Non-invasive Positive Pressure Mechanical Ventilation:

What's new in 2018?

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NIPPV:
CPAP BPAP IPAP EPAP

OMG PAP?

My Real Goals

1) Demystify non-invasive mechanical ventilation (NIPPV)

2) Allow you to better manage and make improved decisions regarding NIPPV when I'm not around

Disclosures

I have no financial connections to any company or product related to my talk today.

Learning Objectives

1) Develop a shared appreciation for respiratory failure:
   - recognition
   - consideration of some form of mechanical ventilation
   - invasive versus non-invasive

2) Foster an appreciation for the difference between continuous positive airway pressure (CPAP) and bi-level positive airway pressure (BPAP)

Learning Objectives

3) Discuss the advantages and disadvantages of heated high flow nasal canula

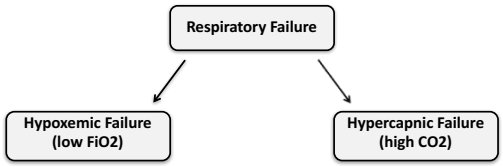
4) Answer all your questions!

Question #1

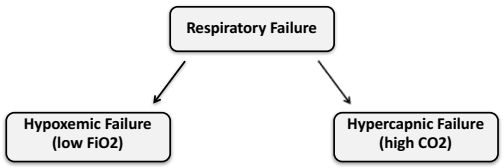
Lots of patients present with shortness of breath or appear to have a high work of breathing.

How do I know if my patient has true respiratory failure that I should intervene upon?

Answer #1



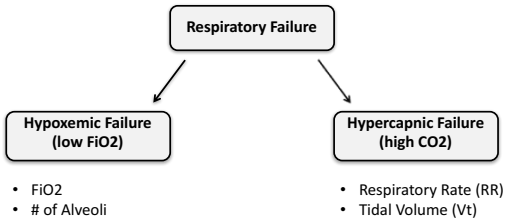
Basic Definition of Respiratory Failure



- $PaO_2 < 55$ mm Hg

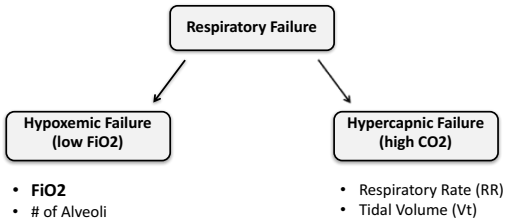
- $PaCO_2 > 45$ mm Hg *and*
- pH < 7.35

Intervening on Failure Can Be Simple



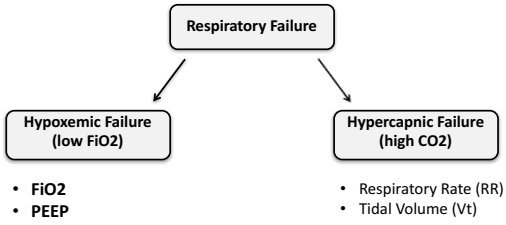
- FiO2
- # of Alveoli

- Respiratory Rate (RR)
- Tidal Volume (Vt)



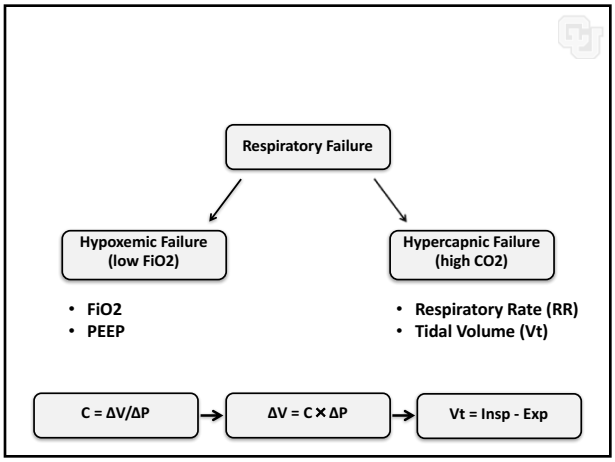
- **FiO2**
- # of Alveoli

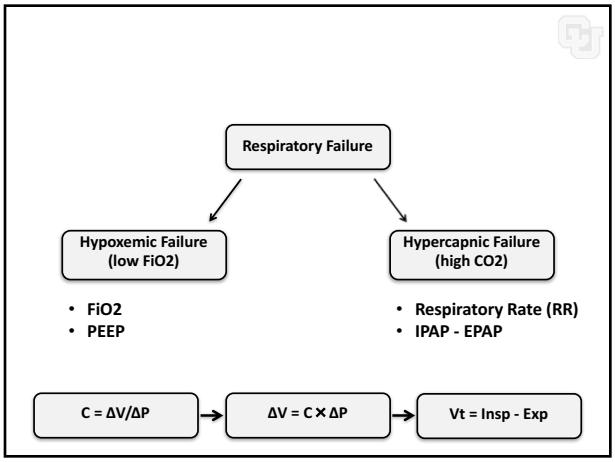
- Respiratory Rate (RR)
- Tidal Volume (Vt)



