Wspomaganie oddechu wysokimi przepływami (Hi flow canulae ventilation)

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What is Hi Flow Nasal Cannula (HFNC)?

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Many Different Definitions

- Is it 1.5 or 2.0 LPM or more?
- Does the size of the baby matter?
- What about the interface, are some interfaces more capable than other interfaces?
- What about the leak, how much is too much and how much is not enough?

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The Flow and Size are Important

- Normal minute ventilation is 250-350 mL/kg/min
- A small baby weighing 1 kg can be on flow in excess of normal minute ventilation with a 50% leak with just 1 LPM flow.
- A working definition is high flow nasal cannula simulating CPAP -- thus delivered flow must exceed minute ventilation to generate positive airway pressure.

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A "No Go" Flow

- A 4 kg baby has a normal minute ventilation of at least 1 LPM.
- So why would a large baby with 2 LPM flow appear air hungry?
- Assuming a 50% leak, high peak flow demands, and a large bore NC, the nasal cannula is obstructing flow during the breathing cycle despite "Hi Flow"

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It's All Relative

- So in six slides, we have seen how a relatively simple subject has been turned into one where traditional definitions do not apply and we have no strict guidelines.
- Yes, every baby is different. And, Hi flow must be individualized.
- And, the interface is also important.

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Mechanism of Action of High Flow Nasal Cannula

- 5 proposed mechanisms of action
- Washout of Nasopharyngeal dead space
- Reduced work of breathing
- Improved mechanics
- Reduced metabolic cost of gas conditioning
- Provision of positive expiratory pressure

Dysart, K., et.al; Respiratory Medicine 2009; 103: 1400-1405

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Systems Available

- Ram - Neotech
- Optiflow – Fisher & Paykel
- Vapotherm – Vapotherm, Inc
- Comfort Flow – Teleflex Medical
- More Technologies Coming…

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Neotech Products

RAM Cannula™

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Optiflow System

- Flow rates range from 1Lpm to 60Lpm
- Oxygen delivery 21-100%
- Heated, humidified system
- Delivery system – nasal cannula or trach adaptor
- 4 Cannula sizes
- Home Option – Airvo and Airvo2

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Optiflow

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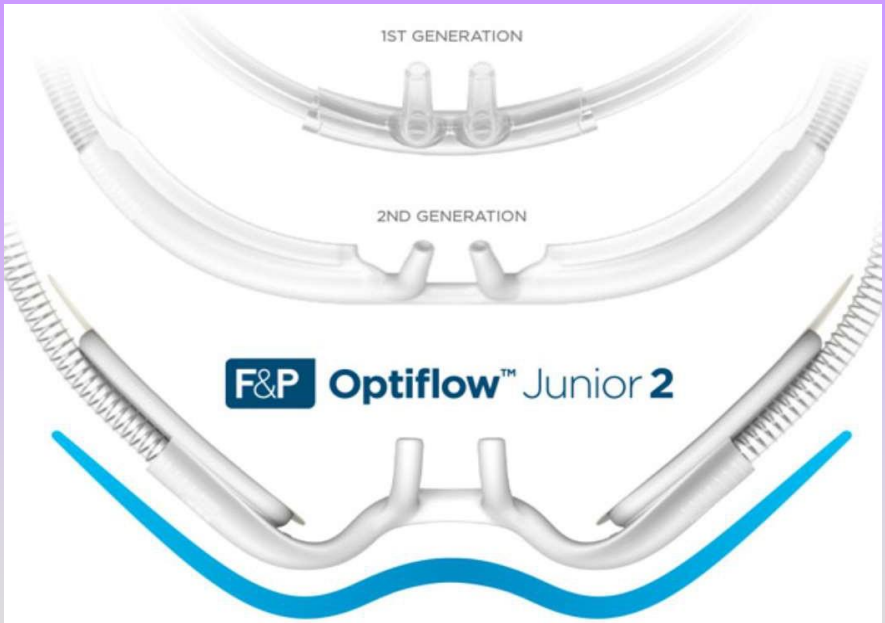

