To Tube or Not to Tube:
Invasive vs Non-Invasive Mechanical Ventilation

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Disclosure Statement

- ☐ I do not have an affiliation, financial or otherwise, with a pharmaceutical company, medical device or communications organization.
- ☐ I have no conflicts of interest to disclose.
- ☐ I have no financial relationships or advisory roles with pharmaceutical or device-making companies, or CME providers.
- ☐ I will be discussing opportunities to better utilize NIV and MV in the acute care setting.
- ☐ My primary perspective is derived from personal practice at my place of employment for the past 27 years, Texas Health Dallas.

Objectives

- Discuss identified patient populations who may benefit from management of respiratory failure with noninvasive mechanical ventilation.
- Describe criteria which demonstrates failure of noninvasive mechanical ventilation and need for invasive mechanical ventilation.

How did we get here?

- Noninvasive Ventilation (NIV) was first used to treat patients with acute respiratory failure in the 1940s
- Invasive mechanical ventilation (MV) — Tracheostomy patients in 1950’s
- Nearly 30 years of literature covering all sorts of NIV treatment for respiratory failure
- The last 15 years have produced the most compelling and reproducible outcome solutions as to when/where/why to use NIV vs MV

Pierson, David J, History and epidemiology of noninvasive ventilation in the acute-care setting. Respiratory Care, January 2009, Vol 54 No 1

How did we get here?

- 1970's: CPAP in neonates, ICU commonality, SIMV
- 1980's: Invasive ventilation for all RF patients, pulse oximeters, CPAP for OSA, first reports of NIV for COPD, Pressure Support, first "bi-level" pressure targeted ventilators
- 1990's: RCT's emerge for RF, precise FiO2 control, increased variety with patient interface in NIV/MV, rise of evidence-based medicine, focus on VILI/ALI and lung-protective strategies
- 2000's: Multiple RCT's, meta-analyses, clinical practice guidelines, NIV standard of care for COPD/CHF, focus on DNI/palliative care

Pierson, David J, History and epidemiology of noninvasive ventilation in the acute-care setting. Respiratory Care, January 2009, Vol 54 No 1

Literature, literature, literature… everywhere!

- **2017 Cochrane review (2014-2016) screened 1,896 records relating to** *High Flow Nasal Cannula for respiratory support in adult intensive care patients*.
- **2013 Cochrane review (1950-April 2011) 2.541 records relating to** *Non-Invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary edema.*

- Huge increase in the utilization of NIV/CPAP over the past 20 years.
- Both methods have been used to facilitate extubation in myriad patient populations and settings, with variable success.
- More recently, NIV/CPAP use is shifting to more proactively avoid intubation.
- Questions abound:
  - What evidence is available for patients at risk for respiratory failure?
  - When is NIV appropriate or unwise?
  - How can NIV be properly/optimally applied?

“Ideally we want to *optimize* utilization, not just *increase* utilization.”

–NS Hill

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How does CPAP/BiPAP help?

- Improves oxygenation
- Improves PcO2
- Reduces work of breathing
- Increases lung compliance
- Increases FRC
- Increases cardiac output **
  - decreases preload and afterload
- Reduces intrapulmonary shunt

Vital FMR, Ladeira MT, Atallah AN. Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cariogenic pulmonary oedema. Cochrane Database of Systematic Reviews 2013, Issue 5. Art. No.:CD005351

Absolute Contraindications

- ☐ Coma
- ☐ Cardiac Arrest
- ☐ Respiratory Arrest
- ☐ Any condition requiring immediate intubation

Relative Contraindications

- ☐ Cardiac Instability: Shock and need for pressor support, ventricular dysrhythmias, complicated acute myocardial infarction
- ☐ GI Bleeding: Intractable emesis and/or uncontrollable bleeding
- ☐ Inability to protect airway: Impaired cough or swallowing, poor clearance of secretions, depressed sensorium and lethargy, GCS < 10
- ☐ Status Epilepticus
- ☐ Potential for upper airway obstruction: Extensive head and neck tumors, any other tumor with extrinsic airway compression, angioedema or anaphylaxis causing airway compromise

Diseases treatment or symptom control?

