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A case study on setting peep in hypoxic respiratory failure

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Abstract

Objective: This case study aims to explore the clinical application of Positive End-Expiratory Pressure (PEEP) in managing hypoxemic respiratory failure in a critically ill patient. The study emphasizes individualized titration of PEEP to optimize oxygenation while minimizing ventilator-induced lung injury.

Materials and Methods: A 46-year-old male presented with acute breathlessness and was diagnosed with hypoxemic respiratory failure. The patient was initially managed with Non-Invasive Ventilation (NIV) and later required invasive mechanical ventilation. Clinical assessment, radiological imaging, arterial blood gases (ABGs), and cardiac markers were used to guide interventions. The case involved continuous monitoring, escalation of antibiotics, cardiopulmonary support, and rigorous nursing care.

Results: Initial NIV support maintained adequate oxygenation (SpO_2 94%), but due to deterioration on day 2, intubation was performed. After four days on mechanical ventilation with carefully set PEEP levels, oxygenation improved significantly (SpO_2 97%). The patient was successfully extubated and transitioned through a step-down respiratory support strategy, including BiPAP and spirometry exercises. The nursing team ensured infection control, suctioning protocol adherence, ventilator management, and early mobilization. By day 7, the patient was discharged in a hemodynamically stable condition, and follow-up showed full recovery within a month.

Conclusion: The case underscores the significance of carefully titrated PEEP in treating hypoxemic respiratory failure. It highlights the importance of a multidisciplinary approach, particularly the role of critical care nurses in monitoring and supporting patients on mechanical ventilation. Through meticulous management and supportive care, including infection control and respiratory therapy, optimal outcomes can be achieved in acute respiratory distress settings.

Keywords: PEEP, hypoxemic respiratory failure, mechanical ventilation, nursing care, critical care, oxygenation, ARDS, case study

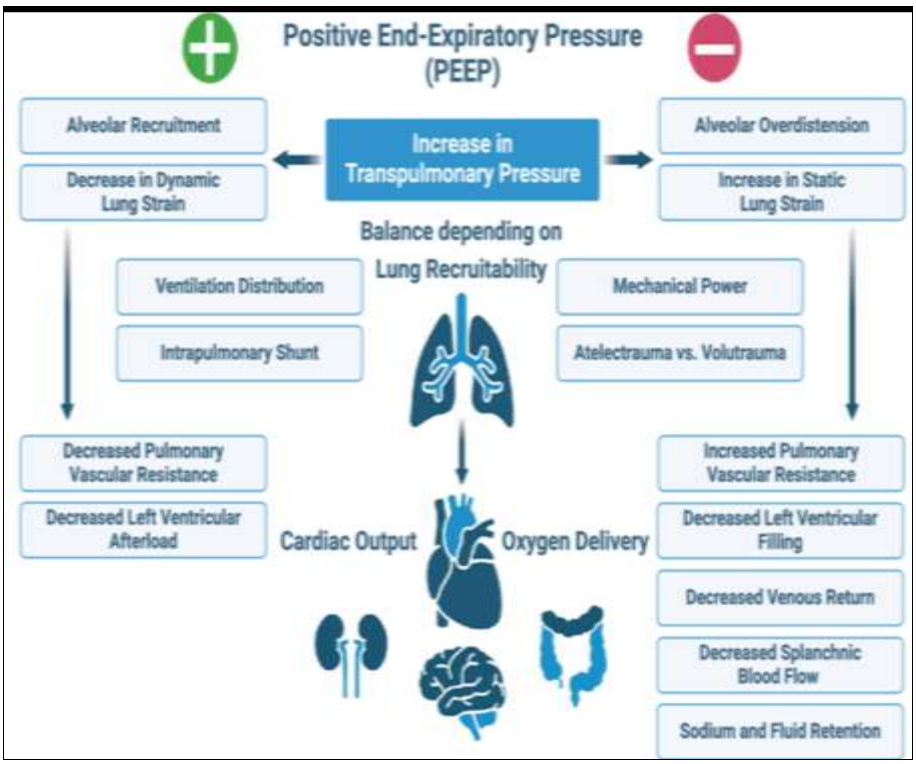
Introduction

Positive end-expiratory pressure (PEEP) refers to the pressure that remains in the lungs at the end of exhalation, above atmospheric pressure, in patients receiving mechanical ventilation. PEEP is primarily used to recruit or stabilize collapsed lung units and improve oxygenation in cases of hypoxemic respiratory failure. It supports the respiratory muscles by reducing the work of breathing and minimizing the effects of atelectasis (Collapsed or fluid-filled lung tissue). By keeping the airways and alveoli open, PEEP increases functional residual capacity and prevents the repeated opening and closing of alveoli, which is essential for effective oxygenation and lung recovery during acute respiratory failure [1].

