

**Out Patient Anesthesia in Children**

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## Common Controversies

- Previously undetected murmur
- Child with a runny nose
- Ex-premature infant
- SDB
- Post-Operative Pain
- PONV

**I hear a “new” murmur, now what?**

## Murmurs

- Very common
- Highest incidence at 3 or 4 years
- “Functional” = normal heart
- Usually short, and soft
- louder when pt supine or ↑ heart rate

**Common Locations to hear murmurs**

## Common “functional” murmurs

- Still murmur-
  - musical or vibratory, midsystolic,
  - left sternal border
- Peripheral pulmonary stenosis-
  - ejection murmur
  - LUSB, radiates-neonates
- Venous Hum-
  - continuous murmur louder in upright position
  - Upper chest

## How loud?

- Grade I Heard only with intense concentration
- Grade II Faint, but heard immediately
- Grade III Easily heard, of intermediate intensity
- Grade IV Easily heard, palpable thrill/vibration on chest wall
- Grade V Very loud, thrill present, audible with only edge of stethoscope on chest wall
- Grade VI Audible with stethoscope off the chest wall

## What to do?

- Controversial
- If child is growing well, acyontic and has good exercise tolerance-anesthesia well tolerated
- Look for systemic symptoms
- If in doubt-Echo +/- Pediatric cardiologist

## Symptoms of Heart Disease

- Feeding difficulties: disinterest, fatigue, diaphoresis, tachypnea, dyspnea
- Poor exercise tolerance
- Resp distress, grunting, nasal flaring, retractions
- Frequent respiratory tract infections
- Central cyanosis or poor capillary refill
- Absent or abnormal peripheral pulses

Modified from Pelech AN: Evaluation of the pediatric patient with a cardiac murmur. Pediatr Clin North Am 1999; 46:167-188.

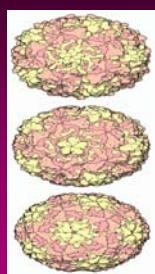
## If in Doubt

- Call Cardiology
- Postpone Case
- Reschedule?

## Child with a Runny Nose



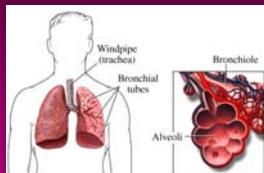
## The Child With a Runny Nose



- 95% of RTI are viral—wide spectrum of species and respiratory tract involvement
- Hyper-reactivity of airways is common for several weeks
- Airways may be more sensitive to "irritants" (secretions, anesthetic agents etc.)

## The Child With a Runny Nose

- Pulmonary function tests abnormalities are not uncommon, including ↓ FVC, FEV<sub>1</sub> and PEF
- ↓ Diffusion capacity and ↑ desaturation after apnea



## The Child With a Runny Nose

- ... “although anesthesia is not good for the common cold, might it not be a good way of passing the time till the cold is gone?”
- No reason for automatic cancellation
- ↑ anesthetic risk usually minor
- Intubation ↑ risk
- Bronchodilators do not ↓ risk
- Glycopyrrolate does not ↓ risk



Ellis. Anaesthesia 10:78-9, 1955

## The Child With a Runny Nose

- Cohen and Cameron:
  - >20,000 children
  - 2-7 x increased risk of respiratory complications with URI
  - 11 x increased risk if they were intubated
  - Study criticized for incomplete documentation as to signs and symptoms of URI



Cohen and Cameron. Anesth Analg 72: 282-8 1991

## The Child With a Runny Nose

- Tait et.al examined >1000 children for elective surgery. Risk factors for increased complications included:
  - Use of ETT in child < 5 yrs
  - H/O prematurity or RAD
  - Paternal smoking (?)
  - Airway surgery
  - Copious secretions and/or nasal congestion



Tait et.al. Anesthesiology 95:299-305, 2001

## The Child With a Runny Nose

- Parnis et.al examining predictors of complications in 2051 patients found that the risk increased with:
  - ETT > LMA > mask airway
  - Parent's report that child has a "cold"
  - H/o snoring, passive smoking
  - Presence of sputum and or nasal congestion
  - Induction with STP > halo > sevo > propofol
  - Non-reversal of muscle relaxant

