

Part 2: Non-invasive ventilation

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James talks to Dr Paul Hamor about modes of non-invasive ventilation, delving deeper into the details in Part 2 of this podcast.

In [Part 1 of this podcast](#), we talked about CPAP and BiPAP and their indications and non-invasive ventilation (NIV) in general.

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About Dr Paul Hamor

Dr Paul Hamor is a Respiratory Sleep Physician, and recently appointed Director of Prevocational Education and Training at [Royal Prince Alfred Hospital](#). Paul has interests in the formulation of educational programs, presentation skills, delivering best evidence based-practice to the ward, as well as change methodology.

Non Invasive Ventilation - NIV

With Dr Paul Hamor, Respiratory & Sleep Physician and Director of Prevocational Education and Training at Royal Prince Alfred Hospital, Clinical Lecturer at University of Sydney, New South Wales, Australia

1. What is NIV?

- *Support of someone's ventilation without intubation*
- Historically used negative pressure (e.g. iron lungs)
- Now uses positive pressure via a mask
- Two main types: CPAP (continuous positive airway pressure) and Bilevel ventilation (BiPap)

2. Explain the settings used in NIV

- **CPAP**

- Constant pressure delivered
- Single number

- **Bilevel ventilation**

- Higher pressure on inspiration (inspiratory positive airway pressure – IPAP) and lower on expiration (expiratory positive airway pressure – EPAP)
- Pressure support is IPAP minus the EPAP
- Can be confusing because different specialties use different terminology
- Expiratory pressure is called EPAP by respiratory physicians but can also be referred to as PEEP (positive end expiratory pressure)
- Settings are sometimes communicated by giving two numbers e.g. 12/6, but this can be confusing
 - Important to clarify which terminology is being used because some specialties will use the first number to refer to the IPAP (respiratory), whilst others will mean the pressure support. For example, 12/6 could mean an IPAP of 12 and an EPAP of 6 OR potentially a pressure support of 12 and an EPAP/PEEP of 6 (making the IPAP 18)
 - As such, it is best practice to clarify specific pressures in all communication (verbal & written) eg: “The IPAP is 12, the EPAP is 6”, or “The PEEP is 6, with a Pressure Support of 6”



3. What are the indications for NIV

- **CPAP**

- Pulmonary oedema –decreases venous return and increases alveolar recruitment. Generally 8-10 cmH₂O is a reasonable starting pressure.
- Obstructive sleep apnoea – positive pressure splits the upper airway open. Need higher pressures when the person is obese to overcome the weight of the tissues.
- Severe hypoxia – alveolar recruitment (i.e. opening up collapsed alveoli).

- **BiPAP**

- Type 2 respiratory failure – acidosis and hypercapnia
- Pressure support/IPAP increases the tidal volume which increases minute ventilation which will decrease CO₂
- Need EPAP to split open the upper airway because the hypercapnia often makes patients lethargic and an IPAP to increase tidal volume. For a normal body habitus example of starting settings would be an EPAP 6 and pressure support of 6 giving an IPAP of 12.

4. Contraindications & relative contraindications for NIV

- Decreased GCS – must be able to maintain their own airway otherwise high risk for aspiration
- Vomiting – also puts at high risk for aspiration
- Inability to remove the mask themselves
- Facial fractures
- Undrained pneumothorax – positive pressure can worsen pneumothorax and transform into a tension pneumothorax
- Hypotension – decrease in venous return will worsen hypotension
- Important to consider these in light of the environment you will be delivering NIV
 - 1:1 nursing may make patient's ability to remove the mask yourself less important
 - If patient is severely hypoxic and fails trial of NIV, will the patient be in a location where you can escalate care and intubate?
 - Close observation is less relevant for routine CPAP for OSA

Case 1- You are a junior doctor working in the ED. A patient comes in with APO – hypertensive, CXR shows APO. You start a GTN infusion and possibly give some IV frusemide. Your registrar says “I think we should start them on CPAP”. What would be your approach to starting this patient on CPAP?

Starting CPAP can be complicated and usually requires 15-20 minutes to initiate treatment and assess tolerance and response

Initiating NIV

Ensure no contraindications

Explain the therapy even though they will likely be in respiratory distress. The mask can be particularly confronting for patients with claustrophobia.

Select the mask size & (if available) shape. Based on the distance between the bridge of the nose and the groove under the bottom lip NOT the size of the entire face. Too big if it slips under the chin, too small if it slips into their mouth when they open it.

Hold the mask to their face without straps and allow the patient to take 4-5 breaths without pressure, so they can become used to the feel of the mask.

Ask the patient if they are OK again before starting CPAP

For APO, start at 8 cmH₂O

Before strapping the patient in hold the mask to their face and let them take a few breaths WITH pressure. Ask if the patient is OK, reassure the patient and be positive!

Straps should be tight enough to hold the mask to the face but not so tight it inhibits movement of the face. You should be able to get your thumb between the strap and the cheek but not your thumb and your finger.

Assessing tolerance

Stay with the patient after starting NIV to assess their tolerance to the machine

Are they breathing with the machine or fighting it

Look at their eyes for signs of intolerance or fear

Hover your hand around the edges of the mask to feel for air leaks. If there are leaks: is the mask size appropriate? Are the straps tight enough? Small leaks will be tolerated, large leaks will impede pressure delivery.

Ensure patient isn't getting hypotensive

Can monitor oxygen saturations (titrate oxygen delivery for 95-98% O₂ saturation), crackles, respiratory distress for indications of response.

