PEDIATRIC VAD RECOVERY GUIDE

Weaning & Explant Phases

OPS

Reverse remodeling and remission from heart failure are possible on VAD support. All patients on VAD support should be considered for surveillance of improvement in myocardial function as outlined below for remission from heart failure and possible VAD explant.

1 Resuscitation/Recovery

Timing Implant to approx. 3 months post implant

Details Incorporate Reverse Remodeling therapies *(see chart on **Weaning & Explant Harmonized Protocol**)*

Surveillance

Echo	Labs	Functional Assessment
Weekly x2 weeks, then once every 2–4 weeks with goal of optimizing VAD support	Weekly BNP or NTproBNP, CMP	6-minute walk test weekly, at 1 month, and 3 months (attention to growth and nutrition)

2 Loading/Evaluation

Timing >3 months post implant

Surveillance

Echo	Labs	Functional Assessment
Monthly. If improving function, consider wean study. ***See Pediatric VAD Recovery Guide: Echocardiogram***	Monthly BNP or NTproBNP, CMP every 1–2 weeks	6-minute walk test or CPET at 3 months, and 6 months post-implant, and after wean study

Echo Weaning Criteria

- Resolution of heart failure symptoms
- Demonstration of increasing LV EF, decreasing LVEDD/LVEDV, > than mild mitral insufficiency on serial echocardiograms
- Down trending or normalized BNP / NTproBNP
- Patient anticoagulation therapeutic at time of encounter

VAD RPM Wean

Consider weaning per ***Pediatric VAD Recovery Guide: Echocardiogram***

3 Interrogation (Pre-Explant)

Timing First cath within first 6 months post implant

Details

- See ***Weaning & Explant Harmonized Protocol*** for Pre-cath considerations and day of cath logistics
- See ***Pediatric VAD Recovery Guide: Catheterization Lab*** for VAD RAMP testing and off pump testing in cath lab (continuous flow and pulsatile)

4 Assessing Suitability for Explant

Functional Status

- Resolution of Failure to Thrive and heart failure symptoms
- Max VO2 > 16ml/kg/min on exercise testing (if performed) and normal PI response to exercise (PI>10)
- Sinus rhythm, minimal ventricular ectopy
- Sustained decrease in BNP/NT-proBNP from initial level post-implant
- On GDMT to maximally-tolerated doses

Echo

Echo with VAD at lowest RPM or rate for > 15 mins

- LVEDD Z score < +2.5 or < 60 mm (adults size patients)
- LVESD < +2.5 or < 50 mm (adults size patients)
- Neutral Interventricular septum
- No more than Mild Aortic/ Mitral Regurgitation
- No worsening of RV function

Cath

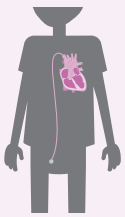
Cath with VAD at lowest RPM or rate for > 15 mins

- LVEDP / PCWP < 15mmHg
- CI ≥2.4 L/min/m2

Post Explant

Continue medicine therapies for at least 12 months, consider indefinitely

Functional and echo assessments weekly x2 weeks, then biweekly for a month, then monthly for 6 months



Consider cardiac cath at 3–6 months post explant if function has not normalized or sooner if function declines or return of heart failure symptoms/ end organ dysfunction

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Intermittent ambulatory rhythm monitoring

Echocardiogram

OPS

0–3 months post-implant

Surveillance *for Remission from Heart Failure*

Monthly echocardiograms with optimization of LVAD settings to support LV recovery

3+ months post-implant

Evaluation *for Myocardial Recovery*

Monthly echocardiograms with optimization of LVAD settings to support LV recovery

Criteria for VAD turn-down assessment:

- Echo findings:
  - Mild or better AVVR
  - LVEDD Z Score < 2.5
  - Semilunar valves opening > 50% of beats
  - LVEF >50%
- Resolution of heart failure symptoms
- Stable mildly depressed or normal right heart function
- Down-trending or normalized BNP / NT-proBNP
- Encouraging weight gain

HeartMate 3™ LVAD:

1. Obtain baseline images
2. Begin decrease in VAD rate, 200 bpm every 3 minutes
3. Repeat imaging every ~600 rpm and at nadir. Do not decrease speed below 4000 rpm or to a flow of <1L/min.

NOTE: A **successful VAD turn-down ECHO** demonstrates stable echo findings and no clinical signs of inadequate circulation.

