased theoretical risk of vascular or atrial **trauma** during catheter insertion.
- Since these catheters are **thermoplastic**, they become more **flexible** at human body temperature. When the catheter is placed, it takes on the vessel shape and decreases trauma risk.

- **Silicon** - increased wall **thickness** → decreases the internal catheter diameter.



- More **flexible**, but their insertion is theoretically harder.
- Their flexibility decreases vessel trauma during insertion.
- Silicon **biocompatibility** makes catheters less thrombogenic.

Composition/materials

Polyurethan polymers

Better biocompatibility
Less kinking

Silicone polymers

Rigidity

Flexibility

Blood flow increases with the catheter **radius** and decreases as its **length** increases.

Jean Léonard Marie Poiseuille

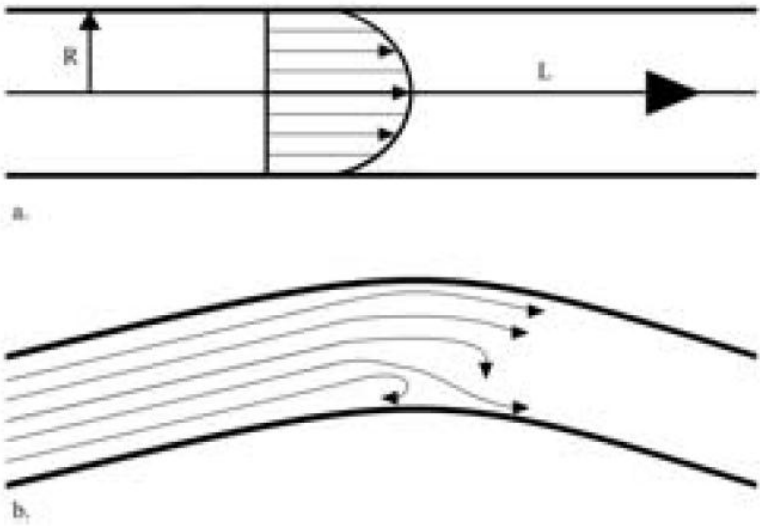
$$Qv = k\,(P \times R^4)/\,(L \times \eta)$$

A 12 Fr catheter theoretically allows a blood flow of approximately 250 mL/min
Naka T et al. Int J Artif Organs 2008;31:905–9

A catheter size between 12 and 13.5 Fr is sufficient for all RRT modalities used in the ICU.

In fluid dynamics, when a fluid flows in parallel layers, with no disruption between the layers, it is considered as a **laminar** flow.

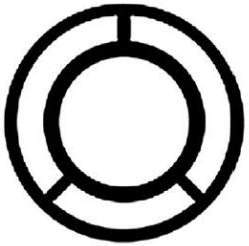
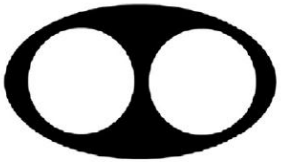
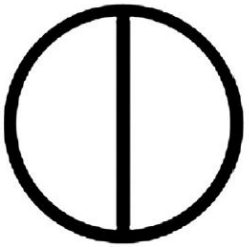
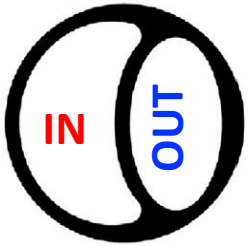
However, once a **catheter curves**, blood flow becomes **turbulent**.



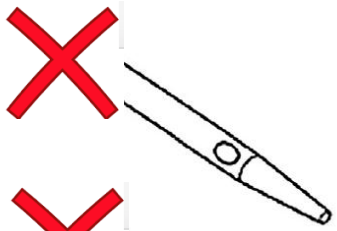
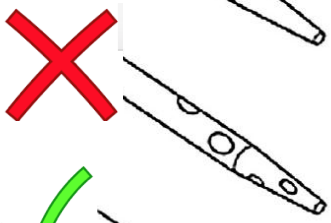
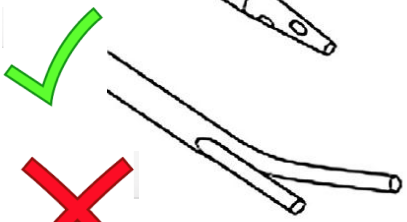
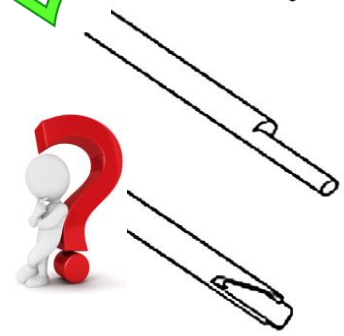
It is no longer a laminar flow; and velocity decreases. As a result, **the blood in the catheter and the extracorporeal system flows slower**, inducing a higher risk of catheter **thrombosis**.

