HIGH FLOW NASAL CANNULA THERAPY IN NICU

Alert	Most of the evidence for High Flow Nasal cannula Therapy (HFNC) as primary or weaning respiratory support is in infants beyond 28 weeks of gestation at birth and >1000 g at birth (Wilkinson D 2016). The best strategy for weaning, or withdrawing HHFNC in preterm infants remains unclear. (Farley RC 2015). Caution is needed in extreme preterm infants (<28 weeks and <1000 g infants) because of the paucity of higher strength evidence (Taha DK 2016). When HFNC is off, nasal prongs must be removed from nares for the infant to breathe with no obstruction.
Indication	Primary or weaning mode of respiratory support in neonates.
Mechanism of Action	High gas flows in preterm infants may provide positive end-expiratory pressure (PEEP) at similar levels to that commonly set with CPAP in clinical practice (Wilkinson D 2016; Al-Alaiyan S 2014). Washout of nasopharyngeal dead-space has also been proposed as an important mechanism of action of HFNC (Dysart K 2009; Frizzola M 2011).
Patient	Neonates in the NICU
Staff	Medical and nursing staff in the NICU
Dosage	The initial recommended flow is 4-6 L/min.
Maximum Flow Rate	Most RCTs in preterm infants used flows no more than 6 L/min. However higher flows up to 8L/min may be considered at the discretion of neonatologist.
Equipment	<table><tr><td>Humidifying base (F&P MR850)</td><td>Optiflow RT 330 Breathing Circuit</td></tr><tr><td>Temperature probe</td><td>Gas blender</td></tr><tr><td>Heater wire adaptor</td><td>Green gas tubing</td></tr><tr><td>1000 ml Water for Irrigation (Baxter)</td><td>Appropriate size Optiflow Nasal cannula (Pictures 2&3)</td></tr><tr><td>Oxygen analyser</td><td></td></tr></table>  Picture 1. Equipment

Picture 2

F&P OPTIFLOW JUNIOR

OPTIFLOW JUNIOR NASAL CANNULA	ITEM CODE	APPROX WEIGHT (KG) 2 4 6 8 10 12 14 16 18 20 22	SPARE WIGGLEPADS
Premature Size	OPT312	Max. flow 8 L/min	OPT010
Neonatal Size	OPT314	Max. flow 8 L/min	OPT012
Infant Size	OPT316	Max. flow 20 L/min	
Pediatric Size	OPT318	Max. flow 25 L/min	

Picture 3

Some Suggested prong sizes:

a. Premature (Red – 8 g) – for babies 700-1250 g
b. Neonatal (Yellow – 10 g) - For babies 1250-3000 g
c. Infant (Purple – 13 g) - For babies >3000 g

Set-up Process

1. Identify the infant for HFNC therapy. Confirm with medical staff and obtain medical order (R1).

2. Ensure the infant is having alternative respiratory support if required while the set-up is put together (R2).

3. Wash hands. Collect all equipment for set-up (R3).

4. Plug humidifier base into wall supply.

5. Slide the humidifying chamber onto the humidifier base.

6. Remove the blue caps on the humidifier. Attach the water-feeding tube to the water-bag. Wet the circuit only when therapy has been confirmed.

7. Attach the elbow of the blue breathing circuit to the water chamber (Picture 4).

8. Slot the pressure manifold on to the water-chamber (Picture 4).

9. Connect green tubing from gas flowmeter of gas blender to nipple on pressure manifold (⑧ in Picture 4).

10. Calibrate Oxygen analyser.

11. Insert Oxygen Analyser to the bottom porthole of the pressure manifold (⑩ in Picture 4).

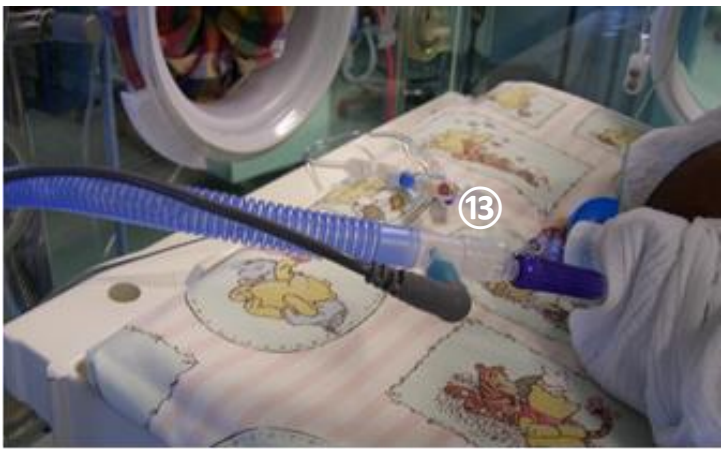
Picture 4.

