Acute Non-Invasive Ventilation (NIV) in Children >10kg

Treatment Guideline and Care Bundle

North Thames Paediatric Network and East of England Paediatric Critical Care Network Approach

N.B Although this guideline is directed at the care of children >10kg receiving Acute NIV this may be limited by device availability in individual Trusts and local agreements, in which case use in conjunction with local policy. (See Appendix 4 for more information)

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Introduction

This guideline has been developed by the North Thames Paediatric Network, the East of England PCC Network, and a working group of key stake holders from hospitals/Trusts from the two networks.

The guideline is intended to reduce variation in practice by promoting a standardised, evidence-based practice approach for delivering acute non-invasive ventilation (NIV) to children > 10kg.

The guideline development process involved a review of current guidelines and policies related to acute NIV from across the regions, and current best practice evidence and research.

This guide is only intended for use with children > 10kg and is only recommended by this group for these patients. For the neonatal patient population, and for children <10kg, please refer to alternative guidelines.

Although this guideline is directed at the care of children aged > 10kg, this may be limited by device availability in individual trusts, in which case please use this document in conjunction with local policy. (See Appendix 4 for more information)

This work has been developed with the best intentions to guide clinical practice, it does however, not remove the need for robust clinical assessment and expertise in decision making in the best interests of the child and family.

What is Non-Invasive Ventilation?

Non-invasive ventilation (NIV) is a method of delivering oxygen by positive pressure mask that allows the treating team to delay or prevent invasive tracheal intubation and ventilation in children who present with acute respiratory failure.

There are two primary modalities of NIV:

- Continuous positive airway pressure (CPAP)
- Bi-level positive pressure ventilation (BiPAP)

CPAP delivers a set pressure to the airways that is maintained throughout the respiratory cycle, during both inspiration and expiration. The application of CPAP maintains Positive End Expiratory Pressure (PEEP), can decrease atelectasis, increases the surface area of the alveolus, improves ventilation/perfusion (V/Q) matching, and consequently improves oxygenation (Davis & Hassell 2007), and reduces work of breathing (Morley 1999). CPAP may also provide a direct bronchodilator effect (Williams et al 2011). Ultimately the aim of CPAP is to improve the respiratory outcomes of the sick infant/child (RCN, 2011).

BiPAP differs from CPAP in that the ventilator delivers different levels of pressure during inspiration (IPAP) and expiration (EPAP). Ventilation is provided mainly by IPAP, whereas EPAP recruits under-ventilated or collapsed alveoli for gas exchange and allows for the removal of the exhaled gas. The indications for CPAP and BiPAP will overlap; in some circumstances BiPAP may be trialled if CPAP has failed. BiPAP may be considered before CPAP in respiratory failure that is characterised by hypercapnia (Haut 2015).

Neither mode of NIV is appropriate for children with a reduced level of consciousness and/or children who are not spontaneously breathing.

Appendix 1: Pre-treatment Optimisation

Optimisation of medical management prior to starting NIV:

Prior to commencing NIV ensure the following have all been optimised; refer to condition specific guidelines where they exist.

- Consider non-medical attempts to settle child (age-appropriate play, distraction, comfort cuddles/pain assessment).
- Analgesia.
- Sedation - consider on a case by case basis.
- Positioning (semi recumbent/side-lying if tolerated).
- Trial on HHHFT (if clinically indicated).
- NGT /OGT to decompress the stomach - leave on free drainage.
- IV fluids – to ensure hydration.
- NBM – to avoid the risk of aspiration and prevent gastric distention.
- CXR - to rule out a pneumothorax.
- Antibiotics – ensure appropriate antibiotic cover as per local policy if any evidence of bacterial infection.
- Nebulisation – with 3% sodium chloride or 0.9% sodium chloride if appropriate.
- Bronchodilators, if appropriate.
- Steroids – No role in bronchiolitis but in a child over the age of 1yr and with significant history of atopy, a trial of steroids may be appropriate.
- Physiotherapy - useful in helping to clear secretions, consider on a case by case basis.

