



**Azienda
Ospedaliero
Universitaria
Careggi**

PLACE 2026
PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

CONGRESSO

ROMA, 25 - 27 Giugno 2026

SEDE DEI LAVORI

A. Roma Lifestyle Hotel
Via Giorgio Zoega 59, Roma

Devices: Tips & Tricks

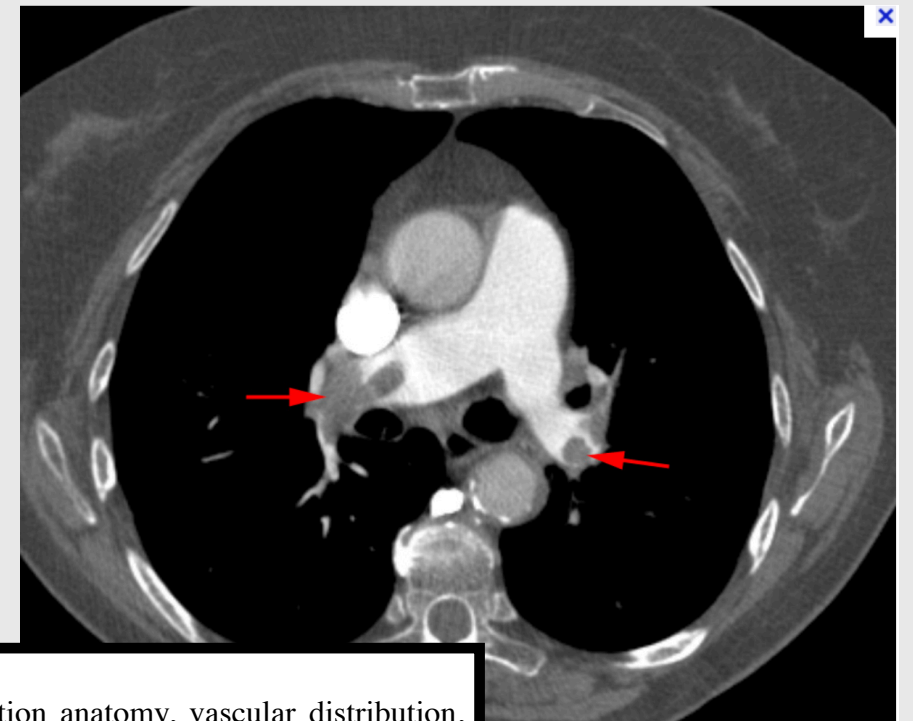
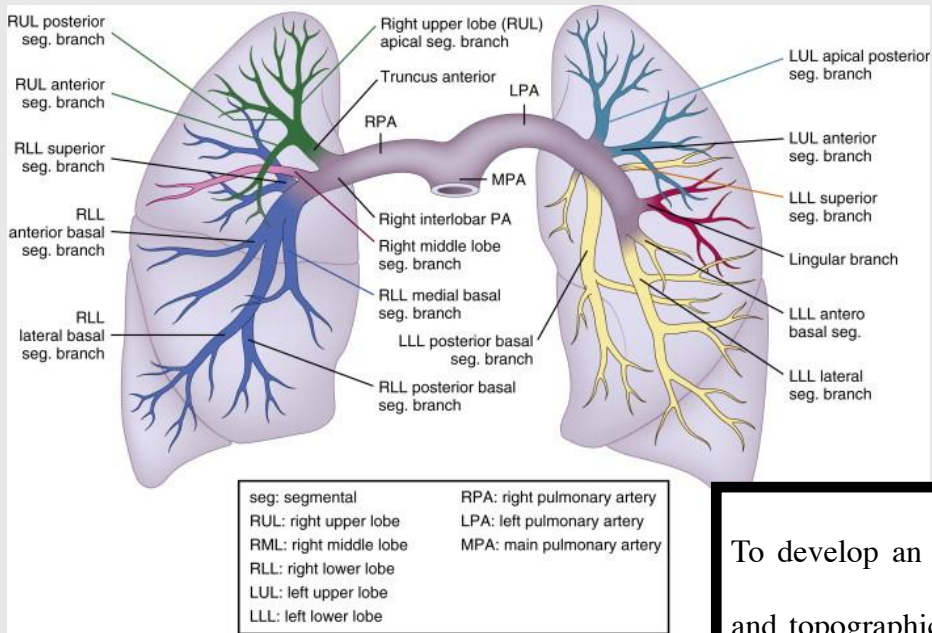


Angela Mignorini

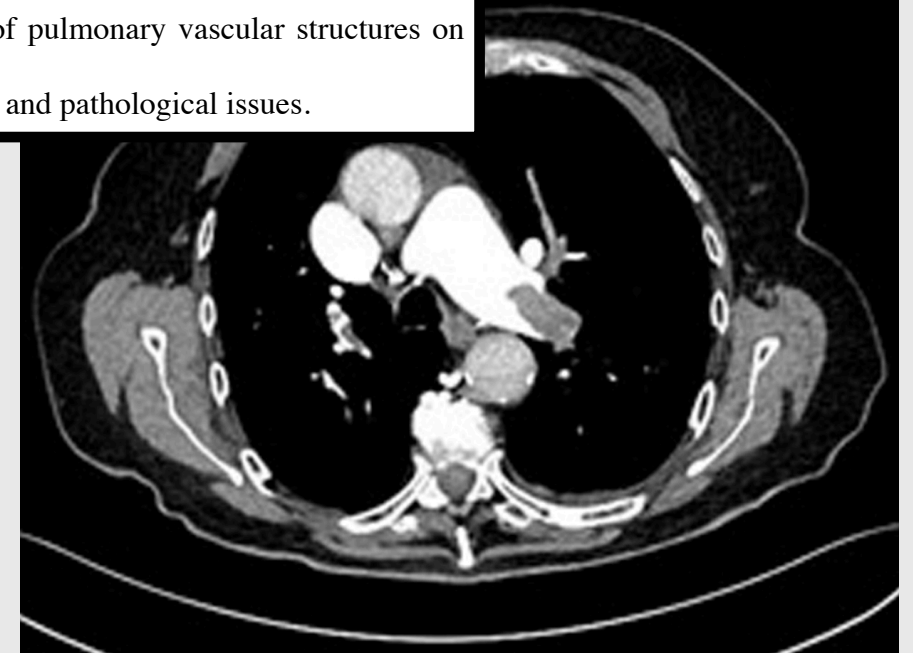
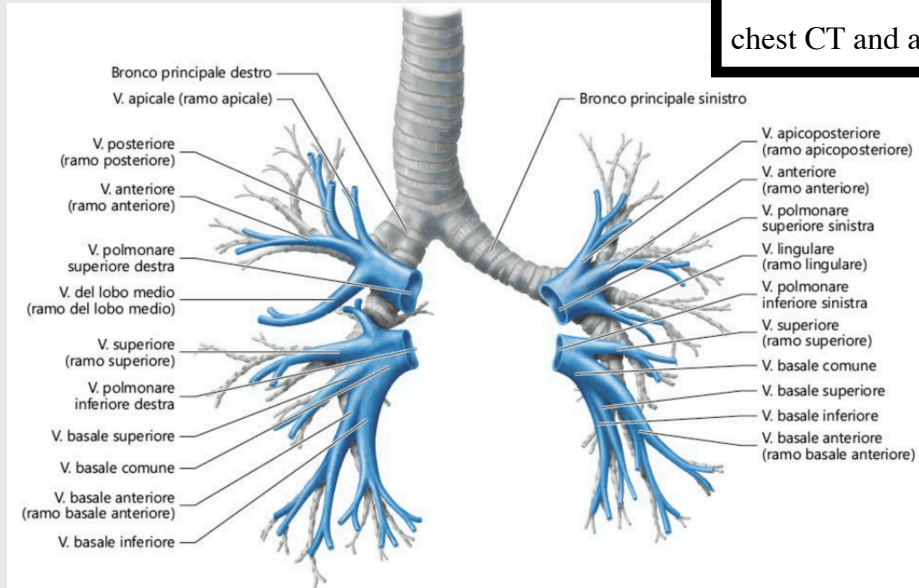
Cardiologia Interventistica d'Urgenza AOUC Careggi - Firenze

No conflict of interest

The Anatomic Feature and Tc scan evaluation: Mandatory Pratical Issues

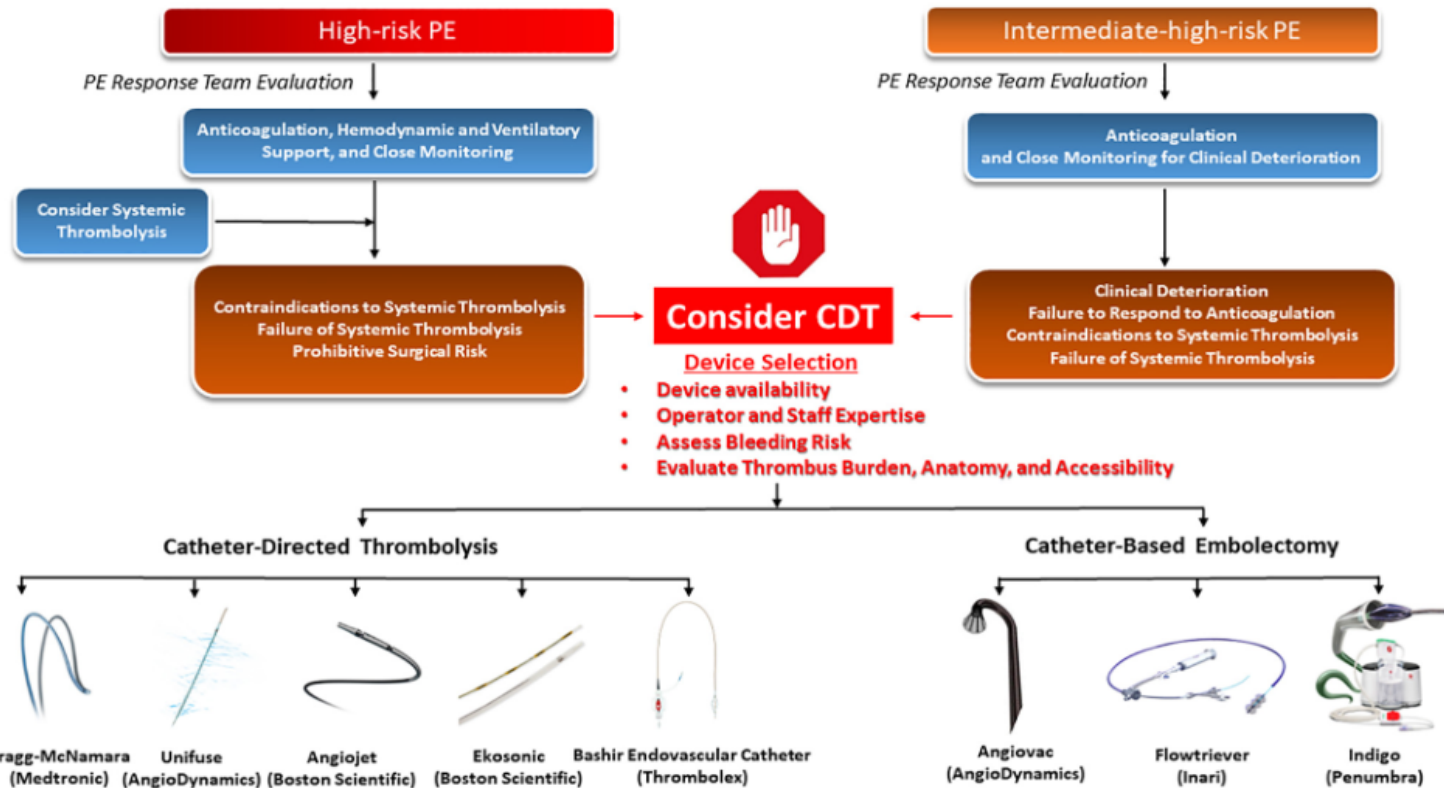


To develop an advanced understanding of pulmonary circulation anatomy, vascular distribution, and topographic relationships, enabling accurate recognition of pulmonary vascular structures on chest CT and appropriate interpretation of their normal variants and pathological issues.



