Non Invasive Ventilation (NIV) for Adults on the Lung Support Unit (LSU) for Patients with Acute Hypercapnic Respiratory Failure (AHRF)

Based on British Thoracic Society (2016) Ventilatory Management of Acute Hypercapnic Respiratory Failure

A trial of NIV should be considered in patients with a pH of <7.35 and a PaCO₂ of >6.5 KPa who have met the inclusion criteria below and remain decompensated despite 1 hour of maximum medical treatment (see page 2 for details) and controlled oxygen therapy using a venturi face mask to maintain SaO₂ between 88-92%

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Absolute Contraindications</th>
<th>Might NIV be Non Beneficial?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. pH &lt;7.35 &amp; PaCO₂ &gt;6.5 KPa with at least one of the following:</td>
<td>1. Decompensated acute hypercapnic respiratory failure due to acute asthma – refer to Critical Care for urgent opinion</td>
<td>1. End stage lung disease</td>
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<tr>
<td>1.2. Neuromuscular disease (NMD) and chest wall deformity (CWD)*</td>
<td>3. Facial burns</td>
<td>3. Terminal diagnosis</td>
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<tr>
<td>1.3. Obesity hypoventilation syndromes/ decompensated obstructive sleep apnoea (OSA)*</td>
<td>4. Fixed upper airway obstruction</td>
<td>4. Patient prior wishes</td>
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<td>5. Poor tolerance of facial O₂</td>
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<td>*see page 3 for exceptions</td>
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<td>6. Poor response to NIV</td>
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<td>7. Overly burdensome</td>
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<td>8. Approaching end of life</td>
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<td>*refer to RCP 2015 guidelines</td>
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</table>

Is the Patient Suitable for NIV on LSU?

Patients with a pH of <7.25 should be referred for a critical care opinion unless appropriate review concludes that the patient would not benefit from invasive mechanical ventilation (IMV)

NIV on LSU not indicated

Is End of Life (EOL) Care a Consideration?

Do not commence a treatment (e.g. NIV) that is considered to be non-beneficial.

The definition of EOL by the General Medical Council (GMC) 2015 is not confined to people imminently dying, but also includes those who may be in their final year, months, weeks or days of life (see page 2 for further details on prognostication)

Spirometry: ___/___/___ (date) FEV₁: _____ % pred _____ FVC: _____ % pred _____ Ratio: ______

MRC Breathlessness Score: 0 1 2 3 4 5 (circle)
1. End of Life Care Considerations

- Estimating prognosis for the last months to years of life is inherently difficult, and all discussions must include this uncertainty.
- Various prognostic indicator tools have been developed to help doctors and healthcare staff to recognise when someone might be coming to the end of their life; most are based on illness trajectories for a cancer diagnosis, organ failure or long-term frailty such as the Gold Standards Framework Prognostic Indicator (2011).
- For those patients who either are older and frail or have an advanced progressive illness, factors that may aid prognostication include:
  - A 'No' answer to the question 'Would I be surprised if the patient were to die in the next 12 months?'
  - Two or more unplanned hospital admissions in the past 6 months.
  - Poor or deteriorating performance status.
  - Persistent symptoms despite optimal therapy.
  - Secondary organ failure arising from an underlying condition.
- Multidisciplinary advance care planning should be an integral part of the routine outpatient management of progressive or advanced disease and care plans should be reviewed on presentation during an episode of AHRF.

2. Acute Exacerbation COPD (AECOPD)

- For most patients with AECOPD, the initial management should be standard medical therapy and targeting an oxygen saturation of 88–92%.
- NIV should be started when pH <7.35 and pCO₂ >6.5 kPa persists or develops despite optimal medical therapy.

3. Standard Medical Therapy

Ensure that the appropriate medical management has been prescribed and administered

- Air driven nebulised Salbutamol 5mg 4 hourly and 5mg PRN
- Air driven nebulised Ipratropium Bromide 500micrograms 6 hourly
- Prednisolone 30mg once daily for 7-14 days
  - Gradual wean if recent multiple steroid use and/ or taking maintenance steroids
  - Consider IV hydrocortisone 100mg 6 hourly if patient cannot take orally
- Appropriate antibiotic therapy, if indicated, according to local hospital policy
- Prescribe controlled O₂ therapy on Cerner via fixed percentage venturi mask, initially starting at 24 - 28% according to arterial blood gases
  - Wean down O₂ to lowest dose required (this may be to room air)
  - Aim to achieve target oxygen saturation of 88–92%
  - DO NOT stop O₂ abruptly without a controlled wean as this is associated with life threatening rebound hypoxemia

