ACI NSW Agency for Clinical Innovation

ICCMU Intensive Care Coordination & Monitoring Unit

IC Manual
best practice guidelines for intensive care

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

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Disclaimer

- This clinical practice guideline (CPG) is aimed at providing the clinicians working in NSW hospitals' intensive care units (ICU) with recommendations to frame the development of policies and procedures related to the provision of non-invasive ventilation for critically ill adult patients in acute care facilities.
- This CPG is not intended to replace the critical evaluation processes that underpin the development of local policy and procedure nor does it replace a clinician's judgment in an individual case.
- Users of this CPG must critically evaluate this CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review conducted. In addition, NSW Health clinicians must review NSW State Government policy documents to identify any directives that may relate to this clinical practice.
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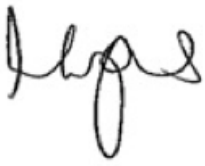
FOREWORD

Over the past three decades non-invasive ventilation has emerged as a core therapy in the management of patients with acute and chronic respiratory failure. Adult patients receiving non-invasive ventilation require complex care involving clinicians across healthcare specialties, highlighting the need for good communication, coordination and teamwork.

The purpose of this guideline is to provide intensive care clinicians with best practice recommendations and guidance about how to best deliver non-invasive ventilation to patients who need this sometimes life saving technology.

Developed under the auspices of the Intensive Care Best Practice Manual Project, this guideline highlights the ability of the Agency for Clinical Innovation (ACI) to facilitate strong working relationships with clinicians as well other executive branches of the Ministry.

On behalf of the ACI, I would like to thank Susan Pearce, Chief Nursing and Midwifery Officer for providing state executive sponsorship for the project and funds for the Project Officer. I would also like to extend my appreciation to the LHD executives for facilitating the participation of LHD staff in developing these guidelines, which I commend to you the clinicians of NSW.



Dr Nigel Lyons
Chief Executive, Agency for Clinical Innovation

ABOUT THE ACI

The Agency for Clinical Innovation (ACI) works with clinicians, consumers and managers to design and promote better healthcare for NSW. It does this by:

- Service redesign and evaluation – applying redesign methodology to assist healthcare providers and consumers to review and improve the quality, effectiveness and efficiency of services.
- Specialist advice on healthcare innovation – advising on the development, evaluation and adoption of healthcare innovations from optimal use through to disinvestment.
- Initiatives including Guidelines and Models of Care – developing a range of evidence-based healthcare improvement initiatives to benefit the NSW health system.
- Implementation support – working with ACI Networks, consumers and healthcare providers to assist delivery of healthcare innovations into practice across metropolitan and rural NSW.
- Knowledge sharing – partnering with healthcare providers to support collaboration, learning capability and knowledge sharing on healthcare innovation and improvement.
- Continuous capability building – working with healthcare providers to build capability in redesign, project management and change management through the Centre for Healthcare Redesign.

ACI Clinical Networks, Taskforces and Institutes provide a unique forum for people to collaborate across clinical specialties and regional and service boundaries to develop successful healthcare innovations.

A priority for the ACI is identifying unwarranted variation in clinical practice and working in partnership with healthcare providers to develop mechanisms to improve clinical practice and patient care.

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All network members completed a 'Declaration of Interest' form based on NHMRC guidelines.
The Guideline Development Network members declared no conflicts of interest.

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1. EXECUTIVE SUMMARY

Over the past three decades the application of non-invasive ventilation (NIV) has emerged as a core therapy in the management of patients with acute and chronic respiratory failure. While the use of NIV in acute respiratory failure was initially confined to the critical care setting it is now well accepted that some patients can be effectively managed in alternative settings where appropriate resources, expertise and staffing are available. The purpose of this guideline is to provide clinicians in adult critical care areas and specialist respiratory care units with best practice guidance regarding the care of patients receiving NIV.

This guideline draws on current best evidence and clinical expertise and describes key aspects of care including: 1) clinical assessment; 2) NIV management; and 3) and patient care. The intent is to support all clinicians so they are able to use NIV in a safe, effective and efficient way across all NSW acute facilities.

The scope of this guideline is for critically ill adult patients who, following medical assessment, require non-invasive positive pressure ventilation. This may occur in intensive care, high dependency and dedicated specialist respiratory units with a higher level of clinical support.

This CPG is not intended to replace the critical evaluation processes that underpin the development of local policy and procedures nor does it replace a clinician's judgment in an individual case. Users of this CPG must critically evaluate this CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review conducted. In addition, users must review local policy and/or government policy documents to identify any directives that may relate to this clinical practice.

SECTION	RECOMMENDATION	GOR
	Indications and contraindications	
1.	Prior to commencement of NIV patients are to be assessed for: • capacity to protect his or her airway • level of consciousness (the exception being suitable "do not intubate" unconscious patients with hypercapnic COPD) • anticipated level of compliance with interface • capacity to manage their respiratory secretions and • potential to recover to a quality of life acceptable to the patient. Failure to meet any one of these criteria renders the patient ineligible for NIV and review of alternate care or escalation of therapy should be undertaken [1, 2].	Consensus
	Assessment	
2.	All patients receiving NIV are to have a documented plan of care. This plan is to be developed on commencement of NIV, reviewed on a regular basis (at least every 24 hours and with a change in the patient's condition) and updated as required. Where available, the care plan is to be developed by a critical care or respiratory Medical Officer or designated clinically qualified respiratory proxy.	Consensus
3.	All patients receiving NIV are to have a formal assessment and documentation of full body skin integrity at least daily. This includes the skin under the interface i.e. nose, face and neck.	Consensus

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SECTION	RECOMMENDATION	GOR
	Continuum of non-invasive ventilation therapy	
4.	Assessment of mask fit, interface type, head strap tightness, skin integrity of mask contact point, ventilation synchrony and degree of mask leak are to be completed each time the interface is adjusted and at least second hourly [3, 4].	Consensus
5.	Interventions to prevent pressure injury secondary to the interface are to be implemented on commencement of NIV.	Consensus
6.	When deterioration in skin integrity is identified, immediate strategies are to be employed to reduce further injury [3].	Consensus
7.	a) Initial settings for bi-level positive airway pressure (BPAP): inspiratory positive airway pressure (IPAP) of 10cmH_2O and expiratory positive airway pressure (EPAP) of 4-5cmH_2O= pressure support (PS) level of 5-6cm H_2O [3, 5]. b) Initial settings for continuous positive airway pressure (CPAP): 5cmH_20 [3, 5].	C
8.	Increases to IPAP of 2-5cmH_2O can be undertaken every 10 minutes or as clinically indicated until therapeutic response is achieved. The maximum IPAP should not exceed 20 – 23 cmH_2O [3].	C
9.	The target tidal volume of 6-8mls/kg (ideal body weight) is the target for all adult patients [4].	C
10.	Optimal non-invasive positive pressure ventilation (NIV) is the lowest pressure and lowest $Fi0_2$ that achieve $Sa0_2$ of 90% or $Pa0_2$ of 60mmHg without further clinical deterioration [6].	Consensus
11.	All NIV circuits are to be actively humidified [7].	C
12.	Heat moisture exchangers (HMEs) are not recommended for NIV [7].	C
13.	Gas temperatures during NIV are to be based on patient comfort [7].	Consensus
	Patient comfort and compliance	
14.	Assessment of patient comfort and pain is to be completed at least second hourly and documented [8].	Consensus
15.	Assessment of patient tolerance for higher levels of NIV is to be completed at least hourly until highest level of compliance reached [8, 9].	Consensus
16.	Patients receiving NIV are to be positioned to achieve maximal chest wall movement and prevent upper airway obstruction [3].	Consensus
17.	A total face or oronasal mask provide a similar clinical outcome and are preferred over the nasal mask in the acute setting [1]. The choice of mask is influenced by: • patient comfort • clinical effectiveness • equipment availability. The total face mask could be considered; however due to the limited use in Australia and limited evidence of greater efficacy it is not the first line therapy.	C

