The Use of Non-Invasive Ventilation in the management of patients with chronic obstructive pulmonary disease admitted to hospital with acute type II respiratory failure (With particular reference to Bilevel positive pressure ventilation)

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Guideline Development Group

Prof Mike Roberts^ (Chair)	Consultant Respiratory and General Physician Barts and The London School of Medicine and Dentistry
Ms Katharine Young ^ (Project Manager)	Clinical Standards Facilitator, Clinical Standards Department, Royal College of Physicians
Dr Paul Plant*	Consultant Respiratory Physician Leeds Teaching Hospitals NHS Trust
Dr Louise Restrick,	Consultant Respiratory and General Physician Whittington Hospital NHS Trust
Dr Robert Winter+	Consultant in Intensive Care medicine Queen's Medical Centre, Nottingham Intensive Care Society
Dr Alistair Reinhardt	Consultant Respiratory and General Physician Whipps Cross University Hospital NHS Trust
Ms Christine Mikelsons	Consultant Respiratory Physiotherapist Royal Free Hospital NHS Trust
Dr Sunny Kaul*	SpR Respiratory & Intensive Care Medicine, St Georges Hospital NHS Trust, London
Dr Joanna Brown*	Consultant Respiratory and General Physician Imperial College Healthcare NHS Trust
Ms Katie Scales,	Consultant Nurse Critical Care Imperial College Healthcare NHS Trust
Karen Reid^	Information Scientist, Royal College of Physicians
* BTS Representative + Intensive Care Society Representative ^ RCP Representative	

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Contents

Appendices

Objective

The objective of the Guideline Development Group was to produce a contemporary guideline for the use of Non-Invasive Ventilation for acute type II respiratory failure in Chronic Obstructive Pulmonary Disease. Whilst there are a variety of ventilator units available most centres now use Bilevel Positive Airways Pressure units (BiPAP) and this guideline refers specifically to this form of ventilatory support although many of the principles encompassed are applicable to other forms of NIV. A concise summary version of this document is also available.[1]

[1] Royal College of Physicians, British Thoracic Society, Intensive Care Society *Chronic obstructive pulmonary disease: non-invasive ventilation with bi-phasic positive airways pressure in the management of patients with acute type 2 respiratory failure.* Concise Guidance to Good Practice series, No 11. London RCP, 2008. http://www.rcplondon.ac.uk/pubs/brochure.aspx?e=258

Methodology

These guidelines were overseen by a multi-professional Guideline Development Group (GDG) which included representatives from intensive care medicine, respiratory physiotherapy, specialist nursing, and respiratory medicine.

A literature search was carried out using the following databases: Medline, Embase, DARE (The Database of Abstracts of reviews of Effects) and The NHS Economic Evaluation database [both are part of the Cochrane library]. For the service provision questions the BNI, HMIC, and CINAHL databases were also searched.

The Information Centre at the Royal College of Physicians holds the search strategy, a database of the literature identified and the papers appraised. GDG members appraised the literature. All abstracts were reviewed. Abstracts were excluded if they related to letters, case reports, editorials.

The guidelines were prepared in accordance with the principles laid down by the AGREE Collaboration (Appraisal of Guidelines for Research and Evaluation). A summary of the guideline development process is given in Appendix i.

Grading of evidence during literature appraisal and grading of recommendations in the guidelines followed the principles used by the Scottish Intercollegiate Guideline Network (SIGN) as indicated in Appendix ii.

The GDG reviewed the evidence and recommendations. Much of the advice is based on expert opinion and practice because of the lack of other evidence. The draft update was circulated to a multi-professional expert panel for peer review. The GDG considered the comments of the expert panel and produced a final version.

Abbreviations used:

COPD	chronic obstructive pulmonary disease
BiPAP	bilevel positive airways pressure
EPAP	expiratory positive airways pressure
IPAP	inspiratory positive airways pressure
NIV	non-invasive ventilation
RCT	randomized control trial

Key

✓	Good practice point

Summary of Guidelines

The purpose of this guideline is to provide standards and practical advice to healthcare staff for the optimal delivery of a non-invasive ventilation service for hospitalized patients with COPD and acute type II respiratory failure. The guideline has been produced for the clinician caring for COPD patients in the emergency and ward areas of acute hospitals.

Service organization

- The service should be run by a named clinical lead with trained and experienced staff and a designated expert available to support the service on a 24/7 basis [C]
- The service should be provided by a cohort of staff with appropriate competencies, experience and skill in caring for respiratory patients [C]
- All staff should have initial training before a new service is introduced or extended to new clinical areas [C]
- A regular continuing training programme for all new staff involved in setting up and looking after patients on NIV should be in place with minimum competency assessments [C]
- Staff involved in the application of NIV should attend a locally organised annual refresher course [C]
- There should be a minimum staffing ratio of 1 nurse to 2 NIV patients for at least the first 24 hours of NIV [C]
- The NIV service should have a written local protocol stating the criteria for selection and treatment of patients and the local setting in which they should be treated [A]
- The criteria for the initiation of NIV in COPD exacerbations should be made available and known to all staff responsible for the care of such patients [C]
- Patient information on the use of NIV should be available to all admitted COPD patients [C]
- Patients with predictors for poorer outcome with NIV should be admitted to settings where early intubation may be facilitated [C]
- A written prescription for the use of acute NIV should be completed for each patient and compliance with NIV documented (hours of use, times on NIV) [C]
- A written plan which addresses how potential failure of NIV will be dealt with, whether escalation of care is indicated or whether NIV is the ceiling of treatment

and whether the patient is for resuscitation or specific palliative care measures should be recorded for each patient [C]

- Equipment should be cleaned and changed according to manufacturer and Infection Control guidelines [C]
- A system should be in place to enable traceability of equipment [C]
- An electrical safety check of NIV equipment should be performed by qualified personnel, once a year [C]
- The acute NIV service should be evaluated and audited annually [C]
- A prospective register of all patients receiving NIV should be part of a quality improvement cycle [C]

Selection of patients for NIV

- NIV should be considered for all COPD patients with a persisting respiratory acidosis after a maximum of one hour of standard medical therapy [A]
- Patients with a pH <7.26 may benefit from NIV but such patients have a higher risk of treatment failure and should be managed in a high dependency or ICU setting [A]
- Patients should be stratified into management groups depending on their pre-morbid state, reversibility of acute illness, relative contraindications to ventilatory support and the patient's wishes [C]

Set Up

- The decision to start NIV should be made by a doctor of ST level 2 or above, or other competent designated health care professional, locally agreed [C]
- Patient consent should be sought whenever a patient is able to provide consent [C]
- Set up should be performed by staff trained in set up of NIV [C]
- A full face mask should be used for the first 24 hours [C]
- Masks should be available in a range of sizes and designs [C]
- A low starting IPAP enhances patient compliance but should be quickly adjusted upwards to achieve therapeutic effect [C]
- Initial settings of IPAP 10cms H_2O titrated rapidly in 2-5 cms increments at a rate of approximately 5cms H_2O each 10 minutes with a usual pressure target of 20cms H_2O or until a therapeutic response is achieved or patient tolerability has been reached. EPAP 4-5cms H_2O is recommended [A]

- Oxygen when required should be entrained into the circuit and the flow adjusted to help achieve SpO2 of 88-92% [C]
- Bronchodilators should preferably be administered off NIV but may be administered on NIV and when so should be entrained between the expiration port and face mask. Delivery of both oxygen and nebulised solutions is affected by NIV pressure settings [B]
- If a naso-gastric tube is in place, a fine bore tube is preferred to minimize mask leakage [C]

Monitoring

- Monitoring should include a mixture of physiological measures and clinical assessment parameters [A]
- Monitoring should include continuous pulse oximetry and ECG monitoring for the first 12 hours and respiratory rate, pulse, blood pressure and assessments of consciousness regularly [B]
- Arterial blood gases should be taken as a minimum at 1, 4 and 12 hours after the initiation of NIV [A]
- These should be used to assist in both formulating a management plan and, within the first 4 hours of NIV, the decision as to the appropriateness of escalating to intubation [A]
- Compliance with NIV, patient-ventilator synchrony and mask comfort are key factors in determining outcome and should be checked regularly [C]
- Staff involved in the care and monitoring of NIV patients should be appropriately trained and experienced [B]

