Short Term Mechanical Circulatory Support

A Physiotherapist’s Guide

Laura McGarrigle
Content

• Indications for short term MCS
• The devices
• Complications
• Medical management
• Physiotherapy Management
• Our experiences at UHSM
Indications for short term MCS

- post open heart surgery
- post MI +/- revascularisation procedure
- cardiogenic shock
- acute cardiomyopathy
- chronic cardiomyopathy with acute decompensation
- post heart transplant
- post implant of long term LVAD
Short Term Cardiac Support Devices

- IABP
- Veno-Arterial ECMO
- Ventricular Assist Device
  - BiVAD
  - LVAD
  - RVAD
IABP

- The most commonly used mechanical circulatory support device.
- **Counterpulsation device**
- Primary goals of increasing myocardial O2 supply, reducing myocardial O2 demand and maintaining systemic BP.

**Contraindications:**
- Aortic dissection
- Severe peripheral vascular disease
- AAA
- End-stage HF (unless bridge to Tx or VAD)

A = One complete cardiac cycle
B = Unassisted aortic end-diastolic pressure
C = Unassisted systolic pressure
D = Diastolic augmentation
E = Reduced aortic end-diastolic pressure
F = Reduced systolic pressure

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**Inflation**

At the onset of diastole, IAB inflation occurs, giving rise to sharp ‘V’ on arterial waveform.

**Effect:**
- Increased coronary perfusion

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**Deflation**

Occurs at end of diastole before systole resulting in reduction of aortic end-diastolic and systolic pressures.

**Effects:**
- Decreased afterload
- Decreased cardiac work
- Decreased myocardial oxygen consumption
- Increased cardiac output

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**Please Note:**

R-wave deflation may provide more effective support for patients experiencing arrhythmias

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Krishna and Zacharowski (2009)
Complications

- Limb ischaemia
- Arterial perforation
- Aortic dissection
- Thrombosis
- Haemorrhage
- Infection
- Dislodgement of plaque / emboli
- Bleeding
- Balloon rupture
- Skin breakdown

Extra Corporeal Membrane Oxygenation = ECMO

Veno-Venous (VV) & Veno-Arterial (VA)
VA ECMO

- Provides temporary respiratory and haemodynamic support
- Used for potentially reversible cardiogenic shock (rare)
- OR bridge to BiVAD therefore to transplant/LVAD
- UHSM - usually an emergency transfer following acute deterioration
- or after heart transplant with primary graft dysfunction (PGD)

Contraindications to VA ECMO

- Multisystem organ failure
- Contraindications for anticoagulation
- Advanced age
- Poor compliance
- Significant co-morbidities
- Obesity

Cardiogenic Shock — “end organ hypo-perfusion due to cardiac failure”
- due to temporary or permanent derrangement in whole circulatory system
- usually primarily due to severe left ventricular (LV) dysfunction

Reynolds and Hochman (2008)
VA ECMO

How does it work?

Source: Cont Edu Anaesth Crit Care & Pain © 2012 Oxford University Press
Central VA cannulation

Oxygenator
The Centrimag© Pump
Ventricular Assist Device (VAD)

Mechanical pump supporting the circulation due to damaged/failing ventricle(s)

Unilateral or bilateral support

RVAD / LVAD / BiVAD

Equipment (pump/cannulae) same as ECMO but without oxygenator (usually!)

Cannulae placement can vary depending on surgeon preference and individual patient

R/L VAD – 2 cannulae, 1 pump
BiVAD – 4 cannulae, 2 pumps
Complications with VA ECMO/ VAD

- Haemorrhage
- Infection
- Thrombus formation (affecting function of pump or oxygenator)
- Embolic event (CVA, limb ischaemia)
- Circuit or pump failure
- Cannulae displacement / malposition

Martinez and Vuylsteke (2012)
Medical Management of VA ECMO/VAD

- Strict anti-coagulation protocol
- Platelet monitoring / transfusion
- Antibiotic Rx and prophylaxis
- Fluid management
- Renal replacement therapy
- Regular TTE/TOE
- Pump speed alteration
- Circuit changes (30 days)
- Family support

