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Guidelines for Medically Stable Children requiring Non-Invasive Ventilation

Aim

This clinical guideline is intended to assist in the management of infants and children who require medium to long term respiratory support in the form of non-invasive ventilatory support such as CPAP or BiPAP **but who are otherwise medically stable**. This is a cross-hospital guideline and where there are slight differences in practice these have been highlighted in blue for CHI at Crumlin and green for CHI at Temple Street

Definition of Terms

NPPV: Non-Invasive Positive Pressure Ventilation; NIV: Non-Invasive Ventilation; CPAP: Continuous Positive Airway Pressure; BiPAP: Bi-level Positive Airway Pressure; IPAP: Inspiratory Positive Airway Pressure; EPAP: Expiratory Positive Airway Pressure; Mode: The mode in which the ventilatory device is set (see S, ST, T); S: Spontaneous mode, in which the machine/device assists each spontaneous respiratory effort; ST: Spontaneous Timed, where a spontaneous breath is assisted and a timed mandatory breath is delivered; T: Timed mode, in which mandatory breaths are delivered according to a set rate; BPM: Breaths per Minute; Ramp: the amount of time taken for the machine to achieve a set pressure (PEEP for CPAP and IPAP for BiPAP); I time (Ti): Inspiratory time; TiMin: The Minimum time spent in inspiration; TiMax: The Maximum time spent in inspiration; OSA: Obstructive Sleep Apnoea; EtCO2: End-tidal Carbon Dioxide; TcCO2: Transcutaneous Carbon Dioxide; Trigger: sensitivity of device/driver to recognise patient taking a breath; Cycle: allows driver/device to recognise when the inspiratory flow is dropping, ventilator changes to allow expiration.

Target patient population

This evidence summary applies to medically stable children requiring noninvasive respiratory support at ward level or acutely unwell children requiring such support within the intensive care unit setting.

Target users

This guide is directed towards health-care professionals engaged in the care of infants and children requiring noninvasive positive pressure support.

Introduction

Non invasive ventilation (NIV) describes the application of positive pressure to the airway without the use of an endotracheal tube. This is commonly applied via a facemask. It can take the form of a constant pressure (CPAP, Continuous positive airway pressure) or pressures that vary with the respiratory cycle (BiPAP, Bi-level positive airway pressure). Pressure is usually delivered via a specific machine designed for non invasive use. This type of ventilation is usually used at home at night but is increasingly being used in hospital in the acute setting (PICU and HDU). The use of non invasive ventilation is a complex procedure with many possible pitfalls, and patients using this system should be regularly followed and assessed by a Respiratory consultant.

Common Uses of NIV

CPAP

- Dynamic upper airway obstruction
  - Obstructive sleep apnoea (OSA)
  - Severe airway malacia
- Acute Respiratory distress
  - Diffuse small airway obstruction eg. Bronchiolitis, asthma

- Acute parenchymal disease eg. Pneumonitis, pneumonia
- Chronic respiratory insufficiency eg. BPD, mild muscular weakness

BIPAP

- Nocturnal hypoventilation
  - Respiratory Muscle Weakness
  - Chronic pulmonary insufficiency eg. Cystic fibrosis (CF)
- Dynamic upper airway obstruction
  - Severe obstructive sleep apnoea (OSA)
  - Severe airway malacia
- Acute Respiratory failure

General Principals

- All patients on NIV at home should have regular out patient follow up by a Respiratory consultant.
- All patients on NIV in the hospital should be under the care of an ICU or Respiratory consultant (if not primarily then as a consulting team).

CHI at Crumlin

- The department of clinical engineering and the NIV nurse specialist should be informed about all inpatients who are using NIV in the hospital.
- All patients on NIV outside of PICU must have a current prescription for NIV in the medical chart at all times. This can be found on the G: drive under NIV scripts. This is accessed only by the respiratory team. If required this can be accessed by the respiratory consultant on call out of hours.

CHI at Temple Street

- the NIV nurse specialist should be informed about all inpatients who are using NIV in the hospital.
- All patients on NIV outside of PICU must have a current prescription for NIV in the medical chart at all times.

Initiation

Initiation can occur in a number of settings.