Escalation

- A management plan in the event of NIV failure should be made at the outset [C]
- When uncertainty exists or the patient is to be denied invasive mechanical ventilation then this should be discussed with the responsible consultant [C]
- If escalation is deemed appropriate this should be discussed at an early stage with the ICU team [C]
- A decision to proceed to invasive mechanical ventilation should normally be taken within 4 hours of initiation of NIV [A]
- Intubation where appropriate is the management of choice in late (>48hrs) NIV failures [B]

Treatment Duration

- Patients who benefit from NIV during the first hours of treatment should receive NIV for as long as possible during the first 24 hours [A]
- Treatment should last until the acute cause has resolved, commonly 2-3 days [C]
- In patients in whom NIV is successful (pH $\geq$7.35 achieved, resolution of underlying cause and symptoms, respiratory rate normalized) it is appropriate to start a weaning plan [C]

Weaning

- Treatment reduction should affect day time ventilation periods first [C].
- After withdrawal of ventilatory support in the day a further night of NIV is recommended [C]
- The weaning strategy should be documented in the nursing and medical records [C]

Palliation

- In cases where NIV has failed and a decision has been made not to escalate treatment a proactive approach to palliation should be adopted [C]

Introduction

Non-invasive ventilation in the management of acute type II respiratory failure in COPD patients represents one of the major technical advances in respiratory care over the last decade with a reduction in mortality of approximately 50% demonstrated in studies.[2] The only existing UK guideline document for the use of NIV was published in 2002.[3] Subsequently NICE recommended that NIV be available in all hospitals admitting patients with COPD.[4] There has since been a rapid expansion in the provision of NIV services with over 90% of UK admitting hospitals offering this intervention. The UK national audit of acute hospital COPD care in 2003 however suggested that treatment was often applied to patients outside the BTS inclusion criteria[5]. This document aims to update the 2002 guidance and to provide a specific focus on the use of NIV in COPD patients with acute type II respiratory failure with the intention of providing a quality framework within which NIV may be provided across the UK. The guideline has been produced for any clinician caring for COPD patients in the emergency and ward areas of acute hospitals.

[2] Ram FSF Picot J Lighthowler J et al. Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease. *Cochrane database of systematic reviews* 2004 issue 3.
[3] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211
[4] NICE Chronic Obstructive Pulmonary Disease: National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. *Thorax* 2004; 59 (Suppl 1)
[5] Price LC, Lowe D, Hosker HSR et al. National COPD Audit 2003: Impact of hospital resources and organisation of care on patient outcome following admission for acute COPD exacerbation. *Thorax*, 2006; 61: 837-42.

The Guidelines

1. Service Organisation

Setting for delivery of acute NIV for patients with exacerbations of COPD

NIV should be delivered in a dedicated setting[6] [IV] that could include an acute medical ward, accident and emergency, high dependency unit or a critical care area.[7] [IV] All patients with acute exacerbations of COPD requiring acute NIV should be treated in hospital and acute NIV should only take place in a setting where escalation to intubation and ventilation is available.✓ Delivery should be confined to a limited number of locations ✓ to ensure that all staff involved with NIV are exposed regularly to at least one patient a month to maintain skills.

Staffing for an acute NIV service for patients with exacerbations of COPD

The service should be run by a named clinical lead, who will usually be a respiratory consultant physician[8] and with staff who have been trained in its application, who are experienced in its use and who are aware of its limitations'.[9] [10] [IV] A designated expert should be available to support the service at all times. The staff group identified to set up NIV can be one or more of a range of health professionals including physiotherapists, nurses, respiratory physiologists, lung function technicians and doctors provided the staff group has the appropriate skills and experience.[11] [IV]

A regular continuing training programme for all new staff involved in setting up and looking after patients on NIV should be in place.✓ All staff should have initial training in setting up and looking after patients on NIV before the service is introduced [12] [13] [IV]

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[6] NICE Chronic Obstructive Pulmonary Disease: National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. *Thorax* 2004; 59 (Suppl 1)
[7] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211
[8] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211
[9] NICE Chronic Obstructive Pulmonary Disease: National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. *Thorax* 2004; 59 (Suppl 1)
[10] Joint Royal College of Physicians Training Board Higher Medical Training Curriculum for Sub Specialty Training in Acute Medicine 2003 http://www.jrcptb.org.uk/Specialty/Documents/Acute%20Medicine%20Curriculum.pdf page 6.
[11] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211
[12] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211

or extended to new clinical areas. Training should be updated annually.✓ Formal competency assessments are recommended to ensure that staff have the necessary skills (an example of a competency checklist is provided in appendix iii) Standards of nursing care are defined by the skills and experience of staff [14] and the ratio of patients to staff. [15] [1B] There should be a minimum staff ratio of 1 nurse to 2 NIV patients for the first 24 hours of NIV.✓

Protocol, guideline or care-pathway based care for provision of acute NIV

An acute NIV service should have a local protocol stating criteria for selection and treatment of patients [16] [17] [1B] and the local setting in which they should be treated (an example is given in appendix iv). The selection of patients should refer to national guidance and the inclusion criteria of randomised controlled trials (RCTs) with any local variation justified. Criteria for admitting patients to ward settings should take into account local expertise and resources.✓ More complex or sicker patients should be admitted to an HDU or ICU depending upon local circumstances.[18] [19][1B] Patients with predictors for poorer outcome with NIV should be admitted to settings where early intubation may be facilitated. These adverse predictors include more serious arterial

[13]Elliott MW, Confalonieri M, Nava S. Where to perform non-invasive ventilation. *European Respiratory Journal*; 2002;19: 1159-1166

[14] Bulow H.H, Thorsager B, Hoejberg JM. Experiences from introducing non-invasive ventilation in the intensive care unit: a 2 year prospective consecutive cohort study. *Acta Anaesthesiology Scandinavica*; 2007;51:165-170

[15] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935

[16] Caples SM, Gay PC. Noninvasive positive pressure ventilation in the intensive care unit: a concise review. *Critical Care Medicine*; 2005;2651-2658

[17] Sinuff T, Keenan SP. Clinical practice guideline for the use of non-invasive positive pressure ventilation in COPD patients with acute respiratory failure. *Journal of Critical Care Medicine*; 2004;19: 82-91

[18] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211)

[19] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935

blood gas abnormalities[20], high baseline heart rates,[21] lower levels of consciousness[22] and large volume secretions.[23] [1B]

A written prescription for the use of acute NIV should be completed for each patient and compliance with NIV documented ✓ (hours of use, times on NIV). (An example of a prescription chart is given in appendix v). Compliance and hours of use of NIV should be recorded for each patient.

A documented plan which addresses how potential failure of NIV will be dealt with should be recorded in writing.✓ This should include whether escalation of care is indicated or whether NIV is the ceiling of treatment and whether the patient is for resuscitation or specific palliative care measures.

Service Evaluation

The acute NIV service should be audited annually, including availability of non-invasive ventilators.[24] [IV] (An example of an audit proforma is given in appendix vi) ✓ The appropriate application of NIV and outcomes of treatment should be demonstrated and services reviewed and modified as appropriate based on local experience and measured against national guidelines. A prospective register of all patients receiving NIV should be part of a quality improvement cycle.

[20] Stuart M, Weinrich M. Integrated health system for chronic disease management: lessons learned from France. *Chest*; 2004;125: 695-703
[21] Elliott MW, Confalonieri M, Nava S. Where to perform non-invasive ventilation. *European Respiratory Journal*; 2002;19: 1159-1166
[22] Sinuff T, Keenan SP. Clinical practice guideline for the use of non-invasive positive pressure ventilation in COPD patients with acute respiratory failure. *Journal of Critical Care Medicine*; 2004;19: 82-91
[23] Caples SM, Gay PC. Noninvasive positive pressure ventilation in the intensive care unit: a concise review. *Critical Care Medicine*; 2005;2651-2658
[24] British Thoracic Society Standards of Care Committee (2002) BTS Guideline: Non-invasive ventilation in acute respiratory failure. *Thorax*; 57: 192-211

2. Selecting patients suitable for NIV

NIV, within both the ICU and the ward environment, has been shown in RCTs and systematic reviews [25] [26] [27] [28] [29] [30] [31] [32] [33] [1A] to reduce intubation rate and mortality in COPD patients with decompensated respiratory acidosis (pH<7.35 and PaCO2 >6kPa) following immediate medical therapy. Ward studies have also shown a reduction in the need for ICU and reduced hospital costs compared to standard medical therapy. Mortality rates are reduced by approximately 50% (Mortality Relative Risk 0.52; 95% CI 0.35 to 0.76)[34], equating in usual clinical practice for a need to treat approximately 10 patients to save one life.

