Noninvasive Ventilation in the Perioperative Period

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Overview

• Noninvasive ventilation (NIV) basics
• Accepted indications for NIV in the ICU
• Perioperative indications for and uses of NIV
• OSA and NIV in the perioperative period

NIV: Background

• Confusing terms

• CPAP
  – Continuous positive airway pressure
  – Improves airway patency, V/Q matching

• Bilevel positive airway pressure (BPAP)
  – Combination of pressure support (a.k.a. IPAP) and positive end-expiratory pressure (a.k.a. EPAP)
  – Alveolar ventilation
NIV in COPD Exacerbations

- Most well-studied acute application of NIV
- First demonstrated to be effective by Meduri et al. (Chest 1989) and Brochard et al (NEJM 1990)
- Since then, multiple RCT’s have confirmed significant benefit of NIV in acute hypercapnic respiratory failure associated with COPD:
  - Compared NIV to usual/standard care
  - “Failure”: intubation, failure to tolerate NIV, or death

NIV in COPD Exacerbations: Meta-analysis Data

- Cochrane Systematic Review 2004
- Decreased mortality
  - RR with NIV = 0.52 (95% CI 0.35-0.76)
- Decreased intubation
  - RR with NIV = 0.41 (95% CI 0.37-0.63)
- Decreased rate of complications
- Decreased length of stay
NIV in Cardiogenic Pulmonary Edema

- Evidence indicates that NIV reduces need for intubation and improves cardiopulmonary physiology
- Most studies suggest mortality benefit but data are conflicting

Acute Hypoxemic Respiratory Failure: Conflicting Data

- Meta-analysis of 8 RCTs suggested benefit
  - Excluded cardiogenic edema
  - 17% absolute risk reduction ICU mortality
  - 23% absolute risk reduction intubation
  - Limited by heterogeneity
- Other studies have demonstrated high failure rate for NPPV in this setting (MGH observational trial, Schettino et al. *CCM* 2008)
- Likely due to heterogeneity of underlying conditions
- May consider its use in this setting, but not as strongly supported by evidence

A reminder for cautious use of NIV in the ICU

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NIV in the Perioperative Period

*NEJM* 2004

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*NEJM* 2004
Harmful effects of general anesthesia on pulmonary function

- FRC
  - Almost immediate reduction by 16-20% of the awake FRC (supine)
  - Alters diaphragm and chest shape
- Atelectasis
  - Generally small, but may involve up to ~10% lung tissue
- Reduced compliance
- Increased venous admixture

Postoperative pulmonary changes

- Reduced lung volumes (decreased FEV₁, FVC, FRC)
- Respiratory muscle dysfunction (may persist > 1 week!)
- Atelectasis, V/Q mismatching, shunt >> hypoxia, CO₂ retention >> respiratory compromise or failure

Postoperative Pulmonary Complications

- 5-10% of all surgical patients (Chiumello et al.)
- 17% of patients undergoing major abdominal surgery developed hypoxemia (P/F ratio < 300) (Squadrone et al.)
- 8% of thoracoabdominal surgery required tracheostomy (Svensson et al.)
- 13-26% of lung resection patients developed significant pulmonary complications (Amar et al., Nakahara et al.)
- 3% of gen surg/vasc patients developed respiratory failure (Johnson et al J Am Coll Surg 2007)

Who’s at risk?

- High ASA class
- Emergency operations
- More complex operations
- Preop sepsis
- Older patients
- Men
- Hx of COPD or CHF
- Preop creatinine > 1.5


Nunn’s Applied Resp Physiology, 6th ed
Perioperative NIV

• Prophylactic vs. therapeutic approaches
  – No significant evidence for outcomes benefits
  – Better data supporting improved gas exchange and mechanics, decreased need for re-intubation
• Range of approaches: CPAP vs BiPAP, Nasal vs. full mask, etc.

Chiumello et al. ICM 2011, Jaber et al. Anesthesiology 2010

Benefits

• Minimize or reverse usual physiologic changes
  – Improve FRC
  – Attenuate decrease in FEV1, FVC
  – Decrease atelectasis
• Maintain reasonable gas exchange
• Avoid intubation and ventilation
  – Ventilator induced lung injury, VAP, delirium, non-pulmonary organ failure

Clinical Trials

Adapted from Chiumello et al.

Bariatric Surgery

• Challenging patient population
  – OSA, restrictive syndrome, obesity-hypoventilation
• Several studies demonstrate physiologic benefits
  – Joris et al., Chest 1997
  – Neligan et al, Anesthesiology 2009
  – Ebeo et al., Respir Med 2002
• No current evidence for outcome benefits (reintubation rate, hospital stay, etc.)
Abdominal Surgery

• Prophylactic
  – Several small studies demonstrating improvement in atelectasis and spirometric data
  – Limited evidence for reduction in reintubation rate
• Therapeutic
  – Several trials demonstrated feasibility, safety, and possible efficacy with NIV (Jaber et al., Chest 2005; Conti et al. Respir Care 2007)

Thoracic and Thoraco-abdominal Surgery

• ? better evidence
• No increased risk of anastomotic disruption or pleural leaks
• Prophylactic
  – Perrin et al. investigated a 7 day pre- with 3 day postop regimen; 32 patients
  – Better spirometric and gas exchange values
  – Decreased hospital LOS (12 vs. 19, p = 0.04)

Thoracic Surgery and NIV Rescue

• Pulmonary complications remain common
  – 13% after resection (Amar et al. Anesthesia Analgesia 2010)
• Mortality increases dramatically with development of ALI/ARDS
  – incidence ALI ~ 4%, ARDS 1.5%

