Neonatal Intubation
When and How?

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Invasiveness = Intubation
What do we know??

- Intubation required for mechanical ventilation
- Current trend is to use non-invasive ventilation and this is growing
- However, many very preterm infants cannot be managed by Non-invasive support alone
- Surfactant introduction was associated with a reduction in death and respiratory morbidity (but NOT BPD or NDI)
- Currently surfactant requires intubation
Adverse Events during Bolus Surfactant Administration

- Oxygen desaturations of 25-50%
- Reflux of drug up the endotracheal tube
- Bradycardia (associated with desaturations) or vagal with airway obstruction
- Fluctuations in cerebral blood flow (decreased)
- Fall in blood pressure
- Rise in pCO2
- Reduction in cortical EEG voltage – also seen with intubation!!
- Extubation during manipulation of infant
Intubation and Surfactant Administration (SA) - Effects on EEG


- 18 of 29 (62%) infants had brainwave suppression following SA on EEG (p=0.008).
- EEG suppression seen in 9 infants during endotracheal intubation, all of who received premedication prior to intubation.
- Five infants had EEG suppression during endotracheal suctioning.
- *Is this benign??*

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Less Invasive Support
What is the Evidence?

- Does avoiding intubation decrease morbidity/mortality?
- Does decreasing exposure to invasive support decrease Morbidity/Mortality?
- Is surfactant given by less/non-invasive routes as effective as that given intratracheally?
- What else can we do to decrease the need for invasive support?
Early DR CPAP and Outcomes

- None of the Early CPAP only infants developed intraventricular hemorrhage of grade III or IV or retinopathy of prematurity of stage 3 or 4.
- Infants with early CPAP failure had a higher incidence of necrotizing enterocolitis compared with infants intubated in DR (15.6% vs 7.3%; b = 2.5 +/- 1.2).
- Need to consider CPAP failure criteria carefully

Intubation in DR

- Was frequently performed to give prophylactic surfactant
- Now this indication is decreasing with use of early CPAP
- Especially a problem for the ELBW infant
- They are more difficult to intubate and require usually 2-3 attempts
- No premedication used in DR
Intubation and IVH

- We reviewed 100 ELBW infants < 750 gm
- Found that > 3 intubations was associated with severe IVH – almost all in Delivery Room!!
- Need to avoid such frequent attempts and perhaps avoid intubation in the delivery room

Neonatal Intubation: Physiologic Responses

- All attempts are associated with fall in SaO₂, HR, increase followed by decrease in BP, except in ELBW where BP falls very quickly
- Laryngoscope in mouth triggers responses
- Longer the attempt – worse are effects!!
- All of these can be prevented or reduced with premedication with atropine, a muscle relaxant and a narcotic or anesthetic agent
- Intubation following premedication was faster!!

Physiology of Intubation
Schmid et al E-PAS2014:3843.563

Studies 24 infants of 24.6 weeks, 630 gm

![Intubation Times Graph]

Surfactant – Other Routes Avoiding Intubation

- Pharyngeal route has been tried intrapartum (Kattwinkel et al J Perinatol. 2004 Jun; 24(6):360-5.)
- Nebulized Surfactant may be an option to avoid intubation (Finer N et al. J Aerosol Med Pulm Deliv. 2010 Oct; 23(5):303-9.)
- Given via LMA
- Given via a fine tracheal catheter passed via the larynx
- One report of giving to fetus via catheter using endoscope!
**Surfactant by LMA**


- Evidence from a single small trial that LMA surfactant in infants \(\geq 1200\) g with established RDS may reduce short term oxygen requirements – Not powered for important clinical effects.
- One current multicenter study and one single center study currently recruiting
  

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**Surfactant by Fine Catheter**

*Gopel et al, Lancet. 2011 Nov 5; 378(9803):1627*

- A thin catheter was inserted into the trachea by laryngoscopy if randomized infants needed a fraction of inspired oxygen more than 0.30.
- First described by Kribs from Cologne in 2007 (Ped Anesth, 2007;17:364)
- 108 infants were assigned to the intervention group and 112 infants to the standard treatment group
- Primary was number of infants ventilated at 72 hrs
36 (33%) infants in the Catheter group were mechanically ventilated compared with 82 (73%) in the standard treatment group (number needed to treat 3, 95% CI 2-4, p<0.0001).

The Catheter group had significantly fewer median days on mechanical ventilation, (0 days. IQR 0-3 vs 2 days, 0-5) and a lower need for oxygen therapy at 28 days (30 infants [30%] vs 49 infants [45%], p=0.032) compared with the standard treatment group.

