The Delivery of Low Flow Oxygen in Neonates

(made interesting)

What shall we talk about?

- Oxygen
- Definition
- Physiology
- Method
- Indication for
- Limitations
- What FiO2 am I delivering anyways??
- Standardizing Practice

Oxygen is…

Essential in the
reversal and prevention
of neonatal hypoxia

O2 Therapy Goal

Optimize tissue oxygenation

With minimal effects of

O2 toxicity & oxidative stress

Indications for…

- Unable to maintain adequate oxygenation
- Correction of documented or suspected hypoxemia by increasing the alveolar and blood levels of oxygen must occur
- Clinical criteria
  - Resp. distress, central cyanosis, apnea, asphyxia, and low SpO2.

Our Sp02 guidelines

≤ 36 weeks = 88 – 92%

- Alarms = 86 – 94

>36 weeks = 90-94%

- Alarms = 88 - 95

- Inadequate Oxygen
  - Death
  - May damage brain cells
  - Developmental problems (poor growth)
- Excessive Oxygen
  - Free O2 radical disease
    - ROP - PaO2 > 80 [1]
    - BPD/CLD
    - May damage brain cells
  - High PaO2's can close or constrict PDA with certain congenital heart defects. (hypoplastic L heart)

Oxygen Toxicity

- During the reduction process of oxygen, a reaction takes place at the cellular level producing toxic Free oxygen radicals

- These are molecules with extra electrons on the outer ring that are toxic to living tissues.

Oxidative Stress

- A balance exist between antioxidant defenses and Free Oxygen Radical

- This balance is disturbed when:
  - ↑ Free radicals – hyperoxia, ischemia (reperfusion), inflammation + infection

  - ↓ in antioxidant defenses
    - premature newborn can have an excess of free O2 radicals as developmentally they have a decrease level of antioxidants.

↑ Free Radicals + ↓ Antioxidants→ BPD,ROP

FREE RADICALS	ANTIOXIDANTS
• Superoxide anion	• Superoxide Dismutase,uric acid, vit E
• Singlet oxygen	• β-carotene, uric acid, vit E
• Hydrogen peroxide	• catalase , glutathione
• hydroxyl radical	• vit C and E
• peroxide radical	• vit C and E
• Hydroperoxyl radical	• Glutathione
• peroxynitrite	• Superoxide dismutase