Huriaux L et al. Anaesth Crit Care Pain Med. 2017 Oct;36(5):313-319.

Design & shape - section

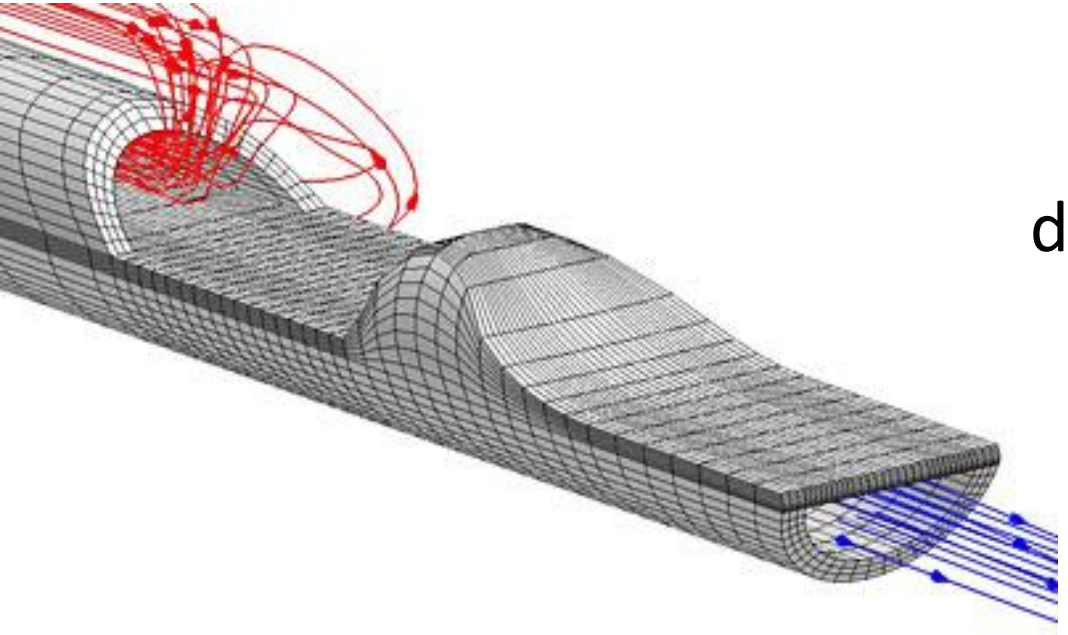
	Advantage	Disadvantage
 a. Co-axial	Small external diameter	Small inflow lumen Large blood contact surface Acute angles (turbulence)
 b. Double-O	Large lumens No angle (less turbulence)	Large external diameter
 c. Double-D	Large lumens	Large external diameter Acute angles along median wall
 d. Cycle-C	No acute angles Inflow lumen larger than outflow lumen Small external diameter	the cycle-C or kidney-shape catheter seems to exhibit the optimal form

Design & shape – distal tip

	Type	Advantage	Disadvantage
	Pointed catheter	Easy introduction	Recirculation Side hole: (parietal suction)
	Multiperforated Pointed catheter	Easy introduction	Turbolences
	Split tip	Less recirculation Laminar flow	Difficult insertion
	Multiperforated Split tip		Turbolences
	**Shotgun tip catheter (step tip)**	Less recirculation	
	Symmetric or Side-by-side catheter	Less recirculation Lumen inversion allowed	

Distance between inflow and outflow tips

Recirculation consists of having some newly dialyzed blood flowing into the same RRT circuit.



