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CLINICAL PROTOCOL – MUHC

(PROTOCOLE CLINIQUE - CUSM)

☐ Medication included ☒ No Medication included

☒ MCH ☐ MGH ☒ RVH ☐ MNH ☐ MCI ☐ LACHINE

THIS IS NOT A MEDICAL ORDER

Title:	Targeted oxygen saturation in the Neonate – "Oxygen With Love" (OWL) Protocol
This document is attached to:	Collective Order – Targeted oxygen saturation in the Neonate – "Oxygen With Love" (OWL) Patient Double identification protocol MUHC Hand hygiene policy Administration of Oxygen Collective Order MCH NICU Maintenance and Weaning of Heated High Flow Nasal Cannula (HHFNC) Oxygen Therapy on the Pediatric Ward Installation and Maintenance of Bubble Nasal Continuous Positive Airway Pressure (NCPAP) Therapy in the Neonatal Intensive Care Unit (NICU) and the Resuscitation room in the Birthing Center at the Royal Victoria Hospital

1. PURPOSE

Administration of oxygen can cause damage to developing lungs, eyes, and other organs via the release of free radicals. On the other hand, too little oxygen (hypoxia) is also associated with increased morbidity in neonates. Multiple large, multi-centric trials have addressed the question of the most appropriate percentage of hemoglobin saturated with oxygen (SpO2 as measured by a pulse oximeter) necessary to minimize these risks. Based on these findings, this protocol aims:

- To guide oxygen use for neonates in the resuscitation room and labour and delivery suites of the Royal Victoria Hospital (RVH), based on the 2015 guidelines of the Neonatal Resuscitation Program (NRP) from the Canadian Pediatric Society (CPS)
- To guide oxygen use via SpO2 and alarm settings for neonates admitted to the Neonatal Intensive Care Unit (NICU), avoiding unnecessary oxygen use as well as prolonged periods of hypoxia
- To minimize large, abrupt changes in the fraction of inspired oxygen (FiO2) administered to these patients.

2. PROFESSIONALS

This protocol applies to the following professionals who work in the resuscitation room, ante and post-partum units, and labour and delivery suites of the Royal Victoria Hospital, as well as the NICU of the Montreal Children's Hospital:

- Nurses (RNs)
- Candidates to the Profession of Nursing (CPNs) who meet the above criteria and work within the limits of their role.
- Respiratory therapists (RTs)

- Physicians (MDs) and neonatal nurse practitioners (NNPs)

3. PATIENT POPULATION

This protocol applies to patients admitted to the NICU at the Montreal Children's Hospital, as well as to newborns who are resuscitated in the resuscitation room, ante and post-partum units, and labour and delivery suites of the Royal Victoria Hospital. Patients excluded from this protocol include patients with diagnoses of:

- Congenital heart disease (CHD)
- Persistent pulmonary hypertension of the newborn (PPHN)
- Patients receiving inhaled nitric oxide (iNO)
- Idiopathic pulmonary hypertension
- Severe retinopathy of prematurity

Patients with contraindications require an individual medical order for oxygen and saturation targets.

4. ELEMENTS OF CLINICAL ACTIVITY

Professionals are responsible to know the limits and extent of their practice as related to the particular protocol.

Equipment needed:

Oxygen saturation monitor (full cardiorespiratory monitor with appropriate SpO2 cassette and cable, or portable pulse oximeter)

Oxygen saturation probe of appropriate size (Massimo™)

Posey™ cover or sock

Oxygen administration equipment for resuscitation:

- Oxygen flowmeter 0-15 lpm
- Oxygen blender
- Flow-inflating bag with 500 mL sized bag OR T-piece resuscitator
- Appropriately sized mask

Oxygen administration equipment for current patient needs:

- The oxygen delivery system will depend on the patient but can include oxygen masks and nasal prongs and all respiratory support systems, such as ventilators, resuscitator bags (both flow inflating and self-inflating), CPAP and NIV devices, and Heated High Flow Nasal Cannula (HHFNC) systems.
- Low flow oxygen flowmeter (0 to 3 lpm range)
- Micro low flowmeter (0 to 1 lpm range)
- Ultra low flowmeter (0-0.2 lpm range)
- Low flow water bottle (as needed for cold humidity)

1. Procedure for Oxygen Use in the Resuscitation Room and Labour & Delivery

- For all neonates requiring resuscitation in the Resuscitation Room and/or Labour & Delivery:
    a. Follow NRP algorithm for initiation of resuscitation (see Appendix A)
    b. If indicated, begin positive pressure ventilation (PPV) or continuous positive airway pressure (CPAP):

i. For those born at greater than or equal to 32 weeks gestational age, start PPV or CPAP in 21% oxygen

ii. For those born at less than 32 weeks gestational age, start PPV or CPAP in 30% oxygen

c. Adjust oxygen delivered via PPV or CPAP to achieve target pre-ductal SpO2 based on time since birth (in minutes) – see Table 1

d. As neonate is stabilized and once they fall outside of the 10 minute window, wean oxygen to achieve target saturations in Table 2.

Table 1. Target SpO2 in minutes after birth

Minute of Life	Target SpO_2 (Preductal)
1 min	60%–65%
2 min	65%–70%
3 min	70%–75%
4 min	75%–80%
5 min	80%–85%
10 min	85%–90%

Data from Kattwinkel J, Bloom RS, et al: Textbook of Neonatal Resuscitation. 6th ed. Elk Grove Village, IL: American Academy of Pediatrics and the American Heart Association; 2010.

Table 2. Target saturations (SpO2) for neonates in the NICU

	Target Saturations	Monitor Alarm Limits
Receiving supplemental oxygen	91% to 95%	Low: 88% High: 95%
Receiving **no** supplemental oxygen	91% to 95%	Low: 91% High: 100%

2. Procedure for Oxygen Use in the NICU

- **<u>Blender FiO2 Settings</u>**:

a. For resuscitation purposes, there must be an oxygen blender attached to an oxygen flowmeter and flow-inflating bag, allowing delivery of between 21% and 100% O2, at each bedside:

- When the neonate's current oxygen delivery system is linked to this blender (eg. Bubble CPAP, high-flow oxygen delivery systems), the blender should be set to meet the neonate's oxygen needs based on oxygen saturation targets, as in Table 2 above.
- When the neonate's current oxygen delivery system is not linked to this blender (eg. ventilator) or when the neonate is no longer receiving respiratory support,

the blender should be set to deliver oxygen at 10% higher than current oxygen needs.

- **Delivered FiO2 adjusments:**

  a. *For patients receiving respiratory support with oxygen greater than 21%:*

     - Oxygen delivered by the respiratory support device should be titrated to ensure the patient is within the target saturation ranges described in Table 2. Alarm limits on the cardiorespiratory monitor should be set as described in Table 2.
     - If SpO2 is above the alarm limit, the FiO2 should be weaned slowly:
       - Decrease FiO2 slowly every 1-3 minutes until SpO2 stays within alarm limit range.
     - If SpO2 falls below the alarm limits, follow algorithm in Appendix B.

  b. *For patients not receiving supplementary oxygen, or who are receiving 21% via their respiratory support device:*

     - Follow alarm limit targets in Table 2
     - If SpO2 falls below the alarm limit, follow algorithm in Appendix B