Parnis et.al Paed Anaesth 11:29-40,2001

## The Child With a Runny Nose

- The increased risk associated with RTI's seems to be minimal
  - No closed claims cases
  - There are a few cases of increased atelectasis
  - In Tait et.al's study of >1000 pts, 3 required admission post-op, 2 for pneumonia, 1 for stridor
  - One case report of death related to laryngospasm and cardiac arrest after extubation in a 15 month old child with a URI

Tait and Malviya. Anesthesia with Upper Respiratory Tract Infection, A&amp;A 100, 2005

## More Recent Studies

- Kim, Kim et.al Korean J Anesthesiol:65; 136-141, 2013
  - Oral ETT, inhalation agents and passive smoking ↑ risk
- Schebesta, Güloglu et.al Can J Anesth: 57; 745-50. 2010
  - Lidocaine gel on LMA ↓ airway complications

## The Child With a Runny Nose

- Assessment:
  - History of "cold" by parents better predictor of laryngospasm than reliance on symptoms
  - Presence of sputum, nasal congestion and RAD ↑ incidence of adverse resp events
  - ✓ for fever, dyspnea, lethargy, wheezing, productive cough and lung field abnormalities
  - Labs, CXR, naso-pharyngeal swabs, rarely practical or helpful

## The Child With a Runny Nose

- Anesthetic Management
  - Avoid irritants!!! (ETT, excessive secretions)
  - Keep child well hydrated, consider humidification
  - Consider anticholinergics
  - Ensure adequate anesthetic depth before any airway manipulations
  - Awake or deep extubation per practitioner's preference

## Cancel When:

- Fever
- Lethargy, wheezing or other pulmonary signs



## Ex-Premature infant for Out Patient Anesthesia



## Ex-premature infant

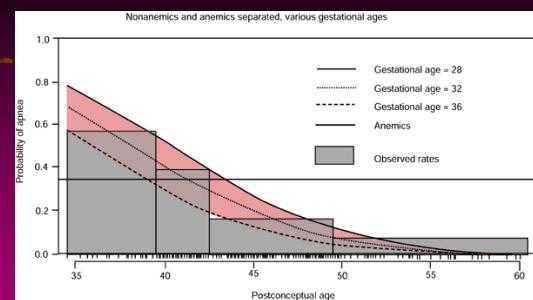
- When are they candidates for outpatient anesthesia?
- Does type of anesthetic matter?
- Does Procedure Matter?

## Guidelines for Ex-Premature infants (CHCO)

- **GUIDELINES:** Risk of post-operative apnea and need for post-procedure admission or observation will be determined at the discretion of the attending anesthesiologist. **PCA**, or post-conception age, is gestational age + post-natal age.
- Former premature infants born prior to 37 weeks gestational age who are less than **56 weeks PCA** at the time of surgery should be admitted overnight for cardiorespiratory monitoring or may require prolonged observation in the PACU prior to discharge.
- Full term infants (gestational age **greater than 37 weeks**) require overnight admission or extended PACU observation if they are **less than 44 weeks PCA** at the time of surgery.
- Patient who receive local anesthesia or spinal anesthesia only without systemic sedation, may be post-operatively managed at the discretion of the attending anesthesiologist.

## Ambulatory Surgicenter (CHCO)

- Term infants > 6 months of age
- Or a former premature infant older than 60 weeks post-conception and not currently on home monitors may be discharged home on the day of surgery if no other indications for admission exist.



Predicted probability of apnea for all patients, by gestational age and weeks of postconceptual age. The risk for apnea diminishes for infants born at later gestational age. The shaded boxes represent the overall rates of apnea for infants within that gestational age range. (From Coté et al.)

- Risk of apnea exceeds 1% in infants born at 32 weeks PCA until ~ 56 weeks
- Increased risk with:
  - Anemia
  - AGA infants
  - On-going apnea at home
- All anesthetics have been implied