NIV should be considered in all patients with an acute exacerbation of COPD in whom a respiratory acidosis ($PaCO_2$>6kPa, pH <7.35 ≥7.26) persists despite immediate maximum standard medical treatment on controlled oxygen therapy for no more than one hour. There is some RCT evidence for the efficacy of NIV in COPD patients who are more acidotic [35] [1B] however such patients have higher rates of NIV treatment failure and intubation. COPD patients with pH <7.26 managed with NIV require more intensive monitoring with a lower threshold for intubation and should be treated within an HDU or ICU setting according to local protocol.

- Standard medical therapy should include:
  - Controlled oxygen to maintain SaO_2 88-92%
  - Nebulised salbutamol 2.5-5mg
  - Nebulised ipratroprium 500µg

[25] Kramer N, Meyer TJ, Meharg J, et al. Randomized, prospective trial of noninvasive positive pressure ventilation in acute respiratory failure. *Am J Respir Crit Care Med* 1995;151:1799–806
[26] Brochard L, Mancebo J, Wysocki M, et al. Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. *N Engl J Med* 1995;333:817–22
[27] Celikel T, Sungur M, Ceyhan B, et al. Comparison of noninvasive positive pressure ventilation with standard medical therapy in hypercapnic acute respiratory failure. *Chest* 1998;114:1636–42.
[28] Martin TJ, Hovis JD, Costantino JP, et al. A randomized prospective evaluation of noninvasive ventilation for acute respiratory failure. *Am J Respir Crit Care Med* 2000; 161: 807-813
[29] Bott J, Carroll MP, Conway JH, et al. Randomised controlled trial of nasal ventilation in acute ventilatory failure due to chronic obstructive airways disease. *Lancet* 1993;341:1555–7
[30] Plant PK, Owen JL 2000
[31] Peter, JV, Moran, JL, Phillips-Hughes, J, et al. Noninvasive ventilation in acute respiratory failure: a meta-analysis update. *Crit Care Med* 2002;30,555-562
[32] Lighthowler JV, Wedzicha JA, Elliot MW 2003
[33] Honrubia, T, Garcia Lopez, FJ, Franco, N, et al. Noninvasive vs conventional mechanical ventilation in acute respiratory failure: a multicenter, randomized controlled trial. *Chest* 2005;128,3916-3924
[34] Ram FSF Picot J Lighthowler J et al. Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease. *Cochrane database of systematic reviews* 2004 issue 3.
[35] Conti G, Antonelli M, Navalesi P,et al. Noninvasive vs. conventional mechanical ventilation in patients with chronic obstructive pulmonary disease after failure of medical treatment in the ward: a randomized trial. *Intensive Care Med.* 2002 Dec;28(12):1701-7

- Prednisolone 30mg
- Antibiotic agent (when indicated)
- All given within the first hour

- Patients should be stratified into 5 groups based on their pre-morbid state, the severity of the physiological disturbance, the reversibility of the acute illness, the presence of relative contraindications (see below) and where possible the patient's wishes.✓ The stratification should be recorded in the medical notes.

1) Requiring immediate intubation and ventilation
2) Suitable for NIV and suitable for escalation to intensive care treatment / intubation and ventilation if required
3) Suitable for NIV but not suitable for escalation to intensive care treatment/ intubation and ventilation
4) Not suitable for NIV but for full active medical management
5) Palliative care agreed as most appropriate management

Inclusion Criteria for NIV

Clinical criteria

- Sick but not moribund
- *Able to protect airway
- *Conscious and cooperative
- No excessive respiratory secretions
- Potential for recovery to quality of life acceptable to the patient
- Patient's wishes considered

*Consider NIV if unconscious and endo-tracheal intubation deemed inappropriate or NIV is to be provided in a critical care setting. There are data [36] [1B] to support the use of NIV in patients who are in a state of coma secondary to hypercapnoea and who respond rapidly to this treatment

Exclusion criteria for NIV

- facial burns/trauma/recent facial or upper airway surgery
- vomiting
- fixed upper airway obstruction

[36] Diaz GG, Alcaraz AC, Talavera JC, et al. Noninvasive positive-pressure ventilation to treat hypercapnic coma secondary to respiratory failure. *Chest* 2005;127:952–60

- undrained pneumothorax
- upper gastrointestinal surgery
- inability to protect the airway
- copious respiratory secretions
- life threatening hypoxaemia
- haemodynamically unstable requiring inotropes/pressors (unless in a critical care unit)
- severe co-morbidity
- confusion/agitation
- bowel obstruction
- patient declines treatment

NIV is not the treatment of choice for patients in heart failure or who have radiological consolidation but is sometimes used if escalation to intubation and ventilation is deemed inappropriate. [37] [38] [IIA]

[37] Conti G, Antonelli M, Navalesi P,et al. Noninvasive vs. conventional mechanical ventilation in patients with chronic obstructive pulmonary disease after failure of medical treatment in the ward: a randomized trial. *Intensive Care Med.* 2002 Dec;28(12):1701-7

[38] Honrubia, T, Garcia Lopez, FJ, Franco, N, et al. Noninvasive vs conventional mechanical ventilation in acute respiratory failure: a multicenter, randomized controlled trial. *Chest* 2005;128,3916-3924

3. Set up

The decision to commence NIV should be made by a doctor of ST level 2 or above or other competent designated health care professional, locally agreed.✓ The initiation of NIV should only be performed by a health care professional trained and competent in the set up of NIV**.** All patients established on NIV should be reviewed as soon as is practicable by the most senior responsible doctor within the hospital.✓ If this is a non-respiratory specialist then the patient should also be referred for review by a respiratory specialist at the first available opportunity. The patient's consent should be sought wherever possible.[39][IV] This process should include an explanation of the treatment rationale, how it may help the patient, the consequences of not receiving this treatment and other therapeutic options available including palliation. The routine provision of information about NIV to COPD patients when encountered in a stable clinical state is desired by patients.[40][III] and facilitates this process. It may also be an invaluable tool during an admission when NIV therapy is proposed to assist patients in decision making or where they are too ill to consider such information their carers in understanding the treatment offered. An example of an explanatory leaflet is provided in supplementary document i.

A standard set up guide may be used (An example is given in appendix vii).✓ The patient should be in a sitting leaning forward, or semi-recumbent position when started on NIV. A full-face mask is recommended for most patients for the first 24 hours followed by switch to a nasal mask for patient comfort when requested. A range of designs and sizes of mask should be available. A range of non-invasive ventilators for ward use are also available. Choice should balance complexity of machine with number and skills of staff who will be using the machines. Selecting a single design for use outside of the ICU setting is recommended. Patients should not be denied non-invasive ward ventilation because of non-availability of a ventilator and battery operated ventilator should be available for transfer of patients between units.

