X 10th Congresso GAVeCeLT Congress

4-5 Dicembre December 4th - 5th

Diagnosis and treatment of PICC occlusion

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DISCLOSURE

CLINICAL DEFINITION : PRECISE DEFINITION IS REQUIRED

Complete description of the catheter function

- The catheter function should be described by both
  the injection and
  the aspiration ability

CINAS = **C**atheter **IN**jection and **AS**piration classificazione

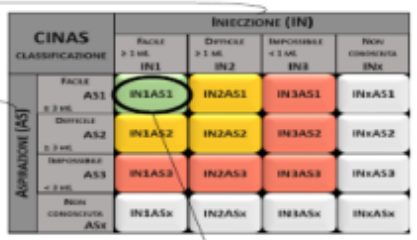
Classification of the catheter function on a 1 to 3 scale

- 1 = facile
- 2 = difficile/ if nor easy, nor impossible
- 3 = impossibile
- X= non conosiuta

- Malfunction definition

"Any condition where, at least, injection or aspiration is no longer easy but has become difficult or impossible"

Goossens GA, 2011



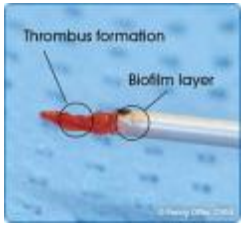
IN1AS1= a well-functioning catheter

UZ LEUVEN

http://gavecelt.it/nuovo/biblioteca/goossens-cinas-classification

9th GAVECELT 2015

CLINICAL DEFINITION AND ASSUMED CAUSES OF OCCLUSION : BEDSIDE

PARTIAL OCCLUSION (IN2AS2 *or* X)	WITHDRAWAL OCCLUSION (IN1 *or* 2 AS3)	COMPLETE OCCLUSION (IN3AS3)
Decreased ability to infuse fluids; resistance to flushing and aspiration Sluggish flow through the catheter	Inability to aspirate blood but ability to infuse without any (or poor) resistance	Inability to infuse and withdraw blood
Maybe caused by Intraluminal thrombus *or* Tip misplacement *or* Drugs/PN deposits or precipitates 	 **Maybe caused by** Fibrin tail *or* Sleeve formation *or* Combination of sleeve and clot formation *or* Tip misplacement 	**Maybe caused by** Clot or Plug (drugs, PN, precipitates, mixture) *or* mechanical (clamping of tubing, PICC) *or* Thrombosis 

All photos by Penny Offer

When do you need an X-ray?

- **An X-ray is useful to be sure that:**

the PICC tip is correctly located

Hydrochloric acid, Sodium bicarbonate 8.4%, Sodium hydroxide infusions can safely been administrated, without extravasation risk

- **Why do you prescribe the X-ray only after failure of the bedside thrombolytic treatment?**

To limit X-ray exposure,

To avoid loosing time and patients transports

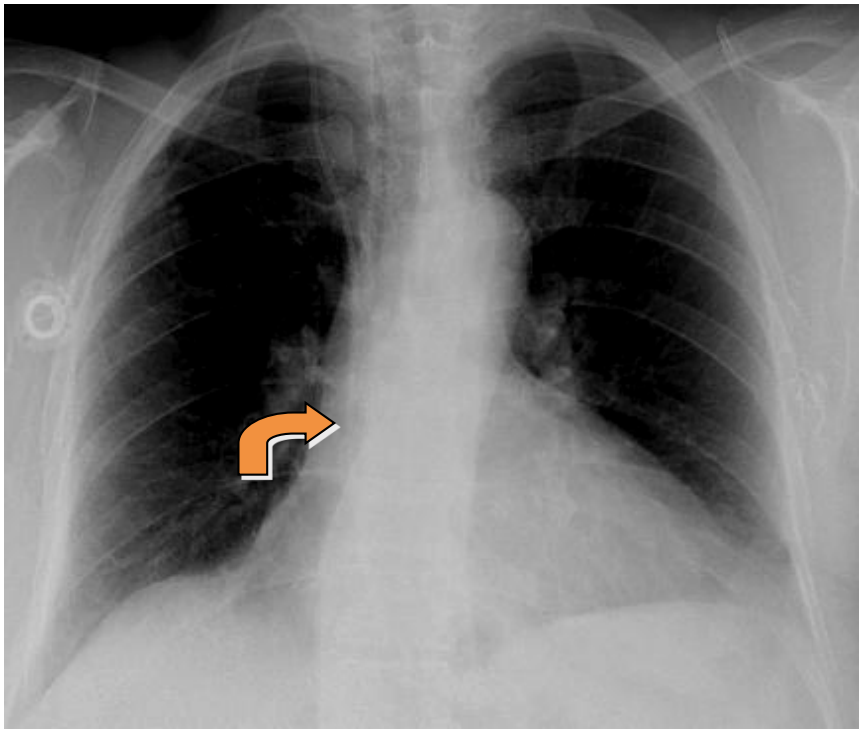
- X ray first when strange sensations/pain or when:

