

Volume-Assured Pressure Support Treatment in COPD

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Objective

- Understanding respiratory failure in correlation with COPD
- Understanding Overlap syndrome
- Effect of AVAPS on the quality of life in COPD patients
- How to obtain AVAPS for Chronic respiratory Failure for a patients at home

Chronic Obstructive Pulmonary Disease

- Chronic Obstructive Pulmonary Disease (COPD) causes airway narrowing and difficulty breathing due to limited airflow and trapped air. Patients often experience weak respiratory muscles, leading to flare-ups and potential respiratory failure.
- CAAT score is useful when evaluating quality of life and symptoms
- Estimated 700,000 hospitalizations occur nationally each year with 1 in 5 readmitted within 30 days of discharge
- National cost for readmission are approximately \$9,000 and \$12,000 each visit and upward of \$20,000

I never cough	0 1 2 3 4 5	I cough all the time	
I have no phlegm (mucus) in my chest at all	0 1 2 3 4 5	My chest is completely full of phlegm (mucus)	
My chest does not feel tight at all	0 1 2 3 4 5	My chest feels very tight	
When I walk up a hill or one flight of stairs I am not breathless	0 1 2 3 4 5	When I walk up a hill or one flight of stairs I am very breathless	
I am not limited doing any activities at home	0 1 2 3 4 5	I am very limited doing activities at home	
I am confident leaving my home despite my lung condition	0 1 2 3 4 5	I am not at all confident leaving my home because of my lung condition	
I sleep soundly	0 1 2 3 4 5	I don't sleep soundly because of my lung condition	
I have lots of energy	0 1 2 3 4 5	I have no energy at all	

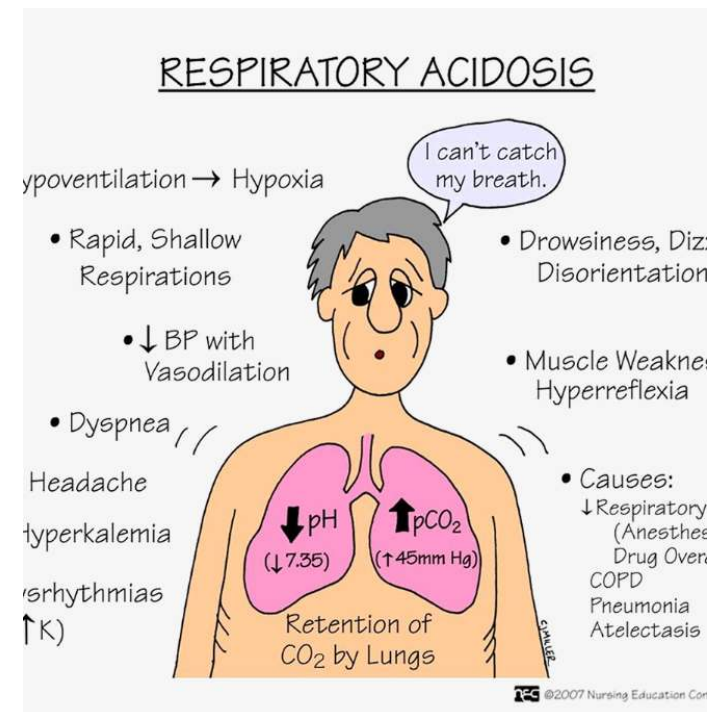
Stage	Spirometric Findings
Mild	FEV ₁ /FVC <.70 FEV ₁ ≥ 80% predicted
Moderate	FEV ₁ /FVC <.70 FEV ₁ between 50% and 80% predicted
Severe	FEV ₁ /FVC <.70 FEV ₁ between 30% and 50% predicted
Very Severe	FEV ₁ /FVC <.70 FEV ₁ <30% predicted or FEV ₁ <50% predicted + chronic respiratory failure

