Approach to PUMP THROMBOSIS   
in Pediatric VADs

**BACKGROUND**

Pump thrombosis is one of the known complications of VAD therapy. Diagnosis and treatment varies by device type and can include medical management to surgical intervention.

**ACTION REVISED DATE:** 05/30/2019

**OBJECTIVES**

This document will focus on the identification and treatment of pump thrombosis for the following devices:

1) Berlin Heart EXCOR

2) Heartmate II

3) HeartWare HVAD

**PROTOCOL**

**WHEN TO SUSPECT?**

1. **BERLIN HEART**
   1. Visible deposition in pump or cannulas, typically dark red or black

**APPROACH**

1. If flapping fibrin or red clot consider changing the pump
2. Check anti-coagulation parameters to ensure in target
3. **CONTINUOUS FLOW PUMPS**

**SCENARIOS**

1. **Isolated Rises in LDH**
   1. Check for hemolysis and other causes of LDH rise
   2. Consider Augmentation of anti-coagulation with IV therapy (PREVENT study)
2. **Pump Thrombosis Signs and Symptoms**

*Heartmate II*

* 1. Sustained power >10W or Power increase >2W from baseline
  2. Evidence of hemolysis (Clinical or Laboratory)
     1. Increased LDH/Change from baseline (1.5 - 2x patient’s baseline LDH level)
     2. Elevated plasma free Hgb >50
  3. Is the LV unloading?

*HeartWare HVAD*

1. Power consumption: increasing Watts (usually at least >2.0 from baseline)
2. Increase in calculated flow, especially a sudden jump in calculated flow as seen on waveform analysis on interrogation of controller.
3. Evidence of hemolysis (Clinical or Laboratory)
   * 1. Increased LDH/Change from baseline (1.5 - 2x patient’s baseline LDH level)
     2. Elevated plasma free Hgb >50
4. Is the LV unloading?

**EVALUATION**

1. Send log files to company for interpretation
2. Check baseline anti-coagulation
3. Send LDH, plasma free Hgb (less sensitive than LDH for pump thrombosis), Bilirubin, liver enzymes, Haptoglobin (not that helpful as often low in VAD patients due to subclinical hemolysis) and CBC and differential, fibrinogen, renal function
4. Rule out inflow or outflow obstruction: consider a CT to look at outflow graft
5. CXR: examine for pulmonary edema due to inadequate off loading

**APPROACH**

**1) Augment anti-coagulation**

1. Consider IV heparin (goal is therapeutic PTT or anti-Xa - whatever sites use) or bivalirudin (PTT 1.5-2x normal PTT)
2. Stop warfarin but continue anti-platelet agents
3. Once the levels are in target range consider reversal of warfarin with vitamin K
4. Monitor LDH q6hrs at first to determine rate of rise can stretch this out if rate of rise not rapid

**2) Consider low dose systemic TPA if ongoing rising LDH and increasing pump power consumption**

*TPA has been successfully reported for the HeartWare HVAD in children, there have been no reports for the Heartmate II or III in children. Before considering TPA,* ***ensure that there are no contraindications and consider liaising with hematology or someone with experience with TPA.*** *Review complications with the family and the lack of evidence. The following is a protocol to consider keeping in mind* ***the bleeding risk is unknown and there is no evidence about efficacy.***

***Things to check:***

1. Neurological exam: ensure to evidence of stroke or bleed before starting
2. Platelets >100
3. Fibrinogen level normal

**Systemic TPA after heparin started**

1. Give FFP 10 mls/kg q 6 hours or continuous infusion (i.e.: 10 mg/kg and divide by 6hrs), begin infusion before starting TPA
2. Ensure and maintain plts >100 and maintain fibrinogen in a normal level
3. Decrease heparin to 10 units/kg/hr
4. Give TPA 0.2 mg/kg/hr and run for 6-8hrs
   1. Max total dose is 100 mg for adults, unclear what max dose is for children
5. Monitor local site to ensure that there is no extravasation of TPA
6. Monitor continuously for bleeding, including neurovitals q1hr, assess pump power continuously and consider checking LDH q4-6hrs (often decrease in LDH slower than changes in pump parameters)
7. If no effect after 6-8 hrs, increase dose to 0.3 mg/kg/hr for 6-8 hrs
8. See above regarding monitoring
9. If no effect in 6-8 hrs than increase to 0.4mg/kg/hr for 6-8 hrs (max dose)
10. If no effect after this time frame - stop TPA and consider other therapies
11. If pump power normalizes discontinue TPA and increase heparin to 20 units/kg/hr (for children >12 months, no bolus); then aim to get heparin back into target range

**If patient is on Bivalirudin**

1. If any possible warfarin effect still on board consider dose of Vitamin K and FFP 10 ml/kg
2. When INR < 2 discontinue bivalirudin and start heparin 10 u/kg/hr
3. After 30 minutes of heparin start TPA 0.2 mg/kg/hr
4. Give FFP 10 mls/kg q 6 hours or continuous infusion (i.e.: 10 mg/kg and divide by 6hrs), beginning infusion before starting TPA
5. Monitor for bleeding, including neurovitals, assess pump power and LDH
6. If no effect after 6-8 hrs, increase dose to 0.3 mg/kg/hr for 6-8 hrs
7. If no effect in 6-8 hrs then increase to 0.4mg/kg/hr for 6-8 hrs (max dose)
8. If no effect after this time frame - stop TPA and consider other therapies
9. Once pump power / pressure normalizes discontinue TPA and increase heparin to 20 units/kg/hr (for children >12 months, no bolus)
10. After 30 minutes restart bivalirudin at previous dose
11. Discontinue IV heparin after 30 min of bivalirudin infusion

**3) When to consider pump exchange**

1. Rapidly rising plasma free where we were worried about the kidney function
2. Early post-operatively (<2 weeks)
3. Multiple embolic phenomenon

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***Disclaimer:*** *The ACTION network is focused on quality improvement efforts such as harmonizing best practice protocols, disseminating them among institutions, and helping centers to improve care practices at the local level. This protocol was developed as a consensus tool for pediatric VAD programs. The information in the protocols are based on center practices, individual opinions, experiences, and, where available, published literature. Centers may choose to adapt this protocol to include in their center-specific protocols with reference to ACTION with the understanding that these are meant as guidelines and not standard of care. (Revised 5/30/19)*