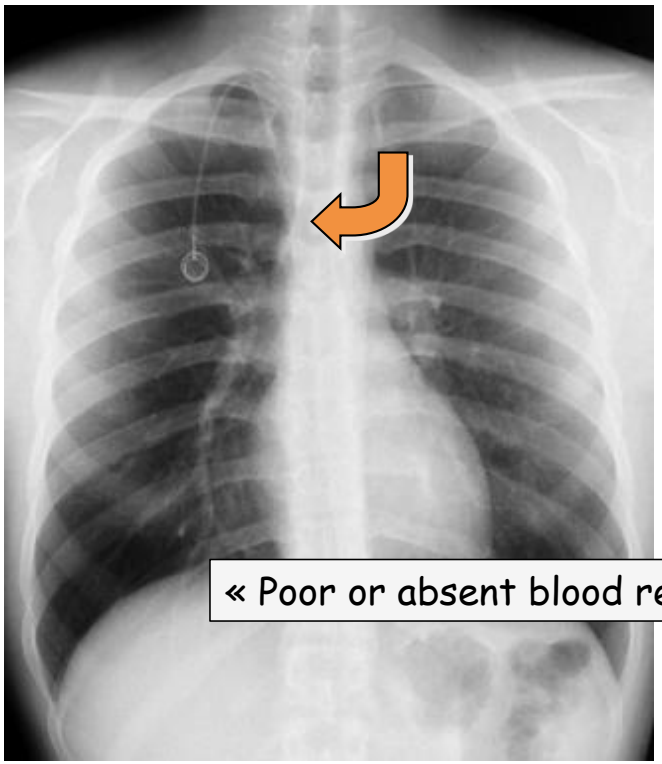


All photos by C. Dupont

ASSUMED CAUSES OF OCCLUSION AFTER THE FAILURE OF BEDSIDE MEDICAL TREATMENT

« Mechanical » problems



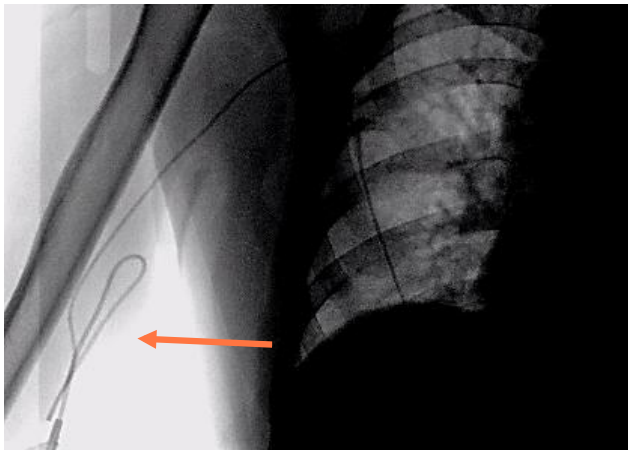


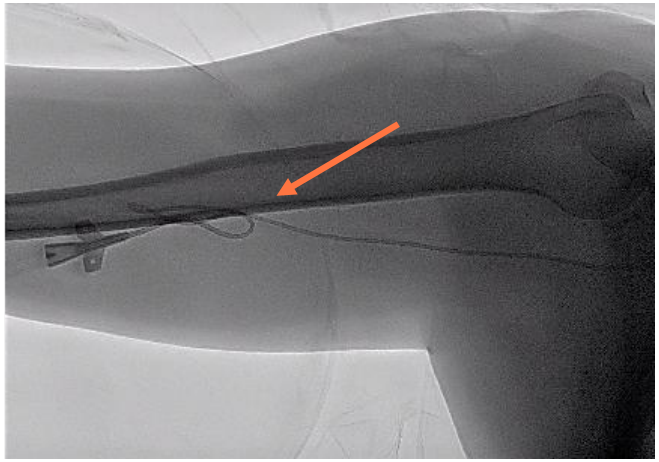
All photos by I. Kriegel

ASSUMED CAUSES OF OCCLUSION AFTER THE FAILURE OF BEDSIDE MEDICAL TREATMENT

« Mechanical » problems

PICC displacement after correct insertion and tip location





All photos by UZ LEUVEN

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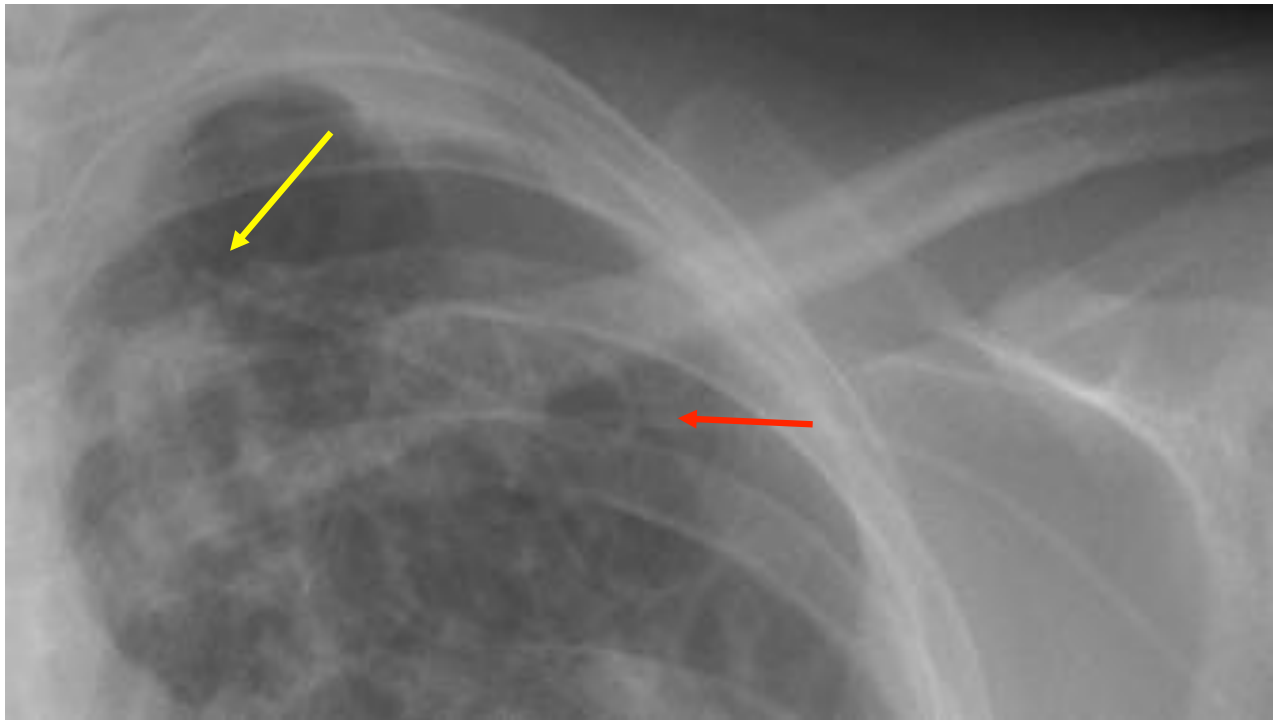