Low flow Oxygen System

Provides an F_iO2 that **will vary** based on the patient's inspiratory flow

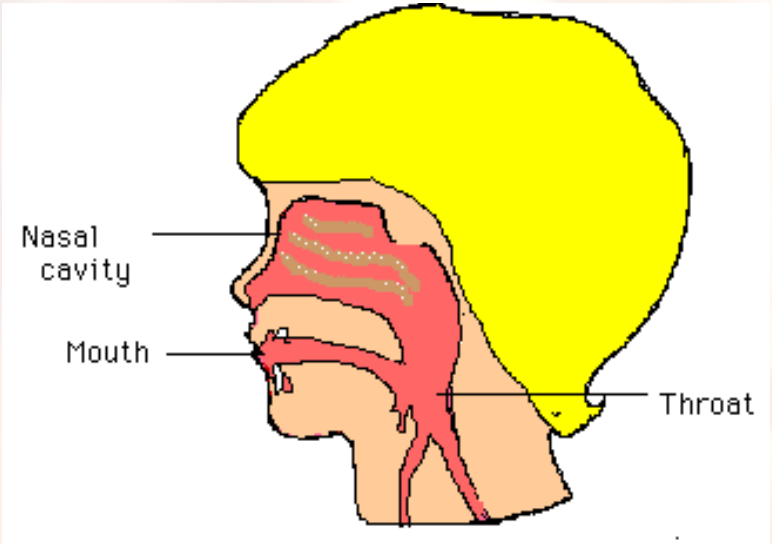
High flow oxygen system

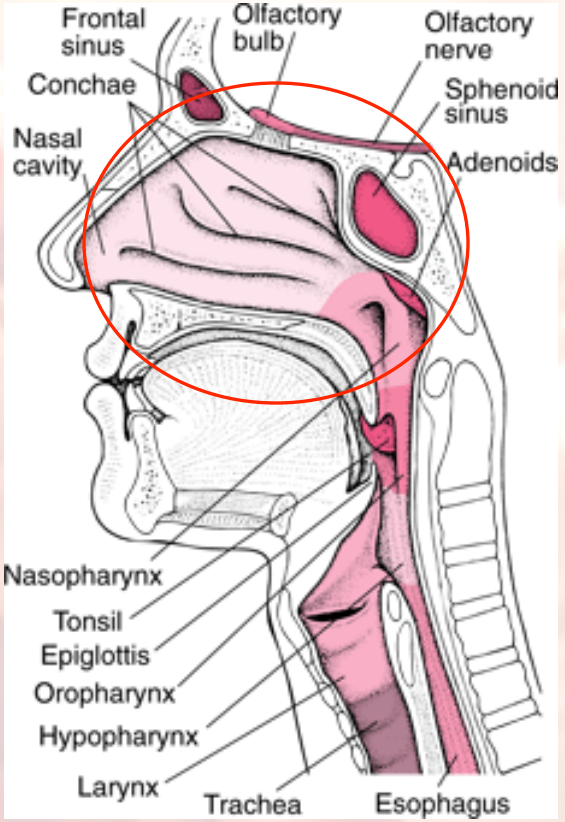
Will deliver a fixed FiO2 at flows that meet or exceed the pts inspiratory flow requirement

Inspiratory Flow Demands and variable FiO2

- Minute ventilation (V_E)
  - How fast they breathe in (inspiratory flow)
- V_E = Breath Rate x Tidal Volume (f x V_T)
- V_E Varies with infant weight

Anatomical Deadspace





- Oxygen flows from the cannula into the pt's nasopharynx, which acts as a anatomical reservoir.

- **Actual FiO2 is a blend of nasal inhaled oxygen including that which fills the nasal nasopharanyx, and room air that is entrained through the mouth and nose.**

Link to nasal cannula video

http://en.wikipedia.org/wiki/Nasal_cavity
https://courses.stu.qmul.ac.uk/smd/kb/cardioresp/acets/nose1.htm

Nasal Prongs (cannula)

- 3 sizes: Premature, infant and pediatric sizes
  - Differ in length and width of prongs
- Flows up to 1 L/min (literature states ≤ 2 L/min)
- No bubble bottles required with low flow NP
- Connect directly to O2 flowmeter (which is connected to wall, **not** blender)

Chart in cc/min vs. liters/min

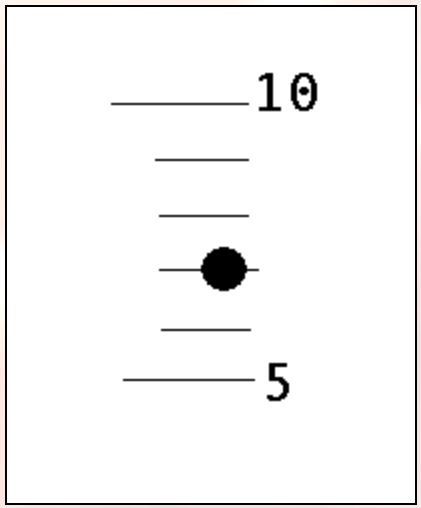
Flowmeters and different increment levels

