CLINICAL PRACTICE GUIDE

Non-invasive ventilation for patients with acute respiratory failure

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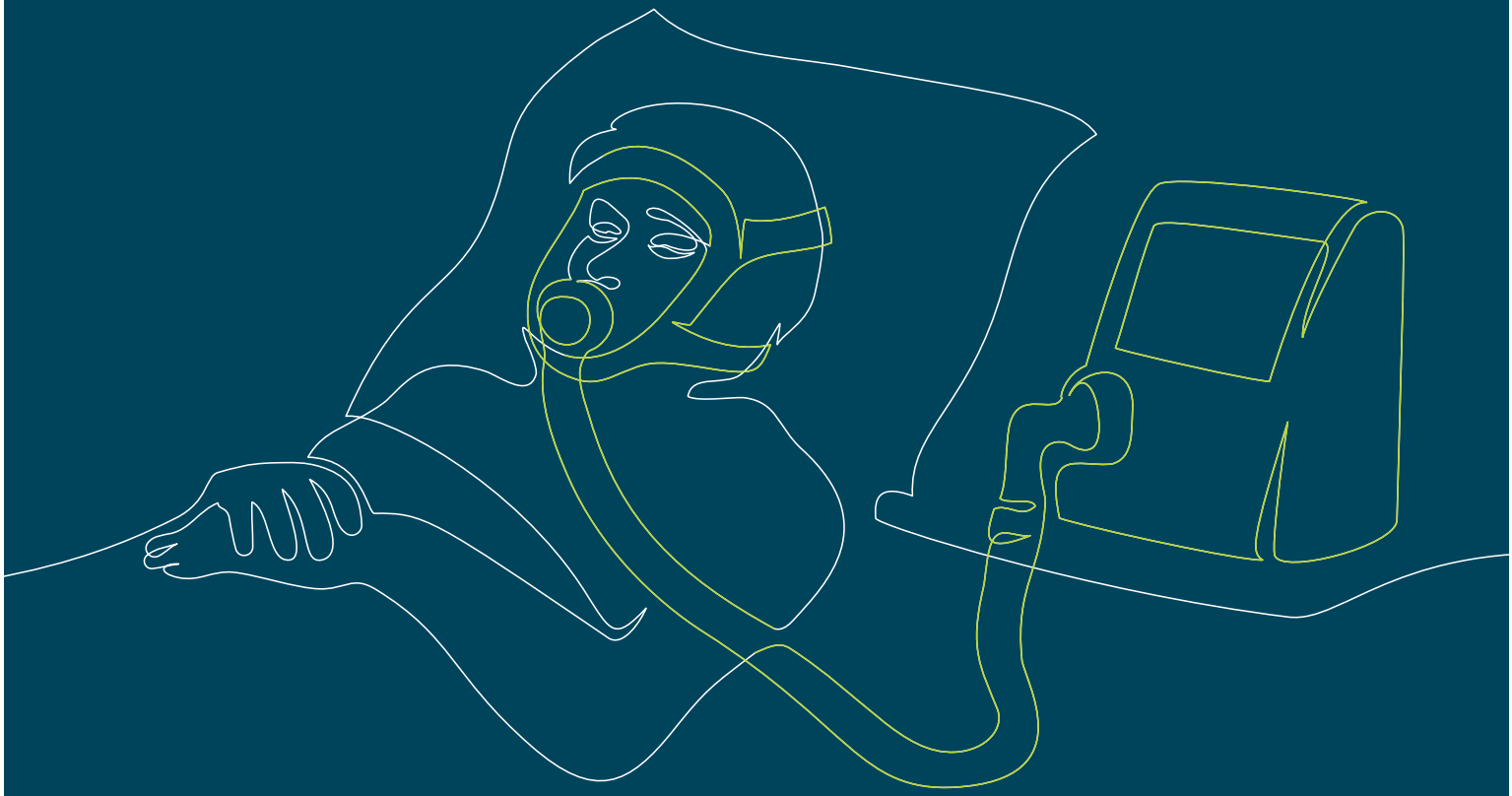

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Intensive Care NSW

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Contents

At a glance

Critically ill patients with acute respiratory failure may require non-invasive positive pressure ventilation.

This guide has been developed to ensure:

- patients receive appropriate care at the right time and within the right location of the hospital
- services are safe, effective and sustainable
- staff receive appropriate education, training and support.

Clinical assessment

- Indications
- Contraindications
- Patient assessment
- Initiation and settings
- Escalation of therapy

Equipment

- Non-invasive ventilation setup
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Staff capability – Education and training – Governance

Introduction

This clinical practice guide is intended to support local health districts (LHDs) and hospitals to develop local procedures and guidelines for non-invasive ventilation (NIV) that are appropriate for their specific patient population.

This guide is for critically ill adult and paediatric (infants to 16 years) patients who have been medically assessed to require NIV as an adjunct to standard medical therapy. This therapy may occur in the intensive care unit (ICU), emergency department (ED), dedicated specialist cardiac and respiratory units or close observation units/beds with a higher level of clinical support.

NIV refers to the delivery of positive pressure ventilation to the patient using an interface, such as face masks, nasal masks or helmets,[1] instead of an invasive interface, such as an endotracheal tube.

NIV modes discussed in this guide include variable positive airway pressure devices (most commonly bilevel), consisting of a higher inspiratory positive airway pressure and a lower expiratory airway pressure, as well as continuous positive airway pressure (CPAP).

The guide does not address the management of stable patients with domiciliary or nocturnal NIV. As every hospital will have its own case mix and resources, each service will need to assess local conditions to ensure that patients receive person-centred, time-sensitive care in a safe environment.

This guide provides information and recommendations on the following key aspects of care:

- Clinical assessment of the patient
- NIV equipment and management
- Patient care

The recommendations can be used to support hospitals to provide NIV therapy 24/7, integrated with critical care or ICU services; to develop locally shared protocols; and to inform monitoring and evaluation of a safe, quality standard of care.

Methods

This is an update to the clinical practice guide published in 2014. The original guide was developed based on a systematic review of the literature and expert consensus.

To inform the update of this guide, a literature review of publications from 2014 to October 2021 was undertaken, with recommendations updated where indicated (see Appendix 1 for the search strategy).

This guide was reviewed in 2021 by the Intensive Care NSW (ICNSW) working group of 10 expert medical, nursing and allied healthcare representatives from LHDs across NSW. The group met regularly to reach consensus on recommendation statements. Consensus was reached on all recommendations included in this guide.

To assess the current state, ICNSW reviewed NIV data from the Incident Information Management System[2] of the Clinical Excellence Commission (CEC). A total of 288 reported NIV incidents from January 2018 to November 2021 were reviewed to identify themes. The highest number of incidents related to pressure injury/skin integrity (n=235), followed by treatment and general care (n=16), devices/gases/consumables (n=15) and organisational management incidents (n=3).

Indications for use of NIV

Recommendations	Source
NIV should be administered in an ICU, ED, close observation unit or monitored bed unit, where there is adequate staff with the capability (skills, knowledge and attitude) to care for a patient on NIV.	Therapeutic Guidelines Limited[3] Beasley R, Chien J, Douglas J, et al.[4]
Patients must be able to maintain protection of their airway prior to initiating NIV.	Consensus
Patients must have a clinical indication for NIV to be initiated.	Consensus

Acute NIV therapy is administered in an ICU, ED, close observation unit or specialty respiratory or cardiac (coronary care) unit, where staff are appropriately trained in caring for patients on NIV. Close observation of patients on NIV is required because of high risk of treatment failure, complications and subsequent need for intubation.[3]

NIV is considered the standard of care in the management of patients with acute hypercapnic respiratory failure (AHRF) due to acute exacerbation of chronic obstructive pulmonary disease (COPD). It reduces the incidence of endotracheal intubation, in-hospital mortality and length of stay.[5]

In addition, NIV can be used for patients with other conditions associated with AHRF, such as neuromuscular disease (NMD), obesity hypoventilation syndrome (OHS), those with severe chest wall deformity and restrictive physiology, those with severe chronic airflow limitation (where it is regarded as the initial standard of care, although the evidence base supporting its use in this situation is not as robust)[4,6] and those with acute cardiogenic pulmonary oedema.[6, 7] Patients with COPD and severe respiratory acidosis (pH <7.26) or a reduced level of consciousness are at greater risk of failing NIV and require closer monitoring.[4]

There is no strong evidence for the use of NIV for patients with acute asthma and community-acquired pneumonia, except for patients with immunosuppression.[6, 8, 9] If an asthmatic patient is behaving more like a patient with COPD, bilevel NIV may be considered.[6]

In patients with AHRF, treatment with high flow nasal cannula oxygen (HFNCO), NIV or CPAP can be considered. These strategies appear safe and effective in mild-to-moderate (PaO2/FiO2 >150mmHg) hypoxemia cases. In moderate-to-severe (PaO2/FiO2 ≤150mmHg) hypoxemia cases, delayed intubation increases mortality in a significant proportion of these patients and NIV should only be applied in the context of the ability to closely monitor; patients should be moved to invasive mechanical ventilation, if required.[10]

In patients with acute pneumonitis secondary to COVID-19 requiring an FiO2 greater than or equal to 0.4, an initial strategy of CPAP significantly reduces the risk of tracheal intubation or mortality compared with conventional oxygen therapy, but there is no significant difference between an initial strategy of HFNCO compared with conventional oxygen therapy.

Clinical indications for NIV as a mode of treatment in adults and children are outlined on page 4.