12. Connect the dark blue plug of the temperature probe to the blue socket on the side of the base (⑪ in Picture 5). Do not twist – the fine pins in the connector will break.

13. Connect the middle light blue two-pin plug of the temperature probe to the socket with a “V” at the elbow of the blue breathing circuit at the water-chamber end (⑫ in Picture 5). Do not use force: Pushing with force will crack the probe socket.

Picture 5

14. Insert the light blue plug at the other end of temperature probe fully into the socket at the patient end of the breathing circuit. (⑬ in Picture 6). **Apply pressure to plug to ensure tight fit into socket. This will prevent temperature probe migrating out of socket causing increased rainout.**



Picture 6

15. Connect the yellow plug of heater wire adaptor into the yellow socket in the humidifying base (⑭ in Picture 5). Do not twist – the fine pins in the connector will break.

16. Connect the short 3-pin black end of the heater wire adaptor ("clover leaf" end) into the socket on the breathing circuit elbow above the chamber (⑮ in Picture 5). The other long cable with 2-pin plug end is not required to be connected to anything in high flow set-up.

17. Choose appropriate size nasal cannula – Refer to Prong Size Chart (Pictures 2 & 3). Prongs should be a good fit but should not completely occlude nares. Occluding nares may produce an inadvertently high PEEP. Suggested prong sizes:
    a. Premature (Red – 8 g) – for babies 700-1250 g
    b. Neonatal (Yellow – 10 g) - For babies 1250-3000 g
    c. Infant (Purple – 13 g) - For babies >3000 g.

18. Attach prongs to tubing.

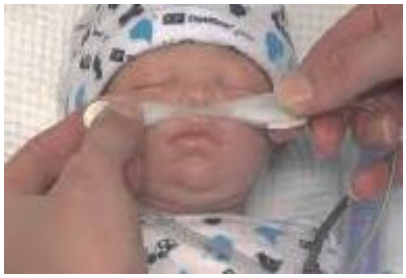
19. Set desired flow prescribed by neonatologist

20. Switch on humidifier. It will select temperature (37°C). Ensure setting is at ET mode.

21. Nares may require suctioning prior to prong insertion (R4).

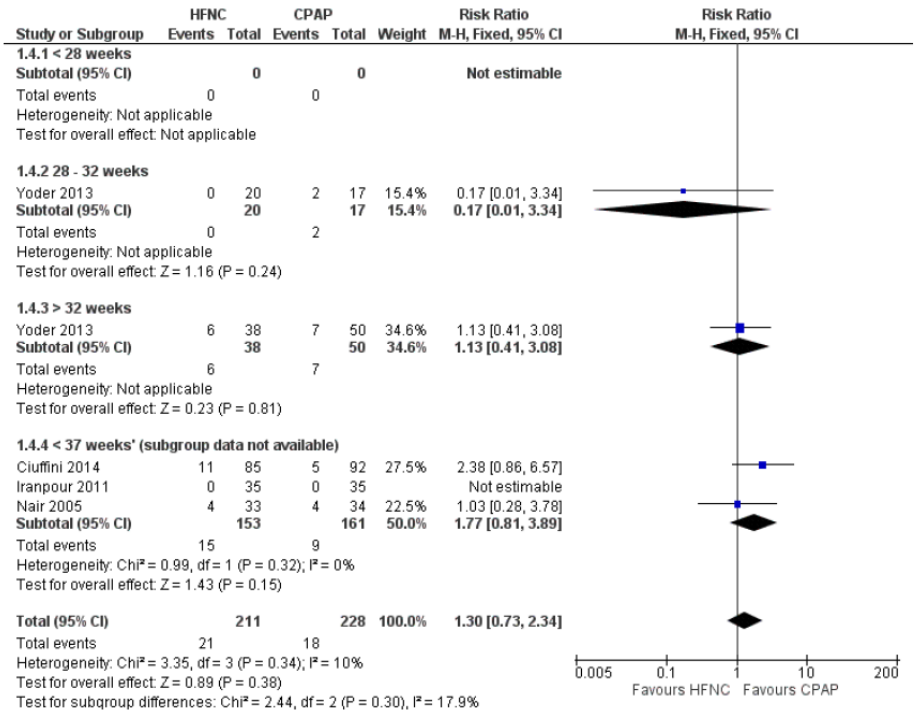
22. Turn on gas flow before placing nasal prongs into nares as prescribed (R5).

