

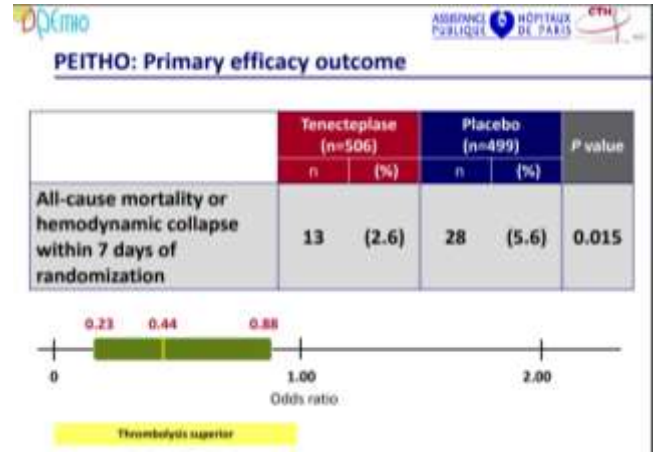
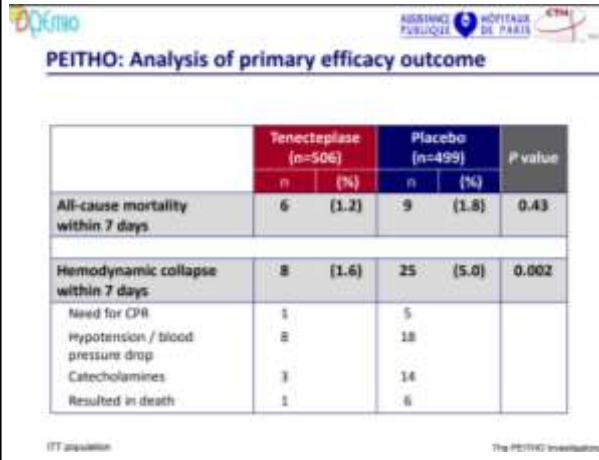
New Management strategies for PE

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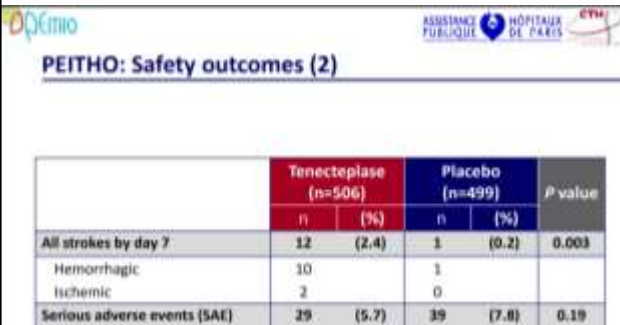
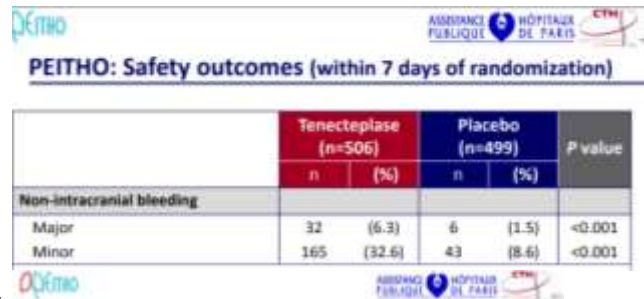
Why do we need new strategies?

- ❑ Thrombolytic efficacy and safety profiles in high risk patients
- ❑ Fragile and high risk patients with contraindications to thrombolysis
- ❑ Unresolved post acute PE sequelae (esp. CETPH)
- ❑ Failure of thrombolysis in intermediate- high risk PE esp. in long term results
- ❑ Cases with mobile right heart thrombi

PEITHO Trial



PEITHO-don't be seduced



PEITHO: Conclusions

- ◆ In patients with intermediate-risk pulmonary embolism, intravenous bolus tenecteplase significantly reduced the primary end point of death or hemodynamic collapse within 7 days of randomization.
- ◆ The results of PEITHO justify the concept of risk stratification of normotensive patients with acute PE.
- ◆ They confirm the notion that early "advanced" (recanalization) treatment prevents clinical deterioration in patients with evidence of right ventricular dysfunction and myocardial injury.
- ◆ In PEITHO, the benefits of thrombolysis came at the cost of a significantly increased risk of major, particularly intracranial, hemorrhage.
- ◆ The patient's age should be taken into account when weighing the expected benefits versus risks of systemic thrombolysis in clinical practice.

