VAD and ECMO Complications in the ICU

Renee Lassinger RN, MSN, ANP-BC
Co-Principal
Advanced Cardiothoracic Consultants, LLC
March 04, 2017
Disclosures

- I do not intend to discuss any off-label use of any device or medication.
- I am an Adult Nurse Practitioner with a primary focus on the critically ill adult. The primary focus of this presentation will be for the adult population, but many of the topics discussed can be translated to the pediatric population.
Objectives

At the end of this lecture, the participant will be able to:

- Review common complications associated with extracorporeal VAD devices
- Review common complications associated with intracorporeal VAD devices
- Review common complications associated with ECMO devices
- Outline treatment of the device during the above reviewed complications
- Outline treatment of the patient during the above reviewed complications
Let’s Get Into It!!
DETAILS
Key is Pre-Operative

- The clues for post-implantation complications or issues are in the past medical history.
- As soon as the patient is identified as a potential MCS patient, start thinking of post-operative complications and how to potentially prevent them.
- Sometimes have weeks, sometimes only have hours to days prior to implant.
Key is Pre-Operative

- Primary reason for failure
- Nutrition, anticoagulation
- Co-morbidities
- Activity level
- Age
Key is Pre-Operative

- 48 yo male NIDCM, former IV drug abuser (>30 years)
- Hep A, Hep B, Hep C, HIV (actually AIDS by CD3-4 count), hypothyroidism d/t amio
- Na 132, sCr 2.5-3.0, LFT’s elevated, HCT 26%, pre-albumin 7.

**WHILE IN OR YOU FIND:**

In past 2 weeks has clotted off: PICC Line x 2, right subclavian vein line, left femoral vein line.
Key is Pre-Operative

- Implanted with pulsatile device
- Given 300 mg ASA PR within 60 mins of coming from OR despite receiving blood based on TEG results, Hep gtt started 4 hours after OR.
- Did not ever clot off device, treated for AIDS with retrovirals which reverted him to HIV status, and lived > 5 years post-device with only 1 DL infection at 4 years post-op (superficial)
- Died after elected not to replace pump when bearing wear out happened.
ECMO and VAD Complications
Extracorporeal Membrane Oxygenation (ECMO)

- Usually emergent
- Usually lifesaving
- Two types: V-V and V-A (or as old-timers call it A-V)
- Key is early recognition and initiation
ECMO Survival¹

Survival for adults is still very low
– Respiratory 52%
– Cardiac 34%
– ECPR 27% (ECMO with CPR)

Survival for V-A ECMO for any population is low
– Adult (34%; 27% ECPR)
– Pediatric (47%, 39% ECPR)
– Neonatal (39%, 38% ECPR)
ECMO Complications$^4$

- Thrombosis (1-22%)
- Bleeding/Coagulopathy (5-79%)
- Limb Ischemia (13-25%)
- Infection (17-49%)
- Neurologic (10-33%)
Ventricular Assist Systems (VAS)

- Usually **planned**
- Usually life prolonging
- Multiple implant approaches/techniques
  - Median sternotomy
  - Left thoracotomy
  - Intraventricular
- Key is early recognition and initiation
Survival for adults is improving
- 80% 1 year (90% June 2006-Dec 2007³)
- 70% 2 year (56% June 2006-Dec 2007³)
- 48% 4 year

Biventricular support is still low at 50% 1 year survival for adults
VAS Complications/COD²

Early

- Neurologic Events
- Right Heart Failure
- Multisystem organ dysfunction
- Device Malfunction
VAS Complications/COD²

**Early**
- Neurologic Events
- Right Heart Failure
- Multisystem organ dysfunction
- Device Malfunction

**LATE**
- Infection
- Multisystem organ dysfunction
- Neurologic Events
- Device Malfunction
MCS Complications

- ECMO
  - Ischemia

- Hemorrhage
- Thrombus
- Infection

- VAS
  - Right heart failure
MCS Complications: Hemorrhage

- Cannulation displacement
  - Dislodging
  - Vessel injury
  - Requires immediate repair/replacement