CDT Devices Available for the Treatment of Pts With High/Intermediate to High Risk

Key Factor Influency Selection of Catheter Device



Anatomical Complexity

- Congenital malformations (e.g., pulmonary arteriovenous malformations; pulmonary artery stenosis)
- Inherited and acquired abnormalities (e.g., pulmonary artery aneurysm)
- Right-sided valvular heart disease

Disease-Related

- Overall thrombotic burden
- Hemodynamic compromise
- Extent and location of thromboembolic material (distal vs. proximal)
- Presence of CTEPH or other type of pulmonary hypertension

Patient-Related

- Access site availability
- Underlying cardiopulmonary disease that may predispose to adverse outcomes
- Underlying arrhythmia or conduction disease (e.g., left bundle branch block)
- Indwelling cardiac device (e.g., pacemaker/defibrillator leads)
- Bleeding risk

Technical Issues

- Ability for a particular device to access the thromboembolic material
- Risk of macro- and microembolization
- Risk of cardiopulmonary trauma
- Interventional suite
- Need for perfusion team
- Operator experience
- Device availability

Device selection should be based on a careful pre interventional assessment on the basis of disease phenotype, patient clinical characteristics, pulmonary thrombus burden and location, bleeding risk, and operator experience.

Different CDT Technologies



CLOT DISSOLUTION

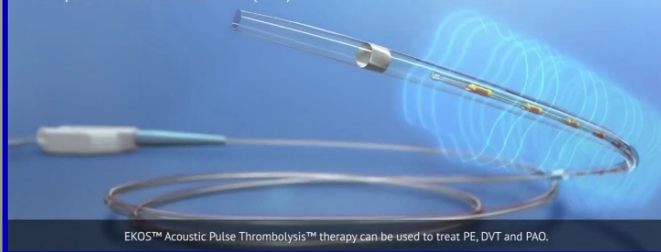
US-ASSISTED LOCAL THROMBOLYSIS

- ✓ Reduced thrombolytic dose
- ✓ Hrs of infusion (7-12 hrs)
- ✓ Small easy-to-use catheter (5–7 Fr)
- ✓ Lower risk of vascular complications
- ✓ Minimal procedural blood loss
- ✓ Effective on distal thrombus location

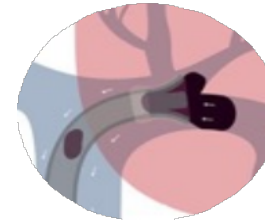
Catheter-Directed thrombolysis

EKOST™ Acoustic Pulse Thrombolysis™

Pulmonary Embolism (PE)
Deep Vein Thrombosis (DVT)
Peripheral Arterial Occlusion (PAO)



EKOST™ Acoustic Pulse Thrombolysis™ therapy can be used to treat PE, DVT and PAO.

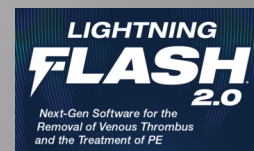
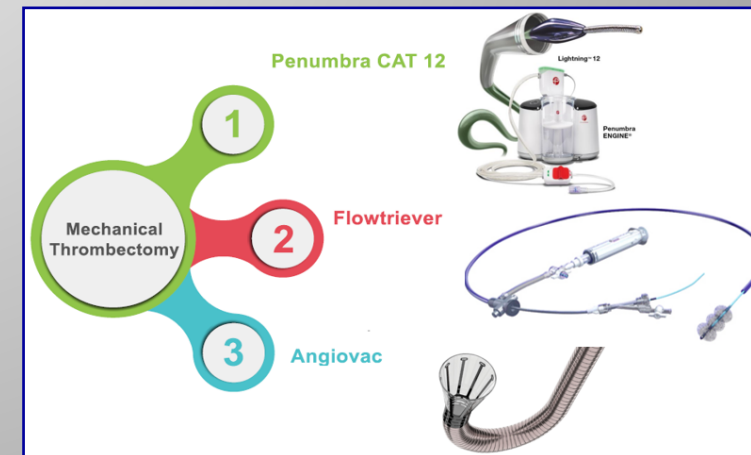


CLOT ASPIRATION

PERCUTANEOUS THROMBECTOMY

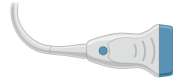
- ✓ Thrombolytic agent NOT required
- ✓ No risk of systemic bleedings
- ✓ Higher vascular complications (16-24 Fr)
- ✓ Short time to treatment (1 hr)
- ✓ Immediate hemodynamic benefit
- ✓ Ideal in hemodynamic instability
- ✓ Effective on large/proximal thrombi

Thrombus Aspiration Systems



Checklist for Intervention

Vein access ultrasound guided



Preimplanted fem vein Proglide (introducer ≥ 10 Fr)

Pig tail 5 Fr, 6 Fr (straight, angled)

Amplatz stiff guidewire 0,035 " - 260 cm (tip floppy 1 cm length)

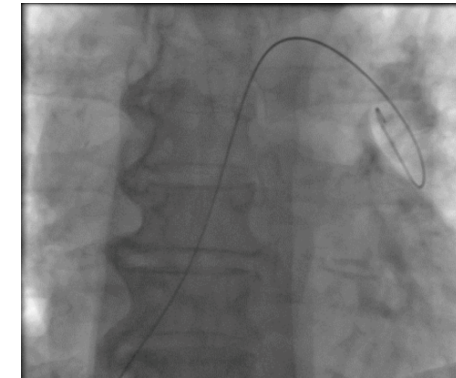
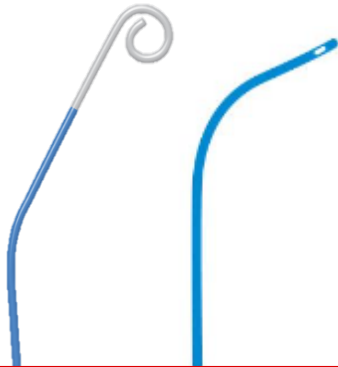
Large Bore Introducer Gore Dryseal 18 Fr, 20 Fr, 24 Fr

Multipurpose catheter

Hydrophilic guidewire 0,035 ", 260 cm (Terumo)

Swan Ganz Catheter

Arterial femoral access in hemodynamic instability



BE CAREFUL:

use echo guided fem vein access, preimplant Proglide in large access, use Pigtail to cross RV

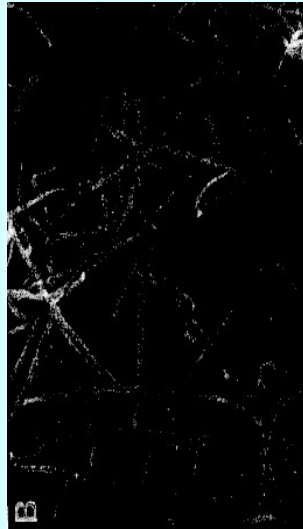
EKOS Device Detail

Fibrin separation

Ultrasound unwinds fibrin without fragmentation of emboli

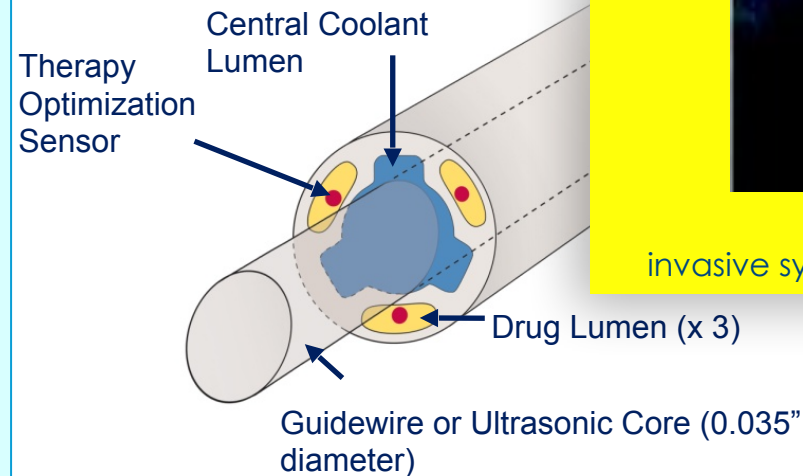


Fibrin without ultrasound



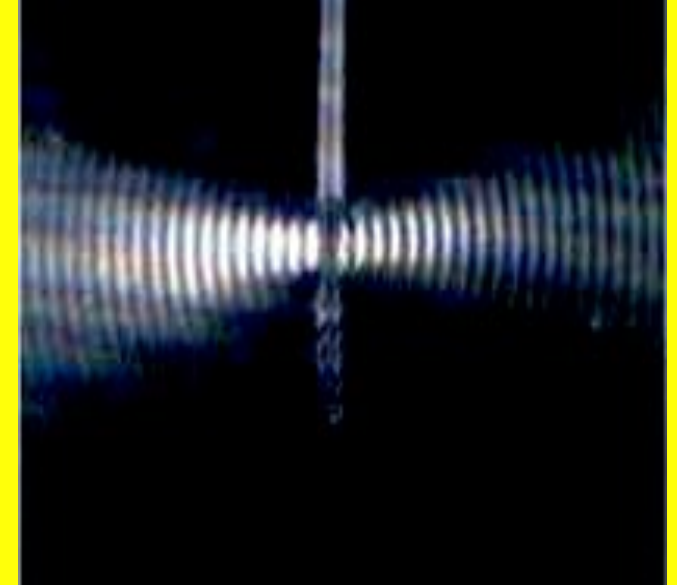
Fibrin with ultrasound

Infusion Catheter cross section



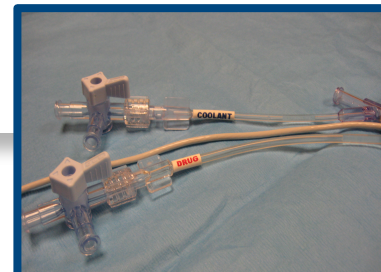
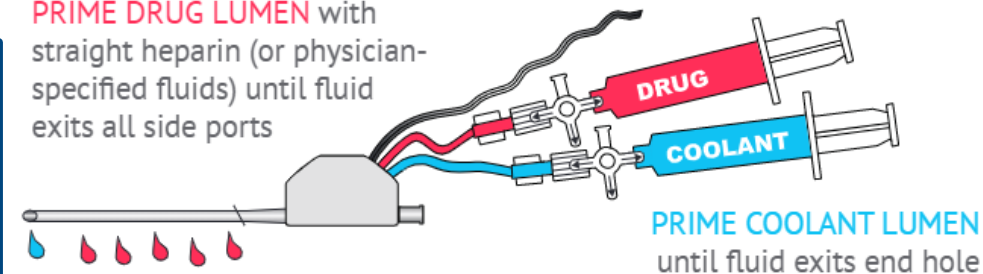
Active drug delivery