All photos by C. Dupont

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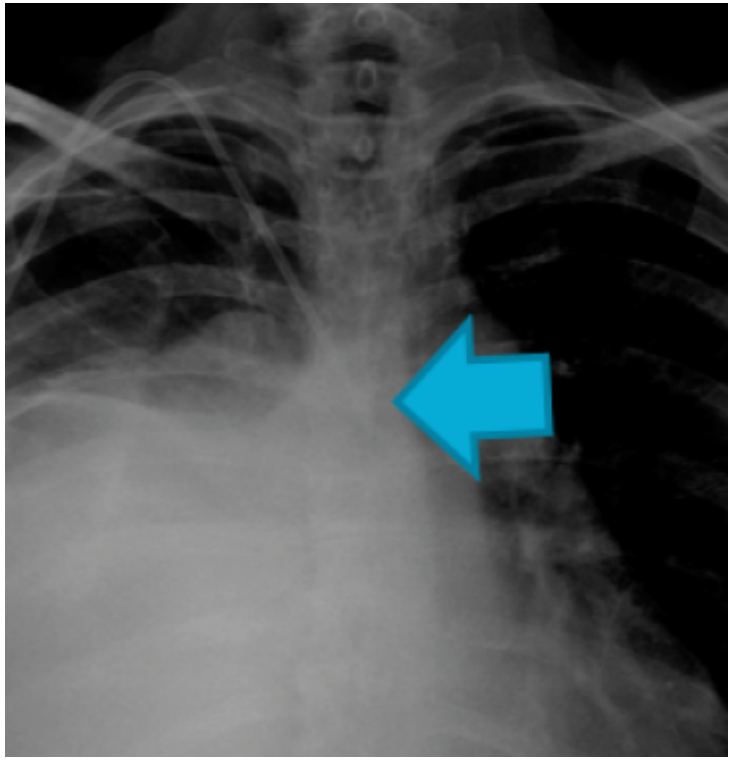
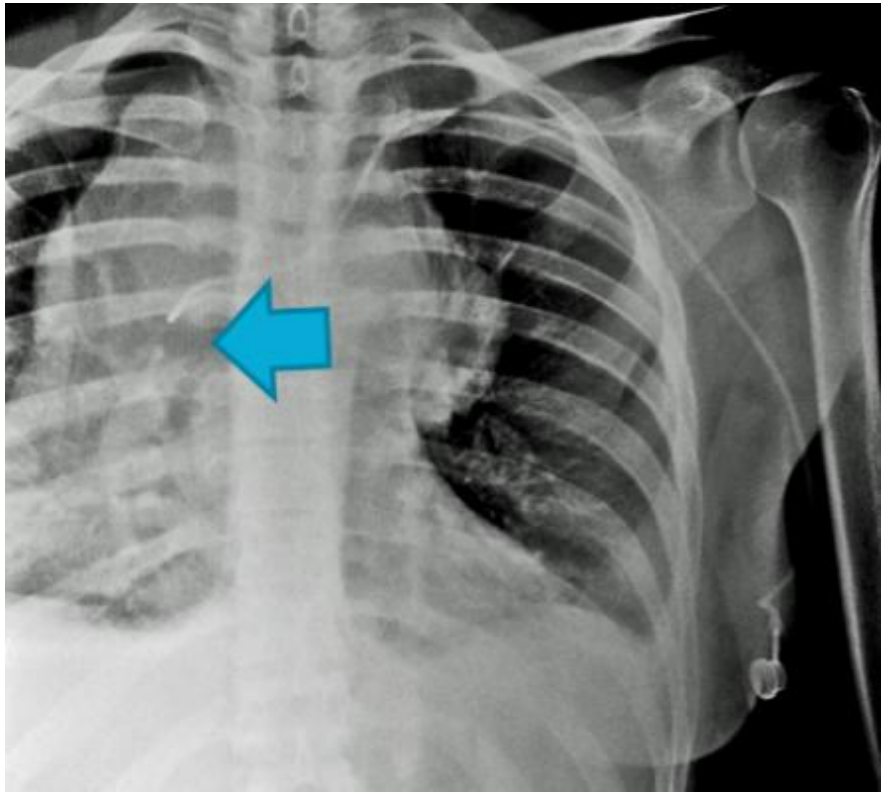


Tip against SVC



All photos by P.-Y. Marcy

What is the plug made of?

•Blood, Precipitates, Contrast media, Lipids

•Most of the time, its composition is mixed and not precisely identifyed

•Shape ? Size? Homogene material?

Unknown

•Exact location in the catheter?

Unknown

All photos by C. Dupont

Through which mechanisms can we clear the lumen?

