DEEP VENOUS THROMBOSIS

PLOT AGAINST TH CLOT
PLOT AGAINST THE CLOT

- OBJECTIVES:
- DEFINITION
- DEMOGRAPHICS
- DIAGNOSIS/IMAGING
- TREATMENT
- CASE HISTORYS
DVT AWARENESS
The Surgeon General’s Call to Action to Prevent Deep Vein Thrombosis and Pulmonary Embolism

2008
DVT - “A National Crisis…”
- U.S. Surgeon General, 2008

>600,000 Americans are diagnosed with DVT annually\(^1\)

300,000 will develop Post Thrombotic Syndrome (PTS)\(^2,4\)

120,000 will suffer recurrent VTE (DVT/PE)\(^3\)

VTE = leading cause of preventable hospital death\(^5\)

DVT is the third most common CV Disease\(^4\)

US spends $2.4B to Treat DVT annually\(^2\)

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DEFINITIONS

• DVT
  – Deep Venous Thrombosis

• PE
  – Pulmonary Embolus

• DVT and/or PE = VTE
  – Venous Thromboembolus
A National Public Health Crisis

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th># of Annual Deaths³</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>Up to 200,000</td>
</tr>
<tr>
<td>AIDS</td>
<td>18,017</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>40,870</td>
</tr>
</tbody>
</table>

- It is estimated that more than 900,000 patients are hospitalized annually with VTE¹
  - Of these, 30 percent die within 30 days, one fifth suffer sudden death due to PE, and about 30 percent develop recurrent VTE within 10 years²
- Approximately 600,000 experience pulmonary embolism (PE)
- For up to 200,000 of those with PE, the blood clot in the lung proves fatal—killing more people than AIDS and breast cancer combined³

3. American Heart Association Fact Sheet - 2008
Deep Vein Thrombosis

- Pathophysiology
- Virchow’s Triad
  - Stasis of Blood Flow
    - Immobility
    - CHF
    - Obesity
    - Air Travel
  - Endothelial injury
    - Trauma
    - Major Surgery
  - Hypercoagulability
    - OCP’s, HRT, CANCER, hypercoagulable state

- Clinical Presentation
  - Leg pain
  - Swelling
  - Prominent femoral vein
  - Discoloration (cyanosis)
  - Tenderness
  - Palpable cord (thrombosed vein)
Clot propagation
Therapeutic Goals of DVT Treatment

- Relieve Patient Symptoms
- Prevent Pulmonary Embolism
- Prevent Further Thrombus Propagation
- Prevent DVT Recurrence
- Maintain Valve Competence
- Prevent Post-Thrombotic Syndrome (PTS)
Post Thrombotic Syndrome (PTS)

• Symptoms
  – Swelling
  – Pain
  – Heaviness
  – Cramps
  – Paresthesias
  – Itching
  – Bursting pain

• Signs
  – Edema
  – Varicose veins
  – Hyperpigmentation
  – Stasis dermatitis
  – Dependent cyanosis
  – Open Ulcer
  – Healed Ulcer
Pathophysiology of Post-Thrombotic Syndrome

- Acute thrombus, inflammation, and the process of vein recanalization cause valvular reflux
- Reflux and/or chronic obstruction causes Venous Hypertension which leads to edema, tissue hypoxia, or ulceration
- Clinical studies suggest that reflux in proximal veins is associated with the manifestation of Postthrombotic Syndrome

Anatomy

- Ilio-Femoral
  - CIV, EIV, CFV
- Femoral-Popliteal
  - FV, PopV
- Tibial Veins
  - PTV, Peroneal V
- Calf Muscle
  - Gastroc V, Soleal V
Anatomy

- Ilio-Femoral
  - CIV, EIV, CFV

- Femoral-Popliteal
  - FV, PopV

- Tibial Veins
  - PTV, Peroneal V

- Calf Muscle
  - Gastroc V, Soleal V
Outcomes

- 30% of DVT patients will suffer from a recurrent DVT over the next 10 years
  - Risk is greatest in the first 2 years
  - More likely if initial DVT was “spontaneous”
- Not related to pregnancy, OCP, HRT, surgery, trauma
“The Long Term Sequelae of DVT in the lower limb comprising the Post-Thrombotic Syndrome generate severe disability and marked compromise in quality of life.”

