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We simplify major findings into brief, straightforward summaries to keep you in the loop.

# Insights into CPAP Therapy

## 1 What is CPAP?

Continuous Positive Airway Pressure (CPAP) is a non-invasive ventilation method delivering constant positive pressure through a mask to maintain open airways. It provides non-invasive respiratory support that improves oxygenation and ventilation, reduces the work of breathing, and decreases the need for intubation and mechanical ventilation.

CPAP is considered a critical tool for respiratory management. It provides effective support in both hospital and prehospital settings. In emergency medical services (EMS), CPAP offers immediate respiratory support to patients in acute respiratory distress and improves outcomes during transport to medical facilities. The portability and ease of use of CPAP masks allow for rapid and effective emergency intervention in the field. Its ability to prevent the progression of respiratory failure and reduce the need for invasive procedures highlights its importance in modern medical practice.

## 2 Clinical Benefits

- **Enhanced Oxygenation:** By keeping airways open and improving alveolar recruitment, CPAP therapy enhances oxygenation, which is beneficial for patients with Acute Respiratory Distress Syndrome (ARDS, Congestive Heart Failure (CHF), and Chronic Obstructive Pulmonary Disease (COPD)
- **Reduced Need for Intubation:** CPAP therapy can prevent the progression of respiratory distress to respiratory failure, reducing the need for invasive mechanical ventilation and intubation.
- **Lowered ICU Admissions:** Effective CPAP therapy stabilizes patients in respiratory distress, reducing the need for ICU admissions by managing acute respiratory conditions in less intensive care settings.



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## 3 Mechanism of Action

• **Airway Support:** CPAP delivers continuous positive pressure during inspiration and expiration, preventing airway collapse and maintaining patency. This continuous positive pressure supports the airways and keeps them open.

• **Reduction of Work of Breathing:** By maintaining alveolar patency, CPAP decreases the effort required for lung inflation during inspiration, thereby reducing respiratory muscle workload and preventing fatigue. This is beneficial in patients experiencing severe dyspnea and respiratory distress.

• **Improvement in Gas Distribution:** CPAP increases alveolar pressure, enhancing the gas distribution within the lungs and promoting the re-expansion of collapsed alveoli. This process improves ventilation/perfusion (V/Q) matching, crucial for efficient gas exchange.

• **Enhanced Gas Exchange:** By increasing alveolar pressure, CPAP helps counterbalance interstitial or capillary hydrostatic pressures, thus reducing the movement of fluid into the alveoli and preventing pulmonary edema.

• **Alveolar/Hydrostatic Pressure Dynamics:** By increasing alveolar pressure, CPAP helps counterbalance interstitial or capillary hydrostatic pressures, thus reducing the movement of fluid into the alveoli and preventing pulmonary edema.

• **Improvement in Cardiac Output:** CPAP raises intrathoracic pressure, which reduces left ventricular afterload, making it easier for the heart to eject blood.

• **Increased Tidal Volume and Stabilized Minute Ventilation:** CPAP enhances tidal volume, thereby decreasing the work of breathing. By stabilizing minute ventilation and increasing functional residual capacity (FRC), it improves ventilation-perfusion (V/Q) matching and can reduce oxygen requirements.

• **Management of Hypercarbia:** Enhanced ventilation with CPAP facilitates effective removal of carbon dioxide, preventing hypercarbia and associated complications such as respiratory acidosis.



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## 4 Indications

### 4.1 Congestive Heart Failure (CHF):

- **Reduction in Left Ventricular Afterload:** CPAP increases intrathoracic pressure, which lowers left ventricular transmural pressure (LVPtm) during systole. This decreases the resistance the left ventricle must overcome to pump blood, leading to reduced left ventricular afterload and the heart's workload.

- **Unloading of Inspiratory Muscles:** By increasing intrathoracic pressure, CPAP reduces the amplitude of esophageal pressure (Pes), thereby decreasing the force needed by the inspiratory muscles with each breath. The unloading of the inspiratory muscles helps prevent fatigue, making breathing easier for patients with CHF.