In addition to medical optimisation, ensure:

- Paediatric consultant/senior doctor have reviewed the patient.
- The anaesthetic/Adult ICU team is made aware of the patient.
- Consider whether the patient should be discussed with the Paediatric Critical Care Transport (PCCT) team.
- A clear plan, anticipating deterioration, is documented in the patient notes.
- The family (and if appropriate, the child) are kept updated.

Careful consideration should also be given to:

- Availability of resources to support the delivery of NIV, including but not limited to, availability of an appropriate bed space in which to nurse the child, availability of equipment and appropriately trained staff.
  Advanced care planning and / or any discussions around escalation of care and the appropriateness of initiating NIV, in the context of the patients /families requests, particularly in a child with co morbidities and / or complex needs.

Acute NIV in children: A North Thames and East of England Approach

Indications	Contraindications
Children should always be discussed with a paediatric consultant and usually also discussed with the transport service. **Type 1 respiratory failure - Hypoxia** • Oxygen saturations <92% in >2L/min O_2 via nasal prongs or >4L via Hudson mask or FiO_2 >0.4 **Type 2 respiratory failure - Hypercarbia** • PCO_2 > 6.5 kPa (in children without pre-existing chronic lung disease) • Rising PCO_2 (> 2 kPa from baseline) • Respiratory acidosis with pH < 7.30 This is not an exhaustive list: • Viral induced wheeze • Obstructive sleep apnoea (OSA) • Tracheomalacia • Pulmonary oedema • Hypoventilation, for example due to neuromuscular weakness • Sickle cell anaemia chest crisis • Apnoeas: short-lived and infrequent • Unresponsive to HHHFT (see guideline) but no **red flags*** **CAUTION – CONSIDER BELOW IN DISCUSSION WITH PAEDIATRIC CRITICAL CARE TRANSPORT SERVICE** • Exacerbation of asthma • Pneumonia/Acute Respiratory Distress Syndrome • Heart failure **(regardless of the blood gas, the child's clinical condition should always be considered in the decision to start acute NIV)**	• Severe respiratory compromise indicating the need for imminent intubation as evidenced by the presence of any of the following red flags: - Recurrent or prolonged apnoea - Severe cardiovascular instability and impending cardiac / respiratory arrest - An FIO_2 of greater than 0.6 to maintain target oxygen saturations - GCS <8/15 and/or need for airway protection • Undrained pneumothorax or pneumomediastinum • Multi organ compromise • Upper airway abnormalities that make NIV ineffective, that may include the following: - Choanal atresia, tracheoesophageal fistula - Craniofacial/mid facial abnormalities - Facial trauma or burns - Base of skull fracture - Recent facial or upper gastrointestinal surgery • Inadequate resources - lack of trained personnel to safely deliver therapy - lack of suitable equipment to safely deliver and / or monitor patients receiving NIV

Staffing ratios

Nursing ratio should be determined based on the assessment of the patient's overall condition, including all clinical (not only respiratory), social and infection control needs. A validated Paediatric Early Warning Score (PEWS) should be used, and all critical care interventions considered. Be prepared to adjust the ratio according to fluctuations in patient condition or location. Nursing staff caring for children on NIV should be competent or be directly supervised by a competent practitioner. Consider whether the infection status and use of PPE for the patient will affect the nursing ratio.

Acuity	Stable / Sustained improvement	Stable/ Improving	Establishing NIV / Unstable or increasing acuity
Descriptor	Established on NIV, clinically stable, gases improved FIO_2 stable below 0.4 or reducing. No agitation, minimal WOB. Saturations within target range.	Established on NIV, clinically stable. FIO_2 0.4-0.5. Improving work of breathing no agitation Saturations within target range	Establishing on NIV or remaining critically unwell since NIV initiated No improvement in work of breathing or getting worse Agitated Apnoea Clinically tiring
Nurse ratio	**1:2**	**1:2**	**1:1**

Environment & Safety

Isolation Refer to the NHSE/STPN/NTPN/EoE and local Infection prevention and control guidance recommended. **See Appendix 2**

Children requiring acute NIV should be nursed in a critical care bed space with access to as a minimum: full cardiovascular monitoring, medical air, oxygen & suction, plug sockets, relevant PPE.