Initial inspiratory positive airway pressure (IPAP) of 10cms H2O and expiratory positive airway pressure (EPAP) of 4-5cms H2O are recommended. These settings are well

[39] GMC 2008 GMC Consent patients and Doctors making decisions together. http://www.gmc-uk.org/guidance/ethical_guidance/consent_guidance/index.asp

[40] Roberts CM, Seiger A, Ingham J. patients views on 3 key service areas within hospital COPD care. Health Educ J 2008 in press.

tolerated by a wide range of patients.[41] [1A] They allow acclimatization of the patient to the machine but may not significantly improve gas exchange, in which case the IPAP can be gradually increased by 2-5cm increments at a rate of approximately 5 cms H2Oeach 10 minutes until a therapeutic response is achieved or patient tolerability has been reached. Increases in IPAP should continue every few minutes until a therapeutic response has been achieved. Referral guidelines may be used to guide non-specialists (see appendix IV a).✓ The therapeutic IPAP for many patients is 20cms H2O. A 4-5cms EPAP setting reduces CO2 re-breathing and assists triggering of the ventilator when using BiPAP. Further increases in EPAP are not recommended without obtaining expert advice.✓

Oxygen should be entrained into the circuit at the same setting of litres/minute as was used through venturi mask prior to starting NIV and then adjusted to maintain the target saturation, usually 88 - 92%. Oxygen entrained into the mask produces lower oxygen concentrations delivered to the patient.[42] [43] [1B]

Bronchodilators should preferably be administered off NIV but may be administered on NIV and when so should be entrained between the expiration port and the face mask. Delivery of both oxygen and nebulised solutions is affected by NIV pressure settings.[44] [45] [1B]

Non-invasive ventilation can be used with a naso-gastric tube in place, in which case this should be a fine bore tube to minimise mask leakage. It is not necessary to place a naso-gastric tube simply because a patient is to receive NIV.

Equipment should be cleaned according to manufacturer and Infection Control guidelines. A bacterial filter must be attached to the ventilator outlet port. This should be changed between patients and at regular intervals according to the manufacturers'

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[41] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935

[42] Thys F, Liistro G, Dozin O et al. Determinants of FiO2 with oxygen supplemenetation during non-invasive two-level positive pressure. *Eur Respir J* 2002

[43] Schwartz AR, Kacmarek RM, Hess DR. factors affecting oxygen delivery with bi-level positive airways pressure. *Respir Care* 2004 49(3):270-5)

[44] Chatmongkolchart S, Schettino G, Dillman C et al. In vitro evaluation of aerosolized bronchodilator delivery during non-invasive positive pressure ventilation: effect of ventilator settings and nebulizer position. *Crit care Med* 2002;30(11):2515-9

[45] Calvert LD, Kackson JM, White JA et al. Enhanced delivery of nebulized salbutamol during non-invasive ventilation. *J Pharm Pharmacol* 2006;58(11):1553-7

recommendations. The filters in the machine's air entrainment mechanism should be changed when visibly dirty and between patients. Single patient use items should not be reused and should be disposed of appropriately. A system should be in place to enable traceability of equipment e.g. in the event of product failure to enable recall of equipment.✓

4. Monitoring of patients with acute respiratory failure managed with NIV

The main outcome measures from RCTs associated with success or failure of NIV are: ABG and specifically pH and $PaCO_2$ at 1, 4 and 12 hours, respiratory rate at 1 hour and heart rate at 1 hour.[46] [47] [1A] Other measurements included in RCTs include clinical assessment of level of consciousness (Glasgow coma scale [GCS] or alert, verbalising, responds to pain only, unresponsive scale [AVPU]), chest wall movement and use of accessory muscles.[48] [49] [50] [51] [52] [53] [1B] It is recommended that during the first 12 hours patients should have continuous pulse oximetry and cardiac monitoring.[54] [IIB]

Frequent clinical monitoring of acutely ill patients is recommended every 15 minutes in the first hour; every 30 minutes in the 1-4 hour period and hourly in the 4-12 hour period.[55] [IIB] Physiological parameters associated with outcomes from the RCTs (RR, HR, level of consciousness, chest wall movement, ventilator synchrony, accessory muscle use, patient comfort, and SpO_2) should be recorded and be used to formulate an iterative management plan. The use of a proforma to chart these indices has been shown to improve successful weaning from NIV on a respiratory ward in a district general hospital.l[56] [IIB]

Patient comfort and therefore enhanced compliance are key factors in determining outcome. Synchrony of ventilation should be checked frequently.✓ A clinical

[46] Lightowler JV, Wedzicha JA, Elliott MW et al. Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ* 2003; 326: 185-187
[47] Ram FSF Picot J Lighthowler J et al. Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease. *Cochrane database of systematic reviews* 2004 issue 3.
[48] Barreiro BT, Gemmel DJ. Noninvasive ventilation. *Crit Care Clin* 2007;23:201-222
[49] Ucgun I, Metintas M, Moral H et al. Predictors of hospital outcome and intubation in COPD patients admitted to the respiratory ICU for acute hypercapnic respiratory failure. *Respir Med* 2006; 100: 66-74.
[50] Phua J, Kong K, Lee KH et al. Non-invasive ventilation in hypercapnic acute respiratory failure due to chronic obstructive pulmonary disease versus other conditions: effectiveness and predictors of failure. *In Care Med* 2005; 31: 533-9
[51] Paus JES, Reid JK, Cockcroft DW et al. The use of non-invasive ventilation in acute respiratory failure at a tertiary care center. *Chest* 2004; 126: 165-172
[52] Robino C, Faisy C, Diehl J-L et al. Effectiveness of non-invasive positive pressure ventilation differs between decompensated chronic restrictive and obstructive pulmonary disease patients. *In Care Med* 2003; 29: 603-10.
[53] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935
[5454] Robino C, Faisy C, Diehl J-L et al. Effectiveness of non-invasive positive pressure ventilation differs between decompensated chronic restrictive and obstructive pulmonary disease patients. *In Care Med* 2003; 29: 603-10.
[55] Robino C, Faisy C, Diehl J-L et al. 2005)
[56] Lane A**,** Wood M, Murray P et al**.** The use of a noninvasive ventilation (NIV) proforma improves successful weaning from NIV on a respiratory ward. *Thorax* 2007;62, suppl iii:A91

assessment of mask fit to include skin condition and degree of leak (particularly onto the corneas) should be performed at the same time [57] [58][IB]. If there are difficulties in patient compliance then a number of common problems should be sought (see as an example the trouble shooting guide appendix viii)

An ABG should be measured after 1 hour of NIV therapy and one hour after every further change in settings. As a standard ABG should be taken and used to assist in the management plan at 4 hours or earlier if judged clinically necessary and again at 12 hours unless the clinical improvement in the patient obviates the need for further ABG analysis.

[57] Barreiro BT, Gemmel DJ. Noninvasive ventilation. *Crit Care Clin* 2007;23:201-222.
[58] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935

5. Escalation

A documented plan which addresses how potential failure of NIV will be dealt with should be recorded in writing at the outset.✓ This should include whether escalation of care is indicated or whether NIV is the ceiling of treatment and whether the patient is for resuscitation or specific palliative care measures.

There is evidence that a decision to proceed to intubation and ventilation ought to be made within the first 4 hours of treatment and studies have examined outcome measures that predict failure of NIV.[59] [60] [1A]

Intubation should also be considered in patients suffering 'late failure' (defined as failure after 48 hours of non-invasive ventilation). Intubation is associated with lower mortality than continued non-invasive ventilation [61] [IIB] in this patient group.

The appropriateness for escalation to invasive mechanical ventilation should be assessed and recorded at the initiation of NIV. When uncertainty exists or the patient is to be denied intubation and ventilation then this should be discussed with the consultant clinically responsible for the patient. If a patient is deemed suitable for intubation and ventilation if NIV fails and subsequent progress is unsatisfactory then early discussion should take place with the ICU team regarding next steps in the escalation of management.

