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Conventional and Non Conventional Interfaces for Non Invasive Respiratory Support

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Conventional and Non Conventional Interfaces for Non Invasive Respiratory Support in Adults and Children

Part two: descriptions, advantages and contraindications.

Success or failure of non invasive respiratory support (NRS) treatment for acute respiratory failure (ARF) is often determined by the choice of the interface. This is mainly due to the strong effect of the interface on a patient's comfort. Furthermore, the interface choice can strongly influence the development of NRS drawbacks, such as air leak, claustrophobia, facial skin erythema, acneiform rash, skin damage, and eye irritation (Nava et al. 2009).

In the first part of this review, we discussed the role of conventional and non conventional interfaces in acute and chronic settings. In Part Two, we will describe interface currently being used in NRS and list the advantages and contraindictations of each.

Mouthpiece

Several types and sizes of mouthpiece are commercially available, to improve patient comfort and patient adherence to NRS. Standard narrow mouthpieces are available with various degrees of flexion, which are held by the patient's teeth and lips; and custom-moulded bite-plates. Oral interfaces are used, especially in North America, for long-term ventilation of patients with severe chronic respiratory failure due to neuromuscular disease, quadriplegia or cystic fibrosis. A recent study suggested that a mouthpiece, in spite of a higher number of asynchronies, was as effective as a full-face mask in reducing inspiratory effort in patients receiving NRS for ARF (Girault et al 2009).

Potentially, mouthpieces may elicit gag reflex, salivation, or vomiting. Long-term continuous use can also cause orthodontic deformities. Vomit aspiration is another potential complication, though so far that risk has only been theoretical. Mouth air leaks may be controlled with a tight-fitting lip seal while nasal pledges or nose clips can be used to avoid leaks through the nares.

Nasal Masks and Pillows

Although nasal masks are often the first choice for long-term ventilation they have also been used for acute hypercapnic and hypoxemic respiratory failure.

Nasal mask interfaces may be divided into the following:
• Full nasal masks (cover the whole nose);

• External nostril masks/nasal slings (applied externally to the nares);
• Nasal pillows or plugs.

Nasal pillows, like nasal slings, have less dead space than facial masks, are less likely to produce claustrophobia, and allow the patient to wear glasses. Nasal pillows offer advantages similar to those of nasal masks: allow expectoration, food intake, speech and reading without removing the mask.

The following lists the potential advantages and contraindications to nasal interfaces:

Advantages

• Less interference with speech and eating;
• Allows cough;
• Less danger with vomiting;
• Claustrophobia uncommon;
• No risk of asphyxia in case of ventilator malfunction;
• Less likely to cause gastric distension; and
• Less likelihood of causing skin breakdown (nasal pillows and nasal slings).

Relative Contraindications

• Leaks from the mouth during sleep;
• Edentulism;
• Nasal resistance > 5 cmH2O.

Absolute Contraindications

• Respiration from the mouth or inability to breath through the nose;
• Oronasal breathing in severe acute respiratory failure;
• Surgery of the soft palate.

Oronasal Masks

Oronasal masks (full-face masks) are the most commonly used for acute respiratory failure (ARF) both of hypoxaemic or hypercapnic origin, followed by nasal masks, total full-face masks, and helmets. Oronasal masks are preferred for patients with ARF because those patients generally breathe through the mouth to bypass nasal resistance. Recent engineering advances remarkably improved mask-face seal comfort and added quick-release straps and anti-asphyxia valves to prevent rebreathing in the event of ventilator malfunction. However the reasons for that preference were the nurses' and/or respiratory therapists' confidence, patient comfort, and minimisation of leaks and complications. It has been found, in the acute setting of hypercapnic respiratory failure, that both nasal and ore-nasal masks performed similarly with regard to improving vital signs and gas exchange and avoiding intubation. However, the nasal mask was less tolerated than the oronasal mask in patients with acute respiratory failure (Kwok et al. 2003). Conversely, in another study in patients with acute on chronic hypercapnic respiratory failure treated with NRS, patient discomfort secondary to the interface was higher in the facial group although nasal group had a significant increase of mask failures.

However studies comparing two different interfaces cannot be blinded and it is impossible to eliminate bias. The decision to change masks was based on subjective opinion by the attending physician and not on objective criteria, and the use of different ventilators to deliver NRS could cause variations in outcome. A cephalic mask (total full-face mask or integral mask) has a soft cuff that seals around the perimeter of the face, so that there is no pressure on areas that an oronasal masks contacts. Compared to conventional fullface mask, a cephalic mask has a larger inner volume because it covers the entire anterior surface of the face. Its main advantage is that it limits the risk of deleterious cutaneous side effects during NRS. This mask also is of potential interest as an alternative to conventional masks for patients with skin breakdown or morphologic characteristics hindering adaptation to other interfaces. It has been found that nose comfort was better with the mouthpiece and the cephalic mask and that the cephalic mask has he same clinical efficacy and requires the same ventilatory settings as the oronasal mask during ARF. It also does not affect carbon dioxide clearance (Fraticelli et al. 2009).

Potential advantages and contraindications of oronasal and/or full-face mask for NRS compared to nasal masks are enlisted below:

Advantages

• Fewer air leaks with more stable mean airway pressure, especially during sleep;
• Less patient cooperation required.