Berlin Heart EXCOR:

1. Obtain baseline images
2. Begin decrease in VAD rate, 10-20 bpm every 5 minutes, with echo at each step.
3. If going below 50 beats/min, administer heparin (50 IU/kg). Wean below 50 beats/min once therapeutic ACT is confirmed (>250sec)
4. Repeat heparin bolus to maintain ACT >250 msec
5. Repeat imaging at 35 bpm and if function stable, consider hand-pumping trial
6. When VAD is stopped, continue to hand pump 1x every 10 seconds for up to 10-15 minutes if patient tolerating
7. Repeat echo at end of hand pumping session to assess native function

prior to final explant assessment

Myocardial Loading

Reloading is designed to assess myocardial reserve under increasing physiologic demand and to promote adaptive remodeling prior to consideration of VAD explant

HeartMate 3™ LVAD:

Wean HM3 gradually to a nadir of ~4800 RPM to reload LV. Consider a decrease of 100–200RPM every 1–2 weeks until nadir is reached.

Berlin Heart EXCOR:

Wean Berlin Heart EXCOR gradually to a nadir of ~70bpm to reload LV. Consider a decrease of 5–10RPM every 2–7days until nadir is reached.

Catheterization Lab

Consider performing cardiac catheterization within the 6 months of VAD implantation to obtain baseline hemodynamic data and consider serial hemodynamic assessments to assess for myocardial recovery.

Pre-Cath Logistics / Planning

- Establish indication: RAMP study vs. "weaning/off-pump" study.
- Review vascular access, anticoagulation management, labs within 1 week of study and planned mode of ECHO: TEE vs TTE.
- Consider deferring cardiac cath if: (**CAUTION:** Increased Stroke Risk)
  - Subtherapeutic anticoagulation
  - Active infection
  - Evidence of systemic inflammation
- Notify all relevant teams: Imaging, HF, VAD coordinator, CV surgery.

Day of Cath Logistics

Medicines

HOLD:

- SGLT2i, for >72 hours prior to cath to minimize risk of euglycemic ketoacidosis.
- ACEi,/ARB/ ARNi AM of study
- Beta-blockers in patients with significantly blunted heart rate

Anticoagulation

Pulsatile VADs: Continue anticoagulation and antiplatelet tx due to risk of thrombosis.

HM3: Warfarin can be held for 24 hours. If the patient is admitted, and INR < 2.5, consider heparin bridge

Lab Assessment

CMP, CBC, LDH, plasma free Hgb, BNP/ NT-proBNP, INR, DTT

Catheterization Team

Consider use of Swan-Ganz catheter for post-cath hemodynamic data collection.

Anesthesia

Aim for spontaneous breathing to mimic physiology in the awake state. Communicate with anesthesia on initiating vasoactive agents as this will impact data interpretation.

Monitoring

Blood pressure (arterial line vs doppler MAP), heart rate (sinus tachycardia may indicate intolerance to changes made during catheterization), consider NIRS.

VAD Parameters

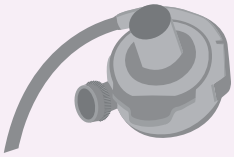
VAD waveform, PI, images of VAD monitor at various RPMs.

Imaging Assessment

Coordinate ECHO parameters to be monitored and refer to supplemental tables for suggested echo data collection.

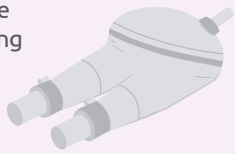
Cath Assessment

HeartMate 3™ LVAD



- Baseline right heart catheterization and echo images.
- Heparin 50 units/kg (max dose of 5000 units) prior to first RPM change.
- Maintain ACT >250 with repeat heparin bolus as needed.
- If baseline hemodynamics are acceptable and the patient is adequately anticoagulated,
  - Decrease pump speed by 200 RPM every 3 minutes to 4000 rpm or 1L/min without reversal of flow by echocardiogram.
  - Reassess hemodynamics and echocardiogram every ~600-800 rpm of weaning and after 15 minutes at lowest speed.
- **CAUTION:** The HM3 loses pulsatility when <4000 RPM
- A concurrent echo focused on the aortic outflow can be useful. Aim for "net-zero" flow through graft. Ensure avoidance of retrograde flow.

Pulsatile VADs



- Administer heparin (50 units/kg) before rate change and monitor ACT, maintaining >250 with repeat bolus if needed.
- If acceptable baseline hemodynamics and patient anticoagulated, decrease Berlin rate by ~20 bpm every 5–10 min with repeat RHC and echo at each step
- For "off pump" trial, continue to hand pump 6x minute: repeat RHC and echo after pre- determined duration (typically 20–60min) › confirm therapeutic ACT during off-pump trial
- **CAUTION:** Prolonged pump stoppage and operation of device at lower beat rates increase the risk of blood stagnation and thrombus formation.
- Gradual steps can be done over several days: non-invasive assessments. Do not decrease below 60 BPM prior to administering heparin.
- Pump should be left in systole once coming off of VAD and after each hand pump.