Anesthesia for non-cardiac surgery in patients with a Berlin Heart

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I HAVE NO DISCLOSURES or COI
Objective

Discuss anesthetic management strategies for patients with a Berlin Heart undergoing non-cardiac surgeries
Berlin Heart EXCOR

- Paracorporeal pulsatile pump
  - Fixed rate, variable stroke volume
  - Sizes 10-80 ml (US 10, 25, 30, 50 ml)
Berlin Heart EXCOR use

- Pump failure failing medical management
  - Cardiomyopathy/myocarditis
  - Congenital heart disease
    - Failure to wean from CPB
    - Conversion from ECMO
  - Transplant failure

- RVAD/LVAD/BiVAD support
  - Bridge to recovery or transplant
  - Placed utilizing CPB with closure of shunts
  - Few size limitations
  - Extubation, enteral feeding, ambulation
Increased usage of Berlin Heart

![Graph showing the number of implantations of EXCOR® Pediatric patients (n=1180) from 1999/00 to 2011/12. The number of implantations increased from 13 in 1999/00 to 377 in 2011/12.](www.berlinheart.de)
Implantation age distribution

Age distribution of EXCOR® Pediatric patients (n=1261).

www.berlinheart.de
Post implantation surgeries

• Cardiac/VAD related surgeries
  • Mediastinal exploration
  • Pump change: non-emergent vs. emergent
    • Thrombus
    • Upsizing of pump
  • Cardiac cath lab

• Common non-cardiac surgeries
  • PICC or tunneled central line
  • Radiologic procedures: CT scan (no MR!!!)
  • ENT: trach, bronchoscopy
PREOPERATIVE considerations

• Medical/surgical history and current issues
• Medications and anticoagulation protocols
• Laboratory studies including echo
• Blood product availability
• Transport/location of procedure
Current medical issues

• Cardiac indication and goal for support
  • Recovery vs. transplant

• Multi-organ system failure
  • Present or resolving hepatic or renal dysfunction
  • Ventilator dependency

• LVAD vs. BiVAD patients
  • RV support is crucial for LVAD patients
  • Consider perioperative use of milrinone
  • Availability of nitric oxide in OR
Current medications

• Anticoagulation
  • Heparin, LMWH, coumadin, antiplatelet drugs

• Cardiac
  • Inotropes: dopamine, milrinone
  • ACE inhibitors
  • B blockers

• Respiratory
  • Nitric oxide

• Antibiotics

• Sedative/analgesic drugs
• Heparin infusion 24 hrs post implant if no bleeding
  • 10-15 U/kg/hr: target PTT 60-85 sec
  • Target ATIII activity > 70%: FFP if necessary

• Conversion to LMWH (< 1 yr)
  • Target Anti Factor Xa level: 0.6-1 IU/ml

• Conversion to Vitamin K antagonist (> 1 yr)
  • Target INR: 2.7-3.5

• Antiplatelet therapy: ASA, dipyridamole
  • Platelet inhibition, TEG followed
Anticoagulation status

- Current anticoagulation protocol
- Current labs
  - CBC, platelet count, INR, PT/PTT, Anti factor Xa
  - TEG
- Consensus between surgeon, anesthesiologist, intensivist/hematologist for perioperative management and transfusion parameters
- Most often conversion to heparin infusion
  - Discontinuation two hours preoperatively
Anticoagulation monitoring

• Daily:
  • aPTT, ATIII, fibrinogen, platelet count, D-dimer
  • INR
  • Anti Xa level

• As needed or available:
  • Platelet aggregation (keep < 30% normal)
  • TEG

• Infected patients may require higher doses of anticoagulation
Patient transport

• Designate person in charge
• Anesthesia team
• VAD specialist: perfusionist or Berlin Heart trained RN
• Respiratory therapist
• Bedside RN
• Extra personnel for IV pole management
• Planning for multi-location procedures
ANESTHETIC considerations

• Airway management
• Vascular access/monitoring
• Induction/maintenance
• Potential issues
• Pump emergencies
• Post-operative management
Airway management

• Current airway status
• Nitric oxide being utilized?
  • Plan for availability even if not currently utilized
• Natural airway/spontaneous ventilation may offer advantages
  • Hypercarbia resulting in increased PVR, decreased RV output can result in LVAD failure
• Post-operative airway management