Drug is actively driven into clot by "Acoustic Streaming"



EKOS treatment is a minimally invasive system for accelerating thrombus dissolution

PRIME DRUG LUMEN with straight heparin (or physician-specified fluids) until fluid exits all side ports

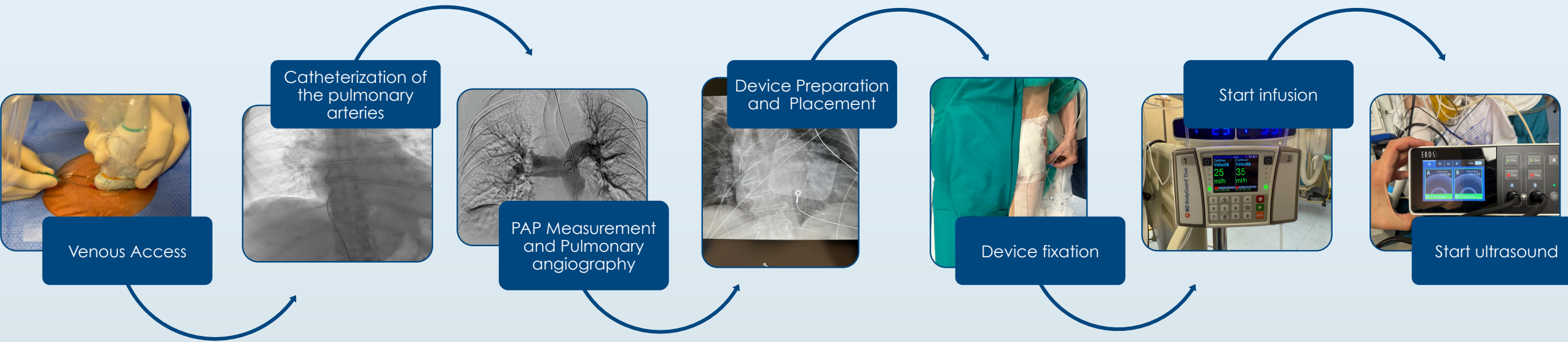


3-way stopcocks or flow switches
COOLANT porDRUG port



DO NOT ASPIRATE CATH ONLY FLASH!

EKOS procedure



- Place Infusion Catheter through a 6 Fr sheath over an 0.035" exchange length guidewire
- Position the distal marker on the Infusion Catheter 1 cm beyond the clot
- Remove 0.035" guidewire
- Flush the guidewire lumen
- Devoice placement and start infusion/Ultrasounf



Two ipsilateral punctions with 1 cm distance in case of bilateral PE

One punction → Two Sheath wires → Two 6 F sheaths (only when access is challenging because of bleeding)

EKOS System Components

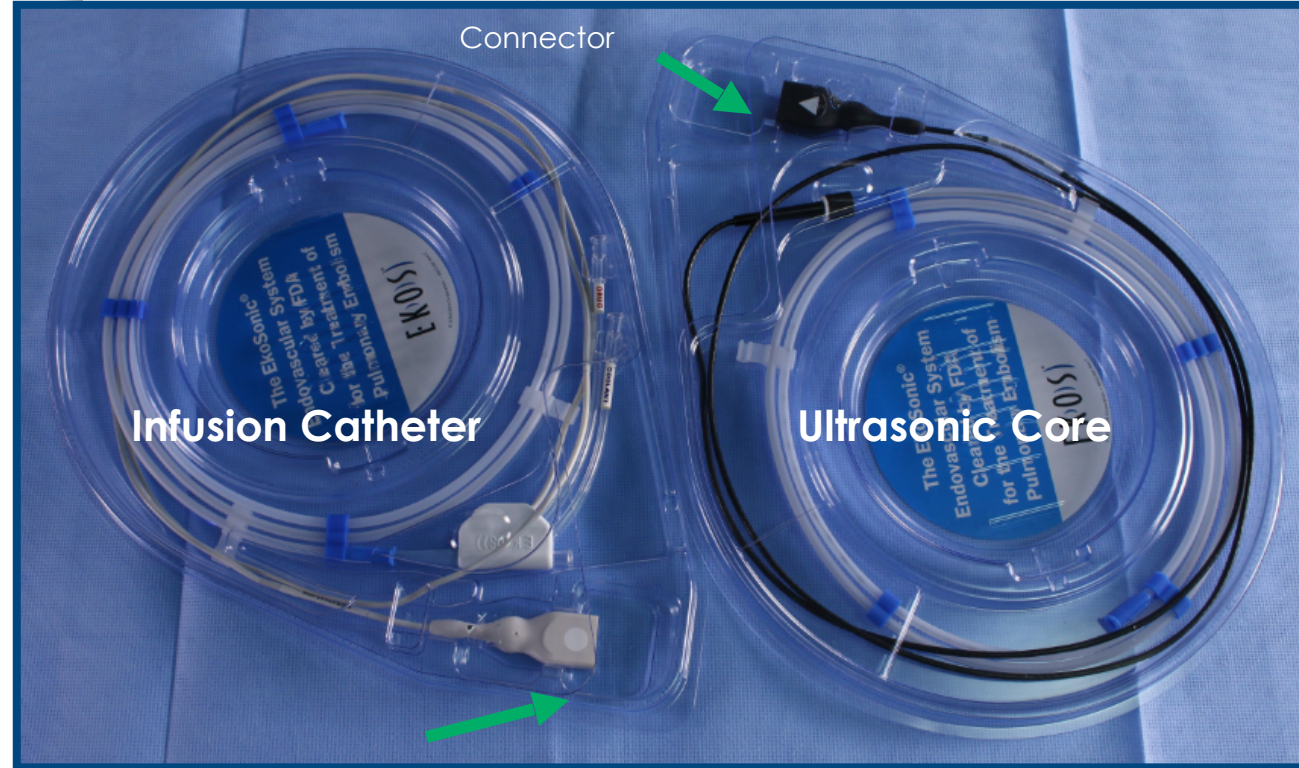
Box contains two packages

- (1) Infusion Catheter
- (1) Ultrasonic Core

Isolate the electrical connectors prior to flushing to ensure they stay dry.



EKOS Device:
Infusion Catheter + Ultrasonic Core

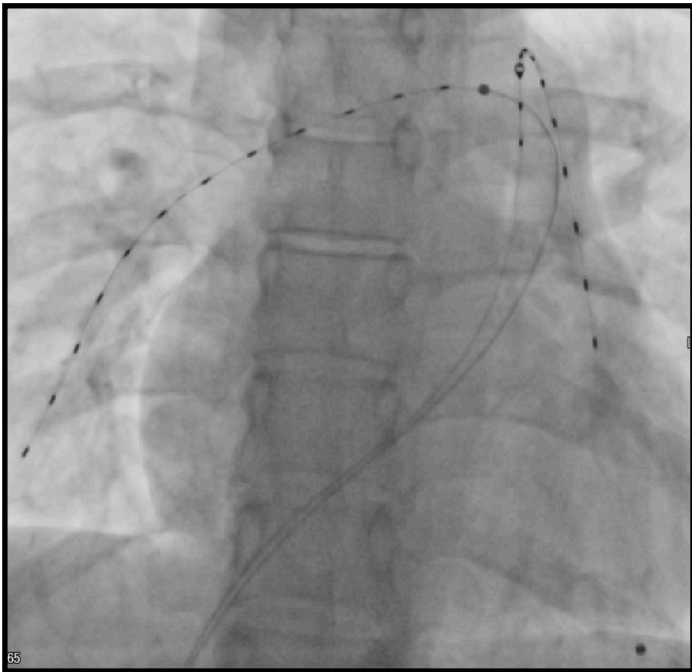
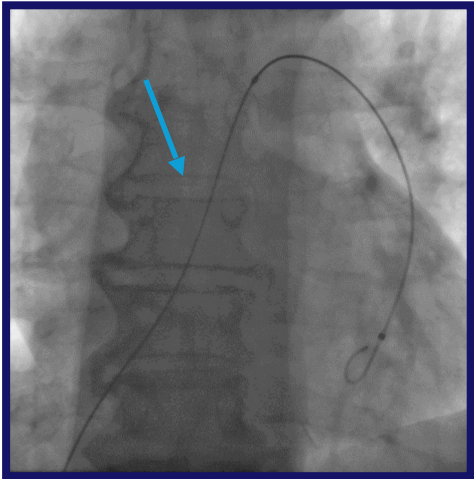


8
IF THE CONNECTORS GET WET, THE DEVICE WILL NOT FUNCTION PROPERLY.

Placing the EKOS catheter and Start Infusion

Caution/Tips:

- Choose an infusion catheter length that matches the thrombus size to ensure effective thrombolysis.
- Decide on single or bilateral catheter placement based on thrombus distribution.
- Position the infusion catheter's distal marker 1 cm beyond the target clot, preferentially in basal segments to enhance stability and reduce complications.
- Optimally, the treatment zone shall encircle the thrombus.
- In case of saddle thrombus may use: 1x 12 cm treatment zone and 1x 18 cm treatment zone (leave proximal marker behind the pulmonary valve in truncus)
- In case of bilateral PE position proximal markers of the catheters at the height of bifurcation 1 cm after pulmonary valve.
- Infuse heparinized saline or normal saline through the **COOLANT** port at 35 ml/hr (Max 120 ml/hr).
- Infuse lytic through the **DRUG** port at a prescribed dose with a flow rate range from 5 ml to 35 ml/hr (10 mg rTPA/100 ml saline, 1mg/h).

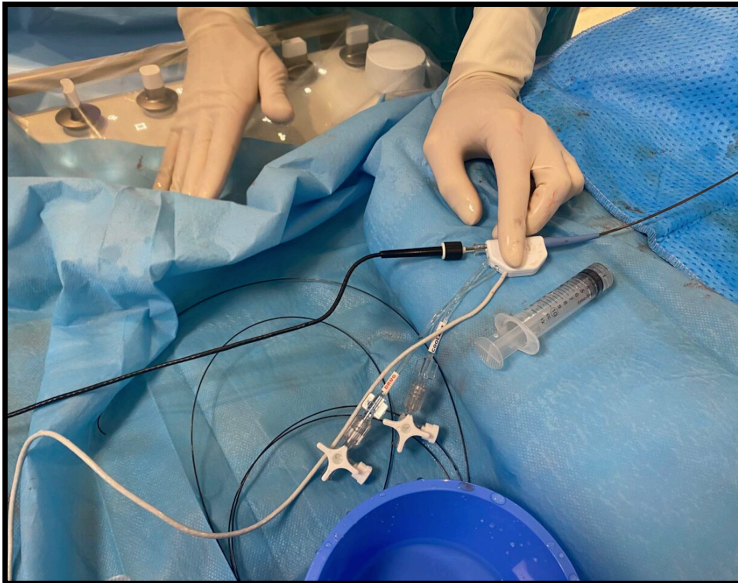


Study	Duration	Initial Bolus	rTPA dosage	Total dosage
ULTIMA	15h	//	-1mg rTPA/cat/h first 5h -0.5mg rTPA/cat/h 10h	10-20mg rTPA
Optalyse	6h	//	1mg rTPA/cath/h	6-12mg rTPA
Hi Peitho	7h	2mg/cat	1mg/cat/h	9-18mg rTPA
Extended Optalyse	14h	//	-1mg rTPA/cat/h first 6h -0.5mg rTPA/cat/h 8h	10-20mg rTPA
No PE Protocol	12-24h	//	0,5-1 mg/cat/h	12-24mg rTPA