Clinical indications for NIV in adults with acute respiratory failure [3, 4, 6-8, 11-13]

- Acute exacerbation of COPD – in the context of acute hypercapnic respiratory failure (pH <7.35 and elevated $PaCO_2$)
- Obesity hypoventilation syndrome (OHS) – in the context of acute hypercapnic respiratory failure (pH <7.35 and elevated $PaCO_2$)
- Neuromuscular disease (NMD) – consider NIV in acute respiratory distress, with a high work of breathing or difficulty with mucus clearance.
- Acute cardiogenic pulmonary oedema, CPAP (hypoxic respiratory failure) or AHRF
- Immunocompromised patients with acute respiratory failure
- Acute pneumonitis, including COVID-19, moderate-to-severe hypoxic respiratory failure PaO_2/FiO_2 >150mmHg, CPAP
- Weaning high-risk patients from mechanical ventilation
- Post-extubation management
- Post-operative acute respiratory failure
- Chest trauma

Clinical indications for NIV in children [9, 14-16]

- Altered control of breathing (e.g. congenital central hypoventilation syndrome)
- Neuromuscular weakness (e.g. Duchenne muscular dystrophy, spinal muscular atrophy)
- Upper spinal cord injury (partial)
- Upper airway obstruction – non-acute (e.g. tracheobronchomalacia, some craniofacial abnormalities)
- Chronic lung disease
- Bronchiolitis (bubble CPAP)
- Post-extubation management
- Obstructive sleep apnoea (already established on home device)

Contraindications for NIV

Before commencing the therapy, contraindications for NIV should be considered. Empathic communication between clinicians and the patient is essential, with clear instructions given to patients about what to expect and ongoing support throughout the therapy.[12] See NIV in a palliative care setting (page 29) for the use of NIV in symptom relief. A discussion should be held with senior clinicians before or during therapy.

The need for emergency intubation and the patient's inability to protect their airway are absolute contraindications to commencing NIV in both adults and children.[3, 8, 9, 11, 17] In such cases, consultation with senior clinicians should take place so that an informed decision can be made to initiate the correct therapy.[3, 6, 8, 11, 12, 14]

The presence of relative contraindications and adverse features requires a higher level of observation, monitoring and decision-making, with early appraisal of whether to commence or continue NIV, or whether intubation is needed.[3, 15, 16]

Absolute and relative contraindications for NIV in adults and children are described in Tables 1 and 2.

Table 1. Contraindications for non-invasive ventilation in adults [3, 6, 8, 12]

Absolute	Relative - adverse features
• Immediate need for tracheal intubation • Imminent cardiorespiratory arrest • Anatomically fixed upper airway obstruction • Facial burns • Decreased level of consciousness in the setting of severe acute traumatic brain injury	• Haemodynamic instability (hypotension in non-cardiac patients) • Impaired consciousness with inability to protect the airway • Altered level of consciousness due to hypercapnia • Recent upper airway surgery (requires discussion with surgeon) • Copious secretions or vomiting • Pneumothorax • Facial injuries, including fractured base of skull • Recent upper gastrointestinal surgery (requires discussion with surgeon) • Following immediate transsphenoidal resection of a pituitary tumour (requires discussion with neurosurgeon)

Table 2. Contraindications for non-invasive ventilation in children [3, 15, 16]

Absolute	Relative - adverse features
• Imminent cardiorespiratory arrest • Unable to protect airway	• Haemodynamic instability • Oral/facial/oesophageal surgery • Pneumothorax

Patient assessment

Recommendations	Source
A full patient assessment must be undertaken before commencing NIV.	Therapeutic Guideline Limited[3] Beasley R, Chien J, Douglas J, et al.[4] Rochwerg B, Brochard L, Elliott MW, et al.[6] Hyzy RC, McSparron J[11]
Relative contraindications and adverse features should prompt consideration for placing the patient in a critical care unit.	Davidson AC, Banham S, Elliott M, et al.[8]
Patient must be assessed regularly for tolerance of NIV therapy.	Consensus
Frequent assessment must occur to escalate to intubation, if required.	Rochwerg B, Brochard L, Elliott MW, et al.[6] Hyzy RC, McSparron J[11]
Before commencing NIV, a management plan should be clearly documented in the patient's health record, which should be communicated to the patient and family.	Therapeutic Guideline Limited[3]

Before initiating the NIV therapy, the patient should be assessed for their: [6, 8, 11, 12, 16]

- capacity to protect their own airway
- level of consciousness
- capacity to manage respiratory secretions
- likelihood of tolerating the planned level of support
- likelihood of deterioration and treatment limitations.

Delays in escalating to intubation, where appropriate, have been associated with poorer outcomes.[5,7,9]

In patients with acute exacerbation of COPD with a high work of breathing and arterial pH <7.35, NIV is associated with improved outcomes when started early.[18, 19]

Before commencing acute NIV:[3, 11, 16]

- Discuss with the patient, family and/or carers whether intubation and invasive mechanical ventilation is an option.
- Explore the patient, family and/or carer's expectations and explain any limitations of the therapy.
- Where possible, obtain and document informed consent.
- Document a management plan that is reviewed regularly and updated as required.
- Document baseline observations, such as arterial blood gases (ABG); respiratory rate (RR); oxygen saturation measured by pulse oximetry (SpO2); work of breathing observed by use of accessory muscles; patient posture; level of consciousness; pain score; cardiac monitoring; blood pressure; heart rate; skin integrity at mask contact points; and other parameters relevant to the patient's comorbidities.
- Set up and check the appropriate ventilator device and circuit.

NIV settings – initial and ongoing

Recommendations	Source
Initial IPAP (inspiratory positive airway pressure), EPAP (expiratory positive airway pressure) settings and any subsequent changes must be prescribed by a senior medical officer.	Consensus

Initial NIV settings are prescribed by the treating physician, with subsequent adjustments guided by agreed measured or monitored parameters and patient comfort. Initial settings may vary depending on clinician judgement.

A crucial principle to be mindful of is that acute respiratory failure is a life-threatening condition. Rapid application and optimisation of effective NIV support should aim to improve dyspnoea and reduce the work of breathing. Reversal or stabilisation of acid–base balance and respiratory failure needs to be achieved in a timely manner, preferably in the first 1-2 hours, to prevent decompensation that requires invasive mechanical ventilatory support.

Table 3 describes the initial NIV settings. Modes and settings should be prescribed based on the patient's clinical presentation and lung pathology. Changes should be guided by the patient's clinical condition, medical supervision and physiological parameters, such as ABG analysis.

Table 3. Guide to initial NIV settings[4, 6, 8, 14, 20-22]

Common setting on the NIV device	Considered initial settings on the NIV device
FiO_2 (fraction of inspired oxygen)	• Titrated to maintain oxygen saturation in prescribed range and consideration of respiratory failure. • Controlled oxygen therapy should be used to achieve a target saturation of 88–92%* in the following patient cohort with chronic respiratory failure:[4, 6, 8] – Acute exacerbation COPD – OHS – Bronchiectasis – Cystic fibrosis – NMD – Chest wall deformities, e.g. kyphoscoliosis • For children with neuromuscular weakness and disease, a target oxygen saturation of no less than 93% should be achieved.[14] • In other acute medical conditions, including NMD and CWD, oxygen should be administered to achieve a target SpO2 range of 92–96%.* [4, 8] • In acute coronary syndrome and heart failure, oxygen administration should be recommended if the SpO2 is <93% and <90%, respectively.[4]
Primary disease group/ patient cohort	**Considered initial settings on the NIV device**
CPAP for hypoxic respiratory failure	• Positive end-expiratory pressure (PEEP)/EPAP 8-12cm (excessive PEEP in the setting of pneumonitis will increase the risk of volutrauma and pneumothorax). • In acute coronary syndrome and heart failure, oxygen administration should be recommended if SpO2 is <93% and <90%, respectively.[4]
COPD and restrictive thoracic cage deformities	• Initial settings:* – S/T mode – spontaneously triggered with a timed backup respiratory rate – IPAP 14cmH_2O – EPAP 4cmH_2O – Rise time 0.2 seconds – Back-up respiratory rate (BRR) 12-16 breaths per minute – Inspiratory time 1.0-1.4 seconds • Increase IPAP in 2cmH_2O increments every few minutes, until maximum tolerance or target tidal volume of 8-10mL/kg ideal body weight is achieved. • An IPAP of 20-25cmH_2O may be required to achieve adequate alveolar ventilation in patients with COPD and chest wall disorders. • Do not increase EPAP in the absence of obesity or obstructive sleep apnoea. • Adjust mask to minimise leaks while being comfortable for the patient. • Minimise FiO_2 to maintain SpO_2 88-92%.†

Table 3. Guide to initial NIV settings (cont.)

Primary disease group/ patient cohort	Considered initial settings on the NIV device
Obesity hypoventilation syndrome (OHS)	• Initial settings:* – S/T mode – spontaneously triggered with a timed backup respiratory rate – IPAP 20cmH_2O – EPAP 8-10cmH_2O – Rise time 0.3 seconds – BRR 12-16 breaths per minute – Inspiratory time 1.4 seconds • Increase IPAP in 2cmH_2O increments, until maximum tolerance or target tidal volume of 8-10mL/kg ideal body weight is achieved. • An IPAP of 20-30cmH_2O is often required to effectively treat alveolar hypoventilation during sleep. • EPAP needs to be sufficient to overcome upper airway resistance and extrapulmonary restriction. Adjust to achieve this and maintain adequate oxygenation and optimal patient triggering. • Adjust mask to minimise leaks while being comfortable for the patient. • Minimise FiO_2 to maintain SpO_2 88-92%.
Neuromuscular disorders (NMD)	• Initial settings:* – S/T mode – spontaneously triggered with a timed backup respiratory rate – IPAP 8cmH_2O – EPAP 4cmH_2O – Rise time 0.3 seconds – BRR 12-16 breaths per minute – Inspiratory time 1.4 seconds • Increase IPAP in 1cmH_2O increments, until maximum tolerance or target tidal volume of 6-8mL/kg ideal body weight is achieved. • An IPAP of 12-16cmH_2O is often sufficient. • A slightly higher EPAP may be required in bulbar disease or obesity, although usually a minimal EPAP is needed. • Adjust mask to minimise leaks while being comfortable for the patient. • Minimise FiO2 to maintain SpO2 88-92%.*
Paediatric considerations	• EPAP settings should not exceed 7-8cmH_2O in most infants or 10-12cmH_2O in most paediatric patients, although this is patient-specific and is not an absolute recommendation. • IPAP setting should be titrated to achieve adequate chest expansion and CO_2 removal.

