Diaphragm Pacing can Decrease Wean Time from Mechanical Ventilation

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Prolonged Mechanical Ventilation

- Defined as greater than 96 hours of mechanical ventilation
- 5-10% of mechanically ventilated ICU patients will become “chronic” – receive PMV
- Etiology – Multi-factorial
  - Underlying lung diseases
  - Critical illness neuropathy
  - Sepsis/Infections
  - VIDD (Ventilator Induced Diaphragm Dysfunction)
PMV: Why is it a Problem?

- 1 year mortality – between 50-60%
- Poor functional outcomes
  - At 1-year, only 9% were able to perform activities of daily living (ADL) independently
  - 26% were moderately independent with ADL
  - 65% were completely dependent on help with ADL.
- Cost
  - 12-month medical cost, $306,000.00 (per pt.)
  - Population growing at rate of 5.5% annually (general hospital admission growth 1.1%)
  - By 2020, it is estimated 605,000 patients annually will require PMV at the cost of -
    - **64 Billion** health care dollars annually
Ventilator Induced Diaphragm Dysfunction: VIDD

- Diaphragm main inspiratory muscle (80%)
- Positive pressure causes muscle inactivity
  - Leading to diaphragm muscle atrophy and weakness
- Diaphragm muscles atrophy 8 times faster than limb muscles (animal studies)
- 18 hours Controlled Mechanical Ventilation (CMV) causes diaphragm atrophy
- Pressure Support Ventilation (PSV) – also causes diaphragm atrophy
PMV – Trauma Patients

- Three fold increase in mortality compared to general adult trauma population (Regional Trauma Center data)
- 12% patients required PMV
- 47% received tracheostomy

Study specifically comparing RTC to trauma centers – take away here – trauma patients have same problems with PMV as general population

- SCI – Substantial decrease in life expectancy for those dependent on mechanical ventilation

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Diaphragm Pacing

- An electrical charge is delivered
- Stimulating the motor points of the phrenic nerve
- Resulting in diaphragm contraction
- Leading to respiration

- FDA approved in SCI and ALS
- Replace – Decrease or Delay Mechanical Ventilation
Study

• Retrospective review of patients who were dependent on full time non-invasive ventilation (NIV) or mechanical ventilation and were failure to wean (FTW) that were implanted with diaphragm pacing (DP)
• Patients were identified by primary surgical and or ICU team
• Evaluated by DP team/ Informed Consent
• IRB approved protocol
  – Off label use of DP system
DP Implantation and Programming

- Pacers programmed
- Each electrode can be programmed independently
- DP use begins post implant Day 1
  - DP is turned and left on – standard ventilator weaning ensues
  - DP is turned on – ventilator removed – multiple breathing sessions with DP daily -length of sessions increasing over time.
<table>
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<tr>
<th>Subject</th>
<th>Age</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Time on PMV -Days</th>
<th>Trach (Days to DeCann)</th>
<th>Days to Wean</th>
<th>Current Survival (Months)</th>
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(42.5 > 1-yr)
DP Electrodes to Monitor dEMG Assess Recovery

Failure to Wean - Tracheostomy Mechanical Ventilation (MV)

On MV no dEMG Day 1
Complete Suppression

First Day off of MV
minimal dEMG Day 1

Complete Recovery
Diaphragm Recovery From a Phrenic Nerve Injury with DP

Prior to DP conditioning

After DP conditioning

Right

Left
Discussion

• Published data showing benefits of early implantation in SCI Posluszny et al. J Trauma Acute Care Surg. 2014 Feb;76(2):303-9;
  – 10 day average wean
  – Neuroplastic effects - recovery
  – Early identification denervated diaphragms (non-weanable)

• This small sample had significant improvement of overall survival and quality of life compared to similar groups of patients

• Shorter wean time

• DP – can be temporary – when full recovery, electrodes easily removed
Thank You
Questions ?