Main objective : to reduce plug adherence to the support

- By dissolution-degradation of the plug *(fibrinolytics, hydrochloric acid, sodium bicarbonate 8.4%, sodium hydroxide)*

- By applying on the plug a higher pressure than the adherence force *(syringe on the hub, guidewire insertion in catheter)*

- By deforming the support of the plug *(Depression/Pression)*

Chemical nature of the obstruction	Treatment
Lipids	**Ethanol - ethyl alcohol** (CVAA 2013) **50 to 70% Ethanol** (Gavecelt 2016) **70% Ethanol** (INS 2016)
Contrast media	**Molar bicar 8,5%** (Gavecelt 2016)
Alkaline drug precipitate (pH > 7)	**Sodium bicarbonate 8.4% or Sodium hydroxide 0.1 mmol/L** (CVAA 2013,INS 2016, GAVECELT 2016)
Acidic drug precipitate (pH < 6) And Amino acid mix in PN	**0.1N hydrochloric acid** (INS 2016, GAVECELT 2016) And **amino acid mix in PN** (CVAA 2013)
Pure thrombus	**Thrombolytics** **urokinase** (Gavecelt 2017 , Muller 2010, Leuven 2017) **rtPA** (CVAA 2013, Gavecelt 2017) **tPA, alteplase, urokinase**, **retaplase**, **tenectaplase**, and **alfimeprase** (INS 2016) **Note: Heparin is not a thrombolytic drug**
Thrombus mixed with other substances	Suspicion of fibrin and lipid mixture: start with **urokinase or other thrombolytic drug**, If the occlusion remains: **NaCl 0.9%** then **Sodium hydroxyde (NaOH)**. (Leuven 2017) In case of occlusion assumed due to drug precipitates, start with **Urokinase** , 2nd . **NaCl 0.9%** , 3rd: **other products** (depending on the composition of the obstructing material). (Leuven 2017)

Chemical treatments: Which products have been tested and recommended?

70% ethanol : Inject a sufficient volume to fill the catheter lumen. For pediatric patients, a dose of 0.55 mL/kg has been used with no more than 3 mL maximum. (INS 2016) 2 injections max. (CVAA 2013, INS 2016) → Efficacy ?
Molar bicarbonate 8.5%→ Efficacy ?
Sodium bicarbonate 8.4% or sodium hydroxide 0.1 mmol/L 2 inj max. (CVAA 2013) → Efficacy ?
0.1N hydrochloric acid → Efficacy ?
Urokinase-bicarbonate or other product? 4 inj max. (Leuven 2016) → Efficacy ?

Chemical treatments of partial occlusions : Which products concentrations and volumes have been tested and recommended?

All photos by UZ LEUVEN

Brown color = red blood cells freed from PN mixture

Urokinase 10 000 UI/mL(Gavecelt 2017) , 2 mL = 20 000 UI (Muller 2010), **3 mL= 15 000 UI** (Leuven)

Rtpa 2 mg/mL(CVAA 2013, Gavecelt 2017) -> 2 INJ MAX

(tPA, alteplase) 2 mg/2 mL, which is allowed to remain in CVAD lumen for 30 minutes to 2 hours and repeated 1 time if necessary, is recommended as safe and effective in restoring catheter patency in neonatal, pediatric, and adult patients.

For pediatric patients weighing 30 kg or less, use the same concentration; however, the volume of tPA should be equal to 110% of the catheter priming volume. (INS 2016)

Urokinase, **retaplase**, **tenectaplase**, and **alfimeprase.** (INS 2016)

Study about PICC occlusion	Dose of Urokinase	Declotting	Hemorrage
Son et al 2014, Vasc Specialist Int	5000 IU/mL 30 min Max 2 inj	87,5%	None
Muller et al 2010, J Radiol	20 000 IU/2 mL 30 min	93,8%	None
Bui et al 2009, J Cystic Fibrosis	5 000 IU/ mL 30 min Max 2 inj	80%	None

Thrombolytic treatments of partial occlusions : Which products concentrations and volumens have been tested and recommended?

Chemical treatments: practical considerations

- Inject the solution as close as possible to the plug

- Do we know the PICC priming volume? Do we care for this in all patients or only in children?

- Withdrawal and discard of degradation products prior to flushing the lumen is recommended <u>but…</u>

… Sometimes repeated injections are required without succeeding to reach the product occluding the catheter. Is this dangerous?

- What are the effects of hydrochloric acid and sodium hydroxide outside the PICC lumen? (CVAA 2013)

- Use ethanol with caution: ethanol may damage some polyurethane PICCs.

→ Refer to manufacturers' directions for use regarding exposure to any form of alcohol.

- Alcohol makes the proteins precipitate and stick them on the inner wall of the PICC. Is alcohol a good choice and which concentration is needed?

Chemical treatments: practical considerations

- In anycase, the chemical treatment should begin by injecting a thrombolytic product
- Altéplase® properties are inhibited or altered in the presence of dextrose
- What is the most efficient concentration of Urokinase? Is there a threshold?
- Is the time spend to clear the lumen related to the thrombolytic concentration?
- How long do we have to wait before giving up?