- Chronic Venous Insufficiency
- Pain-Edema
- Ulceration
- Claudication
- Discoloration
- Varicose Veins
- Amputation
Recurrent VTE

Figure 1:
The Cumulative Incidence of Recurrent Venous Thromboembolism in Patients with a First Episode of Symptomatic Deep Venous Thrombosis.

Cumulative Incidence (%) vs Year

Outcomes

• At least 30% of DVT patients will develop Chronic Venous Insufficiency (CVI)

• Post Thrombotic Syndrome (PTS)
  – Occurs when the DVT injures a valve.
    • Symptoms of swelling, leg pain when standing, varicose veins, chronic pain, skin thickening, skin discoloration, and ulcers.
Long-Term Health Complications of DVT: Pulmonary Embolism

- PE: most preventable cause of in-hospital death\(^1\)
- 70\%-80\% of fatal PE occur in nonsurgical patients\(^2\)
- Improved treatment might have a minimal impact on the number of deaths, more effective prevention of recurrent PE would represent the greatest opportunity to prevent fatal recurrent PE\(^1\)

\(\text{The first manifestation of DVT/PE may be fatal PE}\)

1. Clinical Syndromes and Clinical Outcome in Patients With Pulmonary Embolism: Findings From the RIETE Registry, CHEST 2006 – Lobo et al
GOALS:

• Recognize
• Prevent
• Treat
Recognition

• Half of VTE are predictable
  – Risk factors for the disease
  – Triggering event

• Half of VTE are unprovoked

• Preventative treatment is mandatory
  – Treatment options are based upon risk.
Signs and Symptoms

– Swelling or Pitting edema

• Pain or tenderness
• Warmth
• Red or discolored skin
• Visible surface veins
• Leg fatigue
PHLEGMASIA

ALBA DOLENS

ALBA CERULE
Risk Factors

- Cancer
- Exposure to steroid hormones (OCP, HRT)
- Thrombophilia found in 35% of patients
  - Deficiency of Protein C, Protein S, Anti-thrombin
  - Mutation in factor V and prothrombin genes
    - (Factor V Leiden)
    - (Prothrombin G20210A)
- Paralysis
- Trauma and Major Surgery
- Nursing Home Patients
Figure 4:
Concurrent VTE and Cancer Increases the Risk of Death
Probability of Death within 183 days of initial hospital admission

DVT/PE and malignant disease
Malignant disease alone
## Wells Score for DVT

<table>
<thead>
<tr>
<th>Condition</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active cancer (ongoing treatment or within last 6 months, or palliative)</td>
<td>1</td>
</tr>
<tr>
<td>Paralysis, paresis or recent plaster immobilisation of lower extremities</td>
<td>1</td>
</tr>
<tr>
<td>Recently bedridden &gt;3 days and/or major surgery within 4 weeks</td>
<td>1</td>
</tr>
<tr>
<td>Local tenderness</td>
<td>1</td>
</tr>
<tr>
<td>Thigh and calf swollen</td>
<td>1</td>
</tr>
<tr>
<td>Calf swelling 3 cm &gt; asymptomatic side (measured 10 cm below tibial tuberosity)</td>
<td>1</td>
</tr>
<tr>
<td>Pitting oedema in symptomatic leg only</td>
<td>1</td>
</tr>
<tr>
<td>Dilated superficial veins (non-varicose) in symptomatic leg only</td>
<td>1</td>
</tr>
<tr>
<td>Alternative diagnosis as or more likely than DVT</td>
<td>-2</td>
</tr>
</tbody>
</table>