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SECTION	RECOMMENDATION	GOR
	Escalation of therapy	
18	A clear plan for the parameters indicating escalation to intubation and ventilation in the event of NIV failure is to be documented on clinical presentation or initiation of therapy [3].	Consensus
19.	If the patient does not clinically improve within four hours of starting NIV the decision to intubate and ventilate is to be made [3].	A
20.	Intubation and ventilation is to be implemented rather than NIV continued for late failure (where late failure is defined as failure after 48 hours of NIV) [3].	B
21.	A clear plan for the parameters indicating the decision not to intubate and ventilate in the event of NIV failure is to be documented on clinical presentation or initiation of therapy. This decision is to be discussed between the patient (or enduring guardian) and treating medical specialist and documented in the clinical records [3].	Consensus
22.	An advanced health directive is to be completed for any future presentations if one has not previously been completed [10].	GL2005_056
	Palliation	
23.	Palliation for symptom relief, in combination with opioids and benzodiazepines, to treat breathlessness is to be documented on clinical presentation or initiation of therapy by medical staff. Such plans are to be implemented by nursing staff in response to assessment of patient comfort as required [3].	Consensus
24.	Patients with acute respiratory presentations associated with chronic medical conditions are: • to be asked if they have a current advanced health directive prior to the implementation of NIV. A significant other may provide evidence of any directives and should be included in this conversation. • Patients who do not have a current advanced health directive are to be provided with information relating to advanced care planning as part of an integrated care plan for management of their wishes for end-of-life care, once they are clinically stable [10].	Consensus
	Nursing care	
25.	A clear plan for the nursing care to be provided while the patient is receiving NIV is to be documented within 24 hours of initiation of therapy. This plan is to include the psychosocial support including (but not limited to) cultural safety, spiritual needs, family needs and financial concerns.	Consensus
26.	Oral hygiene is to be attended every two hours as long as the patient's tolerance to cessation of NIV is longer than five minutes. Refer to the Oral Care Clinical Practice Guideline for further information.	Consensus
27.	Eye care is to be attended every two hours. Refer to the Eye Care Clinical Practice Guideline for further information.	Eye Care Clinical Practice Guideline
28.	A full body wash, including facial shave, is to be attended daily or more often as required in response to patient diaphoresis and the patient's level of tolerance..	Consensus

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SECTION	RECOMMENDATION	GOR
29.	Patients are to receive pressure injury prevention management as per the Pressure Injury Prevention Guideline.	Pressure Injury Prevention Guideline
30.	Patients are to be encouraged to sit out of bed as tolerated. When in bed they are to be positioned in an upright position to facilitate chest wall expansion.	Pressure Injury Prevention Guideline
31.	The Physical Activity and Movement Guideline provides a graded mobility schedule. Patients are to be assessed and managed as per this guideline.	Physical Activity and Movement Guideline
32.	Pharmacotherapies (i.e. anti-anxiolytics) are to be documented by medical staff on clinical presentation or initiation of therapy and implemented by nursing staff as required in response to patient assessment [3].	Consensus
33.	Referrals to allied health professionals are to be implemented where services are available in the clinical setting to support the patient and his or her significant other/s psychosocial wellbeing.	Consensus
	Nutrition and hydration	
34.	Oral feeding is to be initiated if the patient is able to tolerate small periods off NIV.	Consensus
35.	No oral intake is to be implemented if the patient has a decreased LOC or the patient is in respiratory distress with an increased work of breathing (i.e. R.R > 30/min). Intravenous fluids are to be commenced in these circumstances.	Consensus
36.	Patients receiving NIV are to have daily UECs and LFT blood samples taken for the duration of their NIV therapy to assess fluid and electrolyte status [3].	Consensus
37.	Patients receiving NIV are to have a strict fluid balance and stool chart implemented for the duration of their NIV therapy to assess elimination and fluid status.	Consensus
38.	Dietetics and nutritionist assessments are to be undertaken and documented for the patient receiving NIV 24 hours after initiation of therapy.	Consensus
	Infection prevention	
39.	Clinicians are to undertake a risk assessment to identity the risk of contamination and mucosal or conjunctival splash injuries when caring for a patient being treated with NIV. PPE (including goggles/face shield/gloves and gown/apron) as per NSW 2007 Infection Prevention Control Policy should be worn according to the risk assessment [11, 12].	PD2007_036 Australian Guidelines for Prevention & Control of Infection in Healthcare.
40.	Clinicians must adhere to the Five Moments of Hand Hygiene [13].	PD2010_058
41.	To reduce the risk of microbial transmission, equipment utilised for each patient must be cleaned as per the NSW Infection Control Policy and ASA Standard 4187 prior to and following use [11, 14].	PD2007_036 AS 4187 2003
42.	Items labeled single patient use are intended to be used in the care of one patient only and are to be discarded when the patient no longer requires the item [11].	NSW Policy PD 2007_036

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SECTION	RECOMMENDATION	GOR
43.	Reuse of an NIV circuit/face mask may be possible only if the items are marked as reuse and cleaning instructions are supplied; the manufacturer's recommendations are to be followed. The NSW Infection Control Policy (PD2007_036) states that the circuit and face mask are classified as a semi-critical item and require cleaning and disinfection before reuse [11].	NSW Policy PD 2007_036
	Governance	
44.	Any health facility that provides NIV should have a policy/procedure stating patient selection criteria and management plan/s for patients recovery, NIV including initial settings and escalation strategies [15].	Consensus
45.	The frequency of documentation for NIV is to be at least hourly in the acute phase and then may be reduced to 2-4 hourly once the patient is stable or is in a specialised respiratory unit.	Consensus
46.	Patients receiving NIV must be located in a ward area where there are appropriate numbers of competent staff able to provide monitoring and titration of therapy consistent with all aspects of patient care required.	Consensus
47.	Organisations providing NIV are to have formal education processes relating to NIV and a competency assessment package for new graduates and staff working in these areas.	Consensus
48.	Where hospitals wish to monitor the outcomes of patients receiving NIV, minimum data for collection could include: • Patient outcome (survival/death) • ICU and or specialist ward and hospital LOS • Length of ventilation • Treatment complications • Machine used and settings • Clinical data (diagnosis, PaO_2, $PaCO_2$) • Quality of life assessment / End of Life Care Planning • Dyspnoea scores (Borg)	Consensus

2. INTRODUCTION

Over the past three decades the application of non-invasive ventilation has emerged as a core therapy in the management of patients with acute and chronic respiratory failure. While the use of NIV in acute respiratory failure was initially confined to the critical care setting it is now well accepted that some patients can be effectively managed in alternative settings where appropriate resources, expertise and staffing are available.

With a rapidly emerging evidence base and the availability of constantly improving ventilator technology, keeping up to date with NIV can be a challenge for many clinicians. In NSW, there is considerable clinical variation between facilities and within facilities for utilisation of NIV and patient outcomes (NSW ICU Practice Audit, 2012). Evidence suggests the use of NIV in the management of acute respiratory failure may:

- reduce the need for invasive ventilation
- decrease the need for prolonged mechanical ventilation
- improve patient outcomes
- reduce hospital and ICU length of stay
- reduce mortality and morbidity in those with acute on chronic respiratory failure [16, 17].

Purpose

The purpose of this guideline is to provide a consistent level of support and guidance to clinicians in adult critical care areas and specialist respiratory care units about the care required for patients receiving NIV. This guideline draws on current best evidence and clinical expertise and describes key aspects of care including: 1) clinical assessment; 2) NIV management; and 3) and patient care. The guideline does not include recommendations regarding other treatments that patients may require including bronchodilators, cortocosteroids or antibiotics.

The degree to which an adult patient is compliant with NIV not only relates to his or her presenting physiological condition, it also involves a combination of issues associated with the therapy. Primary among these issues is the care required to ensure patient comfort, and thus, compliance. The development of this guideline is to formulate recommendations about best practice (based on evidence and clinical expertise) for the care to be provided to a person receiving NIV. The recommendations apply to patients receiving NIV in rural, regional or urban setting and in any adult critical care or specialised respiratory unit, irrespective of the level of Medical Officer and/or allied health professional support.

Scope

The scope of this guideline is for critically ill adult patients who, following medical assessment, require non-invasive positive pressure ventilation as an adjunct to standard medical therapy. This may occur in intensive care, high dependency and dedicated specialist respiratory units with a higher level of clinical support. It should be noted that this guideline was developed using evidence of best practice relating to adult patients only. The concepts and recommendations may be considered when providing NIV to children.

Target clinicians

This guideline has been developed for all healthcare professionals who provide care for patients with acute respiratory failure who are treated with NIV including nurses, doctors, physiotherapists and other allied health professionals.

How the guideline was developed

A systematic guideline development method [18] was used, based on NHMRC processes and the AGREE tool. A guideline development network (GDN) was formed. This network developed the guideline template that outlined the clinical question and specific areas to be addressed within the guideline. Following this a systematic review was undertaken (for more details see below). The practice review was restricted to a review of local practices from all

NSW ICUs. Of the 39 ICUs reviewed, there was a large variance in policies, protocols and practices related to the use of NIV. A technical report was developed from the systematic review and this document was used to inform discussions and recommendation development at the consensus meeting (November 27, 2012).

NHMRC evidence statement forms were used. Following the meeting the guideline document was written and circulated among group members. Consensus development and organisational consultation was undertaken over three stages:

- Guideline group consensus - two intensive care doctors were recruited. This larger guideline group received the guideline and technical report. Agreement on recommendations was undertaken using an online survey (Survey Monkey) and a 1-9 Likert scale. Consensus was set as a median of ≥ 7 (see Table 9).
- The external validation group received the guideline and technical report. Agreement on recommendations was undertaken using an online survey.
- Organisational consultation was undertaken by distributing the guideline via ACI network consultation.
- Following each stage the guideline was revised to reflect the feedback received.

Guideline group

The guideline development network (GDN) was comprised of senior nurses working (or formerly working) in NSW intensive care units (ICU) or respiratory specialist nurses (see author list). This group undertook the bulk of work for the guideline. GDN members completed a declaration of interest form based on NHMRC. No conflicts of interest were declared. Consultation at the consensus meeting occurred with nursing and allied health clinicians from the specialised units outside the intensive care environment where NIV occurs.