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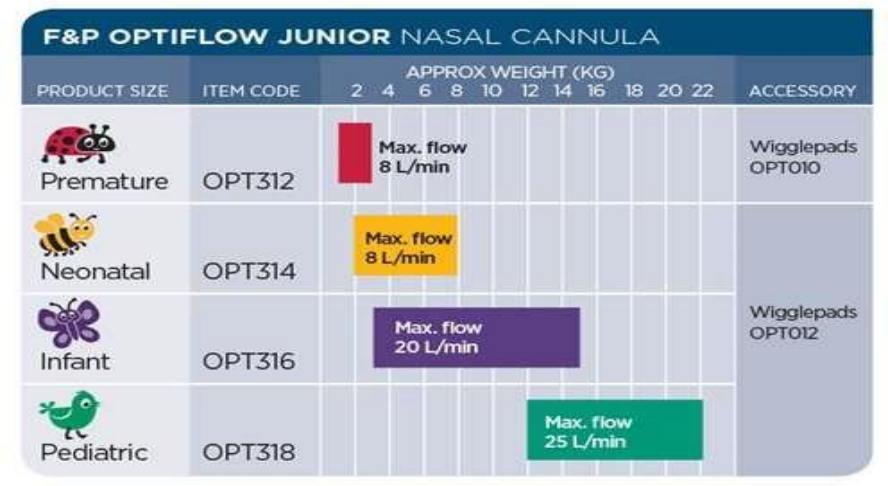

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	OPT312 PREMATURE	OPT314 NEONATAL	OPT316 INFANT	OPT318 PEDIATRIC
PERFORMANCE SPECS				
Max Flow Rate (L/Min)	8	8	20	25
Cannula Weight	9 g	9 g	13 g	13 g
Approximate Age Range	‹ 26 ga – 37 ga weeks	32 ga – 6 months	37 weeks – 3.5 years	1 year – 6 years
Approximate Weight Range	‹ 1 – 3 kg	2 – 8 kg	3 – 15 kg	12 – 22 kg
Compatible with	Unique Swivel connection RT330	Unique Swivel connection RT330	Unique Swivel connection RT330 & 900PT531	Unique Swivel connection RT330 & 900PT531
Compatible Humidifier	MR850	MR850	MR850, Airvo 2	MR850, Airvo 2

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Vapotherm

- Flow rates 1Lpm to 40 Lpm
- Oxygen Delivery 21-100%
- Heated, humidified system
- Delivery system via Nasal Cannula
- 7 different cannulas depending on size of patient
- In hospital transport unit available

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Vapotherm

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Background

- High flow cannulae are not uniform in diameter.
- The cannula or circuit design is a critical element required to achieve high velocity flow.

Ives N.K. (2017) Precision Flow Vapotherm. .Manual of Neonatal Respiratory Care.

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Design/Methods

- Using the recommended range of flows for each cannula, exit velocity was calculated using:

$$\boldsymbol{Exit\ Velocity\ (m/s) = \frac{(L/min)(10^{-3}m^3/L)(1min/60sec)}{\pi(outer\ diameter\ in\ m)^2}}$$

https://www.texasgateway.org/resource/121-flow-rate-and-its-relation-velocity

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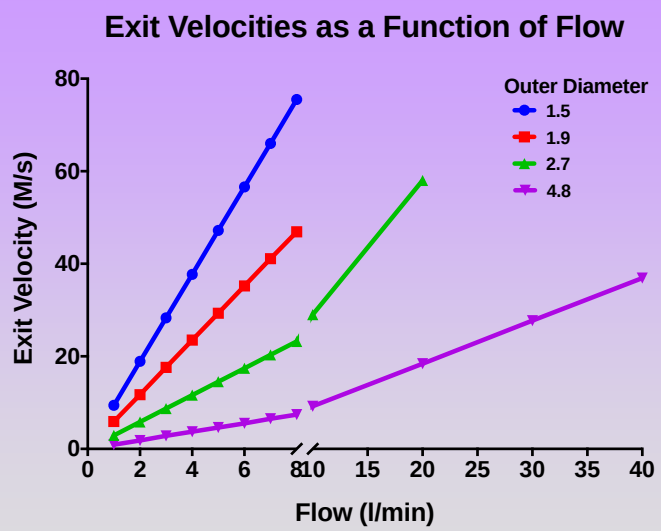
Vapotherm



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High Flow = High Speed?

	Liter per Minute (LPM) Flow to Cannula					
	1 LPM	2 LPM	3 LPM	4 LPM	5 LPM	10 LPM
Nasal Cannula 1 mm ID	9.4 m/s	18.8 m/s	28.2 m/s	37.6 m/s	47 m/s	94 m/s
Nasal Cannula 1.5 mm ID	5.3 m./s	10.6 m/s	15.9 m/s	21.2 m/s	26.5 m/s	53 m/s
Nasal Cannula 2 mm ID	3.4 m/s	6.8 m/s	10.2 m/s	13.6 m/s	17 m/s	34 m/s

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Comfort Flow

- Teleflex medical product
- Flow rates 1-60Lpm
- Oxygen Delivery 21-100%
- Heated, humidified system using conchatherm or conchasmart technology
- Delivery system via Nasal cannula
- 4 different cannulas ranging from neonates-adults

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Comfort Flow

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Which is better, nCPAP or HFNC?