Long term result of PEITHO

Long-term (median 37.8 months) survival was assessed. **Overall mortality rates** were 20.3% and 18.0%, respectively ($p = 0.42$).

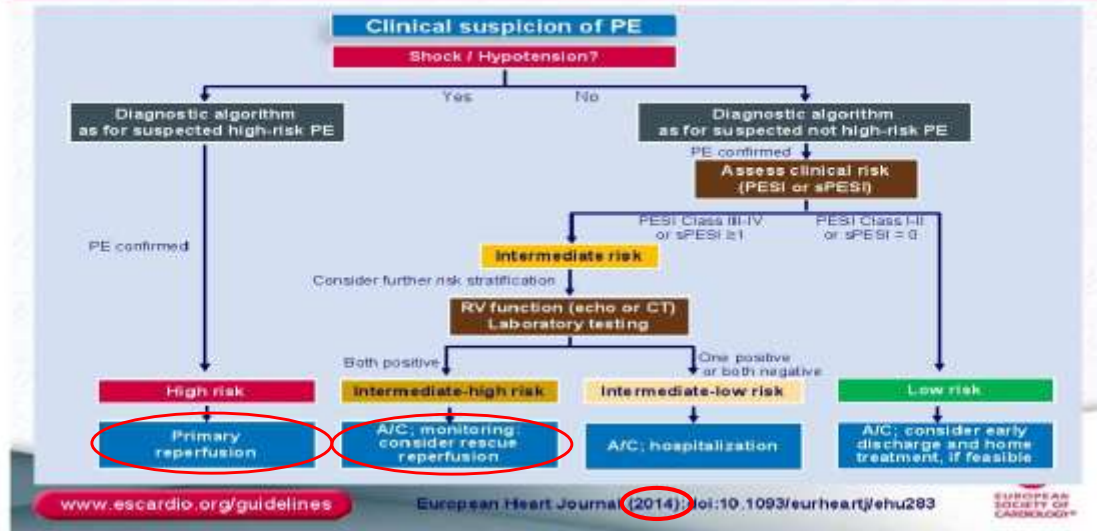
Persistent dyspnea at 1 year follow-up was reported by 36.0% versus 30.0%.

Echocardiography showed no significant differences in **residual pulmonary hypertension or RV function**.

Chronic thromboembolic pulmonary hypertension (CTEPH) was confirmed in 4 (2.1%) versus 6 (3.2%) cases ($p = 0.79$).

We need new strategies

Risk-adjusted management algorithm



Key factors contributing to haemodynamic collapse in acute pulmonary embolism



Options that we have

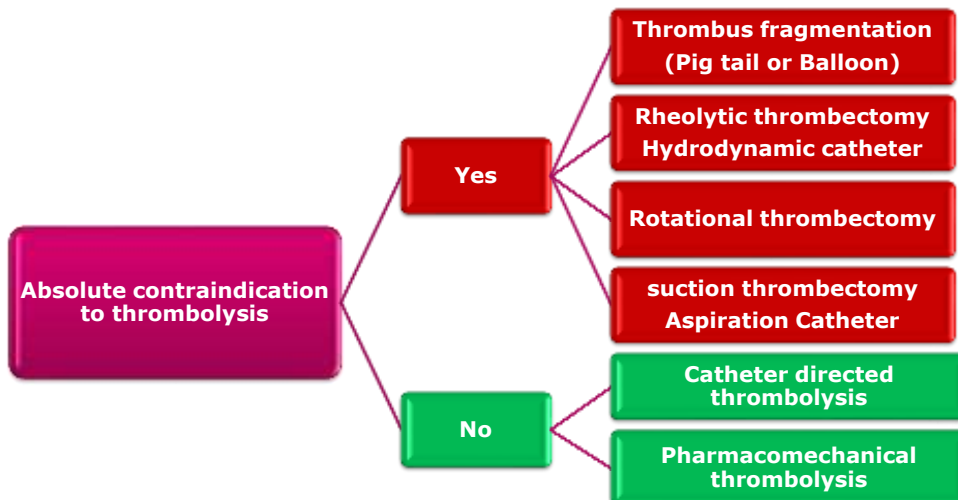
- Surgical embolectomy
- Percutaneous catheter- directed treatment