ALONGSIDE:
Psychology/nutrition/nursing needs
<table>
<thead>
<tr>
<th></th>
<th>IABP</th>
<th>VA ECMO</th>
<th>ST VAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early mobility hindered by...</td>
<td>Femoral placement of cannula. Haemodynamic instability.</td>
<td>Sedation Haemodynamic instability</td>
<td>Clotting derrangement Oozing cannulae sites Previous length of sedation</td>
</tr>
<tr>
<td></td>
<td><strong>BED REST</strong></td>
<td>Bleeding Open chest Cannula placement <strong>BED REST</strong></td>
<td>Low flows</td>
</tr>
<tr>
<td>Monitoring difficulties</td>
<td></td>
<td>Pulseless flow, poor arterial trace (MAP) Pulse oximetry not always accurate</td>
<td>Pulseless flow (+art trace) Pulse oximetry not always accurate Monitor screen off when unplugged from mains.</td>
</tr>
<tr>
<td>Physiotherapy techniques used</td>
<td>Chest clearance unhindered Limb mvt as able Contralateral LL strengthening Encourage ADLs</td>
<td>MHI/VHI Suction Passive mvts Splints Positioning</td>
<td>See rest of presentation</td>
</tr>
<tr>
<td>CAUTION NEEDED...</td>
<td>Haemodynamic instability Hip movement limited (varies in literature ?30 degrees flexion) Disturbing ECG monitoring if ECG triggered ?sternotomy</td>
<td>Manual chest techniques if central cannulation Clotting derranged Low platelets ?sternotomy</td>
<td>APTT ratio &gt; 3 Cannulae bleeding/oozing Unsecured cannulae Neuro changes Altered mental state Manual chest techniques sternotomy</td>
</tr>
<tr>
<td>APTT RATIO</td>
<td>ACT</td>
<td>HEPARIN INFUSION RATE CHANGE</td>
<td>TIME TO WAIT BEFORE REPEAT APTT RATIO/ACT</td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>-------------------------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>&lt;1.5</td>
<td>&lt;180</td>
<td>Increase the hourly rate by 0.2ml (50 units)</td>
<td>4 hours</td>
</tr>
<tr>
<td>1.5 – 2.0</td>
<td>181-200</td>
<td>No change</td>
<td>8 hours</td>
</tr>
<tr>
<td>2.1 – 2.5</td>
<td>201 - 220</td>
<td>Decrease the hourly rate by 0.2 ml (50 units)</td>
<td>4 hours</td>
</tr>
<tr>
<td>2.6 – 3.0</td>
<td>221 - 240</td>
<td>Stop for 1 hour then decrease the hourly rate by 0.2 ml (50 units)</td>
<td>4 hours</td>
</tr>
<tr>
<td>&gt;3.0</td>
<td>&gt; 240</td>
<td>Stop for 2 hours and repeat APTT ratio. Restart infusion only if APTT ratio &lt;2.5. When restarting the infusion, the hourly rate should be reduced by 0.4 ml (100 units) from the original rate prior to stopping</td>
<td>2 hours</td>
</tr>
</tbody>
</table>
Rehabilitation with a Short Term VAD

- Rapidly advancing field
- Risk management essential
- Full MDT involvement necessary
- Published literature lacking

Aims:
Diminish side effects of bed rest
Improve respiratory function
Facilitate normal movement patterns
Prepare for HTx or LVAD insertion
Increase independence, confidence, mood and waiting time QOL.
Reduce ICU LOS and therefore associated complications and cost

Bindoff (2011) Bindoff et al (}
Work in progress report - Assisted circulation

Implantation technique of the CentriMag biventricular assist device allowing ambulatory rehabilitation

Hiroo Takayama, Jonathan M. Chen, Ulrich P. Jorde, Yoshifumi Naka

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Received 26 August 2010; received in revised form 13 October 2010; accepted 14 October 2010

Abstract

Non-implantable ventricular assist device plays a major role in emergent or urgent situation where a patient has acutely decompensating hemodynamics. One of its major disadvantages is that the patient needs to be bed-bound after insertion. We have developed a surgical technique that allows ambulatory management of the patients who received non-implantable device with CentriMag.