- Coagulopathy
  - Multifactorial
  - Anticoagulation maintaining circuit
  - Reaction of blood contact with cannulas
  - Liver dysfunction
  - Bone marrow suppression
MCS Complications: Hemorrhage

Coagulopathy
- Type and dose of anticoagulation is institutionally dependent
- Multiple anticoagulation protocols exist

Platelet dysfunction
- Mechanical destruction
- Liver dysfunction
- Chronic illness
- Bone marrow suppression
- Platelet consumption vs platelet production
MCS Complications: Hemorrhage

**DTI**
- Depending upon type used can have short half-life
- Avoid HIT
- Renal adjustments
- May need advanced anticoag monitoring (TEG?)

**Heparin**
- Major issue is HIT
- aPTT monitoring
- Dependent upon liver and/or renal function
MCS Complications: Hemorrhage

Platelet Monitoring
- Regardless of number, activity can be affected (ie: ↓number/ ↑activity; ↑number/ ↓activity)
- Multiple tests exist (PFA-100, Bleeding times, TEG, Platelet Aggrogometry, Flow Cytometry, etc)
MCS Complications: Hemorrhage

Treatment

- Frequent surveillance of cannulas
- Anticoagulation consistent management
- Platelet activity
- Nutritional management
- Liver function evaluation (shock, congestion, other hepatic disorders)
- Renal dysfunction
- Cause of respiratory and/or cardiac failure (pregnancy, virus, cardiogenic shock, post-cardiotomy failure)
MCS Complications: Hemorrhage

Device Support:
- EMERGENT SITUATION NO MATTER WHAT!!
- Stabilize hemorrhage site as quickly as possible
- Usually requires discontinuation of pump so as not to entrain air in the system
MCS Complications: Thrombus/Embolism

- Usually not fatal
- Neurologic, limb, pulmonary, pump head
- Multifactorial
MCS Complications: Thrombus

- Balance between hemorrhage and clotting is difficult:
  - Multiorgan dysfunction/failure for V-A ECMO and VAD
  - Many patients on anticoagulation/antiplatelet prior to implantation without time to reverse adequately so can overshoot
  - Platelet dysfunction and consumption higher with MCS
MCS Complications: Embolism

Fibrin stranding
MCS Complications: Thrombus

Treatment

- Frequent surveillance of cannulas
- Anticoagulation consistent management
- Platelet *activity*
- Hypertension (Keep MAP < 85)
- Nutritional management
- Liver function evaluation (shock, congestion, other hepatic disorders)
- Renal dysfunction
- Cause of respiratory and/or cardiac failure (pregnancy, virus, cardiogenic shock, post-cardiotomy failure)
MCS Complications: ECMO Ischemia

- Speaking of non-neurologic ischemia
- Usually to the limbs
- Requires thrombectomy if able
- Can also be caused by cannula disrupting circulation
  - Positioning can sometimes alleviate
  - Usually requires de-cannulation with re-cannulation elsewhere
  - If femoral cannulation, may need distal perfusion cannula placed
MCS Complications: Infection

- Pre-operative tells the story
- Co-morbid conditions increase the risk:
  - Diabetics
  - Vasculopathies
  - Nutritional status
MCS Complications: Infection

**Diabetes/Vasculopathies**
- Not uncommon for prolonged hypoperfusion
- Rapid reperfusion can allow for dormant infection to flourish
- Look for fungals (especially if pt improves then worsens, increased LFT’s, increased WBC without associated fevers, decreased Plt count)

**Nutritional Status**
- Pre-albumin < 15 (most are single digits if had prolonged CVD or CHF)
- Prolonged malnutrition (BMI, biometrics)
MCS Complications: Infection

If time before implant:
- Nutrition consult
- Hgb A1C
- Consider IV insulin for diabetic management if severe CHF, skin hypoperfused, cannot absorb SQ insulin readily
- Add protein supplements (pending renal function can withstand)
- Supplemental tube feeding
- Some institutions do surveillance fungal swabs/cultures
  - Nasal, anal, groin, skin folds
MCS Complications: Infection