Port infusion rate ranges

DRUG port: 5 - 35 ml/h

COOLANT port: 35 - 120 ml/h



Sistema FlowTrievery[®] studiato appositamente per il trattamento della PE

Cateteri FlowTrievery

Cateteri Large bore

Disponibili in 3 misure

T16: 16 French
T20: 20 French
T24: 24 French

Trievery20 Curve

20 French
225° orientabilità

Sistema FlowTrievery

FlowTrievery2

6-16MM

Tools aggiuntivi

Intri24

FlowSaver

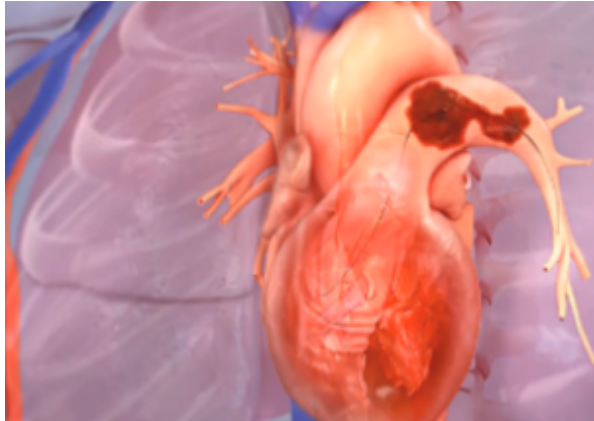
FlowStasis

FlowTrievery

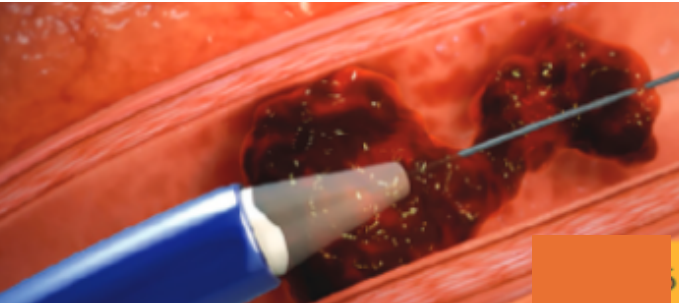
XL 19-25MM

- Durante l'inserimento del FT20/FT24 premere completamente i bottoni della valvola emostatica

Cateteri T24, 20,16



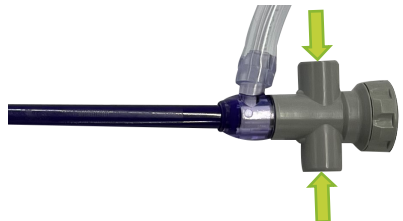
Una volta posizionata la guida Amplatz Super Stiff da 1 cm di punta (0.035"x260cm) nei rami inf della AP Dx o Sx (consiglio: sempre prima a Dx)....



....avanzare il catetere T24 o T20 fino a portarlo in prossimità del trombo (davanti al trombo)

RICORDA:

- **Per avanzare il catetere inserire sempre il dilatatore.**
- Premere sempre i pulsanti grigi dell'Intri24 quando si avvanza il catetere T20 o T24.



È possibile usare il T16 dentro il T20/T24 per aspirare più distalmente



FIG. 8

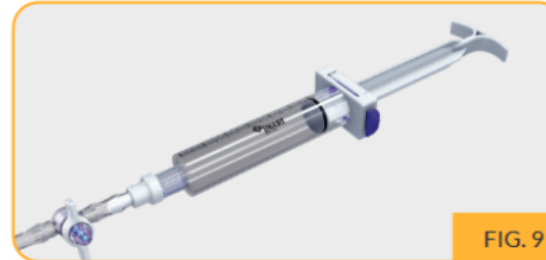


FIG. 9

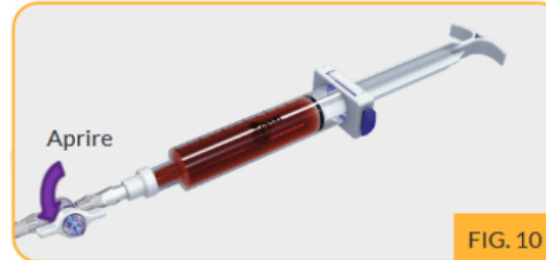


FIG. 10

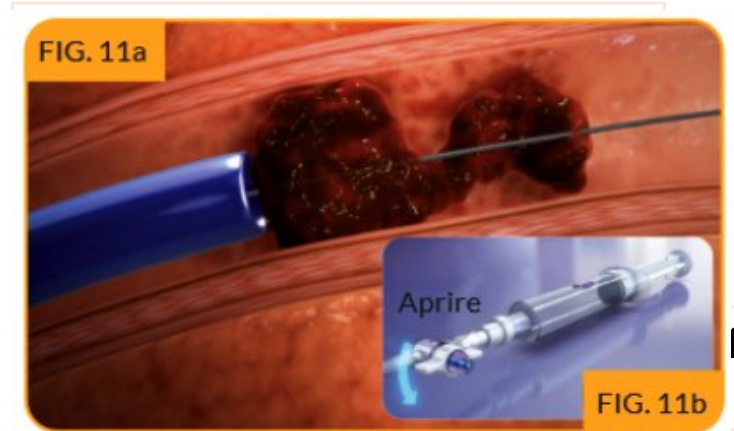


FIG. 11a



FIG. 11b

fo

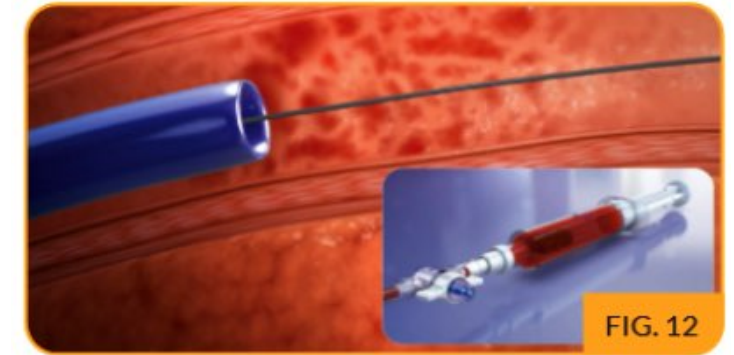


FIG. 12

Se non si riempie la siringa large bore dopo l'applicazione del vuoto e l'apertura della valvola luer lock:

- Aspettare 30 secondi e fare un secondo vuoto
- Se il trombo aspirato occlude la punta del catetere, si raccomanda di eseguire una seconda aspirazione ("double whoosh") per rimuovere il coagulo.
- **Se ciò non risulta efficace e il catetere rimane ostruito durante l'aspirazione, si deve rimuovere il catetere mantenendo l'aspirazione ("lollipop" technique).**

Flow Saver

- Dopo aspirazione dal catetere guida, espellere l'aria in eccesso dalla siringa di aspirazione e connetterla alla porta laterale del FlowSaver.
- Iniettare il sangue nel FlowSaver tenendolo in posizione verticale.
- Disconnettere la siringa luer-lock dal FlowSaver ed espellere l'aria in eccesso.
- Iniettare immediatamente il sangue recuperato attraverso l'Intri24 o altra vena centrale.

Tips:

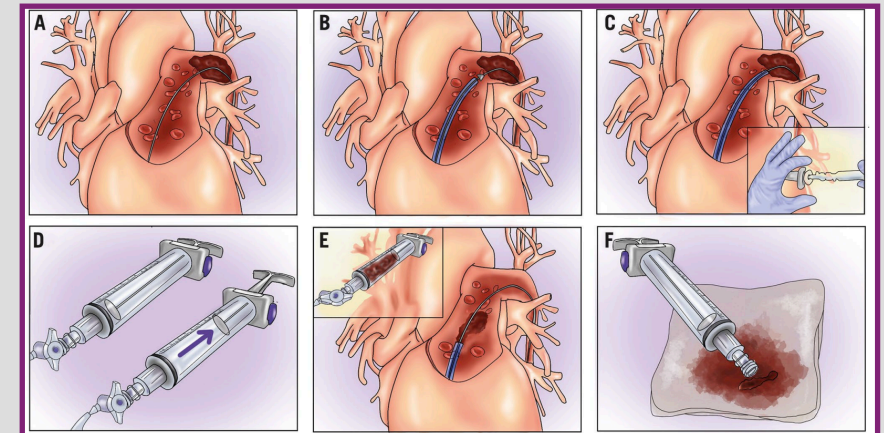
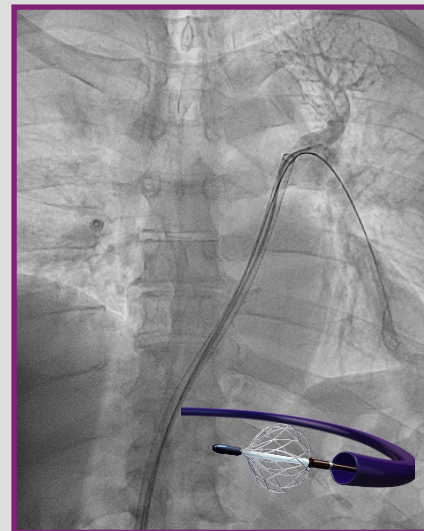
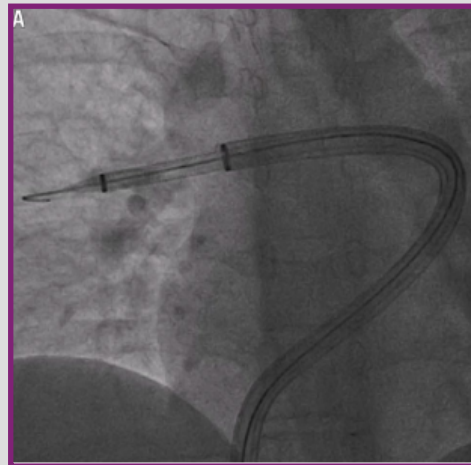
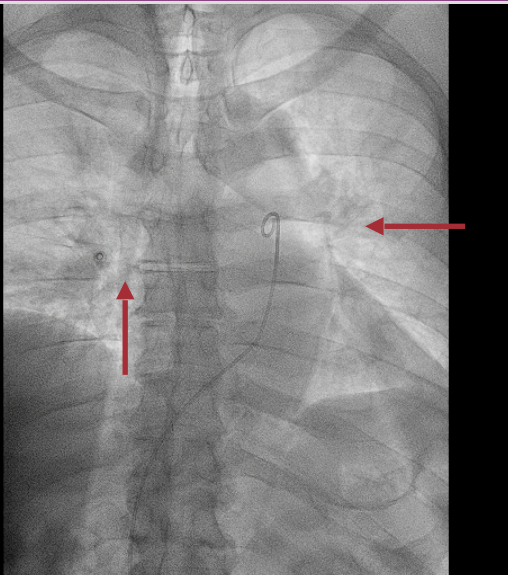
- Considera la significativa perdita di sangue durante queste manovre: è fondamentale valutare attentamente la quantità totale di sangue aspirato e i valori basali di emoglobina per evitare gravi anemia.