ST2 or above should contact LSU if the patient has a pH <7.35 and PaCO₂ >6.5 KPa despite one hour of the above standard medical therapy and a trial of NIV is felt to be beneficial
4. Neuromuscular Disease/ Chest Wall Deformity

- Controlled oxygen therapy should be used in patients with NMD or CWD and AHRF.
- NIV should almost always be trialled in the acutely unwell patients with NMD or CWD with hypercapnia. Do not wait for acidosis to develop.
- In patients with NMD or CWD, NIV should be considered in acute illness when vital capacity (VC) is known to be <1 L and RR >20, even if normocapnic.
- Patients with NMD usually require low levels of pressure support.
- Patients with chest wall deformity usually require higher levels of pressure support.
- In NMD or CWD, unless escalation to IMV is not desired by the patient, or is deemed to be inappropriate, intubation should not be delayed if NIV is failing.
- In patients with NMD or CWD, nocturnal NIV should usually be continued following an episode of AHRF, pending discussion with a home ventilation service.

5. Obesity Hypoventilation Syndromes

- Controlled oxygen therapy should be used in patients with OHS and AHRF.
- In patients with OHS, NIV should be started in AHRF using the same criteria as in AECOPD.
- NIV is indicated in some hospitalised obese hypercapnic patients with daytime somnolence, sleep disordered breathing and/or right heart failure in the absence of acidosis.
- High inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) settings are commonly required in patients with OHS (e.g., IPAP>30, EPAP>8).
- Many patients with AHRF secondary to OHS will require long-term domiciliary support (CPAP or NIV).

6. Bronchiectasis

- In patients with non-CF bronchiectasis, NIV should usually be tried before resorting to IMV in those with less severe physiological disturbance.
- In patients with CF, NIV is the treatment of choice when ventilatory support is needed. All CF patients should be discussed with the CF unit at LHCH.

7. Critical Care Considerations

- Patients with a pH < 7.25 should be referred for a critical care opinion unless appropriate review concludes that the patient would not benefit from IMV.
- Request a critical care opinion regarding feasibility for escalation to level II/III care if the patient has pneumonia or heart failure associated with acute hypercapnic respiratory failure, unless appropriate review concludes that the patient would not benefit from IMV.
- If the patient is eligible for NIV on LSU, and LSU facilities are not available, contact critical care service to evaluate whether local (& regional) critical care capacity can absorb the LSU under-capacity (please be aware that inter-hospital transfer while a patient is actively receiving NIV is not currently possible)
- Clinicians with ongoing responsibility for delivery of interventional treatments (such as NIV) are often best placed to make recommendations on initiation and continuation.
8. Specialist Respiratory Medication

Q. When should IV Aminophylline be considered?

A. It can be added if there is an inadequate response to nebulised bronchodilators after discussion with respiratory specialist or senior doctor.

a. Loading dose in patients not previously treated with oral theophylline
   - Loading dose of 250mg to 500mg (5mg/kg) by intravenous infusion in 100mL sodium chloride 0.9% over at least 20 minutes

b. Follow on/ maintenance treatment
   - Start all patients on a maintenance dose of 500micrograms/kg/hour
   - Theophylline levels MUST be checked 12-24 hours after starting the infusion and the dose adjusted accordingly (therapeutic range: 10–20mg/L)
   - Monitor daily levels during maintenance treatment and adjust infusion rate accordingly
   - If levels are found to be high, stop infusion until levels fall and ensure cardiorespiratory monitoring due to risk of arrhythmia

Diluting agents: Sodium chloride 0.9%, glucose 5%

Dilution: 500mg/500mL or 1g in 1L

Concentration: 1mg/mL

Time to steady state: 2-3 days

Therapeutic range: 10 to 20mg/L

<table>
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<tr>
<th>Infusion rates (mL/hour) for a 1mg/mL solution</th>
<th>Body weight (Kg)</th>
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<tbody>
<tr>
<td>Dose: 500 micrograms/kg/hour</td>
<td>40</td>
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<tr>
<td>mL/ hour</td>
<td>20</td>
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For further information on theophylline please see [http://www.wuth.nhs.uk/media/2155409/Therapeutic-Drug-Monitoring-V8.pdf](http://www.wuth.nhs.uk/media/2155409/Therapeutic-Drug-Monitoring-V8.pdf)

Q. When should IV Doxapram be considered?

A. Doxapram can be used as a respiratory stimulant after discussion with respiratory specialist or senior doctor if NIV is not available; if NIV is not tolerated by the patient or if NIV is considered inappropriate.