23. Remove paper-backing on Wiggle-pads and secure them to cheeks as follows: Stretch skin on the cheeks to ensure no creasing and effective adhesion Pads should sit as close to the nares as possible without intruding on the eyes or mouth. Smooth onto skin and check prongs remain correctly positioned once skin has been released (using the 'cheeky check' to check security of prongs in nares, simulate the infants facial movements by gently squishing their cheeks. If the prongs flick out of the nose, reposition the cannula). Adjust as necessary (R6).

	24. Insert nasal cannula in the infant's nares (Picture 7). Ensure there is a clear space around the nares to allow expiratory flow (R7) 25. Fix cannula to Wiggle pads (Picture 8).  Picture 7  Picture 8 **<u>Points to remember</u>** 26. Check that the cannula is not applying pressure to the sensitive septum. Ensure that there is a slight gap between the cannula and septum. 27. Support weight of tubing (R8). 28. Position infant's head posture to allow head movement (R9). Ensure infant is not lying on high flow tubing and it is loosely secured at the top of the head (not the back) (R10). 29. Position inspiratory line to allow humidification drainage away from the infant to minimise humidification vapours dripping into the infant's nares.
Maintenance and Weaning	1. There is no clear evidence in the literature on optimal weaning strategy. 2. Provide oxygen as required to maintain oxygen saturations (Our NICU SaO_2 Target 90-94% with Alarm limits 89-95% in preterm infants and 95-98% in term neonates). 3. Wean flow as directed by the neonatologists or as discussed during medical ward round and as tolerated by the infant (usually not more than 1L/day). 4. When the flow is at 2-3 L/min, but requiring oxygen, consider gradual wean to low flow nasal cannula oxygen. 5. When the flow is at 2-3 L/min and in air, cease high flow and assess the need for low flow nasal cannula oxygen. **<u>FAILED WEANING PROCESS</u>** 1. If the infant's work of breathing is significantly increased - Restart HFNC at a rate of 4-6 L/min depending on the degree of respiratory distress and after consultation with the neonatologist or fellow. 2. If the infant's oxygen requirement increases (generally $\geq$40%), consider need for CPAP or higher support.
Adverse Reactions	Nasal trauma, pneumothorax, abdominal gaseous distention, treatment failure requiring escalation of respiratory support.

