CPAP for A.P.E

Western Kansas Seminar
Hays, KS
2013

Scott Hubbell, MHSc, RRT-NPS, C-NPT, CCT
Clinical Education Coordinator/Flight RRT
EagleMed

DISCLAIMER

CPAP - Background

Continuous Positive Airway Pressure (CPAP) and related technologies have been in use for since the 1940’s in respiratory failure.

It has been largely indicated to assist patients with primary and secondary sleep apnea, and globally this continues to be its largest market.

In recent history (1980’s) it has found wide acceptance in hospital settings (usually CCU, ICU, and ERs) for patients suffering varying degrees of respiratory failure of a wide variety of origins.

Acute Pulmonary Edema (APE) most common
**CPAP - Background**

CPAP is a non-invasive procedure that is easily applied in the pre-hospital setting.

Think of CPAP like pacing in ACLS, you can always shut it off, you can't just turn off a drug. Once intubated, they stay intubated.

CPAP is an established therapeutic modality, well studied to reduce both mortality and morbidity.

CPAP has been shown to be an preferable alternative to intubation in some patients.

**History of CPAP**

1912 - Maintenance of lung expansion during thoracic surgery (S. Brunnel)

1937 - High-altitude flying to prevent hypoxemia (Barach et al)

1967 - CPPB + IPPV to treat ARDS (Ashbaugh et al)

1971 - Term CPAP introduced, used to treat HMD in neonates (Gregory et al)

1972 - CPAP used to treat ARF (Civetta et al)

1973 - CPAP used to treat COPD (Barach et al)

1981 - Downs generator (Fried et al)

1982 - Modern definition of CPAP (Kielty et al)

**Boussignac CPAP?**

1973- Boeing 707 crashed near Paris France

125 fatalities, 3 survivors with severe respiratory trauma

CPAP was not well known at the time.

Mortality for these injuries was 100%

Dr. Georges Boussignac, decided not to intubate these patients but to treat them instead with Non Invasive Ventilation (NIV) and an early form of CPAP.

The original CPAP was a bag over the head with constant airflow at greater than atmospheric pressure.

*Gives new meaning to “bag em’ till I get there.”*
Physiology of CPAP

Vital Terminology

- Tidal Volume (Vt)
- Minute Volume (Vm)
- Peak Inspiratory Flow
- Functional Reserve Capacity (FRC)
- Inspired Oxygen (FiO2)
- Work of Breathing (WOB)
Airway and Respiratory Physiology

**FRC**

Functional residual Capacity (FRC) is the volume of air in the lungs at the end of a normal passive expiration. Approximately 2400 ml in a 70 kg, average-sized male.

FRC decreases with lying supine, obesity, pregnancy and anesthesia.

Important aim of CPAP is to **increase** functional residual capacity (FRC).

By increasing the FRC, the surface area of the Alveoli is distended. Greater surface area **improves** gas exchange (oxygenation and ventilation)

This improves Spo2/SaO2.

---

Airway and Respiratory Physiology

**WOB**

Work of breathing (WOB) is respiratory effort to effect oxygenation and ventilation.

Important aim of CPAP is to **reduce** work of breathing (WOB).

---

Airway and Respiratory Physiology

**WOB**

Signs of increased WOB:

- Dyspnea on Exertion (DOE)
- Speech Dyspnea
- Tripoding
- Orthopnea
- Accessory Muscle Use/Retractions
- Lung Sounds
**Airway and Respiratory Physiology**

Increased WOB:

- Respiratory Fatigue
- Respiratory Distress
- Respiratory Failure

*CPAP reduces WOB*

**Airway and Respiratory Pathology**

**CHF**

Precipitating Causes
- Non Compliance with Meds and Diet
- Acute MI
- Arrhythmia (e.g. AF)
- Increased Sodium Diet (Holiday Failure)
- Pregnancy (PIH, Pre-eclampsia, Eclampsia)
Airway and Respiratory Pathology

CHF

Severe resp distress
Foamy blood tinged sputum
Accessory muscle use
Apprehension, agitation
Speech Dyspnea
Diaphoresis
Bilateral crackles or “Rales”
Orthopnea (can’t lie down, pillow apnea)

Paroxysmal nocturnal dyspnea (PND)
Cyanosis
Pedal Edema
JVD
Chest pain (possible co-existent AMI)
abnormal vitals (increased B/P; rapid pulse; rapid & labored respirations)

Cardiac Asthma?