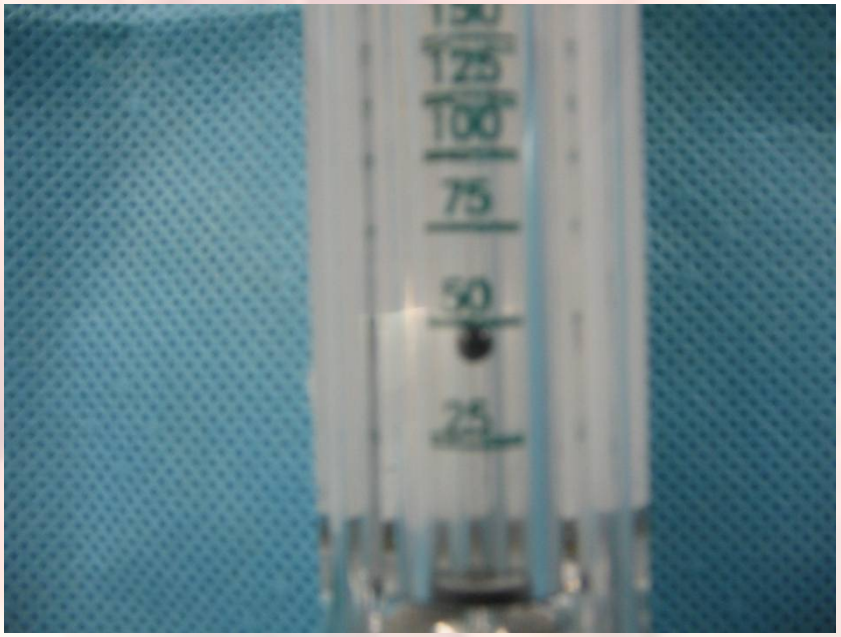
- 0-15 lpm
- 0-3 lpm
- 0-1000 cc (1 lpm)
- 0-200 cc (.2 lpm)
- 0- 45 cc

Do we need them all?

Reading flowmeter level

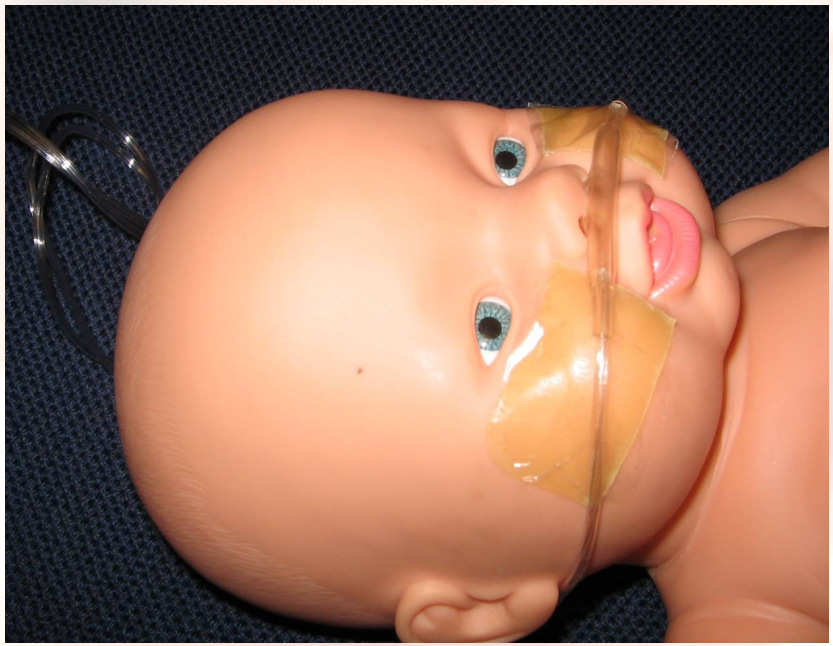
- Always read level at center of float/ball.