Rationales	R1 - To confirm the correct management for the correct infant. R2 - To provide continual oxygenation for the infant. R3 - To adhere to the 5-Moments of Hand Hygiene. R4 - To clear nasal passage prior to prong insertion. R5 - To check that set-up is functioning correctly. R6 – Wiggle pads provides a platform to secure and prevents pressure on skin. R7 – To allow expiratory flow. R8 - To prevent drag on the nasal tubing. R9 - Circuit must allow infant's head to move without restriction. R10 - To ensure uninterrupted flow.
Documentation	• NCC Routine Care Plan • Neonatal Observation Chart L2/L3 • Integrated Clinical Notes
Related Policies and Procedures	NSW Health: Document No GL2016_004. File No 14/6506. Humidified high flow nasal cannula oxygen guideline for metropolitan paediatric wards and EDs – 1st edition. Accessed on 4th August 2016.
Evidence summary	Humidified High Flow Nasal Cannula (HHFNC) has been increasingly adopted as a new means of respiratory support throughout the world. A survey published in 2012 of 167 neonatologists in Australia and New Zealand showed 63% of neonatal intensive care units in Australia and New Zealand were using HFNC but with a diverse clinical practice on the indications and flow rate (Hough JL 2012). A subsequent ANZNN population-based study showed that HFNC usage in very preterm infants<32 weeks increased from 15% in 2009 to 35% in 2012 and 98% of them received endotracheal ventilation or CPAP prior to receiving HFNC (Roberts 2016). HFNC has similar rates of efficacy to other forms of non-invasive respiratory support in preterm infants for preventing treatment failure, death and CLD. Most evidence is available for the use of HFNC as post-extubation support. Following extubation, HFNC is associated with less nasal trauma, and may be associated with reduced pneumothorax compared with nasal CPAP. (Kotecha 2015; Wilkinson 2016) (LOE 1, GOR B). **Caution needs to be exercised in extreme preterm infants (<28 weeks and <1000 g infants) because of the paucity of published data.** **HFNC vs CPAP for respiratory support for preterm infants (Wilkinson 2016).** There were no infants <28 weeks for this comparison. Rates of treatment failure (and need for intubation) within seven days of trial entry were similar between HFNC and CPAP. There were no differences in the rates of death (typical risk ratio (RR) 0.36, 95% confidence interval (CI) 0.01 to 8.73; 4 studies, 439 infants) or chronic lung disease (typical RR 2.07, 95% CI 0.64 to 6.64; 4 studies, 439 infants). The use of HFNC as primary support resulted in a longer duration of receiving respiratory support in one study (Yoder 2013). Other secondary outcomes (including nasal trauma, durations of supplemental oxygen and hospitalisation, pneumothorax, and sepsis) were similar between groups.

Figure 1. Forest plot of comparison: 1 HFNC versus CPAP soon after birth for treatment or prophylaxis of RDS, outcome: 1.4 Treatment failure within 7 days of trial entry.



HFNC versus NIPPV for primary respiratory support after birth (Wilkinson 2016).

One study was available for this comparison (total 76 infants, <35 weeks but >1000 g at birth) (Kugelman 2015). There was no difference between HFNC and NIPPV in rates of treatment failure, death or CLD. Infants randomised to HFNC spent a longer period of time receiving noninvasive respiratory support (median 4 days vs median 2 days, P <0.01).

HFNC versus CPAP to prevent extubation failure (Wilkinson 2016).

Six studies were available for this comparison (total 934 infants). Following extubation, there
were no differences between HFNC and CPAP in the primary outcomes of death (typical RR 0.77, 95% CI 0.43 to 1.36; 5 studies, 896 infants) (Figure 2); or CLD (typical RR 0.96, 95% CI 0.78 to 1.18; 5 studies, 893 infants) (Figure 3). There was no difference in the rate of treatment failure (typical RR 1.21, 95% CI 0.95 to 1.55; 5 studies, 786 infants) (Figure 4); or reintubation (typical RR 0.91, 95% CI 0.68 to 1.20; 6 studies, 934 infants) (Figure 5). Infants randomised to HFNC had reduced nasal trauma (typical RR 0.64, 95% CI 0.51 to 0.79; typical risk difference (RD) −0.14, 95% CI −0.20 to −0.08; 4 studies, 645 infants) (Figure 6).There was a small reduction in the rate of pneumothorax (typical RR 0.35, 95% CI 0.11 to 1.06; typical RD −0.02, 95% CI −0.03 to −0.00; 5 studies, 896 infants) (Figure 7) in infants treated with HFNC. There was also an apparent small reduction in the rate of gastrointestinal perforation or severe NEC (typical RR 0.52, 95% CI 0.24 to 1.11; typical RD −0.02, 95% CI −0.05 to −0.00; 5 studies, 840 infants), though this did not reach statistical significance. There was no significant difference in the incidence of intraventricular haemorrhage, sepsis or ROP between groups.

Figure 2. Forest plot of comparison: 3 HFNC versus CPAP to prevent extubation failure, outcome: 3.3 Death.

