Neonatal Intubation When and How?

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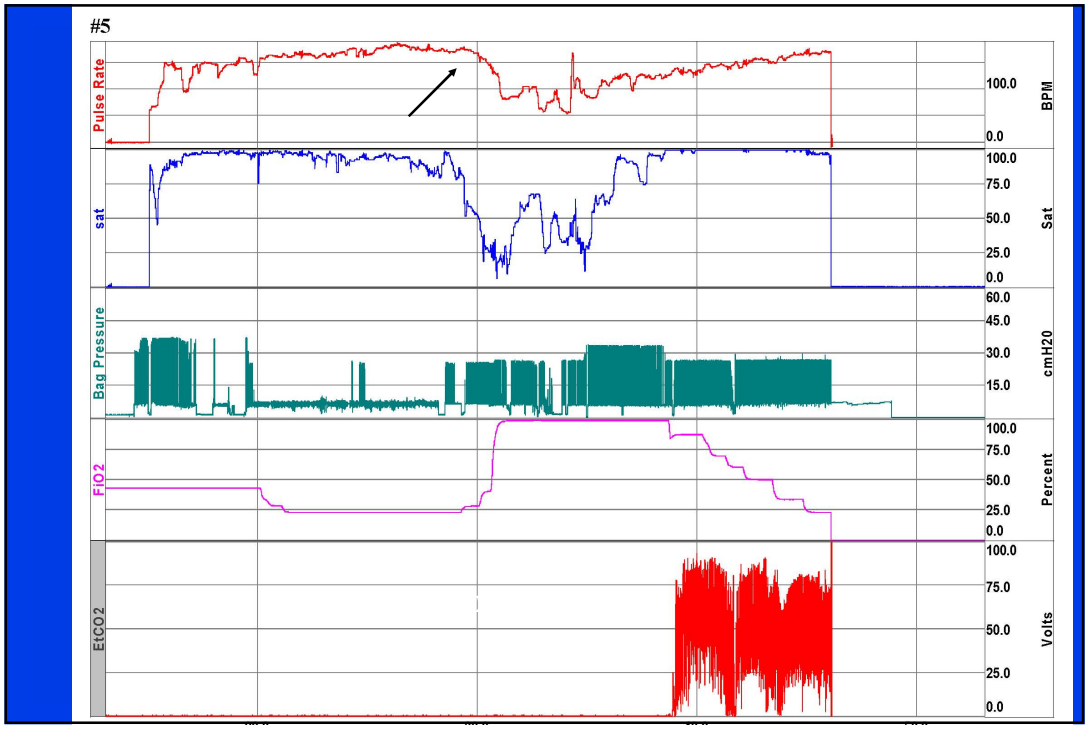
Invasiveness = Intubation What do we know??

- 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 pC02
- Reduction in cortical EEG voltage – also seen with intubation!!
- Extubation during manipulation of infant
- Increased IVH (Gleissner et al J Perinat Med. 2000; 28(2):104-10.)

Intubation and Surfactant Administration (SA) - Effects on EEG

Shangle et al J Peds, 2012 Aug;161(2):252-7

- 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???*

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

Aly et al Pediatrics. 2005 Jun; 115(6):1660-5.

- 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

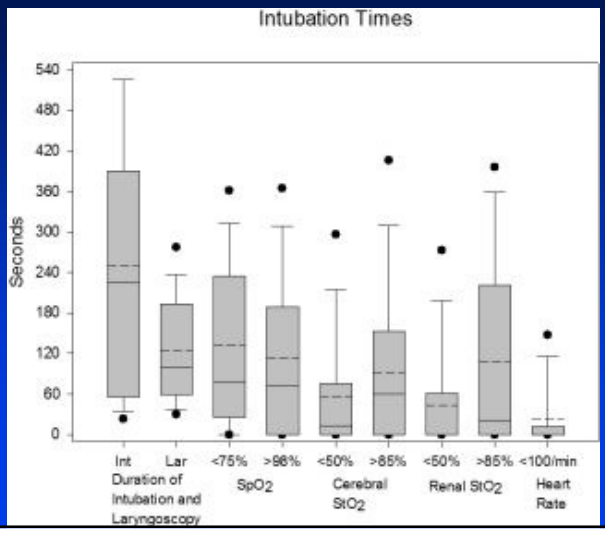
Neonatal Intubation: Physiologic Responses

- All attempts are associated with fall in SaO_2, 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!!

Kelly, M. A. and Finer, N. J Pediatr. 1984 Aug; 105:303-9.

Physiology of Intubation
Schmid et al E-PAS2014:3843.563

Studies 24 infants of 24.6 weeks, 630 gm



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

Abdel-Latif & Osborne. Cochrane Database Syst Rev. 2011; (7):CD008309.

- ✓ Evidence from a single small trial that LMA surfactant in infants >/= 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

(http://clinicaltrials.gov/ct2/show/NCT01116921?term=LMA+and+surfactant&rank=2 , http://clinicaltrials.gov/ct2/show?term=LMA+and+surfactant&rank=3)

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

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

- ✓ 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 swadled, 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 FiO_2 remained > 0.21.
- ✓ 29^0-33^6 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

Yee, et al Paediatr Child Health. 2011 16(10):633.