Consumer consultation

We were unable to recruit a consumer to participate as part of the guideline group or to review the guideline.

Evidence review

A systematic literature review was undertaken. A search of Pubmed, CINAHL, Cochrane and UpToDate was undertaken using the following limits of: 1) 2000-May 2012; 2) English; 3) peer-reviewed; 4) adults. These key words and phrases were used:

- non-invasive positive pressure ventilation
- non-invasive ventilation
- CPAP
- BPAP (biphasic/bilevel)
- care of
- assessment of
- indications for
- contraindications for
- complications of

Senior nurses across NSW intensive care units were allocated a number of journal articles to review using a standard data extraction tool that incorporated SIGN quality criteria for research and AGREE tool for guidelines. Multiple reviewing agents rendered a level of moderation to the selection of evidence that would not otherwise be available. This moderation lends validity to the process of selection of evidence for inclusion in the CPG.

Level of evidence taxonomy

NHMRC procedures and taxonomy were used (See appendix A). Where research evidence could not be identified participants' expert opinion was used with agreement methods applied.

GRADE OF RECOMMENDATION	DESCRIPTION
A	Body of evidence can be trusted to guide practice
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendation/s but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
Consensus	Consensus was set as a median of ≥ 7

Glossary

ABG.....Arterial blood gas

ABHR.....Alcohol-based hand rub

ACPO .....Acute cardiogenic pulmonary oedema

ARF .....Acute respiratory failure

AVPU.....“alert, voice, pain unresponsive” – measure of level of consciousness

BMI .....Body mass index

BPAP.....Bilevel positive airway pressure

BSA .....Body surface area

CPAP .....Continuous positive airway pressure

DC.....Data collector

Dx.....Diagnosis

GDN .....Guideline development network

EUC .....Electrolytes, Urea and Creatinine

GCS.....Glasgow Coma Scale

HDU .....High dependency unit

HME .....Heat and moisture exchange

ICU.....Intensive care units

IDUC .....Indwelling urinary catheter

IRR.....Inter-rater reliability

LFT .....Liver function test

NIV.....Non-invasive positive pressure ventilation

NM.....Nasal mask

ONM .....Oro-nasal mask

PS.....Pressure support

Sx .....Surgery

TFM.....Total face mask

3. RECOMMENDATIONS FOR PRACTICE

Indications and contraindications for NIV

SECTION	RECOMMENDATION	GOR
1.	Prior to commencement of NIV patients are to be assessed for: • capacity to protect his or her airway • level of consciousness (the exception being suitable "do not intubate" unconscious patients with hypercapnic COPD) • anticipated level of compliance with interface • capacity to manage their respiratory secretions and • potential to recover to a quality of life acceptable to the patient. Failure to meet any one of these criteria renders the patient ineligible for NIV and review of alternate care or escalation of therapy should be undertaken [1, 2].	Consensus

Table 2: Clinical indications for non-invasive ventilation

Severe (acute) exacerbation of COPD (pH<7.35 and relative hypercarbia) [5, 16]
ACPO and ARF in the absence of shock or acute coronary syndrome requiring acute coronary revascularization [20]
Immunosuppressed patients with acute respiratory failure [21]
High risk recurrent acute respiratory failure after planned extubation (not indicated post extubation for low risk patients) [1]
Weaning from mechanical ventilation particularly in patients with a background of COPD [22]
Acute respiratory failure following lung resection surgery or post abdominal surgery [1, 23]
Asthma [24]
Acute respiratory failure in selected 'not for intubation' patients [25]
Acute deterioration of disorders associated with sleep hypoventilation such as neuromuscular and chest wall restrictive disorders and obesity hypoventilation syndrome [26-28]
Palliation for symptom relief in combination with opioids and benzodiazepines to treat breathlessness. A medical team decision will be made when NIV is deemed no longer beneficial to the patient's management [3]

Non-invasive ventilation is increasingly being used as an adjunct to standard medical therapy to treat episodes of ARF in the critical care and specialised respiratory ward setting [29, 30]. This technique has also been used as a weaning strategy to facilitate early liberation from invasive ventilation with current evidence suggesting greater benefits in those with a diagnosis of COPD [22]. Although NIV does not reduce the need for reintubation in unselected patients who develop post extubation respiratory failure [1, 30] it has been shown to be effective in preventing respiratory failure after extubation in high risk individuals [31]. When commenced early, NIV has been shown to significantly decrease: mortality, need for intubation, incidence of ventilator-associated pneumonia (VAP), ICU and hospital length of stay (LOS), duration of endotracheal tube (ETT) and total mechanical ventilation, risk of treatment/weaning failure; as well as improve symptoms of respiratory distress in selected patients [17, 22, 32]. Evidence supports the use of bilevel non-invasive ventilation in acute exacerbations of COPD and other disorders characterised by hypoventilation. Continuous positive airway pressure (CPAP) is the other form of NIV, and has been most commonly studied in patients with acute cardiogenic pulmonary oedema (ACPO); While the evidence is mixed regarding the benefit of NIV in ACPO [33], there is a trend towards a reduction in intubation and mortality [34]. However, CPAP is not indicated in the presence of symptomatic CO_2 retention [20]. Evidence for NIV in ARF secondary to acute exacerbations of asthma is controversial; however, if a clinical trial is to be undertaken it should be limited to an appropriately equipped and staffed setting with close monitoring and low thresholds for intubation [1, 24]. At present, there is limited quality evidence to support the use of NIV in disorders such as pneumonia [28] or ARDS [32, 35].

Data from several large registries have shown that over the past decade NIV use has increased at similar relative rates in both COPD and non-COPD diagnostic groups [36]. Of significance for clinical practice, when NIV was used for diagnoses with weak supporting evidence, it was more likely to fail [36]. Furthermore, when patients required intubation after NIV failure they were more likely to die than patients who were intubated directly without a preceding trial of NIV [36]. This highlights the importance of appropriate patient selection when considering NIV.

Despite the benefits to morbidity and mortality classification of disease is not the only determinant for or against the use of NIV; patients must also be assessed for clinical inclusion/exclusion signs and symptoms.

Table 3: Contraindications for non-invasive positive pressure support ventilation

- Heliox therapy in combination with NIV for severe exacerbation of COPD [1]
- Life-threatening hypoxemia (PaO_2 <60mmHg on iO2 100%) [3]
- CPAP in acute lung injury (ALI) [1]
- Respiratory arrest [3]
- Untreated pneumothorax [5]
- Life-threatening dysrhythmias [3]
- Inability to protect own airway [3, 32, 37]
- Copious, unmanageable respiratory secretions [3, 32, 37]
- Facial burns/trauma/recent facial or upper airway surgery [3]

Assessment

SECTION	RECOMMENDATION	GOR
2.	All patients receiving NIV are to have a documented plan of care. This plan is to be developed on commencement of NIV, reviewed on a regular basis (at least every 24 hours and with a change in the patient's condition) and updated as required. Where available, this care plan is to be developed by a critical care or respiratory Medical Officer or designated clinically qualified respiratory proxy.	Consensus
3.	All patients receiving NIV are to have a formal assessment and documentation of full body skin integrity at least daily. This includes the skin under the interface i.e. nose, face and neck.	Consensus

There have been no definitive studies on what observations should be taken on a patient receiving NIV or the optimum frequency of these observations. The frequency and type of observations in this guideline have been based on recommendations from the British Thoracic Society Consensus guideline [3]. This suggests continuous observation of respiratory rate, heart rate, level of consciousness, patient comfort, patient pain score, chest wall movement, ventilator synchrony and accessory muscle use for the first 15 minutes after initiation of treatment, followed by regular observations at 15-minute intervals for the first hour then every 30 minutes in the 1-4 hour period, then hourly for the duration of the treatment.

Regular assessment of gas exchange and acid-base status is required to evaluate the patient's response to treatment. Research has identified that where patients are not shocked the correlation between arterial and venous pCO_2 was poor and it is not clinically acceptable to substitute arterial for venous results [38]. Therefore while venous blood gases (VBGs) are usually easier, less painful and more convenient, it is recommended that ABGs be used to measure biochemistry for patients on NIV.

Table 4 Observations required to inform an integrative management plan lists the parameters to be observed, evaluated and documented to formulate an integrative management plan.