Efficacy of thrombolytic lock (1 to 3 days and more)

Mechanical treatments

• **Guidewire**:

Not recommended (The GAVeCeLT manual of PICC and Midline). In any case of use, it should be completed by a fibrinolytic treatment

• **Injection with « over-pressure »** (here also, end with thrombolytic drug to clear the catheter):

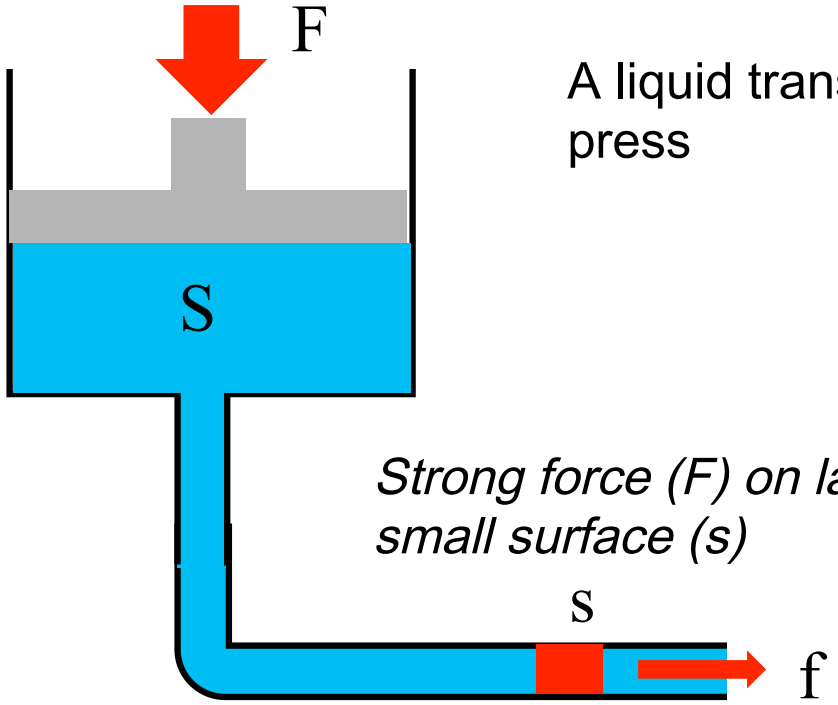
GAVECELT 2016: “if the catheter is of silicone or PUR material, but is not power injectable, 10 ml syringes must be used to unblock it hydraulically to avoid excess pressure in the system. If PICC is power injectable, 5 ml or 2 ml syringes can be used, as they apply greater pressure: such pressure will, in any event, be lower than 325 psi (which is the pressure resistance limit for power injectable catheter)

Usually, the procedure involves repeated infusion of few millimetres of saline solution under pressure, preceded by pumping or small, rapid movements of aspiration/infusion, in order to mobilize the agregates that obstruct the lumen. “

Infusion Nurse Society 2016, Sf2h 2012, 2013: *« Use a syringe no smaller than 10 mL for administration of a thrombolytic or catheter clerance agent. »*

What about the clot coming in the blood circulation?

Foundations :Forces / Pressure

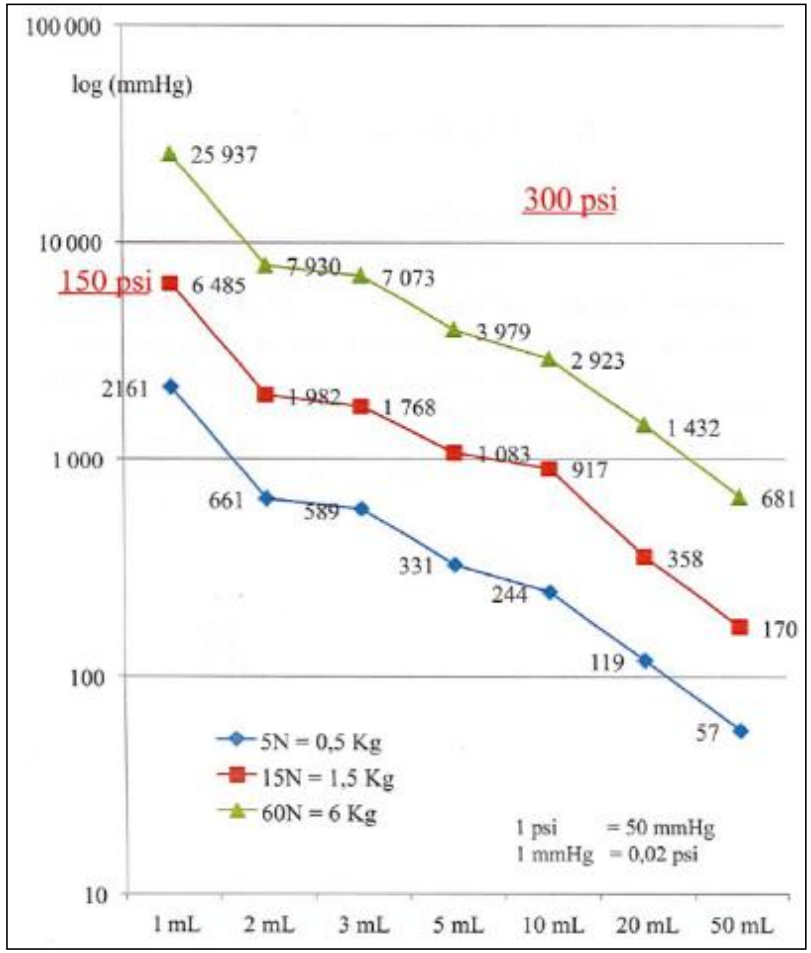


A liquid transmits pressure: principle of the hydraulic press

(Pressure) $P = \frac{F}{S} = \frac{f}{s}$

Strong force (F) on large surface area (S) = weak force (f) on small surface (s)