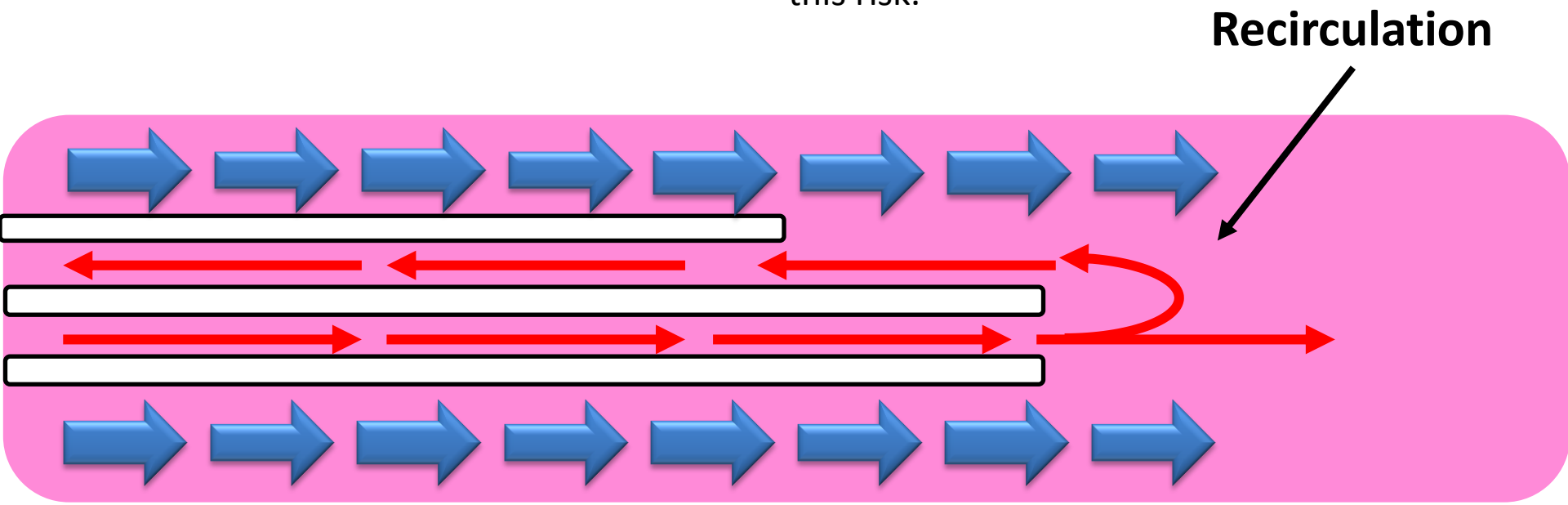
RRT partially loses its efficiency by diminishing the effective overall dialysis dose.

Huriaux L et al. Anaesth Crit Care Pain Med. 2017 Oct;36(5):313-319.

The two main determinants of recirculation are:

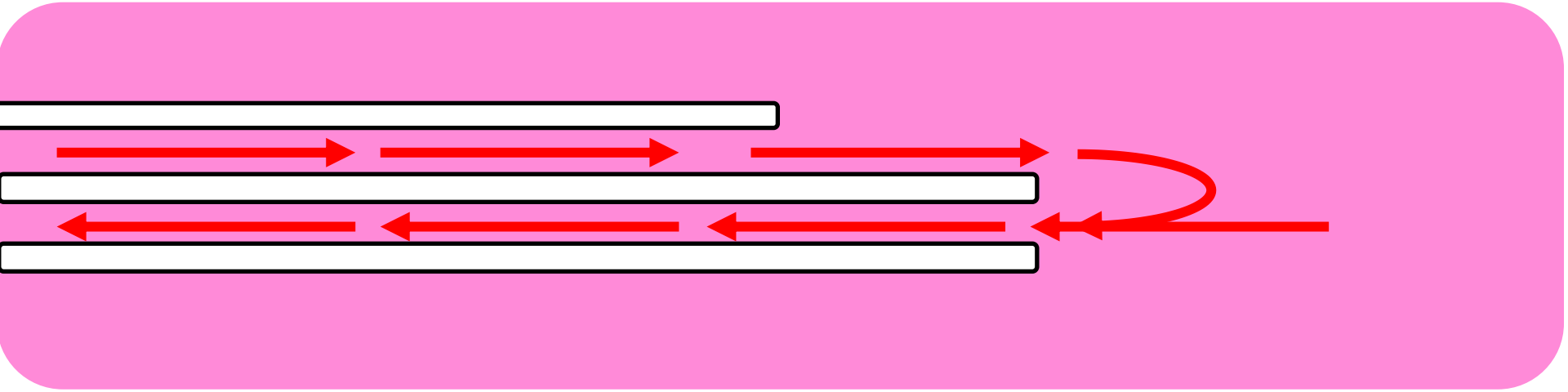
- Vascular blood flow in contact with the distal tip as well as
- The length of the interval between the aspiration and the reinjection holes.