  c. *For patients on low flow oxygen nasal prongs:*

     - Adjust flow on low-flow flowmeter so that SpO2 targets match those in Table 2
     - If SpO2 falls below low alarm limit, follow algorithm in Appendix B
     - If SpO2 goes above high alarm limit:
       i. Decrease flow in increments of 1/8 to 1/4 lpm, to a low of 1/8 lpm and observe.
       ii. If SpO2 remains above high alarm limits despite flow being at 1/8 lpm, try on room air.
       iii. If patient does not tolerate room air (saturations remain below targets), switch to a micro low flowmeter using last successful flow, and reduce flow in increments of 0.1 lpm, to a minimum of 0.1 lpm.
       iv. If SpO2 is above high alarm limits on 0.1 lpm, speak with RT and switch to an ultra low flowmeter using last successful flow. Reduce to lowest tolerated flow while maintaining SpO2 within targets in Table 2.
     - **Weaning of oxygen:** The objective is to assess the patient and wean FiO2 while maintaining the target SpO2 with every nurse or RT check. The goal is to get to room air (21%) as quickly as possible.
       - In the event of frequent desaturations and/or bradycardia, place patient on last successful FiO2, and try again after 4 to 6 hours to wean.
     - Please see attached Table in Appendix C to estimate FiO2 patient is receiving on the flow set. Or go to

       http://www.adhb.govt.nz/newborn/Guidelines/Respiratory/Oxygen/ActualO2.htm

MONITORING & DOCUMENTATION:

Table 3. Monitoring and Documentation

Monitoring	Documentation
In the resuscitation room, labour and delivery suites, and ante- and post-partum units of the RVH	
Oxygen saturation probe and cardiorespiratory leads should be placed as per NRP algorithm (appendix A)	**In the resuscitation room & labour and delivery suites:** The "Peds" Labour and Delivery nurse is responsible for charting minutes of life, SpO2, and FiO2 in cases of resuscitation in these areas. **In ante & post-partum:** A nurse from the ante or post-partum unit is responsible for charting minutes of life (if appropriate), SpO2 and FiO2 during resuscitation in these areas.
In the NICU	
All patients must be on continuous oxygen saturation monitors and cardiorespiratory monitors unless otherwise ordered. **At the beginning of each shift, the RN will verify:** – Alarm limits of the continuous oxygen saturation monitors – FiO2 set on the blender of the flow-inflating bag used for resuscitation – Current FiO2 administered	**For patients on no respiratory support, or respiratory support with low-flow nasal prongs** **The RN will document:** – That alarm limits are set appropriately on the front page of the 24-hr flow sheet (under the "F: FiO2" section) at the beginning of the shift. – Any initiation and/or adjustment of oxygen administered in the notes section of the nursing flow sheet. Additionally, the nursing assessment that prompted the initiation/adjustment must be documented. – A full respiratory assessment, including SpO2, FiO2, and flow administered with each full check of vital signs (no less frequently than Q6H) on the patient's nursing flow sheet.
At the beginning of each shift, the RN will verify: – Alarm limits of the continuous oxygen saturation monitors – FiO2 set on the blender of the flow-inflating bag used for resuscitation – Current FiO2 administered **At the beginning of each shift, the RT will verify:** – FiO2 set on the blender of the flow-inflating bag used for resuscitation	**For patients on all other forms of respiratory support** **The RN will document:** – That alarm limits are set appropriately on the front page of the 24-hr flow sheet (under the "F: FiO2" section) at the beginning of the shift. – A full respiratory assessment with each full check of vital signs (no less frequently than Q6H) in the nursing flow sheet. – **Hourly** assessment of SpO2, FiO2, and respiratory support settings (eg. Pressures, rates, etc) on the patient's nursing flowsheet. **The RT will document:** – A full respiratory assessment no less frequently than Q3H in the RT flow sheet. **The RT and the RN will document:** – First-time initiation oxygen administered in the notes section of the nursing and RT flow sheets. Additionally, the nursing and RT assessment that prompted the

	initiation must be documented. – For **those patients less than 37 weeks**, **those with respiratory distress syndrome, transient tachypnea of the newborn, and those with early chronic lung disease**: it is expected that frequent adjustments (both increases and decreases) in the FiO2 may be needed in order to maintain saturation targets. These frequent adjustments are considered the norm and do not need to be documented. When the infant no longer has these diagnoses, refer to documentation required above. – However, **if oxygen needs increase by over 10% for greater than 1 hour** (eg. unable to wean oxygen after an episode of apnea/bradycardia/desaturation, gradual increase in oxygen needs throughout the day, or sudden and dramatic increase in oxygen needs for at least 1 hour), a note detailing steps taken must be made in the nursing/RT flowsheets, and the medical team should be advised. – For **all other patients on respiratory support**, any initiation and/or adjustment of oxygen administered must be documented in the notes section of the nursing/RT flow sheets. Additionally, the nursing assessment that prompted the initiation/adjustment must be documented.