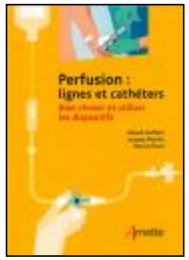
Foundations :Forces / Pressure



837g => **11,2 psi**

1000 g/cm² => 14,2 psi

=> 710 mmHg



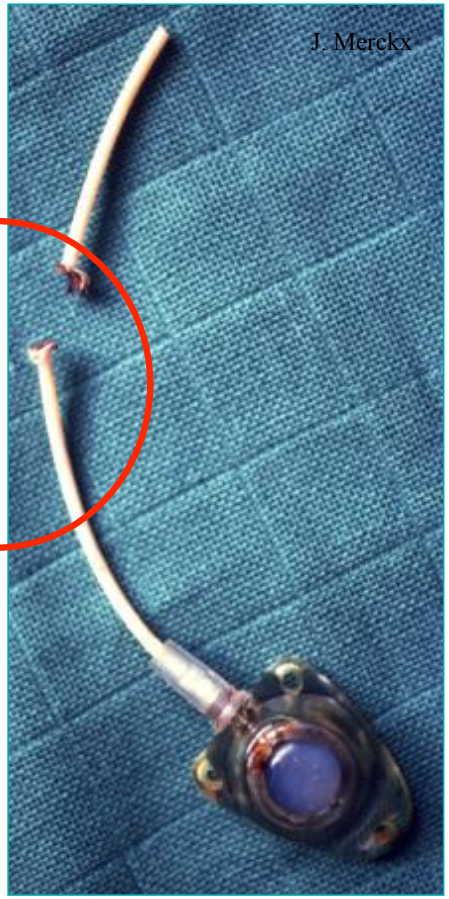
Pressure (Psi) applied by actively pressing the plunger

But risk of interpretation of this information -> Misuse

Misuse+
Silicone+
Extrusion

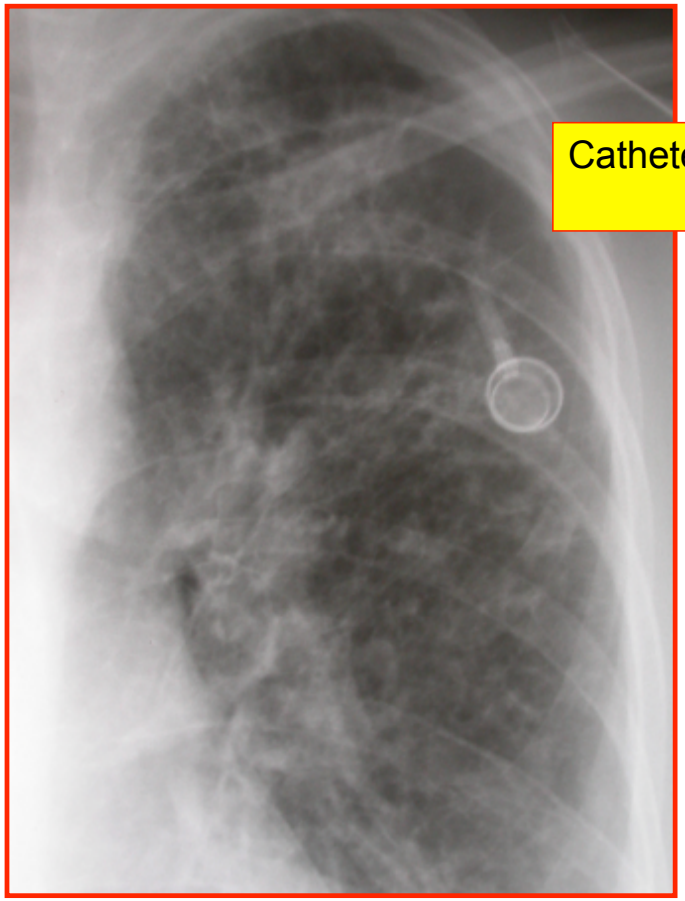
(= heterogeneity and weakened integrity)