According to empirical data, a **2- to 3-cm distance is recommended** for decreasing this risk.



Huriaux L et al. Anaesth Crit Care Pain Med. 2017 Oct;36(5):313-319.

Recirculation is also promoted by lumen reversal.



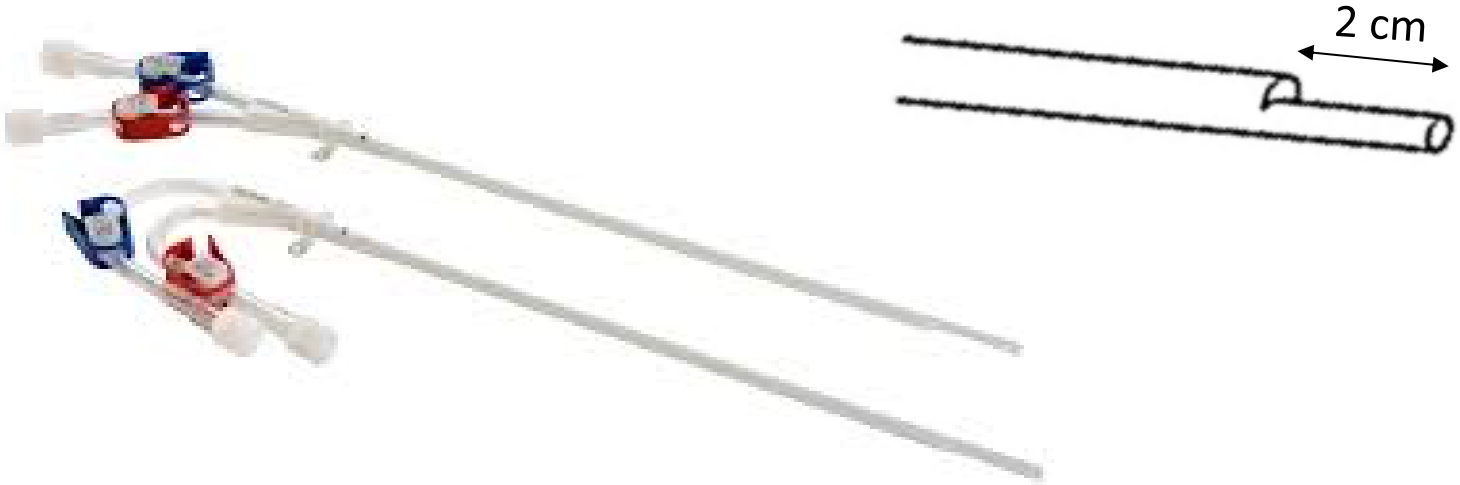
Dialyzed blood is re-injected into the bloodstream through the proximal venous tip.

This recirculation rate, around 23%, consequently decreases the administered dialysis dose

Tal MG et al. J Vasc Interv Radiol JVIR 2005;16:1237–40

Dual lumen, step tip catheters with the venous port 2–3 cm distal to the arterial port may be the preferred type of catheter. These catheters reduce the amount of recirculation and ensure maximal RRT performance.

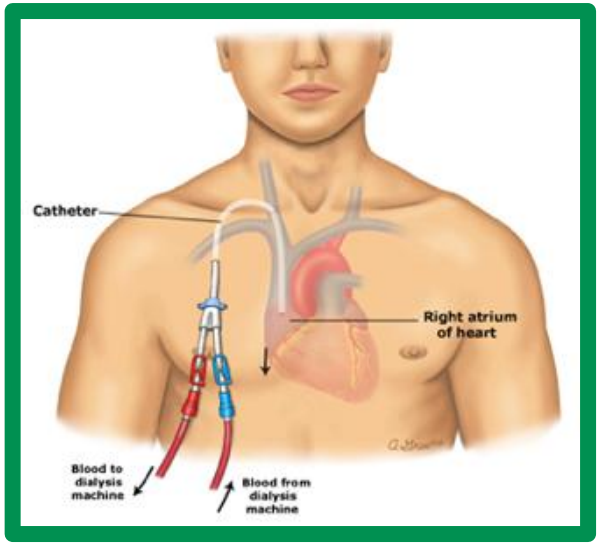
Meersch M & Zarbock A. Curr Opin Critical Care 2018



The obstruction or thrombosis of a RRT catheter lumen may explain numerous **losses of RRT circuits**.