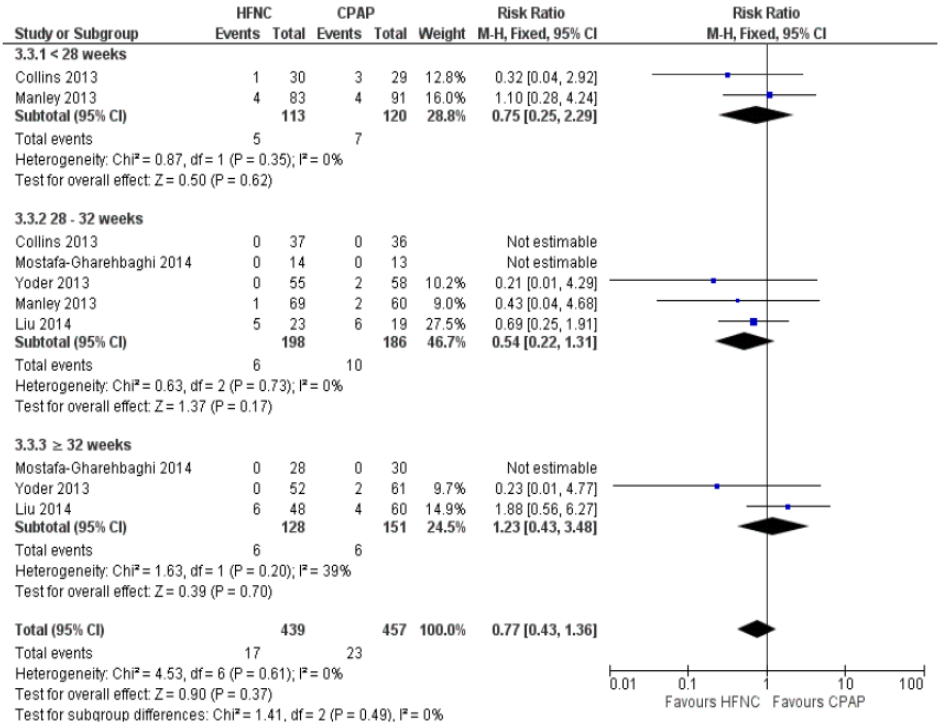


Figure 3. Forest plot of comparison: 3 HFNC versus CPAP to prevent extubation failure, outcome: 3.2 CLD.

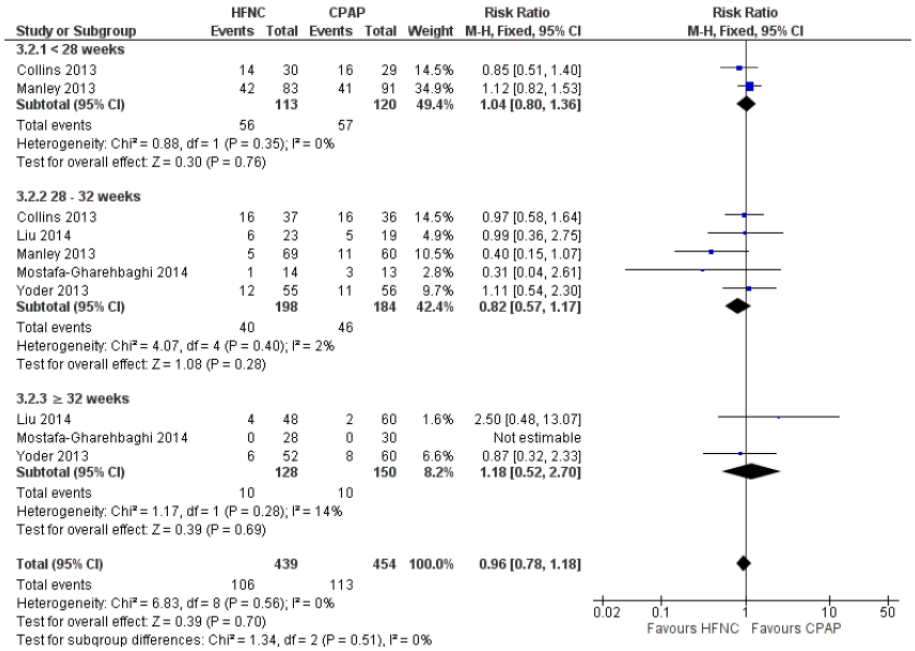


Figure 4. Forest plot of comparison: 3 High Flow Nasal Cannula versus CPAP to prevent extubation failure, outcome: Treatment failure.