- In PICU
- Acutely unwell in a ward setting*
- Inpatient wards
- Elective initiation of NIV

In these settings the procedures that should be followed are outlined below:

In PICU

The requirement for NIV will be decided by the ICU consultant. The Respiratory team should be informed if it envisaged that long term use is a possibility.

Acutely Unwell In Ward Setting

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NIV use on inpatient wards occurs in the setting of clinically well children who have been or who are being electively commenced on treatment. **NIV should only be used in the acutely unwell child in either PICU or HDU** (or SMB in CHI at Temple Street). In exceptional circumstances such as in the *palliative* setting or if a child is *in the process of being transferred* to PICU, NIV can be started acutely on certain wards **ONLY under the direct supervision of a Respiratory or PICU consultant and nurse in charge on the ward.** All NIV settings must be agreed by the supervising respiratory/PICU consultant prior to commencing NIV.

CHI at Temple Street

NIV equipment is not available for ward areas out of office hours (except SMB ward). The homecare company is required for initial safe set up of the NIV machine and interface. Younger patients who are acutely

unwell but not requiring PICU admission (e.g. bronchiolitis) may be trialled on NIV using a Fabian machine (only available on SMB HDU) **ONLY if deemed appropriate by the medical, neonatal or PICU consultant on call.**

Elective Initiation of NIV

Initiation of NIV in outpatients is organised through the respiratory team and the NIV nurse specialist. An appointment will be arranged arranged for the patient to come to the NIV out-patient clinic and be seen by the NIV nurse specialist and the Respiratory consultant. The concept of NIV and the specific NIV requirements for the particular patient will be discussed with the parents. The patient will be fitted for a mask by the NIV nurse specialist/Homecare company. The patient will then have an opportunity to get used to the mask at home for a few weeks. The parents will gradually introduce the mask during the day while the child is awake, and advice will be given in relation to behavioural approaches to optimise tolerance. The homecare company will deliver the appropriate interface and machine to the home with settings as prescribed by the consultant.

CHI at Temple Street

The respiratory team will then organise an appointment to admit the child to the hospital electively after a number of weeks for initiation of NIV with their own machine. Parents and guardians are assessed for competency in appropriate NIV use by the respiratory team during their admission.

Inpatient wards

The requirement for NIV will be decided by the respiratory consultant. This should be discussed with the parents, and the risks and benefits explained. Prior to patients starting on NIV for the first time they will be have continuous monitoring of their ventilation, preferably by cardiorespiratory PSG or transcutaneous oximetry/capnography.

The clinical engineer or NIV nurse specialist (homecare company at CHI at Temple Street) will then discuss the interface, machine and pressures with the ordering consultant and start the patient on NIV. Most children will have been introduced to a mask at home. For those naïve to NIV masks, a gradual introduction will occur - initially using the mask during the day. This should be facilitated, where possible, by the play specialist.

Application

- A prescription for CPAP/BiPAP must be completed by a member of the respiratory team prior to commencement of therapy. (This can be found on the hospital G: drive in the NIV scripts folder or on the hospital intranet under respiratory department – CHI at Crumlin) The most up to date script for each patient should be used.
- Any titration or changes to CPAP/BiPAP should be documented in the medical records.
- The patient should be medically reviewed at least daily.

Nursing Responsibilities

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- The initiation of NIV can be an emotional time for a sick child and their family. It is the nurse's responsibility to help support the child and family at this time.
- A close working relationship must exist with nursing staff , NIV nurse specialist, clinical engineer, play specialist and Respiratory team .
- The success of initiation of NIV is critically dependent on the nurses ability to troubleshoot with any issues that may arise with the mask fittings, skin integrity or machine function.

Nursing Action

- Apply CPAP/BiPAP as per algorithm (found at the back of the CPAP & BiPAP care plan)
- Observe child closely following initiation of NIV
- Fill in the appropriate observation chart for CPAP or BiPAP 2 hourly
- Report/record if child tolerated mask /interface
- Observe and try to maintain a snug fit of mask to face
- Frequent checks should be performed to avoid leak / damage to eyes

- Closely observe skin for any signs of pressure sores or marks. Seek advice from the NIV nurse specialist if any skin markings occur.
- Check for gastric distension with NG or PEG feeding – may require increased aspiration or venting to prevent discomfort/vomiting
- For technical issues with the mask or machine for inpatients, the clinical engineer should be contacted.
- For clinical issues, the Respiratory team should be informed.