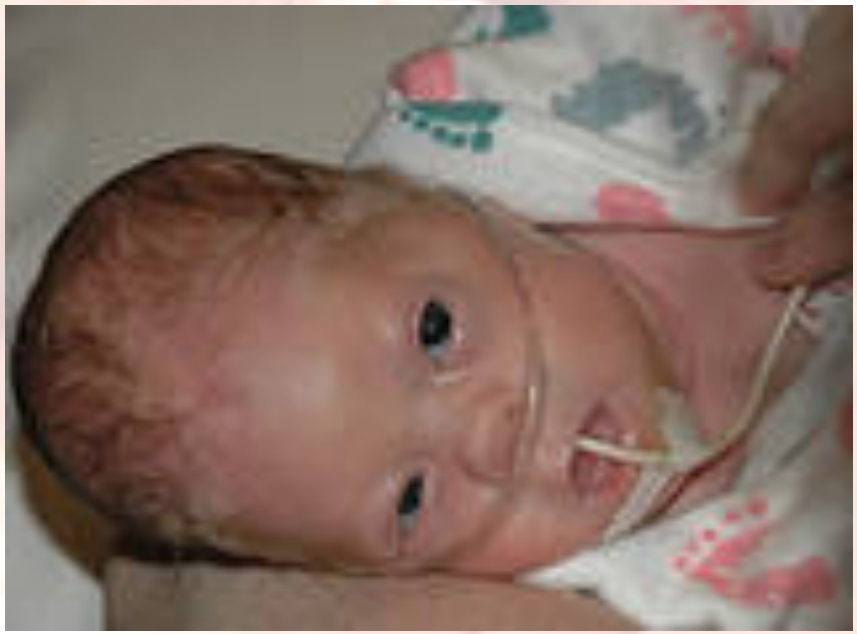




Secure by:

- Applying ComFeel barrier on skin
- Then attach cannula to barrier with Tegaderm





Possible complications of NP's

- Cannot use Nasal prongs in pts with nasal obstruction (choanal atresia, nasal polyps, etc)
- Skin irritation from plastic or securing devices
- Displacement leads to loss of oxygen
- Improper sizing can lead to nasal obstruction
- Inadvertent CPAP may be administered depending on size, gas flow, and the infants anatomy (no NGT)
- Irritation if flows are too high or Laryngeal nerve stimulus.

Limitations of Nasal prongs

- Varying FiO2 – with changes in minute volume and inspiratory flow.
- Unable to keep prongs in place
- Mouth vs. nose breathing is still controversial
- Excessive nasal secretions, edema, deviation
- Keep tubing away from neck to prevent airway obstruction
- Discrepancies between different flowmeter settings

Managing

- Adjustment of oxygen liter flow must be done slowly to prevent **repeated episodes** of alternating **hyperoxia and hypoxia as can:**
  - alter the regulation of vascular endothelial growth factor and this is 1 important factor in the cause of ROP.
  - can promote significant alterations in vascular tone. By avoiding these episodes, risks to the developing vascular bed in various organ systems can be minimized
  - Metabolic alterations in hypoxic cells produce free O2 radicals when exposed to Oxygen (reperfusion)

Managing

- Titration of oxygen
  - To maintain adequate oxygen saturations via pulse oximetry
- May need to apply or increase O2 level when infants are feeding or active.
- Trial on Room Air once at a certain cc/min or calculated FiO2

Low flow oxygen delivery via nasal cannula to neonates.

Neil N. Finer MD, FRCPC, Rosanne Bates RRT, Paula Tomat RRT

Pediatric Pulmonology
Volume 21, Issue 1, pages 48–51, January 1996

- The purpose of this study was to determine the actual FiO2 delivered to neonates when using a low-flow flowmeter and a nasal cannula, and the accuracy with which FiO2 could be estimated using a formula that we developed.

FiO2 measured =

(O2 flow (ml/min) x 0.79) + (0.21 x V_E) / V_E x 100

- where minute ventilation (V_E) equals the minute ventilation in mL/min (V_E = VT X respiratory rate).

Low flow oxygen delivery via nasal cannula to neonates.