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[59] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935

[60] Elliott MW, Confalonieri M, Nava S. Where to perform non-invasive ventilation. *European Respiratory Journal*; 2002;19: 1159-1166

[61] Moretti M, Cilione C, Tampieri A et al. Incidence and causes of non-invasive mechanical ventilation failure after initial success. *Thorax* 2001; 55: 819-825

Treatment options should be where possible discussed with the patient and he/she has the right to make their own decision regarding treatment unless it can be proved that he/she does *not* have capacity to do so.[62] [63] [IV]

Alternatives to non-invasive ventilation, including palliative care, should be proactively implemented for patients where a decision has been made not to escalate to intubation. Such a decision should, where possible, be discussed with the patient or their representative and their views taken into account in the decision making process. [64] [IV]

[62] Mental Capacity act 2005 affects England, Wales (2007) N Ireland (with amendments) www.opsi.gov.uk/ACTS/acts2005/ukpga_20050009_en_1 and Scotland Adults with incapacity act 2000. [Separate but similar legislation for other home countries]
[63] GMC Consent patients and Doctors making decisions together. http://www.gmc-uk.org/guidance/ethical_guidance/consent_guidance/index.asp
[64] GMC Consent patients and Doctors making decisions together. http://www.gmc-uk.org/guidance/ethical_guidance/consent_guidance/index.asp

6. Treatment Duration and Weaning from Ventilation

Treatment duration

Patients who appear to benefit from NIV during the first few hours of treatment should receive NIV for as long as possible (minimum of 6 hours) with appropriate breaks for oral intake, nebulisers etc, during the first 24 hours. [65] [66] [67] [68] [69] [1A] Attention should be paid to skin care on the bridge of the nose during this period.✓ In patients in whom NIV is successful (pH≥ 7.35 achieved, resolution of underlying cause and symptoms, respiratory rate normalised) following an appropriate duration of treatment, it is appropriate to start a weaning plan. Gradual reduction of the duration of NIV should be determined by clinical improvement. ✓

Recommendations

Weaning

Initially weaning should be during the day with extended periods off the ventilator for meals, physiotherapy, nebulised therapy etc. After successfully weaning during the day, most patients will require an additional night on NIV. The definitive UK clinical study[70] [1B] was based upon a 4 day weaning period and a proposed weaning strategy is to continue NIV for 16 hours (including 6-8 hours overnight) on day 2, and 12 hours on day 3 (including 6-8 hours overnight). NIV may be discontinued on day 4 unless continuation is clinically indicated, for example, two hours in the morning, two hours in the afternoon and six hours or more overnight. Some patients make a rapid recovery and shorter weaning periods of 2-3 days are commonly indicated clinically. Other patients may self determine at an earlier stage that they no longer require NIV and self-

[65] Kramer N, Meyer TJ, Meharg J, et al.1995
[66] Brochard L, Mancebo J, Wysocki M, et al. Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. *N Engl J Med* 1995;333:817–22.
[67] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935
[68] Bott J, Carroll MP, Conway JH, et al. Randomised controlled trial of nasal ventilation in acute ventilatory failure due to chronic obstructive airways disease. *Lancet* 1993;341:1555–7
[69] Celikel T, Sungur M, Ceyhan B, et al. Comparison of noninvasive positive pressure ventilation with standard medical therapy in hypercapnic acute respiratory failure. *Chest* 1998;114:1636–42
[70] Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*; 2000;355: 1931-1935

wean. The weaning strategy should be documented in the medical and nursing records. ✓

Long-term nocturnal support may be indicated in selected patients following assessment by the respiratory team. Patients who initially appear to be responding to NIV but deteriorate again after 48 hours of NIV rarely do well if they continue to be managed with NIV and should be considered for invasive ventilation.[71] [IIB]

[71] Moretti M, Cilione C, Tampieri A et al. Incidence and causes of non-invasive mechanical ventilation failure after initial success. *Thorax* 2001; 55: 819-825.

7. Palliation

Palliation of symptoms is appropriate in patients in whom standard medical treatment and NIV fails or where patients have chosen not to receive this treatment and where a decision has been made and documented not to escalate to intubation and mechanical ventilation. Exceptionally continued NIV may be appropriate for palliation of breathlessness where this is agreed with the patient but in the majority it should be withdrawn. Opioids and benzodiazepines can be used to treat breathlessness in this situation. Consider the use of a pathway such as the Liverpool Care of the Dying Pathway with early involvement of the palliative care team. Initiation of palliative care pathways should where possible include appropriate discussion with the patient and family.✓

Appendix i. Guideline development process

These guidelines have been developed in accordance with the principles laid down by the AGREE collaboration (Appraisal of Guidelines for Research and Evaluation).

Scope and purpose

The scope	
Overall objectives of the guidelines	The objective of the Guideline Development Group was to partially update the British Thoracic Society (BTS) guideline for 'Non-invasive ventilation in acute respiratory failure', focusing on the use of Non-invasive ventilation (NIV) in acute respiratory failure secondary to COPD.
The patient group covered	Individuals requiring non-invasive ventilation in acute respiratory failure secondary to COPD
Target audience	Respiratory physicians, Emergency Medicine physicians, nurses with a special interest, physiotherapists with a special interest, junior medical staff, intensive care/ intensivists, general physicians, acute medicine physicians
Clinical areas/questions covered (all relate only to patients with exacerbations of COPD with acute type II respiratory failure)	• Service organisation • Selecting the patients suitable for NIV • Set up of NIV • Monitoring of patients managed with NIV • Escalation • Treatment duration and weaning

Stakeholder involvement

The Guideline Development Group (GDG)	A multidisciplinary group comprising: healthcare professionals: consultants in respiratory medicine and intensive care, nurse specialists, physiotherapy specialists. User representation through the British Lung Foundation.
Funding	This guideline was commissioned and edited without external funding being sought.
Conflicts of Interest	No external funding has been sought or obtained. All authors and group members have declared, and provided details, on any actual or potential conflicts of interest.

Rigour of Development

Evidence gathering	A literature search was carried out using the following databases: Medline, Embase, DARE (The Database of Abstracts of reviews of Effects) and The NHS Economic Evaluation database [both are part of the Cochrane library.] For the service provision questions, the BNI, HMIC, and CINAHL databases were also searched. Conference proceedings and other guidelines from 1988 were included.

	Articles not published in English were excluded. Much of the advice is based on expert opinion and practice because of a lack of other evidence. The search strategy may be obtained by contacting the RCP Information Centre.
Links between evidence and recommendations	The system used to grade the evidence and guidance recommendations is adapted from that published by the Scottish Intercollegiate Guidelines Network.
Piloting and peer review	The final draft was widely circulated to a multi-disciplinary panel and all relevant societies for peer review, this included: : Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Association of Respiratory Nurse Specialists (ARNS) British Association/ College of Occupational Therapists British Thoracic Society • BTS Standards of Care Committee • BTS Registrars group College of Emergency Medicine Intensive Care Society Royal College of Nursing All comments received were considered and incorporated.

Implementation

Methods of implementation	Concise Guideline available on the Royal College of Physicians website (free access): *http://www.rcplondon.ac.uk/pubs/brochure.aspx?e=258* The appendices a draft proforma and standards for auditing against these guidelines etc.
Barriers to implementation	Potential barriers to the successful implementation of these guidelines may be: • Failure of clinical acceptance of guidelines • Service resource limitations
Plan for review	Review is planned for 4 years time (2012).

Appendix ii. Grading system from the Scottish Intercollegiate Guideline (SIGN) methodology

Level of evidence	Type of evidence	Grade of recommendation
Ia	Meta-analysis of randomised controlled trials (RCTs)	A
Ib	At least one RCT	A
IIa	At least one well-designed controlled study, but without randomisation	B
IIb	At least one well-designed quasi-experimental design	B
III	At least one non-experimental descriptive study (eg comparative, correlation or case study	C
IV	Expert committee reports, opinions and/or experience of respected authorities	C

✓	Good practice point

Appendix iii. Example of an NIV Competency checklist

The practitioner must be able to:

1. Identify appropriate patients for NIV and explain the basic physiology behind their decision.
2. Identify the contraindications for the above.
3. Correctly assemble and prepare the equipment
4. Provide an explanation to the patient.
5. Demonstrate the ability to commence the treatment (on a patient) and explain their rationale for doing do.
6. Explain and implement the safety measures required
7. Accurately record the treatment of the patient, the changes in the patients' condition and maintain appropriate documentation throughout the patients' treatment.
8. Demonstrate the ability to assess for and understand the signs of success or not of the treatment and explain their subsequent actions e.g. settings, changes and rationale for doing do.
9. List the potential complications and limitations of NIV therapy.