Fluid leaks into the Interstitial Space
Airways narrow
Mimics bronchoconstriction seen in asthma
May actually exacerbate asthma if a co-existing PMHx
Produces “Wheezing”
RO with capnography

Normal Capnography Waveform

# Obstructive Capnography Waveform
Infiltration of Interstitial Space

Airway and Respiratory Pathology CHF
The following treatments should be done concurrently with CPAP, patient condition permitting*.

High Flow Oxygen!!!
Nitroglycerin *
Lasix
double daily dose if already on Lasix
Opiates*
  Reduce Anxiety
  Mild Vasodilator

(* = defer to local protocol or medical control)

Airway and Respiratory Pathology
Asthma and COPD
Obstructive vs Reactive Airways
Bronchoconstrictive Issues
Poor Gas Exchange
Accessory Muscle Use/Muscle Tiring
CPAP is best reserved for those patients who are refractory to normal interventions, and have a severe presentation.
Airway and Respiratory Pathology
Asthma and COPD

The following treatments should be done concurrently with CPAP, patient condition permitting.*

High Flow Oxygen!!

Bronchodilators*
Albuterol 2.5 mg (0.83% in 3 cc)/ Atrovent 0.5 mg (0.02% in 2.5 cc)
Repeat as needed with Albuterol Only

Magnesium Sulfate* (Status asthmaticus only)
IV: 2 g given SLOWLY, diluted.
Do not give faster than 1 g/minute.

Epinephrine 1:1,100
0.3-0.5 mg IM/SQ for severe refractory bronchospasm
Use Epinephrine with caution on patients over 65 or with cardiac history.

Solu-medrol
IV/IM: 125 mg

(* = defer to local protocol or medical control)

Airway and Respiratory Pathology
Pneumonia

Infectious process
Often confused with, or masked by, CHF
Detailed assessment required
PMhx, Med list review
Sputum type/color
Onset of s/s
Fever
Lack of CHF/Afib Hx

Normal CHF Tx may be ineffective or detrimental
Nitroglycerine (ineffective)
Diuretics (detrimental)

Airway and Respiratory Pathology
Pneumonia

CPAP may be of minimal benefit in Pneumonia*.

High Flow Oxygen!!

Bronchodilators*
Albuterol 2.5 mg (0.83% in 3 cc)/ Atrovent 0.5 mg (0.02% in 2.5 cc) nebulized.
Repeat as needed with Albuterol Only.
Pulmonary hygiene (The pickle or IPV)

(* = defer to local protocol or medical control)
Airway and Respiratory Pathology

Drowning

CPAP may be beneficial to the drowning/near drowning patient

Strongly consider intubation for severe s/s refractory to CPAP and other treatments

Other uses of CPAP

ARDS
Acute Respiratory Failure
Anesthesia (Pre-Op and Post-Op)
Atelectasis
Alternative to Mechanical Ventilation
Weaning from Mechanical Ventilation
Left Ventricular Failure
Renal Failure
Sleep Apnea

Physiology of CPAP
Physiology of CPAP

Airway pressure maintained at set level throughout inspiration and expiration
Maintains patency of small airways and alveoli
"Stents" small airways open
"Distends" alveoli
Improves delivery of bronchodilators
By up to 80%
Moves extracellular fluid into vasculature
Improves gas exchange
Reduces work of breathing

Physiology of CPAP: CPAP Mechanism

Increases pressure within airway.
Airways at risk for collapse from excess fluid are stented open.
Gas exchange is maintained
Increased work of breathing is minimized

Physiology of CPAP: Redistribution of pulmonary edema with CPAP
Physiology of CPAP: Hypotension

CPAP increases intrathoracic pressure
This decreases cardiac output causing hypotension
Therefore hypotensive patients are relatively contraindicated with CPAP...

Physiology of CPAP: Administration of Medications by CPAP

CPAP and Nebulizers can be used together to provide better “penetration” of nebulizer medications through the respiratory tract.