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6. APPROVAL PROCESS

Institutional and professional approval

[Delete explanatory text. This will represent the committees that have reviewed and/or approved the documents. This will vary related to practice and legal parameters. All medication related practice must be reviewed by Pharmacy and Therapeutics.]

Committees	Date approved [yyyy-mm-dd]
☒ Clinical Practice Review Committee (CPRC) (if applicable)	2019/09/05
☐ Adult Pharmacy and Therapeutics (P&T) (if applicable)	NA
☐ Pediatric Medication Administration Policy (PMAP) (if applicable)	NA
☐ Pediatric Pharmacy and Therapeutics (Peds P&T) (if applicable)	NA
☐ Multidisciplinary Council (MDC) (if applicable)	NA

7. REVIEW DATE

To be updated in maximum of 4 years or sooner if presence of new evidence or need for practice change.

8. REFERENCES

Askie, L.M., Henderson-Smart, D.J., Irwig, L., Simpson, J.M. (2002). BOOST, The Effect of Differing Oxygen Saturation Targeting Ranges on Long Term Growth and Development of Extremely Preterm Oxygen Dependent Infants. Pediatr Res 51:378.

Manja, V., Saugstaad, O.D., & Lakshminrusimha, S. (2017). Oxygen Saturation Targets in Preterm Infants and Outcomes at 18–24 Months: A Systematic Review. Pediatrics 139(1):e20161609.

Schmidt, B., Whyte, R.K., Asztalos, E.V., Moddemann, D. et al for the Canadian Oxygen Trial (COT) Group. (2013). Effects of targeting higher vs lower arterial oxygen saturations on death or disability in extremely preterm infants, A randomized controlled trial. JAMA 309 (20) 2111-2120.