Date	Demonstrated	Not yet demonstrated	Assessors comments	Assessors signature

Appendix iv: Example of a Protocol for selection of patients and local setting

XXX Trust Logo

Policy for the use of non-invasive ventilation (NIV) in adult COPD patients, including continuous positive airways pressure (CPAP) and bilevel positive airways pressure (BiPAP)

Policy No:	
Version No:	
Authorisation:	
Date of authorisation:	
Date of issue:	
Review date:	
Produced by:	

Table of Contents

Non-invasive ventilation (NIV) –Use of CPAP and BiPAP

Introduction

Non invasive ventilation (NIV) is the 'the provision of ventilatory support through the patient's upper airway using a mask or similar device' (RCP/BTS/ICS 2008). This may be

- Continuous positive airways pressure (CPAP) or
- Bilevel positive airways pressure (BiPAP)

These treatments may be used as the sole treatment, a holding measure, a trial prior to intubation or the ceiling of treatment (BTS 2002) with the aim to produce:

- Decreased work of breathing
- Increased tidal volume
- Decreased respiratory rate

CPAP is indicated for patients with acute hypoxaemic respiratory failure or cardiogenic pulmonary oedema, whereas BiPAP is indicated in the ward environment for acute hypercapnic respiratory failure but can be used in specialist areas such as the intensive care unit (ICU) for other indications such as weaning from invasive ventilation. NIV is generally contra-indicated in patients with asthma and those patients who do not respond early in treatment.

NIV has been used to support patient care both in critical care areas (A & E; ICU and HDU) and the ward areas for a considerable period of time. Recently there has been an increase in the use of NIV in the ward areas as the evidence for this therapy increases and the ward patient population becomes more acute. For example the National Institute for Clinical Excellence (NICE) guidance for the management of chronic obstructive pulmonary disease (COPD) (2004) recommends the use of NIV in acute exacerbations of COPD. This policy identifies the expected standard of care required for patients receiving NIV and identifies minimum standards for:

- Patient management
- Knowledge and skills
- Equipment
- Documentation

Patient management

2.1 Patients should be referred to the respiratory team for NIV once identified as suitable using the NIV guidelines (Appendix IV.a)

2.3 BiPAP should be initiated following the algorithm in Appendix IV.b

2.4 In pulmonary oedema secondary to acute left ventricular failure CPAP is the treatment of choice and should be initiated as per the algorithm in the local protocol for CPAP document

2.5 Care of patients requiring NIV should be limited to the adult intensive care units, Emergency Medicine Resus, Respiratory ward, Medical admission ward . These areas must ensure that adequate staff are trained and for accredited staff to be available at all times.

2.6 Transfer from A& E to an appropriate ward may be delayed due to the patient requiring extended treatment in A & E Resus or a delay in providing a bed as in 2.4 above. In this case the patient will be classed as a clinical breach.

Equipment

3.1 Non-specialist NIV equipment is stored in the equipment library and is maintained and managed by Medical Physics. Two BiPAP machines will be located in A & E Resus to ensure immediate availability.

3.2 Consumables are to be purchased by each ward separately via NHS supplies (appendix IV.c).

3.3 NIV equipment purchases should be agreed by all clinical teams involved in NIV management to reduce error produced by unfamiliarity with equipment and purchased corporately.

Knowledge and skills

All staff caring for a patient requiring NIV must be deemed competent in the use of NIV before caring for a patient; a suggested competency document is attached (see appropriate document not given here).

An NIV study day will be run to meet the needs of staff caring for these patients.

Documentation

5.1 The NIV prescription chart is used for all patients receiving NIV outside the adult intensive care units and used in conjunction with the early warning score (EWS)

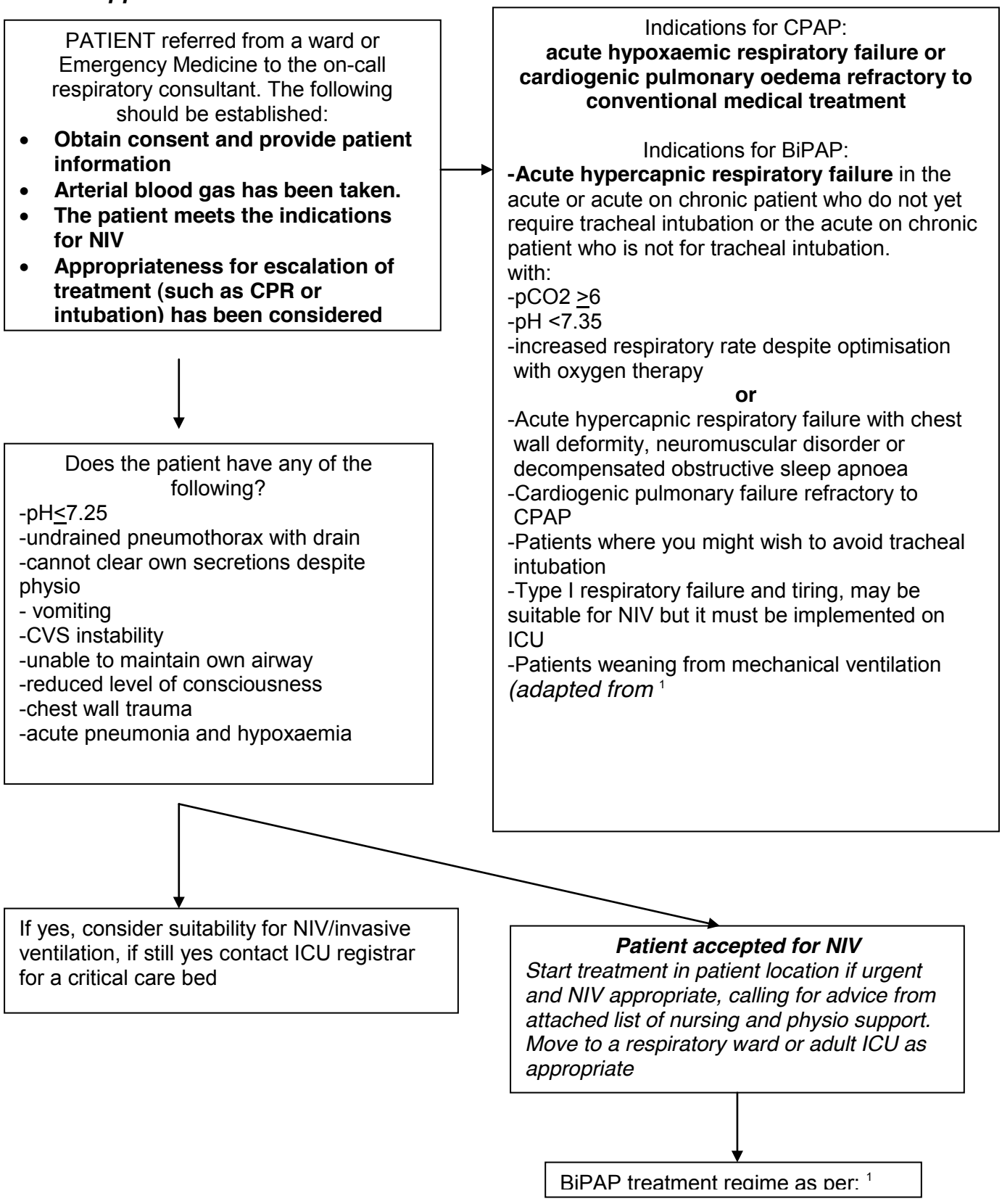
5.2 Documentation of limitations on treatment, weaning regime, further treatment proposals, response to treatment and indications for treatment following NIV guidance, are clearly documented in the patients' notes.

