Catheter Interventions for pulmonary embolism: From Directed tPA Drips to Suction Thrombectomy

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Associate Professor of Surgery
Division of Vascular Surgery
University of Pittsburgh Medical Center
PE - Increasing Incidence

- Most common preventable cause of in-hospital death
- 50% have exercise limitation at 1 year
- 4% will develop Pulmonary Hypertension at 2-3 years

Huang et al - Am J Med 2014
PE Clinical Presentation & Risk of Death

Non Massive
Low Risk
No RVD
- Biomarkers

Submassive
Intermediate Risk
+/- ECHO RVD
+/- Biomarkers

Massive
High Risk
Hypotension

PEITHO Study:
6% will decompensate or die

1%

3-15%

15-30%

>60%

Arrest
PE Clinical Presentation & Risk of Death

Non Massive
Low Risk
No RVD
No + Biomarkers

Submassive
Intermediate Risk
+/- ECHO RVD
+/- Biomarkers

Massive
High Risk
Hypotension

Anticoagulation

Systemic Thrombolyis

Escalation of Treatment
Systemic vs Catheter Thrombolysis

“Systemic thrombolysis vs. AC is associated with a 47% mortality risk reduction ... but also high major bleeding rates (9.2% - 1.5% Stroke)”

Chatterjee et al JAMA 2014

“In intermediate risk PE us-assisted catheter directed thrombolysis is superior to heparin alone in reversing RV dilatation at 24 hours, without an increase in bleeding events”

Kucher et al Circulation 2014

Pubmed Search Citations
"Pulmonary Embolism AND Catheter"

US National Inpatient Sample
Catheter Interventions for PE

It is more than a catheter…
Catheter Interventions for PE

- Standard Catheter Thrombolysis
- Ultrasound Assisted Thrombolysis
- Percutaneous clot extraction
Catheter Interventions for PE
Interventions for PE – Thrombolysis

Standard Catheter Thrombolysis

- Multisidehole catheter introduced within the clot
- 12-24 hour tpa infusion 0.5-2mg/hour
- tPA penetrates & “softens” clot particles
Interventions for PE – Thrombolysis

Ultrasound Assisted Thrombolysis (EKOS)

• Technically similar to catheter directed dripping

Fibrin Separation

Active Drug Delivery

Acoustic Pulse Lysis can in-Vitro increase thrombus clearance by 50%

Fibrin without Ultrasound  Fibrin With Ultrasound

Acoustic streaming drives lytic into clot
Interventions for PE – Thrombolysis

Ultrasound Assisted Thrombolysis (EKOS)

- Technically similar to standard catheter dripping
- Ultrasound may reduce dripping time & tPA dose (?)
- Most literature supporting it – FDA approved
  - ULTIMA RCT
  - SEATTLE II Registry
  - Multiple small series
  - OPTALYSE PE
- No evidence of superiority over standard catheters
Interventions for PE – Thrombolysis

Ultrasound Assisted Thrombolysis (EKOS)

- Technically similar to standard catheter dripping
- Ultrasound may reduce dripping time & tPA dose (?)
- Most literature supporting it – FDA approved

Design and rationale of a randomized trial comparing standard versus ultrasound-assisted thrombolysis for submassive pulmonary embolism

Efthymios D. Avgerinos, MD, Abhisekh Mohapatra, MD, Belinda Rivera-Lebron, MD, Catalin Toma, MD, Christopher Kabrhel, MD, Larry Fish, PhD, Joan Lacomis, MD, Iclal Oca,k MD, and Rabih A. Chaer, MD, MSc, in collaboration with the PERT Consortium, Pittsburgh, Pa, and Boston, Mass

Interventions for PE – Thrombolysis

Ultrasound Assisted Thrombolysis (EKOS)

Recommended Treatment Time: 2, 4, 6, 12 Hours
Interventions for PE - Clot Extraction

Thrombectomy Devices (no need for lytics)

• Small bore Aspiration Catheters/Systems
• Large bore Aspiration Catheters/Systems
Interventions for PE - Clot Extraction

Thrombectomy Devices

- Small bore Aspiration Catheters/Systems
  - Any catheter
  - Pronto Catheter (Vascular Solutions)
  - Aspire (Control Medical Technology)
Manual Fragmentation and Aspiration

Pronto Catheter

Courtesy: E. Avgerinos
Univ. of Pittsburgh
Interventions for PE – Suction Thrombectomy

Thrombectomy Devices

- Large bore Aspiration Catheters
  (Rapid debulking of proximal thrombus)
  - Trerotola (Teleflex)
  - Angiojet (Boston Scientific)
  - Angiovac (Angiodynamics)
  - Indigo (Penumbra Inc)
  - Flowtriever (Inari medical)
Interventions for PE – Suction Thrombectomy

Thrombectomy Devices

• Angiovac
Interventions for PE – Suction Thrombectomy

 Courtesy: R. Chaer
 Univ. of Pittsburgh
Interventions for PE – Suction Thrombectomy

Thrombectomy Devices

• Indigo Penumbra
Interventions for PE – Suction Thrombectomy

Thrombectomy Devices
• Indigo Penumbra

PA Pressure 80
Before

After

PA Pressure 49

Courtesy: E. Avgerinos
Univ. of Pittsburgh
Welcome! A message from Dr. Akhilesh Sista, National Principal Investigator:

Dear EXTRACT-PE Clinical Site,

Welcome to this exciting trial: “A Prospective, Multicenter Trial to Evaluate the Safety and Efficacy of the Indigo® Aspiration System in Acute Submassive Pulmonary Embolism.” It is my honor to lead this trial along with an accomplished Steering Committee. Drs. Jim Benenati, Vic Tapson, and Jim Horowitz. We are also fortunate to have esteemed PE experts on both the Clinical Events and Data Safety Monitoring Board (DSMB) Committees to oversee the safety and efficacy of the trial.