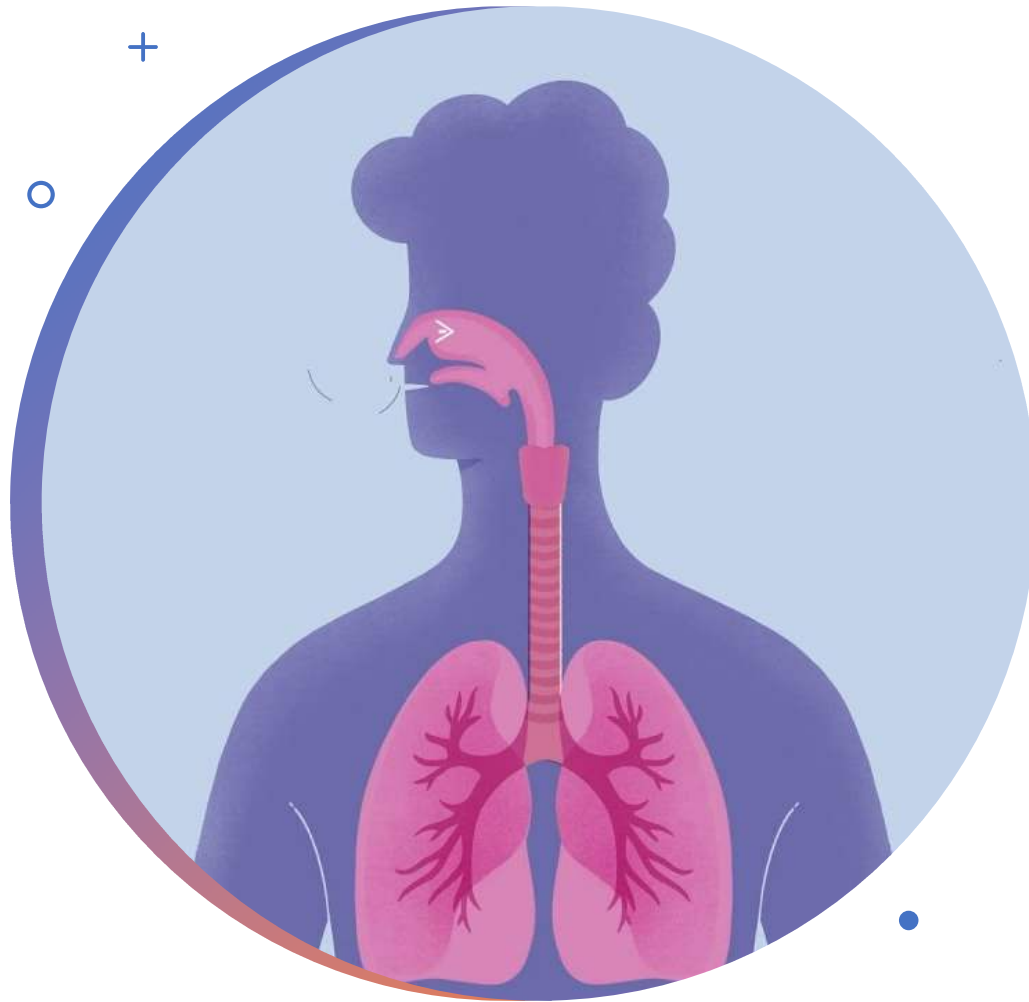
CAAT

1)	I never cough	0 1 2 3 4 5	I cough all the time	☐
2)	I have no phlegm (mucus) in my chest at all	0 1 2 3 4 5	My chest is completely full of phlegm (mucus)	☐
3)	My chest does not feel tight at all	0 1 2 3 4 5	My chest feels very tight	☐
4)	When I walk up a hill or one flight of stairs I am not breathless	0 1 2 3 4 5	When I walk up a hill or one flight of stairs I am very breathless	☐
5)	I am not limited doing any activities at home	0 1 2 3 4 5	I am very limited doing activities at home	☐
6)	I am confident leaving my home despite my lung condition	0 1 2 3 4 5	I am not at all confident leaving my home because of my lung condition	☐
7)	I sleep soundly	0 1 2 3 4 5	I don't sleep soundly because of my lung condition	☐
8)	I have lots of energy	0 1 2 3 4 5	I have no energy at all	☐

Understanding Respiratory failure

- Respiratory failure is a serious medical condition where the lungs are unable to effectively exchange oxygen and carbon dioxide.
- When the respiratory system fails one or both of its functions (oxygenation and ventilation) –oxygenation and carbon dioxide elimination are decreased
- Chronic respiratory failure develops over several days or longer allowing for renal compensation and an increase in bicarbonate concentration shifting the PH to decrease slightly