### Wells Clinical probability score

- **Low probability:** ≤ 0
- **Moderate probability:** 1-2
- **High probability:** ≥ 3
Diagnosis

• Proximal or Whole Leg Duplex
Prevention

• Clear consensus to screen hospitalized patients
• All hospitalized patients at risk should be given prophylaxis
Treatment of the Acute Distal DVT

- In the asymptomatic outpatient
  - Only 15% of patients will develop proximal DVT and fewer will develop PE
  - Repeat duplex in 1-2 weeks
  - Anticoagulate if
    - Cancer, prior DVT, no reversible provoking factor, DVT close to proximal veins, DVT >5cm long, Involves multiple veins or >7mm in diameter

- In the symptomatic outpatient
  - Treatment with anticoagulation is likely helpful

- In the hospitalized patient
  - Treatment with anticoagulation is likely helpful
Treatment of the Acute Distal DVT

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- In the hospitalized patient
  - Treatment with anticoagulation is likely helpful
TREATMENT OF ACUTE DISTAL DVT TIBIAL VEINS
Length of Therapy

- Provoked by Surgery – 3 months
- Provoked by Non Surgical transient factor – 3 months
- Unprovoked – “extended”
  - 6 months
- Provoked by reversible Non Surgical cause – “extended”
  - 6 months
- Active Cancer – “extended” S.Q. LOVENOX
  - Until Remission
- Provoked by irreversible cause – “extended”
  - Life long
TREATMENT OF ACUTE PROXIMAL DVT: ILIAC, FEMORAL, POPLITEAL
Treatment of the Acute Proximal DVT

- Lovenox/Heparin/Fondaparinux with bridge to Coumadin, or: Xarelto, Elaquis, Pradaxa.
- Target INR of 2.5
- Low molecular weight heparin (enoxaparin, dalteparin, tinzaparin) or fondaparinux are the preferred treatment
- Compression Therapy
- Elevation
- Ambulation
Heparin Manufacturing

• Combine 5,000 lbs. intestines, 200 gallons water, 10 gallons chloroform, and 5 gallons toluene. Hold at 90°F for 17 hours.

• Add 30 gallons acetic acid, 35 gallons ammonia, sodium hydroxide to adjust pH, and 235 gallons water. Bring to a boil; then filter.

• Add 200 gallons hot water to filtrate and allow to stand overnight, then skim off the fat.

• Keep pancreatic extract at 100°F for three days, then bring to boil.

• Filter solids and assay for heparin content.
DVT Treatment Evolution

<table>
<thead>
<tr>
<th>Year</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>Anticoagulation Therapy Only</td>
</tr>
<tr>
<td>1980</td>
<td>Systemic Thrombolysis</td>
</tr>
<tr>
<td>1990</td>
<td>Catheter Directed Thrombolysis (CDT)</td>
</tr>
<tr>
<td>2000</td>
<td>Pharmacomechanical Thrombolysis (PMT)</td>
</tr>
<tr>
<td>Today</td>
<td>Isolated Pharmacomechanical Thrombolysis</td>
</tr>
</tbody>
</table>

95% of Today’s Treatment
Who Gets Thrombolytics?
And how are they delivered?
Indications for Treatment using CDT

- Phlegmasia Cerulea dolens
- Acute or Subacute IVC thrombosis
- Acute Iliofemoral DVT
- Acute Femoropopliteal DVT
- Subacute or Chronic Iliofemoral DVT

Goals for Lower Extremity DVT Thrombolysis

- Early return of vein patency
- Preserve valvular function to limit long term complication
- Prevent pulmonary embolism
- Limit Post-thrombotic syndrome
Tools Required for Clot Removal

- Pharmacologic
  - Thrombolytics
    - Tissue Plasminogen Activator TPA
    - Urokinase and Streptokinase (Historic)
  - Anticoagulant
    - Heparin
    - Bivalruden
  - Antiplatelets
    - IIB/IIIA Inhibitors (Aggrostat, Integrelin and Reopro)
    - Clopidogrel
    - ASA
Lower Extremity DVT Thrombolysis: Technique

