Disclosures

• No relevant financial relationship exists with any of the presenters in this presentation and there are no conflicts of interest in this presentation.
Course Objectives

• 1. Be able to describe the different types of and uses for mechanical support devices noted above.
• 2. Be aware of important safety measures for PTs related to each device.
• 3. Be able to state indications and contraindications to mobility for each device.
• 4. Provide cases of patients that have been successfully mobilized using this equipment.
• 5. Open up discussion for a round table to discuss what is working at different hospital systems that are mobilizing with these machines.
Subclavian Intra-Aortic Balloon Pump

Meghan Lahart PT, DPT, CCS
University of Chicago Medical Center
Email: meghan.lahart@uchospitals.edu
Subclavian Intra-Aortic Balloon Pump
What is an IABP?

• First described as used for patients with cardiogenic shock
• Typically placed in the femoral artery which requires bedrest and significant risk for lower extremity ischemia.
• Indicated for patients with
  – refractory angina pectoris
  – post-cardiopulmonary bypass shock
  – temporizing complications of percutaneous coronary intervention
  – complications of myocardial infarction refractory to pharmacologic therapy
Patient Selection for Ambulatory IABP

- Used in patients who benefit from IABP therapy but need ambulatory and long-term support
- Requires ICU setting
- Used as
  - Bridge to transplant: status 1a
  - Bridge to MCS
  - Bridge to determination
  - Bridge to recovery
    - Post-MI or Post ECMO
    - After high-risk surgery
What does an IABP do?

- Increases myocardial oxygen perfusion while increasing cardiac output
- Increasing cardiac output therefore increases coronary blood flow which then increases myocardial oxygen delivery
- Balloon sits in aorta
  - Actively deflates during systole: increases forward blood flow by reducing afterload
  - Actively inflates during diastole: increases blood flow to coronary arteries via retrograde flow
IABP Console

• Computer-controlled mechanism that inflates the balloon with helium linked to an electrocardiogram or pressure transducer at the distal tip of catheter
• Helium has low viscosity and allows it to travel quickly through long connecting tubes as well as lower risk of causing embolism if balloon ruptures.
• IABP augmentation can be set at 1:1, 1:2, 1:3
• Typically when using as bridge to transplant or LVAD will use a 1:1 augmentation
IABP Console Screen
Considerations and Safety Measures

- Limit shoulder flexion on side of IABP placement to 90 degrees
- Leveling the arterial line connected to IABP when ambulating
- Ensuring that the physical therapist has undergone training so as to leave ICU unit with patient
- Never take patient into an area where there are no outlets to plug console in if battery starts to die
- Checking battery life frequently
Subclavian IABP UCMC

- Russo et al. JTCVS 2012;144:951-5
- 52 patients in last 3 years (duration 2-100 days)
  - 34/37 successful bridge to transplant
    - 3 required MCS due to worsening CHF
  - 9 optimize to MCS. All implanted
  - 6 planned slow wean to recovery after high-risk cardiac surgery in low EF patients. 5 discharged
- Lessons learned
  - 90% showed decrease in PCWP, increased CO, increased BP allowing up-titration of medication, renal improvement
    - Need stable rhythm
  - 1CVA with long term deficit during pumping – poor management of driveline rupture
Subclavian IABP Vanderbilt

- Umakanthan et al. JTCVS 2012:143;1193-7
- 18 patients 2007-2010 (duration 5-63 days)
  - >50% contraindications to traditional LVADs
- Subclavian Hemashield graft, daily/aggressive ambulation
- 13/18 successful bridge to transplant
  - 3 too sick for LVADs
  - 1 MI
  - 1 arrhythmia
• Estep et al. JACC HF 2013:V1;No 5
• 50 patients 2007-2012 (duration 4-152 days; median 18)
• Subclavian percutaneous with sheath
  – Minimal ambulation
  – Increased vascular complications due to approach
• 44% required re-positioning, 20% exchange
• 42/50 successful bridge to transplant
  – 4 died and had contraindications for LVADs
  – 3 required increased support
  – 1 needed repositioning to femoral location
Axillary IABP Case
ECMO

Cori Shank PT, CCS
Indiana University Health Methodist Hospital
Email: cshank1@iuhealth.org
What is ECMO?