Flow Triever System

In summary:

- ✓ Obtaining venous access (ultrasound guided large access): pre-implant femoral Proglide to close vascular access at the end.
- ✓ Positioning large vein femoral introduced sheath.
- ✓ Cross the tricuspid valve with a balloon-tipped catheter or a pigtail to avoid chordae entanglement.
- ✓ Perform angio to visualize thrombus burden.
- ✓ Cath distal position is essential for advancing a stiff wire (1 cm floppy tip) to exchange with the mechanical thrombectomy device.
- ✓ Use a catheter dilator when advancing any time it to avoid vessel wall injury.
- ✓ Use MP to select more distal vascular vessel.
- ✓ Start aspiration proximal to the thrombus to prevent catheter blockage.
- ✓ In the left interlobar artery the Triever 20 Fr Curve catheter is advanced within the 24 Fr system with the distal tip curving up to 225° to approach distal wall-adherent thrombi.
- ✓ In cases of a subacute/chronic thrombus that is highly adherent to the vessel wall, mechanical thrombectomy using nitinol disks can be performed. The disks, which are sized according to the target vessel diameter, are advanced inside the thrombus and left in place for 2 minutes to allow slight thrombus compression, then removed. Following this it is advisable to attempt thrombus aspiration again, as its effectiveness tends to be higher after disk use.



Maschio 28 anni

28/04 politrauma della strada, ciclista investito da tramvia a bassa velocità. IOT. All'arrivo in DEA intubato, ipoteso e tachicardico.

TC Total body:

- TC CRANIO-ENCEFALO: Non alterazioni.
- TC MASSICCIO FACCIALE: esile falda ematica intraorbitaria extraconica superiore a destra.
- TC TORACE-ADDOME: esteso pneumotorace a destra.

Estesa area lacerativa del parenchima epatico, IV ed VIII segmento. Frattura scomposta clavicola posteriore di destra; fratture multiple costali. Frattura processi trasversi di D12, L1, L2. Frattura completa del sacro a livello di S4 con angolazione anteriore dei metameri coccigei.

Eseguito drenaggio di pneumotorace dx.

Non poste ulteriori indicazioni chirurgiche urgenti, dopo la valutazione in DEA il paziente è stato trasferito in TI per proseguire cure e monitoraggio.

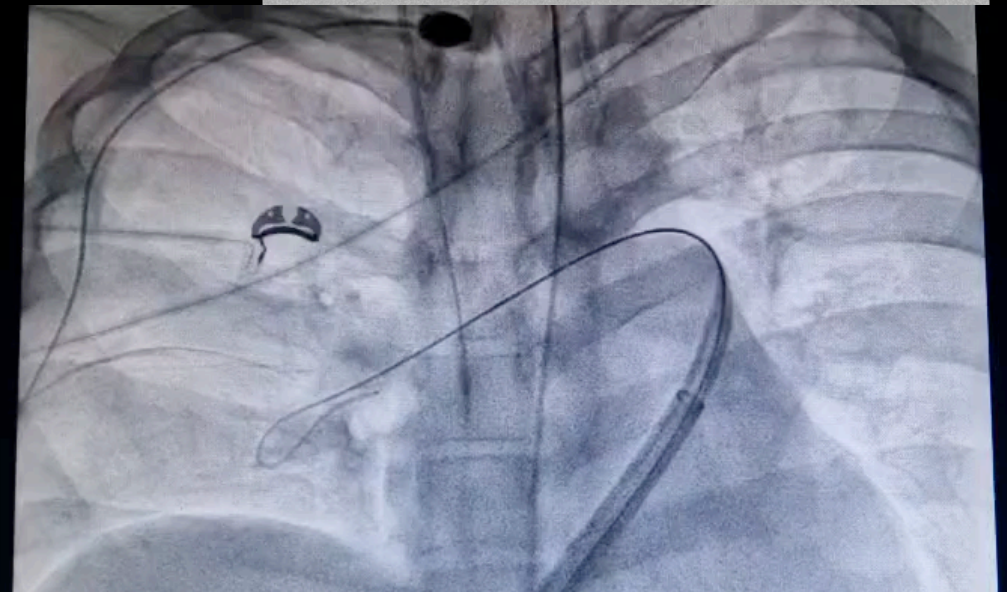
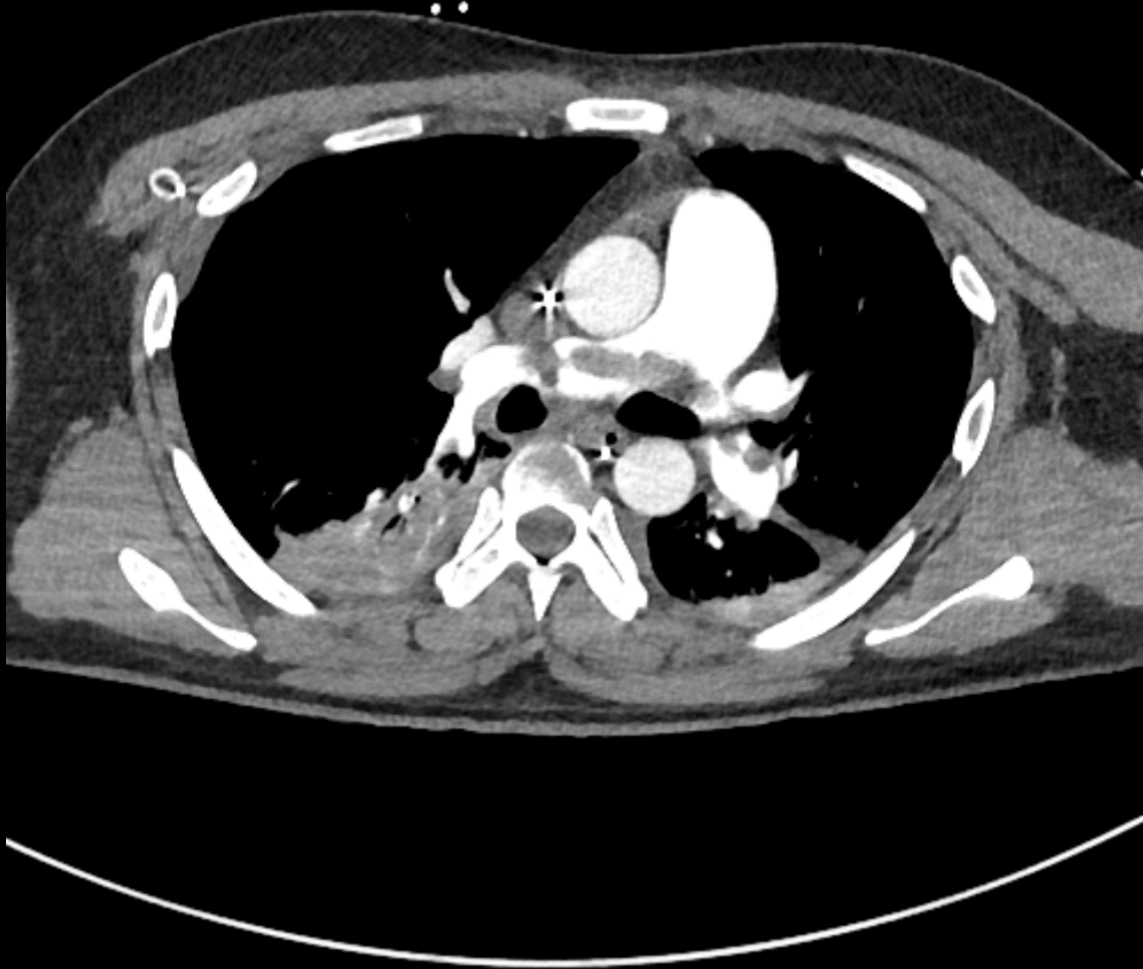
Estubato in data 30/04 (48 ore): neurologicamente integro.

01/05 peggioramento dei parametri ventilatori con alti flussi dipendenza (pO₂ 61, pCO₂ 45, Sao₂ 92, FR 20).
ECG: Rs. FC 100 bpm. PA 100/70. Trop HS 60 pg/mL.

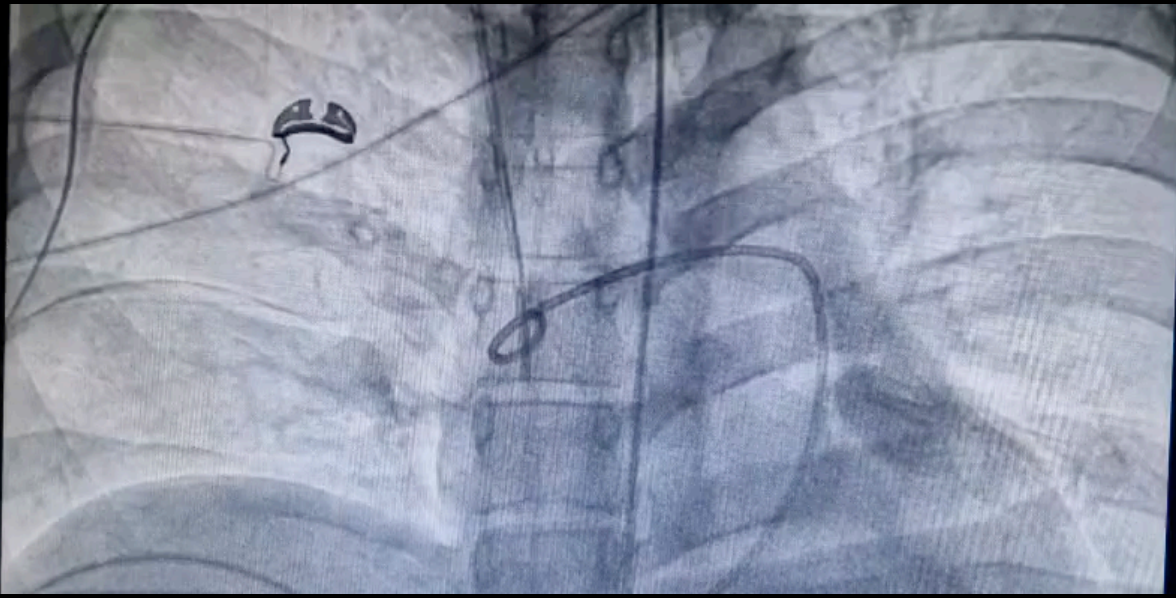
Angio del circolo polmonare-addome: riscontro embolia polmonare a cavaliere.
Trombosi venosa profonda femorale-iliaca sx.



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Angio polmonare conferma trombosi a cavaliere.
Aspirazione meccanica con Flow Tirever 24 Fr. Una siringa aspirata bloccata a 30 cc.



FLOW TRIEVER 24 FR



Angio a 48 ore

Flow Saver recupero lunga trombosi. Tempo procedura 34 min. No perdita ematica.

Posizionamento filtro cavale.

Dopo 3 settimane non più TVP: rimosso il filtro cavale.

TC Toraco-addominale: netto miglioramento della vascolarizzazione polmonare, quadro addominale stabile.

Dimesso con NAO x 3 mesi.