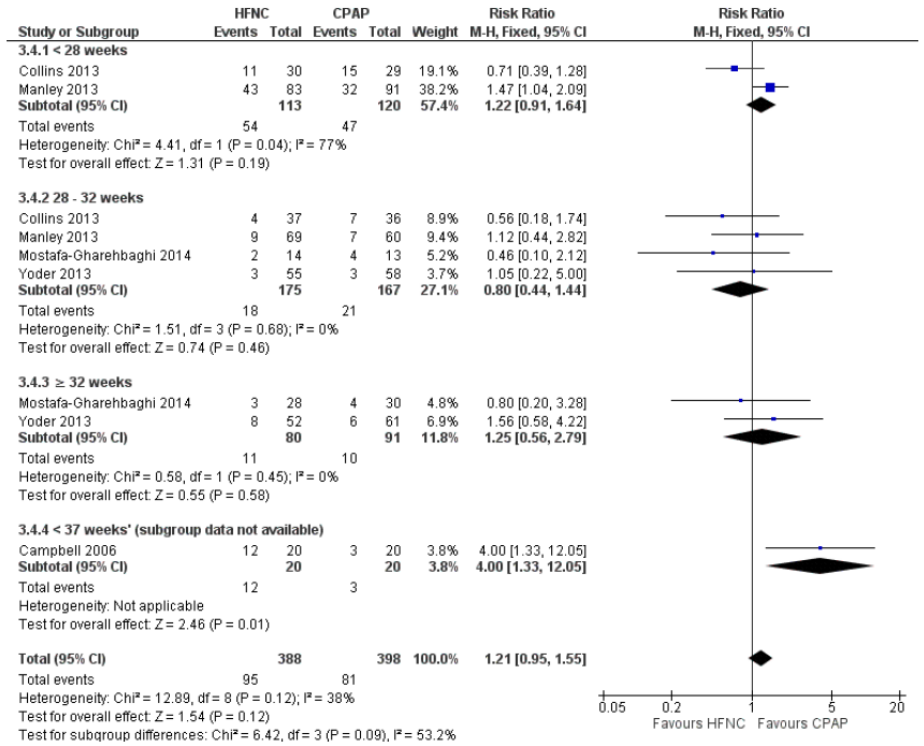


Figure 5. Forest plot of comparison: 3 HFNC versus CPAP to prevent extubation failure within 7 days, outcome: 3.5 Reintubation within 7 days of trial entry.

