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)



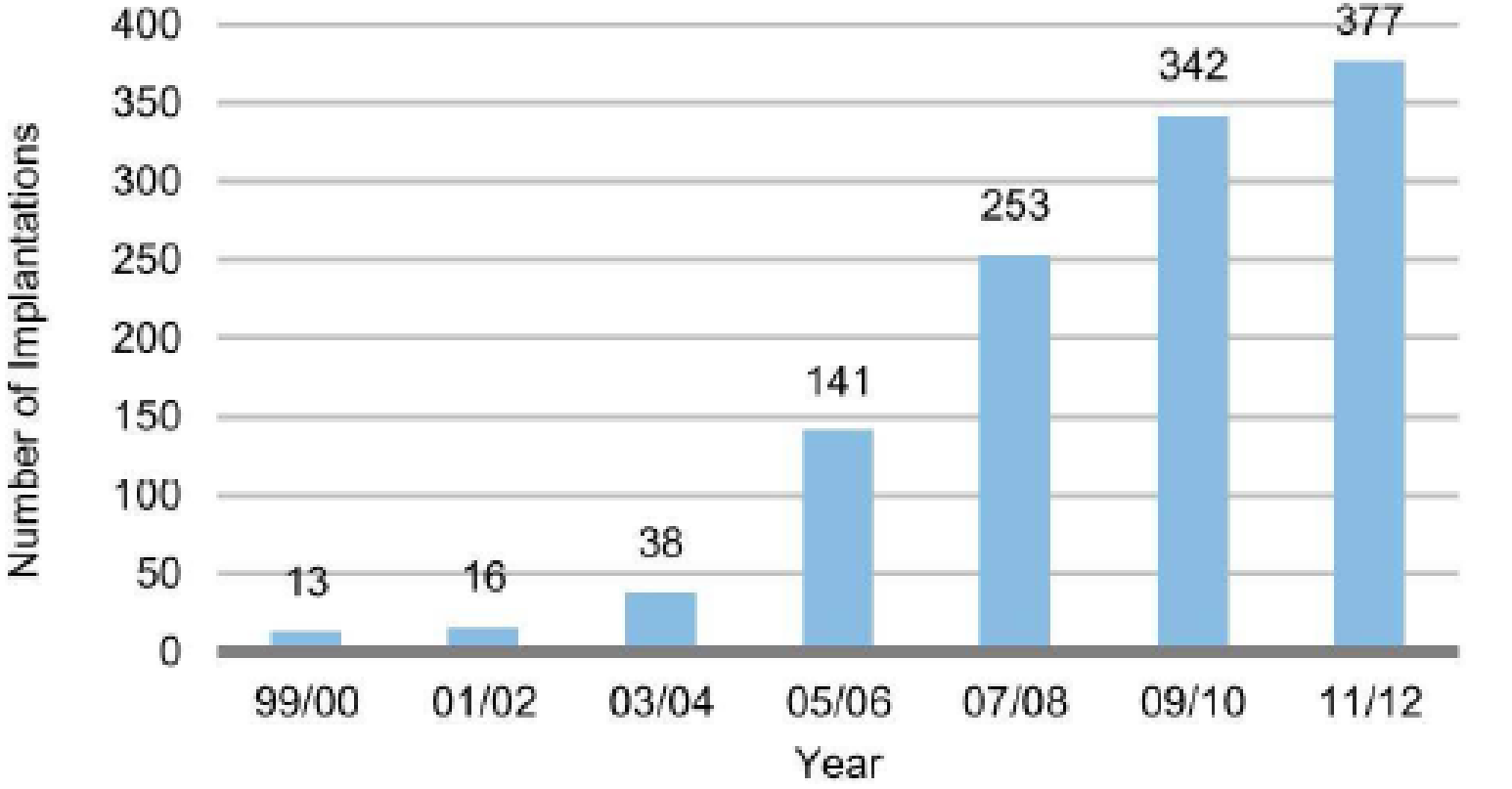
Berlin Heart®



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

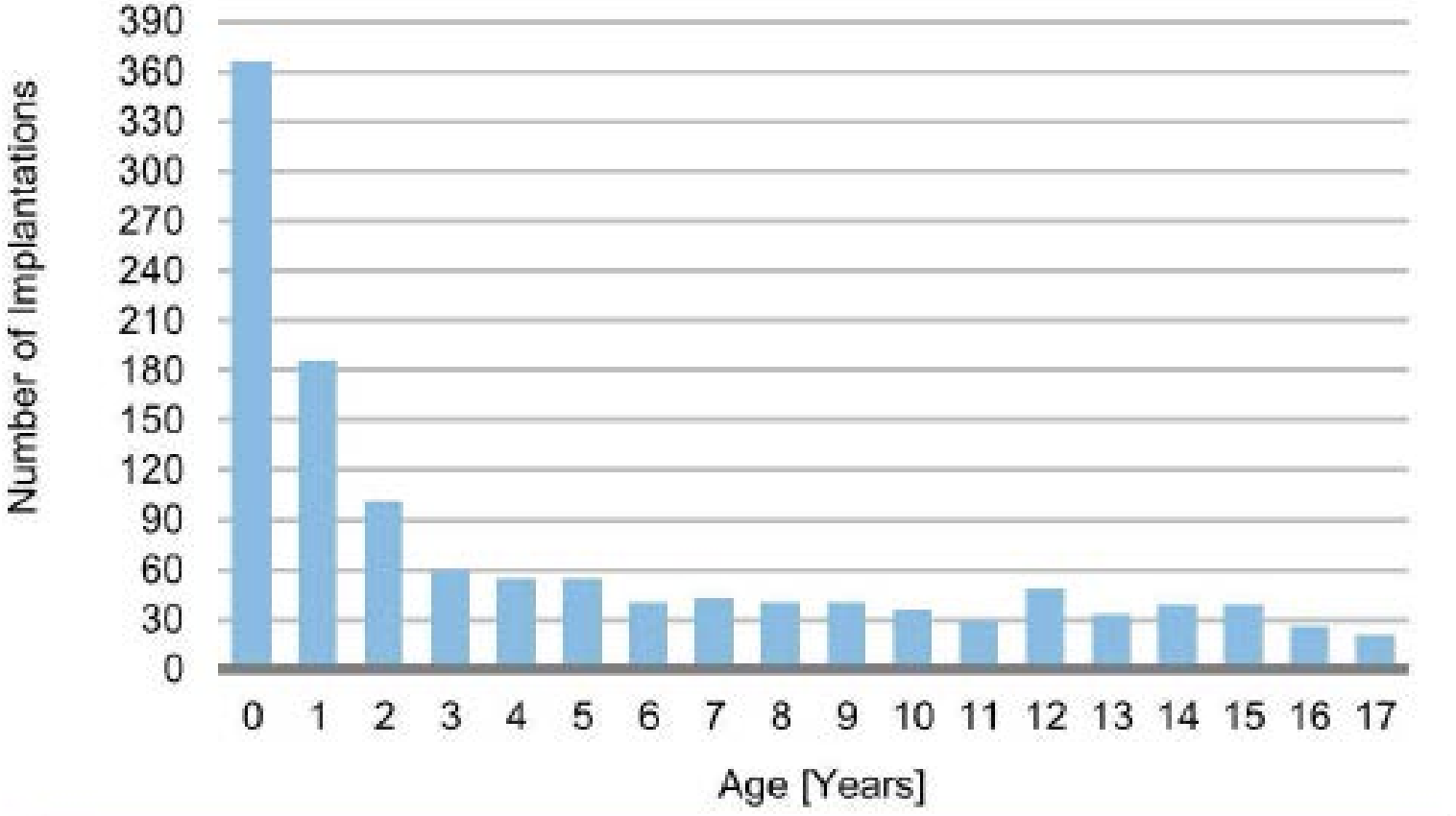
Increased usage of Berlin Heart



Implantations of EXCOR® Pediatric patients (n=1180).

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

Berlin Heart

EXCOR Pediatric

EDMONTON ANTICOAGULATION AND PLATELET INHIBITION PROTOCOL

- 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

TEE

- 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
- ***TCH*: *Mossad et al, Ped Anesth 2011; 21:586***
  - 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”