In such cases, the effective blood flow is lower than prescribed, resulting in a **high filtration fraction** and subsequent early filter thrombosis.

The favored insertion site is at the right internal jugular vein, allowing the catheter to be less curved (**less turbulence**) and shorter (**less resistances**).



$$Qv = k\,(P \times R^4)/\,(L \times \eta)$$

Huriaux L et al. Anaesth Crit Care Pain Med. 2017 Oct;36(5):313-319.

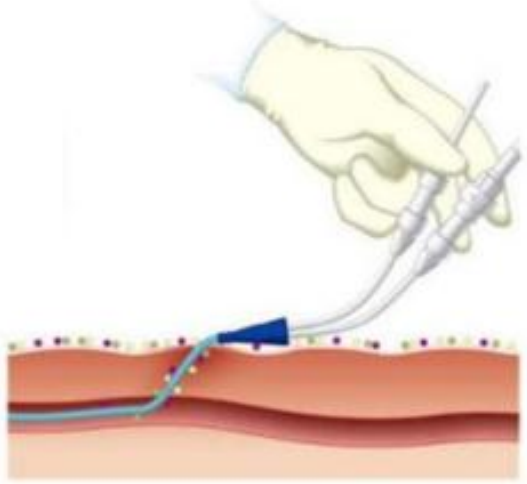
Catheter-Related BloodStream Infections (CRBSI)

Complications of temporary catheters include catheter-related bloodstream infections (CRBSI) and catheter-tip colonization.

As the risk is correlated to **exposure time**, daily reassessment of RRT–catheter is crucial.

CRBSI - Pathogenesis

- Migration of skin organisms at the insertion site into the **cutaneous catheter** tract and long the surface of the catheter with colonization of the catheter tip (most common rout for short-term catheters
- Direct contamination of the catheter or catheter **HUB** by contact with **hands** or contaminated fluids or device
- **Hematogeneous** seeding from another focus of infection (less common)
- **Infusate** contamination might lead to CRBI (rare)



SKIN ORGANISMS

HUB – "handling"

Bloodstream

Infusate

CRBSI

Kidney Disease: Improving Global Outcomes (2012)

The incidence of catheter-related bloodstream infection can be reduced by implementing education-based programs and so-called central-line bundles:

- Hand hygiene
- Maximal barrier precautions upon insertion
- Chlorhexidine skin antisepsis
- Optimal catheter site selection
- Daily review of line necessity

. . . **not using dialysis catheters** for applications other than RRT, except under emergency circumstances

http://kdigo.org/home/guidelines/acute-kidney-injury/.

Strategies for Prevention of Catheter-Related Infections

- Education, Training and Staffing
- Selection of Catheters and Sites
- Hand Hygiene and Aseptic Technique
- Patient Cleansing
- Catheter Securement Devices
- Antimicrobial/Antiseptic Impregnated Catheters and Cuffs
- Antibiotic/Antiseptic Ointments
- Antibiotic Lock Prophylaxis, Antimicrobial Catheter Flush and Catheter Lock Prophylaxis

IL PROTOCOLLO GAVECELT 2017 PER LA PREVENZIONE DELLE INFEZIONI DA DISPOSITIVI PER ACCESSO VENOSO

CORRETTA INDICAZIONE

CORRETTA ASEPSI

Igiene delle mani con gel idroalcolico, prima dell'impianto e prima e dopo ogni manovra di gestione; massime **precauzioni di barriera** durante l'inserzione di dispositive per accesso centrale o accesso periferico di lunga durata; **antisepsi cutanea** con clorexidina 2% in alcool – in applicatori monodose sterili – prima dell'impianto e al momento del cambio della medicazione.