If no time before implant/post-implant:
– Nutrition consult: get gut working as soon as possible for infection control reasons
– Add protein supplements (pending renal function can withstand)
– IV insulin to maintain glucose, poor absorption through skin due to edema
– LFT’s, CBC w/plt count
– Consider endocrinology studies, especially TFT’s
MCS Complications: Infection
MCS Complications: Drive Line Infection

Treatment

– Once infected, always infected
– If superficial, antibiotics
– If deep tissue, then requires aggressive antibiotic regimen (+/- IV antibiotics)
– May require surgical revision
– May require pump change out
VAS ONLY
MCS Complications: VAS Right Heart Failure

- First complication to appear
- Often sets the “pace” for rest of the case
- Can be evaluated/anticipated pre-op
- RAP > 20mmHg
- RVEF < 20%
- Tricuspid regurgitation
- Ascites, JVD and lower extremity edema
- Hepatic dysfunction
MCS Complications: VAS Right Heart Failure

- Post-LVAS right heart function unpredictable
- Right heart dysfunction present in all cases
- 85-95% of cases can be managed with drugs
- 5-15% of cases require an RVAD
- High mortality if RVAD required (60-70%)
Post-Operative Management

Geometric Changes to the heart:

PRE-LVAD

POST-LVAD

**same patient echo**
MCS Complications: VAS Right Heart Failure

- Geometric changes
- Trauma of implant
- Bleeding - hypovolemia
- Bleeding - blood product transfusions (PAP)
- Arrhythmias
- PFO - hypoxia
MCS Complications: VAS Right Heart Failure - Intraoperative

- Assume that all patients will have some degree of RV failure
- Best clue to how well RV will do is when coming up on VAS from CPB (off CPB completely).
- Inotropic support: milrinone vs dobutamine (usually both)
- PAP vasodilation before VAS (at time of ventilation) or at 1st sign of RV trouble (iNO, Flolan, etc)
- TEE evaluation
## MCS Complications: VAS Right Heart Failure - Intraoperative

<table>
<thead>
<tr>
<th>RAP &lt; 20mmHg</th>
<th>Low LVAS flow</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP &gt; 20mmHg</td>
<td>Low LVAS flow</td>
<td>Inotropes</td>
</tr>
</tbody>
</table>

Volume or Drugs:
MCS Complications: VAS Right Heart Failure – Intraoperative/ICU

Acute RV Failure:

Load to RAP 20mmHg – do not overload RV

– Keep PAP from increasing
– Trouble keeping volume up once off CPB
– Combination of inotropic, vasodilating and vasoconstricting drugs
MCS Complications: VAS Right Heart Failure - ICU

- Stabilize rhythm – pacer; Keep HR 90-100/min
- Right heart failure difficult to deal with if pt. bleeding
- Closing chest may be problem
- Don’t “go for the gold” (no: early extubation, weaning of inotropic support)
MCS Complications: VAS Right Heart Failure - ICU

- Can develop slowly post-op during first 24 hours
- Keep PAP (PVR from increasing) – NO
- Control bleeding and volume
- Once stable, leave alone for 16 hours
MCS Complications: VAS Right Heart Failure - ICU

- Wean vasoconstrictors when possible
- Wean inotropes to low dose and leave on for 3-5 days
  - 1st on/1st off principle if on multiple inotropes (ie. Start dobutamine in OR 1st then add milrinone, then wean dobutamine 1st)
- No matter what the course – end up with volume overloaded patient
- Diurese early and a lot, but balance with causing clotting d/t dehydration (surgical “push/pulls” maybe required)
MCS Complications: VAS Right Heart Failure - ICU

- May require longer term pulmonary artery vasodilation
  - Wean iNO when able (preferably at before extubation) but may need after extubation
  - Give PGE$_1$ inhibitor as soon as able to take orals, but may have some peripheral vasodilator issues

- Nutritional management early
  - Replace proteins as soon as possible to assist with maintaining volume in vascular spaces
  - May require “drip” tube feeding to start
Summary

- Review pre-operative information, collect history from family/significant other
- Pre-operative information gives great clues as to post-operative course and management
References


M.D., FACC;