- ✓ 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*
Schmolzer et al, BMJ 2013 Oct 17;347:f5980.

- ✓ 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

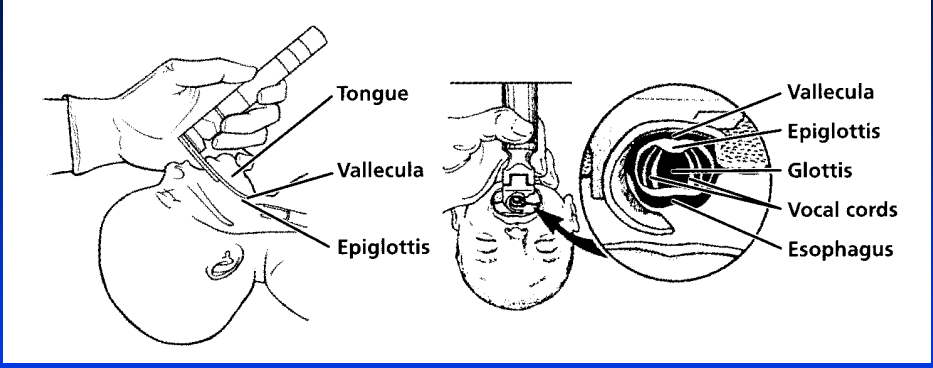
- CPAP failure was predicted by an FiO2 > .3 in first few hours of life
- CPAP failure was associated with a higher risk of death or bronchopulmonary dysplasia at 25-28 weeks' gestation (CPAP-F 53% vs. CPAP-S 14%, relative risk 3.8, 95% CI 1.6, 9.3) and a substantially higher risk of pneumothorax at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

O'Donnell, C. P.F. et al. Pediatrics 2006;117:e16

- 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
Kelly, M. A. and Finer, N. J Pediatr. 1984 Aug; 105:303-9

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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

Durrmeyer et al, Pediatric Crit Care Med. 2013 May;14(4):e169-75.

- 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

Wheeler et al, J Paediatr Child Health 2012 Nov;48(11):997-1000

- All tertiary care neonatal unitys 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

	LOCATION	INTUBATION ATTEMPTS	SUCCESSFUL ATTEMPTS	SUCCESS RATE (Median %)
No Premedication	DR + NICU	1136	402	22
	DR	916	333	25
	NICU	220	69	25
Premedication	NICU	1558	669	43[a]
Paralysis Subgroup	NICU	1372	615	45[a]
TOTAL		2694	1071	36

[a] $p < 0.05$ 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 !

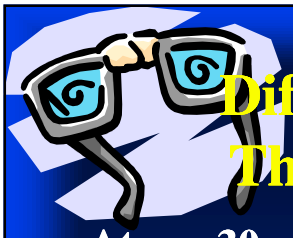
- Vision can be improved

  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

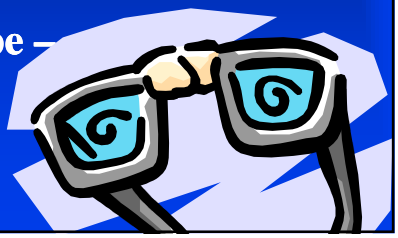


Difficult Neonatal Airway
The Very Preterm Infant

- 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



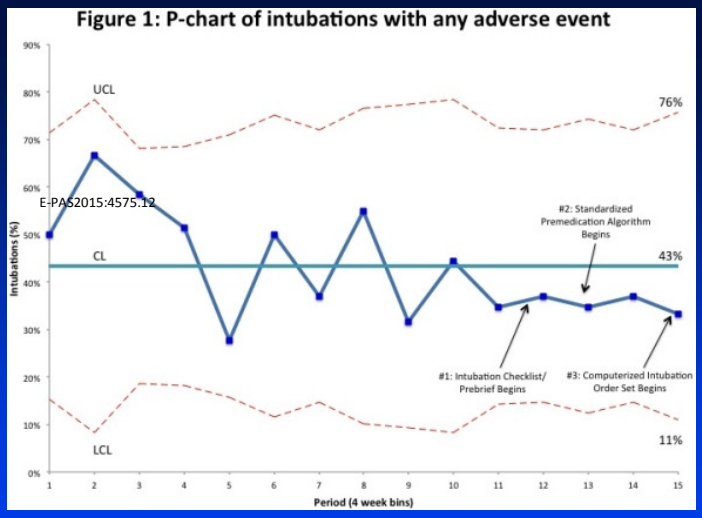
Adverse Events with Neonatal Intubation

Hatch et al PAS – 2015 E-PAS2015:4575.12

- 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.

Adverse Events with Neonatal Intubation

Hatch et al PAS – 2015 E-PAS2015:4575.12



Hypotension with Premedication for Intubation

Tran et al. PAS 2015 EPAS 2015 1574.544
Nishisaki A et alCrit Care Med. 2013;41(3):874-85.

- 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!