Cuffed endotracheal tubes in children: the effect of the size of the cuffed endotracheal tube on intracuff pressure.

Krishna SG et al.

Pediatric Anesthesia 27 (2017) 494-500

In this paper, the authors performed an in vitro and in vivo study to evaluate the effect of the tube size on cuff pressures required to create a seal.

The in vitro phase of the study involved random placement of 10 cuffed ETTs of sizes 4.0, 4.5 and 5.0 in a plastic tube with an internal diameter of 1.0cm connected to a 1L test lung. The intracuff pressure was measured after the cuff was inflated to prevent a leak at CPAP of 20 cmH_2O. The pressures recorded were 45 ± 6, 23 ± 1 and 14 ± 6 cmH_2O respectively.

The in vivo phase of the study involved 100 children having general anaesthesia for a procedure with anticipated duration of under 60 minutes. They were randomised to either a cuffed tube based on the Khine formula (internal diameter of the cuffed ETT = [age/4 + 3]), group R, or a cuffed tube that was a half-size smaller than predicted by the Khine formula, group S. Nitrous oxide was only used for induction and switched off after intubation. The cuff was inflated to prevent an audible leak at CPAP of 20 cmH_2O. Cuff pressures were then measured. If there was no leak after intubation, the tube was exchanged for a smaller size and the patient was excluded from the study. The intracuff pressure to achieve a seal was 25 ± 19 cmH_2O in group R and 37 ± 35 cmH_2O in group S.

Take home message

The use of cuffed endotracheal tubes is becoming more prevalent with our better understanding of the paediatric airway anatomy and the availability of better designed low-pressure cuffed tubes, such as the Microcuff. This study demonstrates that without appropriate sizing, a high-volume, low-pressure cuff can become a high-volume, high-pressure cuff. It is standard practice at my institution to measure cuff pressure and this study reaffirms the need for routine cuff manometry.

Reviewed by: Dr Scott Ma

The effects of tracheal tube cuffs filled with air, saline or alkalinised lidocaine on haemodynamic changes and laryngotracheal morbidity in children: a randomised, controlled trial

Soares SM et al

Anaesthesia 2017 vol. 72 (4): 496 – 503.

This Brazilian study undertook the first assessment of air, saline and lidocaine filled endotracheal tube (ETT) cuffs in children on the premise that benefits have been shown in adults. The outcomes measured all related to extubation- namely haemodynamic changes (heart rate, systolic and diastolic blood pressure) and laryngotracheal morbidity (cough, dysphonia and sore throat).

The method thoroughly describes broad exclusion criteria, randomisation, a standardised anaesthesia protocol, outcome measurement and statistical analysis. The authors have been diligent in excluding potential confounding factors, particularly those which may cause laryngotracheal morbidity. The study involved four groups of 41 children being intubated for elective surgery greater than one hour duration, randomly allocated to receive either air, saline, 0.5% alkalinised lidocaine or 1% alkalinised lidocaine in the

ETT cuff. Cuff pressures were monitored electronically and kept below 20cmH_2O. Serum lidocaine levels were also collected for each child.

Statistically significant improvements in systolic blood pressure, heart rate and sore throat were found with the use of lidocaine-filled ETT cuffs. Heart rate change was the most significant result, with reduced tachycardia following extubation in both lidocaine-filled ETT cuff groups v air- and saline-filled ETT cuffs ($p < 0.001$). The only significant morbidity result was sore throat eight hours post-extubation, with both lidocaine-filled ETT cuff groups having significantly reduced sore throat v the air-filled cuff group. All measured plasma lidocaine levels were well under the toxic level.

Take home message:

This robust study has shown a significant reduction in systolic blood pressure and heart rate changes at extubation in children with lidocaine-filled ETT cuffs. Sore throat at eight hours post-extubation was also significantly reduced in both lidocaine-filled ETT cuff groups. No adverse effects arising from lidocaine use in ETT cuffs were reported.

Reviewed by: Dr Nick Hogan

Intelligence quotient scores at the age of 6 years in children anaesthetised before the age of 5 years.

J. de Heer, H. Tiemeier, S. E. Hoeks and F. Weber.

Anaestheisa 2017 72, 57 – 62.