## Spinal Anesthesia?



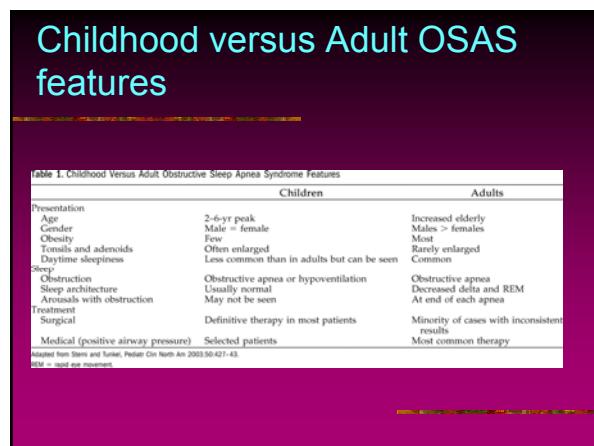
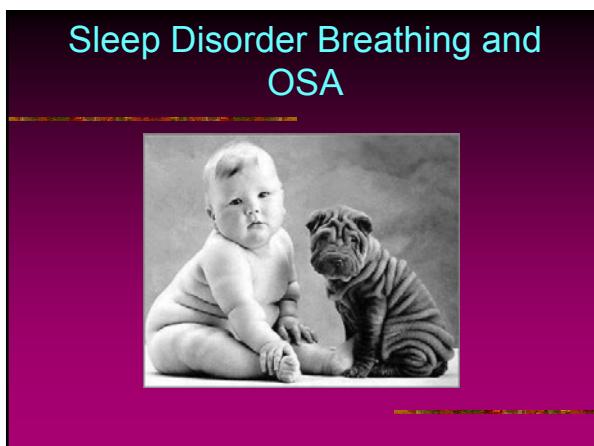
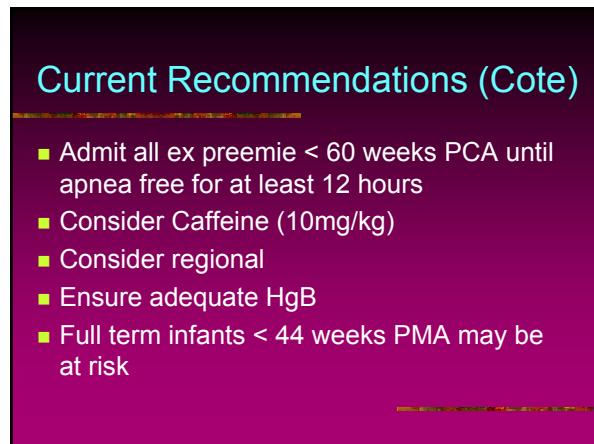
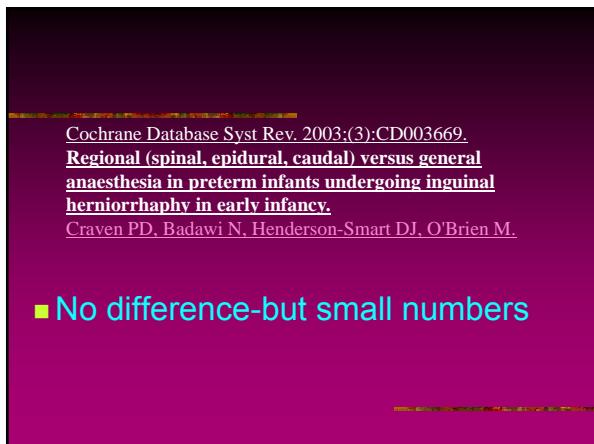
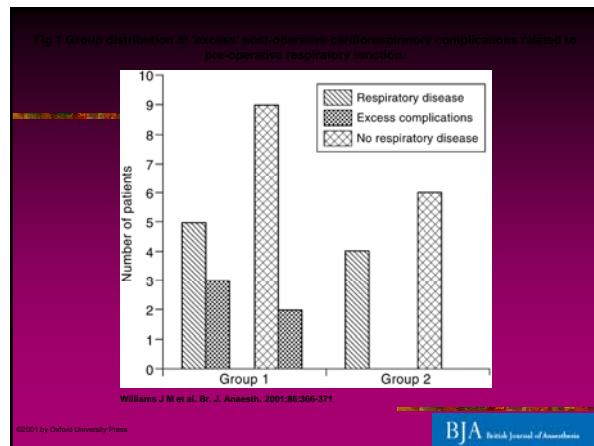
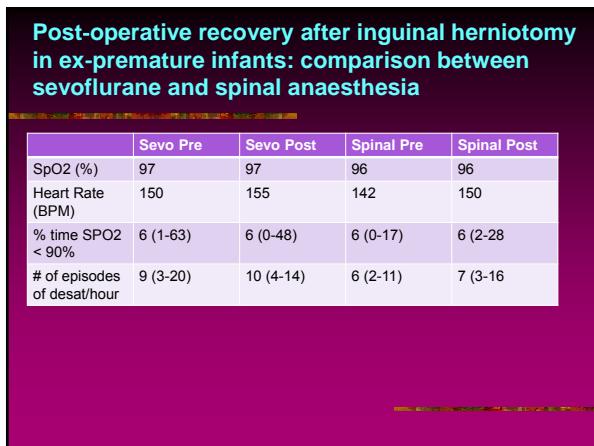
## Williams J M et al. Br. J. Anaesth. 2001;86:366-371

