

NIV - BI-LEVEL POSITIVE AIRWAY PRESSURE (BIPAP)

Introduction

Noninvasive ventilation (NIV) is a method of delivering oxygen by positive pressure mask that allows for the prevention or postponement of invasive tracheal intubation in selected patients who present with severe acute respiratory distress/ failure.

There are two primary modalities of NIV:

- **Continuous Positive Airway Pressure (CPAP):**
 - ♥ This provides for a continuous fixed value of positive airway pressure throughout the patient's respiratory cycle.
- **Bi-level Positive Airway Pressure (BIPAP):**
 - ♥ Here the inspiratory positive airway pressure (**IPAP**) is set at a higher level than the expiratory positive airway pressure (**EPAP**).

CPAP appears to be more effective in saving lives and reducing the need for intubation in selected patients presenting in **acute cardiogenic pulmonary oedema**.

BIPAP appears to be more effective in saving lives and reducing the need for tracheal intubation in selected patients with acute decompensation in **COPD**.

Summary of terminology:

CPAP: Continuous Positive Airway Pressure

BIPAP: Bi-level Positive Airway Pressure

IPAP: Inspiratory positive airway pressure

EPAP: Expiratory positive airway pressure

Pressure Support: The difference between the level of inspiratory positive pressure and the expiratory positive pressure, (i.e. IPAP - EPAP).

NIV: Non-invasive ventilation; is ventilation delivered without an orotracheal tube or tracheostomy tube, as well as negative pressure devices.

NIPPV: Noninvasive positive pressure ventilation - this differs from the term NIV only by its exclusion of negative pressure ventilation devices. Due to the rarity of use of negative pressure devices however, NIPPV and NIV in practice are used interchangeably.

The following refers primarily to the modality of face mask delivered BIPAP

Physiology

The physiological benefits of BIPAP include:

1. Avoiding the complications of invasive ventilation.
2. Can be used for patients who are not suitable for intubation.
3. Can titrate the precise oxygen concentration to the patient.
4. Reduces the work of breathing.
5. The added inspiratory pressure support improves ventilation in patients with respiratory failure.

The major benefit will be in those patients ventilatory failure ie an increasing PaCO₂ with acidosis.

Indications

NIV by the BIPAP modality has the following indications:

Proven benefit:

1. Exacerbation COPD

In particular those patients with impaired ventilatory drive and rising PaCO₂ levels.

Possible benefit:

2. Chronic hypoventilation syndromes
3. Acute cardiogenic pulmonary oedema
4. Non cardiogenic pulmonary oedemas
5. Acute asthma
6. Chest trauma, especially flail segments.
7. Other forms of hypoxic respiratory failure, e.g. pneumonia

Contraindications

1. Uncooperative patients
2. Significant hypotension
3. Unconscious patient
 - A mildly reduced conscious state is only a relative contraindication, but these patients will require constant and close observation from an experienced staff member.
4. Pneumothorax

Complications

1. Vomiting:
 - If the patient vomits, aspiration of gastric contents may occur.
2. Excessive impairment of the venous return:
 - Cardiac output may be reduced due to the increase in intrathoracic pressure, as a result of impaired venous return, especially in preload sensitive patients.
3. Hypotension:
 - CPAP levels should ideally be kept at or below 25 cm H₂O in order to avoid significant haemodynamic complications.¹
4. Barotrauma:
 - Resulting in pneumothorax, which may progress to tension pneumothorax if unrecognized.
5. Mask intolerance.
6. Skin and mucosal necrosis, including epistaxis.
7. Raised intracranial pressure and raised intraocular pressure.
8. Aerophagia, with gastric insufflation (distention) and increased risk of aspiration.

Clinical assessment

There are no universally accepted criteria for commencing NIV in patients who present to the ED with acute respiratory distress, each of the many studies that have been done having unique inclusion and exclusion criteria.

Each case therefore is assessed on its own merits.

Considerations will include:

1. Ruling out of any clear absolute contraindications.
 - This may include prior Advanced Care directives. These however most often relate to "do not intubate" directives, and a trial of NIV will still be reasonable in many instances.
2. Establishing (as far as possible in the setting of emergency presentations) the probable underlying pathology.
3. Assessing for significant respiratory distress:

Again criteria for this are not absolute and no single factor will definitively decide the issue, but rather the overall clinical picture.

In *general* terms important considerations will include:

- Patient exhaustion
- Vital signs:
 - ♥ Pulse > 100
 - ♥ Respiratory rate > 30.
- Pulse oximetry:
 - ♥ SaO₂ < 90 %
- ABGs:
 - ♥ Note that baseline ABGs, recording O₂ therapy is desirable, but *not essential* and should *never delay* treatment when this is clearly necessary.
 - ♥ In less acute presentations, serial ABGs may be a useful guide to the response to medical treatment, or the lack thereof, indicating a trial of NIV should be considered.

Increasing, hypoxia, hypercarbia and acidosis, as well as chronically raised bicarbonate levels are all important parameters.

- ♥ PaO₂ < 60 mmHg with the patient on 60% O₂ (8 L/min by face mask)
- ♥ PaCO₂ >45 mmHg and rising despite treatment.
- ♥ pH < 7.35
- ♥ Bicarbonate > 30 mEq/L

Management

1. Initiation of BIPAP:

This is done on the clinical assessment of each individual case as described above.