This paper looks at the relationship between exposure to general anaesthesia before the age of 5 and non-verbal cognition at 6 years of age. Patients were selected from a prospective cohort called the 'Generation R Study'. Patients who had been anaesthetised before the age of 5 were identified by parental questionnaires. Patients whose parents did not answer the questionnaire or who had co-morbidities that would impact on learning (e.g. trisomy 21, congenital heart disease and retinoblastoma) were excluded from the study. IQ was tested using a non-verbal intelligence test looking at visuospatial ability, and abstract reasoning. Results were corrected for age, to the nearest month.

3441 out of a potential 9901 patients were analysed. The trial found that families with children who had an IQ score and responded to the questionnaire were different to patients that did not. Areas where there were statistically significant differences included prematurity, in hospital vs out of hospital birth, university education, maternal IQ, maternal smoking and maternal alcohol consumption. 415 of the 3441 children included were anaesthetised before the age of 5. The results showed that children who had been anaesthetised had a lower mean IQ than those who had not been anaesthetised: IQ 101.4 (SD 14.6) vs 104.1 (SD 14.5) $p < 0.0001$. The study also found that more of the anaesthetised children were boys.

Take Home Message

It is not clear what the clinical significance of this difference in IQ is. Is this difference relevant on an individual level or on a population level? Multivariate analysis showed a link between lower IQ and gestation < 32 weeks, lower maternal IQ and education and maternal smoking. These were the same factors that were different between responders and non-responders and thus are major confounders in the study. In addition, the authors were unable to analyse questionnaires from over half the families due to missing data. The families with incomplete data were different to families with complete data. The authors acknowledge this in passing but they do not specify the nature of this difference. Anaesthesia records were available for only 67 of the 415 patients. Verification of anaesthesia exposure was only possible for a small number of

patients. The authors acknowledge that they were unable to determine, from their questionnaire, the duration of anaesthesia exposure, how often children were exposed to anaesthetics and at what age. In my opinion, this paper does not inform us on individual patient risk. It may inform us on a population level but It has a number of limitation which impact its applicability in this regard.

Reviewed by: Dr Catherine Olweny

Effects of an alveolar recruitment manoeuvre guided by lung ultrasound on anaesthesia-induced atelectasis in infants: a randomized, controlled trial.

Song I-K et al.

Anaesthesia 2017 vol.72 (2) : 214-222.

Summary

This randomised controlled trial uses ultrasound to both assess atelectasis and guide an alveolar recruitment manoeuvre to reduce lung collapse in anaesthetised infants. It is a physiological study.

Methods

40 infants with no respiratory pathology receiving mechanical ventilation under general anaesthesia (GA) with 5 cm H2O PEEP, were randomly allocated to a recruitment group or control (20 in each). In all infants, alveolar collapse was assessed with ultrasound by the same observer, one minute after mechanical ventilation and then again at the end of surgery. The intervention group received an ultrasound-guided, 5cmH2O stepwise increase in airway pressure from 10cm to a maximum of 40cm with an FiO2 of 0.4, directly after the first US observation.

Findings

In both groups there was about a 50% incidence of significant atelectasis (using an US definition) after a minute of mechanical ventilation. At the second examination this had decreased to 25% in the recruitment group and increased to about 80% in the control group (p=0.001). There was a negative correlation between age and severity of atelectasis overall (r -0.34, p=0.008)

Commentary

The use of ultrasound to assess atelectasis and guide recruitment is still in its infancy in the critical care setting, let alone in paediatric anaesthesia. This study shows that it may be a useful contributor to our understanding of the pathophysiology and time-course of atelectasis in children, and may help in the assessment of pulmonary interventions. At this stage it is an experimental tool and has little clinical relevance.

Reviewed by: Dr Dave Barker

The Association Between Cyanosis and Thromboelastometry (ROTEM) in Children with Congenital Heart Defects: A Retrospective Cohort Study.

Marie-Laure Laskine-Holland et al.

Anesthesia and Analgesia 124 (1): 23-29.

Cyanosis in congenital heart disease (CHD) is associated with complex changes in the coagulation system including polycythaemia, increased deformability of RBC and functional abnormalities of coagulation and fibrinolytic proteins and platelets. This study examines the effects of cyanosis on whole blood coagulation as assessed by intra-operative Thromboelastometry (ROTEM).