Post-operative recovery after inguinal herniotomy in ex-premature infants: comparison between sevoflurane and spinal anaesthesia

Table 1

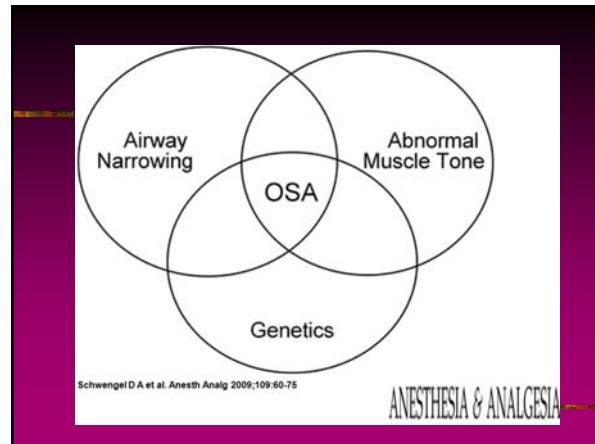
Patient characteristics and intra-operative data. A comparison of post-conceptual age (PCA), gestational age (GA), weight (Wt), pre-operative haemoglobin (Hb) and anaesthetic time (Induction-skin closure) for the two groups (median [range]). There was no significant difference between the groups with regard to all variables. n=number of patients

	Group 1 (n=14) sevoflurane	Group 2 (n=10) spinal
PCA (weeks)	38 [32-46]	40 [36-44]
GA (weeks)	30 [23-35]	8 [26-33]
Wt (kg)	2.6 [1.2-3.5]	2.8 [1.7-3.6]
Hb (g dl <sup>-1</sup> )	10.2 [9.0-13.4]	10.9 [9.6-12.7]
Bilateral repairs (n)	7	5
Induction-incision (min)	23 [16-29]	19 [11-28]
Incision-closure (min)	26 [10-45]	28 [12-48]



## Severity Ranking system based on Polysomnography

	Apnea-hyponea index	Oxygen Saturation Nadir
Normal	0-1	>92
Mild OSA	2-4	
Moderate OSA	5-9	
Severe OSA	>10	<80



A & A July 2009 vol. 109 no. 1 60-75

**Table 7. Key Questions to Ask Parents**

- Does your child have difficulty breathing during sleep?
- Have you observed symptoms of apnea?
- Have you observed sweating while your child sleeps?
- Does your child have restless sleep?
- Does your child breathe through his/her mouth when awake?
- Are you worried about your child's breathing at night?
- Do you have any family history of obstructive sleep apnea, sudden infant death syndrome, or apparent life-threatening events?
- Does your child have behavioral problems?

Adapted from Li et al., Pediatr Pulmonol 2006;41:1153-60; Brouilette et al., J Pediatr 1984;105:10-14; Messner, Otolaryngol Clin North Am 2003;36:519-30; McNamara and Sullivan, J Pediatr 2000;136:318-23; Whiteford et al., Arch Dis Child 2004;89:851-5.

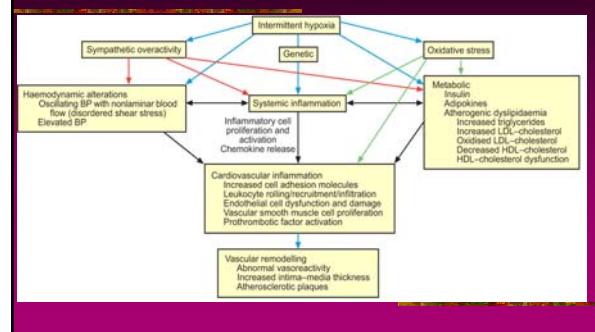
### After Adenotonsillectomy and, in Some Cases, Persistent Obstructive Sleep Apnea