Give due consideration to the appropriateness of the bed space location taking into account: staffing skill mix, isolation requirements, condition of the patient and suitability of the space should escalation to level 3 care be required.

The space should be clutter free with access at all times to both sides of the cot.

There should be a BVM of the appropriate size with the child at all times.

Commencing treatment

1. Ensure on call consultant & anaesthetic team aware of child commencing NIV. Family should be aware of the treatment plan, with explanation of what NIV is and the potential for an escalation in care e.g. to level 3 care.
2. Prepare WETFLAG, drug calculator and intubation checklist CATS PaNDR
3. Select interface and equipment: Based on local availability and patient age and weight. See **Appendix 4** for Equipment Selection Guide. Suction nose and mouth, consider need to apply pressure relieving product to pressure areas before applying interface
4. On initiation: A competent clinician should observe patient for comfort and compliance, or any sudden deterioration after starting NIV.
5. Titrate FIO_2: As prescribed to maintain SpO_2 ≥92 % (or patient specific target saturations) and flow to achieve a PEEP of 5-7CM of H_2O.
6. Re-assess patient & consider repeating blood gas 60 minutes after commencing NIV.
7. Within first 60 minutes of commencing NIV please prepare for next steps in case of patient deterioration.
8. Escalate or wean: to avoid rapid deterioration or unnecessary continuation of NIV, review response to treatment at least 4-6hrly, and follow escalation or weaning criteria.
9. Interdepartmental patient transfers: See **Appendix 5** Transfer of patient on NIV Risk flow chart and STOPP Tool.

8. Hourly, 4 hourly and Essential Care Considerations: See Treatment Chart below

Acute non-invasive ventilation in children treatment guide

	Stable / Sustained improvement	Stable/ Improving	Establishing NIV / Unstable or increasing acuity	Essential Care Considerations (ECCs)
Monitoring & Clinical observations	Continuous pulse oximetry & ECG via monitor with appropriate alarm limit set. Apnoea alarm in situ **Hourly recording of:** Respiratory rate Heart rate Oxygen saturations CRT AVPU Input / output PEWS **Minimum 4 hourly:** Temperature Non-invasive BP	Continuous pulse oximetry & ECG via monitor with appropriate alarm limit set Apnoea alarm in situ **Hourly recording of:** Respiratory rate Heart rate Oxygen saturations CRT AVPU Input / output PEWS **Minimum 4 hourly:** Temperature Non-invasive BP	Continuous pulse oximetry & ECG via monitor with appropriate alarm limit set Apnoea alarm in situ **15 – 30 minute recording of:** Respiratory rate Heart rate Oxygen saturations CRT AVPU Input / output PEWS Non-invasive BP Patient NBM Temperature	• Cluster hygiene cares • 2-4 hourly sats probe site rotation & document • Optimise Positioning • Prong/mask checks – unblocked and in situ • Eye checks – remain visible and not exposed to air flow • Consider referral for physiotherapy assessment • OP & NP suction if indicated and safe to do so • Consider feeding regime alteration **(See Appendix 6 for feeding and sedation recommendations)** • Psychosocial support & clear communication • Change interface every 4-6 hours to prevent pressure necrosis
PEWs Score	Sustained improvement	Stable or improving	Triggering for escalation	**Red Flags**
FiO2 requirement	If stable on 0.4 FIO_2, consider weaning	0.4 – 0.5 FIO_2	> 0.5 FIO_2 or above	• Worsening clinical status/respiratory distress • worsening hypercarbia / acidosis • FiO2 ≥ 0.6 to maintain target oxygen saturations. • Exhaustion /increasing respiratory effort/signs of poor respiratory effort /Clinically tiring • PEWS indicates immediate escalation to resus team
RR & work of breathing	Minimal WOB Sats >92%	Improving	The same or worsening	
Blood gases	Blood gases are not indicated for children who are clinically improving, unless required for another purpose.	Consider blood gas testing in severe worsening respiratory distress or suspected impending respiratory failure.	Blood gas 1 hour after initiating CPAP, thereafter as condition dictates.	
Any agitation?	No	No	Yes	**Immediate Escalation**
Apnoeas, bradycardias or exhaustion	No	No	Yes	• Increase FIO_2 to 1.0 • Call 2222 • Liaise with retrieval team or on site PICU (L3 paediatric critical care unit) • Prepare for intubation • Communicate with the family
Next steps:	**See weaning plan below**	**Continue on NIV** Medical / Nursing team to re-assess every 30 – 60 mins. Re-discuss situation with anaesthetics if FIO_2 0.5 or above.	**See Step 1**	