- ☐ Cardiogenic Pulmonary Edema
- ☐ COPD, Asthma, OSA
- ☐ Pneumonia
- ☐ Neuromuscular disorders: i.e., Guillian Barre, Myasthenia Gravis
- ☐ Acute Lung Injury, ARDS
- ☐ Cystic Fibrosis

Suitable Clinical Conditions for NIV

- ☐ Post-extubation (COPD)
- ☐ Immunocompromised state w/known cause of infiltrates
- ☐ Postoperative respiratory distress/failure
- ☐ DNI/CMO patients
- ☐ Chronic neuromuscular respiratory distress/failure
- ☐ Decompensated OSA/Cor Pulmonale
- ☐ Mild pneumocystic carinii pneumonia
- ☐ Multiple rib fractures
- ☐ *Use with caution:*
  - ☐ *Idiopathic Pulmonary Fibrosis exacerbation*
  - ☐ *ARDS*

Acute Respiratory Failure rates nearly doubled between 2001-2009

- NIV increased from 3.8% to 10.1% in the same timeframe
- MV rates remained largely the same ~ 50%
- Older patients received NIV more often
  - NIV in 50% of > 65 yr
  - NIV used least often in patients < 45 yr
  - NIV success and in-hospital mortality similar in all groups

Use and outcomes of Noninvasive ventilation for acute respiratory failure in different age groups. Respiratory Care, January 2016 Vol 61, No 1

First Line Therapy… in some instances.

- ☐ Cardiogenic Pulmonary Edema
- ☐ COPD exacerbation with moderate hypoxia and pH > 7.32
- ☐ Trauma: 3 or more rib fx, mild-mod hypoxia, lung contusion, & pH > 7.32

Acute Cardiogenic Pulmonary Edema

- 1-yr mortality nearly 30% in AMI patients complicated by acute heart failure
- Acute Cardiogenic Pulmonary Edema:
  - In-hospital mortality 12%
  - 1-yr mortality 40%

Vital FMR, Ladeira MT, Atallah AN. Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cariogenic pulmonary oedema. Cochrane Database of Systematic Reviews 2013, Issue 5. Art. No.:CD005351
Nieminen MS, Bohm M, Cowie MR, Drexler H, Filippatos GS, Jondeau G, et al. Executive summary of the guideline on the diagnosis and treatment of acute heart failure. European Heart Journal 2005;26:384-416

Acute Cardiogenic Pulmonary Edema

- NPPV and CPAP compared to SMC:
  - Reduced hospital mortality (69 lives saved for every 1000)
  - Reduced endotracheal intubation, ICU LOS, and RR
  - NPPV and CPAP were better tolerated than SMC alone
  - No increase in AMI during or after intervention
  - Reduced risk of progression of RF and neurological failure

Vital FMR, Ladeira MT, Atallah AN. Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cariogenic pulmonary oedema. Cochrane Database of Systematic Reviews 2013, Issue 5. Art. No.:CD005351

COPD and NIV

- [ ] NIV should be the first line intervention in addition to SMC to manage RF secondary to acute exacerbation of COPD in all patients.
- [ ] NIV should be tried early in the course of RF and before severe acidosis to reduce mortality, avoid intubation, and decrease treatment failure.
- [ ] Code status and DNI should be addressed ASAP
- [ ] Poor outcomes are associated with late failure of NIV in COPD patients who delay intubation for any reason
- [ ] Early correction of acidosis is essential and is an important prognostic factor for survival

Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis: British Medical Journal, January 2003, Vol 326

