Disclosures

I have no actual or potential conflict of interest in relation to this presentation.

Note: patient research authorization was granted from the patient and his family.

1. Introduce the AngioVac system.
2. Define AngioVac procedure indications and case management.
3. Present a unique case.
AngioVac System

Specialized cannula and extracorporeal circuit for the removal of undesirable intravascular thrombi or emboli

- Thrombus aspiration site
- Large-bore AngioVac cannula
- Filter & bubble trap
- Centrifugal pump
- Venous reinfusion cannula

AngioVac Indications for Use

Vortex Medical AngioVac venous drainage cannula

- Intended use:
  - Thrombus withdrawal, en-bloc, from the iliacal/iliofemoral venous system and/or right heart chambers
  - Percutaneous access:
    - Femoral vein or internal jugular (IJ) vein
    - Cannulation dependent on location of thrombus

AngioVac Circuit Components

- Reinfusion cannula
- AngioDynamics (3/8") tubing pack
- Sorin Centrifugal Pump (SCP) system, or low-cost centrifugal pump console, motor drive and disposable
Venous thromboembolism (VTE) is a disease that includes both deep vein thrombosis (DVT) and pulmonary embolism (PE).
- VTE is the 3rd most common CVD after MI and stroke.
-约100万人每年在美国发生VTE事件，其中许多代表复发性疾病。
-大约3/4的全部VTE事件源于医院化，约30万人每年死于这些患者。
-肺栓塞超过90%是由于DVT引起的。

**Risk/Benefit Analysis**

- 缺乏数据有关治疗安全和有效性
- 干预必须提高当前医疗结果
- 高风险外科干预的替代方案

**Long-term Goals of Percutaneous Intervention**

1. 减少复发性血栓栓塞的发病率
2. 减少慢性静脉充血和血栓后综合征（PTS）
3. 减少下肢症状的严重性和持续时间
4. 预防肺栓塞
**Indications for Intervention**

1. Massive PE ("Saddle" PE)
   - Occlusion of pulmonary artery >50% of its cross-sectional area resulting in hemodynamic compromise

2. IVC Thrombus
   - Significant source of morbidity
   - Major cause: IVC filter occlusion

3. Iliocaval & common femoral vein thrombosis
   - Approx. 10 to 20% of patients with DVT involving the lower extremity have progression to the iliocaval segments

4. Cancer-associated VTE
   - Palliative intervention following failure of conventional treatment for VTE

**AngioVac Treatment Advantages**

- Minimally invasive
  - Reduction in morbidity/mortality
  - Minimizes blood loss
  - Lower cost of treatment

- Alternative to failed therapeutics
  - Anticoagulation therapy is limited in patients with hypercoagulability disorders
  - Only 1 in 5 patients with DVT is an appropriate candidate for thrombolytic therapy

**AngioVac Contraindications for Use**

- Removal of fibrous or calcified material
- Use in the right heart or pulmonary arteries during active CPR
- Requires large caliber venous access at two sites
- Limited steerability of stiff AngioVac cannula
- Relative: HIT
AngioVac Procedure Risks

- Arrhythmia
- Catheter-induced embolization of clot or tumor fragments
- Damage to intracardiac structures
- Failure to manage procedural anticoagulation status
- Venous air embolism
- Relative: hemodilution and post-procedure blood product transfusion

AngioVac Pre-Procedure Checklist

- Attend case briefing
- Visit procedure location to blueprint case setup
- Review plan for anticoagulation
- Assess strategy for cannulation
  - 26 Fr. AngioVac cannula aspiration site
  - Reinfusion cannula site
  - Cannulas for emergent ECMO or CPB standby scenario?

AngioVac Circuit Case Setup

Circuit Volume: 550 mL
ECMO Backup Supplies
- SCP System
- Sorin Revolution pump disposable
- Maquet Quadrox-ID Adult oxygenator
- Medtronic VAD pack
- Stockert flow sensor (3/8”)
- Tubing connectors (i.e. 3/8” wye)
- V-A ECMO cannulas
- Oxygen tank (full)
- Oxygen tubing (green)
- Wall source air/oxygen lines
- Oxygen flow meter
- Supplies for circuit priming

AngioVac Case Preparation
- Patient prep and drape
- Lead CST: sterile AngioVac component hand-off
- Spike and prime AngioVac circuit with balanced isotonic solution
- Systemic heparinization of the patient
  - ACT goal: 250 to 300 seconds
- Vessel cut-down and cannulation