If blood gas shows PH <7.20 or pCO2 >7.50 consider early escalation to Step 2

Step 1:	• Senior review. Contact on call consultant if OOH to request they come into hospital. • Urgent anaesthetic review to inform them of patient who potentially needs intubation & request review. • Call CATS/PaNDR teams for advice. • Speak with Speciality team if applicable	• Are any nebulisers clinically indicated? • Review CXR/ is repeat CXR clinically indicated? • Consider suctioning • Consider physio referral • Ensure good positioning

Step 2:	**Decision made by medical/anaesthetic team to intubate and await transport team.**

Weaning: ***Decision to wean CPAP should be made by both medical & nursing staff.***	**1.** Titrate FIO_2 to maintain SpO_2 above 92% (unless clinical condition indicates otherwise e.g. Pulmonary hypertension). Decrease in 5% increments **2.** Monitor patient on minimal pressure/ FiO_2 for 2 -4 hours **3.** Discontinue CPAP- Consider whether patient requires step down to HHHFT or nasal cannula O_2. **4.** Monitor patient closely for a minimum of 4 hours. **5.** If patient does not tolerate removal of CPAP, go back to previous step.

Appendix 2: Infection Prevention and Control

NTPN/STPN NHSE IPC Advice letter updated in October 2024. Please contact NTPN england.ntpn@nhs.net for the latest version.

RCPCH: National Guidance for the management of children in hospital with viral respiratory tract infections (2023)

National guidance for the management of children in hospital with viral respiratory tract infections (2023) | RCPCH

North Thames Paediatric Network
Connecting paediatric services

East of England Paediatric Critical Care Operational Delivery Network

Appendix 3: Resuscitation Council UK Paediatric Emergency Drug Chart

https://www.resus.org.uk/sites/default/files/2021-05/2492%20AAP%20RCUK%20PET%20chart-5.pdf

Resuscitation Council UK

Paediatric emergency drug chart

GUIDELINES 2021

		Adrenaline	Fluid bolus	Glucose	Sodium bicarbonate		Tracheal tube		Defibrillation
							Uncuffed	Cuffed	
Strength		**1:10 000**	**Balanced isotonic crystalloid OR, 0.9% Saline**	**10%**	**4.2%**	**8.4%**			
Dose		**10 mcg kg^{-1}**	**10 mL kg^{-1}**	**2 mL kg^{-1}**	**1 mmol kg^{-1}**				**4 joules kg^{-1}**
Route		**IV, IO**	**IV, IO**	**IV, IO**	**IV, IO, UVC**	**IV, IO**			**Transthoracic**
Notes			**Consider warmed fluids**	**For known hypoglycaemia**				**Monitor cuff pressure**	**Monophasic or biphasic**
Age	**Weight kg**	**mL**	**mL**	**mL** (recheck glucose after dose and repeat as required)	**mL**	**mL**	**ID mm**	**ID mm**	**Manual**
< 1 month	3.5	0.35	35	7	7	–	3.0	–	20
1 month	4	0.4	40	8	8	–	3.0–3.5	3.0	20
3 months	5	0.5	50	10	10	–	3.5	3.0	20
6 months	7	0.7	70	14	–	7	3.5	3.0	30
1 year	10	1.0	100	20	–	10	4.0	3.5	40
2 years	12	1.2	120	24	–	12	4.5	4.0	50
3 years	14	1.4	140	28	–	14	4.5–5.0	4.0–4.5	60
4 years	16	1.6	160	32	–	16	5.0	4.5	60
5 years	18	1.8	180	36	–	18	5.0–5.5	4.5–5.0	70
6 years	20	2.0	200	40	–	20	5.5	5.0	80
7 years	23	2.3	230	46	–	23	5.5–6.0	5.0–5.5	100
8 years	26	2.6	260	**50**	–	26	–	6.0–6.5	100
10 years	30	3.0	300	**50**	–	30	–	7.0	120
12 years	38	3.8	380	**50**	–	38	–	7–7.5	120
14 years	**50**	**5.0**	**500**	50	–	**50**	–	**7–8**	**120–150**
Adolescent	**50**	**5.0**	**500**	50	–	**50**	–	**7–8**	**120–150**
Adult	**70**	**10.0**	**500**	50	–	**50**	–	**7–8**	**120–150**