- **Improved Cardiac Output and Efficiency:** The combined effect of reduced afterload and decreased respiratory muscle effort allows the heart to pump more efficiently. CPAP maintains cardiac index (CI) without compromising cardiac output. This enhances blood flow and oxygen delivery, relieving symptoms of heart failure and enhancing overall cardiovascular health.

- **Reduction in Heart Rate:** CPAP therapy can lead to a reduction in heart rate, potentially by lowering cardiac sympathetic activity or increasing parasympathetic activity. This decrease in heart rate, combined with reduced afterload, lowers myocardial oxygen consumption, easing the heart's workload. In addition, slower heart rate also allows for better ventricular filling during diastole.

- **Stabilization of Hemodynamics:** CPAP stabilizes intrathoracic pressures, which helps maintain consistent blood pressures and improve hemodynamic stability. This stabilization supports better perfusion of vital organs and reduces the risk of hemodynamic fluctuations that can exacerbate CHF symptoms.



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## 4.2 Cardiogenic Pulmonary Edema:

• **Reduction of Left Ventricular (LV) Afterload:** CPAP reduces LV afterload by lowering LV transmural pressure in these patients. This effect decreases LV filling pressure, thus limiting pulmonary edema without compromising cardiac index

• **Decreased Systemic Venous Return:** CPAP reduces venous return by increasing right atrial pressure (Pra) and mean systemic filling pressure (Pms). This results in a decrease in blood flow due to increased resistance to venous return.

• **Improved Oxygenation and Respiratory Compliance:** CPAP helps to restore functional residual capacity by recruiting alveoli, which reduces right-to-left intrapulmonary shunting and enhances oxygenation. This process improves lung mechanics and respiratory system compliance. By addressing the increased extravascular lung water, reduced lung volume, and increased airway resistance seen in CPE, CPAP aids in balancing oxygen consumption and delivery, thereby reducing the oxygen cost of breathing

• **Decreased Endotracheal Intubation (ETI) Need and Hospital Mortality:** CPAP has been shown to significantly benefit patients with Acute Respiratory Failure (ARF) due to CPE by decreasing the need for endotracheal intubation (ETI) and reducing hospital mortality rates. The use of CPAP improves vital signs and physiological parameters, which reduces the necessity for invasive ventilation. This helps avoid complications associated with invasive procedures, such as upper airway trauma, respiratory tract infections, and cardiovascular disorders.

• **Pre-Hospital Setting Effectiveness:** Early application of CPAP in pre-hospital settings has also been shown to improve symptoms, thereby reducing the incidence of ETI and in-hospital mortality. However, the results vary among studies, suggesting that outcomes may be influenced by factors such as personnel expertise and patient severity.



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## 4.3 Chronic Obstructive Pulmonary Disease (COPD) Exacerbations (10):

- **Reduces Inspiratory Effort:** The application of CPAP results in a significant reduction in inspiratory effort and the pressure-time product for both the diaphragm and the inspiratory muscles in a dose-dependent manner.
- **Improves Breathing Pattern:** CPAP enhances the breathing pattern by reducing the respiratory rate and increasing tidal volume, while minute ventilation remains constant.
- **Relieves Dyspnea:** CPAP decreases the effort required for breathing and helps relieve shortness of breath by counteracting the inspiratory load created by dynamic hyperinflation with intrinsic positive end-expiratory pressure (PEEP).
- **Stabilizes Gas Exchange:** CPAP maintains or improves arterial oxygen tension (Pa,O2) and arterial carbon dioxide tension (Pa,CO2) levels.
- **Decreases Need for Mechanical Ventilation:** Early use of CPAP can prevent the need for intubation and mechanical ventilation during acute COPD exacerbations.