LIGHTNING FLASH^{2.0}

Next-Gen Software for the
Removal of Venous Thrombus
and the Treatment of PE

Designed for Accelerated Clot Detection & Removal

Dual Clot Detection Algorithms

Pressure differential and
flow-based algorithms
designed for:

- Quicker clot detection*
- Quicker patent flow
detection*



Flash Mode
(a.k.a. "Gallop Mode")

Advanced thrombectomy algorithm
designed for expedited VTE clot removal



ELEMENT Laser-Cut Hypotube Design

Engineered to maintain stepwise support
throughout vasculature

Proximal Stability

- Constructed to provide
foundational support
- Polymer transitions optimised to
maintain sheath access
- No proximal hydrophilic application
for higher access site stability

Atraumatic Tip Design

Designed for seamless
delivery



Computer Assisted Vacuum Thrombectomy

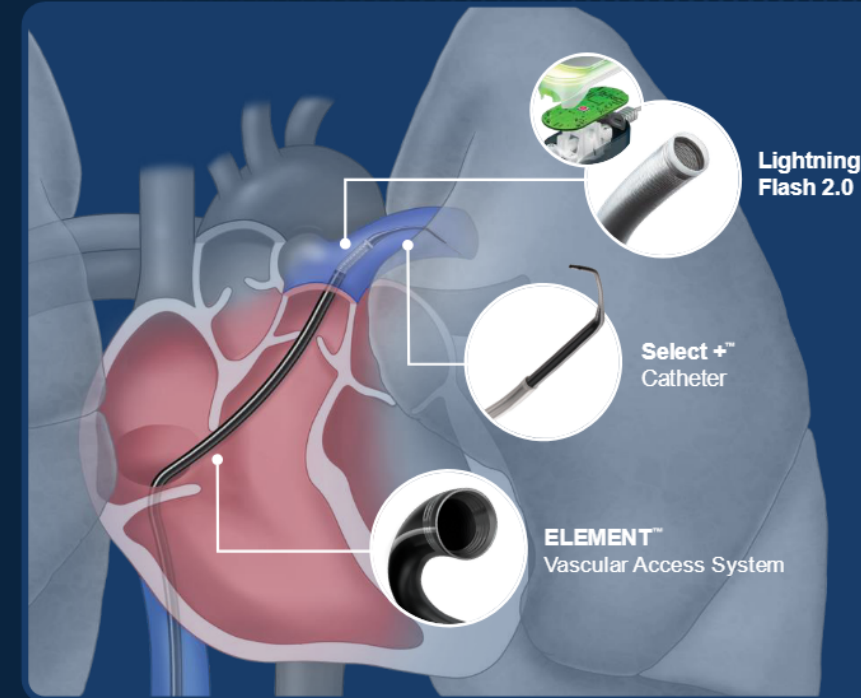
Pulmonary Embolism



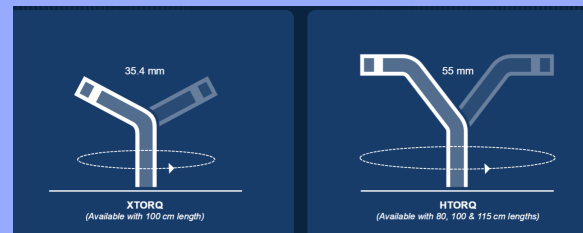
LIGHTNING
FLASH^{2.0}

- Powerful, frontline solution designed
to *accelerate* PE treatment
- Catheter designed for navigation
through tortuous and delicate anatomy

Preferred fem vein access (Echo guided),
preimplant Proglide, use Pigtail to cross RV.



**Dual clot detection algorithm
to reduce blood loss!**



Sampling Mode

Tip of catheter in patent flow



Pneumbra Flash Action Mode

ELEMENT™ Assist Technique



Solid Yellow

Clot Detected

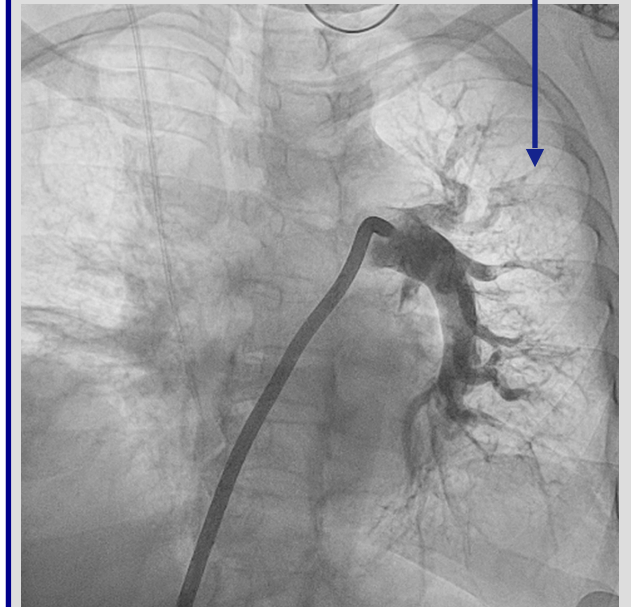
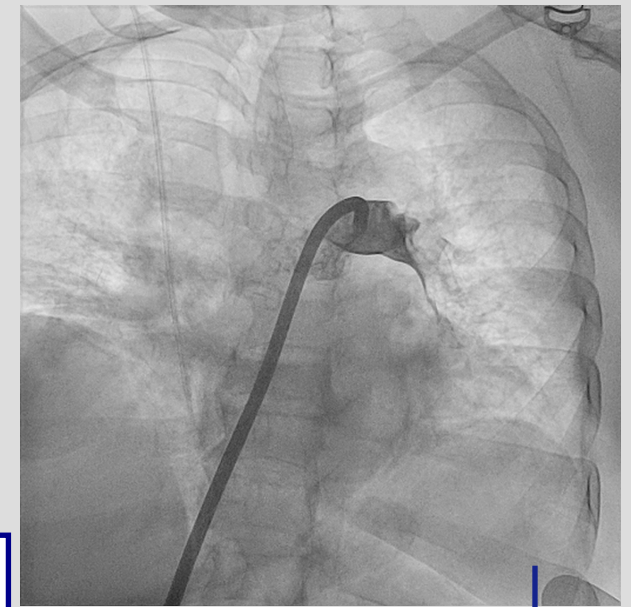
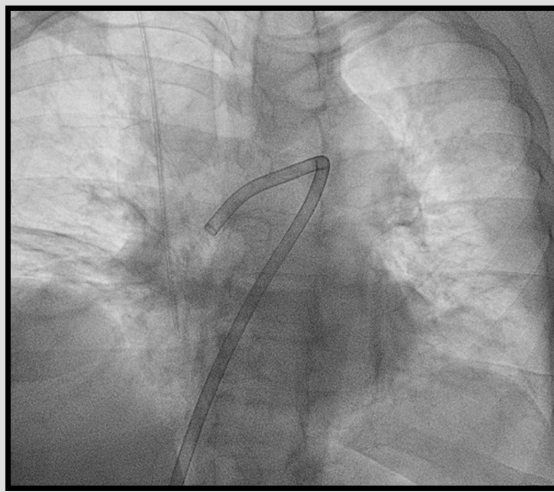
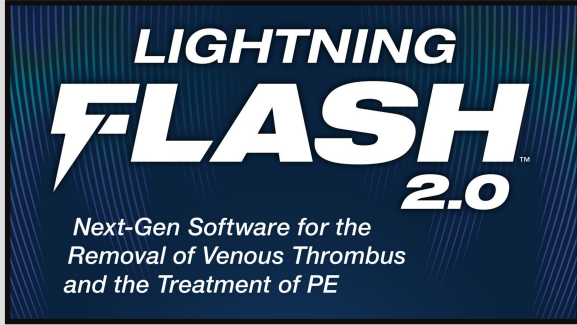
Flash Mode Activated

Procedural and operative techniques and considerations are illustrative examples from physician experience. Physicians' treatment and technique decisions will vary based on their medical judgment. Angiogram recording used with permission. Consent on file at Penumbra, Inc. Individual results may vary depending on patient-specific attributes and other factors. Product availability varies by country. Caution: Federal (FDA) law restricts these devices to sale by or on the order of a physician. Prior to use, please refer to the Instructions for Use (IFU) for complete product indications, contraindications, warnings, precautions, potential adverse events, and detailed instructions for use. Please contact your local Penumbra representative for more information.

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Indigo™ System • CAVT.
Computer Assisted Vacuum Thrombectomy





In summary:

- Vascular venous access echo guide and pre implate proglide to close fem access at the end.
- Cross the tricuspid valve with a balloon-tipped catheter or a pigtail to avoid chordae entanglement. Perform angio to visualize thrombus burden.
- Use a stiff wire (1 cm floppy tip) to exchange with venous long introducer (Element 60-80 cm to the pulmonary artery or Dryseal 1 fr) and then introduce the thrombectomy device.
- Use catheter select dedicated to reach more distal vascular vessel.
- Once the catheter has been advanced and the clot has been reached, aspiration can be initiated by turning ON the flow switch and advancing the catheter through the thrombus.
- Close attention to the system's visual and auditory cues to optimise aspiration and minimise blood loss.
- In case of suspected catheter obstruction remove through the sheath in aspiration.



71 anni, uomo (70 kg, 170 cm)

Accede in PS per dispnea, lipotimia e dolore toracico oppressivo insorti mentre si trovava nel bosco.
In anamnesi artrite reumatoide in terapia steroidea e con farmaci biologici.
Nel 2016 intervento di resezione vescicale con confezionamento di neovescica per etp vescicale.



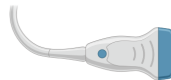
ECG: fibrillazione atriale a elevata fvm 125 bpm; PA 90/60 mmHg



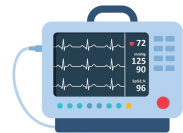
Ecografia: sezioni destre dilatate, ridotta funzione longitudinale (TAPSE 6 mm), D-shape del SIV, moderato rigurgito tricuspidalico con Vd/Ad 40 mmHg (TRV 3 m/s)



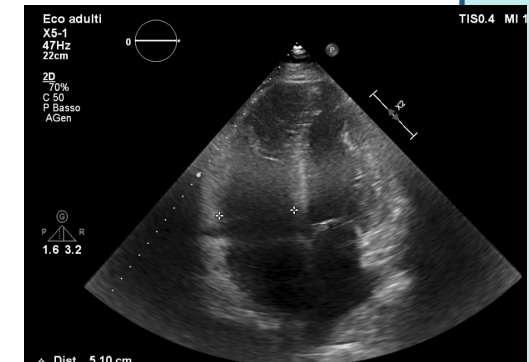
Esami: Hb 12.5 g/dL, hsTnT 225 pg/mL, NTproBNP 5477 pg/mL, Lattati 7 mmol/l