Acute Hypoxemic Respiratory Failure

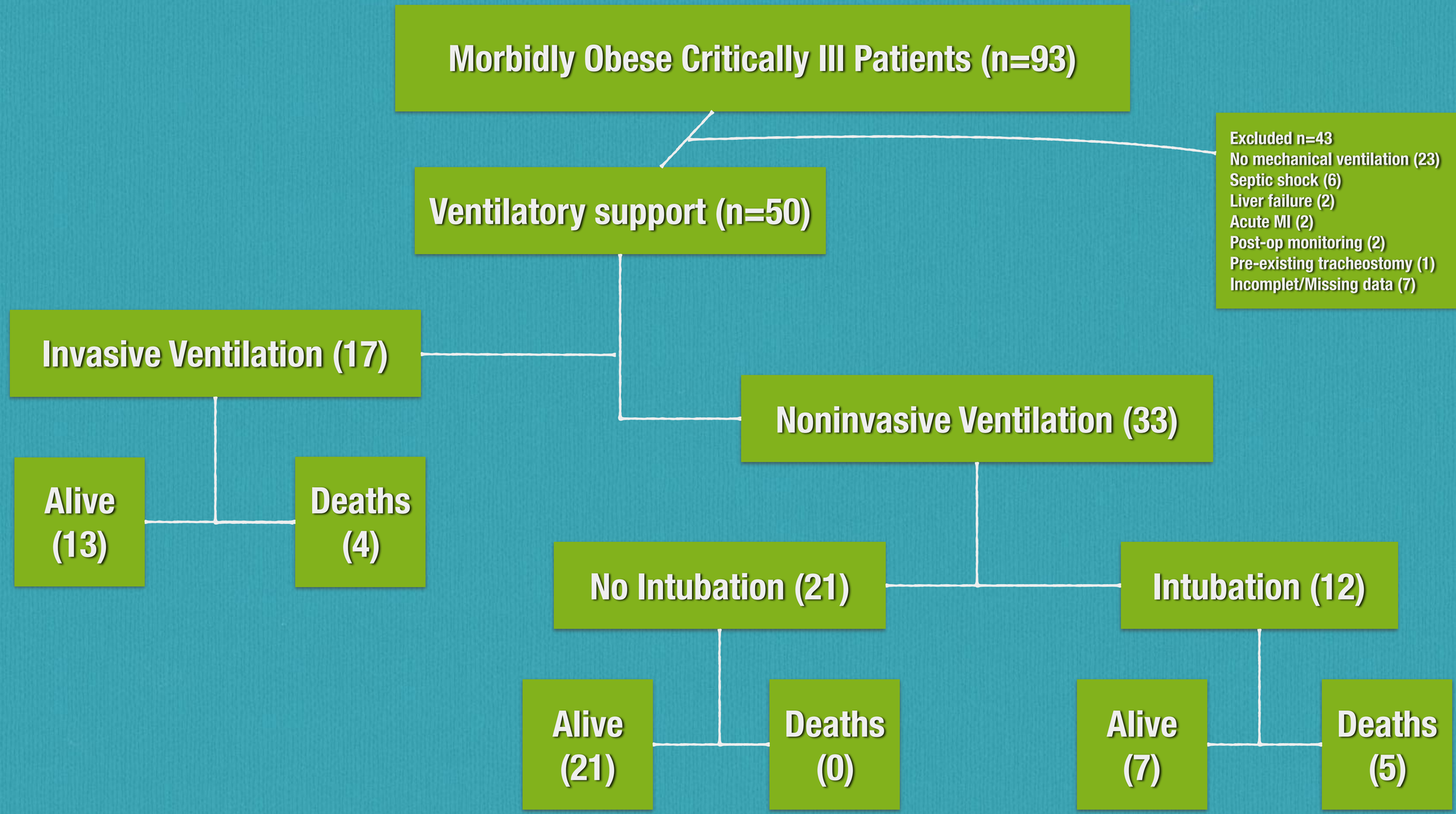
- Homogenous group: similar P/F ratio, PaCO2, & pH
- 30% (108/354) patients failed NIV and required intubation
  - ARDS/CAP ~ 50%
  - Atelectasis ~ 30%
  - Pulmonary contusion ~ 18%
  - Non-cardiogenic pulmonary edema ~ 10%
- 70% (246/354) avoided intubation
- Failure to demonstrate improvement after 1 hour (ABG) correlated with a much higher risk of intubation.
  - P/F < 146 after 1 hour independently associated with NIV failure
- Prudent attention to those with ARDS is essential (35% mortality in their study)

Antonelli, M, Conti G, Moro, M.L., Esquinas A, et al. Predictors of failure of noninvasive positive pressure ventilation in patients with acute hyperemic respiratory failure: a multi-center study. Intensive Care Medicine. (2001)27:1718-1728