## 4.4 Drowning

- **Improved Oxygenation:** CPAP helps reverse the hypoxic insult in drowning victims by providing continuous positive airway pressure which helps to recruit and retain patent alveoli, to ensure adequate oxygenation and ventilation.
- **Reduction of Pulmonary Edema and Secretions:** The body's response to water aspiration involves an inflammatory cascade that may necessitate continuous positive pressure to open and keep alveoli functional. For drowning patients who have adequate perfusion and can breathe spontaneously, CPAP can effectively perform this role.



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## 4.5 COVID-19 Patients with Acute Respiratory Failure

- **Improved Oxygenation:** CPAP has been shown to improve oxygenation in patients with severe hypoxemic respiratory failure due to COVID-19. The application of CPAP increases the functional residual capacity (FRC) and enhances gas exchange.
- **Reduced Respiratory Rate:** CPAP helps in reducing the respiratory rate in patients, indicating a decrease in the work of breathing and improved respiratory efficiency.
- **Avoidance of Intubation:** CPAP can prevent the need for mechanical ventilation in some patients by improving oxygenation and reducing the severity of respiratory failure.
- **Stabilizes Gas Exchange:** CPAP maintains or improves arterial oxygen tension (Pa,O2) and arterial carbon dioxide tension (Pa,CO2) levels.
- **Management in Medical Wards:** CPAP can be effectively administered to severely hypoxemic patients in medical wards, outside of intensive care units (ICUs), allowing for broader use in hospitals with limited ICU capacity, although it may be less effective for elderly patients with high oxygen requirements.

## 4.6 Pre-Intubation and Post-Extubation Support

- **Pre-Intubation:** CPAP enhances oxygenation by providing continuous positive airway pressure (CPAP) before endotracheal intubation. This maintains positive end-expiratory pressure (PEEP), which reduces atelectasis, increases alveolar surface area, and improves ventilation/perfusion (V/Q) matching, thereby enhancing overall oxygenation.
- **Post-Extubation:** CPAP is used post-extubation for patients who still require positive pressure support but do not need invasive ventilation. It benefits patients with obstructive sleep apnea (OSA) or congestive heart failure (CHF) by keeping airways open, improving gas exchange, and reducing the work of breathing.



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## 5 Contraindications

### 5.1 Uncooperative or Extremely Anxious Patients:

Patients who are unable or unwilling to tolerate the CPAP mask or who experience significant anxiety may not be suitable candidates for CPAP therapy.

### 5.2 Reduced Consciousness:

CPAP is contraindicated in patients with significantly reduced consciousness who cannot protect their airway, as they may be at risk for aspiration.

### 5.3 Cardiovascular instability or Respiratory Arrest:

Patients with severe hemodynamic instability or those in respiratory arrest should not receive CPAP therapy. CPAP may not provide sufficient respiratory support in these cases and could exacerbate cardiovascular instability.



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## 5.4 Pneumothorax:

CPAP is contraindicated in patients with pneumothorax or other air leak syndromes, as the positive pressure can exacerbate the air leak and worsen the condition.

## 5.5 Severe Nausea with Vomiting:

Patients experiencing severe nausea and vomiting are at increased risk of aspiration if CPAP is applied.

## 5.6 Excessive Respiratory Secretions:

Excessive respiratory secretions can obstruct the airways and impair the effectiveness of CPAP therapy. Patients with copious secretions require frequent suctioning and may not be suitable for CPAP.

## 5.7 Severe Air Trapping Diseases:

In patients with severe air trapping conditions, CPAP may exacerbate hyperinflation and increase the risk of barotrauma.

## 5.8 Low blood pressure:

If the patient has a systolic blood pressure < 90 mm Hg.