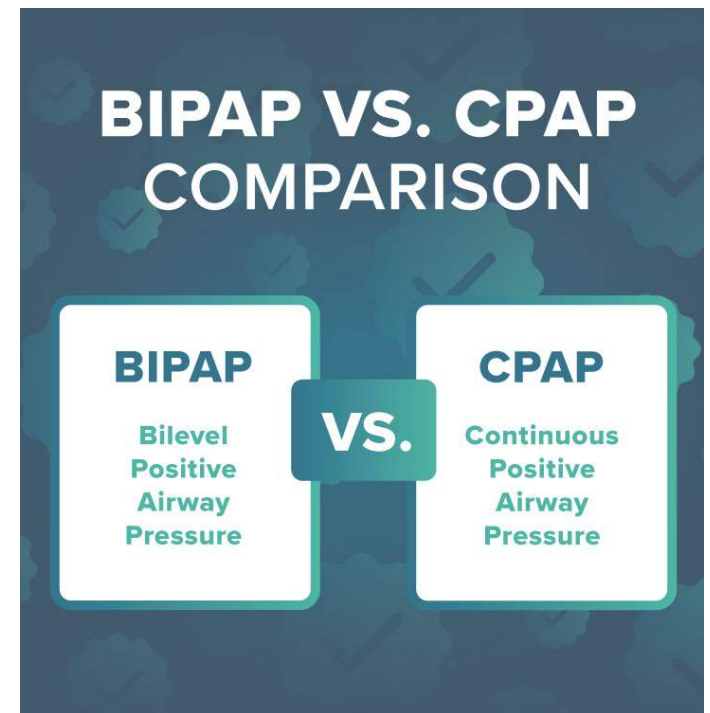


Respiratory Failure Prevalence in COPD

- Acute respiratory failure represents the progression of COPD
- Changes may occur in individuals with less COPD severity; however, this will have a dramatic impact the deterioration
- Patient with an acute hypercapnic episode of respiratory failure are associated with significantly higher mortality rate both initially and with in the following 12 months.

CPAP and BIPAP used with AECOPD

- Continuous positive airway pressure (CPAP) causes improvement in respiratory patterns, by splinting open the airway and reducing airway resistance, however, it increases dynamic pulmonary hyperinflation - effects are more significant in patients with inspiratory muscle weakness.
- Bilevel Positive Airway Pressure sets and inspiratory pressure and expiratory positive pressure that causes volume to be a dependent variable. Asynchrony and intolerance is noted some decreasing compliance and effect.



IVAPS (Intelligent Volume-Assured Pressure Support)

IVAPS dynamically adjusts pressure support on a breath-by-breath basis to ensure that the patient's tidal volume meets a preset target.

- **How IVAPS Works:**

- Monitors tidal volume in real-time.
- Increases pressure support when tidal volume drops below the target.
- Decreases pressure support if tidal volume exceeds the target.
- Regulates the backup respiratory rate.
- Enhances patient safety with intelligent alarms and preset limits.

- **Clinical Uses of IVAPS:**

- Management of COPD exacerbations with unstable breathing patterns.
- Support for neuromuscular disorders, including ALS and muscular dystrophy.
- Treatment for sleep apnea patients who require adaptive support during varying sleep stages.



AVAPS Average Volume- Assured Pressure Support

- **Overview:**

AVAPS is designed to maintain a consistent average tidal volume over time, rather than adjusting on a breath-by-breath basis.