• Retrievable Filter protection
• Prone position
• Popliteal Access via ultrasound guidance (5 Fr sheath)
• Guidewire across occlusion
• Infusion of thrombolytic agent and use of Mechanical Thrombectomy device
  – Pulse spray
  – Continuous infusion (infusion catheter and wire)
  – 24 to 48 hours
• Angioplasty if needed
• Stenting of treatable proximal lesions (i.e. iliac)
• Heparinization to Coumadin
• Filter Removal 2 weeks
Who Gets Treatment

• Anatomy
  – Common Femoral
  – External Iliac
  – Common Iliac
  – IVC

• Not high bleeding risk

• Good long term prognosis
Angiojet
Why is Thrombolysis not a more common treatment for DVT?

- Extensive data supporting anticoagulation
  - Emerging data for thrombolysis
- Post-Thrombotic syndrome poorly understood
  - Latent – often occurs years after the initial insult
- Concern for major hemorrhage with prolonged exposure to thrombolytic therapy
  - Better technology
  - Short, single-session lytic exposures (<20 minutes) now possible
- ICU admission for 1-4 days can be expensive, and uncomfortable to the patient
  - Newer devices (Trellis) treat in single session without ICU stay
Review of recent studies on catheter-directed treatment for DVT
CDT improves patency and reduces PTS compared to anticoagulation


CaVenT Trial:
Randomized, controlled clinical trial determining benefit of CDT
- 209 patients in 20 Norwegian hospitals; first time, acute IFDVT
- Treatment: anticoagulation vs. anticoagulation + CDT with tPA
- Patency evaluated at 6 months f/u
- Post-thrombotic syndrome (PTS) rates evaluated at 6 and 24 months f/u
CDT improves patency and reduces PTS compared to anticoagulation


- CDT group achieved:
  - Higher patency at 6 months f/u
  - Lower rate of PTS at 24 months f/u
- Further improvement in PTS rates likely if more adjunctive procedures had been performed following CDT
Greater thrombus removal gives lower PTS rate

Study to evaluate correlation between residual thrombus and post-thrombotic syndrome (PTS)

- 71 consecutive IFDVT patients treated with CDT
- Blinded comparison of pre- and post-treatment phlebograms and evaluation of CEAP/Villalta scores
First study to demonstrate:

- **Direct** and **significant** correlation of between PTS scores and thrombus clearance

- **Conclusion:** when thrombus clearance is complete, PTS can be avoided


Greater thrombus removal gives lower PTS rate
EKOS therapy results in higher rates of treatment success than PMT

Review article of various DVT treatment strategies

Baylor experience N=178

- Acute (≤14 days) + chronic (>14 days) clots
- Threatment: ultrasound accelerated thrombolysis and/or (pharmacotherapy) mechanical therapy (AngioJet or Trellis)

Chronic clots:
- EKOS or EKOS+PMT results in a HIGHER RATE OF COMPLETE LYSIS THAN PMT alone
Case

- 37 year old female presents with 2 days of acute leg swelling
- Severe swelling and pain.
- History of
  - Smoking
  - OCP
  - Spent the 12 hours in the car from Miami to Norfolk
- Duplex Ultrasound
  - DVT from popliteal vein to external iliac vein
Lower Extremity DVT Thrombolysis
Lower Extremity DVT Thrombolysis
Deep Venous Thrombosis
INITIAL VENOGRAM & USE OF MECHANICAL THROMBECTOMY DEVICE

Initial venogram & Use of Mechanical Thrombectomy Device
TPA Thrombolysis: 12 Hour Infusion
### Choosing the Right Treatment