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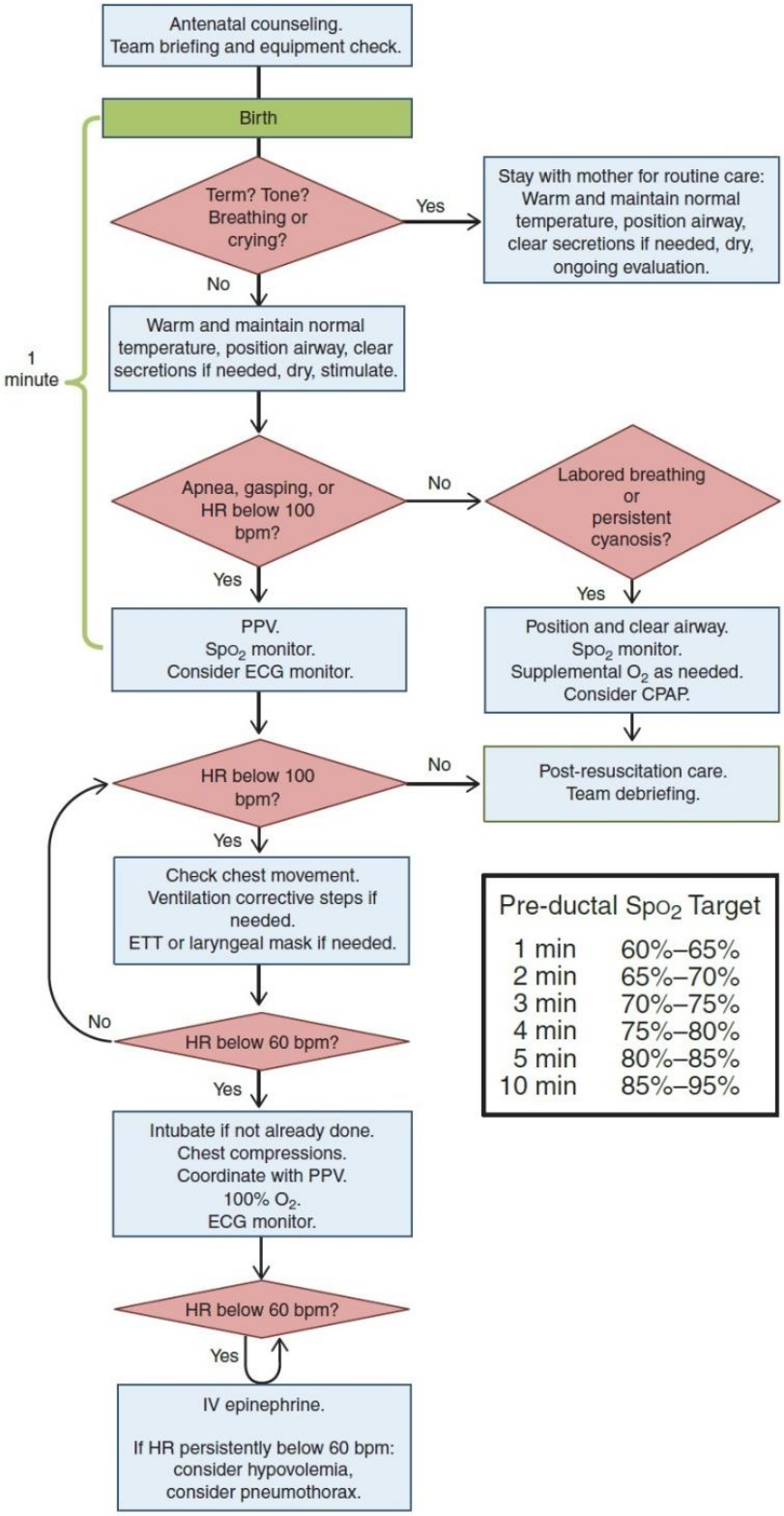
The BOOST II United Kingdom, Australia, and New Zealand Collaborative Groups. (2013). Oxygen saturation and outcomes in preterm infants. N Engl J Med 368: 2094-2104.