No increase in other morbidities or Death

Also known as LISA Technique

Klebermass-Schrehof et al Neonatology
2013;103(4):252-8

- LISA technique – similar also reported better outcomes compared to historical controls
- Caffeine is administered before MIST technique – usually within 15-30 min of birth – Not mentioned in manuscripts!!
- Operators are experienced, gentle, infants are swaddled, and was initially used with very high CPAP levels – Benivista valve used in Europe
MIST Approach

*Dargaville et al., Arch Dis Child Fetal Neonatal Ed. 2013 Mar; 98(2):F122-6.*

**Dargaville et al Neonatology 2012; 101: 326**

- For infants at 25-28 weeks gestation, need for intubation <72 h was diminished after MIST compared with controls (32% vs 68%; OR 0.21, 95% CI 0.083 to 0.55), with a similar trend at 29-32 weeks
- Infants receiving MIST had a shorter duration of oxygen therapy.
- Planning Trial to compare MIST to INSURE using angiocatheter #16 - OPTIMIST Trial

Surfactant by Aerosol

*Minocchieri et al- E-PAS2013:3500.7*

- Compared CPAP to CPAP and 200 mg/kg nebulized surfactant (Curosurf, Chiesi Farmaceuti) using a customized vibrating membrane nebulizer (eFlow Neonatal Nebulizer System, Pari Pharma GmbH) in 64 infants. Surfactant (100 mg/kg) was readministered after 12 h if FiO₂ remained > 0.21.
- 29⁰-33⁶ w GA infants treated with CPAP and nebulized surfactant had a reduced need for intubation in the first 72 h compared to CPAP alone.
Early CPAP and need for Intubation and Ventilation

- Fourteen studies were reviewed. Eleven studies provided varying degrees of supportive evidence (level of evidence 3 to 4) that the use of primary CPAP can reduce the need for intubation and mechanical ventilation.
- Avoidance of intubation and mechanical ventilation is more likely in mature infants >27 weeks' gestation.

Does Avoiding Intubation Prevent BPD?
Fischer&Buhrer Pediatrics 2013 Nov;132(5):e1351-60

- Reviewed 7 trials – 3289 infants
- Avoiding intubation reduced death or BPD
  - OR = 0.83, (.71 - .96)
- 4 trials – 2782 infants
- CPAP alone associated with decreased death or BPD
  - OR= 0.9, (.82 - .98)
At what point should infants on CPAP be intubated for Surfactant?

Dargaville et al Neonatology 2013;104(1):8-14. doi

- CPAP failure was predicted by an FiO2 > .3 in first few hours of life
- CPAP failure was associated with a higher risk of death or bronchopulmonary dysplasia at 25-28 weeks' gestation (CPAP-F 53% vs. CPAP-S 14%, relative risk 3.8, 95% CI 1.6, 9.3) and a substantially higher risk of pneumothorax at 29-32 weeks.

Intubation in DR

- Often done as emergency when infant cannot be stabilized and for very compromised infants
- Not surprising that intubation is associated with increased risk of IVH
- Aly et al showed that intubation in the DR increased Severe IVH (OR=2.7, CI 1.1-6.6, P=0.03).

Aly et al Brain Dev. 2012 Mar; 34(3):201-5.)
**Neonatal Intubation**

**Intubation of Preterm Neonate**

- Current guidelines suggest use of premedication including paralytic for non-emergent intubations.
- Our experience has shown that intubations are shorter and more successful when used.
- However, do not use in presence of facial dysmorphia, micrognathia, cleft palate, etc.
- Will obliterate spontaneous breathing and will result in fall in ventilation and increase CO2 unless compensated for.
**DR and NICU Intubation of ELBW Infants**

*More Difficult - Lane et al J Pediatr 2004; 145:67*

- DR Intubation success rate per-attempt was 39% for infants ≤28 weeks, and 54% for infants >28 weeks.
- NICU success rate was 32% for <28 weeks, and 60% for infants >28 weeks in the NICU.
- 17% of infants of ≤28 weeks were intubated on the first attempt compared with 53% for infants of >28 weeks.

**DR Intubation**


- Deterioration during intubation occurred in 4 of 24 attempts <30 seconds vs 20 of 27 >30 seconds.
- Fall in SpO2 and HR greater in infants whose SpO2 <70% when intubated.
- The mean SpO2 was 70% at intubation.
- 17/25 (68%) deteriorated if SpO2 <70% vs 8/26 (31) >70%.
- We believe that this is too low and that bag and mask should be given till the SpO2 >85% before attempting intubation.
Intubation for Resuscitation of ELBW Infant

✓ We need to emphasize better stabilization for ELBW infants
✓ Immediate attempts at intubation before attempts at stabilization are probably inappropriate!
✓ Early intubation may allow early baro/volutrauma
✓ Prophylactic surfactant is effective at 15 minutes and early surfactant is also beneficial < 2 hours!

Physiologic Response to Intubation

• All attempts are associated with fall in SaO₂, HR, increase followed by decrease in BP, except in ELBW where BP falls very quickly
• Laryngoscope in mouth triggers responses
• Longer the attempt – worse are effects!!
• All of these can be prevented or reduced with premedication with atropine, a muscle relaxant and a narcotic or anesthetic agent
Premedication - Current Use

* Singh et al, E-PAS2014:3844.618
* Jackson et al, E-PAS2014:2939.545
* Chandrasekharan et al, E-PAS2014:328

- Single center review - Used in approx 50%, less by faculty
- They did not report improved success with premed and noted increased PaCO2 with paralysis
- Single center review demonstrated decrease ventilation and increase PaCO2 with paralysis, more with surf
- A survey of US NICUs with a 40% response rate reported that
- Premedication with analgesics were routinely used for elective intubations in 67% of US NICUs surveyed (40% response rate) compared with 97% of all Level III UK NICUs (100% response rate).