Dilution Available as 1g/500mL in glucose 5% (premixed bags sometimes available)

Concentration 2mg/mL

Time to steady state: The following dosage regimen has been shown to result in the rapid production of steady state concentration of Doxapram

<table>
<thead>
<tr>
<th>Doxapram: Dose of 2mg/ mL</th>
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<tbody>
<tr>
<td>Time</td>
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<tr>
<td>First 15 minutes</td>
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<tr>
<td>15 - 30 minutes</td>
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<td>30 - 60 minutes</td>
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<td>60 minutes onwards</td>
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Appointing committee:
Non Invasive Ventilation (NIV) for Adults on Lung Support Unit (LSU) with Decompensated Type 2 Respiratory Failure V2
August 2016. Review date August 2018.
M Parsonage – Respiratory ANP, Dr Z Wahbi – Consultant Physician, Dr C Cowan – Consultant Intensivist & CSL Critical Care
Please inform Advanced Nurse Practitioner or nursing staff on Ward 38 that NIV may be required as soon as possible to allow time to ensure the availability of bed and/or NIV machine

Signature Log

<table>
<thead>
<tr>
<th>Name (print)</th>
<th>Grade</th>
<th>Signature</th>
<th>Initial</th>
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Contraindications to NIV

There are few absolute contraindications to a trial of NIV but some adverse features, especially when combined, require more caution and more intense monitoring

*The presence of adverse features increases the risk of NIV failure

<table>
<thead>
<tr>
<th>Absolute Contraindications</th>
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<tbody>
<tr>
<td>Severe facial deformity</td>
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<td>Facial burns</td>
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<tr>
<td>Fixed upper airway obstruction</td>
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</tbody>
</table>

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<tr>
<th>Relative Contraindications</th>
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<tbody>
<tr>
<td>pH &lt;7.15 (pH &lt;7.25 and additional adverse features)</td>
</tr>
<tr>
<td>GCS &lt;8 unless due to COPD hypercapnia</td>
</tr>
<tr>
<td>Confusion/agitation</td>
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<tr>
<td>Cognitive impairment (warrants enhanced observation)</td>
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</table>

Important Notes

NIV is not the treatment of choice for patients whose primary diagnosis is pneumonia or heart failure* but may be used in COPD patients with these conditions, if appropriate review concludes that the patient would not benefit from invasive mechanical ventilation.

Please document rationale for starting NIV if they do not fulfil the outlined criteria.

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**Approving committee:**

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Date of admission Time of admission
___/___/___ ____:___

Date of NIV assessment Time of NIV assessment
___/___/___ ____:___

THIS SECTION MUST BE COMPLETED AND SIGNED BY THE ADMITTING DOCTOR or BY A RESPIRATORY SPECIALIST BEFORE STARTING NIV ON LSU

### NIV on LSU Indication (tick box)

1. As a trial therapy, with appropriate review conclusion that the patient may derive benefit from invasive mechanical ventilation (IMV)*

2. As a ceiling of treatment, with appropriate review conclusion that the patient would not benefit from invasive mechanical ventilation (IMV)

### NIV on LSU Working Diagnosis (tick box)

1. Exacerbation COPD

2. Chest wall deformity/ Neuromuscular disease

3. Obesity hypoventilation syndromes/ decompensated obstructive sleep apnoea

* Ask for an early Critical Care review to assess suitability for escalated therapies if the patient may derive benefit from invasive ventilation (IMV) when starting NIV

- Does the patient meet the criteria for NIV on LSU? YES ☐ NO ☐
- If NIV fails; will intubatory ventilation be beneficial? YES ☐ NO ☐

Inform Critical Care within a maximum of 4 hours (or earlier if there is additional deterioration) if the patient is appropriate for escalated therapies including invasive mechanical ventilation (IMV) if there is a poor response to NIV.

Resuscitation Status must be clearly documented if a patient is started on NIV. Ensure the proforma is signed and that it has been discussed with family and patient where appropriate (consider capacity when patient is decompensated).