Table 4: Observations required to inform an integrative management plan

BASELINE OBSERVATIONS	
Respiratory	• ABG • RR • SpO_2 • Evaluate patient level of breathlessness - Borg Scale (see Table 5)
Cardiac	• Heart rate • Blood pressure • Cardiac monitoring
Neurological	• Level of consciousness e.g. AVPU
Patient comfort	• Pain score
NB Consider other systems as pertains to patient co-morbidities	
ONGOING OBSERVATIONS	
Repeat ABGs	• After 1 hour of therapy and 1 hour after every subsequent change in settings • After 4 hours or earlier in patients who are not improving clinically
Frequent clinical monitoring of acutely ill patients	• Every 15 minutes in the first hour • Every 30 minutes in the 1-4 hour period • Then hourly
Observations should include:	• RR, continuous pulse oximetry, HR, BP, AVPU • Pain score • Patient comfort, including interface skin integrity • Chest wall movement, ventilator synchrony, accessory muscle use [1]

Table 5: Borg Scale

MODIFED BORG SCALE			
0	Nothing at all	5.	Severe
0.5	Extremely slight (just noticeable)	6.	
1.	Very slight	7.	Very severe
2.	Slight	8.	
3.	Moderate	9.	Extremely severe (almost maximal)
4.	Somewhat severe	10.	Maximal

Borg RPE scale © Gunnar Borg, 1970, 1985, 1994, 1998

Continuum of non-invasive ventilation therapy

Interface

SECTION	RECOMMENDATION	GOR
4.	Assessment of mask fit, interface type, head strap tightness, skin integrity of mask contact point, ventilation synchrony and degree of mask leak are to be completed each time the interface is adjusted and at least second hourly [3, 4].	Consensus
5.	Interventions to prevent pressure injury secondary to the interface are to be implemented on commencement of NIV.	Consensus
6.	When deterioration in skin integrity is identified, immediate strategies are to be employed to reduce further injury [3, 39].	Consensus

The frequency of NIV use in the management of patients with acute respiratory failure has increased over the past decade. One of the factors that have been identified in contributing to the successful application of NIV and patient compliance is the choice of a suitable interface [40].

There are four types of mask interfaces available for use with NIV:

- oro-nasal mask
- nasal mask
- total face mask (TFM)
- helmet

A practice survey audit of NSW ICUs in late 2012 revealed that of the 39 units surveyed, all used the oro-nasal mask, 13 used the TFM, three used nasal masks and only one used the helmet.

Mask (or interface) intolerance may be attributed to several factors:

- discomfort, claustrophobia or poor fit
- excessively tightened straps
- excessive air leak
- patient ventilator asynchrony
- skin breakdown, especially on the bridge of the nose
- oronasal dryness

The oronasal mask covers the nose and mouth and is commonly used and associated with the successful delivery of NIV. They allow mouth breathing and reduce air leaks [41]. However, they may cause patient discomfort, skin breakdown, and air leak due to poor fit over the bridge of the nose or mandible. In addition, they interfere with speech, eating and expectoration [40].

The nasal mask covers the nose only. These masks are associated with less reliable delivery of set pressures as they permit more air leakage through the mouth [41].

Total face masks are larger and cover the whole face. The air seal created around the perimeter of the face eliminates some of the air leak. It also prevents pain and skin damage to the bridge of the nose. Some of its limitations include claustrophobia, increased oronasal dryness and these masks can be difficult to fit and may be associated with greater patient intolerance [8].

The helmet is a special interface device designed to contain the head of the patient completely and it provides a seal all around the patient's neck. The helmet may have several advantages compared to other interfaces. It allows relatively free movement of the head while maintaining a good seal without compression on the face or head. The lack of pressure points on the face avoids the main complications associated with the use of a face mask: intolerance, pain and skin necrosis [42]. However, concerns in relation to use of helmets with hypercapnic patients include less efficient correction of $PaCO_2$ [43] and increased patient ventilator asynchrony compared with face masks [44].

Oronasal masks are generally preferred to other interfaces when initiating NIV in patients with acute respiratory failure [45]. Although nasal masks may be more comfortable for some patients [46] and have been associated with less claustrophobia, however the rate of NIV failure appears to be higher, most likely due to mouth leaks [47]. Pressure injuries, especially over the nasal bridge, occur with both types of mask. Even with prophylactic dressings, around 50% of patients will still develop pressure injuries [39].

When using simple bilevel devices and single limb ventilator circuits, the interface used needs to have a low dynamic dead space to prevent CO_2 rebreathing. This can be achieved by ensuring that the intentional leak ports are positioned within the mask itself rather than between the mask and tubing [25, 48].

Practice point 1: Preventing pressure injury

Prior to commencement of NIV or as soon as practicable, proactive pressure injury prevention measures should be taken. These include use of specialist devices to prevent tubing (e.g. a nasogastic tube) from being pressed into the skin and the use of protective interfaces such as a hydrocolloid dressing.

When deterioration in skin integrity is identified, additional strategies need to be implemented to minimise further injury. These may include: changing the interface (consider full face mask) [8], and repositioning of the interface so as to ensure the mask is not pressing on the bridge of the nose or that the straps are not pressing into the skin.

Initiation and titration of therapy

SECTION	RECOMMENDATION	GOR
7.	a) Initial settings for bi-level positive airway pressure (BPAP): inspiratory positive airway pressure (IPAP) of 10cmH_2O and expiratory positive airway pressure (EPAP) of 4-5cmH_2O= pressure support (PS) level of 5-6cm H_2O [3, 5]. b) Initial settings for continuous positive airway pressure (CPAP): 5cm H_20 [3, 5].	C
8.	Increases to IPAP of 2-5cmH_2O can be undertaken every 10 minutes or as clinically indicated until therapeutic response is achieved. The maximum IPAP should not exceed 20 – 23 cmH_2O [3].	C
9.	The target tidal volume of 6-8mls/kg (ideal body weight) is the target for all adult patients [4].	C
10.	Optimal non-invasive positive pressure ventilation (NIV) is the lowest pressure and lowest $Fi0_2$ that achieve $Sa0_2$ of 90% or $Pa0_2$ of 60mmHg without further clinical deterioration [6].	Consensus

An initial inspiratory positive pressure (IPAP) of 10cmH_20 and expiratory positive airway pressure (EPAP) of 4-5 cmH_20 should be used [3-6]. Note that IPAP-EPAP=Pressure support (PS) level. A tidal volume of 6-8ml/kg should be aimed for [4].

IPAP should be increased by 2-5cm increments at a rate of approximately 5 cmH_20 every ten minutes or as clinically indicated with a usual pressure target of 20 cmH_20 or either a therapeutic response is achieved [3] or patient tolerability has been reached [4].

Acutely ill patients are to be under direct visual observation by appropriately qualified staff. At a minimum, qualified nursing staff must be present at the bedside to provide continuous monitoring and visual observation of the patient's tolerance of NIV until the patient is stable [3-6]. Patients at high risk of adverse complications, including patients who have a decreased level of consciousness secondary to raised CO_2 level or those who are confused and hypoxic, are to remain under constant direct observation until their condition has improved.

Optimal NIV (therapeutic response) is defined as the lowest pressure level of NIV and lowest FiO_2 which maintains SaO_2 at 90% or PaO_2 60 mmHg without further deterioration of any clinical parameters [6].

Humidification

SECTION	RECOMMENDATION	GOR
11.	All NIV circuits are to be actively humidified [7].	C
12.	Heat moisture exchangers (HMEs) are not recommended for NIV [7].	C
13.	Gas temperatures during NIV are to be based on patient comfort [7].	Consensus

Practice Point 2 : Bilevel positive airway pressure settings and pressure support

On many bilevel positive airway pressure specific ventilators IPAP - EPAP= PS. However if using an invasive ventilator in NIV mode the PS level may be above PEEP meaning that PEEP + PS = IPAP (Peak Inspiratory Pressure). It is important to be familiar with the ventilator used at the individual site to ensure that the patient receives the required pressure support level.

The natural human airway heats and humidifies inspired gas, reaching a temperature of 37°C and 100% relative humidity. NIV increases demand on the normal airway. Demand can manifest itself by increasing heat and water loss resulting in drying of the respiratory mucosa leading to respiratory compromise. This may manifest itself as increased mucus viscosity, difficulty in sputum clearance, sputum retention, increase airway resistance, decreased pulmonary compliance and atelectasis [49]. The gas required to deliver NIV combines both entrainment of room air containing ambient humidity and pipeline supplemental oxygen, which is dry gas. Ventilation machines with an inbuilt oxygen blender mix both the ambient and pipeline gas delivered through the circuit. The success of NIV depends on the patient's tolerance of therapy and level of comfort [50]. To aid success inline humidification will complement and enhance normal airway humidification.

There are two inline humidification circuits available for consideration. Heat and moisture exchangers (HME) provide passive humidification and heated humidification provides active humidification. Critical care areas have extensive experience with HMEs as they have been used for the delivery of humidification for invasive ventilation. They are used because of their simplicity and low cost [51]. However it must be accepted that when HMEs are placed inline they increase dead space within the circuit. This dead space can increase resistance to flow and increase the patient's work of breathing (WOB) [52]. For the delivery of NIV an increase in work of breathing may decrease patient compliance to therapy [53]. In addition, mask and mouth leak can occur when using HMEs. This may render the HME less efficient as the purpose of an HME is to capture expired tidal volume moisture so it is not lost to atmosphere [52]. It is worth noting that Boyer [54] found no differences in respiratory outcomes, including respiratory rate, end tidal CO_2, minute ventilation, oxygen saturation, ABG and comfort perception when comparing active and passive humification.