- Extracorporeal Membrane Oxygenation (ECMO) or Extracorporeal Life Support (ECLS)
- The use of mechanical devices to temporarily support heart and/or lung function during cardiopulmonary failure, allowing organ recovery or replacement
PATIENT SELECTION

• Must be a reversible process.
• Patient should be placed on ECMO within first 5 days.
• Have an “exit strategy”.
  • Bridge to recovery
  • Bridge to transplant
  • Bridge to implantable device – LVAD
• Goal of ECMO?
Types of ECMO Support

• Veno-arterial (VA) ECMO
  – Blood is removed from a vein, circulated through a blood pump and artificial lung, and returned to an artery
  – Supports heart and lungs

• Veno-venous (VV) ECMO
  – Blood is removed from a vein, circulated through a blood pump and artificial lung, and returned to a vein
  – Supports lungs only
Indications for VA-ECMO

• Cardiogenic shock with inability to oxygenate due to
  • Acute MI
  • Cardiac arrest
  • Decompensated heart failure
  • Post-partum cardiomyopathy
• Post-cardiotomy shock
• Bridge to durable VAD/TAH support or transplant
• Absence of non-reversible organ failure
  • Neurologic
  • Underlying end-stage malignancies
V-A ECMO Cannulation

- Surgeon
- At bedside or in OR
- Central cannulation
- Femoral cannulation
Indications for VV-ECMO

- Potential reversible lung insult
- Condition consistent with ARDS
- Mechanical ventilation < 7 days
- Profound hypoxemia or hypercapnea
- Bridge to lung transplantation
- Absence of non-reversible organ failure
  - Neurologic
  - Underlying end-stage malignancies
V-V ECMO Cannulation

- Surgeon
- At bedside or in OR
- Avalon Catheter – Bi-caval catheter inserted into the right internal jugular vein.
  - Blood is removed from superior and inferior vena cava and returned to the right atrium directly at the tricuspid valve
- Femoral vein-Internal Jugular cannulation
ECMO CIRCUIT

Main components:
• Tubing
• Gas exchange
• Blood pump
• Heat exchange
ECMO CIRCUIT
ECMO CIRCUIT
Patient Management on ECMO

- Lots of info! How long do I have?
- Support gas exchange and allow lungs to rest
- Anticoagulation...risk for bleeding!
- Prophalactic Antibiotics
- Diuretics
- Appropriate sedation and anxiety control
- Neuro checks
- Limb perfusion
Target Guidelines
The Red Book

- Temp
- pH
- pCO2
- pO2
- Hgb saturation (SpO2)
- Hgb
- INR
- Platelets
- ACT
What does that mean for me as a PT?

- Aren’t these patients too sick?
- *Ambulatory* ECMO??
- PT implications

What does Research say?
Lung Transplant and Ambulatory ECMO

• Pre Transplant
  • IPF
  • Cystic Fibrosis

• Post Transplant
  • Primary Graft Dysfunction
Physical Therapy and ECMO

• Appropriateness for PT
• Plan of care
• Considerations and Safety Measures
• Center specific protocols
Appropriateness for PT

• Is the patient stable?
  • Vent settings.
  • Bleeding
  • Vital signs

• Communication with team is crucial
Plan of Care
Considerations and safety measures

- Cannulation sites
- Ambulatory team
- Equipment
- Unexpected outcomes
Cannulation Sites

• How do you secure those big cannulas so they don’t kink or dislodge?

• Any ideas?
Ambulatory team; the key players.

• Time for PT! Who needs to be there?
  – PT
  – ECMO clinician (perfusionist/RN/RT)
  – RT
  – RN
  – Extra hands! Rehab tech, CNA, RN
  – OOPS!...Let’s not leave out the docs!
    • Cardiothoracic surgeon
    • Intensivist/pulmonologist
    • Cardiologist
Equipment

• Treadmill
  – Safety precautions:

• Stationary Bike
  – Safety precautions:

• Walking with a walker/standing frame/walking frame
  – Safety precautions:

• Weights
Show me some action!