=

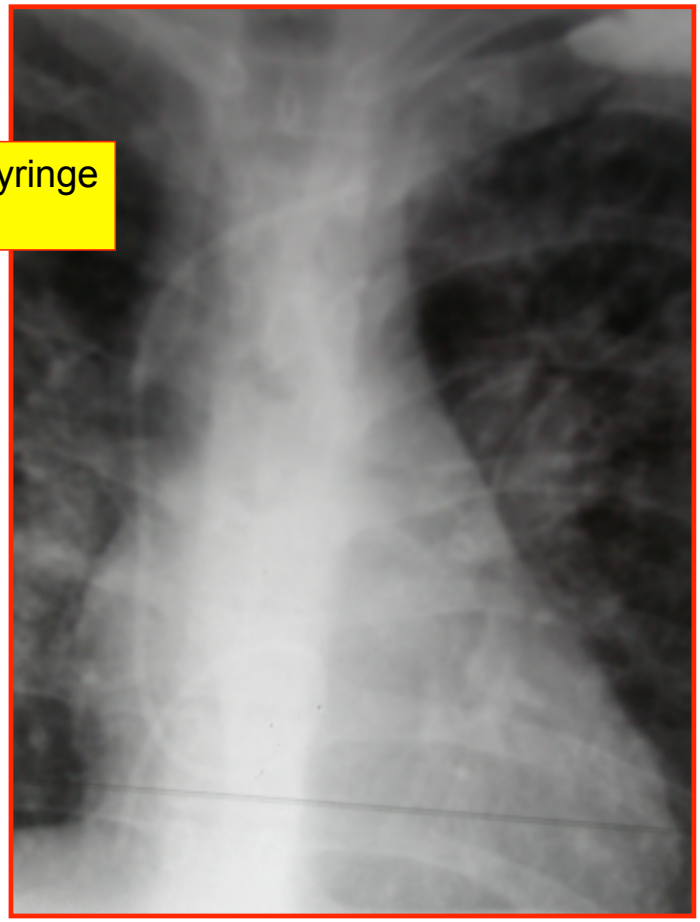


Catheter breakage by using a 2 ml syringe
= too much pressure

But risk of not being gentle anymore
-> Misuse

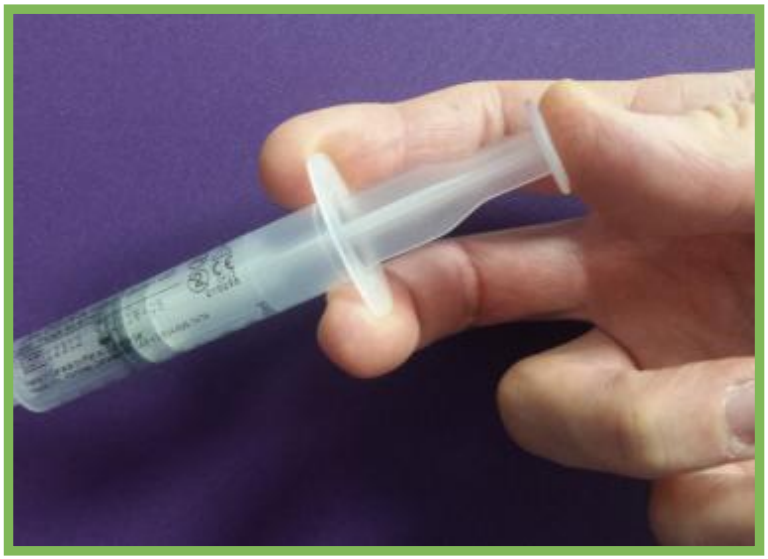


Catheter breakage by using a 10 ml syringe
With high force



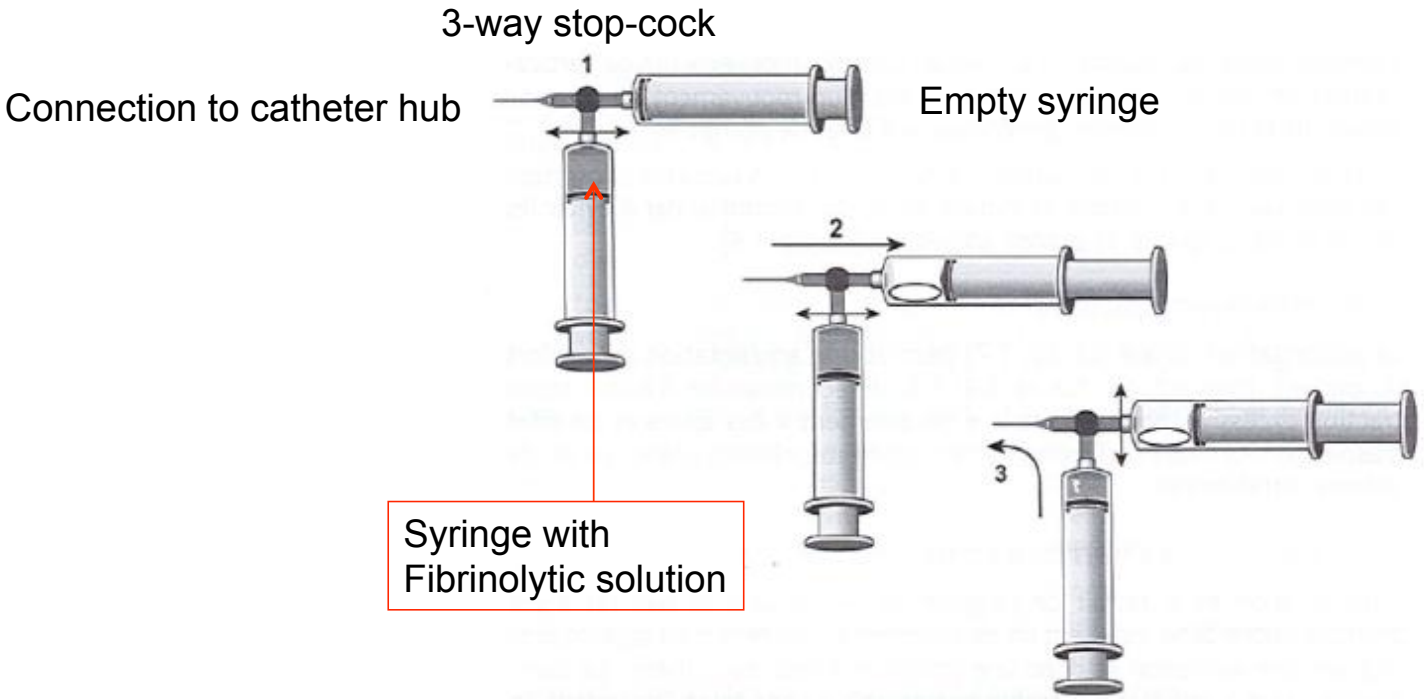
All photos C. Dupont

BE GENTLE, USE YOUR THUMB



TOO HIGH is THE FORCE

All photos C. Dupont except Yoda unfortunately



- Injection by using the « negative pressure » technique:
  no high pressure risk and still efficient

MAYO, 1998

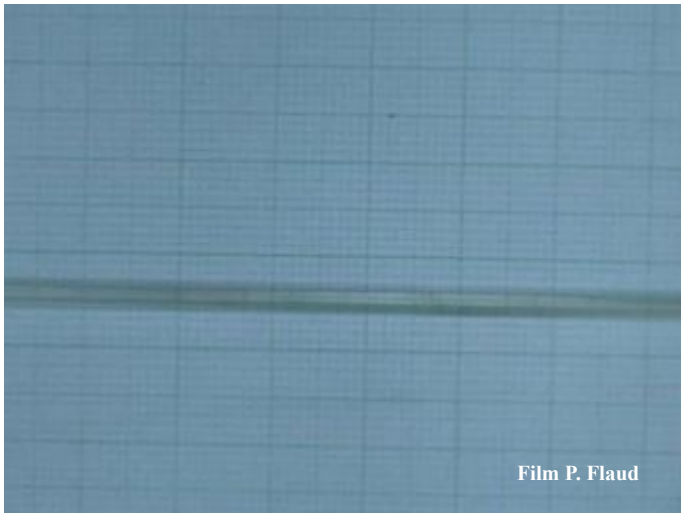
Mechanical treatments: practical considerations