Cardioversion	Synchronised Shock, 1.0 joules kg^{-1} escalating to 2.0 joules kg^{-1} if unsuccessful.
Amiodarone	5 mg kg^{-1} IV or IO bolus in arrest after 3rd and 5th shocks. Flush line with 0.9% saline or 5% glucose (max dose 300 mg).
Atropine	20 mcg kg^{-1}, maximum dose 600 mcg.
Calcium gluconate 10%	0.5 mL kg^{-1} for hypocalcaemia, hyperkalaemia (max dose 20 mL); IV over 2–5 min if unstable, over 15–20 min if stable.
Lorazepam	100 mcg kg^{-1} IV or IO for treatment of seizures. Can be repeated after 10 min. Maximum single dose 4 mg.
Adenosine	IV or IO for treatment of SVT: 150 mcg kg^{-1} (0–11 months of age); 100 mcg kg^{-1} (1–11 years of age) Increase dose in steps 50–100 mcg kg^{-1} every 1–2 min for repeat doses. 12–17 years: 3 mg, followed by 6 mg after 1–2 min if required, followed by 12 mg after 1–2 min if required. Requires large saline flush and ECG monitoring.
Anaphylaxis	Adrenaline 1:1000 **IM**: < 6 months 100–150 mcg (0.1–0.15 mL), 6 months–6 years 150 mcg (0.15 mL), 6–12 years 300 mcg (0.3 mL), > 12 years 500 mcg (0.5 mL); can be repeated after 5 min. After 2 IM injections treat as refractory anaphylaxis and start low dose adrenaline infusion IV.

Weights averaged on lean body mass from 50th centile weights for males and females.

Drug doses based on Resuscitation Council UK Guidelines 2021 recommendations.