**Lytic Exposure Time**

<table>
<thead>
<tr>
<th>Treatment Method</th>
<th>Treatment Time (Hours)</th>
<th>Lytic Exposure Method</th>
<th>Lytic Exposure Time (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDT</td>
<td>20:00 – 72:00</td>
<td>Directed - Systemic</td>
<td>20:00 – 72:00</td>
</tr>
<tr>
<td>Isolated PMT</td>
<td>1:30 – 2:00</td>
<td>Concentrated - Isolated</td>
<td>00:10 - 00:20</td>
</tr>
</tbody>
</table>

**Isolated Pharmacomechanical Thrombolysis using the Trellis Peripheral Infusion System**

*As presented at VEITH 11/2008 ~ 1,304 Venous Patients Commercial Registry*
**Isolated PMT Clinical Data**

**1,300+ Patient Clinical Registry***

<table>
<thead>
<tr>
<th>Safe</th>
<th>Major Bleed Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated Pharmacomechanical Thrombolysis (Trellis® System)(^1)</td>
<td>Ultrasound Assisted (EndoWave®)(^2)</td>
</tr>
<tr>
<td>0%</td>
<td>3.8%</td>
</tr>
</tbody>
</table>

*Isolated Pharmacomechanical Thrombolysis using the Trellis Peripheral Infusion System ~ As presented at VEITH 11/2008 ~ 1,304 Venous Patients Commercial Registry*

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Radiology 2000; 211:39-49
2008: DVT Treatment Paradigm Shift

National Quality Forum & Joint Commission
• Published a consensus statement requiring protocols for DVT prophylaxis and treatment
  www.qualityforum.org/publications/reports/vte.asp

American College of Chest Physicians
• Released updated clinical practice guidelines that suggest the use of pharmacomechanical thrombolysis for acute proximal DVT
  Chest 2008; 133; 454-545 DOI10.1378/chest.08-0658

Office of the Surgeon General
• Released 7th Call to Action in 11 years focusing on DVT as a national health issue
  www.surgeongeneral.gov/topics/deepvein/

American Journal of Medicine
• Dedicated entire supplement to prophylaxis and treatment of DVT with focus on aggressive removal of select DVT’s and institutional need to develop DVT protocol
  AJM Volume 121, Issue 11, Supplement 1 (November 2008)
Summary

- Anticoagulation Therapy alone is not enough
  - Prolonged DVT symptoms
  - Post-Thrombotic syndrome (PTS)
- Thrombolysis provides symptom relief and reduces Post-Thrombotic Syndrome
  - IVC thrombus – yes!
  - Iliofemoral DVT – yes!
  - Femoropopliteal DVT – Consider in severe cases
- Pharmaco-Mechanical Thrombolysis offers the opportunity to restore patency in a single setting
  - Isolated PMT – Trellis Device
Case 1

- 45 yo female two weeks s/p hysterectomy presented to ED with severe right leg swelling. History of prior left leg DVT treated with anticoagulation in 1995.
Initial Venogram Right Leg
Post Trellis + Iliac Stent
May-Thurner Syndrome

- External Iliac Compression Syndrome
- Right CIV compressed between spine and Right CIA
- Should be considered in cases of recurrent right leg DVT
Indications for IVC Filter

- **Broad Agreement**
  - Acute VTE with contraindication to anticoagulation
  - Failure of anticoagulation

- **Less Agreement**
  - Chronic thromboembolic pulmonary hypertension
  - Limited cardiopulmonary reserve and acute VTE
  - Iliocaval thrombus
  - Proximal free-floating thrombus
  - Thrombolysis of ilio caval DVT
  - Treatment of VTE in cancer patients
  - Treatment of VTE in pregnant patients
  - VTE prophylaxis in high-risk trauma patients
  - VTE prophylaxis in high-risk surgery patients
IVC Filter Placement and DVT Thrombolysis
Upper Extremity Deep Venous Thrombosis

- In past, believed to occur infrequently with a benign course
- Presently, incidence is increasing
  - Hospitalized patients
  - Malignancy
  - Central venous catheters
- Clinical consequences are significant
Upper Extremity Deep Venous Thrombosis

