Volume 3 No. 4, December 2007

Home non-invasive ventilation for children with obstructive sleep apnoea syndrome

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Introduction

Obstructive sleep apnoea syndrome (OSAS) in children is associated with adenotonsillar hypertrophy and airway collapsibility during sleep. These children do not develop significant upper airway obstruction while awake, because of the tonic airway muscle activity. During sleep, upper airway muscles tend to relax, particularly during rapid eye movement (REM) sleep, resulting in the collapse of the upper airway, pressing against the enlarged tonsils and adenoid inside the airway lumen. Furthermore, children with OSAS have increased airway collapsibility during sleep.[1]

Adenotonsillectomy is generally accepted as the first line treatment for children suffering from OSAS.[2] Non-invasive ventilation during sleep is considered an effective alternative.[2,3] The efficacy of NIV has been well demonstrated in recent studies, provided that it is properly used on a regular basis.[4-7] In reality, commencement and maintenance of NIV in children remain challenging.

Indications for NIV

In the author's unit, NIV was often in the groups of children listed in Table 1.

Table 1. Clinical indications for NIV

- Residual OSAS after adenotonsillectomy
- Expected poor outcome of adenotonsillectomy
- Severe OSAS awaiting adenotonsillectomy
- Parental / patients' preference
- Craniofacial / neuromuscular anomalies

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We routinely evaluate the possible regrowth of the adenoid in the cases with residual OSAS after adenotonsillectomy. When a large obstructing adenoid is detected, the treatment of choice is revision adenoidectomy. The decision on expected outcome of adenotonsillectomy is somewhat arbitrary, usually depending on the clinical evaluation of the size of the tonsils and adenoid, in relation to the size of the upper airway space. This decision is often made under joint evaluation with ENT surgeons.

Choice of NIV Ventilation Mode

Portable NIV machines are available in different operating modes. The basic modes include continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BPAP).

CPAP increases intraluminal upper airway pressure, elevating it to above the upper airway critical closing pressure. Thus, CPAP continuously keeps the upper airway passage patent. BPAP has the theoretical advantage of having two levels of pressure, a lower pressure for expiration and a higher pressure for inspiration. BPAP is believed to offer additional benefit of having a higher pressure during inspiration to overcome the airway obstruction, while having a lower pressure during expiration to lower the work of breathing. In practice, the benefit of BPAP has been limited by the problem with leaking and the erratic triggering mechanism. Trigger delay frequently occurs during inspiration and suboptimal timing of the expiratory trigger also occurs.[8,9]

A recently published article has demonstrated a similar adherence rate to treatment with either CPAP or BPAP in children with OSAS.[10] Thus, at present, there is no solid data to show the additional benefit of using BPAP

over CPAP in children with OSAS. Given the additional complexity in titration of the optimal pressure, difficulty in arriving at the optimal trigger setting, and the additional cost for BPAP machine, the author empirically put most patients on CPAP, as the first line NIV treatment. BPAP may be considered as the first line in patients with neuromuscular weakness and patients requiring high pressure setting.

Efficacy of NIV

A few studies have demonstrated the efficacy of NIV. Successful application of CPAP in children were demonstrated in more than 70% of the cases who were able to use it.[6,7,11] However, even with the best possible supervision and support given, around 20-30% of the cases fail to use NIV.[10,11] Most of the failure cases occur at the initiation phase. In those, who have successfully used it, CPAP and BPAP are both effective, with a reasonable adherence.[10]

Institution of NIV

NIV could be applied on the right patients across all age groups from infants to adolescents. Successful institution of NIV requires meticulous attention to a few important principles outlined below.

1) Preparation

a. Explain the nature of NIV in detail, and help patients and parents to have a realistic expectation.
b. Choose the right interface. This may look easy and straightforward but often it is a challenging task requiring meticulous fitting and trial. In general, nasal mask is preferred over full face mask.
c. Help patients develop a positive coping skill towards the challenging task of NIV. Patients who are rather passive almost always end up in failure.
d. Enquire about potential financial difficulty. This helps a lot in minimising the need to switch machines and interface at the later stage because of financial reason.
e. Ensure the patency of the nasal passage. Many patients fail to use NIV simply because their nasal passages are not patent. A combined assessment with ENT surgeon may be required in difficult case.

2) Habituation

a. Successful habituation is the prerequisite for application of NIV. Attempt to put on the NIV in NIV-naïve children after they fall asleep almost always end up in failure, as these children will often wake up in the middle of the night with a complete horror to find the mask on their nose with a strong wind blowing through it.
b. The principle of habituation is to train the patient to tolerate the NIV in phases, to such an extent that the use of NIV has become effortless and without discomfort.
c. In younger children, behavioural desensitisation therapy is often implemented during the habituation phase. This is often done by gradual exposure to the mask and NIV during the daytime.[5,11]
d. In older children, habituation can often be performed by allowing to patient to use a low setting over a short period of duration.

3) Titration

a. The principles of titration is identify an optimal pressure (or pressure range) to maintain airway patency in all body positions and sleep stages, thereby eliminating apnoea, hypopnoea, snoring, and respiratory related arousals.
b. This is best done in the laboratory setting attended by trained technician. The technician is important in the accurate identification of sleep stages, body position, and events, as well as ensuring the proper placement of the mask interface. The technician will then increase or decrease the pressure setting accordingly.
c. Different protocols exist. But the principle is to start with a basic pressure, and gradually stepping it up if obstructive events were observed at that pressure level.
d. Automatically titrating positive airway pressure

4) Monitoring

a. Meticulous initial follow-up is important. Every trivial discomfort or concern should be addressed.
b. Monitoring is best performed with a hotline system, and frequent initial follow-up.
c. Machines capable of tracking the exact usage can be very helpful. The self-reported or parent-reported usage is often unreliable.

Use of Humidifier

Use of convection type heated humidifier is generally encouraged in children using NIV. The humidifier effectively eliminates nasal block, excessive nasal discharge, and sore throat in many patients. These seemingly trivial problems may become the reason for dropout and non-adherence to NIV.

Infection control is an important issue in the use of humidifier. The water chamber should be emptied and rinsed everyday. Regular cleansing of the water chamber according to the product instruction is usually done weekly. Only boiled water or sterile water should be used for filling the water chamber.

Conclusion

NIV is a helpful tool for management of OSAS even in children. CPAP is the most commonly used NIV in this setting. Meticulous attention to the details determines the success rate of NIV.

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