Surgical Embolectomy

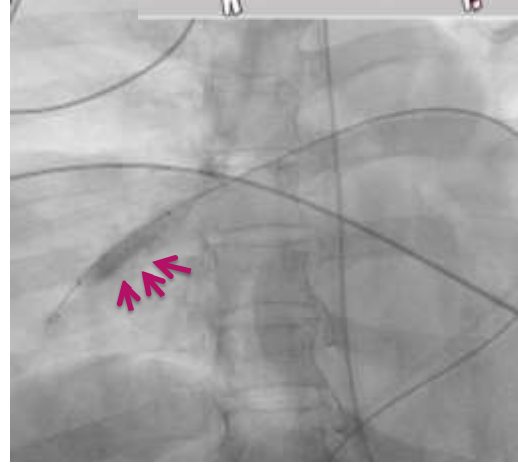
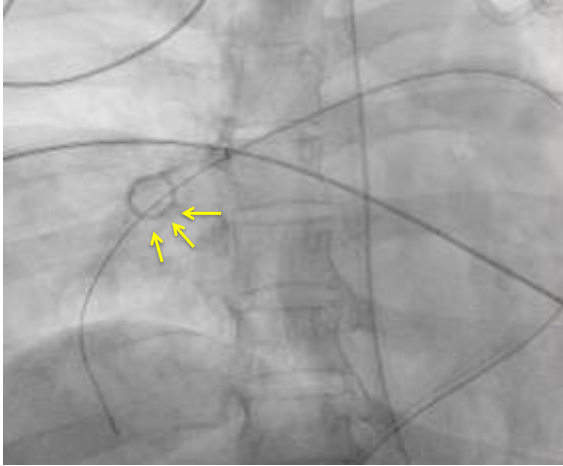
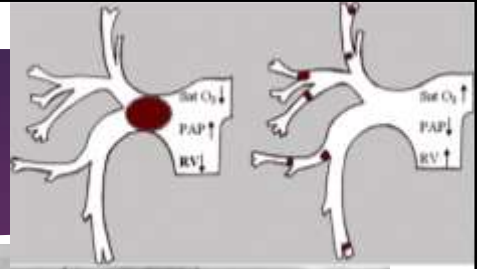


- ❑ Pulmonary embolectomy is technically a relatively simple operation.
- ❑ With a rapid multidisciplinary approach and individualized indications for embolectomy before hemodynamic collapse, perioperative mortality rates of 6% or less have been reported.
- ❑ Pre-operative thrombolysis increases the risk of bleeding, but it is not an absolute contraindication to surgical embolectomy
- ❑ It is better than re administration of thrombolysis
- ❑ Limited indications: failed thrombolysis or patients with contraindication

Catheter-directed treatment



Thrombus Fragmentation

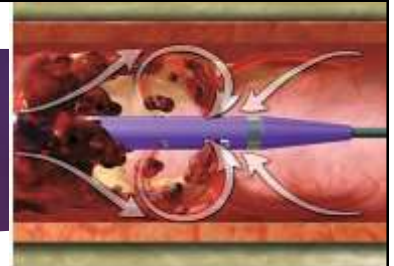


Rheolytic Thrombectomy



Amplatz

- There are several rheolytic thrombectomy devices, which have been used off label in the pulmonary arteries (e.g. The Amplatz device and the Anjojet,..)



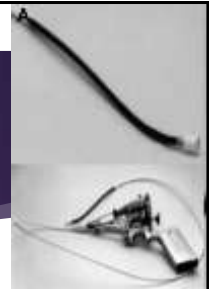
Rotational Thrombectomy


- These catheters designed to aspirate, macerate, and remove pulmonary artery thrombus using a high-speed rotational coil within the catheter body that creates negative pressure through an L-shaped aspiration port at the catheter tip.
- This technique is usually combined with catheter-directed thrombolysis. It combines the benefits of fine thrombus fragmentation with aspiration.
- Its downside is that prolonged aspiration may potentially cause hemodynamic deterioration in patients with PE-related shock because of blood loss.