- **How AVAPS Works:**

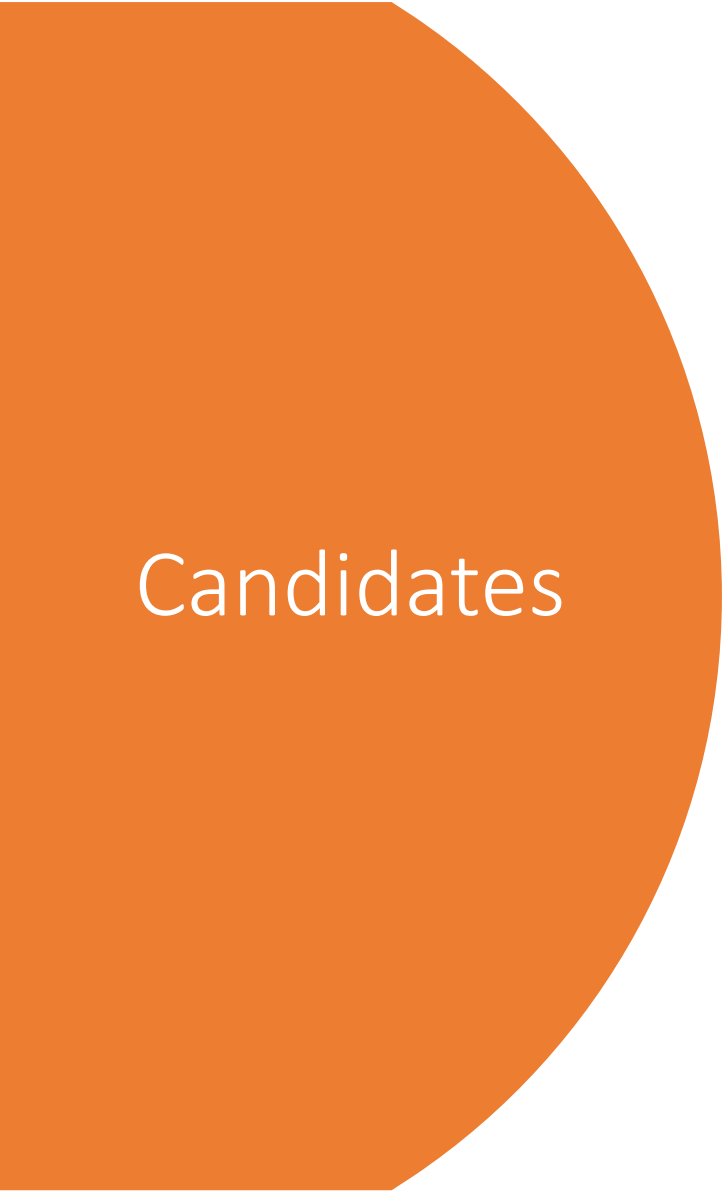
- Measures tidal volumes over multiple breaths.
- Adjusts pressure support gradually to maintain an average tidal volume.
- Provides stable and consistent ventilation for patients.



Clinical Uses of AVAPS:

- Management of Obesity Hypoventilation Syndrome and COPD
 - Support for restrictive lung diseases.
 - Home ventilation solutions for chronic, stable respiratory conditions.
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Feature	IVAPS	AVAPS
Mode Type	Intelligent, adaptive pressure support	Volume-assured, average tidal volume control
Targeting Mechanism	Real-time adjustment per breath	Average tidal volume maintenance
Patient Monitoring	Continuous and dynamic	Based on average tidal volume
Clinical Use	Complex, variable respiratory failure	Stable, chronic respiratory failure
Algorithm Complexity	Advanced machine learning algorithms	Simpler, rule-based adjustments
Setup Complexity	Requires expert calibration	Easier setup and maintenance

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Candidates

- Neuromuscular
 - Obesity hypoventilation syndrome
 - Restrictive thoracic disorders COPD
 - Chronically ill patient with decreasing lung compliance
 - Chronic respiratory failure
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Early AVAPS use in COPD hospitalizations

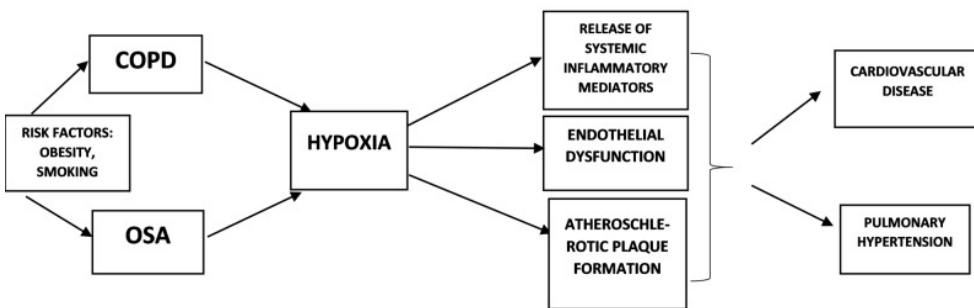
- Study completed on 80 patients with respiratory failure in the ER 33 S/T and 47 AVAPS. The results concluded PaCO₂ excretion was faster in the AVAPS group in the first hour with 3 patient requiring intubation; while 5 required intubation in the S/T group.
- Study carried out on 100 patient's randomly divided into 2 groups. AVAPS patients had a significant reduction in PCo₂ compared to BIPAP at 6 and 24 hours.

