CME article

Noninvasive ventilation: Selection of patient, interfaces, initiation and weaning

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Abstract

Noninvasive ventilation (NIV) is the term used when patients are mechanically ventilated without using an invasive artificial airway. NIV is widely used to provide ventilator support for patients with acute or chronic respiratory failure. This article deals with the indications and contraindications of NIV, various interfaces, their advantages and disadvantages, selection of interface and weaning of patients from NIV.

Keywords: Criteria for success, interfaces, noninvasive ventilation, weaning

Introduction

Noninvasive ventilation (NIV) is the term used when patients are mechanically ventilated without using an invasive artificial airway. NIV is widely used to provide ventilator support for patients with acute or chronic respiratory failure. This article aims to discuss the selection of patients for NIV, selection of interface, devices, its initiation and weaning of patients from NIV.

Delivery and selection criteria

***Delivery*:** There are two basic methods of providing NIV. They are 1) Negative pressure ventilation provided using chest cuirass, pneumobelt or the iron lung and 2) Positive pressure ventilation.

The chest cuirass is placed around the chest and negative pressure is created inside the cuirass which in turn pulls the thoracic cage outward. The pneumobelt is tied around the abdomen and the diaphragm is moved by creating negative pressure inside this pneumobelt. The iron lung encases both the chest and the abdomen inside the tank.

For all practical purposes and for discussion here, we will discuss only noninvasive positive pressure ventilation (NIPPV) and NIV will be synonymous with NIPPV.

Noninvasive positive pressure ventilation

***Benefits*:** NIV in acute care reduces need for intubation, reduces incidence of nosocomial pneumonia, shortens ICU and hospital stay, reduces mortality and preserves ciliary movement. It is more comfortable for the patient and thus reduces requirement of sedation. In chronic care, it alleviates symptoms of chronic hypoventilation, improves duration and quality of sleep, improves functional capacity and prolongs survival.

***Indications for NIV*:** Several conditions have been found to be appropriate for treatment with NIV. The conditions most suited are acute exacerbation of chronic obstructive pulmonary disease (COPD), acute asthma and cardiogenic pulmonary oedema. However, it can also be used in hypoxaemic respiratory failure, community acquired pneumonia, immunocompromised patients, postoperative patients, post-extubation and do not intubate status.

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***Contraindications for NIV*:** NIV is inappropriate in patients with respiratory arrest with a need for immediate intubation, haemodynamically unstable patients, patients with an inability to protect the airway (impaired cough or swallowing) and in those with excessive secretions.

***Selection criteria*:** NIV is selected when *two or more* of the following findings (symptoms and signs of respiratory failure) are present in patients with indications as mentioned above:

1. Use of accessory muscles of respiration
2. Paradoxical breathing
3. RR > 24 breaths / min
4. Dyspnoea (moderate to severe, or increased from baseline in COPD patients)
5. $PaCO_2$ > 45 mm Hg , pH < 7.35
6. PaO_2/ FiO_2 < 200 mm Hg

Interfaces

There are five types of interfaces and they are Nasal Mask/Nasal pillow, Full-Face Mask, Total face Mask, Helmet and Mouth-piece. They can be further classified into vented and nonvented masks. The masks with anti-asphyxia valve and incorporated exhalation ports are usually called vented whereas masks are usually called nonvented if they have a '*standard elbow*'. The advantages and disadvantages of each type are given below in *Table 1*. When selecting the interface the clinician should select an interface that minimises dead space, leaks and maximises comfort.

***Choice of Interfaces*:** In acute care, a full face mask is preferred over nasal masks and nasal pillows whereas in chronic care nasal masks are preferred over nasal pillows, full-face masks and mouthpiece. The factors influencing the choice of interface are type of respiratory failure, patient condition and tolerance. The choice of the type of ventilator must depend on aspects ensuring sufficient CO_2 management (elimination). There should also be adequate safety precautions in case of ventilator failure in order to avoid asphyxia / carbon dioxide (CO_2) narcosis before deciding on the interface.

No interface has been shown to be clearly superior to any other to reduce rate of endotracheal intubation rate or mortality. The full-face interface provides better seal and maintenance of airway pressure, and may be more effective than the nasal interface for adult patients with acute respiratory failure. If carbon dioxide retention is also an issue and if the patients do not tolerate NIV using full-face or nasal masks, the total face mask, can be used to improve patient acceptance. The helmet is better for acute hypoxic respiratory failure and not for NIV treatment of patients with hypercapnic respiratory failure.