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## REFERENCES


1. Pinto VL, Sharma S. Continuous Positive Airway Pressure. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482178/
2. Paternoster G, Sartini C, Pennacchio E, Lisanti F, Landoni G, Cabrini L. Awake pronation with helmet continuous positive airway pressure for COVID-19 acute respiratory distress syndrome patients outside the ICU: A case series. Med Intensiva (Engl Ed). 2022 Feb;46(2):65-71. doi: 10.1016/j.medine.2020.08.009. PMID: 35115111; PMCID: PMC8802662.
3. Gharib, A. Effect of continuous positive airway pressure on the respiratory system: a comprehensive review. Egypt J Bronchol 17, 1 (2023). https://doi.org/10.1186/s43168-022-00175-1
4. Schwerin DL, Goldstein S. EMS Prehospital CPAP Devices. [Updated 2023 Mar 7]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470429/
5. Wang K, Liang ZY, Wang XL, Li Y, Lu YR, Liu JF, Li JH, Xu LM, Chen GQ, Chang P, Cen ZR, Chen X. Continuous positive airway pressure improves respiratory mechanics and efficiency of neural drive in stable COPD: an exploratory study. J Thorac Dis. 2020 Mar;12(3):626-638. doi: 10.21037/jtd.2019.12.120. PMID: 32274128; PMCID: PMC7139021.
6. Yan AT, Bradley TD, Liu PP. The role of continuous positive airway pressure in the treatment of congestive heart failure. Chest. 2001 Nov;120(5):1675-85. doi: 10.1378/chest.120.5.1675. PMID: 11713153.
7. Bellani G, Laffey JG, Pham T, Madotto F, Fan E, Brochard L, Esteban A, Gattinoni L, Bumbasirevic V, Piquilloud L, van Haren F, Larsson A, McAuley DF, Bauer PR, Arabi YM, Ranieri M, Antonelli M, Rubenfeld GD, Thompson BT, Wrigge H, Slutsky AS, Pesenti A; LUNG SAFE Investigators; ESICM Trials Group. Noninvasive Ventilation of Patients with Acute Respiratory Distress Syndrome. Insights from the LUNG SAFE Study. Am J Respir Crit Care Med. 2017 Jan 1;195(1):67-77. doi: 10.1164/rccm.201606-1306OC. PMID: 27753501.
8. Naughton MT, Rahman MA, Hara K, Floras JS, Bradley TD. Effect of continuous positive airway pressure on intrathoracic and left ventricular transmural pressures in patients with congestive heart failure. Circulation. 1995 Mar 15;91(6):1725-31. doi: 10.1161/01.cir.91.6.1725. PMID: 7882480.
9. Bello G, De Santis P, Antonelli M. Non-invasive ventilation in cardiogenic pulmonary edema. Ann Transl Med. 2018 Sep;6(18):355. doi: 10.21037/atm.2018.04.39. PMID: 30370282; PMCID: PMC6186545.
10. Goldberg P, Reissmann H, Maltais F, Ranieri M, Gottfried SB. Efficacy of noninvasive CPAP in COPD with acute respiratory failure. Eur Respir J. 1995 Nov;8(11):1894-900. doi: 10.1183/09031936.95.08111894. PMID: 8620959.
11. Grayson, K (2016). Drowning patient resuscitation and monitoring. EMS1. https://www.ems1.com/ems-products/capnography/articles/drowning-patient-resuscitation-and-monitoring-Kv2g6vvRzZqxCkO5/
12. Ferrer M, Cosentini R, Nava S. The use of non-invasive ventilation during acute respiratory failure due to pneumonia. Eur J Intern Med. 2012 Jul;23(5):420-8. doi: 10.1016/j.ejim.2012.02.011. Epub 2012 Mar 28. PMID: 22726370; PMCID: PMC7126754.
13. Kofod LM, Nielsen Jeschke K, Kristensen MT, Krogh-Madsen R, Monefeldt Albek C, Hansen EF. COVID-19 and acute respiratory failure treated with CPAP. Eur Clin Respir J. 2021 Apr 11;8(1):1910191. doi: 10.1080/20018525.2021.1910191. PMID: 33889343; PMCID: PMC8043540.
14. Mattera, C. J., & posts. (2010, December 29). Physiology explains CPAP's effectiveness - JEMS: EMS, emergency medical services - training, paramedic, EMT News. JEMS. https://www.jems.com/patient-care/physiology-explains-cpap-s-eff/


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