- **FiO2**
- **PEEP**

- Respiratory Rate (RR)
- Tidal Volume (Vt)

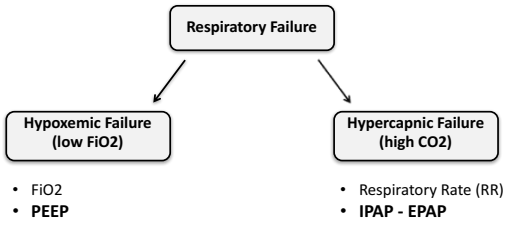




Question #2

Once I have decided that my patient is in failure, which machine do I choose, CPAP or BPAP?

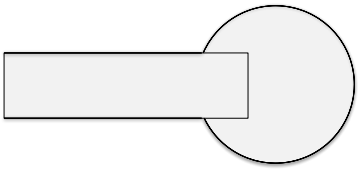
We Already Answered This…Mostly



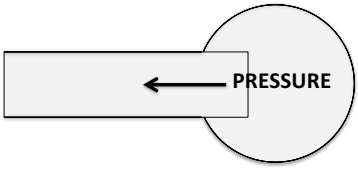
- FiO2
- **PEEP**

- Respiratory Rate (RR)
- **IPAP - EPAP**

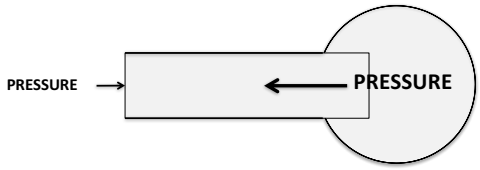
PEEP Matching



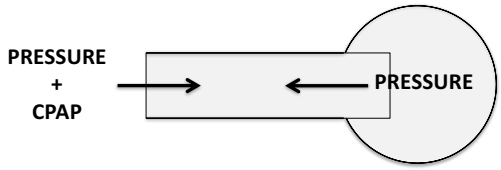
PEEP Matching



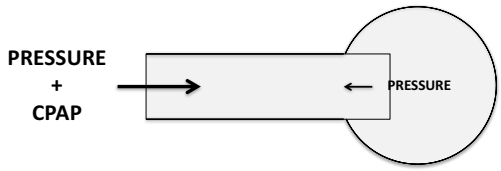
PEEP Matching



PEEP Matching



PEEP Matching



Question #3

Let's start with a standard COPD patient. I recognized failure clinically and I ordered an ABG to look for hypercapnea. I know that 20% of COPD patients admitted to the hospital will go on to develop hypercapnic failure.

When should I start NIPPV?

COPD and NIPPV at the Door

- By the evidence, there's no defined role for CPAP in COPD exacerbations
- Starting early (before hypercapnea has developed):
  - **Does relieve dyspnea**
  - **Offers no mortality benefit**
  - **Demonstrates no difference in intubation rates (7% v. 8%)**
  - **Is poorly tolerated**

Keenan SP et al. Resp Crit Care 2005
Bardi G et al, Eur Resp J 2000

COPD and NIPPV in Early Failure

- Using NIPPV when pre-intubation hypercapnea (pH = 7.25 – 7.35) is present is <u>VERY</u> helpful
  - **Fewer ICU escalations**
  - **Fewer infectious complications**
  - **Improved hospital LOS**
  - **Reduced intubations**
  - **Improved dyspnea**
  - **Improved survival**

Schmidbauer W et al, Em Med J 2011
Plant PK et al, Lancet 2000

COPD and NIPPV in Late Failure

- It's OK to ***try*** NIPPV if you think intubation is likely (pH < 7.2) unless:
  - Arrest
  - Periods of apnea
  - Significantly altered mental status
    - GCS < 7
    - medication-requiring agitation
  - Bradycardia
  - Hypotension

COPD and NIPPV in Late Failure

"Those who get better quickly, do better; those who don't fair worse"

EARLY IMPROVERS

- **No increase in mortality**
- **Decreased ICU LOS**
- **Reduced complications**
- **Less O2 on discharge**
- **Fewer readmission at 1 yr**
- **Fewer trachs**
- **Cheaper**

NON-EARLY IMPROVERS

- **Prolonged hospital stay**
- **Prolonged ICU stay**

Conti G et al, Int Care Med 2000
Jurjevic M et al, Coll Anthropol 2009

Question #4

I did everything correctly but my patient just isn't getting better.

When do I pull the trigger on intubation?

When to Intubate?

"Those who get better quickly, do better; those who don't fair worse"

- Most improvement is seen within 1-4 hours
- Trend toward worse mortality in those who had delayed intubation (> 4 hours)

Wood KA, et al. Chest 1998
Plant PK et al, Thorax 2001

Question #5

What about asthma? Does it respond the same as COPD?