- Severe obstructive sleep apnea on polysomnography
- History of prematurity, especially with respiratory disease
- Age <3 yr
- Morbid obesity
- Nasal problems (deviated septum, enlarged turbinates)
- Mallampati score 3 or 4
- Neuromuscular disorders/disordered pharyngeal tone
- Genetic or chromosomal disorders
- Craniofacial disorders
- Enlarged lingual tonsils
- Upper respiratory infection within 4 wk of surgery
- Cor pulmonale
- Systemic hypertension
- Marked obstruction on inhalational induction
- Disordered breathing in the postanesthesia care unit
- Difficulty breathing during sleep
- Growth impairment due to chronic obstructed breathing

## Role of Hypoxia

- Rats exposed to intermittent hypoxia develop increased opioid sensitivity
- Hypoxia can lead to inflammatory response and vascular remodeling
- Wilson et.al and others have found a 2 ½ X increase in the incidence of respiratory complications in children undergoing T&A who had evidence of nocturnal desaturation to 80% or less

## Relationship between intermittent Hypoxia and Systemic responses

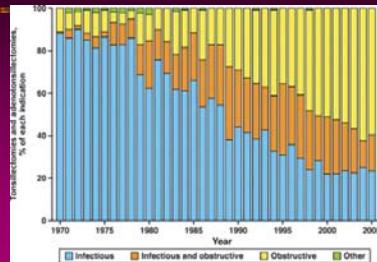


## Tonsillectomy in 2012

- **Pediatric Anesthesia Volume 21, Issue 7,** pages 771–780, July 2011 Karen Brown
- Obstructive symptoms and sleep disordered breathing are most common causes of T&A
- Few polysomnography
- ↑ incidence of peri-op complications
- ↓ doses of opioids or sedatives

### Outcome, risk, and error and the child with obstructive sleep apnea

Karen A. Brown



Pediatric  
Anesthesia  
Volume 21,  
Issue 7, pages  
771–780, July  
2011

Surgical indications for adenotonsillectomy (T&A) in Olmsted County, Minnesota, USA between 1970 and 2005.

## STBUR

*Pediatr Anesth*, 2013 Jun;23(6):410-4. doi: 10.1111/paa.12166. Epub 2013 Apr 1.  
The STBUR questionnaire for predicting perioperative respiratory adverse events in children at risk for sleep-disordered breathing.  
Tait AG, Voigt-Levin T, Christensen B, O'Brien LM.

- Snoring
- Trouble Breathing
- UnRefreshed

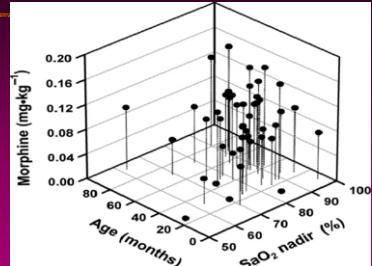
## STBUR

- Does your child:
  - Snore more than ½ the time?
  - Snore loudly?
  - Trouble/struggle to breath
  - Stop breathing during the night
  - Wake up Unrefreshed
- Score > 3 = 3X risk of PRAE(<sub>perioperative respiratory adverse events</sub>)
- Score = 5 + 10 X risk of PRAE

## Anesthetic Considerations

- ↑ pre-op desat= ↑ sensitivity to opioids
- Require less opioids
- Standard opioid doses may be relative overdose
- Consider nocturnal oxygen monitoring prior to surgery

### Outcome, risk, and error and the child with obstructive sleep apnea



Pediatric Anesthesia  
Volume 21, Issue 7, pages 771-780, 3 MAY 2011

## Race

- African Americans compared to Caucasians
  - ↑ SDB
  - ↑ OSAS
- African Americans have lower O<sub>2</sub>Sat nadir
- Pharmacogenetics work on different ethnicities

## BMI



- Severely obese children have a higher incidence of unplanned admission and readmission

Table 2. Frequency of QA events between normal weight, overweight and obese children				
QA Events	Normal weight (n = 4171), (%)	Overweight (n = 875), (%)	Obese (n = 1048), (%)	P values*
Preoperative				
Asthma	12.7	14.4	16.1	0.006
Diabetes	0.53	0.4	2.6	0.001
Hypertension	1.4	2.6	4.1	0.001
Intraoperative				
Difficult mask airway	2.2	3.6	7.4	0.001
Difficult laryngoscopy	0.4	0.2	1.3	0.005
Bronchospasm	0.4	0.0	0.5	0.156
Dental injury	0.0	0.1	0.1	0.111
Cardiac arrest	0.0	0.0	0.0	ns
PACU				
Upper airway				
Obstruction	0.07	0.3	1.6	0.001
Stay >3 h	0.66	1.3	1.9	0.026
z2 antiemetics	0.6	1.1	1.3	0.039
Vomiting	0.4	0.8	0.6	0.263
Unplanned admit	0.5	0.5	1.0	0.063

Nafiu OO, et al. Childhood body mass index and perioperative complications. *Pediatr Anesth* 2007; 17: 426-430.