Obesity Hypoventilation Syndrome

- Small number of good studies due to multiple co-morbidities
- A 1997 consensus conference suggested NIV was NOT the best treatment option
- 10 years later: BMI > 35, with very strict inclusion criteria
- 50 morbidly obese patients with acute respiratory failure
- OHS patients in pure hypoxic failure tend to respond to NIV better
- CPAP and NIV faired well with no statistical change in mortality

Duarte, A. Justino, E. Bigler, T. Grady, J. Outcomes of morbidly obese patients requiring mechanical ventilation for acute respiratory failure. Critical Care Medicine. (2007) Vol.35 No. 3



Duarte, A. Justino, E. Bigler, T. Grady, J. Outcomes of morbidly obese patients requiring mechanical ventilation for acute respiratory failure. Critical Care Medicine. (2007) Vol.35 No. 3

Do Not Intubate, Comfort Measures Only

- 27 studies evaluating 2,020 patients with DNI orders
- 3 studies evaluating 200 patients with CMO orders
- Survival rates in the DNI group at 1 year were comparable for patients treated in a well-equipped hospital ward vs. ICU
- Take-away: A well-equipped hospital ward with well-trained staff are capable of providing quality NIV to patients.

Wilson, M. Majzoub, A. Dobler, C. Curtis, J. Nayfe, T. Noninvasive ventilation in patients with Do-Not-Intubate and Comfort-Measures-Only orders: a systematic review and meta-analysis. Critical Care Medicine. August 2018 Vol. 46 No. 8

Novel Therapy? Helmet NIV/CPAP

- Not widely available in the US
- European studies are low powered, yet promising — not well accepted in the US
- July 2018 Critical Care Medicine article
  - Single center, 83 patients over 3 years
  - 90 day mortality was 22.3% lower in helmet group vs mask group

New Player? High Flow Nasal Cannula

- Crowley et al concluded:
  - "We were unable to demonstrate whether HFNC was a more effective or safe oxygen delivery device compared with other oxygenation devices in adult ICU patients."
- Frat et al concluded:
  - HFNC, SOT, NIV did not result in significantly different intubation rates
  - There was significant difference in favor of HFNC in 90-day mortality

Corley, A. Rickard, CM. Aitken, LM. Johnston, A. Barnet, et al. High-flow nasal cannula for respiratory support in adult intensive care patients. Cochrane Database of Systematic Reviews 2017, Issue 5. Art. No.: CD010172
Frat, JP. Thille, A. Mercat, A. Girault, C. Ragot, S. High-flow oxygen through nasal cannula in acute hyperemic respiratory failure. NEJM June 4 2015, Vol. 372 No. 23

Review of where we are now…

- ☐ Recommend the use of NIV in addition to SMC in COPD exacerbations (pH > 7.32 and relative hypercarbia, mild-severe hypoxemia) *
- ☐ First line therapy in ACPE & RF in the absence of shock or ACS requiring revascularization
- ☐ CPAP/NIV not be used in patients who have ALI with AHRF
- ☐ NIV be used in immunosuppressed patients with RF
- ☐ NIV be used to facilitate early extubation in COPD patients **
- ☐ NIV be used after planned extubation in patients at increased risk of recurrent RF **
- ☐ CPAP for post abdominal/thoracic surgery patients with RF **
- ☐ Oronasal mask superior to nasal mask

Conclusion:

- Delayed intubation in the setting of NIV might result in excess mortality.
- Further studies that analyze the existence of a direct relation among an early PaO2 improvement with outcomes such as mortality and need for intubation will be helpful.

Question 1

1. The primary goal of noninvasive and invasive positive pressure ventilation is:

   A. Reduce the carbonic acid load on the cardiopulmonary/renal system

   B. Support ventilation/oxygenation and reduce the work of breathing

   C. Reverse the negative effects of multi-system organ failure

   D. Provide time for family members to decide the fate of a loved one

Question 2

2.Assessing the compliance and/or effectiveness of noninvasive ventilation should included the following:

A.Vitals, LOC, ABG, need for neuromuscular blockade

B.Vitals, LOC, ABG, reduction in ST elevation on EKG

C.Vitals, LOC, ABG, patient comfort, and the ability to manage secretions

D.Vitals, LOC, ABG, ability to ambulate