Table 3. Guide to initial NIV settings (cont.)

Primary disease group/ patient cohort	Considered initial settings
Patients already established on home NIV and no acute changes in respiratory function from baseline	• Commence at the same pressures used at home, and then titrate as clinically indicated.

Additional consideration for NIV settings

AVAPS (average volume assured pressure support)/VtPS (volume targeted pressure support)

The delivery of a pre-set average assured volume, based on ideal body weight, that is delivered between a range of IPAP upper (Insp Max) and lower (Insp Min) setting and an EPAP setting

Considerations

- Volume control (or volume assured) modes of providing NIV may be more effective when high inflation pressures are required.
- Although volume-targeted ventilators have the potential to deliver known tidal volumes, most machines have a limited capacity to correct for leaks (either around the mask or through the mouth if a nasal mask is used) and this can lead to underventilation.

PCV pressure control: ventilator timed breath with IPAP and EPAP, with a set inspiratory time. Tidal volume is variable. Pressure-targeted ventilators are designed to increase flow until peak pressure is reached, which means that they effectively compensate for all but the largest leaks.

Considerations

- Patients with OHS who had AHRF had better outcomes receiving pressure control rather than overnight pressure support. Pressure control in this cohort of patients is recommended initially.[8]
- Pressure-targeted ventilators use a single-limb circuit, with exhaled gas usually being vented through ports near the face or nasal mask. There is the potential to re-breathe carbon dioxide if airflow is low during expiration, and for this reason, a minimum end expiratory pressure of 4cmH_2O is advisable when using pressure-targeted ventilation.[22]

* Source: Non-invasive ventilation (NIV) for hypercapnic respiratory failure, adult. District Hospital Health Pathways Hunter New England.

† Trials are underway to further explore outcomes in ICU patients targeting liberal versus conservative (lower) oxygen saturation.[23, 24]

Commencement of NIV

On commencement of NIV, it is recommended that patients have a documented plan of care that is reviewed at least every 24 hours and with a change in the patient's condition. The plan should include education, support and management of family expectations.

In an emergency, the following should occur concurrently:

- Documentation, including a prescription of NIV settings, how potential failure of the therapy will be dealt with and whether escalation of care is indicated.
- In the setting of those with or at risk of hypercapnic respiratory failure, an altered calling criteria is essential, aiming for an SpO2 88-92%.
- The care plan and prescription of therapy should be developed by a critical care or respiratory medical officer.[4, 25]
- When starting NIV, seek to achieve optimal support as soon as possible and successfully coach the patient in the use of NIV.
- Adjust NIV, escalating the pressure support ventilation to reduce the work of breathing, reduce dyspnoea and enhance tidal volumes.
- Ensure there are no excessive leaks, and the patient remains in synchrony with triggering the machine.
- Adjust PEEP to overcome upper airway resistance, assist with oxygenation and recruit atelectatic lung.
- Be prepared to spend time with the patient when initiating the NIV support to ensure the best chance of success.

Failure to observe an improvement in respiratory acidosis or see a reduction in the work of breathing within the first 1-2 hours of NIV commencement is a risk factor for poor outcome.[8] It is important to actively optimise NIV settings and adjust the pressure support ventilation to achieve these goals.

Patients should have a formal assessment and documentation of full body skin integrity, which is repeated at least daily. This includes the skin under the interface, i.e. bridge of the nose, face and neck. When the therapy is first applied, the clinician should stay with the patient, ensuring the patient achieves mask comfort and tolerance of the therapy.

Commencement of NIV on children requires either a nasogastric or orogastric tube for gastric decompression. This mitigates the risk of aspiration and diaphragmatic splinting, which can impair respiration in small children and infants. Adults require ongoing assessment for gastric insufflation and consideration of nutritional requirements.

Escalation of therapy

Recommendations	Source
Emergency equipment must be readily available at the bedside and staff should be trained in its use, in case of patient deterioration.	Consensus
Recognition, escalation and management of the deteriorating patient must be prompt and a plan initiated.	Consensus
Limitations of treatment (e.g. 'do not intubate' and Advanced Care Directives) must be documented and discussed with the patient and family prior to commencement of therapy and handed over at the commencement of each shift.	Roberts CM, Brown JL, Reinhardt AK, et al.[26]

Escalation involves a process of engaging healthcare professionals in the management of the patient by responding to patient deterioration and/or clinician concern. An escalation plan should be established at the initiation of therapy, with early identification of parameters that indicate worsening respiratory failure. A medical officer must review the patient if there are signs of deterioration and/or the patient is not tolerating NIV.

Clinical signs of deterioration are:

- increased RR
- acidosis
- decreased level of consciousness
- decrease in oxygenation despite increasing FiO_2.

In children similar clinical signs can be evident in the case of NIV failure, with the addition of bradycardia.

The decision to not escalate to mechanical ventilation should be made by a senior ICU, ED or respiratory medical officer, and discussed with the patient (or next of kin if patient is unable to participate in conversation). Document the plan to not intubate and any limitations to the therapy in the patient's health record.[3]

NIV setup and humidification

Equipment

Recommendations	Source
Patient and equipment safety checks must be completed at the commencement of each shift.	Consensus

The equipment required for NIV should be checked for the type of NIV device and its accompanying consumables.

Before use, it is essential to set the ventilator alarms and prepare the following equipment:[27]

- Non-invasive ventilator with alarm capability
- Ventilator tubing (single or dual limb, depending on the device)
- Exhalation port for single-limb circuits
- Exhalation valve for dual-limb circuits
- Face mask and sizing gauge
- Oxygen port should be entrained as close to the patient as possible if NIV does not have piped oxygen[8]
- Vented mask for CO_2 clearance
- Non-vented mask for dual-limb circuits and patients with airborne conditions, e.g. COVID-19
- Bacterial and viral filter.

The following safety equipment must be checked and available by the patient's bedside:

- Emergency cardiac arrest trolley/airway trolley, which includes self-inflating resuscitation bag along with a mask of appropriate size with PEEP valve
- Suction and high suction ready for immediate use
- Oropharyngeal/nasopharyngeal airway of appropriate size
- NIV settings checked, and alarms set appropriately.

Considerations in the selection of a ventilator for NIV[22, 28]

- Leak compensation mechanism
- Sensitivity and adjustability of the patient triggering mechanism
- Continuous monitoring of pressure-flow-volume wave forms
- Continuous monitoring of all parameters, including exhaled tidal volume owing in the presence of dual-limb circuits
- Oxygen blenders to ensure stable oxygenation and delivery
- Oxygen port if no piped gas supply
- Various levels of adjustment of trigger and cycling to manage patient–ventilator synchrony
- Rebreathing
- Alarms
- Portability (size, weight, battery)
- Cost
- Staff knowledge and skill mix

Humidification

Recommendations	Source
Apply heated humidification as it is regarded as more comfortable. It is not essential but can be considered if the patient reports mucosal dryness or if respiratory secretions are thick and tenacious.	Davidson AC, Banham S, Elliott M C, et al.[8] Oto J, Nakataki E, Okuda N, et al.[29]
Pressure injuries from the NIV interface should be avoided by: • ensuring correct measurements for mask sizing, fitting mask symmetrically and avoiding overtightening • ensuring the skin is clean and dry • removing the interface regularly • applying a protective barrier to the skin.	Alqahtani JS, Al Ahmari MD[30] Barker NW, Elphick H[31] Brill A[32] Mortamet G, Amaddeo A, Essouri S[33] Visscher MO, White CC, Jones JM[34]
Compatibility of the chosen interface with the ventilator and circuit, and exhalation port identified and checked before NIV is commenced.	Barker NW, Wilcox M, Elphick H[31] Brill A[32]

The selection of the humidification system to be used with NIV should be based on the patient's lung condition,[35] ventilator settings, interface selection, intended duration of use and other factors such as body temperature. Two humidification systems are available for consideration:

- Heat and moisture exchangers (HME), which provide passive humidification.
- Heated humidification, which provides active humidification.

Passive humidification may be used in the short term where urgency of oxygenation and ventilation is required or during periods of time where electrical support for active humidification is unavailable, e.g. during transport.

Heated humidification may reduce resistance in the upper airway and promote patient comfort when leak is high.[8] Heated humidification can reduce upper airway dryness,[29] which may assist in secretion clearance, comfort and tolerance.

In children with neuromuscular weakness requiring NIV who have continued tenacious secretions, nebulised normal saline may be considered.[14] Increased moisture may present a clinical dilemma related to potential skin breakdown and pressure injuries.[30, 36]

Interface

The interface is one of the most important determinants of the success of NIV therapy. Ensure the mask chosen is the correct size for the patient. To prevent leaks, an optimum seal between the patient's face and the device is essential, although it can be difficult to obtain. Applying too much pressure to the face results in patient discomfort and pressure ulcers, which reduces tolerance to NIV and the success of the treatment.[30-33]

Interfaces are selected for an individual based on evaluation of their clinical condition, face shape and size, preference of type of interface, and professional experience and training of the clinician. Sizing guides are provided by manufacturers to aid in this decision-making. It is still common for multiple interfaces to be trialled.[31]

Interfaces are either classified as vented or non-vented. Vented masks have a leak which allows for effective CO_2 clearance, and non-vented masks need an exhalation port in the single-limb circuit (close to the mask) or an exhalation sensor in a dual-limb circuit. Full-face masks are those that cover the mouth and nose and should be used for general/non-specialist use.[8]

Nasal masks or pillows are usually the most comfortable to use for most children and should be the first choice. Air leaks can occur through an open mouth when nasal mask ventilation is used. When this is a problem, a chin strap or a mask covering the nose and mouth (face mask) may be needed.[14]

Full-face masks used with single-limb circuits contain an anti-asphyxia valve. This is a safety feature, which opens in the event of low pressure and ventilator power failure, enabling the patient to breathe room air rather than rebreathing CO_2.[32] CO_2 rebreathing is affected by interface volume, flow during expiration and position of an exhalation port within the interface or in the circuit.[31]

For safety, it is important to check the compatibility of the interface, connections and circuit with the device delivering positive pressure, including a device and interface test, if required, by the device manufacturer.[32]

The most commong interfaces used in the acute care setting are outlined in Table 4.