Safety

The patient receiving any form of CPAP/NIV needs to be medically assessed for their capacity to self-ventilate adequately in case of ventilator, circuit or interface failure. Where a patient cannot self-ventilate adequately there should be provision for the immediate availability of a backup mechanical device/driver, circuit and interface.

Complete standard bedside safety checks

Check that ventilator settings correlate with documented prescription/medical records

Familiarize yourself with equipment checklist at the start of shift

If documented or correlating prescriptions are not present, seek medical input.

Ongoing management

Potential Complications – Clinical

- Secretion build up inside mask
- Oral and Nasal dryness
- Eye irritation from air leak
- Non-compliance with delivery of NIV
- Mucus plugging
- Nasal congestion
- Gastric distension
- Aspiration
- Pressure areas from mask, tubing and strapping
- Pressure areas from nasogastric tubing
- Pneumothorax
- Decreased cardiac output

Potential Complications – Mechanical

- Inadequate ventilation (ie: hypoxaemia, hypercapnoea)
- Mechanical failure of ventilation delivery device
- Mechanical failure of humidification device
- Non 'synchronisation' with device
- Interface leak, damage and misfit
- Circuit leak and damage
- Inadequate humidification
- Change in FiO2 related to leak or change in minute volume

Complications/troubleshooting

- Assess patient for adequacy of airway and breathing / ventilation
- Troubleshoot interface, circuit and device
- Seek medical review when necessary

Always start at the patient and work your way back to the machine.

Low pressure alarms.

- Ventilator tubing not connected or loose connection to the mask.
- Loose connection somewhere else in the circuit.
- Crack, tears or holes in the circuit.

High Pressure alarms

- Coughing, this can cause “back pressure” in the circuit.
- Airway obstruction/mucus plug, in the airway or tube.
- Bent tubing.
- Excessive water in tubing.
- Change in breathing pattern, (breathing hard and fast).

Discharge

On discharge from hospital, all children on NIV should have an appointment for follow up in the Respiratory clinic and an appointment for an overnight oximetry/capnography study to titrate pressures. The following people must be informed when a patient is being discharged from hospital after initial initiation of NIV:

- The NIV nurse specialist (nursing staff)
- The patients PHN (nursing staff)
- The patients GP (Respiratory Team)
- The patients local paediatrician if applicable (Respiratory Team)
- The homecare company

A copy of the prescription should be kept in the patient's notes and on the respiratory G drive, and forwarded to the homecare company.

Risks

The commonest acute risk with NIV is skin marking and damage from mask pressure. This is particularly common in children with developmental delay. Significant skin marking can preclude the use of NIV, a potentially serious complication. This can usually be avoided by ensuring that the mask and head gear are the appropriate fit and size and the mask is not tightened excessively. It can be tempting to over-tighten the mask or headgear to ensure there is no leak. This should be carefully avoided. In the long term, mask pressure can impair the growth of the mid-face and cause significant problems. This is particularly common with nasal masks. Children with nasal masks should have clinical photography of the face on an annual basis – CHI at Crumlin.

Equipment

The NIV machine and the mask are supplied and maintained by the home care company. The details of the relevant companies can be found on the back of the devices. In the community, parents can call the home care company to troubleshoot issues related to the mask or machine. Equipment is rented from the homecare companies, and paid for by the HSE in the case of children with medical cards and certain children with long term illness cards and by the parents in all other circumstances.

Follow Up

With normal growth and development, and changes in clinical conditions over time, NIV requirements may alter. Adequate ventilation needs to be assessed on a regular basis. After initial initiation, children should have a further titration with overnight oximetry / capnography in six to eight weeks. Some children may require additional titration over a number of months to correct abnormalities in ventilation. On a long term basis, children should have annual transcutaneous oximetry / capnography studies to titrate pressures. A download of the machine data should occur at the same time, and regular outpatient follow up in the respiratory clinic is required.

Link to Reference list