Heated humidification (HH) requires the movement of gas through a heated water chamber. This results in the delivery of increased humidity during NIV therapy to decrease airway resistance, improve ventilation and improve the removal of secretions.[49]. The advantage of this is twofold: first, continuous humidification can be delivered even in the event of mask and/or mouth leaks and second, temperature adjustments can be made to improve patient comfort and thereby increase patient tolerance. It is worth highlighting that studies by Holland [49] found that as IPAP is increased relative humidity is reduced although at higher humidifier temperatures this was less significant.

Patient comfort and compliance

SECTION	RECOMMENDATION	GOR
14.	Assessment of patient comfort and pain is to be completed at least second hourly and documented [8].	Consensus
15.	Assessment of patient tolerance for higher levels of NIV is to be completed at least hourly until highest level of compliance reached [8, 9].	Consensus
16.	Patients receiving NIV are to be positioned to achieve maximal chest wall movement and prevent upper airway obstruction [3].	Consensus
17.	A total face or oronasal mask provide a similar clinical outcome and are preferred over the nasal mask in the acute setting [1]. The choice of mask is influenced by: • patient comfort • clinical effectiveness • equipment availability. The total face mask could be considered; however due to the limited use in Australia and limited evidence of greater efficacy it is not the first line therapy.	C

Patient comfort and enhanced compliance are key factors in determining successful application of non-invasive ventilation. Some of the factors that contribute to patient comfort and compliance include [3, 5, 32]:

- choice of suitable interface
- levels of pressure applied
- position of the patient
- synchrony of ventilation
- pharmacotherapy for dyspnoea, anxiety and pain
- humidification
- palliation of symptoms.

Choice of suitable interface

One of the factors contributing to the successful application of NIV and patient compliance is the choice of a suitable interface. There are four types of mask interfaces available for use with NIV; they are the oronasal mask, nasal mask, total face mask (TFM) and the helmet. A suitable interface is one that provides patient with a good fit and minimises the risk of excessive air leak and skin breakdown due to increased pressure from the interface, especially to the bridge of the nose. It is important to avoid excessively tightened straps and consider whether the patient feels claustrophobic. Regular mouth care is essential to prevent oronasal dryness. A comfortable interface will help avoid some of the adverse effects of NIV and improve patient compliance with therapy [5, 32].

Level of pressure applied

The patient is generally commenced on well-tolerated levels of IPAP and EPAP that can be gradually increased. An initial inspiratory positive airway pressure (IPAP) of 10cm H_2O and expiratory positive airway pressure (EPAP) of 4–5cm H_2O can be used. IPAP should be increased by 2–5cm increments at a rate of approximately 5cm H_2O every 10 minutes until a therapeutic response is achieved or patient tolerability has been reached [3].

Position of patient

The patient should be in a sitting or semi-recumbent position in bed. Consider side lying position to remove pressure from a pendulous abdomen (obesity / pregnancy).

Synchrony of ventilation

Synchrony of ventilation should be checked frequently. Assess and monitor chest wall movement and accessory muscle use [3, 4]. Use a visual analogue scale (0-10: 10 representing maximum comfort, as if you were breathing without a mask; 0 indicates maximum discomfort you could imagine). Frequent clinical monitoring of patients on NIV will enable the assessment of synchrony and aid in the achievement of desired pressure settings.

Pharmacotherapy for dyspnoea, anxiety and pain

Consider the use of appropriate pharmacotherapy to relieve and alleviate symptoms of dyspnoea, anxiety and pain [3].

Palliation

Using NIV to provide palliation of symptoms is appropriate in some patients, where standard medical treatment fails and a decision has been made, and documented not to escalate to intubation and mechanical ventilation or where a patient chooses not to have interventional treatment.

If the patient gains symptom relief continued NIV may be appropriate for palliation of breathlessness but therapy would normally be withdrawn. Opiates and benzodiazepines can be used to treat breathlessness in this situation. The palliative care team should be involved and a suitable care pathway followed after discussion with the patient and family [3].

Escalation of therapy

SECTION	RECOMMENDATION	GOR
18.	A clear plan for the parameters indicating escalation to intubation and ventilation in the event of NIV failure is to be documented on clinical presentation or initiation of therapy [3].	Consensus
19.	If the patient does not clinically improve within four hours of starting NIV the decision to intubate and ventilate is to be made [3].	A
20	Intubation and ventilation is to be implemented rather than NIV continued for late failure (where late failure is defined as failure after 48 hours of NIV) [3].	B
21.	A clear plan for the parameters indicating the decision not to intubate and ventilate in the event of NIV failure is to be documented on clinical presentation or initiation of therapy. This decision is to be discussed between the patient (or enduring guardian) and treating medical specialist and documented in the clinical records [3].	Consensus
22.	An advanced health directive is to be completed for any future presentations if one has not previously been completed [10].	GL2005_056

Escalation plans to invasive mechanical ventilation in the event of NIV failure should be documented in the patient's clinical record on or at the onset of clinical presentation or within four hours of starting NIV [3]. This discussion should occur with the patient and the treating medical specialist where possible. If the patient does not have the capacity to make this decision due to their physical condition, the patient's enduring medical guardian needs to be included as their proxy. In the absence of an enduring guardian, the next of kin may be included in the discussion to escalate therapy however they have no legal capacity to provide consent [3, 55].

Clinical and physical parameters that may be recorded/documented and used to formulated a management plan for escalation to invasive mechanical ventilation include respiratory rate, chest wall movement, accessory muscle use, ventilator synchrony, heart rate, blood pressure, level of consciousness (AVPU or GCS) and ABGs [3].

"Late Failure" is defined as a failure to improve after 48 hours of NIV [3]. It is suggested that for these patients escalation to invasive mechanical ventilation, rather than persisting with NIV, should occur.

If there is uncertainty or invasive mechanical ventilation is considered inappropriate the treating medical specialist, or appropriate proxy, is to discuss this with the patient (where possible), the patient's enduring medical guardian and their next of kin. Documentation of the "not for intubation" plan and limitations to therapy are made in the clinical/medical records [3].

Due to limited literature specific to escalation of NIV to invasive mechanical ventilation, the level of evidence is low.

Palliation

SECTION	RECOMMENDATION	GOR
23.	Palliation for symptom relief, in combination with opioids and benzodiazepines, to treat breathlessness is to be documented on clinical presentation or initiation of therapy by medical staff. Such plans are to be implemented by nursing staff in response to assessment of patient comfort as required [3].	Consensus
24	Patients with acute respiratory presentations associated with chronic medical conditions are: • to be asked if they have a current advanced health directive prior to the implementation of NIV. A significant other may provide evidence of any directives and should be included in this conversation. • Patients who do not have a current advanced health directive are to be provided with information relating to advanced care planning as part of an integrated care plan for management of their wishes for end-of-life care, once they are clinically stable [10].	Consensus

Palliative care is increasingly recognised as an integral component of comprehensive care for all critically ill patients, regardless of prognosis [56]. Pain management and optimal palliative therapy are part of the therapeutic targets for every patient with pain assessment and management falling within the comprehensive cope of care that should be provide concurrently with curative interventions and interdisciplinary care [57].

There is some literature relating to the development of advanced care directives for patients receiving invasive ventilation, but not specifically for NIV [58-60]. The consensus of the development group for this CPG was to apply the evidence of best practice for the intubated/ventilated patient, to the patient receiving NIV.

Patients with current and legally valid advanced health directives must have their wishes in relation to end-of-life care honoured, irrespective of whether this is against the medical model of best practice for patients eligible for NIV [10].

Critically ill patients with medical conditions who require NIV and do not have a current advanced health directive are to be provided with information relating to advanced care planning as part of an integrated care plan for management of their wishes for end-of-life care. This should occur once they are clinically stable [10]. Significant others, including next of kin, have no legal power to consent to an advanced health directive unless they hold enduring power of guardianship for the patient (NSW Guardianship Act 1987), however it is considered good clinical practice to include significant others when clinical decisions have been made relating to escalation or withdrawal of ventilation support [61].

Nursing care

SECTION	RECOMMENDATION	GOR
25.	A clear plan for the nursing care to be provided while the patient is receiving NIV is to be documented within 24 hours of initiation of therapy. This plan is to include the psychosocial support including (but not limited to) cultural safety, spiritual needs, family needs and financial concerns.	Consensus
26.	Oral hygiene is to be attended every two hours as long as the patient's tolerance to cessation of NIV is longer than five minutes. Refer to the Oral Care Clinical Practice Guideline for further information.	Consensus
27.	Eye care is to be attended every two hours. Refer to the Eye Care Clinical Practice Guideline for further information.	Eye Care Clinical Practice Guideline
28.	A full body wash, including facial shave, is to be attended daily or more often as required in response to patient diaphoresis and the patient's level of tolerance..	Consensus
29.	Patients are to receive pressure injury prevention management as per the Pressure Injury Prevention Guideline.	Pressure Injury Prevention Guideline
30.	Patients are to be encouraged to sit out of bed as tolerated. When in bed they are to be positioned in an upright position to facilitate chest wall expansion.	Pressure Injury Prevention Guideline
31.	The Physical Activity and Movement Guideline provides a graded mobility schedule. Patients are to be assessed and managed as per this guideline.	Physical Activity and Movement Guideline
32.	Pharmacotherapies (i.e. anti-anxiolytics) are to be documented by medical staff on clinical presentation or initiation of therapy and implemented by nursing staff as required in response to patient assessment [3].	Consensus
33.	Referrals to allied health professionals are to be implemented where services are available in the clinical setting to support the patient and his or her significant other/s psychosocial wellbeing.	Consensus

There have been no definitive studies on what clinical nursing cares should be provided to a patient receiving NIV or the optimum frequency of these cares. A survey of clinical practice undertaken across the across 39 NSW ICUs simultaneously during the development of this CPG, informed the recommendation statements.