References

6.1 Baudouin, S; Blumenthal, S; Cooper, B; Davidson, C; Davison, A; Elliot,M; Kinnear, W (Chairman); Paton, R; Sawicka, E; Turner , L(Secretary) Non-invasive ventilation in acute respiratory failure British Thoracic Society Standards of Care Committee Thorax 2002 57:192-211

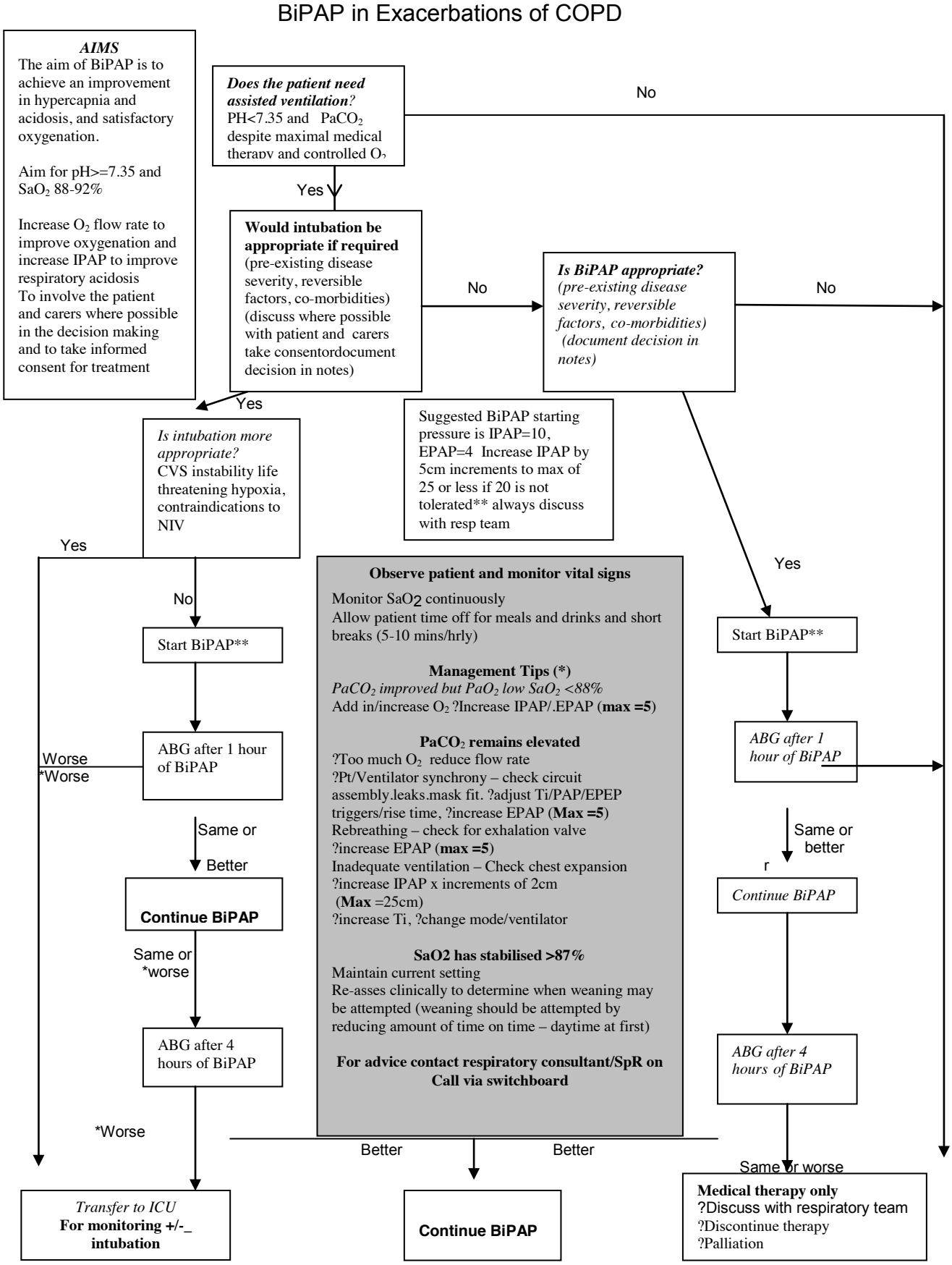
6.2 Royal College of Physicians, British Thoracic Society, Intensive Care Society *Chronic obstructive pulmonary disease: non-invasive ventilation with bi-phasic positive airways pressure in the management of patients with acute type 2 respiratory failure.* Concise Guidance to Good Practice series, No 11. London RCP, 2008.

Appendix IV.a – NIV Referral Guidelines



[1] Royal College of Physicians, British Thoracic Society, Intensive Care Society *Chronic obstructive pulmonary disease: non-invasive ventilation with bi-phasic positive airways pressure in the management of patients with acute type 2 respiratory failure.* Concise Guidance to Good Practice series, No 11. London RCP, 2008. http://www.rcplondon.ac.uk/pubs/brochure.aspx?e=258

Appendix IV.b – Initiating BiPAP Therapy



The use of BiPAP should always be discussed with the on call respiratory consultant or SpR

** Pressures do need to be individualised and expert advice should be sought. IPAP may need to be >20

Appendix IV.c – Ordering Information

BiPAP Spares:

Please note each BiPAP loaned from the library will come with a bacterial filter and an oxygen entrainment valve ready for the tubing to be attached
All other spares are to be purchased via NHS supplies top-up

Note: bacterial filter should be changed every 24 hours on the BIPAP units

Supplier	Description	Supplier Code	Catalogue Code	Price
	Breathing circuit for BIPAP without pressure line (box of 30)			
	small full face mask + headstrap (each)			
	medium full face mask + headstrap (each)			
	large full face mask + headstrap (each)			
	Petite nasal mask + headstrap (pack of 5)			
	Small nasal mask + headstrap (pack of 5)			
	Medium/large nasal mask + headstrap (pack of 5)			
	Bacterial filter (box of 100)			

Appendix v: NIV Prescription Chart

NON-INVASIVE VENTILATION (NIV) PRESCRIPTION CHART

Patient Name: …… **Hospital Number:** ……

Date of Birth: …… **Diagnosis**: ……

NIV Prescription Checklist

Does the patient have capacity to provide consent for this procedure? (Refer to Mental Capacity Act 2005 and Codes of Practice) If YES the patient should provide consent If NO patient should be treated according to 'best interests' If patient has capacity to consent, has consent been provided? If NO treatment should not be provided	YES YES	NO NO
Is there a respiratory acidosis (i.e. pH<7.35, $PaCO_2$>6) despite best medical therapy?	YES	NO
Has the patient been discussed with the on-call SpR/StR/ Physician? If YES with whom? . . . . . . If NO to above and patient is to remain under GIM care or is to be admitted under GIM from Emergency Medicine, admitting GIM team to contact the l respiratory team (as soon as they have taken over the patient's care) and sign to that effect Time Respiratory Team Contacted: …… Signature of GIM on-call doctor: ……	YES	NO
Has a decision been made and documented about escalation of treatment if NIV fails?	YES	NO
If the patient is a candidate for intubation, have they been discussed with the on-call ICU registrar/consultant? If Yes with whom?.....	YES	NO/ NA

NIV PRESCRIPTION AND CHANGES TO SETTINGS

DATE	TIME	IPAP/TV*	PEEP/ EPAP	O_2 on NIV	O_2 off NIV	Recommended NIV usage	Name & Signature

DATE/TIME																		
PH																		
$PaCO_2$																		
PaO_2																		
HCO_3																		
Base Excess																		
FiO_2																		
SpO_2																		
IPAP/EPAPor TV/PEEP* settings																		
Resp Rate																		

*Where NIV is delivered by a volume cycled machine
Monitor SpO_2 continuously aiming for SpO_2 > 85%. Blood gases should be repeated 1-2 hours after initiating NIV and 4-6 hours later and then dependent on progress

Suggested NIV usage and weaning guide

Patients should be encouraged to wear it as much as possible (i.e. 24 hours) initially, as blood gases improve this can be reduced. For example 2 hours off in the morning and evening one day, 4 hours off in the morning and evening the following day, all day off the next day.