IL PROTOCOLLO GAVECELT 2017 PER LA PREVENZIONE DELLE INFEZIONI DA DISPOSITIVI PER ACCESSO VENOSO

SCELTA CORRETTA DEL SITO DI EMERGENZA

TECNICA CORRETTA DI IMPIANTO

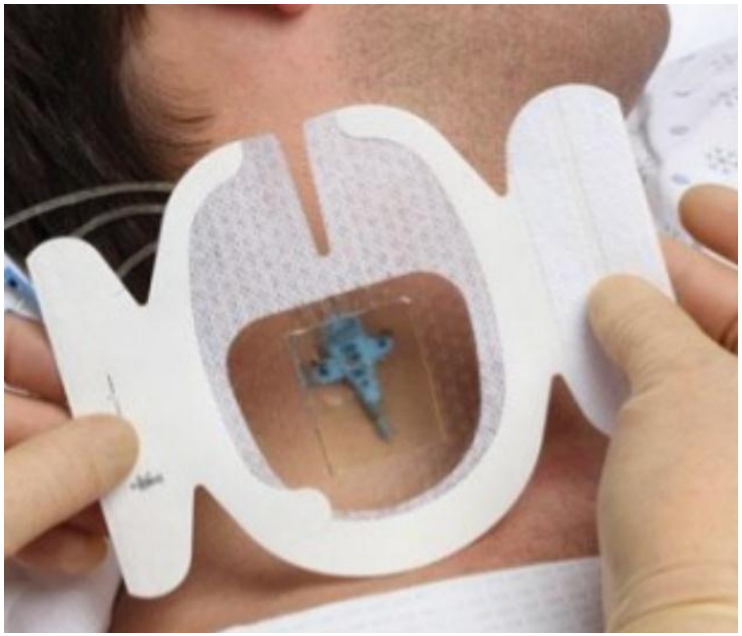
Utilizzare sempre l'impianto **ecoguidato** per il posizionamento dei dispositivi centrali e dei dispositivi periferici di lunga durata.

FISSAGGIO APPROPRIATO

Evitare sempre punti di sutura e cerotti; stabilizzare invece il dispositivo con un sistema **sutureless** appropriato (integrato nella medicazione, o ad adesività cutanea, o ad ancoraggio sottocutaneo).

IL PROTOCOLLO GAVECELT 2017 PER LA PREVENZIONE DELLE INFEZIONI DA DISPOSITIVI PER ACCESSO VENOSO

PROTEZIONE DEL SITO DI EMERGENZA



Utilizzare membrane trasparenti semipermeabili ad alta **traspirabilità**, associate a feltrini a rilascio di **clorexidina** o a sigillo del sito di emergenza con colla al cianoacrilato.

GAVeCeLT
Gli Accessi Venosi Centrali a Lungo Termine

Journal of
Infusion Nursing

Infusion Therapy Standards of Practice

(estratto del testo tradotto in Italiano)

29. CATETERI VENOSI PER EMODIALISI

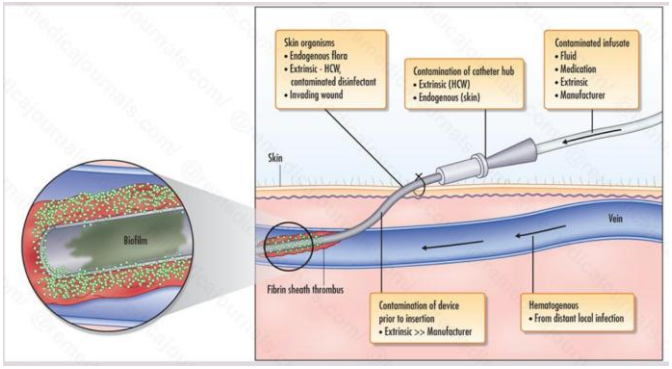
29.1 La scelta del tipo più adeguato di catetere venoso per l'emodialisi deve avvenire in collaborazione con il paziente/caregiver e con il **team multiprofessionale**, in funzione del piano terapeutico previsto.

Quando si cambia la **medicazione** di un catetere venoso per dialisi oppure una medicazione che copre una fistola artero-venosa o una protesi artero-venosa, occorre indossare **guanti sterili e mascherine**.

Utilizzando un catetere per dialisi **tunnellizzato** con cuffia ormai stabilizzata è sufficiente l'uso di guanti puliti

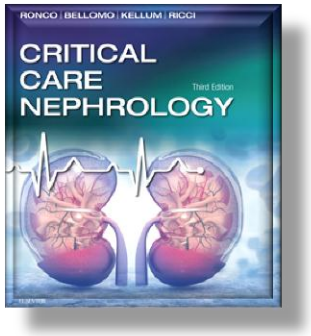
CRBSI – Lock solutions

The goal of a **prophylactic "lock" solution** is to decrease **thrombi** and **biofilm** formations that trigger catheter colonization and catheter-related bloodstream infections.