A number of clinical practice guidelines have been developed on oral care, eye care, pressure injury prevention and physical activity and movement. These guidelines should be referred to, to assist in the management of the patient requiring NIV.

Due to this patient group's relative intolerance to disruption of therapy and limited activity tolerance, complications can be difficult to prevent. Patients may be at an increased risk of a number of complications including:

- ocular complications due to the increased gas flows drying the cornea
- poor oral hygiene due to the inability to tolerate removal of the NIV and BPAP mask
- pressure injury development on face due to mask interface and on dependant areas due to reluctance to move due to breathlessness
- abdominal distension due to swallowing of air.

Nursing staff need to take proactive steps to limit complications.

Practice point 3: Oral care

Where the patient cannot tolerate mask removal for oral care use ice chips or artificial saliva solutions to hydrate the oral mucosa.

Psychosocial care

While there is evidence indicating that providing psychosocial support to intubated and ventilated patients including, but not limited to meeting cultural safety, spiritual and family needs and addressing financial concerns is helpful, no evidence was found for the impact of these interventions for patients receiving NIV.

The consensus of the development group for this CPG was to apply the evidence of best practice for the intubated/ventilated patient, to the patient receiving NIV [61]. [62] (2010), suggests that significant improvements in patients' outcomes including vital signs, sleep, satisfaction and decreases in pain and anxiety ratings are linked to psychosocial support for patients in the ICU. The same author found complication rates and length of stay are also reduced when psychosocial support is provided to ICU patients. Psychosocial support may include: religious, spiritual, sleep, familial, social, welfare (financial) and/or emotional support [61].

Nutrition and hydration

SECTION	RECOMMENDATION	GOR
34.	Oral feeding is to be initiated if the patient is able to tolerate small periods off NIV.	Consensus
35.	No oral intake is to be implemented if the patient has a decreased LOC or the patient is in respiratory distress with an increased work of breathing (i.e. R.R > 30/ min). Intravenous fluids are to be commenced in these circumstances.	Consensus
36.	Patients receiving NIV are to have daily UECs and LFTs blood samples taken for the duration of their NIV therapy to assess fluid and electrolyte status [3].	Consensus
37.	Patients receiving NIV are to have a strict fluid balance and stool chart implemented for the duration of their NIV therapy to assess elimination and fluid status.	Consensus
38.	Dietetics and nutritionist assessments are to be undertaken and documented for the patient receiving NIV 24 hours after initiation of therapy.	Consensus

A number of authors have recommended that patients should be able to tolerate small periods off NIV for the purpose of maintaining nutritional intake to meet the increased physiological requirements associated with his or her increased respiratory effort. Patients unable to tolerate these periods of NIV should be considered for escalation of ventilator support.

Practice point 4: Nutrition and hydration

- Patients should have no oral intake if they:
  - have a reduced level of consciousness (consideration should be given to appropriateness of NIV for these patients)
  - are in respiratory distress (i.e. if respiratory rate is greater than 30 breaths per minute, continuous respiratory assessment is recommended)
- To assist in evaluating fluid and electrolyte status patients should have regular (at least daily) EUC and LFTs.
- It is desirable to monitor and document elimination status daily (strict fluid balance chart and consider daily weigh).
- If patients remain NIV dependent for > 24hrs consider dietician review where available.
- Patients must have intravenous access so that fluids and other therapy may be administered.
- Monitor for abdominal distension and consider using an NG tube where abdominal distension occurs.

Infection prevention

SECTION	RECOMMENDATION	GOR
39.	Clinicians are to undertake a risk assessment to identity the risk of contamination and mucosal or conjunctival splash injuries when caring for a patient being treated with NIV. PPE (including goggles/face shield/gloves and gown/apron) as per NSW 2007 Infection Prevention Control Policy should be worn according to the risk assessment [11, 12].	PD2007_036 Australian Guidelines for Prevention & Control of Infection in Healthcare.
40.	Clinicians must adhere to the Five Moments of Hand Hygiene [13].	PD2010_058
41.	To reduce the risk of microbial transmission, equipment utilised for each patient must be cleaned as per the NSW Infection Control Policy and ASA Standard 4187 prior to and following use [11, 14].	PD2007_036 AS 4187 2003
42.	Items labeled single patient use are intended to be used in the care of one patient only and are to be discarded when the patient no longer requires the item [11].	NSW Policy PD 2007_036
43.	Reuse of an NIV circuit/face mask may be possible only if the items are marked as reuse and cleaning instructions are supplied; the manufacturer's recommendations are to be followed. The NSW Infection Control Policy (PD2007_036) states that the circuit and face mask are classified as a semi-critical item and require cleaning and disinfection before reuse [11].	NSW Policy PD 2007_036

Hand hygiene

The NSW Health Hand Hygiene Policy (PD2010_058) states that all staff must perform hand hygiene as per the Five Moments for Hand Hygiene (http://www.hha.org.au/); Hand hygiene must occur before touching the patient; prior to a procedure; after a procedure or body fluid exposure risk; after touching a patient; after touching a patient's surroundings. Hand hygiene can be performed using appropriate soap solutions and water or ABHR (alcohol-based hand rub). Soap and water must be used when hands are visibly soiled.

Based on the 'My 5 moments for Hand Hygiene', URL: http://www.who.int/gpsc/5may/background/5moments/en/index.html *© World Health Organization 2009. All rights reserved.*

NSW Ministry of Health policies

Prevention of infection is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering infection control. Local policy must also be consulted.

1. Infection Control Policy: http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_036.html
2. Infection Control Policy: Prevention & Management of Multi-resistant Organisms (MRO): http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_084.html
3. Hand Hygiene Policy: http://www0.health.nsw.gov.au/policies/pd/2010/pdf/PD2010_058.pdf

Other relevant policies and standards

1. Australian Guidelines for the Prevention and Control of Infection in Health Care http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/cd33_complete.pdf
2. Cleaning, disinfecting and sterilising reusable medical and surgical instruments and equipment, and maintenance of associated environments in healthcare facilities. ASA 4187:2003.

Personal protective equipment

The Australian Guidelines for the Prevention and Control of Infection in Health Care and the NSW Infection Control Policy (PD2007_036) state that all procedures that generate or have the potential to generate secretions or excretions require that either a face shield or a mask with protective goggles be worn. PPE must be discarded appropriately on leaving the patient's environment.

The clinical manifestation of the disease, the site of infection, the presence and type of a pathogen dictate the probability of spread of infection by either droplet or airborne means.

Table 6: Pathogen factors and effects

FACTORS	EFFECT
Type of respiratory activity	Different activities produce different numbers and sizes of particles. e.g. coughing, sneezing,suctioning, chest physiotherapy, non-invasive positive pressure ventilation.
Frequency of respiratory activity	Frequent activities associated with clinical disease are more likely to spread pathogens.
Number of particles generated	Activities that atomise more particles are more likely to spread pathogens e.g. non-invasive ventilation, suction and chest physiotherapy.
Site of infection	Activities that generate aerosols from the infected region of the respiratory tract are more likely to propagate disease.
Pathogen load	Sufficient pathogen load must be present in expelled particles to establish infection in a susceptible individual.
Pathogen type	The size of the pathogen may determine the size and infectivity of expelled particles.

Droplets

Particles are generated by natural human activities including breathing, talking, sneezing and coughing [63]. Airborne sized particles are considered to be ≤ 5µm in size and droplet-sized particles are considered to be ≥5µm in size [63]. Simonds (2010) found that the particle size predominately produced by non-invasive positive pressure ventilation and chest physiotherapy was >10µm [64]. Particle sizes of infectious organisms vary. The NSW Infection Control Policy (PD 2007_036) classifies the additional transmission based precautions required for respiratory infections based on the particle size. Droplets larger than 100µm often fall to the floor within 1m of the source patient or evaporate on surfaces forming fomites and may later become re-suspended in the air [65].

Two studies [66, 67] identified that during NIV droplets were found up to 1m from the patient during therapy such as chest physiotherapy and non-invasive mask positive pressure ventilation. However, the 2007 Centers for Disease Control guideline states that "it may be prudent to don a mask when within 6 to 10 feet of the patient" (1.8 to 3m) [68].