Duff et al Resuscitation 2013; 84:702-5
Vascular access/monitoring

• Adequate access for volume administration is essential
  • PICC line or tunneled central lines frequently present
  • PIV placement may be challenging

• Arterial access
  • Patient condition/surgical procedure considered

• Risk of CVL placement/air entrainment
  • Negative pressure generated by pump may easily entrain air during line placement
  • Anti-siphon valves for indwelling central lines
• Useful for evaluation of
  • Volume status/preload
  • RV dysfunction
  • Positioning of cannulas
Induction/maintenance

• **Most important principle**: maintenance of SVR and volume status

• Induction
  • Ketamine least likely to result in hypotension
  • Remifentanil associated with hypotension

• Maintenance
  • Hypotension during maintenance of anesthesia not significantly associated with any particular technique
  • Larger doses of volatile or intravenous agents were associated with hypotension

_Cave et al Ped Anesth 2010; 20:647-59_
Potential issues

- Hypotension/hypovolemia
- RV strain/failure in LVAD patient
- Dysrhythmias/bradycardia in LVAD patient
- Pump failure/loss of cardiac output
Management of hypotension

• Assessment of volume status
  • Pump membrane wrinkled during diastole?
• Fluid bolus 10 cc/kg generally effective
• Use of phenylephrine bolus or norepinephrine infusion for persistent hypotension
  • Patients on preoperative inotropes less likely to experience hypotension on induction *(Cave et al)*
• Manipulation of pump settings
  • Increase rate or manipulate systole/diastole intervals
Pump visualization

- Clear drapes should be utilized
  - Inspect drive lines for kinking
  - Mirror to evaluate underside of pump
  - Evaluate filling and ejection of pump
    - Wrinkling of membrane indicates hypovolemia
- Signs of thrombus
  - Availability of Berlin specialist/CT surgery
Inadequate perfusion or circulatory arrest

- **Evaluate pump first!**
  - Obstruction or kinks in inflow/outflow cannulae
  - Thrombosis - call CT surgery
  - Disconnection – call CT surgery
  - Power/battery failure – hand crank

- Changes in preload/contractility/afterload
  - LVAD patients particularly vulnerable

- Respiratory failure/hypoxemia/hypercarbia
  - Resultant pulmonary hypertension can affect output
Treatment

- **NO PULSE/FLOW noted with pulse check**
  - Support airway if not intubated
  - Call specialist if not present; evaluate pump
  - Utilize hand crank for power failure

- **NO PULSE/FLOW with hand crank**
  - Begin CPR

- **PULSE/FLOW present**
  - Support airway if not intubated
  - Evaluate potential etiologies
Postoperative issues

• Airway management
• Pain/sedation management
• Resumption of anticoagulation protocols
Institutional experiences

- **Edmonton:** Cave et al, *Ped Anesth* 2010; 20:647
  - 11 patients, 29 non-cardiac procedures

  - 21 patients, 62 non-cardiac procedures

- **Newcastle upon Tyne:** Haynes et al, *Ped Anesth* 2010; 20:1137
  - 40 patients, 77 VAD related and non-cardiac procedures

- **GOS:** Pratap et al, *Ped Anesth* 2010; 20:812
  - 23 patients, 26 VAD related and non-cardiac procedures
Key concepts

• Decreases in SVR are poorly tolerated
  • Volume infusion first line of therapy
  • Availability of phenylephrine, norepinephrine

• RV support is critical in LVAD patients
  • Nitric oxide
  • Milrinone
  • Treatment of dysrhythmias or bradycardia

• Discuss transfusion parameters

• Defibrillation can be performed if necessary
Controversies

• Who cares for these patients?
  • Pediatric cardiac anesthesiologists
  • Pediatric anesthesiologists
  • Intensivists

• Availability of pump trained personnel
  • Perfusionist vs. Berlin Heart trained RN
  • Continuously present or available?

• Performance of CPR with a Berlin Heart in place
www.berlinheart.de

• Sign up for “medical professional” use on website
• Strongly suggest reading and/or printing “Instructions for Use”