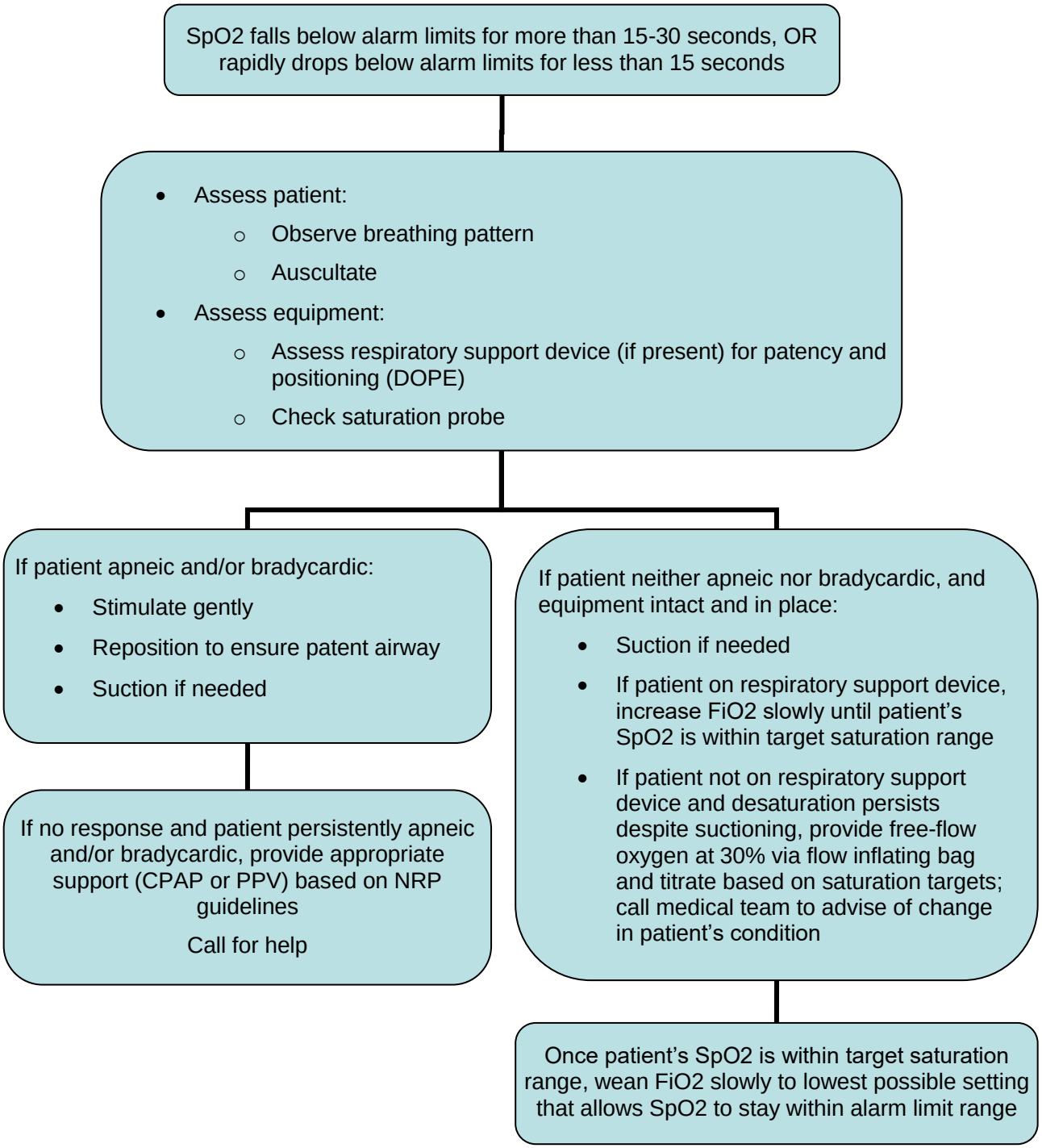
Version History (for Administrative use only)			
Version	**Description**	**Author/responsable**	**Date**
1	Description (Creation, Approval)	Elissa Remmer, RN	2019/0
No	Description (Creation, Approval, Revision with modifications, Revision without modifications, etc.)	Management Acronym, Function	
No	Description (Creation, Approval, Revision with modifications, Revision without modifications, etc.)	Management Acronym, Function	
No	Description (Creation, Approval, Revision with modifications, Revision without modifications, etc.)	Management Acronym, Function	

APPENDIX A

2015 guidelines of the Neonatal Resuscitation Program (NRP) from the Canadian Pediatric Society



Appendix B – Algorithm for the Desaturating Patient



STOP-ROP Effective FiO_2 Conversion Tables for Infants on Nasal Cannula

Example: What is the effective FiO_2 of a 1.5 KG infant on 100% cannula with a flow of 0.25 LPM?

Answer: Use 1.5 KG and 0.25 LPM in Table 1 to get a factor of 17. Use the factor of 17 and 100% oxygen in Table 2 to get an effective FiO2 of 34%.