Table 2. Severe intraoperative and immediate postoperative adverse events among severely obese and normal weight children undergoing tonsillectomy			
Adverse events	Normal weight (n = 200)	Severely obese (n = 100)	P*
Any intraoperative or emergence events <sup>a</sup>	3 (1.5)	14 (14.0)	<0.001
Bronchospasm	1	2	0.259
Airway obstruction	0	7	<0.001
Stridor/laryngospasm	1	4	0.044
Aspiration	0	0	—
Severe hypoxemia, SpO <sub>2</sub> ≤ 70%	1	5	0.017
Any recovery room events <sup>a</sup>	1 (0.5)	3 (3.0)	0.074
Bronchospasm	0	1	1.000
Airway obstruction	0	3	0.036
Aspiration	0	0	—
Reoperation for tonsilar bleeding	1	0	1.000
Tracheal reintubation <sup>b</sup>	1	1	1.000
Any perioperative events <sup>a</sup>	4 (2.0)	15 (15.0)	<0.001

## More References

- Brown KA, et.al. Recurrent hypoxemia in children is associated with increased analgesic sensitivity to opiates. *Anesthesiology*. 2006 Oct;105(4):665-9
- Brown KA, et.al: Recurrent hypoxemia in young children with obstructive sleep apnea is associated with reduced opioid requirement for analgesia. *Anesthesiology*. 2004 Apr;100(4):806-10;

## Parental Presence During Induction of Anesthesia



## Parental Presence at Induction

- Premedication is probably better
- PPIA and midazolam -- no additional benefits
- Parents want to be with their kids
- Parents are more satisfied

## Parental Presence

- Prepared parents are awesome
- Calm parents are helpful
- Anxious parents are a challenge
- Recent Case report:  
■ Mother freaked out after induction
- A & A December 2012 vol. 115 no. 6 1371-1372

## Lots of other distraction techniques

- Books, music
- Screens
- Video Games
- Stories, etc.
- Studies underway by Kain et.al to determine best parental/health care worker interactions

## The Studies of Kain et.al

- 93 ASA I-II pts, 2-8 yrs, outpt surgery
- Randomized to parents only in OR, midazolam 0.5mg/kg only, or neither
- Multiple anxiety scales and coping and temperament measures prior to intervention
- Lower anxiety at induction in midazolam group

Anesthesiology. 1998 Nov; 89(5): 1147-56

## Kain et.al

- 103 pts, 2-8 yrs, ASA I-II outpt surgery
- Randomized to midaz or midaz + PPIA
- Multiple anxiety scales and coping and temperament measures prior to interventions
- Anxiety and compliance scores were equal between the 2 groups, but **parental satisfaction was higher**

2000 Apr; 92(4): 939-46

## PPIA

- If given a choice, the majority parents will choose PPIA, even if their child had minimal or no anxiety on a previous surgery
- PPIA is associated with
  - ↑ HR and skin conductance level, but no EKG changes in the parents



Anesthesiology. 2003 Jan; 98(1): 58-64

## Post-operative Pain



## Post-operative Pain Management

- Combined general-regional techniques are very common
- Most blocks are placed after the child is anesthetized.
- Ultrasound has made this easier and more practical



## Catheters

- With good education and follow up, easy and effective
- Minimal complications
  - Skin
  - Mechanical
  - Leaking

[Can J Anaesth. 2009 Nov;56\(11\):843-50. Continuous peripheral nerve blocks for postoperative analgesia in children: feasibility and side effects in a cohort study of 339 catheters.](#)

Dadure C, Bringuier S, Raux et.al

[Anesth Analg. 2003 Sep;97\(3\):687-90. Perioperative continuous peripheral nerve blocks with disposable infusion pumps in children: a prospective descriptive study.](#)

Dadure C, Pirat P, Raux et.al

[Paediatr Anaesth. 2011 Apr;21\(4\):406-10. Feasibility and efficacy of placement of continuous sciatic perineural catheters solely under ultrasound guidance in children: a descriptive study.](#)

Ponde VC, Desai AP, Shah DM, Johari AN.