Goals of CPAP use in the field

Primary Goals
- Increase amount of inspired oxygen (FiO2)
- Increase the SpO2 and PaO2 of the patient
- Decrease the work load of breathing (WOB)
- To reduce overall mortality

Secondary Goals:
- Reduce the need for emergent intubations of the patient
- Decrease hospital length of stay (LOS)
### CPAP vs. Intubation

<table>
<thead>
<tr>
<th>CPAP</th>
<th>Intubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-invasive</td>
<td>Invasive</td>
</tr>
<tr>
<td>Easily discontinued</td>
<td>Intubated stays intubated</td>
</tr>
<tr>
<td>Easily adjusted</td>
<td>Requires highly trained personnel</td>
</tr>
<tr>
<td>Use by EMT-B (in some states)</td>
<td>Significant complications</td>
</tr>
<tr>
<td>Minimal complications</td>
<td>Requires sedation or RSI</td>
</tr>
<tr>
<td>Does not (typically) require sedation</td>
<td>Potential for infection</td>
</tr>
<tr>
<td>Comfortable</td>
<td># Not so much (can't verbalize)</td>
</tr>
</tbody>
</table>

### Key Point:

- This module discusses CPAP in patients >8 years of age
- CPAP has been safely used in children, infants, and neonates in the in-hospital and critical care settings
- Local protocols may allow use in children and infants
  - Appropriate sized equipment mandatory
  - Risk increases
  - Consult medical control and local protocols

### A note on misdiagnosis

- There is a significant misdiagnosis rate of CHF in the field, most commonly confused with pneumonia
- CPAP still demonstrated significant improvement in other (non-CHF/APE) respiratory emergencies
  - Risks are greater in non CHF/APE
  - CPAP Max Pressures are lower non CHF/APE
  - Caution is required non CHF/APE
2003 Helsinki EMS Looked at “patients in Acute Severe Pulmonary Edema (ASPE)”

<table>
<thead>
<tr>
<th>Study Group:</th>
<th>121</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmed CHF:</td>
<td>38  (32%)</td>
</tr>
<tr>
<td>Miss- DX:</td>
<td>83  (68%)</td>
</tr>
<tr>
<td>Non CHF Patients that got better with CPAP:</td>
<td>34  (28%)</td>
</tr>
<tr>
<td>Non CPAP mortality:</td>
<td>(17.8%)</td>
</tr>
<tr>
<td>CPAP Mortality:</td>
<td>(8%)</td>
</tr>
</tbody>
</table>

Other Notes:
- Confirmed by MNP
- Treated with Low-Mid FiO2, Nitrates. No Lasix
- 4 intubated in field (3%)

(Kallio, T. et al. Prehospital Emergency Care. 2003. 7(2))

Contraindications/Exclusion Criteria

**Physiologic**
- Unconscious, Unresponsive, or inability to protect airway
- Inability to sit up
- Respiratory arrest or agonal respirations
- Persistent nausea/vomiting
- Hypotension: Systolic Blood Pressure less than 90 mmHg
- Inability to obtain a good mask seal

**Pathologic**
- Suspected Pneumothorax
- Shock associated with cardiac insufficiency
- Penetrating chest trauma
- Facial anomalies (trauma/burns)
- Closed Head Injury
- Has active upper GI bleeding or history of recent gastric surgery
- Vomiting

Cautions

History of Pulmonary Fibrosis
- Claustrophobia or unable to tolerate mask (after initial 1-2 minutes)
  - Coaching essential
  - Consider mild sedation (scope)
- Has failed at past attempts at noninvasive ventilation
- Complains of nausea or vomiting
- Has excessive secretions
- Has a facial deformity that prevents the use of CPAP
Administration

CPAP is measured in cm/H₂O
Start with device in the lowest setting, and titrate upward.
Initial dose at 0-2 cm/H₂O
Titrated up to*:
10 cm/H₂O MAX for CHF or
5 cm/H₂O MAX for COPD,
near drowning, and
respiratory failure form other causes.

* ( = defer to local protocol or medical control)

Selling CPAP?

Placing CPAP is an anxiety inducing event in the hypoxic respiratory distressed patient!
Verbally calming, coaching, and preparing (AKA: Selling) your patient on CPAP is essential
Similar to calming a hyperventilation patient

Complications

CPAP may drop BP due to increased intrathoracic pressure.
A patient must have a systolic BP of at least 90mmHg to be a candidate for CPAP.
Increased Intrathoracic pressure means decreased ventricular filling and increased afterload, thus decreasing cardiac output and blood pressure.
Providers should be comfortable giving a CPAP patient NTG. If they are too hypotensive for NTG, then they are too hypotensive for CPAP.
Risk of pneumothorax
Increased intrathoracic pressure = increased risk
Higher in Asthmatics and COPD
Gastric Distention, and vomiting
Strongly consider placement of a gastric tube (if in scope of practice)
Risk of corneal drying
High volumes of air blowing at eyes, especially on long transports.
Discontinuing of CPAP

CPAP therapy needs to be continuous and should not be removed unless the patient:
cannot tolerate the mask, success of tolerance to the treatment increased with proper coaching by EMS crew
requires suctioning or airway intervention,
experiences continued or worsening respiratory failure,
Develops severe hypotension
or a pneumothorax is suspected.