Hypoxemic respiratory failure is a life-threatening condition marked by severely impaired oxygenation, often necessitating mechanical ventilation with positive end-expiratory pressure (PEEP) to enhance gas exchange. Setting appropriate PEEP levels is crucial for improving oxygenation while minimizing the risk of ventilator-induced lung injury. However, identifying the optimal PEEP in critically ill patients remains a significant challenge due to the complex interaction between lung mechanics, recruitability, and hemodynamic stability [2].

This case study examines the clinical approach to PEEP adjustment in a patient with hypoxemic respiratory failure, emphasizing the underlying physiological principles, decision-making processes, and the outcomes of various PEEP strategies. Through this analysis, we aim to offer practical insights into best practices for individualized PEEP titration, ensuring a balance between lung protection and sufficient oxygenation in critically ill patients [3].

Physiology of PEEP



Reinflates collapsed alveoli and maintains alveolar inflation during exhalation
PEEP
↓
Decreases alveolar distending pressure
↓
Increases FRC (Functional residual capacity) by alveolar recruitment
↓
Improves ventilation
↓
Increases V (ventilation)/Q (quantity of perfusion) improves oxygenation, decreases work of breathing

Indications to PEEP
1. Refractory hypoxemia to any cause
2. Intra pulmonary shunts
3. Decreased FRC & Lung compliance

Complications to PEEP:
1. Decreased venous return
2. Decreased cardiac output
3. Barotrauma
4. Increased intra cranial pressure
5. Alters renal metabolism and water balance[4].

Contra indications to the use of PEEP/CPAP (Continuous Positive Airway Pressure):
Absolute
Tension pneumothorax

Relative
1. Barotrauma
2. Hypovolemia
3. Increased ICP (Intracranial Pressure)
4. Pre-existing bullae
5. Recent lung surgeries
6. Unilateral lung disorders [5].

Case Presentation
A 46-year-old male patient presented to ER with complaints with one day history of sever breathlessness associated with cough and vomiting on 15/03/2025. Patient went outside clinic and came to Apollo Hospitals, Secundreabad for further evaluation and management.

On presentation to the ER patient had severe shortness of breath. ABG S/O Hypoxemia. Patient was Tachypnic. Started on NIV support. Shifted to MICU (Medical intensive care unit). CT Chest done, CT shows ARDS V/S Pulmonary oedema. Haemoglobin was 16.6. TLC count 18,700. Tachycardia was present with a pulse rate of 120/min. BP was 130/70 mmHg. On auscultation bilateral vesicular breath sounds were heard. The patient was admitted and treatment started. Trop I' was done which was found to be high at 5463 ECG showed ST depressions in V2 to V6 Lead 2 and aVF, Cardiologist opinion was taken and advice followed. On subsequent test trop I' was high, NT-pro BNP was done and found to be high. HbA1c was also high (den ova). Endocrinologist opinion was taken and advice followed. COVID RT-PCR was done which was found to be negative. 2D echo showed RWMA with mild LV dysfunction and mild MR.

On day of admission(15/3/2025) and Day 1 (16/3/2025) patient was on NIV support and patient was maintain 94% of spo2, Day 2 (17/3/2025) due to persistent type I respiratory failure and NIV failure an impending arrest patient was intubated, and patient was on mechanical ventilation with volume assisted control mode. Day

3(18/3/2025), BAL sample sent for Bio fire film Panel. Antibiotics were escalated and other supportive measures continued. Day 4 (19/3/2025) Patient spo2 was 97% and ABG become normal and planned for extubation in the morning hours and extubated at 12.15 pm, the patient kept on NRBM oxygen mask with 12lit of o2/intermittent NIV support and the patient was maintains spo2 97%. Day 5(20/3/2025) patient was on intermittent NIV support, Day 6(21/3/2025) Patient condition was improved and patient was tapered initially to NIV than to BIPAP support, started spirometer exercises and wheelchair mobilization started. As patient condition improved patient was advised to overnight BIPAP support and the patient being discharged in a haemodynamically stable condition on Day 7(22/3/2025).