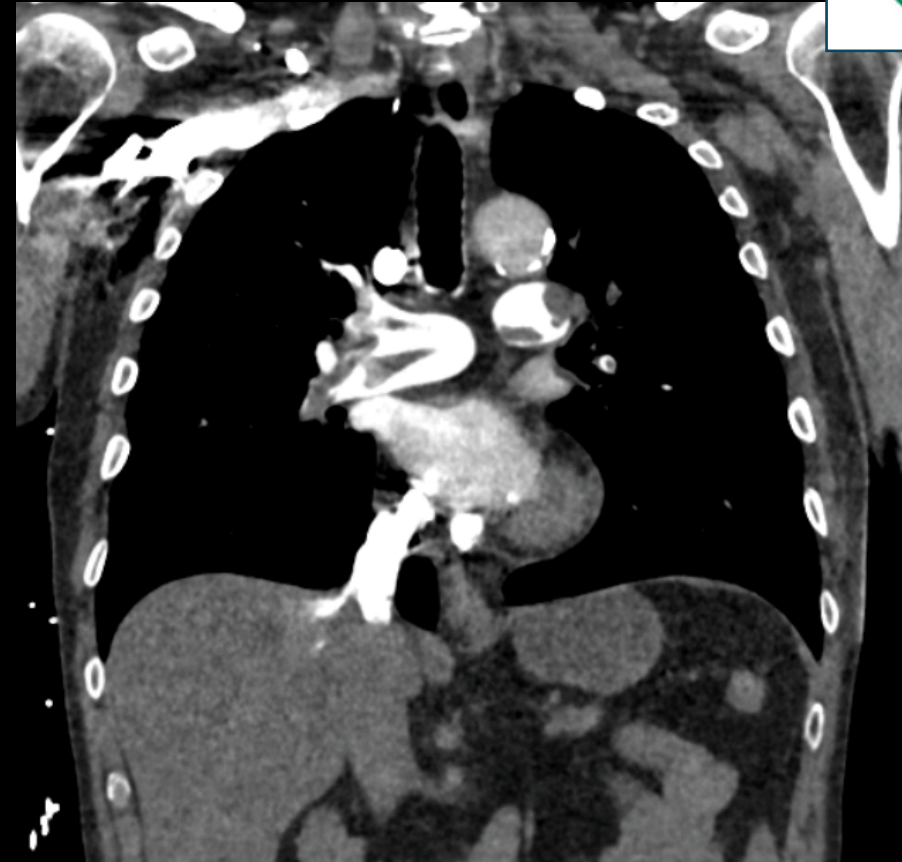


ECD AAIL: trombosi vena poplitea destra



Scadenti scambi respiratori in Maschera Reservoir (HI < 100 e alcalosi respiratoria)





Presenza di difetti di riempimento nel tronco della a. polmonare, disposti a "cavaliere" e nei rami principali bilateralmente. Rapporto $VDx/VS_n > 1$, ectasia tronco della polmonare 3 cm.

PAZIENTE AD ALTO RISCHIO.

Terapia trombolitica in PS: somministrato trombolitico rtPA 100 mg in 2 ore.

**Dopo 4 ore reperti invariati tachicardico (FA FVM 120 bpm), PA 95/60 mmHg, tachipnoico, necessita' di alti flussi di O2 e lattati 5.
PERT Escalation.**

CONFERMA DIAGNOSTICA DI EP ACUTA
(parametri clinici e strumentali)
Inizio terapia anticoagulante

STRATIFICAZIONE DEL RISCHIO

Presenza di instabilità emodinamica?

NO

PESI class III-V or sPESI ≥1?

SI

Disfunzione VD (TTE or CT) + elevazione Troponina?

SI

NO (o 1 solo di 2)

NO

RISCHIO ALTO*

RISCHIO INTERMEDIO-ALTO

RISCHIO INTERMEDIO-BASSO

RISCHIO BASSO**

LE DI PRIMA LINEA

Controindicazioni alla trombolisi?

NO

TROMBOLISI

Peggioramento clinico o mancato miglioramento a 2-4 h?

SI

NO

TERAPIA ANTICOAGULANTE E MONITORAGGIO

NO

SI

NO

SI

TP ANTICOAGULANTE E DIMISSIONE PRECOCE

NO

SI

ATTIVAZIONE PERT*

Paziente operabile?

NO

TROMBECTOMIA TRANSCATETERE

SI

EMBOLECTOMIA CHIRURGICA / TROMBECTOMIA TRANSCATETERE

Controindicazioni alla trombolisi?

SI

TROMBOLISI RESCUE / EMBOLECTOMIA CHIRURGICA / TROMBECTOMIA TRANSCATETERE

NO

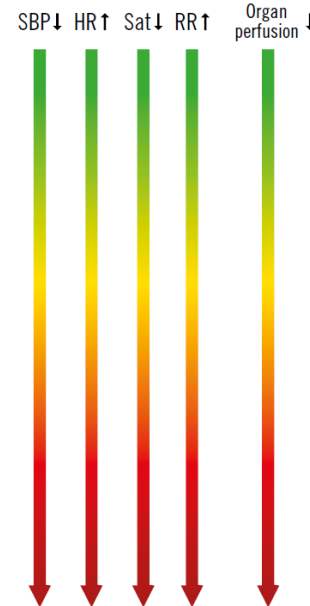
PERT - TERAPIE RIPERFUSIVE AVANZATE*

EuroIntervention 2022

PERIPHERAL INTERVENTIONS
EXPERT CONSENSUS

Percutaneous treatment options for acute pulmonary embolism: a clinical consensus statement by the ESC Working Group on pulmonary circulation and right ventricular function and the European Association of Percutaneous Cardiovascular Interventions

Cascade of instability



Treatment success

→ switch to / continue anticoagulation

Treatment failure with lack of improvement

→ consider treatment escalation with reperfusion treatment

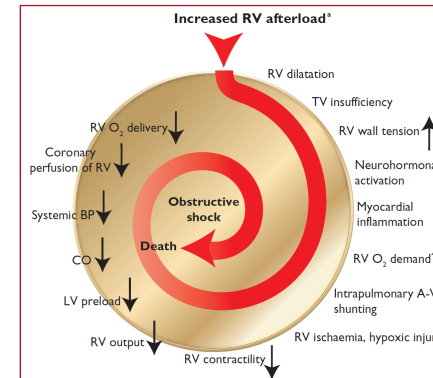
**24-48 hrs of anticoag.
2-4 hrs after lysis.**

Treatment failure with deterioration

→ escalate treatment with reperfusion treatment

Life threatening scenario

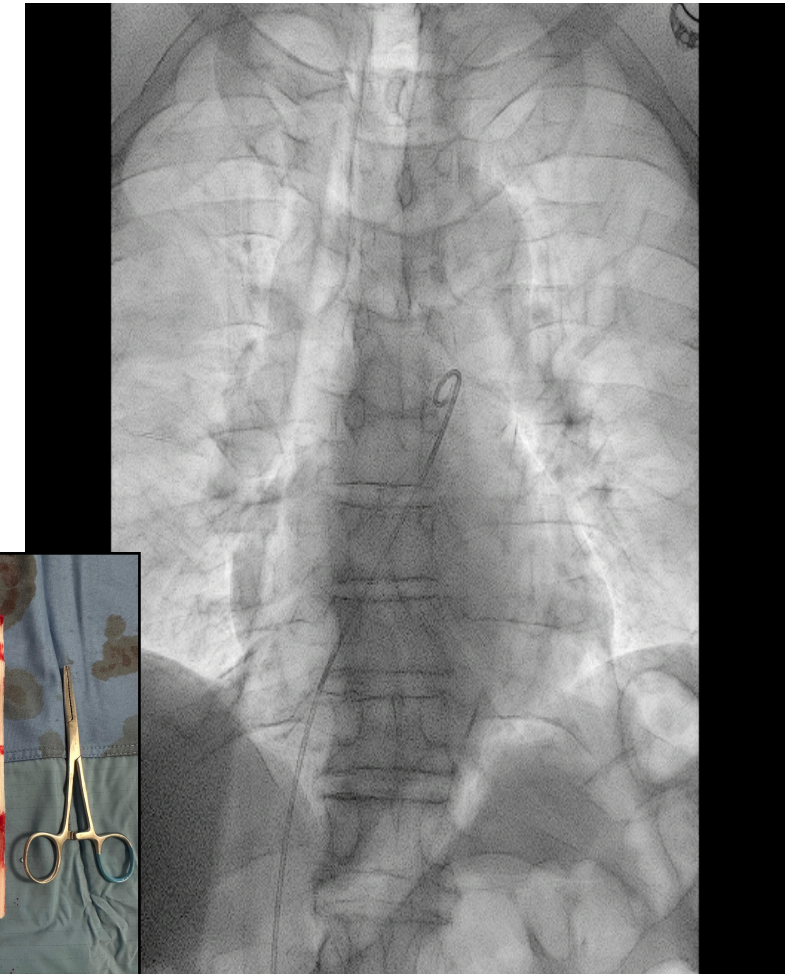
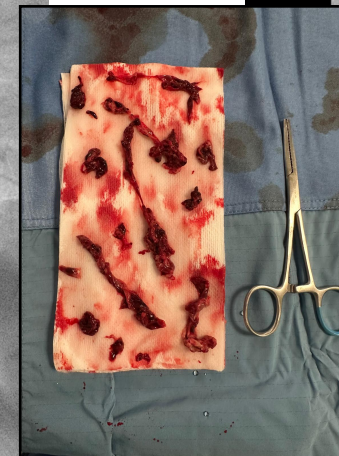
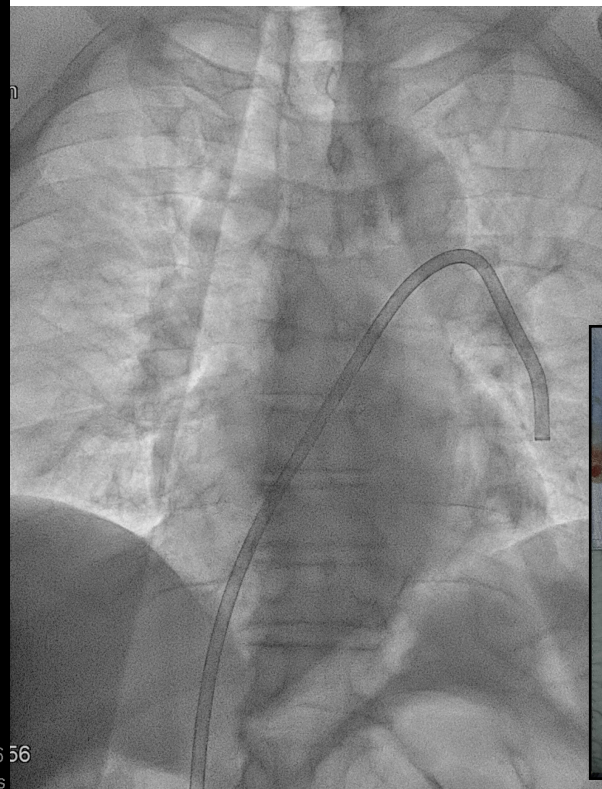
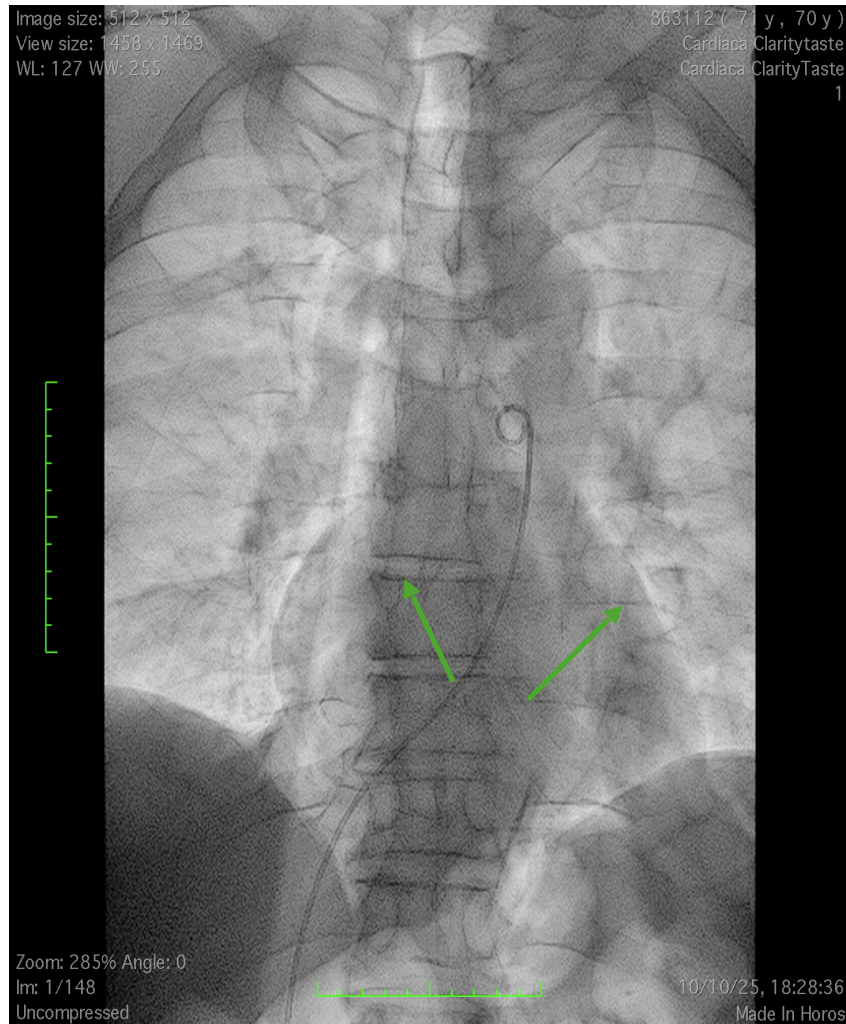
→ start emergency reperfusion and cardiovascular support