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HFNC vs CPAP for primary support

	Nair 2005	Iranpour 2011	Yoder 2013	Ciuffini 2014
Methods	RCT	RCT	RCT	RCT
Subjects	67 preterm infants 28 to 34 weeks gestational age	70 preterm infants 30 to 35 weeks gestation	432 term and preterm infants of more than 28 weeks GA	177 Inborn preterm infants 29 to 36 weeks gestation
Protocol	HFNC (mean flow rate 5 to 6 L/min) or CPAP (5 to 6 cmH_2O).	HFNC (1 to 4 L/min) Nasal CPAP 6 cmH_2O	HFNC (mean flow rate 3 to 5 L/min) or CPAP (5 to 6 cmH_2O).	High flow nasal cannula (flow rate 4 to 6 L/min) Nasal CPAP (4 to 6 cmH_2O)
Outcome	respiratory failure requiring intubation	Treatment failure (intubation); death; duration of hospitalization	respiratory failure requiring intubation	Need for intubation and mechanical ventilation

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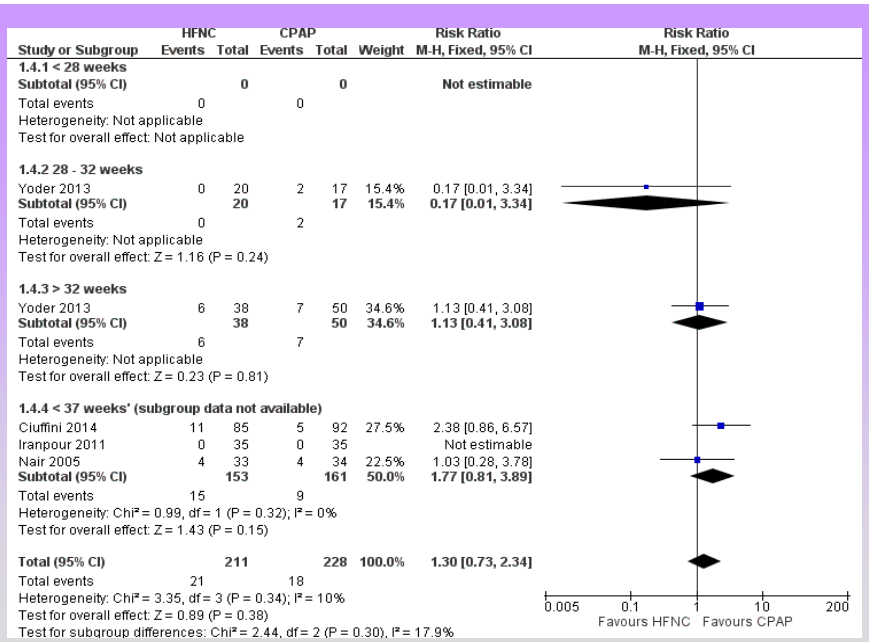

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HFNC vs CPAP for primary support

- **No difference in rate of death** (typical risk ratio (RR) 0.36, 95% confidence interval (CI) 0.01 to 8.73; 4 studies, 439 infants)
- **No difference in chronic lung disease** (typical RR 2.07, 95% CI 0.64 to 6.64; 4 studies, 439 infants).
- HFNC resulted in a longer duration of receiving respiratory support with similar efficacy.
- Morbidities were similar between groups.

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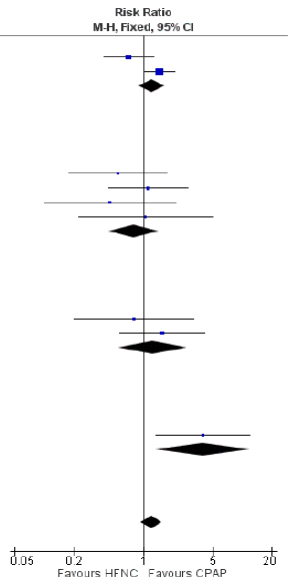
HFNC for Support after Extubation