Table 4. Common interfaces used in the acute care setting [8, 15, 16, 31-33, 37]

Nasal mask and nasal pillows	• The nasal mask covers only the nose, is more comfortable and allows the patient to communicate. • It is less claustrophobic and more likely to have leaks, which can be significant in the acute setting. • Its efficacy depends on the patient keeping their mouth closed. • The use of chin straps can help prevent leaks from the mouth.
Oronasal mask	• The oronasal mask is widely used, as patients with acute respiratory failure are often mouth breathers with high respiratory demands. • It covers both the nose and mouth of the patient, which enables better elimination of CO_2. It can cause eye irritation during permitted leak. • Some oronasal masks avoid pressure across the bridge of the nose, cover the mouth and have an integrated nasal bolster to fit shape and size of nose and nares.
Full face mask	• Full face mask is an alternative to the oronasal mask. • It meets the perimeter of the face and so does not apply direct pressure to the bony prominence areas. • It can be used to interchange with the oronasal mask to relieve pressure.
Helmet	• The helmet consists of transparent plastic material that allows the patient to observe and interact with the surrounding environment. • A nasogastric tube can be inserted through this helmet for improved patient comfort and increased staff convenience. • Its use decreases pressure ulcers, conjunctivitis and gastric distension. • It should only be used in appropriate settings with close monitoring and more frequent observation.[32]

Infection control

Recommendations	Source
Clinicians must undertake a risk assessment to identify the infection risk and wear appropriate PPE.	Clinical Excellence Commission[38] Clinical Excellence Commission[39] Clinical Excellence Commission[40]
The 5 Moments of Hand Hygiene are essential for infection prevention control and safety for the patient and healthcare worker.	Australian Commission on Safety and Quality in Health Care[41]

Clinicians must follow the 5 Moments of Hand Hygiene, wear appropriate PPE and follow NSW Health infection control policies.[41] Patients and carers must receive direct instructions and education on hand hygiene and other infection control principles required in the care of the patient. The infection risk to clinicians when caring for patients with airborne diseases is high if precautions are not taken.[38-40]

Considerations for the patient with COVID-19 and NIV

Several studies show that use of NIV compared with other oxygen therapy devices does not create substantially higher levels of air or surface viral contamination in the immediate care environment.[42-44] However, considerations must be made when managing a patient with COVID-19 to ensure there is minimal risk to staff and patient safety by:

- staff complying with strict use of appropriate PPE, ensuring contact, droplet and airborne precautions are in place
- ensuring good mask fit
- ensuring staff have been fit tested and are fit checked each time they enter the room or commence patient care
- using a negative pressure room or single room, where available. Alternatives are single rooms or shared ward spaces with a cohort of confirmed COVID-19 patients only
- using closed NIV circuit[45]
- checking the use of viral filter in exhalation circuit for increasing resistance from water/condensate build-up.

The COVID-19 Infection Prevention and Control Manual of the Clinical Excellence Commission provides guidance on requirements for the management of patients with suspected or confirmed COVID-19, the use of PPE and transmission prevention strategies.[40]

Complications of NIV

Although NIV therapy is generally well-tolerated by most patients, it is not completely free from minor and even serious complications. The safety of NIV can be enhanced by a greater awareness of prediction and prevention of complications.[46] Potential complications of and the associated preventative strategies for NIV are listed in Table 5.

Table 5. Complications and preventative strategies for NIV [3, 14, 46-49]

Complication	Preventative strategies
Pressure injuries related to interface/straps on nose, face, ears	• Correctly fitting mask - position symmetrically, permitting acceptable leak • Use a silicone nasal bridge pad under the mask or at-risk areas to prevent pressure injuries • Apply a hydrocolloid dressing to the pressure injury; however this may increase air leaks • Forehead spacers integrated into oronasal masks can reduce the pressure of the mask on the nasal bridge • Minimise strap tension • Switch to different mask type • Provide and manage NIV with regular breaks • Consider total face mask
Claustrophobia/anxiety/ discomfort/intolerance	• Reassurance • Discuss treatment and benefits • Reduce inspiratory pressure • Decrease strap tension • Consider mild sedation or anxiolysis
Air swallowing with gastric/ abdominal distension, potentially leading to vomiting and aspiration, or airway obstruction	• Insertion of nasogastric tube for gastric drainage • Antiemetics • If there is a risk of vomiting, consider how rapidly the mask can be removed and use an integration of anti-asphyxiation valve
Hypotension	• Ensure adequate hydration • Careful patient selection; use with caution or in a higher acuity unit if patient is medically unstable, hypotensive, or has uncontrolled cardiac ischaemia or arrhythmia, or uncontrolled bleeding • ECG monitoring, 12 lead

Table 5. Complications and preventative strategies for NIV (cont.)

Complication	Preventative strategies
Barotrauma	• Careful patient selection • Reduce inspiratory pressure • Choose correct interface and size • Early recognition using respiratory observation and consider hyperinflation
Aspiration	• Gastric drainage when appropriate • Place patient in sitting position
Oronasal mucosal dryness	• Second hourly oral care • Active humidification
Eye irritation	• Second hourly eye care • Adjust strap tension • Consider different mask
Increased intraocular pressure	• Consider use of oronasal mask
Impaired communication	• Utilise communication boards • Regular breaks from therapy if possible
Impaired nutrition	• Dietetics assessment at commencement of therapy and daily review • Encourage oral intake • Maintain fluid balance chart and food chart

Troubleshooting

The efficacy of NIV depends on the equipment and interface selected, good clinician experience, and meticulous monitoring.[31, 50, 51]

Table 6. Common issues and troubleshooting

Unintentional leak	• To provide ideal ventilation during NIV, it is important to maintain pressure gradient from ventilator through the circuit, and from the mask to the patient's airways. Large air leaks can cause the following: – a drop in the delivered alveolar pressure – reduction of tidal volume. • Ensure a correctly fitted mask is used. Higher mask pressure against the face may decrease air leaks but may increase the risk of pressure injuries. Decreasing the airway pressure applied by the ventilator may also decrease air leaks. • In paediatric patients, air leaks around the interface are frequently the reason for NIV being ineffective and/or poorly tolerated, which can be minimised by selecting the interface carefully.
CO_2 rebreathing	• This is a complication that occurs when the exhalation port is blocked, distal to mask on a single-limb circuit, or the mask chosen does not have an exhalation device, so CO_2 cannot escape. It is essential to know which circuit (single or dual limb) is appropriate for the chosen mask.
Mask-related problems	• The first few hours of acute NIV are very important. Time taken to fit the mask and build the patient's confidence is well invested. • Masks are designed so that as the pressure in the interface rises, the mask cushion is pressed flat against the face. Paradoxically, if the mask is applied too tightly, this effect is lost, leading to more leaks. Excess tightening of mask can cause upper airway obstruction by retropulsion of the mandible. • Leaks can be reduced by loosening the mask straps. • Check mask fits properly to prevent skin injury, which is common in infants and children with craniofacial malformations.[50]
Patient–ventilator asynchrony	• Particular attention should be given to detecting patient–ventilator asynchronies and unintentional leaks (often mouth leaks), as these represent the most common residual respiratory events in children treated with NIV. [50] • Ventilator asynchrony should be considered in all agitated patients.[8] – Trigger asynchrony: several subtypes of trigger asynchrony exist, including ineffective triggering (missed efforts), double triggering and auto triggering. The detection of the type of trigger asynchrony requires examination of the pressure/flow waveform. Single-limb devices with a proximal exhalation port have better synchrony with the patient's demand for flow/pressure than dual-limb devices with distal exhalation valves. Adequacy of rise/slope time, trigger sensitivity (time, flow, pressure) and mode should be examined. – Cycling asynchrony: BRR, IE ratio and expiratory trigger (time, flow, pressure) dependent on mode should be examined.
Gastric distention	• Insertion of gastric tube or venting of PEG/PEJ tubes to decompress stomach.[20] • Increasing the rise time may reduce gastric swallowing of gas flow.

Care of the patient on NIV

Recommendations	Source
All patients receiving NIV must have a documented care plan. The patient and plan should be reviewed once per shift and as required.	Roberts CM, Brown JL, Reinhardt AK, et al.[26]

- Time spent with the patient in the first hours of the therapy should be used for fitting the mask correctly, ensuring the comfort of the patient and building the patient's confidence.
- Patients and families should be educated and informed about the therapy, and reassured if the patient feels pressure and discomfort while adjusting to the therapy.
- Social work involvement may assist and support the management of patient, family and/or carer expectations.
- Pharmacotherapies, including anti-anxiolytics and mild sedation, may be considered to facilitate patient tolerance and comfort. These should be prescribed by medical staff at the initiation of therapy or as required.[32]
- Nonpharmacological options should also be considered (e.g. music and/or play therapy in paediatric patients and increased parental support/comfort).
- A clear nursing care plan is to be documented within 24 hours of the initiation of therapy. This plan should include psychosocial support, and cultural, spiritual and religious needs.
- Oral hygiene is to be attended every two hours. Oral care includes brushing teeth, cleaning the mouth by rinsing with water and/or an antiseptic mouth rinse (in neonates expressed breast milk for immuno-supportive oral care (ISOC) may be used) and applying moisturiser to the lips. The interface should only be removed for short periods and only if safe to do so in a critically unwell/deteriorating patient.
- Eye care is to be attended every two hours. Refer to the Eye care of the critically ill guideline for further information.
- Patients are to receive pressure injury prevention management as per the Pressure Injury Prevention for Critically Ill Adults guideline, with particular attention paid to any areas that are in contact with the interface and straps. Use of a protective barrier such as hydrocolloid dressing may be used on areas at risk of pressure injuries.
- Patients should be encouraged to sit out of bed as tolerated. When in bed, the patient should be positioned in an upright position to facilitate chest wall expansion, while maintaining a comfortable position. Occupational therapy may be required if specific equipment is required, especially for paediatric patients.
- Patients should be assessed and managed following the ICNSW Physical Activity and Movement Guideline, which provides a graded mobility schedule.