Suction Thrombectomy

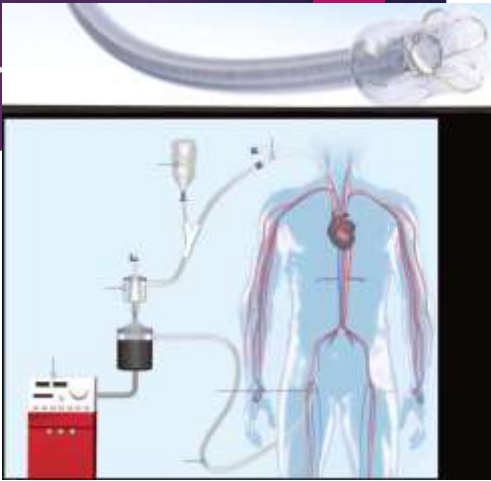
- Very early introduced by Greenfield, using a 12-French catheter with a cup on its distal end.
- Suction was applied to the catheter hub with a large volume syringe.
- A portion of thrombus was engaged in the cup and removed along with trailing adherent thrombus through a large diameter vascular sheath in either the femoral or jugular veins.





Suction catheters.

- ❑ Many systems available with the same idea
- ❑ AngioVac (needs perfusionist and large catheters)
- ❑ FlowTrievers (Rigid, FDA approval)
- ❑ Penumbra (Off Label use)



Angiovac catheter and reperfusion circuit, in which aspirated clot is filtered from aspirated blood, which is subsequently returned to the patient

Catheter-directed thrombolysis

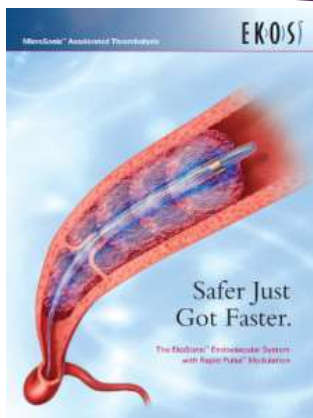
- ▶ Catheter-directed thrombolysis may be achieved with a variety of devices, including the ClearWay™ RX infusion catheter (Atrium Medical Corporation, Hudson, New Hampshire) with intrapulmonary injection of tPA or tenecteplase.
- ▶ This technique by itself may be successful; additional success is suggested when combined with other mechanical methods of thrombus fragmentation or aspiration.
- ▶ It requires positioning of an infusion catheter within the embolus, with injection of a bolus of thrombolytic drug, followed by a continuous infusion.

Catheter-directed thrombolysis



- Lower doses of the thrombolytic agent are used (average doses of tPA 10 to 20 mg vs systemic tPA infusion dose of 100 mg as a standard).
- Local delivery of the drug protects it from deactivation by circulating inhibitors and achieves higher drug concentration at the site of thrombus. The main complication is major bleeding; most bleeds occur at puncture site.

Ultrasound-accelerated thrombolysis The EKOS system



To Summarize



Advantages and disadvantages of different devices used for catheter directed therapy for massive and submassive pulmonary embolism

Methods of CDT	Device name	Advantages	Disadvantages
Catheter directed thrombolysis	ClearWay™RX infusion catheter (Atrium Medical Corporation, Hudson, NH)	High success rate as a stand alone technique	Risk of major bleeding
Ultrasound accelerated thrombolysis	EkoSonic™ EKOS® Catheter	Similar efficacy with smaller dose of thrombolytics	Lower treatment related complication and reduced thrombolytic infusion time.

Methods of CDT	Device name	Advantages	Disadvantages
Aspiration thrombectomy	Greenfield Suction embolectomy catheter™ (Medi-tec/Boston Scientific, USA)	Longest device experience	Large Lumen catheter required and catheter is difficult to manipulate due to size and stiffness
Thrombus Fragmentation	Pigtail rotational catheter™ (Cook-Europe, the Netherlands)		Increased risk of distal embolization
	Fogarty arterial Balloon embolectomy catheter™ (Edwards Lifescience Corp, Irvine, CA)		
	Amplatz-thrombectomy Device™ (ATD)		
Rheolytic thrombectomy	AngioJet™ (MEDRAD, Warrendale, PA)		Not designed for the large sized main pulmonary arteries. Risk of arrhythmias
	Hydrolyser™ (Cordis, Miami, FL)		
	Oasis™ (Medi-tec/Boston Scientific, Natick, MA)		
Rotational Embolectomy	Rotarex™	Does both fragmentation and aspiration	Prolonged aspiration may cause hemodynamic deterioration.
	Rotational thrombectomy devices, Aspirex™ (Straub Medical, Wings, Switzerland)		
	Cleaner™ (Rex medical, Athens, TX)		