Potential Relative Contraindications :

• Tetraparetic patients with severe impairment in arm movement in the home care setting.

Absolute Contraindications (Common to all Interfaces During NRS):

• Vomiting;
• Claustrophobia.

The Helmet

The helmet has a transparent hood and soft (polyvinyl chloride or silicon) collar that contacts the body at the neck and/or shoulders. A helmet has at least two ports: One through which gas enters, and another from which gas exits. The helmet is secured to the patient by armpit straps. All the helmets on the market are latex- free and available in multiple sizes.
Recent engineering improvements gave helmets more comfortable seals, better seal against leak, and anti-asphyxia valves to limit rebreathing in the event of ventilator malfunction.

Helmets were originally used to deliver an accurate oxygen concentration during hyperbaric oxygen therapy. The United States Food and Drug Administration has not approved any of the available helmets, but helmets have been approved in many European countries.

Potential advantages and contraindications of helmets for NRS compared to oronasal and/or full-face masks are:

Advantages

• Less resistance to flow coming from CPAP flow generator or from the ventilator;
• Can be applied regardless of the facial contour, facial trauma, or edentulism;
• Allows coughing; • Less need for patient cooperation;
• Better comfort;
• Less interference with speech;
• Securing system has lower risk of causing skin damage.

Relative Contraindications

• Need for volume monitoring;
• Patient with high respiratory rate and short inspiratory time.

Absolute Contraindications

• Claustrophobia;
• Tetraplegia.

The helmet has been also proven to be effective and efficient when used outside the ICU (Cosentini et al. 2010; Squadrone et al. 2010).

NRS in Infants and Children

In children hypoxemic respiratory failure mainly occurs in disorders characterised by parenchimal pathologies, such as bacterial and viral pneumonia as well as by airway obstruction, such as bronchiolitis and status asthmaticus (Calderini et al. 2010). Actually there is a lack of well-designed, controlled experiments of nPPV in children with acute hypoxemic respiratory failure. However there are some indications suggesting that nPPV may reduce respiratory rate and heart rate within one hour and reduced tracheal intubation by 47 percent as compared to standard therapy (Yanez et al. 2008). It turns out that patient-ventilator asynchronies frequently occur when nPPV is used and nCPAP by helmet could represent a valid alternative in non-hypercapnic patients. nCPAP has been shown to be effective in the early treatment of acute severe bronchiolitis (Fauroux et al. 2005). Nasal CPAP with either gas mixture (airoxygen or heliox) may be safe and effective in ameliorating gas exchange and respiratory pattern in this population. Furthermore, when heliox is used in place of an air-oxygen mixture the level of improvement of the clinical scores and transcutaneous PCO2 was almost doubled (Martinon-Torres et al. 2008).

Immunosuppressed children have been regarded as having a poor outcome, particularly when tracheal intubation and conventional mechanical ventilation for respiratory failure is required. Thus nPPV may play a relevant role in this setting (Piastra et al. 2009).

In children, the interfaces more frequently used are facial masks, moulded masks and modified nasal cannulae, and in some cases full-face masks, but nasal masks seem to be the preferred type, particularly in younger children. Nasal cannulas and nasal masks are easy to use and keep in place but are highly flow resistive and associated with mucosal bleeding, excess of nasal secretion with nares obstruction. Nasal mask is associated with large air leaks from mouth leading to airway depressurisation and interruption of respiratory treatment. Facial mask has the advantage to limit oral leak but can increase the number of failures due to patient discomfort from tight fitting masks, facial skin breakdown and difficult positioning. The transparent paediatric helmets, made of polyvinyl chloride, have been recently proposed as a possible alternative to masks with better tolerance and reduced need of sedation (Chidini et al. 2010a; Chidini et al. 2010b). However a monitoring of inspired oxygen fraction, pressure and temperature is mandatory even in PICU setting. New options have been recently tested to improve the efficiency of helmets to unload the respiratory system muscles, avoiding the use of a ventilator, thus likely minimising CO2 rebreathing and patient ventilator asynchronies (Moerer et al. 2009; Isgrò et al. 2010).

Conclusion

A wide "armamentarium" of conventional and non conventional interfaces may lead to NRS success both in acute and chronic settings. Oronasal and total full-face masks should be considered the first option in patients with ARF, especially if nPPV is required. Practically, a full face mask or a total full face mask should be the first-line strategy in the initial management of hypercapnic acute respiratory failure with NRS. Differently, in mild ARF we recommend trying a nasal mask first which is better tolerated, or nasal pillows, which is less likely to cause skin damage. In the long term setting nasal mask ventilation and mouthpiece play a major role. Oronasal interfaces as well as tailored made to measure mask may be used in selected case as in chronic mouth breather and children with anatomical difficult profile.

However, the helmets should be considered in special cases, and especially in infants and children with ARF needing CPAP. Helmet CPAP with continuous flow devices may be an appealing approach taking into account the related problems with CO_2 clearance.

Physicians must bear in mind that, when switching from CPAP to nPPV, helmet mechanical property must be considered to obtain effective patient muscle downloading.

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