Staphylococcus Aureus (on biofilm)

Catheter-locking solutions based on **antithrombotic/antiseptic** or **antibiotic** or **fibrinolytic** mixtures have proved to be efficient in preventing endoluminal contamination by bacteria and reducing catheter-related bloodstream infections (CRBSI).

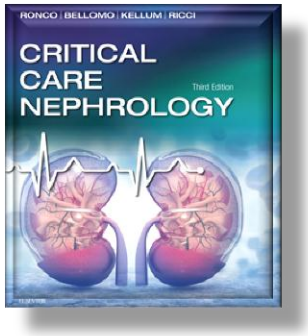


MC Weijmer et al. Nephrol Dial Transplant. 17:2189-2195 2002 12454232
M Allon. Clin Infect Dis. 36:1539-1544 2003 12802753
CW McIntyre et al. Kidney Int. 66:801-805 2004 15253736
M Agharazii et al. Nephrol Dial Transplant. 20:1238-1240 2005 15855206

Most of the studies concern tunneled haemodialysis catheters and extrapolation to non-tunneled catheters seems limited.

L. Huriaux et al. Anaesth Crit Care Pain Med 36 (2017) 313–319

Significant benefits of these approaches have been proved in randomized controlled prospective studies evaluating **citrate** or **citrate/taurolidine** mixtures.



R Boorgu et al. ASAIO J. 46:767-770 2000 11110278
B Bayes, et al. Nephrol Dial Transplant. 16:1521-1522 2001
MG Betjes, et al. Nephrol Dial Transplant. 19:1546-1551 2004 14993498
CE Lok et al. Nephrol Dial Transplant. 22:477-483 2007

- Catheter-locking solutions, using an antithrombotic, antiseptic, and fibrinolytic mixture of agents have **proved superior efficacy** to prevent thrombosis and/or infection.

- **Heparin is no longer the state-of-the-art** lock solution because it facilitates Staphylococcus aureus biofilm formation.

- All catheter-locking solutions (single or dual activity) must be evaluated in terms of **specific indications** (e.g., patients at risk, salvaging option) and cost-effectiveness or risk (antibiotic resistance) before they can be recommended for routine clinical practice.

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Haemodialysis catheters in the intensive care unit

Laetitia Huriaux [a,*], Paul Costille [a], Hervé Quintard [b], Didier Journois [c], John A. Kellum [d], Thomas Rimmelé [a]

- The use of lock solutions could theoretically lead to **increased costs as well as to bacterial resistance**.

- To date, due to lack of evidence, we do not recommend lock solutions.

- The exception could be patients with long-term catheters who have a history of multiple catheterrelated bloodstream infections despite strict adherence to aseptic practices