Current Status

❑ Guidelines

❑ Evidence

Acute phase treatment

	Recommendations	Class	Level
	PE with shock or hypotension (high risk)		
	It is recommended to initiate intravenous anticoagulation with UFH without delay in patients with high-risk PE.	I	C
Medical	Thrombolytic therapy is recommended.	I	B
Surgical	Surgical pulmonary embolectomy is recommended for patients in whom thrombolysis is contraindicated or has failed.	I	C
Catheter directed	Percutaneous catheter-directed treatment should be considered as an alternative to surgical pulmonary embolectomy for patients in whom full-dose systemic thrombolysis is contraindicated or has failed.	Ila	C

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Acute phase treatment

	Recommendations	Class	Level
	PE without shock or hypotension (intermediate or low risk)		
	Reperfusion treatment		
Medical	Routine use of primary systemic thrombolysis is not recommended in patients without shock or hypotension.	III	B
	Close monitoring is recommended in patients with intermediate-high risk PE to permit early detection of haemodynamic decompensation and timely initiation of rescue reperfusion therapy.	I	B
	Thrombolytic therapy should be considered for patients with intermediate-high-risk PE and clinical signs of haemodynamic decompensation.	Ila	B
Surgical	Surgical pulmonary embolectomy may be considered in intermediate-high-risk patients if the anticipated risk of bleeding under thrombolytic treatment is high.	Iib	C
Catheter directed	Percutaneous catheter-directed treatment may be considered in intermediate-high-risk patients if the anticipated risk of bleeding under thrombolytic treatment is high.	Iib	B

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Comparison of pulmonary embolism treatment devices based on currently available evidence

Treatment method	Type of device	No. of patients	Outcomes
Suction thrombectomy	Greenfield suction embolectomy catheter	$n = 46^{[72]}$ 33 with massive PE 4 with submassive PE 9 with chronic PE	Mean PAP reduction from 32 to 24 mmHg in 31 patients
	Angiovac	$n = 5^{[73]}$ 4 with massive PE 1 with submassive PE	Technical success in 2 of the 4 patients with massive PE
	Flowtriever	$n = 1^{[74]}$	Procedure successful
	Flowtriever	FLARE trial - ongoing	pending
Mechanical thrombectomy	Penumbra	None	None
	Amplatz thrombectomy device	$n = 9^{[74]}$ (5 were treated with tPA)	Reduction of Miller index from 18 to 11 Mean PAP reduction from 57 to 55 mmHg Addition of tPA achieved further mean PAP reduction to 39 mmHg
	Angiojet	$n = 15^{[71]}$ 10 were treated with tPA	9 patients - significant clot resolution 5 patients - moderate clot resolution 1 patient - minimal clot resolution
	Angiojet	$n = 51^{[76]}$ 22 patients - massive PE 29 patients - submassive PE	92% technical success Mean reduction of Miller index by 51%
Catheter directed fibrinolysis	USAT	$n = 39^{[77]}$ (ULTIMA trial) 29 patients - UFH alone 30 patients - unfractionated heparin + USAT	Greater mean decrease of RV/LV ratio in the UFH + USAT group vs UFH alone (0.30 vs 0.03)

Nosher JL et al. Endovascular treatment of pulmonary embolism

Take Home Message

- Pulmonary embolism is a serious disease that is the third leading cause of death for hospitalized patients.
- The best therapy for intermediate-high risk patients is controversial and needs further study
- New strategies of treatment of PE are promising yet needs further study

Take Home Message

- For patients with massive PE in and an absolute contraindication for systemic thrombolysis, a failure of systemic thrombolysis or no time for the 2 h of administration of systemic thrombolytic agents, mechanical thrombectomy provides the primary alternative to surgical thrombectomy.
- In intermediate-high risk PE, catheter directed therapy decreases the need for treatment escalation, the time for clinical improvement, but does not increase overall survival.