Nursing Management

Highly skilled and specialized nursing care was provided to the patient. The nurses plays the integral role in the recovery of the patient. Hand hygiene maintained, pressure ulcer risk assessment with Braden scale, ventilator associated pneumonia bundle, catheter associated urinary tract infection prevention bundle implemented to prevent hospital acquired infections. Bi pap management and other supportive care like spirometer exercise, and simple active exercises explained to the patient and the patient attenders.

Medical management

Medications such as Antibiotic (INJ. Meropenim 1gm TID), antiplatelet (Clopidogrel 75 mg BD), cardiac supportive drugs (Tab. Ivabrad 2.5 mg BD, Tab. Aztor 80 mg, Tab. Nikorandil 5 mg BD), steroid (Tab. Wysolone 20 mg OD), diuretics (Tab. Dytor plus 10/50 OD), antiviral (Cap. Fluvir 75 mg BD), Nebulization Duolin 1Res TID, Budecort 1Res BD administered to the patient, and to prevent peptic ulcer prophylactically Inj. Pantoprazole 40 mg OD administered to the patient for 7 days.

Nutritional support

Enteral feeding always maintained, Checking position of NGT (Naso Gastric Tube) to prevent aspiration, Assessing feed intolerance, Interruption of feeds i.e., a temporary pause of feeding at night time done when the patient was on ventilator, after extubation patient started with oral liquids and diet.

Care during high PEEP ventilation:

The nursing team played a critical role in ensuring proper care during PEEP ventilation, unnecessary disconnection of ventilator were avoided as its leads to drop in end expiratory pressure leading to worsening hypoxemia, closed suction units was used to minimise disconnections. Vitals signs were monitored closely with particular attention to hypotension and tachycardia, as well as peak pressures and saturation for any sudden changes, and looking for Pneumothorax. Cuff pressure checked each shift, it is kept at 20 cm H2O pressure, dressing and tape changed once a day when the patient was on ventilator. Safety equipment's such as Suction catheter/apparatus, Airway, Laryngoscope, Tube-Endotracheal and tracheostomy tubes, Boogie, tracheal dilator, Laryngeal mask airway (LMA) was kept ready for any emergency situation to prevent complications.

Infection control prevention

The nurses ensure, strict aseptic techniques, personal and environmental hygiene was maintained. Hand hygiene, propped up position (30 - 40 degree), closed suctioning, regular oral care using chlorhexidine mouth wash, sedation vacation, Peptic ulcer disease prophylaxis, Deep vein thrombosis prophylaxis measures maintained. All care bundles of central line insertion and maintenance was followed. Early initiation of Ryle's tube feed was provided to maintain adequate nutrition.

Patient comfort and pain management

Head of the bed elevation 30-45 degree maintained.
Re positioning /Passive limb exercises done.
Pain control and sedations given.
Prevention of pressure sore followed.
Hygiene-Eye care/Mouth care, Body care maintained.

Care during suctioning

As per the protocol Pre oxygenation, and reassurance given to the patient to prevent suction induced hypoxemia. The diameter of suction catheter ensured it is half of the inner diameter of the airway. We avoided larger catheters because it causes mucosal trauma. Suction gauge adjusted to 80 120 mm Hg, to prevent Hypoxia, trauma, and atelectasis.

Follow Up

On Day 7 patient has been discharged from the ward in a stable condition with all necessary instructions. The patient was instructed to visit OPD once a week. In home patient has followed doctor, physiotherapist and dietician advice and recovered well and back to normal life within a month.

Patient and Family Education

The patient and family members were educated about avoiding smoke, air pollution/dusty areas by wearing a mask, and balancing a healthy lifestyle, and patient were explained about involving in physical activity like some exercises, proper using technique of inhalers, importance of spirometer exercise, balanced nutrition comes under taking high protein diet and low fat diet, maintaining a healthy mental status by doing some yoga's or meditation, and follow-up with the consultant for regular monitoring of the patient health.

Discussion

This case highlights the importance of accurate diagnosis, timely intervention, and effective nursing management in the treatment of Type I respiratory failure.

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