## Post-operative Pain Management

- Fentanyl can be used intra-nasally if no IV access. Blood levels appear to be equivalent to IV
- Morphine 0.05-0.1 mg/kg
- Ketorolac 0.5 mg/kg IV, 1mg/kg IM , intranasal max doses 30 and 60 mg respectively



## Post-operative Pain Management

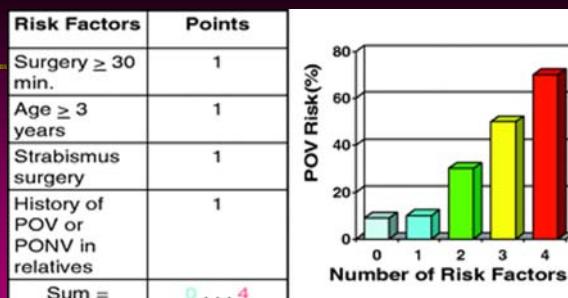
- Acetaminophen (A) up to 45 mg/kg p.r.
- Bolton et.al measured serum levels in 55 pts undergoing T&T, who received 40 mg/kg p.r. pre-operatively.
  - Levels did not reach toxicity in any pts
  - Efficacy, esp post discharge was deemed greater (although no control group)

Bolton et.al. Paed Anaesth 12:29-35,2002



## Acetaminophen

- Intravenous-
  - 12.5mg/kg IV infused over 15mins q 4 hours
  - 15mg/kg over 15 minutes q 6 hours
- Very effective can be used in a wide variety of situations
- Educate health care providers regarding other meds with acetaminophen



■ Gan, T. J. et al. Anesth Analg 2007;105:1615-1628

## PONV

- Eberhart et.al have developed a score to determine the risk of POV in children. Four independent factors were found:
  - Duration of surgery > 30 minutes,
  - age ≥ 3yrs
  - strabismus surgery
  - h/o prior POV or a relative with a h/o POV

Eberhart et.al Anesth Analg 99: 1630-7,2004



## PONV--Treatment

- Keeping the patient well hydrated
- Don't force oral intake
- Minimize use of volatile agents
- Medications
  - Dexamethasone has been shown to be anti-emetic in doses of 0.05-1mg/kg
  - Ondansetron, granisetron etc are all effective esp in combination with Dex

## Respiratory Complications

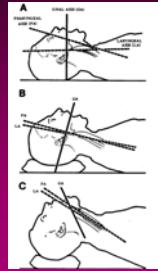
- Perioperative respiratory complications occur in about 10-30% of patients in the peri-operative period
- Bronchospasm, laryngospasm, airway obstruction, oxygen desaturation and stridor are the most commonly seen complications
- Deep vs awake extubation is not implicated as a risk factor

## Respiratory Complications

- Incidence ↑ with:
  - URI -- most studies
  - Trainees
  - ENT procedures
  - Passive smoking
  - Intubation without muscle relaxants
- The risk for laryngospasm is reported to be ~1.7 – 4.2%
  - Magnesium 15 mg/kg prevented laryngospasm in one study, although lidocaine 1.5mg/kg did not

## Laryngospasm-Treatment

- 100% oxygen + Fink maneuver (painful jaw thrust)
- Positive pressure ventilation to PIP of 20cm H<sub>2</sub>O
- Propofol 0.8mg/kg has been shown to help in ~78% of patients
- Sux 10-20% of intubating dose



## Selected References

- Risk factors for laryngospasm in children during general anesthesia. Flick RP, Wilder RT, Pieper SF, van Koeverden K, Ellison KM, Marienau ME, Hanson AC, Schroeder DR, Sprung J. Paediatr Anaesth. 2008 Apr;18(4):289-96.
- Screening by pulse CO-oximetry for environmental tobacco smoke exposure in preanesthetic children. Cardwell K, Pan Z, Boucher R, Zuk J, Friesen RH. Paediatr Anaesth. 2012 Sep;22(9):859-64.
- Risk assessment for respiratory complications in paediatric anaesthesia: a prospective cohort study. von Ungern-Sternberg BS, Boda K, Chambers NA, Rebmann C, Johnson C, Sly PD, Habre W. Lancet. 2010 Sep 4;376(9743):773-83.

## Conclusion

- A new scale has been developed to help assess the risk of PONV in children
- Respiratory complications are fairly common, but easily treated