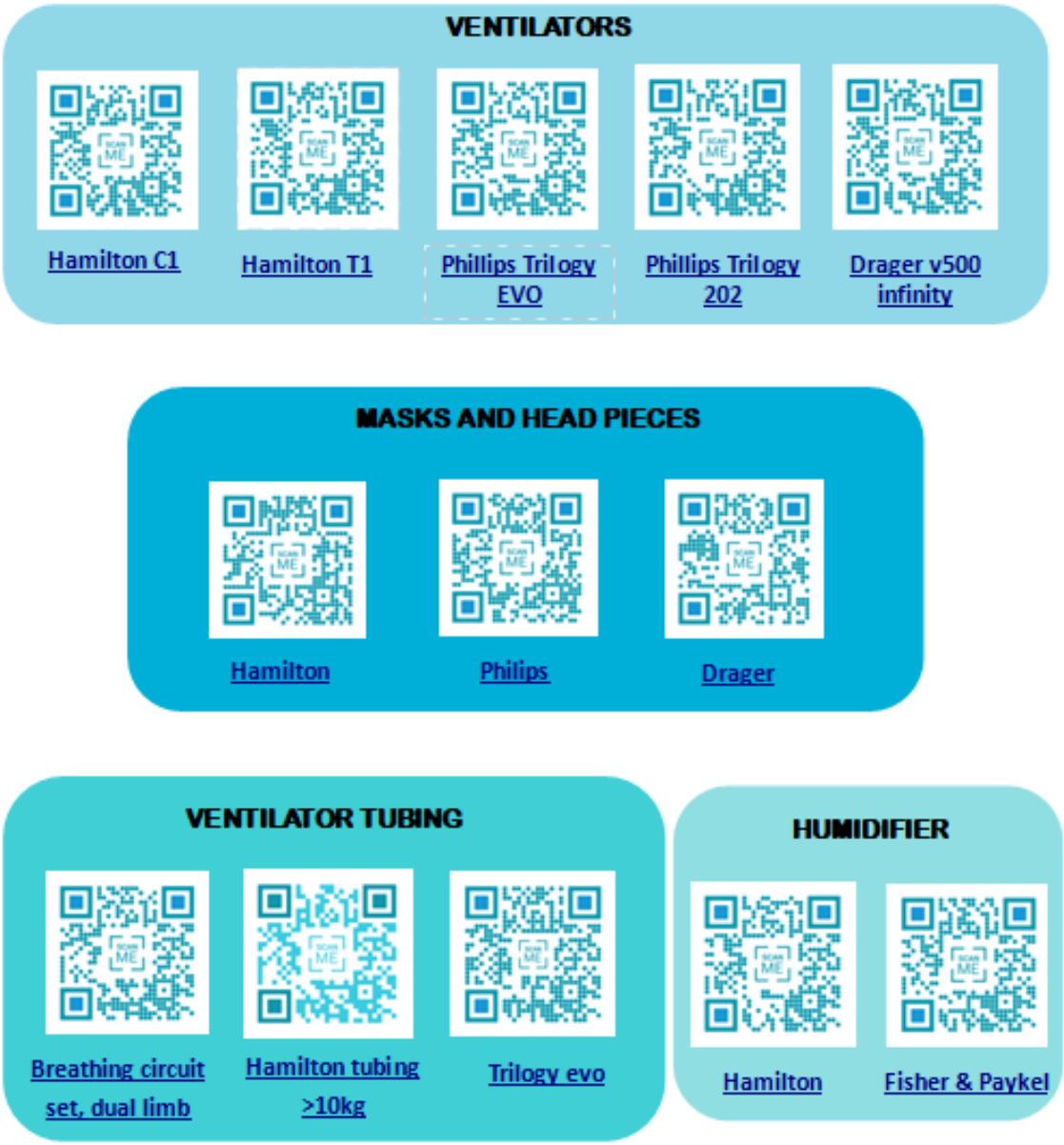
Recommendations for tracheal tubes are based on full term neonates.

For newborns glucose at 2.5 mL kg^{-1} is recommended.

Appendix 4: Equipment selection guide

The below table details commonly used devices across the North Thames Paediatric Network & East of England Paediatric Critical Care ODN, the appropriate age range and links to set up guides/troubleshooting.

This list is not exhaustive and is up to date at time of publishing.



Appendix 5: Transfer of patient on acute NIV risk flow chart

Child in ED / CAU / PAU requires acute NIV

Child is clinically stable and able to transfer to paediatric critical care inpatient area on face mask/non re-breathe oxygen prior to commencing acute NIV

YES

Prepare to transfer patient

Ensure appropriate bed space safety checks have been carried out and appropriately competent staffing available in paediatric critical care area. Prepare child for transfer using checklist below, ensure:

- No red flags (refer to guideline)
- Emergency equipment - Transfer bag, portable O_2 Cylinder, Portable Suction, BVM
- Full cardiovascular monitoring
- IV access secured
- Appropriately trained staffing to carry out transfer (see checklist)
- Support e.g., porters/lift
- Acute NIV set up and ready in PCC bed space

Complete **STOPP Tool**

Transfer patient

NO

Initiate acute NIV in ED / CAU / PAU

Follow network clinical guideline

Patient has stabilised on NIV:

No red flags, work of breathing has improved.

YES

Able to transfer on NIV

Unable to transfer on NIV:

Ensure patient stable on high flow face mask oxygen, consider ability to transfer on AIRVO3.

Complete **STOPP Tool** prior to transferring patient. Ensure appropriate bed and staffing available in paediatric critical care area (HDU)

Transfer Patient

NO

Patient not safe for transfer to in patient ward, will require escalation of treatment in situ.