Observations and monitoring of the patient receiving NIV

Recommendations	Source
On initiation of NIV therapy, observations should be recorded every 30 minutes for 1-2 hours, then hourly until deemed stable, and frequency documented in notes by medical and nursing team.	Consensus
A comprehensive respiratory assessment should be undertaken and recorded at least once per shift; when the patient's respiratory status changes; and when ventilator settings are adjusted.	Consensus
Oxygen and NIV settings should be prescribed with a target oxygen saturation range and instruction as to SpO_2 and FiO_2 at which a clinical review should be sought, in all cases of AHRF aim for minimum SpO_2 88-92%.	Beasley R, Chien J, Douglas J, et al.[4] Davidson AC, Banham S, Elliott M, et al.[8]

Adult and paediatric patients should receive a thorough respiratory assessment by nursing staff at the commencement of each shift; where the patient's respiratory status changes or where NIV settings are adjusted; and with changes to alternative interface.[7, 8, 27]

Further observations include documentation of NIV parameters and patient comfort.[27] Assessment of ABG should be dependent on the patient's clinical status, as a component of treatment evaluation, and facility/LHD guidelines.[21, 52]

Oxygen and NIV settings should be prescribed with a target oxygen saturation range and instruction, including SpO_2 and FiO_2 levels at which a clinical review should be sought.[4, 8]

Table 7. Observations for adult and paediatric patients receiving NIV[3, 4, 8, 20, 27, 53]

Observations	
Respiratory	• Respiratory rate (RR) • Oxygen saturation (SpO_2) via continuous pulse oximetry should be available in all clinical situations in which oxygen is used[4] • Dyspnoea score • Minute volume (MV) • Tidal volume (TV) • Appropriate tidal volume range [6 – 8ml/kg (IBW)]: – 6-8mL/kg neuromuscular and restrictive chest wall disorders[8] – 8-10mL/kg obstructive diseases and obesity[4, 8] • Leak (acceptable leak as per manufacturer and interface recommendations) • Patient triggering (% or observation of ventilator waveform) • Chest wall movement, ventilator synchrony, accessory muscle use • Chest auscultation • Gastric distention – insertion of gastric tube or venting of PEG/PEJ tubes to decompress stomach[20]
Cardiac	• Heart rate (HR) • Blood pressure (BP) in adults • Continuous cardiac monitoring or continuous oxygen saturation monitoring
Neurological	• Level of consciousness, e.g. alert, confusion (new), voice, pain, unresponsive (ACVPU)
Patient comfort	• Pain score • Sedation score, e.g. Richmond agitation sedation scale (RASS -1 to + 1). (In paediatrics, AVPU and SPOC chart observations may be used.) • Assessment of skin integrity

(contd on the next page)

Table 7. Observations for adult and paediatric patients receiving NIV (cont.)

Observations	
Ventilator settings and parameters *Settings and parameters are dependent on device and mode.	**Mode:** CPAP Spontaneous (S)/ Spontaneous Timed (S/T) Other settings may be used specific to the primary disease groups, e.g. pressure control (PCV A/C)/volume control (VtPS/AVAPS) See Table 3 for description and initial settings for primary disease groups. **Settings and parameters:*** • FiO_2 or litres per minute (L/m) • PEEP (EPAP/CPAP)) • IPAP • Pressure support (PS) • Back-up respiratory rate (BRR) (S/T mode) • Inspiratory time (TInsp) • I:E ratio • IPAP Max/IPAP Min • Rise time/slope • Inspiratory trigger • Expiratory trigger • Tidal volume (VT or TV) • Minute ventilation (spontaneous and timed) **Alarm settings:** • Apnoea alarm • Low and high minute ventilation • Maximum pressure (max P) protection in volume control mode • Low and high respiratory rates • Battery backup
Supplementary observations	
Arterial blood gases	• Arterial blood gases provide the most accurate assessment of acidosis, PaO_2 and $PaCO_2$. • As clinically indicated or requested by medical officer, should rely on other patient clinical parameters to determine success of the therapy. • On the critically ill patient:[4] – with cardiorespiratory or metabolic dysfunction. – who is breathless and a reliable oximetry cannot be obtained. – who has deteriorating oxygen saturation requiring increased FiO_2.

Table 7. Observations for adult and paediatric patients receiving NIV (cont.)

Supplementary observations	
Venous blood gases	If arterial blood gas analysis is unavailable, use venous blood gas analysis: • Consider a diagnosis of AHRF with venous pH <7.32 and $PvCO_2$ >50mmHg. • Interpret with caution; venous PCO_2 does not correlate accurately with arterial PCO_2. (The difference between venous and arterial pH is usually 0.02 to 0.03.) • If access to repeated arterial blood samples is not feasible, monitoring response by measuring the venous pH regularly is a reasonable alternative and preferable to no monitoring.
Radiological evaluation	• Chest radiography
Frequency of vital signs and ventilation observations	**On initiation of therapy, change to settings or deterioration of vital signs:** • Continuous oxygen saturation • Every 30 minutes in the 1 to 2 hour period • Then hourly until stable (no changes to settings required, no deterioration in vital signs) • Once stable, all appropriate alarm parameters should be set.

Skin protection strategies

Skin-protective strategies include:[30-34]

- a correctly fitted mask harness and straps
- ensuring the skin is clean and dry
- regular relief of pressure and skin assessment by removing interface
- use of protective barrier, such as hydrocolloid or silicone dressing
- alternating interface.

Nutrition and hydration

Recommendations	Source
All patients receiving NIV must be referred for dietetics review on initiation of therapy	Consensus
Oral feeding should only be initiated if the patient is able to tolerate small periods off NIV (with or without alternative oxygen therapy) without deteriorating.	Terzi N DM, Reignier J, Ruckly S, et al.[54]
Patients receiving NIV should have strict fluid balance for monitoring of input and output for the duration of NIV therapy	Consensus
Consideration should be given to nasogastric or orogastric tube for decompression in adults	Consensus
Paediatric patients must have nasogastric or orogastric tube inserted while receiving NIV	Mehta NM SH, Irving SY, Coss-Bu JA, et al.[55]
Paediatric patients should be nil by mouth before retrieval	The Royal Children's Hospital Melbourne[21]

A nutritional assessment must be included in the care of the patient, including malnutrition risk and energy requirements. Malnutrition has been associated with adverse outcomes for critically ill patients.[48, 54-57] A nutritional plan should outline when, how and which nutrition option is to be delivered. The care teams involved should include dietetics, speech pathology and intensive care clinicians.

Enteral nutrition should be considered carefully, as it has been associated with an increased risk of airway complications, including vomiting, aspiration, airway obstruction and pneumonia.[32]

Weaning

Recommendations	Source
Protocols or guidelines should be in place that cover the process of weaning from NIV.	Masip J, Peacock WF, Price S, et al.[7]
Weaning parameters and escalation plans should be documented by a medical officer in the patient's health record before commencing the weaning process.	Masip J, Peacock WF, Price S, et al.[7]
Emergency intubation equipment should be available and easily accessible in case weaning fails and intubation is required.	Consensus

NIV should be continued until AHRF has resolved, and is generally ceased when the patient has recovered from the reason the therapy was initiated or at signs of NIV failure.[7]

Respiratory and cardiac units, including close observation units/beds, ED and ICUs that manage patients receiving NIV therapy, should have protocols or guidelines which inform and support the weaning from NIV therapy, whether this is alternating with reduced oxygen therapy, HFNCO therapy or weaning the parameters.[7, 58]

A proportion of patients with COPD and AHRF may require long-term support with domiciliary NIV. They may require discharge on NIV and then should be assessed by a domiciliary ventilatory failure service during their admission within four weeks of discharge to determine their need for long-term support. This should be considered in patients with COPD and chronic hypercapnic respiratory failure, especially in those with recurring admissions with AHRF.[59]

Factors such as $PaCO_2$, pH, respiratory rate and a fluid balance are important indicators of progress and suitability to wean. If a patient shows signs of distress, such as increased respiratory rate or shortness of breath, they should be returned to the pre-weaning therapy/parameters and a medical officer contacted for patient review. The patient should be supported post weaning with controlled oxygen therapy depending on their requirements, maintaining SpO_2 88-92%.[7]

A high proportion of patients with OHS, NMD and restrictive thoracic cage deformities will require ongoing NIV support during their admission. These patients should be assessed by a domiciliary ventilatory failure service at the time of their admission and within four weeks of discharge to optimise long-term ventilatory support for them.

NIV in a palliative care setting

Recommendations	Agreement
Referrals should be made to the palliative care team at the time the decision is made to palliate.	Masip J, Peacock WF, Price S, et al.[7]
Clear goals with endpoints and advance care planning should be established and documented in the patient's care plan, in collaboration with the patient and family.	Masip J, Peacock WF, Price S, et al.[7] Shah NM, D'Cruz RF, Murphy PB[60] Davies JD[61] Tripodoro VA, Rabec CA, De Vito EL[62]
Clinicians caring for palliative patients should have experience in end-of-life care.	Masip J, Peacock WF, Price S, et al.[7]

NIV is seen as an option in improving the quality of life and extending meaningful survival as part of end-of-life care.[63] The use of NIV for symptom management may be considered when invasive mechanical ventilation and monitoring is not a desired option. In patients at the end-stage of chronically progressive diseases such as COPD, MND, chronic heart failure, the goal of therapy is not the improvement of physiological parameters but the palliation of symptoms. There is little evidence that use of NIV at end of life has a preferred benefit for comfort and breathlessness rather than symptom control by palliative medication.[61]

NIV may also be initiated to allow the patient time to establish their preference regarding escalation with a progressive or advanced disease process, or a change in the therapeutic goal to comfort at end of life. In this instance, advanced care planning documentation is essential to determine therapeutic options for the patient.[7]

The use of NIV in the palliative care setting has a weak evidence base, but when used judiciously it should contribute to symptom relief, in addition to other palliative care adjuncts, without adding to the care burden.[7] NIV may relieve breathlessness and improve oxygenation in palliative patients.[60, 64, 65] However, clear endpoints, e.g. more comfort, relief of breathlessness and improved communications, should be established before attempting NIV to avoid futile therapy.[61, 62] Assessment and validated measures of comfort or pain, respiratory distress, agitation and secretion clearance should be used to monitor and evaluate symptom relief.[67]

Clinicians should have training in end-of-life care and be supported by a palliative care team.[7] The following should be considered:

- Reason for the therapy
- Whether therapy will increase or relieve suffering
- Response expected
- Treatment escalation
- Withdrawal of NIV plans.[61, 65]

When the therapeutic goal of care for a patient who is dependent on NIV changes to cease NIV, it may be helpful to down-titrate the dependence with adjustment to medication and other patient-requested comfort measures.