- video
SynCardia temporary Total Artificial Heart

Tina Fields, PT, MPT, CCS
University of Michigan Hospital
Email: chrifiel@med.umich.edu
What is the SynCardia Total Artificial Heart (TAH)

- A mechanical assist device for persons with biventricular heart failure.
- Switched from animal models to human implants early 1980s
- First BTT in 1985
- To date >1,350 implants worldwide.
- Replaces both native ventricles and all four heart valves.
- Pneumatic Device -- Pulsatile
- Successful bridge to transplant in 70-80% of cases depending on source of information.
Syncardia Total Artificial Heart Status

• 2004: The world's first FDA-approved Total Artificial Heart “for use as a bridge to transplant in cardiac transplant-eligible candidates at risk of imminent death from biventricular failure”

• 2008: Approved by the Centers for Medicare & Medicaid Services.
How it works

• Replaces all 4 valves & both ventricles:
  – 70cc ventricles (non compliant)
  – No inotropes, ECG, CPR, Defibrillation

• Pneumatic Device:
  – Airflow empties ventricles with each beat
  – External Console or Driver provides air supply and power to device when mobilizing the patient.

• Preload Dependent (goal CVP 5-10)
Candidates for TAH

- Candidates Include:
  - Patients with biventricular heart failure
  - Heart Transplant Candidate
  - BSA >1.7m2 (3D imaging to check size)
  - Must tolerate anti-coagulation

- Exclusions:
  - Ineligible for heart transplant
  - BSA<1.7m2
  - Unable to be anti-coagulated
  - Medically Unstable.
Risks of TAH

• Stroke (<2.5%)
• Infection
• Anemia (avoid transfusion)
• Bleeding (10-20% in first 24-48 hours)
• Cardiac Tamponade (can occur into recovery period)
TAH vs LVAD

• TAH:
  – Is not dependent on right heart function
  – No hemodynamic consequence from arrhythmias
  – Minimal device to blood contact – less risk of clotting
  – No issues with VSD
  – Cannot be explanted
  – Less oxygen demand (ventricles ~10%)
  – No surgical pocket required
TAH “Vital” Signs

• Heart Rate: fixed (120 to 135 bpm)
• BP: (goal SBP < 140)
• Oxygen Saturations: (92-100%)
• % Systole: fixed (50 to 60%)
• Vacuum: fixed (0 to -10)
• Stroke Volume: (50s-low 60s mL)
• Cardiac Output: Can be as high as 9.5L/min
Safety measures with TAH

- Ventricles should always partially fill
- Ventricles should always fully empty
- Battery Power check for transport
- Portable air tanks (~15 minutes per 1000psi)
- Avoid kinking or splitting of tubing
- No CPR or defibrillation
Thoughts for PT

- Immediate post-operative increase in Cardiac Output
- Sternotomy Precautions:
  - no lift/push/pull >10
  - full shoulder ROM
- Start PT POD#1 assuming hemodynamic stability.
- Monitor for partial fill & complete emptying
- Noise of device – sleep, constant reminder
- Stuck in hospital if don’t qualify for Freedom Driver
Patient Mobilization s/p TAH

• Multiple Team Players:
  – Console (skilled)
  – Portable Air Supply (prn)
  – Lines/oxygen
  – Wheelchair Follow (prn)
  – Physical Assistance for mobility
  – Assistive Device

• Progresssion = Aggressive
• Limitations
What is the Freedom Portable Driver?

• A wearable power supply and air compressor for the TAH
• It allows patients who are **medically stable** to leave the hospital s/p TAH implant.
• To qualify patients must tolerate the Freedom Driver settings.

• **2014:** The Freedom® portable driver received FDA approval on June 26, 2014
Patient s/p TAH implantation
Freedom Portable Driver

- Weighs 13.5 lbs
- Driveline = 5 feet
- Driveline Pressures Fixed
- % Systole Set (50%)
- Vacuum Set (-10)
- HR is only adjustable variable from 120-135.
Wearable: Backpack
Upcoming Trials

• Destination Therapy Trial:
  – Device avg implant time is 6 mo to 2 years

• 50cc Ventricle Trial:
  – Allow use for patients with BSA >1.1m² (female and pediatric patients)
  – Capable of producing 4.5-6 lpm


References


References

• www.syncardia.com