A retrospective cohort study of 320 children undergoing CHD surgery during a 12 month period in 2014-15 in Toronto was undertaken. All children had a baseline ROTEM performed after insertion of an arterial line. Routine haematology and coagulation studies were also performed. Children were excluded if they underwent surgery other than congenital cardiac surgery or if they received anti-platelet or anticoagulant medication preoperatively. Thromboelastometry (TEM) was performed using a ROTEM delta haemostasis analyser, measuring ExTEM, FibTEM, and InTEM and ROTEM parameters. 345 baseline ROTEM TEM profiles from 320 patients were including in the cohort. 22% of children were cyanotic (defined as oxyhaemoglobin concentration < 85%)

Cyanotic children had decreased clot firmness in the fibrinogen/fibrin polymerisation component of the clot (FibTEM) compared with noncyanotic children (mean difference (95%CI) interim 2(0-3)mm: p=0.01, and maximal (2(1-3)mm; p=0.01.). However, the association between cyanosis and clot firmness was not significant after accounting for confounding factors (haematocrit, platelet count and gender).

Take Home Message

Apart from being a retrospective study, further limitations of this study include the fact that children were categorised into quite broad age categories (<3 months, 3-12months, 1-5 years and >5 years) , potentially missing some of the effects of developmental haemostasis in early life when coagulation is most variable. Also, fibrinogen concentrations were not measured routinely in the preoperative blood profile, so it is difficult to comment on concentration of fibrinogen and the finding of decreased clot firmness measured. The increasing use of point-of-care coagulation testing to guide transfusion practice warrants further studies in children with CHD.

Reviewed by: Dr Nicole Anderson

Anaesthetic implications of the changing management of patients with mucopolysaccharidosis

H.A Hack et al.

Anaesthesia and Intensive Care 2016, 44(6): 660-668

Children with mucopolysaccharidosis have posed airway challenges of varied complexities for the paediatric anaesthetist. With the development of improved medical therapies to improve survival and quality of life, these patients are more frequently turning up for general anaesthesia. In this review, the authors describe the changing face of clinical management of the mucopolysaccharidoses in three phases: an initial phase of accumulation and dissemination of knowledge; a phase of beneficial results from new treatment modalities and a final phase of patients entering adulthood having had successful medical treatment. This well-written review is an interesting read for those of us who regularly see these patients in the hospital.

Reviewed by: Dr Scott Ma

Nasal high-flow oxygen delivery in children with abnormal airways.

Humphreys S et al.

Pediatric Anesthesia 27 (2017) 616-20

The authors performed a prospective observational study to assess the utility of nasal high-flow (NHF) oxygen delivery in children having shared airway procedures in follow-up to a study that demonstrated an increase in safe apnoeic oxygenation time in children associated with use of THRIVE [1]. Twenty children having spontaneously ventilating general anaesthesia for upper airway surgery or dynamic airway assessment where the anaesthetist used NHF to maintain oxygenation were analysed. Induction technique was at the discretion of the anaesthetist. All patients had general anaesthesia maintained using a TIVA technique with propofol with/without remifentanil or alfentanil. All patients had their airways topicalised with 4mg/kg lignocaine via direct laryngoscopy. Jaw support was maintained until the procedure started and NHF was applied using weight-based flow rates.

There was a wide age range of children with a variety of pathologies included in this trial including children who were already intubated and mechanically ventilated but extubated for the intervention. The lowest oxygen saturation measured in the study was 77% in a neonate after an apnoeic period of 3 minutes with an obstructing cervical lymphangioma. This case was the only one requiring rescue intubation in the cohort studied. Average lowest saturation in all patients was 96% (SD 6%). The median duration of the procedures in the cohort was 32 minutes (maximum 61 minutes).

Take home message

This paper suggests that the use of NHF in spontaneously ventilating children may be useful in maintaining oxygenation for procedures where endotracheal intubation is not feasible. It does not address adequacy of ventilation and the extent of hypercarbia that may result in this technique. It must also be stressed that while NHF can prolong apnoeic oxygenation time, it is still essential to be vigilant for apnoea and airway obstruction. NHF will not work when there is complete airway obstruction, as demonstrated in the sentinel case of the study, nor provide a rescue tool for a CICO situation.

Reviewed by: Dr Scott Ma

Article: Selective induction of IL-1B after a brief isoflurane anaesthetic in children undergoing MRI examination.