Follow **immediate escalation** section on network clinical guideline.

DO NOT ATTEMPT TO TRANSFER PATIENT

Appendix 6: Observations and Cares, Feeding and Sedation recommendations

All children requiring CPAP should be nursed in a critical care bed with access to full cardiovascular monitoring and close nursing observation.

<table>
<tr><th colspan="2">Continuous</th></tr>
<tr><td colspan="2">• ECG
• Saturation
• Naso-gastric/ oral-gastric tube on free drainage (unless stable enough for feeds -see below)</td></tr>
<tr><th colspan="2">Hourly</th></tr>
<tr><td>Clinical Observations:
• Respiratory rate
• Work of breathing
• Heart rate
• Oxygen saturations
• Capillary refill time
• AVPU
• PEWS score
• Strict fluid balance
• Parental or nursing concern
• Pain / comfort score
• Visual inspection of interface – adequate seal, free from secretions, skin integrity</td><td>Equipment checks:
• PEEP
• Flow L/min
• FIO2
• Humidifier temp check
• Humidifier water check
• Check NIV device tubing for water tracking up towards patient</td></tr>
<tr><th colspan="2">4 hourly</th></tr>
<tr><td>• Blood pressure
• Temperature (unless pyrexial or hypo-thermic then as clinically indicated)</td><td>• Cluster cares
• Aspiration of NG/OG – to reduce risk of tummy distension due to air and to check absorption if feeding</td></tr>
<tr><th colspan="2">4 hourly (minimum) patient specific</th></tr>
<tr><td>• Sats probe position change
• Change patient position
• Nose & mouth care
• Assistance with personal hygiene
• Consider comfort/play/distraction appropriate for child’s developmental stage</td><td>• Interface checks (Position, fit, seal and comfort)
• Any evidence of skin break down complete risk assessment and initiate management, consider alternative interface if available
• Eye checks (visible & not exposed to airflow).</td></tr>
</table>

Blood Gases

Perform blood gas analysis - as the patient’s condition dictates.

NOTE: Blood gases should not replace clinical assessment of the patient. Capillary blood gas can be considered in patients showing signs of worsening respiratory distress, supplemental FIO_2 of >0.6 or suspected impending respiratory failure (NICE 2019)

Feeding patients on NIV

- NBM
- IV fluids
- Review 12-24hours and begin feeding if happy with clinical condition

All children requiring NIV should be nursed in a critical care bed with access to full cardiovascular monitoring and close nursing observation.

Stable / improving	Unstable / increasing acuity
NBM for 4-6 hours post stabilisation on NIV Then if: No red flags Consider starting feeds as below	Patients should not be considered for feeds, NGT/OGT should remain on free drainage. Monitor blood glucose Consider IV fluids
Starting feeds:	
Ensure senior clinician in agreement Ensure family aware of plan Consider continuous NG feeds then review	Maintain strict fluid balance Fluid allowance agreed
Watch for:	
Respiratory deterioration associated with feeding Abdominal distention/discomfort Tolerance of feeds	

Sedation of patients on acute NIV

Some children may struggle to settle on NIV, consider all the following strategies to assist. The use of a validated comfort / pain assessment tool may assist in indicating when/when not to consider sedation.

The irritable / unsettled / agitated child may be displaying symptoms of hypoxia / hypercapnia. Ensure this child is assessed appropriately and both hypoxia and hypercapnia have been addressed as causative.

Non-medical interventions	Pharmacological sedation
• Cuddles • Pain score and analgesia if indicated • Consider if child is hungry and meets criteria for enteral feeding • Involve play team as appropriate to support with distraction • Check all pressure areas (all hard surfaces eg ECG leads, interfaces, cannulas, NIV mask etc.)	Chloral hydrate may be considered on a case by case basis. Discussion and agreement with the paediatric consultant. Refer to the BNFc for dosage and indications; however, the lowest dose should always be given due to the ongoing risks of respiratory depression. The child should be fully monitored and closely observed for any adverse effects.

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