VAPS use at home

- VAPS treatment resulted in the greatest improvement over all areas including vitality, confidence, physical function, and decreased bodily pain. Patients also had a decrease in daytime PaCO₂ and increased 6-minute walking distance
- Prevents respiratory failure, alleviates anxiety, increased physical function, decreases atelectasis, decrease muscle fatigue



Overlap Syndrome (OS): COPD and OSA

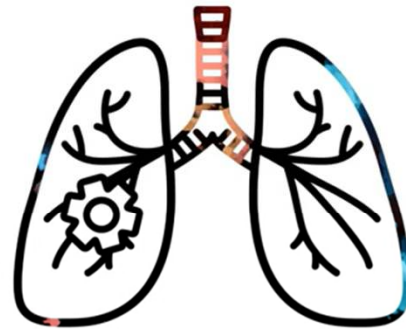


- Identified in patient with Obstructive Sleep Apnea (OSA) and COPD
- Increase of Hypoxia in OS causes increased risk of cardiovascular disease including atrial fibrillation, right heart failure, and pulmonary hypertension-increasing mortality rate
- Sleep disorders are the third most common factor affecting the quality of life in COPD
- 2015 study assess 44 COPD patients who had full polysomnography suitable for analysis, OSA was present in 29 of those individuals (65.9%).

Treatment for Overlap syndrome

- CPAP: The most effective treatment for OSA. However, can weaken respiratory muscle preventing the muscles from resting and decreasing compliance.
- BIPAP: Treatment for patients with COPD and OSA is beneficial.
- VAPS and IVAPS : Increases comfort and compliance

Getting Started with iVAPS: A Guide for Clinicians



Case Study

54y/o male with a history of OSA and COPD (overlap syndrome) presented to ED with complaints of SOB and respiratory failure. Upon admission patient was hypoxic and hypercapnic with decreased mental status. Patient is noncompliant of his CPAP due to comfort and discontinued use in 2018. Patient's spirometry results FEV1/FVC 43% FEV1 32 %. Patient has had 5 admission in the past 12 months with 2 readmissions in the last month. Admission diagnosis involved was for respiratory failure, CHF and A-fib with RVR.

- pH 7.350 - 7.450 **7.334 (L)**
- PCO2 35.0 - 45.0 mmHg **70.3 (HH)**
- PO2 80.0 - 100.0 mmHg **109.0 (H)**
- O2 Saturation Arterial % 99.0
- HCO3 21 - 28 mmol/L **37 (H)**

Rational:

Due to patient's untreated OSA and worsening of Respiratory failure and COPD. Patient will require volume ventilation to promote gas exchange via NIV therapy. Patient was intolerable of continuous pressures and is demonstrating the need for mouthpiece ventilation for daytime as the pCO2 elevates.

His frequent hospitalization and exacerbation are progressing his disease process and causing a decrease in his physical ability from muscle atrophy. BiPAP has been tried and failed and confirmed by an ABG.

Contraindications

- Cardiac/Respiratory arrest
- Upper airway blockages
- GI bleeds
- Encephalopathy
- Fascial problems

Complications



Barotrauma



Hemodynamic compromise



NIV- Associated pneumonia



Increase aspiration risk



Facial skin lesions and CO2 retention

Does INS cover NIV

Steps for qualifying a patient for AVAPS

1. Chronic respiratory failure or Acute on Chronic respiratory failure
2. Patient will need one of the following
 - A. PCO₂ >52mm Hg or FEV1<50% of predicted
 - B. PCo₂ between 48-51 mm Hg or FEV1<51-60% of predicted and 2 or more respiratory related hospital admissions within the past 12 months
3. Notes must include
 - a. FaceSheet
 - b. Doc H/P and any Medical necessity for pressure support ventilation due to progression of disease.
 - c. ABG results
 - d. Information if patient was previously on bi-level with or without rate as an outpatient and documentation of why bi-level was not sufficient