For CPR ☐ DNACPR ☐

Affix Patient Label
Consent

1. Does the patient and/or family consent to NIV?

YES ☐ NO ☐ BEST INTERESTS ☐

- *Be aware - patient may not have capacity to consent fully if in acute hypercapnic respiratory failure. Discuss with family to assess patient’s previous wishes.*

2. Has the plan of care including the possibility of escalation or withdrawal and/or palliation been discussed with the patient and/or family?

YES ☐ NO ☐

- *The patient should have a potential for recovery to a quality of life acceptable to the patient and the patient’s wishes should always be considered.*
- *Any variance to consent must be documented in case notes along with the reasons.*

Important Notes

- It is essential that the patient has a baseline ABG (within 1 hour of starting NIV), respiratory rate and heart rate documented on LSU ABG chart prior to starting.
- Times on NIV should be documented clearly (on rear of LSU ABG chart).
- All patients must have a plan of care documented in the medical case notes to include clear instructions on management and treatment if NIV fails.
- *The patient MUST be reviewed with an ABG at 1 hour and 4 hours (or earlier if clinical deterioration) by the clinician who started NIV (or proxy) to assess response to treatment and decide on further management.*

Name of medical officer (print): _____________________________________________

Signature: ____________________________

Grade and Bleep no: ____________________________

Date and time: ____________________________

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SET-UP:
- The decision to commence NIV should be made by a respiratory specialist or a doctor at specialty level ST 2 or above who is competent to do so
- A trained health care professional should initiate NIV
- The patient should be in a sitting or semi-recumbent position in bed
- Full face mask in the first 24 hours and then switch to nasal mask if preferred by the patient

Initial Pressure Settings

COPD/ OHS/ CWD a starting IPAP of 15 cm H₂O (20 IF pH <7.25) and an EPAP of 3-5 cm H₂O is recommended

*Up titrate IPAP over 10-30 min to an IPAP 20-30 (or max tolerated) to achieve adequate augmentation of chest/ abdominal movement and slow respiratory rate

IPAP should not exceed 30 or EPAP 8 without specialist respiratory expert review

NMD aim for an IPAP of 10 (or 5 above the normal setting if the patient has domiciliary NIV)

Back up rate
16-20 (set appropriate inspiratory time)

I:E ratio
COPD 1:2/ 1:3
OHS/ NMD/ CWD 1:1

Inspiratory time
COPD 0.8-1.2 sec
OHS/ NMD/ CWD 1.2-1.5 sec

NIV SETTINGS SHOULD BE OPTIMISED BEFORE INCREASING FiO₂

Use NIV as much as possible in the first 24 hours
Wean depending on tolerance and ABG over the next 48-72 hours

*COPD – Chronic Obstructive Airways Disease
OHS – Obesity Hypoventilation Syndromes
CWD – Chest Wall Deformity
NMD – Neuromuscular Disease

*See Appendix for more information
MONITORING:
- Continuous monitoring of oxygen saturation is essential
- Oxygen when required should be entrained into the circuit and flow adjusted to keep O₂ saturation usually around 88-92%
- ECG monitoring is advised for all patients with a tachycardia >120bpm, dysrhythmia or known cardiomyopathy
- Monitor:
  - Chest wall movement
  - Heart rate
  - Respiratory rate
  - Patient comfort
  - Level of consciousness
  - Ventilator synchrony
  - Accessory muscle use

- Ongoing clinical assessment of mask fit to include skin condition and degree of leak (particularly the corneas) should be performed

ARTERIAL BLOOD GAS TENSIONS or CAPILLARY SAMPLING
- Prior to starting NIV
- Must be done after 1 hour on NIV
- Repeat after 4 hours or earlier in patients who are not improving clinically
- Repeat ABG intermittently thereafter
- Consider twice daily (early morning and evening) for patients established on NIV

DURATION OF NIV TREATMENT
- Generally patients should be ventilated for as many hours as possible on NIV or as clinically indicated and can be tolerated in the first 24 hours
- Breaks from NIV should be made for administration of drugs/ nebuliser therapy/ physiotherapy/ meals, etc., but nasal oxygen must be continued to keep SaO₂ 88-92% or according to treatment plan
- If pH and RR are not improving after 4-6 hours on NIV with optimal pressures and maximal medical therapy, a decision to either:
  - Discontinue NIV if ceiling of care and re-focus on comfort and dignity in end of life care
  - Escalation to intubatory ventilation, if considered according to the documented treatment plan
  - May consider NIV as palliation
- Failure after 48hrs of NIV is unlikely to respond to further NIV, and intubatory ventilation should be offered if appropriate review concludes that the patient may derive benefit from it.