	Campbell 2006	Collins 2013	Manley 2013	Yoder 2013	Liu 2014
Methods	RCT	RCT	RCT	RCT	RCT
Subjects	40 intubated preterm infants (birth weight 1250 grams).	132 intubated very preterm infants (< 32 weeks gestation at birth).	303 intubated very preterm infants (< 32 weeks' gestation at birth)	432 term and preterm infants of more than 28 weeks' GA	155 infants (< 7 days old), of which 150 were preterm
Interventions/controls	HFNC (mean gas flow 1.6 L/min) or variable flow CPAP (5 to 6 cmH_2O) after extubation.	HFNC (8 L/min) or nasal CPAP (8 cmH_2O) after extubation	HFNC (5 to 6 L/min) or CPAP (7 cmH_2O) after extubation	HFNC (mean flow rate 3 to 5 L/min) or CPAP (5 to 6 cmH_2O).	HFNC (gas flow 3 to 8 L/min depending on infant weight) or nasal CPAP after extubation
Outcome	need for reintubation	extubation failure	treatment failure	respiratory failure requiring intubation	treatment failure

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

Study or Subgroup	HFNC Events	HFNC Total	CPAP Events	CPAP Total	Weight	Risk Ratio M-H, Fixed, 95% CI
3.4.1 < 28 weeks						
Collins 2013	11	30	15	29	19.1%	0.71 [0.39, 1.28]
Manley 2013	43	83	32	91	38.2%	1.47 [1.04, 2.09]
Subtotal (95% CI)		**113**		**120**	**57.4%**	**1.22 [0.91, 1.64]**
Total events	54		47			
Heterogeneity: Chi² = 4.41, df = 1 (P = 0.04); I² = 77%						
Test for overall effect: Z = 1.31 (P = 0.19)						
3.4.2 28 - 32 weeks						
Collins 2013	4	37	7	36	8.9%	0.56 [0.18, 1.74]
Manley 2013	9	69	7	60	9.4%	1.12 [0.44, 2.82]
Mostafa-Gharehbaghi 2014	2	14	4	13	5.2%	0.46 [0.10, 2.12]
Yoder 2013	3	55	3	58	3.7%	1.05 [0.22, 5.00]
Subtotal (95% CI)		**175**		**167**	**27.1%**	**0.80 [0.44, 1.44]**
Total events	18		21			
Heterogeneity: Chi² = 1.51, df = 3 (P = 0.68); I² = 0%						
Test for overall effect: Z = 0.74 (P = 0.46)						
3.4.3 ≥ 32 weeks						
Mostafa-Gharehbaghi 2014	3	29	4	30	4.0%	0.80 [0.20, 3.20]
Yoder 2013	8	52	6	61	6.9%	1.56 [0.58, 4.22]
Subtotal (95% CI)		**80**		**91**	**11.8%**	**1.25 [0.56, 2.79]**
Total events	11		10			
Heterogeneity: Chi² = 0.56, df = 1 (P = 0.45); I² = 0%						
Test for overall effect: Z = 0.55 (P = 0.58)						
3.4.4 < 37 weeks' (subgroup data not available)						
Campbell 2006	12	20	3	20	3.8%	4.00 [1.33, 12.05]
Subtotal (95% CI)		**20**		**20**	**3.8%**	**4.00 [1.33, 12.05]**
Total events	12		3			
Heterogeneity: Not applicable						
Test for overall effect: Z = 2.46 (P = 0.01)						
Total (95% CI)		**388**		**398**	**100.0%**	**1.21 [0.95, 1.55]**
Total events	95		81			
Heterogeneity: Chi² = 12.89, df = 8 (P = 0.12); I² = 38%						
Test for overall effect: Z = 1.54 (P = 0.12)						
Test for subgroup differences: Chi² = 6.42, df = 3 (P = 0.09), I² = 53.2%						



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HFNC Support after Extubation

- **No difference in 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)
- **No differences in rate of death** (typical RR 0.77, 95% CI 0.43 to 1.36; 5 studies, 896 infants)
- **No differences in CLD** (typical RR 0.96, 95% CI 0.78 to 1.18; 5 studies, 893 infants).
- **Statistically insignificant 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.
- **No significant difference intraventricular haemorrhage, sepsis or ROP between groups.**

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Possible Conclusions

- HFNC is similar to nCPAP as a non-invasive respiratory support in preterm infants for preventing treatment failure, death or BPD.
- Post-extubation support but not initial support may produce better outcomes.
- In very tiny babies, there is insufficient data to recommend HFNC over other forms of non-invasive ventilation..
- HFNC may be associated with lower incidence of pneumothorax and nasal trauma compared to nCPAP.

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Speculation

- If nasal cannula were like CPAP with a continuous flow by mechanism and a defined pressure pop off, would outcomes be better than nCPAP?
- Are the differences between HFNC and nCPAP really predicated on the obligate delivery of flow on HFNC and the potential for “flow by” on nCPAP?

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