NIPPV and Asthma

- The evidence for NIPPV in asthma is far inferior to the evidence in COPD
  - No randomized trials exist
  - Meta analyses are fuzzy
- My recommendation: I wouldn't do it
  - Rate is intubation are not decreased
  - Mortality is not improved
  - Those with delayed intubations do worse

Question #6

Moving on to a standard CHF patient. I recognized heart failure clinically and am worried about respiratory failure from pulmonary edema

Is NIPPV valuable in this population?

NIPPV and CHF at (before) the Door

- 6 good (but heterogeneous) trials of *pre-hospital* and early hospital use of NIPPV
  - Reduced need for intubation
  - Improved mortality
- No difference between CPAP and BPAP

Thompson J et al, Ann Emerg Med 2008

NIPPV and CHF for Early Failure

- 30 reasonable to good trials for NIPPV in CHF in the hospital
  - Clear evidence across the board
  - Fewer intubations
  - Improved mortality
  - No increase in complications (i.e. heart attack)
  - No evidence in cardiogenic shock
- No difference between CPAP and BPAP

Good A et al, NEJM 2008

NIPPV and CHF for Late Failure

- No evidence in cardiogenic shock

Question #7

Heated high flow nasal canula (HFNC) offers an alternative form of non-invasive ventilation. It is attractive in that patients can eat and talk while on it.

But is it as good as CPAP? Is it as good as BPAP?

How Does HFNC Work?

- HFNC provides CPAP ventilation

Liter Flow	PEEP
10L	**0**
20L	**0**
30L	**3**
40L	**4 (5?)**
50L	**5 (7?)**

How Does HFNC Work?

- It is the only NIPPV device that washes out deadspace!

HFNC in Respiratory Failure

- FLORALI (2015)
  - HFNC versus BPAP in acute respiratory failure (?ARDS)
- No worse in trials for COPD, CHF, peri-extubation
- Better tolerated
- My Recommendation: Call pulmonary and give it a try

Question #8

What about special populations, like my bone marrow transplant or immune compromised cancer patients?

NIPPV in the Immune Compromised

- The #1 reason for ICU admission in the immune compromised is acute respiratory failure
- The data on CPAP and BPAP overlap
- Weaker evidence than our other groups
  - **Fewer ICU escalations**
  - **Independent predictor of mortality**
  - **Reduced intubations**
  - **Reduced rate of nosocomial PNA**

Gristina GR et al, Crit Care Med 2011

Ask Me About All the Rest…

Post chest surgery
Post abdominal surgery
Post trauma
Pandemic illnesses
Following all extubations
Following a high-risk extubation
- Age > 65
- Known cardiopulmonary disease

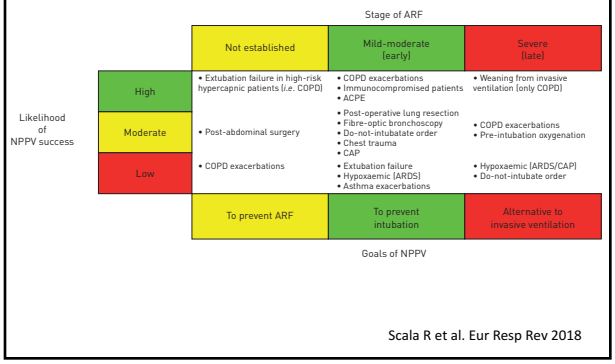
Following early extubation failure

TABLE 2 Recommendations for actionable PICO questions

Clinical indication[#]	Certainty of evidence[¶]	Recommendation
Prevention of hypercapnia in COPD exacerbation	⊕⊕	Conditional recommendation against
Hypercapnia with COPD exacerbation	⊕⊕⊕⊕	Strong recommendation for
Cardiogenic pulmonary oedema	⊕⊕⊕	Strong recommendation for
Acute asthma exacerbation		No recommendation made
Immunocompromised	⊕⊕⊕	Conditional recommendation for
***De novo* respiratory failure**		No recommendation made
Post-operative patients	⊕⊕⊕	Conditional recommendation for
Palliative care	⊕⊕⊕	Conditional recommendation for
Trauma	⊕⊕⊕	Conditional recommendation for
Pandemic viral illness		No recommendation made
Post-extubation in high-risk patients (prophylaxis)	⊕⊕	Conditional recommendation for
Post-extubation respiratory failure	⊕⊕	Conditional recommendation against
Weaning in hypercapnic patients	⊕⊕⊕	Conditional recommendation for

#: all in the setting of acute respiratory failure; ¶: certainty of effect estimates: ⊕⊕⊕⊕, high; ⊕⊕⊕, moderate; ⊕⊕, low; ⊕, very low.

Rochwerg et al. Eur Resp J 2017



Scala R et al. Eur Resp Rev 2018

Thank You!