Emmett E. Whitaker et al.

J Anesth (2017) 31:219–224

Background

Numerous studies have demonstrated marked cellular and or behavioural changes after anaesthesia exposure. Mechanisms of anaesthesia induced developmental neurotoxicity are multifactorial. Systemic inflammation is a potential mechanism linked to a myriad of neurodevelopmental, neurocognitive and neuropsychiatric disorders. The effect of surgery and its inflammatory response is known but the authors felt it was important to evaluate the effect of anaesthesia alone on the inflammatory response. There have been previous studies which reported pro-inflammatory cytokine elevation in the cerebrospinal fluid and blood of children with neuro-inflammatory disorders. Both animal and human studies have shown that systemic inflammation causes measurable neurodegenerative effects in adults and children. Therefore, there are surgical and anaesthesia induced inflammatory changes likely to be reflected in the central nervous system, but biological markers of inflammation are easier to measure in the peripheral blood. One of these IL-1B is found in neurone rich areas, and is implicated in apoptosis which worsens neurodegeneration.

Study Hypothesis and Methods

Anaesthetic agents are known to induce neuroinflammation in juvenile animal models in the absence of surgical stress, therefore the authors hypothesised that anaesthesia exposure alone triggers a systemic inflammatory response that can be measured by the inflammatory biomarkers in the serum of children undergoing MRI exams. The selection of isoflurane is based on the authors conclusion that it is the most commonly used anaesthetic worldwide. This single blinded study looked at whether isoflurane anaesthesia without surgery caused systemic inflammation in children. They measured pre and post anaesthetic levels of serum L-1B, a marker of systemic inflammation in children. 25 patients, (Aged 6 months to 11 years), ASA I-II, undergoing MRI scanning were recruited. Exclusions criteria included SA > II, known neurological disease, prematurity, recent infection, treatment with anti-inflammatory medications. Patients received a sevoflurane induction followed by peripheral IV and LMA insertion. Isoflurane anaesthesia was then titrated. Two blood samples were taken, one during IV placement, and one on arrival to PACU. Serum cytokine levels were compared pre and post isoflurane using paired t- tests.

Results

In all patients, Interleukin -1B increased after isoflurane when compared to pre-isoflurane samples. A brief (60 minute) exposure to general anaesthesia without induced surgical stress significantly increased serum IL-1B ($p<0.0002$).

Take Home Message

This is a small study, however the sample size of 25 patients was sufficient to detect a 50% difference in serum cytokines at 80% power and a type 1 error of 0.05. The measurement of cytokines occurred during a short anaesthetic exposure, therefore not allowing sufficient time for all cytokines involved. The up-regulated kinetic curve of the cytokines may be due to very short time intervals between exposure and pre anaesthetic. There is also a limitation by the type of anaesthetic agent used and data may not reflect other anaesthetic agents commonly used. In summary this is an interesting development on the subject of neurotoxicity in the paediatric population. As with many other studies on anaesthesia induced developmental neurotoxicity, there are still no clear answers on the long term effects of all mechanisms postulated, and it is important to interpret studies with relevance to clinical practice.

Reviewed by: Dr Balvindar Kaur

Upper airway in infants – a computed tomography-based analysis.

Wani et al.

Pediatric Anesthesia 27 (2017) 501-505

This study looked at CT scans of the airways of 40 infants aged between 0-12 months of age, who were undergoing imaging unrelated to airway pathology. The infants were either naturally asleep or had a spontaneously ventilating sevoflurane general anaesthetic without an airway device insitu. Transverse and anteroposterior (AP) diameters were measured at the subglottic level and at the cricoid ring. The transverse diameter was greater at the cricoid when compared to the subglottis ($p<0.001$) whereas the AP diameter was greater at the subglottis compared to the cricoid ($p<0.001$). However, the mean AP diameter was greater than the mean transverse diameter at both the subglottic and cricoid levels.

Take home message

This study supports other recent evidence that the shape of the upper airway in infants does not change as one moves distally and is elliptical rather than a conical shape as previously believed. This may result in an uncuffed ETT exerting pressure on the lateral walls of the airway while still allowing an air leak at the anterior and posterior position. This creates an argument for use of a cuffed ETT in this population providing appropriate care is taken with its placement, assessment for a leak prior to inflation of the cuff and measurement of intracuff pressure.