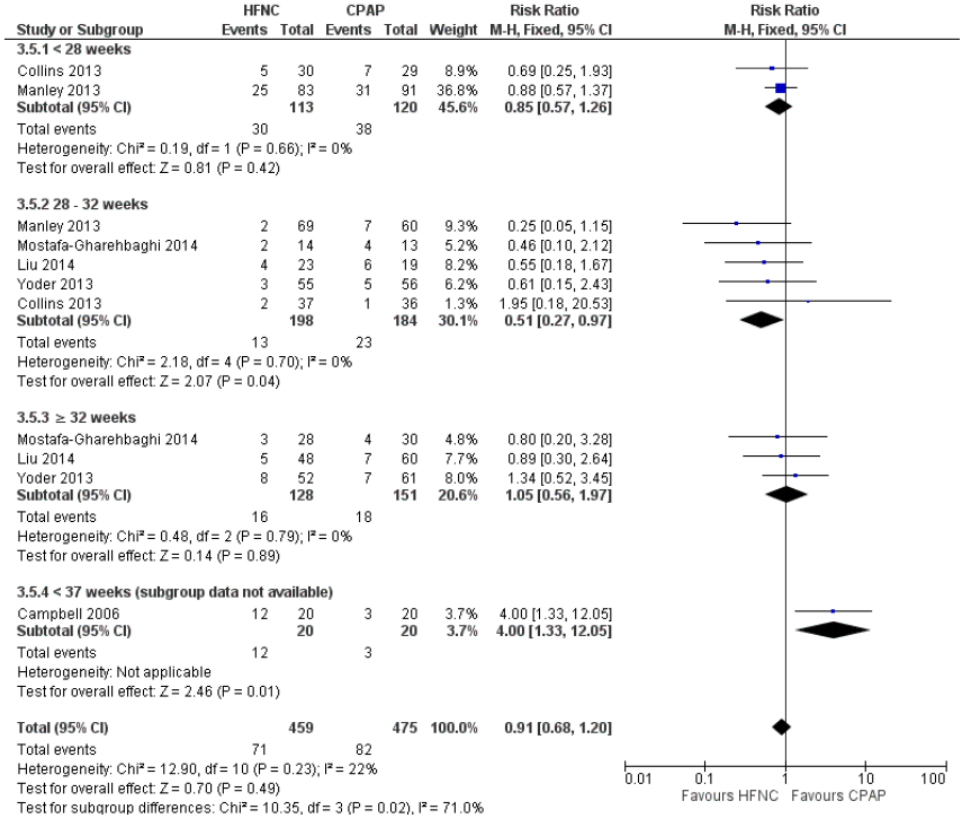


Figure 6. Forest plot of comparison: 3 HFNC versus CPAP to prevent extubation failure, outcome: Nasal trauma.

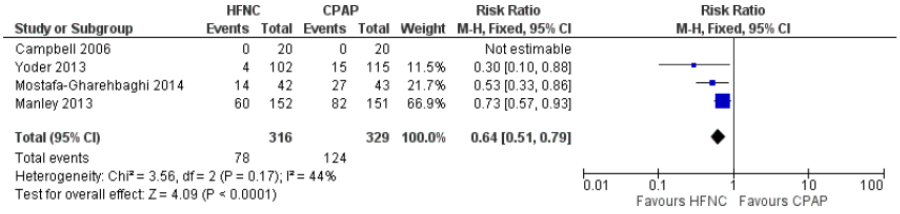
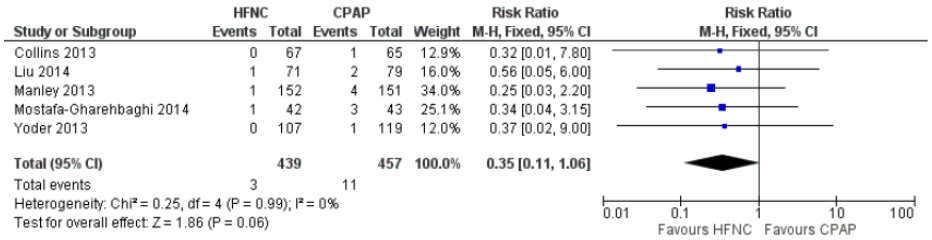


Figure 7. Forest plot of comparison: 3 HFNC versus CPAP to prevent extubation failure, outcome: Pneumothorax.



HFNC for weaning from CPAP (Wilkinson 2016)

Two studies compared the use of HFNC versus continued CPAP for weaning preterm infants who were stable on low levels of CPAP (Abdel Hady 2011; Badiee 2015). In one of these studies (Abdel Hady 2011), infants randomised to HFNC had a longer total duration of oxygen therapy (median 14 days vs median 5 days P <0.001) and a longer period of respiratory support (median 18 days vs median 10.5 days, P < 0.05). Infants in the HFNC group had a slightly longer duration of respiratory support prior to randomisation (median 8.5 days, IQR 7 to 14.25) compared with the CPAP group (median 5.5 days, IQR 3 to 13, P = 0.07). In the second study (Badiee 2015), infants randomised to HFNC had a shorter duration of oxygen therapy (21 hours vs 50 hours); however, infants in this group commenced weaning at an earlier gestational age (32.2 weeks vs 33.6 weeks). Four babies in the CPAP group required intubation in one study, while no infants randomised to HFNC weaning required intubation. There was no difference in weaning failure, nor in major morbidities (sepsis, IVH, BPD). There was a small overall reduction in length of hospitalisation in infants receiving HFNC (typical RD −3.3 days, 95% CI −6.6 to 0.0 days; 2 studies, 149 infants).