- Pulmonary embolus: 8 to 36%
  - Prandoni P, Current opinions in pulmonary medicine 1999

- Compared with lower extremity DVT
  - UEDVT have a higher rate of PE: 8% vs. 17%
  - Mortality is higher: 13% vs. 48%

- The post-thrombotic syndrome: 4.1 to 34.9%
Upper Extremity Venous Thrombolysis
Upper Extremity Venous Thrombolysis
Upper Extremity Venous Thrombolysis
Upper Extremity Venous Thrombolysis
Upper Extremity Venous Thrombolysis
Retrievable SVC Filter
Retrievable SVC Filter
Conclusions

• Recognition
• Prevention
• Appropriate Treatment

• When to refer?
  – All proximal Thromboses
    • Femoral, Iliac and IVC
  – Very symptomatic
  – Post thrombotic legs
DIAGNOSIS OF PE
# Wells Criteria for PE

Table 1. Wells Prediction Rule for Diagnosing Pulmonary Embolism: Clinical Evaluation Table for Predicting Pretest Probability of Pulmonary Embolism*

<table>
<thead>
<tr>
<th>Clinical Characteristic</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous pulmonary embolism or deep vein thrombosis</td>
<td>+ 1.5</td>
</tr>
<tr>
<td>Heart rate &gt;100 beats per minute</td>
<td>+ 1.5</td>
</tr>
<tr>
<td>Recent surgery or immobilization (within the last 30 d)</td>
<td>+ 1.5</td>
</tr>
<tr>
<td>Clinical signs of deep vein thrombosis</td>
<td>+ 3</td>
</tr>
<tr>
<td>Alternative diagnosis less likely than pulmonary embolism</td>
<td>+ 3</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>+ 1</td>
</tr>
<tr>
<td>Cancer (treated within the last 6 mo)</td>
<td>+ 1</td>
</tr>
</tbody>
</table>

**Clinical Probability of Pulmonary Embolism**

<table>
<thead>
<tr>
<th>Probability</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0-1</td>
</tr>
<tr>
<td>Intermediate</td>
<td>2-6</td>
</tr>
<tr>
<td>High</td>
<td>≥7</td>
</tr>
</tbody>
</table>

PE DIAGNOSIS

• Hx: CP-INSPIRATORY, SOB,DOE,DVT,LEG PAIN or SWELLING.
  EXAM: TACHPNEA, TACHYCARDIA,HYPOXIC.
  LABS: D-DIMER,BNP,CARDIAC ENZYMES, V/Q SCAN, CTA.
CATHETER DIRECTED TREATMENT OF PULMONARY EMBOLISMS

With Permission from EKOS and Dr. Kucher
Modified ACC Presentation 2013
HEPARIN vs. THROMBOLYSIS COMPARISON of 13 STUDIES

• OUTCOME                HEPARIN   THROMBOLYSIS
  • N=254                  N=337
  • COMPLETE LYSIS: 4%     45%
  • PARTIAL LYSIS: 14%     18%
  • NO CHANGE/WORSE: 82%   37%
Rationale

• Systemic PE Thrombolysis is associated with a 13% risk of major bleeding and 1.8% risk of intracranial hemorrhage
  – Real world 20% major bleeding and 3% ICH

• As such, systemic Thrombolysis is withheld in 2/3 of patients with massive PE
Ultima Trial

- Multicenter, Randomized Controlled Trial
- Ultrasound Assisted Catheter Directed Thrombolysis
- Superior to Heparin alone for reversing RV enlargement
- Acute Symptomatic PE confirmed by CT
- RV/LV ration >1 on echo (normal is 0.6)
Ultima Trial

Measurement of subannular RV/LV ratio (apical 4-CH view)