Governance

Recommendations	Source
Patient receiving NIV therapy should be medically reviewed daily at a minimum, and the management documented in the patient's health record	Davies M and Juniper M[66]
The location of the patient is dependent on the severity of illness and the skill level and experience of the nursing staff.	Davidson AC, Banham S, Elliott M, et al.[8] Davies M and Juniper M[66]
NIV should be provided in a designated respiratory, cardiac, intensive care or close observation unit/bed with enhanced staffing levels and monitoring facilities.	Davidson AC, Banham S, Elliott M, et al.[8] Agency for Clinical Innovation[52]
The NIV service should be continually reviewed to ensure patient safety. This review should occur via: • incident reports • agreed datasets with NIV quality indicators • at least quarterly morbidity and mortality multidisciplinary meetings.	Agency for Clinical Innovation[52]
If patients on NIV are managed in multiple areas, shared protocols and guidelines should be used.	Davidson AC, Banham S, Elliott M, et al.[8] Agency for Clinical Innovation[52]
All staff managing patients on NIV should have access to expert NIV education and support.	Davidson AC, Banham S, Elliott M, et al.[8]
An escalation plan should be developed and documented in the patient's health record before commencing NIV.	Davies M, Juniper M[66]
Managers should procure equipment to facilitate appropriate provision of NIV.	Consensus

All patients requiring NIV should be cared for in an environment with the necessary systems and governance structures in place to manage the complexity and acuity of these patients. Patients on NIV should receive high-quality care, in an environment where a culture of improvement with quality and safety processes, initiatives and research exists. Strong clinical leadership, with a multidisciplinary team approach and executive sponsorship and oversight, is essential.

Hospitals providing NIV therapy should be able to provide a 24/7 service that is integrated with critical care services.[8] Where the service is provided over multiple areas, shared protocols and guidelines should be developed and kept up to date to maintain a standard of safe care.[8]

If NIV is provided outside of an ICU setting in a close observation unit, specialist respiratory ward or coronary care unit, the primary supervision of the patient should be under the care of a specialist respiratory physician or an internal medicine physician trained and expert in the delivery of NIV and the treatment of acute respiratory failure.

Education and training

Recommendations	Source
Facilities providing NIV must have formal education processes for staff.	Elliot M, Nava S, Schonhofer B[51] Piper A, Chu CM. Davies M, Juniper M[51, 63, 66]
An education program should be comprehensive and cover all aspects of NIV management.	Elliot M, Nava S, Schonhofer B[51]
Staff should be supported by access to relevant clinical educators, with educational resources readily available.	Consensus
Staff caring for the patient receiving NIV therapy should be deemed competent according to local policies.	Consensus

Staff who provide care for patients on NIV within any hospital setting require training in all aspects of NIV, and must be assessed as competent to provide safe and necessary care.[8] It has been demonstrated that patients have poorer outcomes when they receive NIV in non-designated clinical areas where staff training, patient monitoring and point-of-care testing are not available.[66]

It is necessary to invest in NIV training programs for both nursing, medical and allied healthcare professionals who support the provision of NIV in ICU, critical care areas and respiratory ward areas.[63] Training should involve both theory and practice, and formal assessment of skills knowledge and attitude, and should be supplemented with on-the-job training and refresher sessions.[51, 63, 67] Simulation is also useful for training and assessing competency.[51]

An education/training program needs to be comprehensive and cater for all aspects of NIV management, including managing family expectations of NIV and withdrawal of NIV and associated implications, for all levels of staff and in multiple areas.

Clinical elements required in a training program[51]

- Reason for commencement on NIV
- Patient's pathophysiology of the disease
- Which patients should receive NIV
- Understanding how the therapy works
- When therapy should start and ensuring this happens without delay
- How to use a ventilator or device and altering therapy based on documented parameters
- Escalation when patient is not improving and emergency management
- Troubleshooting equipment
- Care required for the patient during therapy, including correctly fitting masks
- Communication with the patient and family, including difficult conversations when the therapy fails or treatment changes to palliation.
- Managing patient and family expectations of NIV treatment and the withdrawal of NIV with the associated outcomes.

Staffing

Recommendations	Source
The number and skill level of nursing staff required to provide patient care should be based on the number and acuity of the patients within each ward, unit and department in a clinical service.	NSW Ministry of Health[68]
Medical coverage 24/7 to support the NIV patient should be readily available.	Crossingham I[69]

Staff caring for patients on NIV are required to be competent in managing the patient and the device, as well as keeping up to date with regular training and education as technology evolves and patient management changes.[8]

The level of nursing care depends on the level of NIV support a patient needs. The location where the patient is managed depends on their level of acuity. These patients may be managed in an ICU, COU or respiratory ward.

The number and skill level of nursing staff required to provide patient care should be based on the number and acuity of the patients in each ward, unit and department within a clinical service.[70] Nurses and midwives must have the appropriate skills, experience and qualifications for the clinical environment where they provide patient care.

On a dedicated respiratory ward, the nurse capability and skill-mix, patient stability, frequency of observations and nocturnal use of NIV dictate the nurse-to-patient profile. Consideration of these factors and the patient's condition ensures patient safety and allows for a rapid response if the patient's condition deteriorates.[52, 66]

Medical staffing is also essential to provide a NIV service, with medical coverage readily available to patients and nursing staff 24/7 to respond to escalation of care and NIV emergencies.

Conclusion

Careful consideration when selecting a patient for NIV and the timing of such intervention are essential to the success of the therapy. The use of NIV without a criterion that has a strong evidence base is likely to cause a risk of therapy failure, with potentially poor outcomes and the need for escalation to invasive ventilation.

Recent advances in technology leading to NIV devices with automated ventilation algorithms and inbuilt monitoring software capabilities have created an increase in the choice of modes to ventilate patients. However, more research is needed to evaluate whether the improvements gained from the use of these devices ensure safer delivery of this therapy in less acute environments.[70]

References

1. Scala R, Accurso G, Ippolito M, et al. Material and technology: back to the future for the choice of interface for non-invasive ventilation - a concise review. Respiration. 2020;99(9):800-17. Available from: https://www.ncbi.nlm.nih.gov/pubmed/33207357 DOI: 10.1159/000509762

2. Clinical Excellence Commission. Incident Management System. Sydney: CEC; 2021 [cited 10 Dec 2021]. Available from: https://www.ehealth.nsw.gov.au/solutions/clinical-care/quality-safety/ims

3. Therapeutic Guidelines Limited. Non-invasive ventilation: introduction to non-invasive ventilation. Melbourne: Therapeutic Guidelines Limited; 2020 [cited 10 Dec 2021]. Available from: https://tgldcdp.tg.org.au.acs.hcn.com.au/viewTopic?etgAccess=true&guidelinePage=Respiratory&topicfile=noninvasive-ventilation

4. Beasley R, Chien J, Douglas J, et al. Thoracic Society of Australia and New Zealand oxygen guidelines for acute oxygen use in adults: 'Swimming between the flags'. Respirology. 2015 Nov;20(8):1182-91. Available from: https://www.ncbi.nlm.nih.gov/pubmed/26486092 DOI: 10.1111/resp.12620

5. Osadnik CR, Tee VS, Carson-Chahhoud KV, et al. Non-invasive ventalation for people with respiratory failure due to exacerbation of chronic obstructive pulmonary disease (COPD). Cochrane Database Syst Rev. 2017;7. Available from: https://www.cochrane.org/CD004104/AIRWAYS_non-invasive-ventilation-people-respiratory-failure-due-exacerbation-chronic-obstructive-pulmonary DOI: 10.1002/14651858.CD004104.pub4

6. Rochwerg B, Brochard L, Elliott MW, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. Eur Respir J. 2017 Aug;50(2). Available from: https://www.ncbi.nlm.nih.gov/pubmed/28860265 DOI: 10.1183/13993003.02426-2016

7. Masip J, Peacock WF, Price S, et al. Indications and practical approach to non-invasive ventilation in acute heart failure. Eur Heart J. 2018 Jan 1;39(1):17-25. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29186485 DOI: 10.1093/eurheartj/ehx580

8. Davidson AC, Banham S, Elliott M, et al. BTS/ICS guidelines for the ventilatory management of acute hypercapnic respiratory failure in adults. Thorax. 2016;71. Available from: https://thorax.bmj.com/content/71/Suppl_2/ii1

9. Manti S, Licari A, Leonardi S, et al. Management of asthma exacerbations in the paediatric population: a systematic review. Eur Respir Rev. 2021 Sep 30;30(161). Available from: https://www.ncbi.nlm.nih.gov/pubmed/34261742 DOI: 10.1183/16000617.0367-2020

10. Grieco DL MS, Roca O, Spinelli E, et al. Non-invasive ventilatory support and high-flow nasal oxygen as first-line treatment of acute hypoxemic respiratory failure and ARDS. Int Care Med. 2021;47:851–866. Available from: https://link.springer.com/article/10.1007/s00134-021-06459-2 DOI: 10.1007/s00134-021-06459-2