Please contact the Respiratory teams for advice

THIS PATIENT SHOULD NOT RECEIVE SEDATION

Date	Comments/communication	Signature	Print name
	Contraindications to NIV considered and not applicable in this case **Other comments**		

Appendix vi: Example of NIV audit proforma

Consultant: 1.		2.
Date and time of admission to HH/CXH		Date and time of admission to B2/5S: (Please specify if another ward)
Resus State:		Date of resus decision:
Admission Diagnosis: COPD Chest wall/ neuromuscular Obesity/ hypoventilation Cardiogenic pulmonary oedema Other: (specify)	*Smoking History* Current/Ex Pack year history Never **CXR consolidation** Yes No (please circle)	*Relevant Past Medical History:* ***(please circle)*** Cardiac disease Hypertension Diabetes CRF Chronic Liver Disease Other respiratory disease (specify): Previous FEV_1 (if available) Previous FEV_1 as % predicted (if available):

Performance status:

Normal activity without restriction

Strenuous activity limited, but can do light work

Limited activity but capable of self-care

Limited activity, limited self care

Confined to bed/chair, no self-care

No record / patient unable to give info

Exercise tolerance in meters: _____

Decision to commence NIV made by: Consultant SpR SHO Other (specify)

Consent received from patient carer/relative

Clinical plan if NIV fails Escalate to ITU/Intubation Palliative /supportive management

Date and time commenced: Initial IPAP/EPAP setting:

Date discontinued:	No. of nights on NIV:	Weaning programme: Yes No	Total length of stay (days)

ARTERIAL BLOOD GASES

	Date	**Time**	**FiO_2**	**pO_2**	**pCO_2**	**pH**	**$HC0_3$**	**BE**
Immediately pre-NIV								
1-2h post-NIV								
4-6h post-NIV								
Discharge								

Machine used:

Complications of NIV: Yes No Specify:

Outcome of NIV	*Reason for Failure*	*Outcome of Admission*
Success / Improved Failure / no benefit.	Intolerance of mask Excessive secretions Nasal bridge erosions Tracheal intubation Leaks (poor mask fitting) Patient choice to stop Rx Other: (specify)	Discharged without NIV Discharged on LTOT ☐ Transferred to X Hospital for home NIV Died (likely cause of death respiratory) Died (likely cause of death non-respiratory) Other: (specify) Resp FU arranged Yes No (please delete as appropriate)

Appendix vii: Example of an NIV set up guide

Action	Rationale
Ensure ward emergency equipment available	Provide safe environment
Patient discussed with nursing staff, medical staff (at all times) and physiotherapists (in hours)	To ensure NIV is the appropriate intervention and support is available
Ensure the NIV chart has been fully completed with an appropriate prescription	To ensure appropriate settings are maintained
Check with medical staff that patient has a recent CXR which is clear of pneumothorax/pneumonia	Pneumothorax must be discounted prior to starting NIV as positive pressure can cause lung barotrauma. If a patient already has a pneumothorax the size can be increased by NIV. NIV is unlikely to succeed if pneumonia is present
Explain procedure to patient positively and calmly. Take consent from patient or relative/carer. The patient will require reassurance throughout the procedure. Sit the patient up in bed	To gain consent and co-operation. This is potentially a frightening and claustrophobic experience
Set up the equipment as shown in the diagram. Ensure filter is connected to the port on the NIV machine before attaching the tubing	To prevent contamination of the machine
Carry out as much preparation as possible away from patient's bedside	To prevent distressing patient
Check size of mask which must fit firmly and not encroach on upper lip and into corners of the eye. **Assess mask size using gauge on mask pack.** **Use nasal mask in preference to full face mask unless patient cannot keep mouth closed.**	To ensure seal and prevent air leaks which may reduce effectiveness or cause complications e.g. conjunctivitis
Apply hydrocolloid semi-permeable dressing to bridge of patient's nose. Check for any poor facial skin condition.	This is a very high risk pressure area. Existing poor facial skin condition may also be exacerbated
Connect patient's current supplemental oxygen to second O_2 supply	Maintain O_2 supply whilst preparing equipment
Set mode to spontaneous/timed mode, set IPAP, EPAP (or if volume cycled machine, PEEP and I:E) and back up BPM settings as instructed by NIV chart	To ensure machine is functioning correctly and that a back-up rate is provided in the spontaneous/ timed mode
Turn the machine on and connect entrained O_2 to connector	To commence treatment and provide oxygen supply
Ask patient to breathe through nose and maintain tight mouth seal. Hold mask to patient's nose for a few minutes	To reassure patient and acclimatize
Attach head cap straps to mask and obtain seal. The mask should be firm but **not tight** and small leaks may be acceptable. If unable to maintain mouth seal patient may require a full face mask	To ensure no leaks
Ensure that exhalation port (if using a fixed leak circuit) on connector between mask and tubing is not blocked and facing away from patient	To prevent build up of CO_2
Document a set of observations	Provide baseline for assessing progress
Watch chest wall movement and titrate settings to achieve therapeutic effect – increase in chest wall movement and improved clinical signs	Improving the tidal volume is the aim as inadequate Vt is the cause of the patient's ventilatory failure

Appendix viii: Example of a trouble shooting guide

Persistently elevated $PaCO_2$	• Is there excessive mask leak? Check mask fit. Consider total-face mask. • Is the circuit set up correctly? Check connections and identify leaks. • Is there re-breathing? Is the expiratory port patent? • Is the patient being over-oxygenated? Especially consider the desired level of O_2 therapy during periods off NIV. Consider the acceptable level of PaO_2 aimed for. • Consider increase in IPAP. • Is the patient spending sufficient time on the ventilator? Encourage more sustained periods of use, particularly during sleep. Address compliance issues. • If the patient is very obese or has other causes of chest-wall restriction, a volume-controlled ventilator may be more effective. • Consider decrease in EPAP if very high level set (>8).
Mask leaks	• Small leaks are normal and acceptable, but larger leaks may cause inefficient ventilation, eye irritation, noise, dry mouth and nasal symptoms. • Be prepared to try different mask types and headgear. • Consider customised foam, or granuflex for comfort.
Asynchrony between Patient and ventilator	• This is rare using the Respironics Harmony machine as its triggering is very sensitive. • Check that the correct tubing is used in the circuit. The tubing should be smooth on the inside to allow flow to be detected accurately by the machine. • If the patient has a feeble inspiratory effort, the machine may not sense inspiration. An increase in EPAP may help. • If the patient is very tachypnoeic, increasing the IPAP may help Ensure that the IPAP rise time is as quick as possible.
Hypocapnia/Alkalosis	• Minute ventilation is too high. Reduce IPAP. • Is ventilation still required?
Difficulty inflating the chest	• Poor expansion of the chest and desaturation may be due to bronchospasm, mucus plugging, pneumothorax, atelectasis/collapse, consolidation, pulmonary oedema or rarely circuit tube

	obstruction/kinking. Clinical examination is necessary. Chest X-ray may be needed.
Nasal Problems	• Nasal redness/soreness/nasal bridge sores? Appropriate padding or a change of mask may be necessary. • Rhinitis/Nasal crusting/Bleeding? Ask about nasal symptoms. Consider short-term use of 0.5% ephedrine nose drops for stuffiness. Alternatively, nasal steroid preparations can be employed (nosebleeds are a relative contraindication to nasal steroids). Anticholinergic drops (ipratropium bromide) or aqueous spray may be helpful for nasal streaming. For longer-term use, consider humidification.
Dry mouth	• Regular mouth care is essential. • Consider humidification.
Gastric distension	• Check for abdominal pain or distension occurring during NIV. • Try to reduce IPAP if possible. • Consider a nasogastric tube with a nasogastric tube guard, accepting a small leak will ensue. Small leaks should not cause a problem.
Persistent hypoxaemia	• Check correct O_2 entrainment into circuit near machine. If there is definite OSA or atelectasis, then increasing EPAP may help (remember to increase IPAP as well to maintain same amount of pressure support). • Deteriorating clinical condition in the presence of hypoxaemia should lead to an urgent re-evaluation of the cause and consideration of intubation and mechanical ventilation. **CONTACT ITU**.
Patient position	• The patient should be positioned sitting upright with their head up. • Consider additional support (soft collar, rolled-up towel) if necessary.
Non co-operation/ aggressive behaviour	Assess for patient agitation, confusion and not maintaining mask ventilation. • This may be due to hypoxaemia or hypercapnia. Ensure constant supervision, as it may be necessary to hold the mask in place until the ABGs correct themselves, before the confused/agitated state settles. This may be life saving. Relatives can be helpful. • **SEDATION MUST BE AVOIDED WITHOUT SENIOR MEDICAL OR ANAESTHETIC INPUT.** Haloperidol may be useful to decrease agitation and facilitate tolerance of NIV therapy. Avoid benzodiazepines.