Infectivity of the patient

Patients requiring NIV are critically ill and frequently do not have a microbiological diagnosis of their respiratory failure. Each patient requires a careful risk assessment of their probable diagnosis to guide the appropriate placement of the patient (i.e. isolation) and to inform staff on the need for transmission based precautions. Transmission-based precautions may need to be implemented based on clinical presentation as opposed to confirmed microbiological status.

Selection of PPE

Selection of PPE must be based on assessment of the risk of disease transmission to other patients and staff. Local policies and current health and safety legislation must also be taken into account. The NSW Infection Control Policy (PD2007_036) lists the additional precautions required for a number of diseases transmitted via the droplet or airborne route.

Cleaning of equipment

The manufacturer's instructions regarding single use or reuse of the mask interface and circuit are to be followed. Single patient use items are to be discarded when no longer required by the patient. If the manufacturer's instructions permit mask and circuit reuse then the NSW Infection Control Policy (PD2007_036) is to be followed. The mask and circuit used for NIV are classified as semi-critical items and must be cleaned and disinfected prior to its reuse. Cleaning is to precede disinfection. Items must not be stored soaking in disinfectants as they may become contaminated or the disinfectant may degrade over time. The manufacturer's instructions must be checked for compatibility of the instrument or equipment with the method of disinfection to be used. Disinfection is to be achieved by either thermal or chemical methods. Thermal disinfection must be used in preference to chemical disinfection. Chemical disinfection may only be used for items for which thermal disinfection methods are unsuitable (NSW Health PD2007_036).

Table 7: Respiratory infectious diseases that require additional precautions

DISEASE	AIRBORNE	DROPLET	CONTACT
Avian influenza	X	X	X
Adenovirus pneumonia		X	X
Haemorrhagic fevers (Marburg, Lassa, Ebola)	X	X	X
Haemophilus influenzae		X	
Influenza (seasonal)		X	X
Measles	X		
Neisseria meningitides (Meningococcal disease)		X	
Norovirus	X		X
Pandemic influenza	X	X	X
Parovirus B19		X	
Pertussis (Whooping Cough)		X	
Respiratory syncytial virus (RSV)		X	X
Rubella		X	X
SARS	X	X	X
Shigella (incontinent adults)		X	
Streptococcal pneumonia or Scarlett Fever		X	X
Tuberculosis	X		
Varicella	X		X

Adapted from Australian Government guidelines
(http://www.health.gov.au/internet/wcms/publishing.nsf/content/icg-guidelines-index.htm)

Table 8: Precautions definitions

AIRBORNE PRECAUTIONS	DROPLET PRECAUTIONS
• Negative pressure room (if available) single room if not available • P2 mask	• Single room • Goggles/face shield • Surgical mask
COMBINED AIRBORNE AND DROPLET PRECAUTIONS	**CONTACT**
• Negative pressure room (if available) single room if not available • P2 mask • Goggles/face shield	• Gown • Gloves

Workplace health and safety

Prevention of work injury is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering work health and safety. Local policy must also be consulted.

NSW Work Health and Safety Act 2011
http://www.legislation.nsw.gov.au/maintop/view/inforce/act+10+2011+cd+0+N

The NSW Work Health and Safety Act 2011 states that organisations must eliminate the health and safety risks to workers where at all possible. When it is not possible to eliminate risks, the risk must be minimised as far as reasonably practicable. Organisations must provide appropriate PPE for use by staff. Staff have a responsibility to use that PPE according to Policy.

The worker has an obligation under the NSW Work Health and Safety Act (2011) to;

i) take all reasonable care for their own safety

ii) take care that their acts or omissions do not adversely affect the health and safety of other persons

iii) comply with any reasonable instruction they are given.

Governance

SECTION	RECOMMENDATION	GOR
44.	Any health facility that provides NIV should have a policy/procedure stating patient selection criteria and management plan/s for patients recovery, NIV including initial settings and escalation strategies [15].	Consensus
45.	The frequency of documentation for NIV is to be at least hourly in the acute phase and then may be reduced to 2-4 hourly once the patient is stable or is in a specialised respiratory unit.	Consensus
46.	Patients receiving NIV must be located in a ward area where there are appropriate numbers of competent staff able to provide monitoring and titration of therapy consistent with all aspects of patient care required.	Consensus
47.	Organisations providing NIV are to have formal education processes relating to NIV and a competency assessment package for new graduates and staff working in these areas.	Consensus
48.	Where hospitals wish to monitor the outcomes of patients receiving NIV, minimum data for collection could include: • Patient outcome (survival/death) • ICU and or specialist ward and hospital LOS • Length of ventilation • Treatment complications • Machine used and settings • Clinical data (diagnosis, PaO_2, $PaCO_2$) • Quality of life assessment / End of Life Care Planning • Dyspnoea scores (Borg)	Consensus

Environment (location of care)

To date, no studies have directly evaluated outcomes of acute NIV delivered in ward areas compared to therapy commenced in critical care locations. However, two meta-analyses of NIV in patients with COPD and acute respiratory acidosis found no significant difference in outcomes analysed in relation to location of care [16, 17]. Nevertheless, severity of acidosis at presentation has been shown to be a key factor influencing outcome with NIV [5, 69], with pH <7.25 significantly increasing the likelihood of NIV failure [70], especially if pH remains below this threshold following two hours of therapy [69]. As the benefits of NIV are modified by the severity of the presenting respiratory acidosis, pH is a useful and readily accessible metric for stratifying the risk of NIV failure and identifying the best location to perform therapy. The experience and familiarity of staff using NIV also has implications for the success of therapy, with longitudinal studies demonstrating the ability to manage more severely ill patients over time without increasing the risk of treatment failure [71]. Therefore, cases of mild to moderate respiratory acidosis (7.25-7.35) and single organ failure may be effectively and safely managed in a dedicated ward area, provided sufficiently trained and experienced staff are available to initiate and monitor therapy. Patients with a pH <7.25 or those that are less acidotic but have significant concurrent clinical problems, are better nursed in critical care areas where higher staffing ratios and complex interventions are available.

With the exception of acute cardiogenic pulmonary oedema [39], the evidence for using NIV for other conditions leading to hypoxemic respiratory failure is either weak or lacking [1, 72]. Given the potential for more rapid deterioration and adverse consequences related to accidental disconnection from ventilator support, patients with hypoxemia are more safely managed in more highly monitored and staffed critical care areas.

Staffing

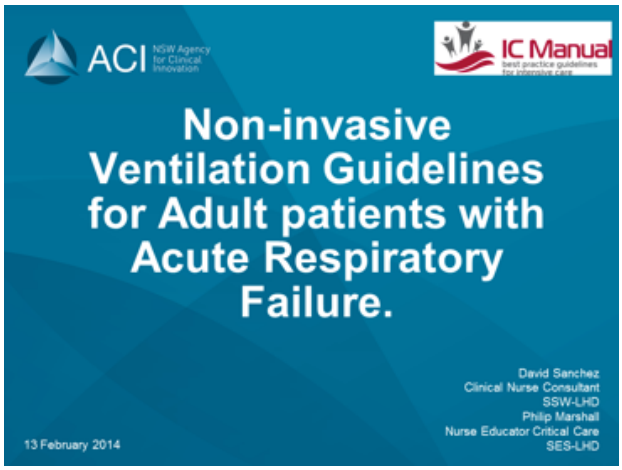
The need for patients managed with NIV to be closely monitored by trained clinicians has been highlighted in a number of studies [5, 16]. Although one of the advantages of NIV is that it can be used with success outside of critical care areas thereby reducing the demand on ICU beds, there still needs to be sufficient staff available to initiate therapy, monitor and troubleshoot problems in order for positive outcomes and patient safety to be achieved. Nurse to patient ratios of 1:1 to 1:2 reported in studies of NIV carried out in critical care areas permit close monitoring and timely intervention as needed and are appropriate for patients with greater acuity of illness [3]. When reported, staffing levels in ward-based studies have been considerably lower, ranging from 1:2.6 to 1:13 [1, 5]. Lower staffing ratios in ward areas have the potential to adversely affect outcome in patients that are not appropriately selected. Although studies have shown NIV does not significantly increase routine bedside nursing workload [5, 73]; it should be appreciated that additional time is required to initiate and fine tune NIV settings, especially during the first eight hours of treatment [73]. In patients with moderate to severe acidosis, failure to spend time individualising and troubleshooting NIV may lead to poorer outcomes [5]. Conversely, patients with milder acidosis may be less tolerant of NIV [1] and without ongoing encouragement use therapy less than is required to gain the full benefits [74]. Failure to identify patients not responding adequately to NIV can cause inappropriate delays in intubation[30] and even if invasive ventilation is commenced morbidity and mortality is increased [29]. Therefore, nurse-patient ratios of no more than 1:2 in critical care areas and 1:4 in a ward settings is recommended to ensure patient safety and rapid response to deterioration.