11. Hyzy RC, McSparron JI. Noninvasive ventilation in adults with acute respiratory failure: benefits and contraindications. UpToDate [updated 31 Aug 2022; cited 10 Dec 2021]. Available from: https://www.uptodate.com/contents/noninvasive-ventilation-in-adults-with-acute-respiratory-failure-benefits-and-contraindications?search=Noninvasive%20ventilation%20in%20adults%20with%20acute%20respiratory%20failure:%20benefits%20and%20contraindications&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

12. Scala R. Challenges on non-invasive ventilation to treat acute respiratory failure in the elderly. BMC Pulm Med. 2016 Nov 15;16(1):150. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27846872 DOI: 10.1186/s12890-016-0310-5

13. Thille AW, Monseau G, Coudroy R, et al. Non-invasive ventilation versus high-flow nasal oxygen for postextubation respiratory failure in ICU: a post-hoc analysis of a randomized clinical trial. Crit Care. 2021 Jun 28;25(1):221. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34183053 DOI: 10.1186/s13054-021-03621-6

14. Hull J, Aniapravan R, Chan E, et al. British Thoracic Society guideline for the respiratory management of children with neuromuscular weakness. Thorax. 2012;67:i1-i40. Available from: https://thorax.bmj.com/content/67/Suppl_1/i1 DOI: 10.1136/thoraxjnl-2012-201964

15. Fedor KL. Noninvasive respiratory support in infants and children. Respir Care. 2017 Jun;62(6):699-717. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28546373 DOI: 10.4187/respcare.05244

16. The Royal Children's Hospital Melbourne. Continuous positive airway pressure (CPAP) and non-invasive ventilation (NIV), Clinical guidelines (Nursing). Melbourne: RCH; 2022 [updated Jan 2022; cited 10 Dec 2021]. Available from: https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Continuous_positive_airway_pressure_(CPAP)_and_non-invasive_ventilation_(NIV)/

17. Hyzy RC, McSparron JI. Noninvasive ventilation in adults with acute respiratory failure: Practical aspects of initiation. UpToDate [updated 20 May 2022; cited 10 Dec 2021]. Available from: https://www.uptodate.com/contents/noninvasive-ventilation-in-adults-with-acute-respiratory-failure-practical-aspects-of-initiation?search=Noninvasive%20ventilation%20in%20adults%20with%20acute%20respiratory%20failure:%20Practical%20aspects%20of%20initiation&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

18. Jayaev A SR, Steiner MC, McMillan V, Roberts CM. Time to NIV and mortality in AECOPD hospital admissions: an observational study into real world insights from National COPD Audits. BMJ Open Respiratory Research. 2019;6:1-7. Available from: https://bmjopenrespres.bmj.com/content/bmjresp/6/1/e000444.full.pdf

19. Chen T, Bai L, Hu W, et al. Risk factors associated with late failure of noninvasive ventilation in patients with chronic obstructive pulmonary disease. Can Respir J. 2020;2020:8885464. Available from: https://www.ncbi.nlm.nih.gov/pubmed/33123301 DOI: 10.1155/2020/8885464

20. Aitken L, Marshall A, Chaboyer W. ACCCN's Critical Care Nursing 3rd edition. Chatswood: Elsiever; 2015.

21. The Royal Children's Hospital Melbourne. Clinical Guidelines (Nursing): Observation and continuous monitoring. Melbourne: RCH; 2022. [updated April 2019; cited 10 Dec 2021] Available from: https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Observation_and_continuous_monitoring

22. Wheatley I. Use of non invasive ventilation for respiratory failure in acute care. Nursing Times [online]. 2021;117:18-22. Available from: https://www.nursingtimes.net/clinical-archive/respiratory-clinical-archive/use-of-non-invasive-ventilation-for-respiratory-failure-in-acute-care-01-03-2021/

23. The Bottom Line. Conservative oxygen therapy during mechanical ventilation in the ICU. United Kingdom: The Bottom Line; 2019 [updated 1 Nov 2019; cited 10 Dec 2021]. Available from: https://www.thebottomline.org.uk/summaries/icm/icu-rox/

24. Young DP. Critical Care Reviews Podcast [Internet]. Podcast: 34 mins. Available from: https://podcasts.apple.com/au/podcast/mega-rox-trial/id1136652884?i=1000487937153

25. Goksu E, Kilic D, Ibze S. Non-invasive ventilation in the ED: Whom, When, How? Turk J Emerg Med. 2018 Jun;18(2):52-6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29922730 DOI: 10.1016/j.tjem.2018.01.002

26. Roberts CM, Brown JL, Reinhardt AK, et al. Non-invasive ventilation in chronic obstructive pulmonary disease: management of acute type 2 respiratory failure. Clin Med (Lond). 2008 Oct;8(5):517-21. Available from: https://www.ncbi.nlm.nih.gov/pubmed/18975486 DOI: 10.7861/clinmedicine.8-5-517

27. Duan J, Han X, Bai L, et al. Assessment of heart rate, acidosis, consciousness, oxygenation, and respiratory rate to predict noninvasive ventilation failure in hypoxemic patients. Intensive Care Med. 2017 Feb;43(2):192-9. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27812731 DOI: 10.1007/s00134-016-4601-3

28. Soo Hoo GW. Non-invasive ventilation. Medcape; 2020. [updated 18 Jun 2020; cited 10 Dec 2021] Available from: https://emedicine.medscape.com/article/304235-overview

29. Oto J, Nakataki E, Okuda N, et al. Hygrometric properties of inspired gas and oral dryness in patients with acute respiratory failure during noninvasive ventilation. Respir Care. 2014 Jan;59(1):39-45. Available from: https://www.ncbi.nlm.nih.gov/pubmed/23764857 DOI: 10.4187/respcare.02351

30. Alqahtani JS, AlAhmari MD. Evidence based synthesis for prevention of noninvasive ventilation related facial pressure ulcers. Saudi Med J. 2018 May;39(5):443-52. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29738002 DOI: 10.15537/smj.2018.5.22058

31. Barker N, Wilcox M, Elphick H. A review of the benefits, challenges and the future for interfaces for long-term non-invasive ventilation in children. Int J Respir Pulm Med. 2018;5(1):1-7. Available from: https://pdfs.semanticscholar.org/ab8d/03d058657ac6584b1011e51aba0f1e6f9ee3.pdf

32. Brill A. How to avoid interface problems in acute non-invasive ventilation. Breathe. 2014;10(3):230-42. Available from: https://breathe.ersjournals.com/content/10/3/230

33. Mortamet G, Amaddeo A, Essouri S, et al. Interfaces for noninvasive ventilation in the acute setting in children. Paediatr Respir Rev. 2017 Jun;23:84-8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27887916 DOI: 10.1016/j.prrv.2016.09.004

34. Visscher MO, White CC, Jones JM, et al. Face masks for noninvasive ventilation: fit, excess skin hydration, and pressure ulcers. Respir Care. 2015 Nov;60(11):1536-47. Available from: https://www.ncbi.nlm.nih.gov/pubmed/26420902 DOI: 10.4187/respcare.04036

35. Kumar A, Sinha C, Kumar A, et al. Inefficient humidification as the cause of noninvasive ventilation failure in COVID-19 patients. Braz J Anesthesiol. 2021;71(6):671-2. Available from: https://doi.org/10.1016/j.bjane.2021.07.021

36. Alqahtani JS, Worsley P, Voegeli D. Effect of humidified noninvasive ventilation on the development of facial skin breakdown. Respir Care. 2018 Sep;63(9):1102-10. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30166409 DOI: 10.4187/respcare.06087

37. Lebret M, Leotard A, Pepin JL, et al. Nasal versus oronasal masks for home non-invasive ventilation in patients with chronic hypercapnia: a systematic review and individual participant data meta-analysis. Thorax. 2021 Nov;76(11):1108-16. Available from: https://www.ncbi.nlm.nih.gov/pubmed/33859049 DOI: 10.1136/thoraxjnl-2020-215613

38. Clinical Excellence Commission. Decision algorithm for recommended personal protective equipment in allied health procedures. Sydney: CEC; 2020 [cited 10 Dec 2021]. Available from: https://www.cec.health.nsw.gov.au/keep-patients-safe/COVID-19

39. Clinical Excellence Commission. Airway management: respiratory precautions for use during COVID – 19 pandemic. Sydney: CEC; 2020 [cited 10 Dec 2021]. Available from: https://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0010/572563/CEC-Respiratory-Precautions.pdf

40. Clinical Excellence Commission. COVID-19 infection prevention and control manual: for acute and non-acute healthcare settings. Sydney: CEC; 2021 [cited 10 Dec 2021]. Available from: https://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0018/644004/COVID-19-IPAC-Manual.pdf

41. Australian Commission on Safety and Quality in Health Care. 5 moments for hand hygiene. Canberra: Australian Government Department of Health and Aged Care; 2019 [cited 10 Dec 2021]. Available from: https://www.safetyandquality.gov.au/our-work/infection-prevention-and-control/national-hand-hygiene-initiative-nhhi/what-hand-hygiene/5-moments-hand-hygiene

42. Hamilton FW, Gregson FKA, Arnold DT, et al. Aerosol emission from the respiratory tract: an analysis of aerosol generation from oxygen delivery systems. Thorax. 2022 Mar;77(3):276-82. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34737195 DOI: 10.1136/thorax-jnl-2021-217577

43. Wilson NM, Marks GB, Eckhardt A, et al. The effect of respiratory activity, non-invasive respiratory support and facemasks on aerosol generation and its relevance to COVID-19. Anaesthesia. 2021 Nov;76(11):1465-74. Available from: https://www.ncbi.nlm.nih.gov/pubmed/33784793 DOI: 10.1111/anae.15475

44. Winslow RL, Zhou J, Windle EF, et al. SARS-CoV-2 environmental contamination from hospitalised patients with COVID-19 receiving aerosol-generating procedures. Thorax. 2022 Mar;77(3):259-67. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34737194 DOI: 10.1136/thoraxjnl-2021-218035

45. Australian national COVID-19 Clinical Evidence Taskforce. Australian guidelines for the clinical care of people with COVID-19. Canberra: Australian Government Department of Health and Aged Care; 2020 [cited 10 Dec 2021]. Available from: https://snlg.iss.it/wp-content/uploads/2020/11/LG-australian-Full-guidelines-COVID.pdf