Sample notes:

Patient requires a non-invasive ventilator due to the severity of chronic respiratory failure J96.10 consequent to COPD J44.9. Ventilation is required to decrease work of breathing, improve pulmonary status and interruption of respiratory support could lead to serious harm including decline in health status, increased risk of CO₂ retention and death. Patient requires AVAPS over BIPAP due intolerance of BIPAP and continued distress. Patient is able to clear their secretions and protect their airway.

Primary Diagnosis

- COPD
- Emphysema
- Chronic Bronchitis
- Cystic Fibrosis
- Scoliosis
- Intestinal Lung Disease
- Obesity Hypoventilation Syndrome (OHS)

Take Away

- IVAPS should be consider in patient with Acute/Chronic Respiratory failure as a first line intervention – Shows rapid results in CO2 reduction compared to BIPAP
- Patient with overlap syndrome may have received CPAP once for OSA management, however, due to the progression of COPD and physiological changes it may not be the most beneficial and ultimately further progression and decrease compliance
- Evaluate patient need for post-acute continuation of therapy to improve quality of life and decrease hospital utilization and disease progression.
 - Patient with an acute hypercapnic episode of respiratory failure are associated with significantly higher mortality rate both initially and within the following 12 months.
 - 80% of patient have an estimated 12% to 40% of muscle lose per week for prolong bed rest. This is increased with intubated patients. It can take an average of 1 week to recover per day of hospitalization.
- VAPS can improve oxygenation, ventilations, decrease atelectasis, increase heart function witch ultimately can reduce blood pressure, heart rate, and the risk for pulmonary hypertension and cardiovascular disease.
 - Can also be used in patient with obesity hypoventilation and restrictive patients



Questions

Resources

- <https://www.sciencedirect.com/science/article/pii/S0012369215446501>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8880836/>
- [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9811600/#:~:text=As%20compared%20to%20BIPAP%20\(S%2FT\)%20mode%2C%20application,mechanics%20during%20exacerbation%20in%20COPD.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9811600/#:~:text=As%20compared%20to%20BIPAP%20(S%2FT)%20mode%2C%20application,mechanics%20during%20exacerbation%20in%20COPD.)
- [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6298617/#:~:text=The%20overlap%20syndrome%20\(OS\)%20was,with%20OSA%20or%20COPD%20alone.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6298617/#:~:text=The%20overlap%20syndrome%20(OS)%20was,with%20OSA%20or%20COPD%20alone.)
- <https://rtmagazine.com/disorders-diseases/chronic-pulmonary-disorders/copd/bipap-noninvasive-ventilation-copd/>

Case Study

- 60 Y.O. Man with a history of COPD, anxiety, chronic respiratory failure. FEV1/FVC 40% FEV1 20% post-bronchodilator. Findings consistent with VERY SEVERE, GOLD GRADE 4, GROUP D COPD. Patient has been readmitted 3 times in the past 12 months due to acute respiratory failure. Patient stated, "I get short of breath at home and very anxious, so I call the ambulance". Patient is a current smoker with limited activity. Upon arrival patient was intubated during current visit.
- Rational: This patient has stage 4 COPD treated with medication. Patient is limited at home due to severity of the COPD and frequency of COPD exacerbations. During these readmissions patient receives BIPAP, Q4 Duoneb and steroids. Patient would benefit from a AVAPS machine at home to prevent rehospitalizations and decrease the work of breathing during exacerbations and anxiety.

pH 7.391
PCO2 **52.7 mmHg**
PO2 98.9 mmhg

HCO3 21 - 28 mmol/L
32 (H) Base Excess, Arterial
-2 - 2 mmol/L
6 (H)

Ventilation Mode PRVC

pH **7.247 (L)**
PCO2 **84.2 mmHg**

PO2 **41.1 mmHg**

HCO3 21 - 28 mmol/L
37 (H)

Base Excess, Arterial -2 - 2
mmol/L **7 (H)**

Ventilation Mode Arterial
BIPAP