4. IMPLEMENTATION TOOLS

Education tools

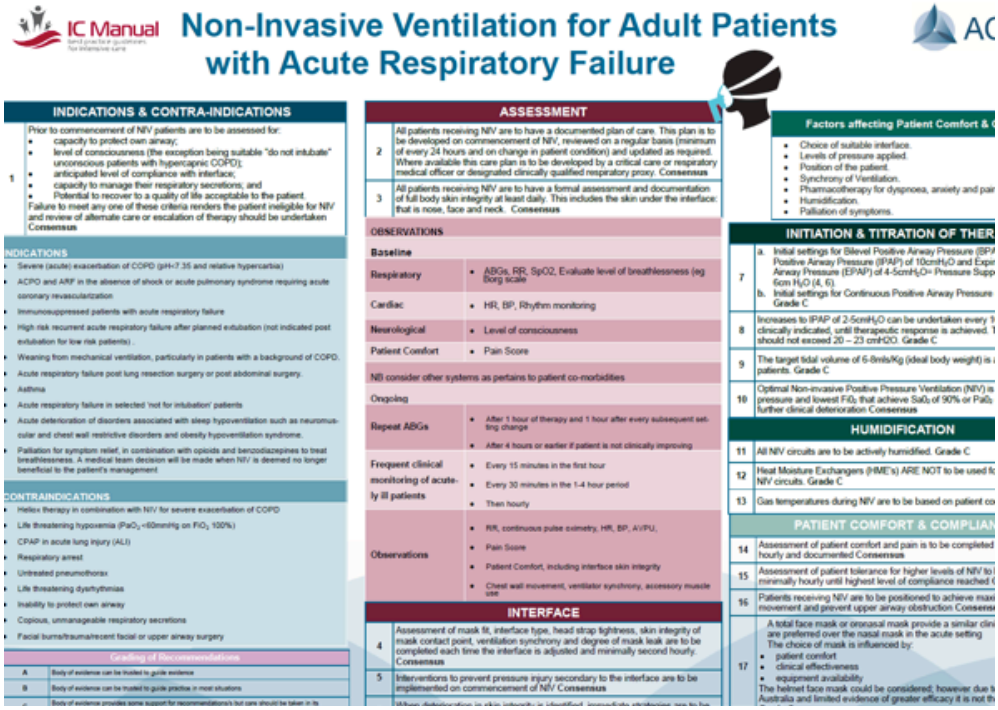
Vodcasts available at ACI Vimeo

http://vimeo.com/user10508752/albums



Wall poster or handout

- Available in A3 or printer-friendly A4 formats



www.aci.health.nsw.gov.au/networks/intensive-care

Acute NIV clinical management plan

Date/time commenced: _____

Mode: _____ Humidification: _____ Inspiratory rise time: _____

Tidal volume: _____ AVPU score: _____ Back-up ventilator rate: _____

Commence pressures	**Bilevel**	IPAP	☐	EPAP	☐
	CPAP	IPAP	☐	EPAP	☐
Final pressures	**Bilevel**	IPAP	☐	EPAP	☐
	CPAP	IPAP	☐	EPAP	☐

Target range pO_2 ___ to ___ / SpO_2 ___ to ___ / pCO_2 ___ to ___

Planned treatment progression

- Acute resuscitation plan y / n
- Advanced care plan y / n
- Agreed treatment ceiling: _____
- Maximum duration NIV trial: _____
- In event of NIV treatment failure escalation plan: _____ Intubation: _____ Palliation: _____
- Appropriate care setting/staff ratio ICU 1:1 ICU 1:2 HDU 1:2
- Specialist close observation ward 1:2 Specialist close observation ward 1:4

	DATE: ___/___/___	**DATE: ___/___/___**	**DATE: ___/___/___**	**DATE: ___/___/___**
O2 l/m on NIV				
O2 l/m off NIV				
NIV removed for				
Max time off NIV				

Weaning plan: _____

_____

_____

Time/date
NIV ceased: _____

Reason: _____

_____

_____

NIV AUDIT TOOL													
			POSSIBLE ANSWERS	1	2	3	4	5	6	7	8	9	10
1	Plan of care	Patient has a documented plan of care completed by a Medical Officer (on initiation and updated 24hrly if applicable)	Yes/No										
2	Interface (mask)	Appropriately fitted to individual patient	Yes/No										
3	Skin integrity	Documented assessment of skin integrity at least daily											
4	Humidification	NIV circuit is actively humidified											
5	Patient care	Oral care and eye care documented as attended 2-4/24											
6	Position	Patient sitting in an upright position											
7	NIV documentation	NIV documentation attended 1/24 (acute phase)											
8	Observations	Clinical observations attended as per guideline (below)											
9	Pain and comfort	Assessed and documented 2/24											
10	Escalation of therapy	A clear plan for the parameters indicating escalation to intubation and ventilation in the event of NIV failure is documented on clinical presentation or initiation of therapy											
11	Staffing	Patient is nursed minimum 1:2 (acute) or 1:4 (ward areas-stable)											
Observations		Repeat ABGs: • after 1 hour of therapy and 1 hour after every subsequent change in settings • after 4 hours, or earlier in patients who are not improving clinically Frequent clinical monitoring of acutely ill patients: • every 15 minutes in the first hour • every 30 minutes in the 1-4 hour period • then hourly Observations should include: • RR, continuous pulse oximetry, HR, BP, AVPU • pain score • patient comfort, including interface skin integrity • chest wall movement, ventilator synchrony, accessory muscle use	COMMENTS										

5. GUIDELINE DEVELOPMENT HISTORY

1. April 2012 – GDN executive formed; guideline scope and systematic review formulated
2. May 2012 – Team building; finalisation of guideline scope and CPG workplan; evidence-based practice education; team plan
3. May-November 2012 – Systematic review work undertaken culminating in development of technical report
4. December 2012 – Consensus development meeting – recommendation development
5. December 2012-June 2012 – Guideline writing
6. June 2013 – Internal consensus (Table 9)

- **Change to recommendations** (Table 10)

7. July 2013 – External validation
8. August 2013 – Organisation consultation via ACI networks – nil changes made

Table 9: GDN and EVP consensus results

RECOMMENDATION	1	2	3	4	5	6	7	8	9	10
Internal consensus	9 (8-9)	9 (8-9)	9 (8-9)	8 (8-9)	8 (8-9)	9 (8-9)	8 (7-9)	8 (8-9)	8 (7-9)	8 (7.75-9)
External consensus	8 (8-9)	8 (8-9)	8 (8-9)	8 (8-9)	8.5 (8-9)	9 (8.25-9)	7 (6.5-8)	7 (5-7.75)	7 (7-8)	7 (7-8)

RECOMMENDATION	11	12	13	14	15	16	17	18	19	20
Internal consensus	8 (7-9)	8 (8-9)	8 (7-8)	8 (8-9)	8 (8)	8 (8-9)	8 (8-9)	9 (9)	8 (8-9)	8 (7-9)
External consensus	8 (6-8)	7 (6-8)	8 (7-9)	8 (8-9)	8 (7-9)	8 (7-9)	9 (8-9)	7.5 (7-8)	8 (8-9)	8 (7-8)

RECOMMENDATION	21	22	23	24	25	26	27	28	29	30
Internal consensus	9 (8-9)	9 (8-9)	8 (8-9)	9 (8-9)	8 (7-9)	8 (8-9)	8 (8-9)	8 (8-9)	8 (8-9)	8 (8-9)
External consensus	7 (7-8)	8.5 (8-9)	8 (8-9)	8 (8-9)	8 (7-9)	7 (7-8)	8 (7-8.75)	7 (7-8)	8 (7.25-9)	9 (8-9)

RECOMMENDATION	31	32	33	34	35	36	37	38	39	40
Internal consensus	8 (8-9)	7.9 (8-9)	8 (8-9)	8 (7-8)	9 (8-9)	8 (7-9)	9 (7-9)	8 (8-9)	8 (8)	8 (8-9)
External consensus	9 (8-9)	7.93 (7-9)	8 (5.5-9)	8.5 (7.25-9)	8 (8-9)	8 (8-9)	7 (7-8)	8 (8-9)	8 (8-9)	8 (7.5-9)

RECOMMENDATION	41	42	43	44	45	46	47	48	49	
Internal consensus	9 (8-9)	8 (8-9)	9 (9)	8 (8-9)	8 (8-9)					
External consensus	9 (8-9)	9 (8-9)	9 (8.25-9)	8.5 (7-9)	9 (8-9)	8 .5 (8-9)	9 (8-9)	8.5 (8-9)	8 (7-9)	

median (IQR)

Table 10: Recommendation change log (post-internal validation)

RECOMMENDATION NUMBER AT EXTERNAL VALIDATION	RECOMMENDATION NUMBER AT INTERNAL VALIDATION	REASON FOR CHANGE
7	7	NIV to be split into two so that settings for BPAP and CPAP can be discussed separately.
8	8	Change of wording to cover maximum level of IPAP.
9	9	Adding "ideal body weight" to statement for initial setting. Not actual weight.
10	10	Change wording to include the word "therapeutic".
28	28	Wording to include "as patient tolerates".
33	33	Add the word "antianxiolitics" after pharmacological intervention.

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