Weaning from nasal CPAP (Tang et al, 2015, not included in Cochrane Review)

The optimal strategy for weaning very preterm infants from nasal continuous positive airway pressure (NCPAP) is unclear. Reported strategies include weaning NCPAP to a predefined pressure then trialling stopping completely (abrupt wean); alternate periods of increased time off NCPAP whilst reducing time on until the infant is completely weaned (gradual wean); and using high flow nasal cannula (HFNC) to assist the weaning process. The aim of this RCT was to determine the optimal weaning from NCPAP strategy for very preterm infants. In this pilot single centre, factorial design, 4-arm randomised controlled trial, sixty infants born <30 weeks gestation meeting stability criteria on NCPAP were randomly allocated to one of four groups. Group 1: abrupt wean with HFNC; Group 2: abrupt wean without HFNC; Group 3: gradual wean with HFNC; Group 4: gradual wean without HFNC. The primary outcomes were duration of respiratory support, chronic lung disease, length of hospital stay and time to full suck feeds. The primary outcome measures were not significantly different between groups. Group 1 had a significant reduction in duration of NCPAP (group 1: median 1 day; group 2: 24 days; group 3: 15 days; group 4: 24 days; p = 0.002)
and earlier corrected gestational age off NCPAP. There was a significant difference in rate of parental withdrawal from the study, with group 2 having the highest rate. Group 3 had a significantly increased duration on HFNC compared to group 1. In summary, use of high flow nasal cannula may be effective at weaning infants from NCPAP but did not reduce duration of respiratory support or time to full suck feeds. Abrupt wean without the use of HFNC was associated with an increased rate of withdrawal by parent request.

	HFNC – Association with increased morbidity and length of hospitalisation in ELBW (≤1000 g at birth) infants A multicentre retrospective study from USA (Taha DK 2016) was conducted for infants born between January 2008 and July 2013, weighing ≤1000 g at birth, and received HFNC or CPAP. A total of 2487 infants met the inclusion criteria (941 CPAP group, 333 HFNC group, and 1546 HFNC + CPAP group). The primary outcome of BPD or death was significantly higher in the HFNC group (56.8%) compared with the CPAP group (50.4%, P < .05). Similarly, adjusted odds of developing BPD or death was greater in the HFNC+CPAP group compared with the CPAP group (OR 1.085, 95%CI 1.035-1.137, P = .001). The number of ventilator days, postnatal steroid use, days to room air, days to initiate or reach full oral feeds, and length of hospitalization were significantly higher in the HFNC and HFNC + CPAP groups compared with the CPAP group. However, these findings need to be interpreted with caution. This a is retrospective cohort study involving Alere neonatal database comprising infants from multiple private, government, and self-insured employer health plans. No details were provided on CPAP pressure and high flow litre flow and also whether high flow was used a primary or weaning mode.
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	Neonatal Network (ANZNN). High-flow support in very preterm infants in Australia and New Zealand. Arch Dis Child Fetal Neonatal Ed 2015;0:F1–F3. Taha DK, Kornhauser M, Greenspan JS, Dysart KC, Aghai ZH. High Flow Nasal Cannula Use Is Associated with Increased Morbidity and Length of Hospitalization in Extremely Low Birth Weight Infants. J Pediatr 2016;173:50-5. Tang J, Reid S, Lutz T, Malcolm G, Osborn DA. Randomised controlled trial of weaning strategies for preterm infants on nasal continuous positive airway pressure. BMC Pediatrics 2015;15:147. Yoder BA, Stoddard RA, Li M, King J, Dirnberger DR, Abbasi S. Heated, humidified high-flow nasal cannula versus nasal CPAP for respiratory support in neonates. Pediatrics 2013;131:e1482–90. Wilkinson D, Andersen C, O'Donnell CPF, De Paoli AG, Manley BJ. High flow nasal cannula for respiratory support in preterm infants. Cochrane Database of Systematic Reviews 2016, Issue 2. Art. No.: CD006405. DOI: 10.1002/14651858.CD006405.pub3.

REVISION & APPROVAL HISTORY

Neonatal Services Division Quality Committee

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