There is a risk of facial skin breakdown and is related to the design of face mask. It can be avoided by using the correct sized mask, not securing the headgear too tightly, and using some padding on the bridge of the nose (full-face, nasal masks).

Predictors of success during NIV in the acute care setting

The following parameters are monitored for the prediction of success of NIV in the patients:

- Minimal air leak
- Low severity of illness
- Respiratory acidosis ($PaCO_2$ > 45 mm Hg but < 92 mm Hg)
- pH < 7.35 but > 7.22
- Improvement in gas exchange within 30 min to 2 h of initiation
- Improvement in respiratory rate and heart rate.

The success of NIV depends on the selection of the patient. Although, NIV is widely used both in intensive care unit and chronic care units, there is a low utilisation of NIV especially due to lack of experience among physicians, nurses and respiratory therapists.

***NIV as a weaning tool*:** Weaning from NIV is considered once patients are stable and can be done by progressively decreasing the levels of positive airway pressure, discontinuing the therapy for increasing lengths of time or both.

Prolonged intubation and invasive ventilation carry the risks of ventilator-associated pneumonia and other complications. NIV can be used as an intermediate mode in these patients in whom weaning and extubation has been unsuccessful. Such patients are seen to develop a rapid and shallow breathing pattern during a spontaneous breathing trial. Thus, a weaning strategy that includes NIV

Table 1: Various interfaces used for NIV, their advantages and disadvantages

Interface	Advantages	Disadvantages
Nasal masks	Add less dead space and help minimise the feeling of claustrophobia. Allow eating / drinking and expectoration.	Sometimes, chin straps are used with nasal masks in order to reduce mouth leakage. However, this combination is rarely effective. The improvement in arterial blood gas tensions is slower using nasal masks in comparison with full-face mask.
Nasal pillows	They are less claustrophobic than nasal masks but have similar advantages and disadvantages as nasal masks	Similar advantages and disadvantages to nasal masks when compared with full-face masks.
Full face Mask	Allows delivery of higher ventilation pressures with less leakage. Require less patient cooperation and permit mouth breathing. Higher quality of ventilation (at least during the initial phase of intervention) in terms of minute ventilation and improved blood gases.	
Total Face Mask	Can be used in selected patients with acute and chronic respiratory failure Improves comfort, minimises air leak from the mask interface, improves alveolar ventilation.[1] Less dislodgment and decrease need to adjust the mask. More comfortable than standard face mask.[2] Less claustrophobia.[1]	Greater amount of dead space than nasal or nasal-oral mask. (Nasal 105 mL, full face 250 mL, total face 1,500 mL).[1] Eye irritation and gastric inflation more common.
Helmet interface	The helmet is a new interface with a potential for increasing the success rate of noninvasive ventilation by improving tolerance Theoretically, the helmet has important advantages: • Improved tolerance (satisfactory interaction of the patient with the environment) • Fixation system (may reduce the risk of skin lesions) • Universal fit (can be applied to any patient regardless of facial anatomy)	Less effective in treating hypercapnia. Less efficient in reducing inspiratory effort (triggering and cycling issues). Middle and inner ear damage Noise levels Currently not recommended for treating hypercapnic respiratory failure patients.

may reduce mortality rates and other complications without increasing the risk of weaning failure or reintubation.

It is advisable that once the patient stabilises for at least 48 h on mechanical ventilation, a spontaneous breathing trial (SBT) may be given after at least 48 hours of stabilisation. If it is successful, and the patient is capable of maintaining his own airway with good cough reflexes, the patient can be extubated. If the patient fails SBT, then the patient must be stabilised with full support mechanical ventilation for one hour. After stabilisation, extubate the patient and provide ventilator support with NIV.

NIV is initially given continuously (22-24 h) with discontinuation only for feeding, drinking or expectoration. The time on NIV is gradually decreased according to patient's tolerance and requirement. In case the patient develops postextubation respiratory failure, NIV support should be applied only if there are no contraindications and the patient continues to be compliant.

Complications of NIV: One of the biggest complications of NIV is failure to identify failure of NIV. A reasonable period of NIV should be given to patients who fit the criteria for commencing NIV. Periodic reassessment must be carried out to check whether NIV has been effective. If there is no improvement in oxygenation even after 4-6 hours and the patient continues to be hypoxic (PaO_2/FIO_2 ratio remains low), it may be an indication to intubate his trachea and provide invasive mechanical ventilation.

Interface related problems such as mask intolerance due to claustrophobia and poorly fitting mask are common reasons for failure of NIV.