WEANING FROM NIV
- Weaning from NIV will be patient specific and based on clinical criteria and patient improvement
- After 24 hours if pH ≥ 7.35, the respiratory rate is normal and the patient is improving, begin weaning plan
- The following weaning process is recommended:
  - NIV use during the day can be tapered in the following 2–3 days, depending on pCO₂ self-ventilating, before being discontinued overnight
  - NIV can be discontinued when there has been normalisation of pH and pCO₂ and a general improvement in the patient’s condition
  - Long term nocturnal support may be needed in selected patients after assessment by respiratory expert
SPECIAL CONSIDERATIONS:

- NIV may cause gastric distension, if a nasogastric tube is required then a fine bore tube is preferred to minimize mask leakage
- Nebulised drugs should normally be administered during breaks from NIV but can be given via ventilator tubing if the patient is NIV dependent
- Avoid over tightening of mask to reduce the risk of nasal bridge ulceration

PALLIATION

- Patients receiving NIV as ‘ceiling of care’ who fail to improve decline further treatment, and would not derive benefit from intubatory ventilation, will need appropriate end of life (EOL) care and attention
- IF IMV is not intended should NIV fail then sedation/ anxiolytics are indicated for symptom control in the distressed or agitated patient
- Subcutaneous morphine 2.5–5 mg (± benzodiazepine) may provide symptom relief and may improve tolerance of NIV

References:

Appendix

Indications for NIV
- COPD: pH < 7.35, pCO2 > 6.5, RR > 23
- Neuromuscular disease: Respiratory illness with RR > 20 if usual VC < 1L even if pCO2 < 6.5 or pH < 7.35 and pCO2 > 6.5
- Obesity: pH < 7.35, pCO2 > 6.5, RR > 23 or Daytime pCO2 > 6.0 and somnolent
- NIV Not indicated: Asthma/Pneumonia
  - Refer to ICU for consideration of IMV if increasing respiratory rate/distress or pH < 7.35 and pCO2 > 6.5

Contraindications for NIV
- Absolute: Severe facial deformity, Facial burns, Fixed upper airway obstruction
- Relative: pH < 7.15 (pH < 7.25 and additional adverse feature), GCS < 8, Confusion/agitation, Cognitive impairment (warrants enhanced observation)

Indications for referral to ICU
- AHRF with impending respiratory arrest
- NIV failing to augment chest wall movement or reduce pCO2
- Inability to maintain Sao2 > 85-88% on NIV
- Need for IV sedation or adverse features indicating need for closer monitoring and/or possible difficult intubation as in OHS, DMD.

NIV Setup
- Mask: Full face mask (or own if home user of NIV)
- Initial Pressure settings: EPAP: 3 (or higher if OSA known/expected)
- IPAP in COPD/ OHS/KS: 15 (20 if pH < 7.25)
  - Up titrate IPAP over 10-30 mins to IPAP 20-30 to achieve adequate augmentation of chest/abdo movement and slow RR
  - IPAP should not exceed 30 or EPAP 8 without expert review
  - IPAP in NM: 10 (or 5 above usual setting)
- Backup rate: Backup Rate of 16-20. Set appropriate inspiratory time
- I:E ratio: COPD 1:2 to 1:3, OHS, NM & CWD 1:1
- Inspiratory time: 0.6-1.2s COPD, 1.2-1.5s OHS, NM & CWD
  - Use NIV for as much time as possible in 1st 24 hours. Taper depending on tolerance & ABGs over next 48-72 hours
  - SEEK AND TREAT REVERSIBLE CAUSES OF AHRF

NIV Monitoring
- Oxygenation: Aim 88-92% in all patients
  - Note: Home style ventilators CANNOT provide > 50% inspired oxygen.
  - If high oxygen need or rapid desaturation on disconnection from NIV consider IMV.

Red flags
- pH < 7.25 on optimal NIV
- RR persisting > 25
- New onset confusion or patient distress

Actions
- Check synchronisation, mask fit, exhalation port: give physiotherapy/bronchodilators, consider anxiolytic
- CONSIDER IMV

Possible need for EPAP > 8
- Severe OHS (BMI > 35), lung recruitment eg hypoxia in severe kyphoscoliosis, oppose intrinsic PEEP in severe airflow obstruction or to maintain adequate PS when high EPAP required

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