Injection under « over-pressure »:

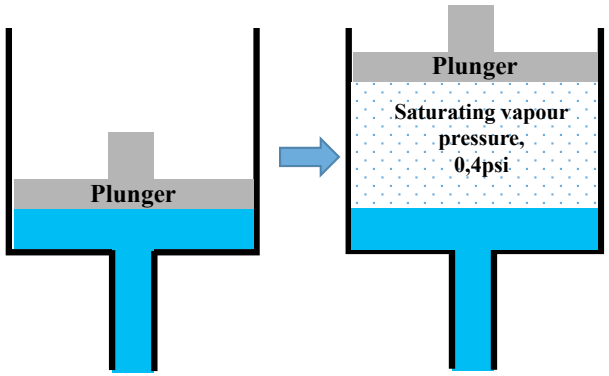
GAVECELT 2016: “Usually, the procedure involves repeated infusion of few millimetres of saline solution under pressure, preceded by pumping or small, rapid movements of aspiration/infusion, in order to mobilize the agregates that obstruct the lumen.”

Foundations: Physical effects of a depression

Liquid remains at same level



Foundations: Physical effects of a depression



- Pulling back the plunger creates a depression which brings some of the liquid to the vapour state (liquid/vapour equilibrium)
- This depression can force dissolved gases out of the solution

Water saturation vapour pressure (NS)
≈ 3000Pa ≈ 3 % atm. pressure

Segmentation risk of the liquid column

➢ Risk : Can lead to the creation of a gas layer between plunger and liquid

• POP Technique

- First description

David Stewart. Care of the critically ill, 17(3) June 2001

"Fill a 5cc or 10cc syringe with 1 mL Normal Saline (NS)
Connect the syringe to the hub of the occluded catheter
Hold the syringe vertically and pointing downward
Pull the piston to the very end of the shaft and release briskly

Repeat procedure every 2 seconds until patency is restored
Discard blood and rinse with a Heparin/saline solution "

(according to Stewart)

- Possible alternatives

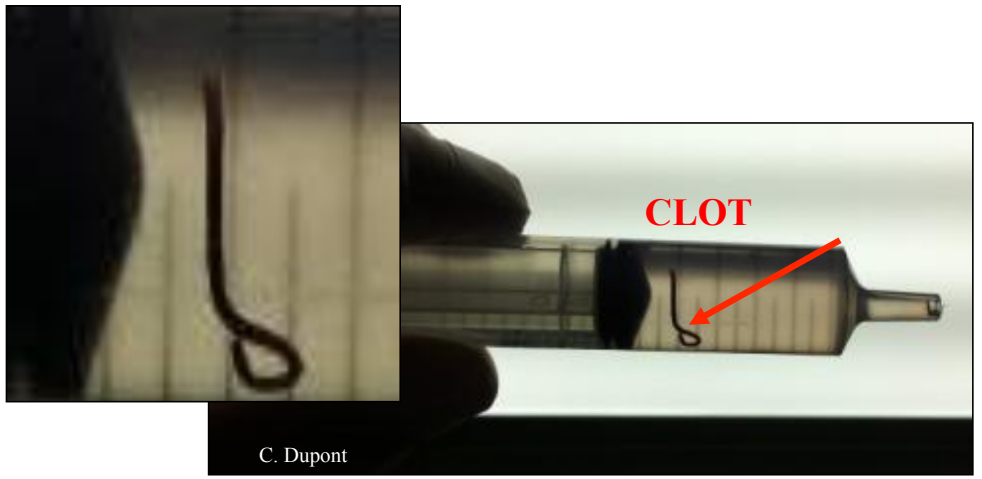
  - Repeated piston pull and stepwise release: pumping

  - Repeated piston pull followed by pressure application

  - Horizontal syringe orientation

- The POP Procedure

➢ **Some find it effective:**
(here also, end with thrombolytic drug to clear the catheter)



➢ **Others still have doubts**

- No known maximum pressure value (hard to obtain measurement but ongoing effort is maintained)
- Compatibility with valved catheter not established (Groshong)
- Ejection of protein matrix + precipitates + or – microorganisms or catheter fragment
- Risk of « bicycle pump » effect

POPping will release the clot only if adhesion is **WEAK**

=

in practice, effectiveness and use are limited

POP procedure (pending)

1 - Connect a 10cc syringe containing 1-2 mL normal saline

2 – Hold the syringe vertically throughout the process

3 – Aspirate about 4-5 mL
Pause and hold (~ 2 seconds)

4 – Release the piston ===> to initial position
Pause (~ 2 seconds)

5 – Repeat the process from step 3
Do not ever actively apply pressure on the piston

Conclusion

- Guidelines, algorythms, « big data bases »… shouldn't replace critical thinking and judgment based on scientific studies.

- Inject thrombolytic solution as soon as you observe resistance to flushing or/and blood withdrawal is disappearing or being altereded.

- Wonder if the occluded PICC is still useful.

- Consider the possible risks and benefit before starting or going on acting (primum non nocere).

Conclusion

➢Long live to evidence based practice and the studies to come!

<u>BUT</u>

Prévention+++

Organisation ++++

Protocols+++

= THE BEST « POP » technique

Prevention first to avoid ALL the worst !