Table 1: Factor as function of flow and weight

	Weight (KG)								
Flow (LPM)	0.7	1	1.25	1.5	2	2.5	3	3.5	4
0.01 = 1/100	1	1	1	1	1	0	0	0	0
0.03 = 1/32	4	3	3	2	2	1	1	1	1
0.06 = 1/16	9	6	5	4	3	3	2	2	2
0.13 = 1/8	18	13	10	8	6	5	4	4	3
0.15 = 3/20	21	15	12	10	8	6	5	4	4
0.25 = ¼	36	25	20	17	13	10	8	7	6
0.50 = ½	71	50	40	33	25	20	17	14	13
0.75 = ¾	100	75	60	50	38	30	25	21	19
1	100	100	80	67	50	40	33	29	25
1.25 = 1 ¼	100	100	100	83	63	50	42	36	31
1.50 = 1 ½	100	100	100	100	75	60	50	43	38
2	100	100	100	100	100	80	67	57	50
3	100	100	100	100	100	100	100	86	75
4	100	100	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100	100	100

Factor = 100 * min(1, LPM/KG)

Assumptions:

1. The tables should be reasonably accurate for most STOP-ROP infants. Benaron and Benitz assumed that there is a constant nasal flow over the inspiratory cycle and that the upper airway does not act as a reservoir.
2. Inspiratory time = 0.3 seconds
3. Tidal volume = 5 ml per KG body weight
4. At flows of LPM <wt in KG, either inhalation is entirely nasal, or cannula flow is low enough on each breath, that the infant inhales all output from the cannula.

Additional notes:

1. Infants on low flow who mouth-breathe will dilute their cannula flow and have lower than estimated effective FiO_2.
2. Infants on high flow fill the nasopharynx (and even their open mouths if mouth breathing), so effective FiO_2 will be the same as the O_2 concentration.
3. Infants who have nasal obstruction (partial or complete) will not actually receive/inhale the flow being provided through the cannula.

Rule of Thumb (already implicit in the tables): For most STOP-ROP infants, if flow (LPM) exceeds body weight (KG), then effective FiO2 equals nasal cannula oxygen concentration.

The tables are adapted from equations (3) and (4) in: Benaron DA & Benitz WE "Maximizing the Stability of Oxygen Delivered Via Nasal Cannula" Arch. Pediatr. Adolesc Med 148: 294-300, March 1994

Disclaimer: These tables only approximate effective inspired oxygen. Actual inspired oxygen will be influenced by the infant's clinical condition and factors noted under "Assumptions". Interpret the tables in the context of clinical correlation.

Table 2: Effective FiO_2 (%) as a function of factor and oxygen concentration

	Oxygen Concentration (%)						
Factor	21	22	25	30	40	50	100
0	21	21	21	21	21	21	21
1	21	21	21	21	21	21	22
2	21	21	21	21	21	22	23
3	21	21	21	21	22	22	23
4	21	21	21	21	22	22	24
5	21	21	21	21	22	22	25
6	21	21	21	22	22	23	26
7	21	21	21	22	22	23	27
8	21	21	21	22	23	23	27
9	21	21	21	22	23	24	28
10	21	21	21	22	23	24	29
12	21	21	21	22	23	24	30
13	21	21	22	22	23	25	31
14	21	21	22	22	24	25	32
15	21	21	22	22	24	25	33
17	21	21	22	23	24	26	34
18	21	21	22	23	24	26	35
19	21	21	22	23	25	27	36
20	21	21	22	23	25	27	37
21	21	21	22	23	25	27	38
25	21	21	22	23	26	28	41
29	21	21	22	24	27	29	44
30	21	21	22	24	27	30	45
31	21	21	22	24	27	30	45
33	21	21	22	24	27	31	47
36	21	21	22	24	28	31	49
38	21	21	23	24	28	32	51
40	21	21	23	25	29	33	53
42	21	21	23	25	29	33	54
43	21	21	23	25	29	33	55
50	21	22	23	26	31	36	61
57	21	22	23	26	32	38	66
60	21	22	23	26	32	38	68
63	21	22	24	27	33	39	71
67	21	22	24	27	34	40	74
71	21	22	24	27	34	42	77
75	21	22	24	28	35	43	80
80	21	22	24	28	36	44	84
83	21	22	24	28	37	45	87
86	21	22	24	29	37	46	89
100	21	22	25	30	40	50	100

$FiO_2 = 21 + Factor * (Concentration-21)/100$