Intermittent positive pressure ventilation and/or intubation should be considered if patient is removed from CPAP therapy.

KEY POINT:
CPAP will not cure all patients!
Some patients just really want a tube!

“Don’t give up to early but know when to give up”

Documentation: Modified Borg Scale

‘0’- No breathlessness at all
‘1’- Very slight
‘2’- Slight breathlessness
‘3’- Moderate
‘4’- Somewhat severe
‘5’- Severe
‘6’- Very severe
‘7’- Very, very severe (Almost maximum)
‘10’- Maximum
CPAP and Intubation

Intubation will be inevitable in some patients regardless of the use of CPAP, and the provider must be prepared for rapid intervention by RSI/MAI or other means as feasible.

Indications to proceed to ET placement are (not all inclusive):
- Deterioration of mental status
- Increase of the EsCO2
- Decline of SpO2
- Progressive fatigue
- Ineffective tidal volume
- Respiratory or cardiac arrest.

Research Review

JAMA December 28, 2005 “Noninvasive Ventilation in Acute Cardiogenic Edema”, Massip et. al.
- Meta-analysis of studies with good to excellent data
- 45% reduction in mortality
- 60% reduction in need to intubate
Research Review

**CPAP therapy can improve A.P.E. patients in Minutes.**
Has been compared to D50 in hypoglycemic patients

"CPAP was associated a decrease in need for intubation (-26%) and a trend to a decrease in hospital mortality (-6%) compared with standard therapy alone."

2000 Cincinnati EMS looked at "CHF patients in imminent need of intubation"
- 19 patients included, CPAP administered
  - Pre- and post-therapy pulse ox increased from 83.3% to 95.4%
  - None of the patients were intubated in the field
  - Average hospital stay reduced from 11 days to 3.5 days

"**CPAP is to APE like D50 is to insulin shock**"

— Russell K. Miller Jr, MD, FACEP

Research Review

**CPAP in COPD:**
- 85 patients in a single ICU over a study period.
  - Randomization control group

CPAP significantly reduced need of ETT in COPD patients by 48%
Complications were decreased by 32%
Mortality decreased by 20%

"**CONCLUSIONS.** In selected patients with acute exacerbations of chronic obstructive pulmonary disease, noninvasive ventilation can reduce the need for endotracheal intubation, the length of the hospital stay, and the in-hospital mortality rate."

Research Review BiPap vs. CPAP

“Though BiPAP (BiPAP) has theoretical advantages over CPAP, there are questions regarding its safety in a setting of CHF. The Key to success in using NIV to treat severe CHF is proper patient selection, close patient monitoring, proper application of the technology, and objective therapeutic goals. When used appropriately, NIV can be a useful adjunct in the treatment of a subset of patients with acute CHF at risk for endotracheal intubation.”

Reviews in Cardiovascular Medicine, vol. 3 suppl. 4 2002, “Role of Noninvasive Ventilation in the Management of Acutely Decompensated Heart Failure”

Research Review: BiPAP vs CPAP

BiPAP resulted in overall higher intrathoracic pressures – reduces myocardial perfusion
BiPAP resulted in lower tidal volumes
BiPAP resulted in higher WOB

Research review: Pre-hospital CPAP

19 patients
Mean duration of therapy 15.5 minutes
Oxygen sat. rose from 83.3% to 95.4%
None were intubated in the field
2 intubated in the ED
5 subsequently intubated in hospital
“Pre-hospital CPAP is feasible and may avert the need for intubation”
Review

CPAP is not a substitute for patients needing IPPV or intubation.
CPAP works best when used in conjunction with other therapies.
CPAP doses start at ZERO and titrate up
- Max of 10 cmH2O for APE
- Max of 5 cmH2O for other causes
CPAP is effective in COPD when CAREFULLY used.

Key Points of CPAP

CPAP, while very beneficial in many patients, is not risk free.
- Pneumothorax
- Regurgitation and aspiration
- Hypotension

Questions?