Continuous Positive Airway Pressure for Treatment of Postoperative Hypoxemia
A Randomized Controlled Trial

Squadrone et al. 2005

• CPAP vs. standard treatment to prevent re-intubation after major abdominal surgery
• Inclusion based on P/F ratio < 300 after 1 hour screen
• 209 patients randomized
• CPAP 7.5 vs. O₂ via Venturi mask for 6 hours
• Re-intubation: 10 (control) vs. 1 (CPAP)
• Decreased occurrence of pna, infection, sepsis; no difference in hospital LOS
• Early discontinuation due to benefit
Noninvasive Ventilation Reduces Mortality in Acute Respiratory Failure following Lung Resection

Auriant et al., AJRCCM 2001

- Randomized prospective trial standard therapy vs. nasal mask NIV
- 48 patients meeting criteria for respiratory failure NIV: Bilevel with goal Vt 8-10 ml/kg,. RR < 25
- Primary outcome: need for intubation and mechanical ventilation
- Secondary outcomes: 120 d mortality, ICU and hosp LOS, need for FOB

Outcomes

- Duration of NPPV: 2.1 +/- 2.4 d with 14.3 h/day (+/- 2.8h)
- Need for intubation: 5/24 vs. 12/24 (p = 0.035)
- In-hospital deaths: 3/24 vs. 9/24 (p = 0.045)
- No difference in LOS
- 120 d mortality: 3/24 vs. 9/24 (p = 0.045)
- No complications attributable to NIV

Respiratory Failure after Esophagectomy

- Would you consider the use of NIV?
- Possible reasons to avoid NIV:
  - Risk of aspiration
  - Anastamotic disruption


- Small case-control study of 36 patients receiving NIV matched to controls receiving conventional therapy
- Bilevel NIV used for a mean of 6 +/- 2 days; mean 9.5 h/day over first 48 hours
- Reduced need for re-intubation (9/36 vs 23/36, p = 0.008), ICU LOS and lower incidence of sepsis and anastamotic breakdown

Auriant et al., AJRCCM 2001
Practical Matters

• Patients should be in ICU or PACU when initiating for rescue or therapeutic indications
• Focus closely on monitoring, particularly at initiation of treatment
• Should be applied early in course of disease
• Improvement in ABG (pH, pCO\(_2\)) over first 1-2 hours needs to be assessed
  – If pH, pCO\(_2\) and/or mental status are worse than pre-NIV, pt probably needs intubation

Practical Matters II

• CPAP vs. BPAP
  – No clear benefit to suggest one approach, although recommend BPAP for treatment of respiratory distress or failure
  – Consider need for higher levels of support in morbidly obese patients (may need PSV up to 12 cm H20)

Practical Matters III

• Mask types
• Settings
  – CPAP: start with 7-10 cm H\(_2\)O
  – BPAP: 3-5/3-5 initially and titrate
  – Limit total insufflation P < 25 cm H\(_2\)O
• How long to treat?
  – Initially, 60-120 minutes
  – Subsequently, 60-90 mins q 2-3 h
  – 8-12 hours/day

Jaber et al. Anesthesiology 2010

Contraindications to NIV

• Impending circulatory collapse or respiratory arrest
• Unable to protect airway/altered mental status
• Excessive secretions or UGI bleeding
• Recent facial, transsphenoidal, or upper airway surgery
• Unable to get good fit with mask
• Inability to adequately monitor patient
Potential Complications of NIV

- Local pressure-related:
  - Ulceration of nasal bridge, face
- Aspiration
- Gastric distention
- Intolerance of mask
- Failure to recognize failure

Obstructive Sleep Apnea & Perioperative Care

OSA

- Increased risk for perioperative morbidity
  - 24% of patients with OSA had significant post-op complication vs. 9% in controls (Gupta et al. Mayo Clinic Proc 2001)
Screening: STOP-Bang

- **Snoring**: Do you snore loudly (loud enough to be heard through closed doors)?
- **Tiredness/fatigue**: Do you often feel tired, fatigued, or sleepy during the daytime?
- **Observed**: Has anyone observed you stop breathing during your sleep?
- **Pressure**: Do you have or are you being treated for high blood pressure?
- **BMI > 35 kg/m²**?
- **Age > 50?**
- **Neck circumference > 40 cm?**
- **Gender**: male?

Screening: Preop and PACU

- **Sleep apnea clinical score (SACS, aka Flemons) combined with PACU monitoring**
- **31% of patients at risk for OSA based on high SACS score**
- **Perioperative desaturations and pulmonary complications associated with high SACS score and recurrent PACU events**

Gali et al., Anesthesiology 2009
Known or Suspected OSA

• High risk for complications
• Post-op monitoring very challenging, as pulse oximetry and even capnography can fail to detect the most serious of complications

Possible Interventions

• Extended PACU monitoring
• Routine continuous pulse oximetry
• Triage to higher levels of care
• Minimize narcotic use
  – Neuroaxial analgesia
  – Regional anesthesia
• Continue home NIV
• Consider initiating new NIV

UCSF Guidelines

• All patients receiving newly instituted NIV are triaged to ICU
• Patients on home CPAP/BiPAP can be managed on any unit, although must be placed in TCU or ICU if supplemental oxygen need greater than 4L/min (or equivalent Fio2)
• In most cases, home devices may be used

Summary

• Anesthesia and surgery can have profound effects on respiratory function
• NIV should be considered as an option to prevent and treat respiratory impairment and failure
• OSA increases perioperative risk
• Optimal management of OSA in periop period is unclear