We have individually seen how the Indigo Aspiration System can remove thrombus; it is now time to evaluate it in a prospective and rigorous fashion. The Indigo Aspiration System has the potential to remove thrombus with no or minimal thrombolytic drug use, a feature that could improve options for patients.

Thank you for participating in this important trial, and for your hard work in getting your sites up and running. Please feel free to email or call me with any study related questions. My cell is 410-908-1406, and my email is Akhilesh.Sista@nyumc.org. I look forward to working with you.

Steering Committee Members

- James Benenati, MD, FSIR
  Medical Director, Noninvasive Vascular Laboratory
  Program Director, Vascular/Interventional Radiology Fellowship Baptist Cardiac & Vascular Institute Baptist Hospital of Miami
- James Horowitz, MD, FACC
  Clinical Assistant Professor, Department of Medicine
  NYU Critical Care Associates
- Victor Tapson, MD
  Director of Pulmonary and Critical Care Medicine

Subject Enrollment

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<th>Month</th>
<th>Committal Enrollment</th>
<th>Excluding Enrollment</th>
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<td>Dec-17</td>
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Interventions for PE – Suction Thrombectomy

Thrombectomy Devices

- Flowtriever Inari
# FLARE Enrollment by Investigator

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<th>Investigator</th>
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<th>Total</th>
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<td>Tom Tu</td>
<td>Baptist Health</td>
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<td>Chris Adams</td>
<td>Charleston Area MC</td>
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<td>Wissam Jaber</td>
<td>Emory University</td>
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<td>Rohit Bhatheja</td>
<td>Florida Hospital</td>
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<td>Mitch Silver</td>
<td>OhioHealth</td>
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<td>Sameer Khandhar</td>
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<td>Rohit Amin</td>
<td>PRC / Sacred Heart</td>
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<td>Mitch Weinberg</td>
<td>North Shore / Lenox Hill</td>
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<td>East Jefferson GH</td>
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<td>Eric Peden</td>
<td>Houston Methodist</td>
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<td>Robert Maholic</td>
<td>UPMC Hamot</td>
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<td>David Holmes</td>
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<td>Scott Lilly</td>
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<td>Catalin Toma</td>
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<tr>
<td>Hussam Hamdalla</td>
<td>Ephraim McDowell</td>
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<td>Glenn Hoots</td>
<td>Tampa General</td>
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<td>Victor Tapson</td>
<td>Cedars-Sinai</td>
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<td>Monica Hunter</td>
<td>CRA / Birmingham Heart</td>
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**TOTAL ENROLLED** 106
## Safety of Catheter Interventions

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<th>Trial</th>
<th>Type of Intervention</th>
<th>Pts</th>
<th>Major Bleed</th>
<th>ICH</th>
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<td>Kuo et. al 2009</td>
<td>Various</td>
<td>594</td>
<td>~3.2%</td>
<td>0.1%</td>
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<tr>
<td>ULTIMA-2014</td>
<td>EKOS (Lysis)</td>
<td>30</td>
<td>0%</td>
<td>0%</td>
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<td>PERFECT 2015</td>
<td>sCDT EKOS (Lysis)</td>
<td>101</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>SEATTLE II 2015</td>
<td>EKOS (Lysis)</td>
<td>150</td>
<td>10%</td>
<td>0%</td>
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<td>NIS Data 2015</td>
<td>Various</td>
<td>352</td>
<td>~3.7%</td>
<td>0.3%</td>
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RCT
Coronary Sinus Perforation  Tricuspid Rupture
Avgerinos et al, J Vasc Surg 2018 in press


- 1,168 patients

- Massive PE
  - 8% Mortality
  - 6.7% Major Bleeding

- Submassive PE
  - <1% Mortality
  - 1.4% Major Bleeding
UPMC Algorithm

Assess Bleed Risk
UPMC Algorithm

Assess Bleed Risk

Low or Intermediate

Low Risk

AC vs IVC Filter

Intermediate - Low

Low or Intermediate

AC

High

IVC filter
UPMC Algorithm

Assess Bleed Risk

- **Intermediate - High**

- **Low**
  - Catheter Lysis

- **Intermediate**
  - Catheter Lysis or Suction Thr. or AC

- **High**
  - IVC filter
Assess Bleed Risk

High Risk

Low
- Systemic Lysis +/- ECMO

High
- Suction Thrombectomy or Surg. Thrombectomy or ECMO

UPMC Algorithm
Take Home Messages

- Catheter Interventions for PE are here to stay
  - Catheter Lysis vs Catheter Thrombectomy are complimentary
- Faster Clot removal & RV function recovery
- Prevention of RV failure / decompensation
- Prevention of Pulmonary Hypertension (?)
- They are not complication-free procedures but complications are less than those of systemic lysis
- Careful patient selection in high-volume centers with appropriate expertise is essential till larger studies are available.