Reviewed by: Dr Philippa Lane

Pediatric upper airway dimensions using three-dimensional computed tomography imaging.

Wani et al.

Pediatric Anesthesia 27 (2017) 604-608

This study looked at the airway volumes and shapes of 54 children aged between 2 months to 8 years, using three-dimensional CT scans. The children were undergoing imaging as part of their evaluation as patients affected with pediatric oncologic diseases and were either naturally asleep, had chloral hydrate for sedation or had a spontaneously ventilating sevoflurane anaesthestic without an airway device insitu. Subglottic, cricoid and tracheal volumes and shapes were evaluated. There was an increase in the mean airway volume from the subglottic to the cricoid to the tracheal regions and these demonstrated a linear relationship with age. The difference between the smaller subglottic region and the larger cricoid region was statistically significant ($p=0.009$).

Take home message

This study adds to the evidence demonstrating that the subglottic region and not the cricoid is the narrowest part of the airway and refutes the long held belief of the conical shaped airway in children. However this does not give us information on the most rigid aspect of the airway, which theoretically may provide the most resistance to the passage of an ETT and be at risk of damage.

Reviewed by: Dr Philippa Lane

Assessment of Risk Factors for a Sustainable "On-Table Extubation" Program in Pediatric Congenital Cardiac Surgery: **5-YearExperience**.

Reena Khantwal Joshi, Neeraj Aggarwal, Mridul Agarwal, Veronique Dinand , and Raja Joshi.

Journal of Cardiothoracic and Vascular Anesthesia, Vol30; 6(December), 2016: pp 1530–1538.

This single centre, prospective observational study aimed to define risk factors for failure of early extubation (in theatre extubation) following paediatric cardiac surgery. 448 patients selected as suitable for early extubation were included in the study which was conducted over a 5 year period. The exclusion criteria were age less than 3 months, mechanically ventilated preoperatively, signs of anatomic airway compromise, proven airway anomaly, preoperative cardiovascular shock, frequent arrhythmias and complex repairs with Risk Adjusted Congential Heart Surgery (RACHS) category V and VI. Patients were extubated as planned if specific criteria were met at the end of surgery. If these criteria were not met, patients were transferred to the intensive care unit intubated. The main outcomes examined were failure to extubate in the theatre, the need for re-intubation and mortality.

Criteria for extubation in the operating theatre were: Stable hemodynamics, good systemic ventricular function on echo, no active surgical bleeding, mixed venous oxygen saturation > 50% (disease adjusted), urine output > 2 ml/kg/hr, satisfactory respiratory parameters (ABG and ventilator mechanics) and optimal acid-base and metabolic status. The main results were that 92 % of the patients were extubated in the operating theatre and of these 2.4 percent were re-intubated. The mortality in the whole group was 4 out of 448 (0.9%). The study found 100 % success rate for early extubation in low risk patients (RACHS Category I) and in patients undergoing adult congenital heart surgery and re-do sternotomy. They also had an extubation rate of 85 % in patents who had pulmonary hypertension pre-operatively. The authors state that four deaths in the group were not found to be directly caused by fast tracking. There was a statistically significant increase in re-intubation rate with increase in RACHS category. 10 % of the 412 patients extubated in theatre required non-invasive ventilatory support. The median ventilatory time in the delayed extubation group was 26 hours and 14 of these 36 patients (39 %) required non-invasive ventilatory support, and none were re-intubated.

Factors that were identified by multivariate analysis to predict failure to extubate in the operating room were weight < 5kg, age < 1 year, cardiopulmonary bypass time > 120 minutes and the presence of other non-cardiac structural anomalies. Pulmonary hypertension, redo sternotomy, a higher RACHS category and an aortic cross clamp time > 60 minutes did not achieve significance in multivariate analysis of risk factors. Based on their results, respiratory mechanics in infants less than 3 months and past research, the authors suggest that 5 months is a comfortable age for consideration of early extubation. Maximum extubation rates were achieved in children greater than 10 kg and failure occurred more in children less than 4 kg. They propose that more complex surgery is performed in small children and that in their setting, poor nutrition may have been a factor.

