

Non-Invasive Ventilation

Ciara Dolan, Clinical Specialist Physiotherapist, Dr. Fatma Gargoum & Prof. Anthony O'Regan
Galway University Hospital



Acute Hypercapnic Respiratory Failure

Acute hypercapnic respiratory failure (AHRF) or type II respiratory failure results from an inability of the respiratory pump and lungs to provide adequate alveolar ventilation to maintain a normal arterial CO₂.

Co-existent hypoxaemia is usually mild and easily corrected. AHRF is defined as pH <7.35 and pCO₂ >6.5 kPa. AHRF accounts for 20% of admissions with exacerbation of COPD. Other causes of AHRF include neuromuscular disease (NMD), chest wall deformities, central nervous system (CNS) depression and obesity.

Non-invasive ventilation (NIV) is the application of two levels of pressure called inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) via a tight fitting mask over the face.

- IPAP-positive pressure on inspiration which offloads inspiratory muscles and increases tidal volume. This aids the removal of CO₂.
- EPAP- positive pressure on expiration which splints open the airways, reduces work of breathing, increases functional residual capacity, increases gas exchange and oxygenation.

Indications for NIV:	Contraindications for NIV:
<ul style="list-style-type: none"> • COPD 	<ul style="list-style-type: none"> • Absolute
pH <7.35 pCO ₂ >6.5	Severe facial deformity
<ul style="list-style-type: none"> • NMD 	Facial burns
pH <7.35 pCO ₂ >6.5 or respiratory illness with RR >20	Fixed upper airway obstruction
<ul style="list-style-type: none"> • Obesity 	<ul style="list-style-type: none"> • Relative
pH <7.35 pCO ₂ >6.5 or pCO ₂ >6 and daytime somnolent	pH < 7.15
	GCS < 8
	Confusion/agitation



Initiation of NIV

Compared with standard medical therapy, NIV improves survival, reduces the need for endotracheal intubation, reduces complications and reduces length of stay. NIV should be started when pH <7.35 and pCO₂ >6.5 kPa persist or develop despite optimal medical therapy

- Optimum medical therapy:**
- Controlled O₂ therapy SpO₂ 88-92% all patients
 - Bronchodilation (salbutamol 2.5mg/ipratropium 500mcg 6 hourly +/- salbutamol 5mg prn)
 - Steroids (PO prednisolone)
 - Antibiotics (if indicated)
 - Diuretics (if indicated)

Strong evidence to suggest that one hour of medical management prior to NIV will reverse AHRF in approx. 20% of cases.

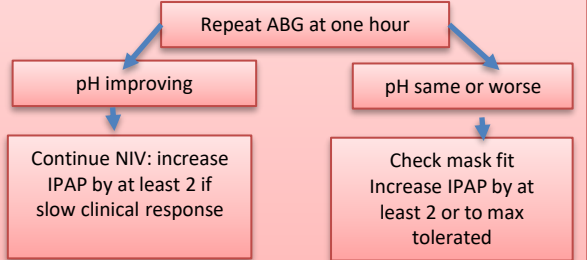
- Repeat ABG at one hour and commence NIV if AHRF persists.
- Checklist prior to NIV
1. Optimum medical management
 2. CXR to rule out pneumothorax. Note: consolidation on CXR can increase mortality
 3. Establish resuscitation status and escalation plan
 4. Prescribe NIV ideally using a standardised pathway

Prescription of NIV

- **IPAP**- start with at least 14cm H₂O but aim to increase to at least 20cm H₂O within 30mins to 1 hr if tolerated (no higher than 30 without expert review).
 - NMD start at 10 cm H₂O
 - If patient is on home NIV start with IPAP at least 2 cm H₂O higher than home settings
- **EPAP**- 4 cm H₂O (or higher if OSA known or suspected) No higher than 8 cm H₂O without expert review.
- **Pressure support (PS)** = IPAP minus EPAP. **The bigger the PS or 'gap', the higher the tidal volume, which should reduce CO₂.**
- **Timed Inspiration (Ti)** 1.0s (1.4s for NMD)
- **Rise Time (RT)**- 3 (Lower RT= quicker rise from EPAP to IPAP= less comfortable but more therapeutic, higher RT= slow rise from EPAP to IPAP= more comfortable but less therapeutic
- **Resp rate (RR)**- 12- 20 or 2 below patients own RR

Monitoring response to NIV

- Aim to increase IPAP to 20 cm H₂O within first hour if tolerated
- Patient should have continuous monitoring of SpO₂ (and ECG if HR >120)
- ABG should be repeated at 1 hour and no later than 2 hours post commencing NIV



- Repeat ABG every 4 hours or until acidosis resolves
- Consider ICU review if GCS <8, pH <7.25, rising pCO₂ at 4 hours

Weaning of NIV

NIV should be used continuously for the first 24 hours. Once pH normalised and pCO₂ close to baseline NIV weaning can begin slowly. Begin by weaning day time NIV over 2-3 days but continue nocturnal NIV. Consider domiciliary NIV if patient has previous admission requiring NIV or persistent hypercapnia and unable to wean.

References

Davidson C, Banham S, Elliott M, Kennedy D, Gelder C, Glossop A, Church C, Creagh-Brown B, Dodd J, Felton T, Foëx B. British Thoracic Society/Intensive Care Society Guideline for the ventilatory management of acute hypercapnic respiratory failure in adults. *BMJ Open Respiratory Research*. 2016 Mar 1;3(1):e000133.

Davies M, Allen M, Bentley A, Bourke SC, Creagh-Brown B, D'Oliveiro R, Glossop A, Gray A, Jacobs P, Mahadeva R, Moses R. British Thoracic Society Quality Standards for acute non-invasive ventilation in adults. *BMJ open respiratory research*. 2018 Apr 1;5(1):e000283.

Juniper MC, Ellis G, Protopapa KL, Smith NC. Inspiring change: a report on acute non-invasive ventilation. *British Journal of Hospital Medicine*. 2017 Sep 2;78(9):497-502.