Many patients with end stage COPD will have Advanced Care Directives that include wishes such as “not for ICU” or “not for intubation”.

BIPAP, however may still provide a relatively simple and non-invasive treatment option for some of these patients. It may enable them to survive their acute illness in some cases, in others the modality can provide significant relief from the distress of hypoxia and exhaustion, and so in this regard may be used in a palliative sense.

2. Settings:

Commencement:

In general terms for COPD, commencement settings are:

- **IPAP = 10-15 cm H₂O and 4-5 cm H₂O EPAP.**
- **15 cm H₂O IPAP and 5 cm H₂O EPAP will provide 10 cm H₂O pressure support.**
- **NB: The IPAP must initially be greater than the EPAP by at least 4cm of water, it must never be less.**
- Rate 12 breaths per minute
- O₂ concentration, according to clinical need.

Titration of pressure support:

IPAP may be increased in 1 cm H₂O increments, up to a maximum comfort level. This can be increased over minutes as tolerated.

Once the IPAP is at the maximum tolerated pressure the EPAP can be increased slightly if there are ongoing signs of respiratory distress:

- Use of accessory muscles
- Active expiration
- Basal rib indrawing
- Hypoxia

The EPAP is increased in 1cm increments generally up to a **maximum of 8 cm** water.

3. Monitoring:

All patients undergoing NIV will require close one to one direct observation by nursing staff experienced in the use of the device.

Close monitoring be required in regard to:

- All vital signs
- SaO₂
- Conscious state
- Tidal volumes (Vt) and minute ventilation (VE).
- The pressure gauge:
 - ♥ This should be observed to ensure that the set BIPAP levels approximate the actual levels measured on the on the pressure gauge. If the pressure gauge is lower the circuit must be checked for leaks.
- ECG
- Patient comfort/ anxiety levels
- Signs of patient exhaustion/ tiring.
- For patients in whom serial ABGs are considered to be desirable, an arterial line will be useful to avoid the need for repeated distressing needling.
- Checking for pressure areas from the mask at least 2 hourly.

4. Sedation:

Constant **explanation** and **reassurance** to the patient, is a vital and important aspect of NIV in the acutely unwell patient.

These patients can suffer considerable anxiety, and this can be exacerbated by a tight fitting mask.

Judicious small titrated doses of IV opioids can help in assisting these patients when verbal reassurance is not enough. Note that any type of sedative agent is general considered a contraindication to COPD patients, however with close one on one medical supervision, small titrated doses are safe and beneficial for significantly distressed patients in the acute phase of their presentation.

5. Nil by mouth:

Patients should generally remain nil orally while being stabilized in the ED, other than essential oral medication because of the risk of aspiration, or if the patient should subsequently require intubation.

Although NIV may be removed for short periods of time, this should be for as brief a period as possible. The patient must be closely observed during such periods.

6. Adjunctive therapies:

Note that in cases of asthma and COPD, nebulized bronchodilator therapies can be delivered via the NIV tubing.

7. Failure of BIPAP:

Patient deterioration despite NIV therapy will require either a decision to initiate more aggressive therapy (i.e. intubation and mechanical ventilation) or a decision to palliate the patient.

Indications of NIV failure may include:

- Deterioration in conscious state
- Increasing agitation
- Deterioration in vital signs:
 - ♥ Decreasing blood pressure
 - ♥ Increasing respiratory rate
 - ♥ Increasing pulse rate
- Deteriorating respiratory status:

- ♥ Inability to maintain satisfactory oxygenation ($\text{PaO}_2 < 80$ mmHg or $\text{SaO}_2 < 90\%$)
- ♥ A rising PaCO_2
- ♥ Physical exhaustion

Note: The possibility of a complication of the NIV therapy, e.g. pneumothorax, aspiration or impaired venous return should additionally always be kept in mind

8. Weaning of BIPAP:

Unlike CPAP used in cases of APO, BIPAP is usually required for longer periods for patients with COPD. It may take up to 24 hours before a patient is ready to be weaned from BIPAP and so admission to an ICU/HDU will be usually be necessary.

In general terms:

- Decrease IPAP by 1-2 cm H_2O at regular intervals, (usually by 2 cm) according to clinical response until $\text{IPAP} = \text{EPAP}$.
- Next reduce **both** IPAP and EPAP by 1-2 cm H_2O at regular intervals according to clinical response until 4 cm H_2O is reached.
- Once this is achieved BIPAP can be removed.

Increase IPAP or EPAP again if there is clinical deterioration.

BIPAP is usually only reapplied if further reversible factors are identified and further aggressive management is appropriate.

Disposition:

Patients with COPD or asthma, in distinction to patients with acute cardiogenic pulmonary oedema, will usually require relatively longer periods of NIV, before weaning can be considered.

Following stabilization in the ED and a period of observation, patients who cannot be weaned off their BIPAP will require admission to a High Dependency Unit (or similar) for ongoing NIV.

These HDU cases may include a small number of selected patients with Advanced Care Directives, that exclude them from an ICU setting and its attendant advanced life-supporting therapies, where it is thought that a more prolonged period of NIV will enable them to survive their acute illness.

References:

1. Torres J.D et al. Non-invasive ventilation, Update on Uses for the Critically Ill Patient, vol 1 no. 2. EM Critical Care, August 2011

Dr J Hayes.

Acknowledgements:

Dr G Duke.

Stacy Williamson, Clinical Nurse Educator

Reviewed February 2013