Take Home Message

This paper shows that yes, in that institution, an extreme fast tracking program is feasible. Careful patient selection is critical but surprisingly factors that might be considered predictive of failed early extubation did not reach significance. What is lacking is evidence to show some clinical or other benefits for example in terms of time efficiency and cost efficiency. The analgesic regime used by the group is low dose fentanyl with dexmedetomidine. Consideration of analgesic regime would be critical to the success of such a program. In addition, close collaboration between the anaesthesia team and the intensive care team would be important.

Reviewed by: Dr Catherine Olweny

Smartphone-based behavioural intervention alleviates children's anxiety during anaesthesia induction – a randomised controlled trial.

O. Cumino et al.

European Journal of Anaesthesiology 2017; 34:169-175

This was a randomised controlled trial in 84 healthy children aged between 4 and 8 years old, presenting for their first surgical procedure. The aim was to discover whether non-pharmacological measures such as smartphones and information leaflets provided to families pre-operatively reduced anxiety at induction of anaesthesia.

Children were randomised into four groups; a control group in which parents were given usual verbal information about what to expect, one in which verbal information as well as a leaflet were provided, one in which there was verbal information as well as provision of a smartphone, and the final group in which a smartphone and an information leaflet were provided. The leaflet contained answers to 'frequently asked questions' as well as advice as to how the parent could contribute to a more successful anaesthetic for their child. Smartphones contained a variety of age-appropriate applications and were given to the child in the pre-operative holding area, they were used right through until anaesthesia was induced. Anxiety levels were assessed in the pre-op area as well as in theatre at the time the face mask was applied using a validated anxiety scale.

Significant results

There was no difference in anxiety levels between the groups whilst in the holding area. Anxiety levels in the operating room were greatest in the control group in which no information leaflet or smartphone were provided to the family, and were reduced to a statistically significant degree in both the smartphone groups when compared with the control group.

Take home message

Anxiety at induction is relevant to all paediatric anaesthetists and most of us are interested in ways to combat it. The statistics discussed in this study were confusing and therefore difficult to interpret but overall it seems that extra written information has no significant impact on anxiety levels but the use of a smartphone pre-operatively does reduce anxiety in children immediately prior to induction. Unfortunately, this study was not blinded and did not compare smartphones to pharmacological pre-medications. In many children anxiety levels can be low just prior to induction or even as the facemask is applied but this does not mean they will then be cooperative with the entire procedure. The authors did not comment on whether the children continued to happily use the smartphone throughout the mask induction as they only measured anxiety levels as the facemask was applied. Therefore, on the basis of this study we cannot conclude that smartphones are a reliable alternative to a robust pre-medication. However, using a smartphone is generally easy and low-cost and we have reason to believe they may help children navigate the surgical experience.

Reviewed by: Dr Amanda Dalton

A clinical audit to assess the efficacy of the Coolsense Pain Numbing Applicator for intravenous cannulation in children

P. Ragg, G. Cahoon, A. yeo, G. Chalkiadis

Anaesth Intensive Care 2017, 45(2), 251-255

Summary

This prospective audit conducted at the Royal Children's Hospital, assessed the use of coolsense in 100 children aged 6 to 18 years undergoing intravenous cannulation for MRI. Coolsense is a topical applicator used to rapidly anaesthetise skin via cooling prior to painful procedures.

Primary outcomes consisted of assessing both pain scores (numerical pain rating scale) and satisfaction (five-point Likert Scale) for patient and carer, ease of cannulation as assessed by the inserter (pre and post coolsesnse application) and finally success or failure of cannulation. Secondary outcomes were complications of using the device.

The median age of patients recruited was 12 years with equal ratio of male to females. 94% and 97% of patients and carers respectively reported mild pain or less. Satisfaction scores were similarly high, with 94% in both groups claiming to like or really like the use of coolsense. No clinically significant change was observed in vein visibility or palpability post coolsense. Overall success rate at first attempt was 95% (Anaesthetic consultant, fellow, registrar, technician and radiographers). Few complications were noted of which they were temporary and mild including erythema (3%) and transient blanching (5%). 97% of patients claimed they would want coolsense to be used again for cannulation.

Take home message

Coolsense appears to represent an alternative to topical creams traditionally used for IV cannulation, with added benefits of rapid onset and ease of use. This audit demonstrates favourable outcomes with minimal complications. However, it would be helpful to compare its use to those topical anaesthetics already in common use.

Reviewed by: Dr Sorcha Evans