Assessing response

Oxygen saturations and requirement - titrate oxygen delivery for saturations of 95-98%

Crackles

Level of respiratory distress

5. When is it safe to take a patient off CPAP?

- Patients with OSA will usually need lifelong CPAP, unless dramatic weight loss
- Patients with APO will often require around an hour
- Patients with severe hypoxia should be trialled on CPAP in a place where you can intubate (e.g. ICU) if this fails. Usually these patients have refractory hypoxaemia, tend to have prolonged time on CPAP and up to 50% will eventually need intubation. They should not be managed on the ward.

6. What are the indications for BiPap?

- COPD with respiratory acidosis
 - pH < 7.35 and hypercapnia
 - Some patients will be chronic CO₂ retainers and will have hypercapnia with a normal pH due to renal compensation
 - Acidosis can be an ominous sign in COPD and should be acted on quickly
- Chronic respiratory failure
 - Neuromuscular disease
 - Chest wall deformity e.g. kyphoscoliosis
 - Obesity hypoventilation syndrome
- Pulmonary oedema with hypercapnia
 - Possibly following an initial trial on CPAP
- Assisting extubation in ICU
 - After extubation patient can be weaned down to BiPap
 - Reduces reintubation rates
- NB: Asthma is **NOT** a recognised indication but is currently under investigation. There is concern around BiPap delaying intubation in severe asthma.

Case 2 – A junior doctor is called to see a patient admitted to the ward with an exacerbation of COPD. The gas result shows acidaemia with a raised CO₂. What should they start thinking of?

Is this worsening of their exacerbation of COPD?

This is rare on the wards because patients are generally getting appropriate treatment.
Can still happen occasionally.

Is the patient on too much oxygen?

Hyper-oxygenation can lead to hypercapnia secondary to multiple mechanisms, including loss of hypoxic pulmonary vasoconstriction in areas of low V/Q, as well as central causes.

Is there an element of APO?

Has the patient been getting copious fluid?

Do they have some diastolic dysfunction?

Treat this with frusemide as a first step, but may also need CPAP or APO.

Is the patient hypoventilating due to opioids?

Could be treated with naloxone or NIV or both.

Is there something in the abdomen restricting their ability to expand their chest?

COPD patients are very dependent on their muscles to breathe so abdominal distension or pain could tip a patient into respiratory acidosis.

Case 3 – A patient has borderline hypoxia on 2-4L oxygen. The ABG shows hypercapnia with pO₂ of 65. Occasionally a junior doctor will take the oxygen off in an attempt to improve the hypercapnia. What do you think about this?

This is wrong

Sometimes too much oxygen will cause hypercapnia

Hypoxia will kill you faster than hypercapnia!

Saturations 88-92% is physiologically adequate oxygenation. If the saturation is < 88% then the patient should receive supplemental oxygen

A finger Sats probe is OK, you don't need an ABG. An ABG has a role in showing accurate acid-base status and hypercapnia but isn't necessary to assess oxygenation

If the patient is hypercapnic with oxygen saturations 88-92% then treatment is BiPAP and probably referral to ICU depending on the protocols and facilities at your hospital

How do you start BiPap in this patient with COPD?

- Decide on the location the patient will receive BiPap
- Decide on the EPAP
 - COPD patients have intrinsic PEEP and
 - Need an EPAP of about 4-6 cmH₂O to overcome this
- Decide on the pressure support/IPAP
 - Consider the level of hypercapnia and acidosis and use this to determine the pressure support
 - Reasonable to start with pressure support of 6-8 i.e. an IPAP of 12-14

- Titrate oxygen delivery to saturations of 88-92%
- Repeat ABG in 1 hour

— What should you consider if the ABG isn't improving after an hour?

- If not improving (and you haven't done this already) then involve ICU
- Assess the patient's response to the machine
 - Is their respiratory effort enough to trigger the inspiratory pressure support. You might be able to reduce the inspiratory trigger on some machines.
 - Rise time - this is how quickly the machine will switch from EPAP to IPAP. 1 = 100 ms, 5 = 500 ms. If the patient is very tachypnoeic you should set the rise time at 1-2.
 - Is the pressure support high enough? You could consider increasing to 8-10cmH₂O which would increase tidal volume and reduce hypercapnia.
 - Is the EPAP high enough? You could increase to 6-7. It will be hard for patient to exhale if the EPAP is higher than 8, (but may be necessary in the grossly obese patient).

— Take home messages

- NIV isn't a device to set and forget
 - You have to spend 15-20 minutes with a patient to get it right
- Don't let NIV delay intubation if the patient needs this
 - Make sure you are in an environment where the patient could be intubated if they were to deteriorate further
- Do another ABG an hour after starting NIV to assess response to treatment

Resources

BTS guideline - Non-invasive ventilation in acute respiratory failure

British Thoracic Society - Non-invasive Ventilation guidelines

Non-invasive Ventilation Guidelines for Adult Patients with Acute Respiratory Failure

Related Podcasts

- [Part 1: Non-invasive ventilation](#)
- [Hypoxia and O₂ therapy](#)

- Hospital acquired pneumonia
- Tracheostomies

Tags: #ABG,#bilevel ventilation,#BiPAP,#CPAP,#Emergency Medicine,#intubation,#NIV,#Non-invasive ventilation,#respiration,#respiratory,#ventilation