Angiografia Polmonare Tromboaspirazione

Risultato Angiografico Finale



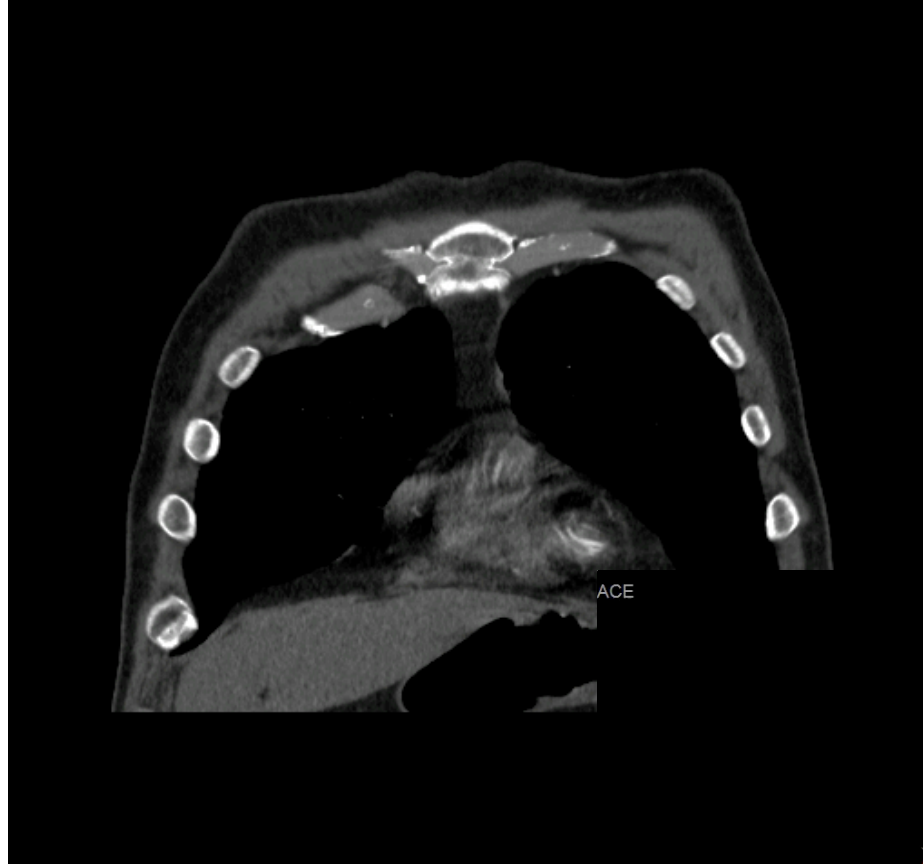
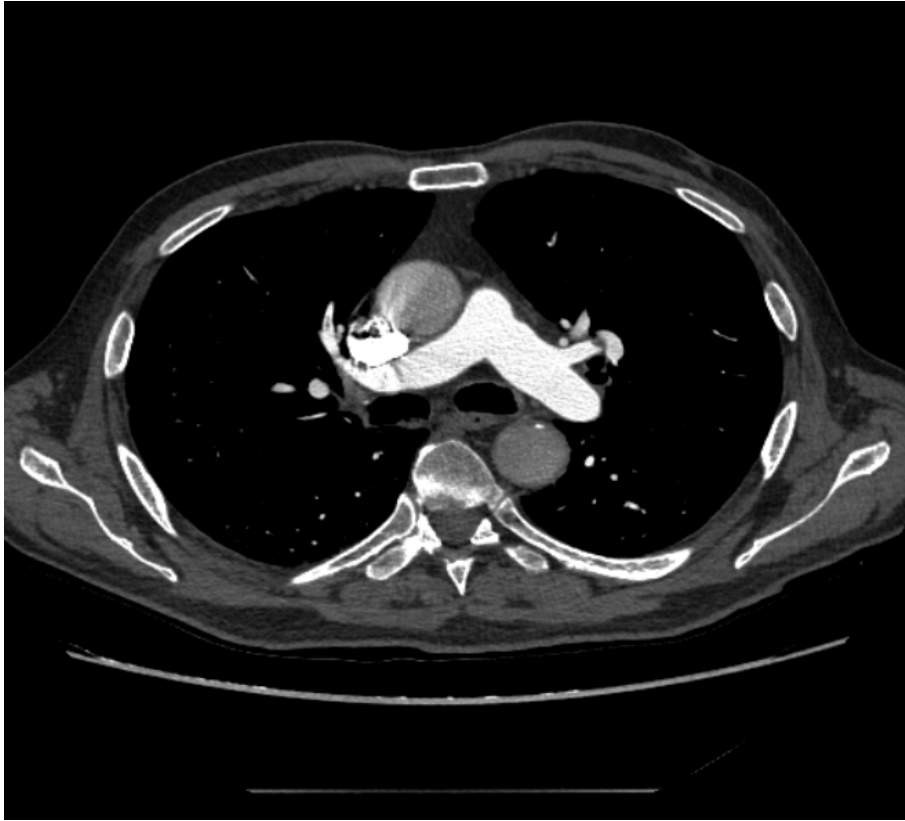
Angio polmonare: conferma importante trombosi ramo polmonare dx e sx.

Gore Dry Seal 16F in right femoral vein. Amplatz Ultra Stiff guide wire.

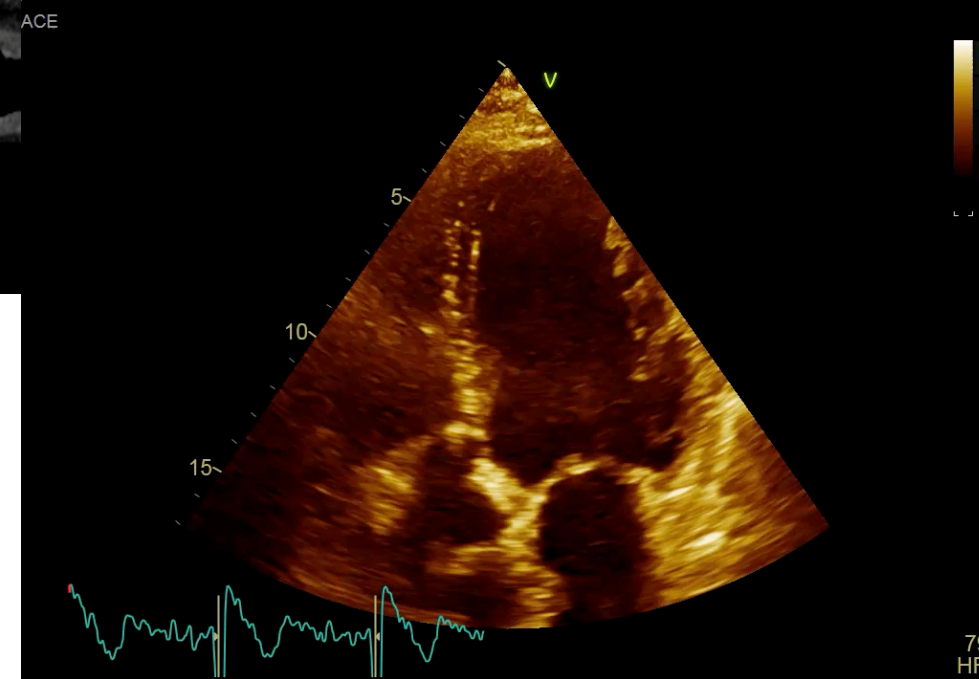
Aspirazione meccanica con Flash Lighting Penumbra. Perdita ematica 250 cc. Tempo procedura 40 minuti.



Angio-TC di controllo



- Miglioramento clinico, emodinamico, respiratorio.
- AngioTC in 3 giornata marcata riduzione del carico trombotico.
- Riduzione dimensioni vdx, con recupero funzione.
- Paziente dimesso dopo 10 giorni in NAO



Summary

In acute PE, percutaneous thrombectomy is not terminated only when the pulmonary arteries appear completely free of thrombus, but rather when a hemodynamically meaningful decompression of the RV has been achieved, as documented by:

- Clinical improvement;
- Reduction in pulmonary pressures;
- Angiographic restoration of flow in the main pulmonary arterial branches;

or when the risk associated with further intervention exceeds the anticipated benefit.

This principle underlies contemporary catheter-directed thrombectomy strategies for acute pulmonary embolism.

Flow Triever vs Flash Lighting

Feature	FlowTriever	Lightning Flash
Mechanism	Aspiration + mechanical retrieval	Computer-assisted aspiration (CAVT)
Sheath size	16–24 Fr	12–16 Fr
Central clot burden	Excellent	Good
Distal reach	Good	Excellent
Blood loss	Higher	Lower
Debulking speed	Very high	High
Key strength	Large central thrombi	Blood preservation and better distal access
On ECMO support	No need clamping	Need clamping

FlowTriever offers the most aggressive thrombus extraction for large central PE, whereas Lightning Flash provides efficient aspiration and superior navigation in distal thrombus location and less blood loss.

Take Home Message



Novel interventional percutaneous device for EP pts treatment have shown positive data on safety and efficacy.
Need for more randomized trials data in assessing the role of percutaneous treatment in the management of PE and to define the impact in term of clinical outcome.



Accurate identification of pts at intermediate/high risk who may benefit from escalation to percutaneous treatment is needed.



Short therapeutic window to reevaluate pts with EP for CDT is essential to improve outcome (“time-dependent clinical status”).



The variety of currently catheter technologies affords the opportunity to select the most appropriate device for each patient that should be based on a careful assessment of disease phenotype, patient clinical characteristics, thrombus burden/ location, bleeding risk, contraindication to lysis, device availability and operator experience.

Answering such clinical pts/logistic priorities with caution to data from ongoing RCTs and high quality observational studies will be paramount to improve EP outcome.