AngioVac V-V Bypass Management
- Flow target = BSA and flow dynamics
- Slowly initiate system flow for a gradual hemodilutional effect
- Monitor negative inlet pump pressures (P1) < -180 mm Hg
- Fluctuations in flow indicate status of the venous drainage cannula
- If flow cannot be resumed, remove AngioVac venous drainage catheter and evacuate clot
Optimizing Flow

- Optimal flow anatomy and volume in structure
  - IVC ≈ 3 to 4 L/min
  - RA/PA ≈ 1.5 to 2.5 L/min
  - Maximize flow in largest volume area 2 to 3 cm from UIM
- Regular, rhythmic chatter: vascular collapse
- Irregular chugging: engagement of material
- Do not exceed flow stagnation for > 10 minutes

AngioVac Procedure Finale

- Continuously monitor the emboli filter trap
  - Replace filter if maximum clot capacity is reached
  - Ensure hemodynamic stability
  - Removal of AngioVac venous drainage cannula
  - Heparin reversal with protamine

A Novel AngioVac Case

Pertinent patient history
- 48 yo male
- Weight: 93.1 kg
- BMI: 29.44 kg/m²

Patient presentation
- Saddle pulmonary embolus presenting as syncope and troponin elevation
- Otherwise stable hemodynamics
- LVEF: 64%
Patient Facts & Primary Indication

Related medical history
- TEE: massive bilateral pulmonary emboli with severe right heart strain
- Chronic bilateral lower extremity DVTs
- Contraindicated for thrombolytic therapy due to cranio-facial injury and PE cross-sectional area
- Pertinent outpatient medications: warfarin and aspirin

Indication for AngioVac device thrombectomy
- Saddle pulmonary embolism

AngioVac Procedure With ECMO

Systemic heparinization to ACT > 300 seconds and initiation of V-A ECMO
- Left femoral artery: arterial reinfusion cannula
- Right femoral vein: partial AngioVac reinfusion/ECMO draw cannula
- ECMO flow: 3 to 4 L/min

AngioVac V-V bypass cannulation
- Right Lt: AngioVac cannula
- Right femoral vein: AngioVac system reinfusion cannula wye'd in to the femoral venous cannula and ECMO circuit

AngioVac System Management

AngioVac system flow: 2 to 5 L/min
- Venous inlet pressures: -60 to -150 mm Hg

AngioVac cannula was removed, flushed, and reinserted as needed
- Inlet and outlet of AngioVac circuit: clamped in the presence of continuous ECMO support
Special Case Considerations

V-A ECMO initiated prior to AngioVac procedure due to risk of intra-op hemodynamic collapse

- Concern of right ventricular outflow tract (RVOT) occlusion with large-bore AngioVac cannula
  - Massive saddle PE at PA bifurcation also obstructing RVOT
  - Potential for release of PE → death

Partial V-A ECMO support was tolerated during AngioVac thrombectomy treatment

- ECMO flow target: ≤ 2.0 L/min/m² CI
- Maintain RA preload for optimal AngioVac system flow and clot retrieval

AngioVac Procedure Outcome

- Duration: approx. 2 hours
- Improved perfusion and no residual thrombus in the main right pulmonary artery
- ECMO provided stability of circulatory support during the case
- ECMO weaned at the completion of the AngioVac procedure
Case Discussion

- V-A ECMO + AngioVac: 1st reported case in literature
- Modification to the reinfusion circuitry of the AngioVac system to provide simultaneous V-A ECMO support
- Contingency plan in patients who are at risk of hemodynamic collapse during catheter-based thrombectomy treatment
- Process improvement ideas
- Chart ECMO flows every 5-10 minutes
- Note AngioVac events during ECMO flow variation
- Monitor ECMO circuit inlet pressure

Conclusion

- The AngioVac is an extracorporeal V-V bypass system intended to remove undesirable intravascular material
- Greatest indications for use in patients with:
  - Fresh thrombus load
  - Contraindications to thrombolytic Rx
- Desire for an alternative to surgical intervention
- VTE is a big deal: 3rd most common CVD
- Future studies should examine recurrence of thrombus in patients following AngioVac intervention
- Concomitant ECMO support should be considered in high-risk patients undergoing thrombectomy

References