Premedication and Neonatal Intubation

* Kumar et al, Pediatrics. 2010; 125(3):608-615;
* AAP Guideline

- Neonatal Intubation associated with marked physiologic instability
- Reviewed medications used
- Developed guideline which recommended that for non-emergent intubations premedication including a paralytic is recommended
- Still not practiced for majority of intubations
Canadian Pediatric Society – Fetus and Newborn Committee

Barrington et al, Paediatr Child Health. Mar 2011

- Recommend a vagolytic, a rapid acting narcotic, and a rapid acting short duration muscle relaxant
- If the decision is made to intubate using a potent opiate but without muscle relaxation, we recommend that a muscle relaxant be drawn up in the correct dosage and be available for use in case of chest wall rigidity.

Current Premedication use in Neonates


- Evaluated use of premedication and whether it followed current recommendations in French Neonatal Units in 2005-2006.
- Premedication use prior to neonatal intubation was not systematically used and when used it was most frequently inconsistent with recent recommendations.
Current Premedication use in Neonates

- All tertiary care neonatal units in Australia and New Zealand use premedication for Intubation
- 93% use paralytics
- This is quite different from US units!!

Neonatal Intubation Distributions by Premedication and Location.
Le et al J Perinatology 2014 Jun;34(6):458-60

<table>
<thead>
<tr>
<th>Location</th>
<th>Intubation Attempts</th>
<th>Successful Attempts</th>
<th>Success Rate (Median %)</th>
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</thead>
<tbody>
<tr>
<td>No Premedication</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DR + NICU</td>
<td>1136</td>
<td>402</td>
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<td>DR</td>
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<td></td>
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<tr>
<td>TOTAL</td>
<td>2694</td>
<td>1071</td>
<td>36</td>
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</tbody>
</table>

* p < 0.05 when comparing to no premedication group.
Difficult Neonatal Intubations: Causes

- Most of these are a result of failing to perform the procedure correctly
- Commonest errors are:
  - Lack of good exposure – overextension, improper holding of laryngoscope, prying, not lifting, lack of adequate cricoid pressure, poor vision because of short focal length, wrong blade size or shape – I try to avoid distal curve
  - Failure to use appropriate premed

Why Does Intubation Fail?

- The primary reason for intubation failure in tiny infants, and larger babies with abnormal airways, is VISION!

- Vision can be improved
  - Glasses or Loupes – Not well accepted
  - Video – Expensive, large, difficult to use.
**Difficult Neonatal Airway**

*The Very Preterm Infant*

- Laryngoscopes and blades are too big!!
- These infants have small mouths and it is difficult to get a clear view of the larynx
- When the ETT is inserted there is very little space to see
- Seeing is difficult because the focal distance for these infants is very short
- None of the current videolaryngoscopes have appropriate size and curvature – not useful for < 800gm infant

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**Difficult Neonatal Airway**

*The Very Preterm Infant*

- At age 30, you can clearly something 13 cm in front of your eye
- By age 50 this has become 40 cm
- When holding at 00 laryngoscope, the blade is 6 cm, and most operators eyes are about 6-10 cm away from proximal end of blade
- Thus if you are > 40, you will have trouble seeing something clearly at < 20 cm
Difficult Neonatal Airway

- We have placed a number of sets of magnifiers (3X) in the DR and NICU
- For me they are life saving
- For most who try them, the airway becomes much easier to recognize
- We now have a videolaryngoscope – Storz with a 19 inch screen

Adverse Events with Neonatal Intubation


- 273 neonatal intubations reviewed
- Reported a severe adverse event rate of 8.8% and a 35% rate of non-severe events which included difficult bag and mask ventilation – 7.3% and esophageal intubation of 21.4%.
- Hypotension was most frequent severe adverse event – 3.7% of intubations.
- Adverse events most frequently associated with emergent intubations following unplanned extubation.
2/3 of infants premedicated for intubation developed significant hypotension after premedication, with a fall off ≥ 20% following blade insertion.

Following intubation, an additional 11/31 decreased their MAP 21-51%.

A large multi-center cohort study of childhood intubations reported that adverse events occurred in 20% of intubations.

Hypotension receiving intervention was the most common severe event in children, occurring in approximately 3%
Respiratory Support for the ELBW Infant 2014

✓ Whenever possible give infant a trial of CPAP
✓ Consider early caffeine
✓ If infant reaches failure criteria – probably ideally FiO2 consistently > .35, consider the least invasive approach for surfactant administration
✓ Fine catheter/angiocath, brief intubation followed by extubation, aerosol in future if studies support
✓ Continued support including nutrition, noninvasive ventilation – not yet proven!