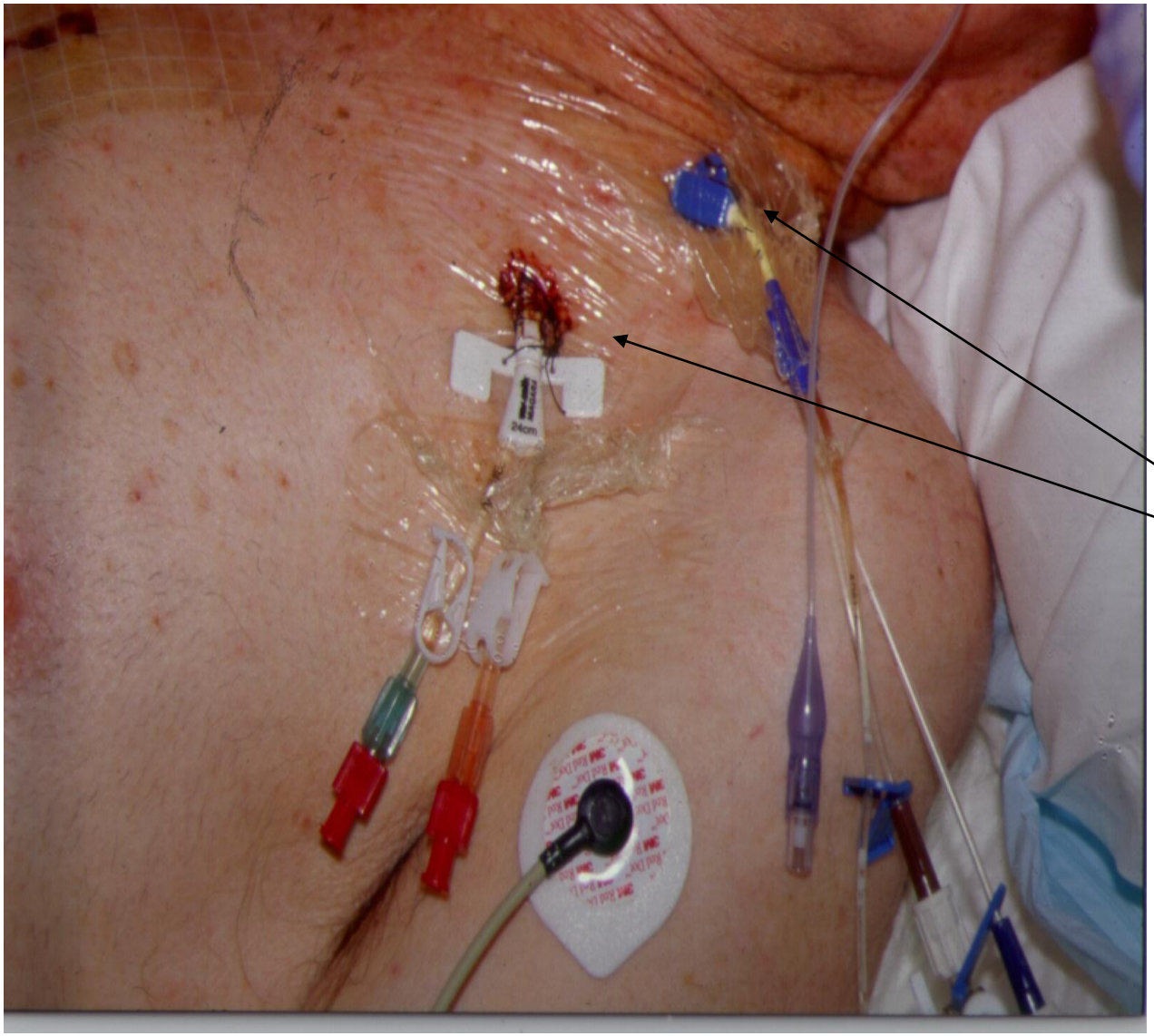
CRBSI – Lock solutions

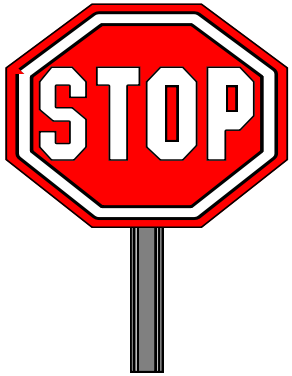
CDC guidelines **strongly recommend against** routinely using antibiotic lock solutions in CVC, because of their potential to promote fungal infections, antimicrobial resistance, and systemic toxicity.

5.4.6: **We suggest not using antibiotic locks for prevention of catheter-related infections of nontunneled dialysis catheters in AKI requiring RRT. (*2C*)**

Exceptions . .

- long-term cuffed and tunneled catheters with history of multiple catheter-related bloodstream infections despite maximal adherence to aseptic technique
- […] or patients with heightened risk of severe sequelae from a catheter-related bloodstream infection





Keep access catheter away from CVC lines, as drugs may be drawn into CRRT circuit when they sit adjacent to each other in the SVC

e.g. inotropes

Courtesy Dr. Z. Ricci

The ”ideal” catheter (?)

1) Optimal external **diameter** according to modality: > 12 Fr
   Size matters!

2) Optimal **shape**: cycle-C catheter (still under investigation!)

3) Optimal distal **tip**: shotgun tip catheter (step tip)

4) Preferred insertion **site**: right jugular or femoral (the jugular site is best in fat people … the femoral site is best in normal or thin people

5) **Avoid** left jugular and subclavian insertion sites

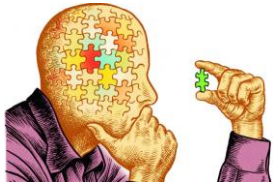
6) No line **reversal**

7) Use **ultrasound** guidance

8) Check correct position with chest **radiography** (superior vena cava territory)

9) **Remove** it as soon as possible!

Final Thoughts



Dialysis catheter is a CRITICAL component of the RRT circuit

Adequate catheter selection (site, size, length, material, design…) can minimize complications and improve the quality of the treatment

Access issues MUST be identified and fixed rapidly !

IX edizione

CRRT nursing

CORSO CRRT

L'accesso Vascolare

GRAZIE

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