1. Obtain an end-diastolic image defined as last available image prior to the onset tricuspid valve closure
2. Obtain center line through interventricular septum
3. Obtain tricuspid annular line at septal insertion point of tricuspid valve, perpendicular to interventricular septum line
4. Obtain subannular line 1 cm above and parallel to annular line
5. Obtain RV and LV dimensions on the subannular line using endocardial borders
6. Calculate the RV/LV ratio: RVEDD divided by LVEDD
RV/LV ratio (echo)

P < 0.0001

Baseline: 1.28
24 hrs: 0.99
90 days: 1.5

EKOS + Heparin
RV/LV ratio (echo)

- Baseline: 1.28 (P<0.0001)
- 24 hrs: 0.99
- 90 days: 1.20

- Baseline: 1.20
- 24 hrs: 1.17
- 90 days: 1.20 (P=0.31)

EKOS+Heparin
Heparin
RV/LV ratio (echo)

- Baseline: 1.28 (P<0.0001)
- 24 hrs: 0.99
- 90 days: 1.20 (P=0.31)

- Baseline: 1.20
- 24 hrs: 1.17
- 90 days: 1.17

EKOS+Heparin
Heparin
RV/LV ratio (echo)

<table>
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<tr>
<th></th>
<th>Baseline</th>
<th>24 hrs</th>
<th>90 days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EKOS+Heparin</strong></td>
<td>1.28</td>
<td>0.99</td>
<td>0.95</td>
</tr>
<tr>
<td><strong>Heparin</strong></td>
<td>1.20</td>
<td>1.17</td>
<td>0.98</td>
</tr>
</tbody>
</table>

P-values:
- Baseline vs 24 hrs: P<0.0001
- Baseline vs 90 days: P<0.0001
- 24 hrs vs 90 days: P=0.31
- 24 hrs vs 90 days (Heparin): P<0.0001
Systolic RV dysfunction

P = 0.29**

**Two-sided exact Mantel-Haenzel test
△ Wilcoxon rank sum test
Systolic RV dysfunction

**EKOS + Heparin**

- Baseline
- 24 hrs
- 90 days

**Heparin**

- Baseline
- 24 hrs
- 90 days

*P < 0.0001* 

**Two-sided exact Mantel-Haenzel test**

△ Wilcoxon rank sum test
Systolic RV dysfunction

P = 0.01**

P < 0.0001^a

P = 0.02^a

0%  20%  40%  60%  80%  100%

Systolic RV Dysfunction

Baseline  24 hrs  90 days

Baseline  24 hrs  90 days

EKOS + Heparin

Heparin

Severe
Moderate
Mild
Normal

**Two-sided exact Mantel-Haenzel test
^a Wilcoxon rank sum test
Systolic RV dysfunction

**Two-sided exact Mantel-Haenzel test**

\( \Delta \) Wilcoxon rank sum test
### Secondary endpoint analysis

<table>
<thead>
<tr>
<th>Clinical outcomes at 90 days</th>
<th>EKOS + Heparin (N = 30)</th>
<th>Heparin (N = 29)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>0</td>
<td>1*</td>
<td>0.49</td>
</tr>
<tr>
<td>Recurrent venous thromboembolism</td>
<td>0</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>Major bleeding</td>
<td>0</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>Minor bleeding</td>
<td>3**</td>
<td>1§</td>
<td>0.61</td>
</tr>
</tbody>
</table>

* rehospitalization and death from advanced pancreatic cancer

** two patients with transient mild hemoptysis without medical intervention, one patient with groin hematoma requiring manual compression

§ one patient with transient anal bleeding following endoscopic removal of colon polyp
Angiojet
Conclusions

• Catheter directed (ultrasound accelerated) Thrombolysis was superior to heparin in reversing right heart dysfunction.

• No increase in bleeding complications

• At 90 days the right heart function is improved with CDT over Heparin
Phlegmasia

35 YO Female with 3 days of:
abdominal & Back pain with bilateral leg swelling & color changes.
PMH: HTN, Previous PE/IVC filter, Recent Subdural Hematoma, Obestiy. IUD. + Smoking