46. Gay PC. Complications of noninvasive ventilation in acute care. Respir Care. 2009 Feb;54(2):246-57; discussion 57-8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/19173756

47. Carron M, Freo U, BaHammam AS, et al. Complications of non-invasive ventilation techniques: a comprehensive qualitative review of randomized trials. Br J Anaesth. 2013 Jun;110(6):896-914. Available from: https://www.ncbi.nlm.nih.gov/pubmed/23562934 DOI: 10.1093/bja/aet070

48. Kogo M, Nagata K, Morimoto T, et al. Enteral nutrition during noninvasive ventilation: we should go deeper in the investigation-reply. Respir Care. 2017 Aug;62(8):1119-20. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28733319 DOI: 10.4187/respcare.05684

49. Nickson C. Non-invasive ventilation. Melbourne; Life in the Fast Lane: 2019 [updated: 14 Sep 2019; cited: 10 Dec 2021]. Available from: https://litfl.com/non-invasive-ventilation-niv/

50. Amaddeo A, Khirani S, Griffon L, et al. Non-invasive ventilation and CPAP failure in children and indications for invasive ventilation. Front Pediatr. 2020;8:544921. Available from: https://www.ncbi.nlm.nih.gov/pubmed/33194886 DOI: 10.3389/fped.2020.544921

51. Elliot M, Nava S, Schonhofer B. Non-invasive ventilation and weaning: principles and practice, Second edition: CRC Press; FL, USA: 2019.

52. NSW Agency for Clinical Innovation. Non-invasive ventilation guidelines for adult patients with acute respiratory failure. Sydney: ACI; 2014 [Cited 10 Dec 2021]. Available from: https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0007/239740/ACI14_Man_NIV_1-2.pdf

53. Ergan B, Nasilowski J, Winck JC. How should we monitor patients with acute respiratory failure treated with noninvasive ventilation? Eur Respir Rev. 2018 Jun 30;27(148). Available from: https://www.ncbi.nlm.nih.gov/pubmed/29653949 DOI: 10.1183/16000617.0101-2017

54. Terzi N DM, Reignier J, Ruckly S, et al. Initial nutritional management during noninvasive ventilation and outcomes: a retrospective cohort study. Critical Care. 2017;21(1):293.

55. Mehta NM, Skillman HE, Irving SY, et al. Guidelines for the provision and assessment of nutrition support therapy in the pediatric critically Ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. Parenter Enteral Nutr. 2017;41(5):706-42. Available from: https://ccforum.biomedcentral.com/articles/10.1186/s13054-017-1867-y

56. Perth Children's Hospital. Bronchiolitis. Perth: Perth Children's Hospital: 2020 [updated Dec 2021; cited 10 Dec 2021]. Available from: https://pch.health.wa.gov.au/For-health-professionals/Emergency-Department-Guidelines/Bronchiolitis

57. Singer P, Rattanachaiwong S. To eat or to breathe? The answer is both! Nutritional management during noninvasive ventilation. Crit Care. 2018 Feb 6;22(1):27. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29409542 DOI: 10.1186/s13054-018-1947-7

58. Aitken L, Marshall A, Chaboyer W. Ventilation and oxygenation management. In: Paulus F, Rose L, editors. Critical Care Nursing. 4th Ed. Elsevier; 2019. p. 493-525.

59. Macrea M, Oczkowski S, Rochwerg B, et al. Long-term noninvasive ventilation in chronic stable hypercapnic chronic obstructive pulmonary disease. An official American Thoracic Society Clinical Practice Guideline. Am J Respir Crit Care Med. 2020 Aug 15;202(4):e74-e87. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32795139 DOI: 10.1164/rccm.202006-2382ST

60. Shah NM, D'Cruz RF, Murphy PB. Update: non-invasive ventilation in chronic obstructive pulmonary disease. J Thorac Dis. 2018 Jan;10(Suppl 1):S71-S9. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29445530 DOI: 10.21037/jtd.2017.10.44

61. Davies JD. Noninvasive respiratory support at the end of life. Respiratory Care. 2019;64:701-11. Available from: https://pubmed.ncbi.nlm.nih.gov/31110038/. DOI: 10.4187/respcare.06618.

62. Tripodoro VA, Rabec CA, De Vito EL. Withdrawing noninvasive ventilation at end-of-life care: is there a right time? Current opinion in supportive and palliative care 2019;13:344-50. Available from: https://pubmed.ncbi.nlm.nih.gov/31599816/. DOI: 10.1097/SPC.0000000000000471

63. Piper A, Chu CM. Non-invasive ventilation: Inspiring clinical practice. Respirology. 2019 Apr;24(4):306-7. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30508875 DOI: 10.1111/resp.13449

64. Diaz de Teran T, Barbagelata E, Cilloniz C, et al. Non-invasive ventilation in palliative care: a systematic review. Minerva Med. 2019;110:555–63. Available from: https://pubmed.ncbi.nlm.nih.gov/31359741/. DOI: 10.23736/S0026-4806.19.06273-6.

65. Wilson ME MA, Dobler CC, et al. Noninvasive ventilation in patients with do-not-intubate and comfort-measures-only orders: a systematic review and meta-analysis. Crit Care Med. 2018;46:1209–16. Available from: https://pubmed.ncbi.nlm.nih.gov/29498939/ DOI: 0.1097/CCM.0000000000003082

66. Davies MG, Juniper MC. Lessons learnt from the National Confidential Enquiry into Patient Outcome and Death: acute non-invasive ventilation. Thorax. 2018;73:904-7. Available from: https://thorax.bmj.com/content/73/10/904.citation-tools. DOI: 10.1136/thoraxjnl-2018-211901.

67. Davies M, Allen M, Bentley A, et al. British Thoracic Society Quality Standards for acute non-invasive ventilation in adults. BMJ Open Respir Res. 2018;5(1):e000283. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29636979 DOI: 10.1136/bmjresp-2018-000283

68. Australian College of Critical Care Nurses. ACCCN Workforce Standards for Critical Care Nurses. ACCCN; 2016 [cited 10 Dec 2021]. Available from: https://www.acccn.com.au/about-us/publications/workforce-standards

69. Crossingham I. In defence of ward-based non-invasive ventilation. J Intensive Care Soc. 2018 Feb;19(1):4-5. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29456594 DOI: 10.1177/1751143717722351

70. Chu C-M, Piper A. Non-invasive ventilation: a glimpse into the future. Respirology. 2019;24:1140-2. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/resp.13710. DOI: 1111/resp.13710.

Appendix 1: Literature search strategy

The literature search to inform this guideline update and review was undertaken within the context of the 2014 Non-invasive Ventilation Clinical Practice Guideline. Initially, a bibliography citation search was conducted using keywords: “non-invasive ventilation”, “intensive care patients” and “high dependency patients”. Home NIV was excluded. Following this, a structured search of databases was conducted, which is outlined below. Paediatric studies and review articles were also included in this review.

Results of search strategies

Structured research questions:				
1. What is the management of adult patients receiving NIV for acute respiratory failure? 2. What is the management of paediatric patients receiving NIV for acute respiratory failure?				
P	Population (of interest)	Adult and paediatric patients in the ICU, ED and acute respiratory wards		
I	Intervention	Non-invasive ventilation		
C	Control (group)		N/A	✓
O	Outcome (measured)			

Search strategy

Databases:		PubMed, Medline, Cochrane, Google	
Key words/terms:		NIV and acute respiratory failure, Clinical observations for patients receiving NIV, Observations for patients on NIV, Monitoring of patients receiving NIV, NIV complications, Troubleshooting NIV, Paediatric NIV ventilation settings, adult NIV ventilation settings, Paediatric and adult NIV interfaces, care of the patient receiving NIV, Risks of NIV, Nutrition for the patient receiving NIV, humidification and NIV.	
Publication years:		2014-2021	
Other search filters:		Meshing of terms, and combined searches included in strategy	
English language only		✓	
Adult	37	Paediatric	10

New evidence, which became available since the guideline was first published in 2014, as well as some studies included in the guidance previously have been used in this update.

Glossary

ABG	arterial blood gas
ACPO	acute cardiogenic pulmonary oedema
AHRF	acute hypoxic respiratory failure
AGP	aerosol generating procedure
AVAPS	assured volume assisted pressure support
ACVPU	alert confusion voice pain unresponsive
BIPAP	bilevel positive airway pressure
BRR	back-up respiratory rate
CCU	coronary care unit
CLD	chronic lung disease
CEC	Clinical Excellence Commission
CO_2	carbon dioxide
COPD	chronic obstructive pulmonary disease
COU	close observation unit
COVID	coronavirus disease
CPAP	continuous positive airway pressure
CPG	clinical practice guide
CT	computed tomography
CWD	chest wall deformity
DMD	duchenne muscular dystrophy
ED	emergency department
EPAP/PEEP	expiratory positive airway pressure/positive end expiratory pressure
IBW	ideal body weight
IPAP	inspiratory positive airway pressure
FiO_2	fraction of inspired oxygen

Glossary (cont.)

GCS	Glasgow Coma Scale
HME	heat and moisture exchange
ICNSW	Intensive Care New South Wales
HFNCO	high flow nasal cannula oxygen
ICU	intensive care unit
ISOC	immuno-supportive oral care
LHD	local health district
NIV	non-invasive ventilation
MND	motor neurone disease
MNW	motor neurone weakness
OHS	obstructive hypoventilation syndrome
OSA	obstructive sleep apnoea
PEG/PEJ	percutaneous endoscopic gastrostomy/jejunostomy
PPE	personal protective equipment
PS	pressure support
RASS	Richmond Agitation Sedation Scale
RR	respiratory rate
SMA	spinal muscular atrophy
SPOC	Standard Paediatric Observation Chart
OSA	Obstructive Sleep Apnoea
SpO_2	plethysmography oxygen saturation
SaO_2	Arterial oxygen saturation
VBG	venous blood gas
V_T or TV	tidal volume
VtPS	volume targeted pressure support

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