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Keywords: Ventricular assist device; CentriMag; Rehabilitation

Postoperatively, an abdominal binder is used at the upper abdomen. The patients are allowed to be out of the bed as soon as they are extubated, and early rehabilitation is initiated by the physical therapists. Further rehabilitation is facilitated to walk as the patients tolerate either in the intensive care unit or in the general floor. The longest support with the CentriMag was 144 days. From January 2007 until August 2009, 63 patients underwent surgical CentriMag ventricular assist device (VAD) placement for cardiac support. The majority of those who recovered from acute illness were mobilized out of the bed, and 14 patients were able to ambulate and participated in rehabilitation. There was no adverse event associated with physical activity.
Early mobility of a patient with a CentriMag® Right Ventricular Assist System and Thoratec Heartmate II® Left Ventricular Assist System

Houser, E. E.; Fields, C.

- Early mobility can be completed safely
- therapy and mobility began post-operative day 2
- notable functional improvement
- ambulation
- Stairs
- Balance exs

- Standard of care written for future patients
- Algorithm written to aid therapists decision making
Rehabilitation with a Short Term VAD

Safety features....
✓ Echocardiogram to assess for thrombus
✓ APTT ratio within specified limits
✓ Knowledge of surgical procedure
✓ Discussed with transplant MDT
✓ Cannulae well secured with Hollister Clips
✓ Pt able to sit up in chair position prior to mobilising
✓ Alert, orientated, follows instructions
✓ Enough staff present

Bindoff (2011); Hollander et al (2014); Freeman and Maley (2013)
Flows monitored throughout

Track ceiling hoist

Lines monitored for “chatter”

Policy dependent on institution

AT LEAST 4 staff to ambulate

Chair kept behind patient at all times

1 staff solely responsible for cannulae

1 staff responsible for patient

Bindoff (2011); Hollander et al (2014); Freeman and Maley (2013)
What Rehabilitation?

Passive progressing to active limb exs
Resisted limb exs
Bed bike (Motomed)
Sitting balance on edge of bed
Standing practice
Transfers
Mobility
Step ups at bed side
Exs Bike at bedside

CAUTION!!
Unable to use standing hoist safely (sling)
Avoid free standing hoist
Don’t walk through doorways
Keep within patient zone on CTCCU
### UHSM – Bridge to TX/LVAD patients since Dec 2012

<table>
<thead>
<tr>
<th>PATIENT</th>
<th>DEVICE</th>
<th>OUTCOME</th>
<th>COMPLICATIONS</th>
<th>Best CPAx on VAD (and on d/c home)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>BiVAD</td>
<td>LVAD then HTx</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>AB</td>
<td>BiVAD</td>
<td>Htx</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>NG</td>
<td>BiVAD</td>
<td>LVAD then HTx</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>TM</td>
<td>BiVAD</td>
<td>HTx</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>ML</td>
<td>BiVAD</td>
<td>RIP</td>
<td>CVA significant hemiplegia</td>
<td>N/A</td>
</tr>
<tr>
<td>RS</td>
<td>BiVAD</td>
<td>HTx</td>
<td>Pan resistant infection, cannula moved</td>
<td>37/50   (47/50)</td>
</tr>
<tr>
<td>RC</td>
<td>BiVAD</td>
<td>LVAD</td>
<td></td>
<td>41/50   (48/50)</td>
</tr>
<tr>
<td>PJ</td>
<td>BiVAD</td>
<td>HTx</td>
<td>Infection, cannula moved</td>
<td>35/50   (48/50)</td>
</tr>
<tr>
<td>SH</td>
<td>BiVAD</td>
<td>HTx</td>
<td></td>
<td>42/50   (46/50)</td>
</tr>
</tbody>
</table>
Bibliography


Thanks 😊

Any questions?