Mask related: Discomfort, facial skin erythema, nasal bridge ulceration

Pressure related: Nasal congestion, nasal or oral dryness, eye irritation, sinus or ear pain, gastric insufflation

Major complications: Aspiration pneumonia

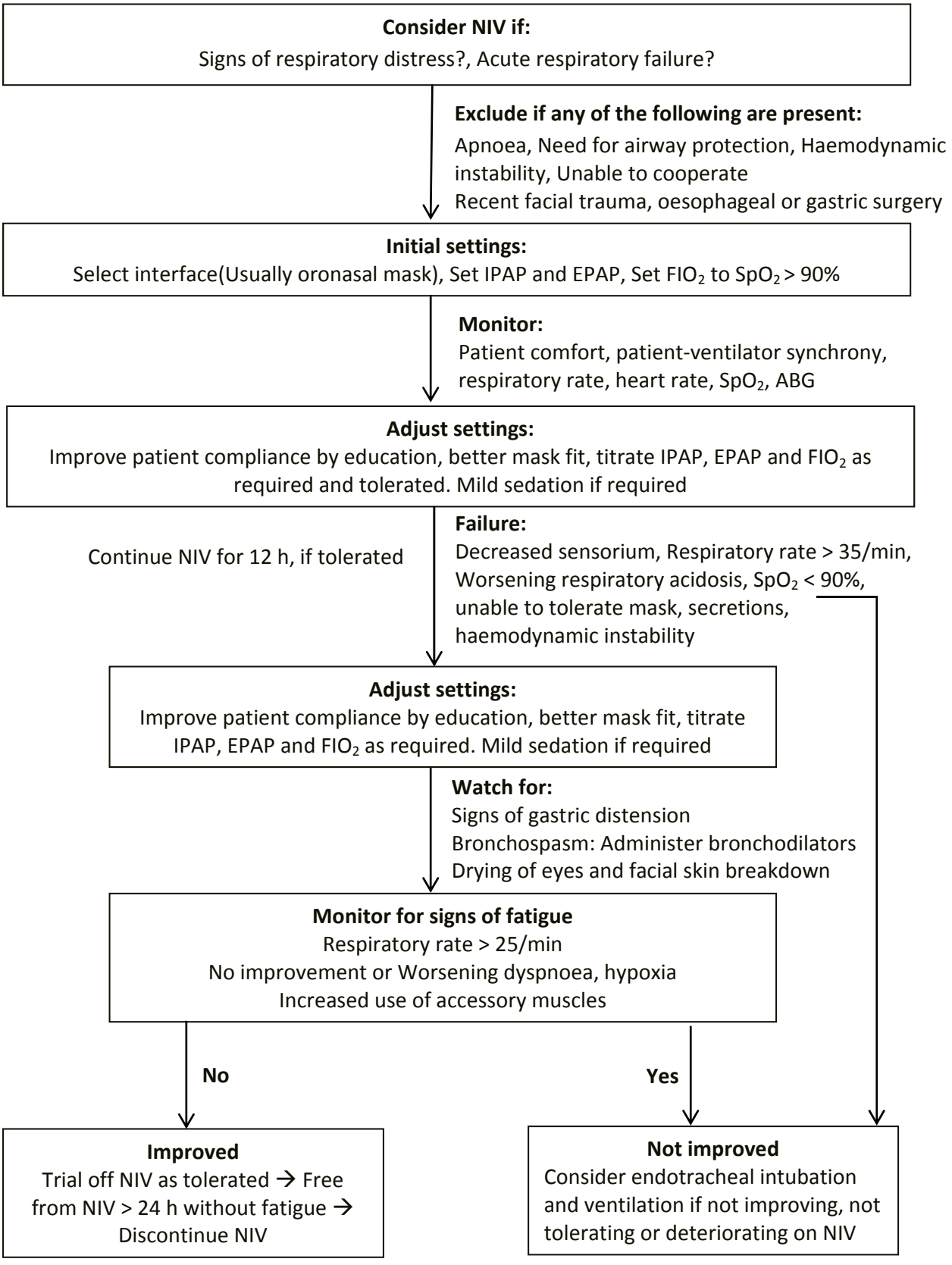

Figure 1: Algorithm for NIV initiation, monitoring and weaning

Summary

NIV is a very useful tool in the intensive care unit. It is best applied to patients in early acute respiratory failure whereas they have also been found to be helpful for the treatment of acute hypercapnic respiratory failure and to facilitate weaning from prolonged invasive mechanical ventilation. The choice of interface and its management affect the success of NIV. Complications, especially interface-related must be avoided meticulously.

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