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- For both groups of infants, increments of 25 mL/min of flow produced distinctive changes in FiO2 at all levels ($P < 0.001$).
- The calculated FiO2 did not significantly differ from the actual FiO2 at any flow. The calculated FiO2 was most predictive when using an assumed tidal volume of 5.5 mL/kg.
- Conclude that an accurate flowmeter connected to 100% humidified oxygen can produce a wide range of predictable FiO2s for neonates, especially those with birthweights of less than 1,500 g.
- The proposed formula allows useful estimation of the infant's FiO2

Calculations

- Not usually used in clinical settings do to formula's being cumbersome to use.

FiO2 measured =

(O2 flow (ml/min) x 0.79) + (0.21 x V_E) / V_E x 100

- Availability of printed tables
  - may improve starting, managing, and weaning the FiO2 delivery for Nasal Prongs.
  - Knowledge of FiO2 for transfer

O2 Delivery with LFNP

1250 Gram baby

Baby Resp. Rate	Flowmeter setting cc/min 5	10	15	20	*25	30	40	50	75	100	150	200	250
30	23	25	27	29	*31	32	36	40	50	59	78	98	100
40	22	24	25	27	*28	30	32	35	43	50	64	78	93
50	22	23	24	26	*27	28	30	32	38	44	55	67	78
60	22	23	24	25	*26	27	29	31	35	40	50	59	69
70	22	23	23	24	*25	26	28	29	33	37	46	54	62
80	22	22	23	24	*25	25	27	28	32	35	43	50	57
90	22	22	23	24	*24	25	26	27	31	34	40	47	53
100	22	22	23	23	*24	24	26	27	30	32	38	44	50
110	22	22	23	23	*24	24	25	26	29	31	37	42	47

3000 gram Baby

Baby Resp. Rate	Flowmeter setting cc/min 5	10	15	20	25	30	40	50	75	100	150	200	250
30	22	23	23	24	25	26	27	29	33	37	45	53	61
40	22	22	23	23	24	25	26	27	30	33	39	45	51
50	21	22	22	23	23	24	25	26	28	31	35	40	45
60	21	22	22	23	23	23	24	25	27	29	33	37	41
70	21	22	22	22	23	23	24	24	26	28	31	35	38
80	21	22	22	22	22	23	23	24	25	27	30	33	36
90	21	22	22	22	22	23	23	24	25	26	29	32	34
100	21	21	22	22	22	22	23	23	25	26	28	31	33
110	21	21	22	22	22	22	23	23	24	25	28	30	32

Oxygen Delivery Through Nasal Cannula to Preterm Infants: Can Practice Be Improved?

PEDIATRICS Vol. 116 No. 4 October 2005, pp. 857-861
Michele Walsh, MD, MS*, William Engle, MD , Abbot Laptook, MD , S. Nadya J. Kazzi, MD, MPH||, Susie Buchter, MD, Maynard Rasmussen, MD#, Qing Yao, PhD** for the

National Institute of Child Health and Human Development Neonatal Research Network

- Room air trial when infant reaches 0.23 FiO2 via NP may reduce unnecessary days with low levels of O2 and may reduce LOS in hospital.

Standardizing Nasal Cannula Oxygen Administration in the Neonatal Intensive Care Unit

PEDIATRICS Vol. 118 Supplement November 2006, pp. S187-S196

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Blended low flow O2 delivery

- Attach Low flow meter to blender
- Fixed set O2 flow at .5 l/min
- Adjust FiO2 via Blender
- Decrease expense and purchase of Low Flow Meters
- Precaution: Discrepancies in flow and FiO2 between set and delivered values can occur in low-flow blenders at flows below the recommended range of the blender.*

Points to take home

- Can we standardize practice with in our NICU and FHA
- Decrease the number of days our babies are on oxygen.
- Can we limit our types of flow meters
- Identify estimated FiO2 based on calculated charts and infants wt. and RR
- Perform Room Air trials from a standard FiO2 or flowrate based on infants wt.
  - How low do we go?