UPDATE TOPICS IN PAEDIATRIC ANAESTHESIA

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Cuffed ETTs

Cuffed endotracheal tubes for children under 8 coupled with the use of circles would be probably one of the biggest and fastest changes I have seen in paediatric anaesthesia in the last 8 yrs of my practice. In talking to colleagues in Australasian tertiary centres, uptake seems very high and yet looking at published audits from overseas use of cuffed tubes may be only around the 30% mark. (1)

Where do I see the advantages of cuffed tubes?:

- Confirmed decrease in tube exchange rate from in some studies 25% to 2%. (2) The advantages of this include, time saving, possible cost saving and less trauma and intubation stress.
- Reduced environmental pollution has been shown with levels of volatile and nitrous in the operating theatre significantly reduced. (2) (Not to mention keeping the greenies happy).
- Low flow anaesthesia is possible giving us the choice of using more expensive volatile agents without blowing the budget or the environment.
- Reliable lung function monitoring and capnography. (3) This is becoming increasingly important with some studies suggesting a more detrimental effect of hypocapnia on the neonate than first thought. Main et al (4) showed that with an uncuffed ETT compared with a cuffed tube tidal volume and lung mechanics are overestimated and clinical decisions may be misinformed. In addition Bernstein et al (5) found the occurrence of autocycling with flow triggered ventilators increased significantly with the presence of a leak.
- Reduced pulmonary soiling. Some work has suggested decreased soiling with a cuffed tube however as yet morbidity has not been proven to be decreased.

What do I see as the concerns regard cuffed tubes?

The classical concern was the fact that a cuff inflated in the narrower subglottic/cricoid region of a child would lead to mucosal ischaemia and post extubation oedema and stridor. As you know this was probably more a cuff design issue than anything else. With modern high volume low pressure cuffs this does not appear to be a problem and there is even some suggestion a cuffed tube may be safer. Large series in anaesthesia and intensive care have failed to show an increase in morbidity while enjoying the advantages of a cuffed tube. Newth et al (6) looked at 860 children intubated with cuffed and uncuffed tubes over a 1 year period in a paediatric ICU and found no increase in morbidity with cuffed tubes despite data showing that cuffed tubes were selected for the sickest children and those expected to need longer ventilation.

Murat (7) has also published large amounts of data on her experience with cuffed tubes in anaesthetising children without any increase in morbidity. In addition MRI studies have confirmed the cricoid is not a circular structure as first thought confirming why the presence of a leak with an uncuffed ETT does not eliminate the risk of mucosal ischemia. (8) This is not to say there are no problems with the use of cuffed tubes as reports of problems have been presented. Most of these cases have highlighted the poor design of cuffed tubes for children which have classically been merely a downsizing of the adult cuffed tubes.

Problems have included:

- High cuff pressures to achieve a seal, long cuffs leaving little margin for positioning the ETT.
- Long distance between the end of the cuff and tube tip sometimes making it impossible not to have the cuff below the cricoid or the tip endobronchial.
- Thick cuffs with sharp folds in the deflated position and a large external diameter (9)

There are now cuffed ETTs available for children which solve these problems and which have performed very well in the literature. It should be noted however that a conflict of interest has been declared in many of the articles as the investigators have had a role in developing the tube. I would have to say however that we have been very impressed with the performance of these tubes in our institution.

Ultrasound in Paediatric Anaesthesia

Nerve Blocks

Ultrasound is being used increasingly in paediatric anaesthesia by those lucky enough to have ready access. Regional anaesthesia has only been used sporadically in paediatrics in the past with a few centres doing most of the cases. Reasons cited for the lack of use include poor and variable anatomical landmarks in the child, concern about complications, difficulty with assessing the success of the block, and frequent need for a general anaesthetic anyway.

Advantages of regional analgesia in children can include, improved pain control, decreased opiate related side effects and decreased incidence of ventilation particularly in neonates. In recent years the number of articles published on ultrasound guided blocks in children appears to be increasing exponentially and in many institutions has fired up new found enthusiasm for regional anaesthesia in children. In a major French audit looking at practice in 2005 compared with 1994 peripheral nerve blocks had increased by 200-500%. (10)

If anything the paediatric literature is more supportive of the use of ultrasound for regional anaesthesia than the adult literature. Weintraub et al (11) in an early study of ilio-inguinal blocks performed by the fascial click technique found that in 86% of cases the LA was not deposited in the plain between internal oblique and transversus abdominus. In a subsequent study Willschke (12) randomised children to ilio-inguinal block with ultrasound or fascial click. In the ultrasound group LA was injected until the nerve was surrounded with local. They found the ultrasound group required less intra and post-operative analgesia despite having a significantly lower volume of local. Oberndorfer (13) also showed a reduced dose of LA when using ultrasound for sciatic and femoral blocks in children while achieving a longer duration of analgesia than the nerve stimulator group. In a recent study looking at infraclavicular blocks in children ultrasound increased the block success rate from 64% in the nerve stimulator group to 99%. Kasia (14) in his review of RCTs looking at ultrasound in children concluded ultrasound improves the quality, onset, duration and success rate of nerve blocks. Studies in adults comparing block success rate between ultrasound and other techniques have been conflicting, however time to perform the block, and onset time were generally shorter in the ultrasound group and fewer needle passes were required. Ultrasound showed the biggest advantage when the blocks were performed by relatively inexperienced regionalists. While it has yet to be confirmed that using ultrasound results in increased safety for regional anaesthesia in children encouraging results in this area include the fact that ultrasound can result in fewer needle passes, a lower dose of LA for a better block and appears to be the best method currently available to detect an intraneural injection. A study has also looked at using ultrasound for epidural placement. (15) Since having an ultrasound permanently available for paediatric anaesthesia at our institution, our use of regional anaesthesia for children has increased markedly. Regular ultrasound guided blocks used include ilio-inguinal, TAPs, rectus sheath, penile as well as upper and lower limb blocks.

Vascular Access

A safe statement would be “we find ultrasound a godsend in our paediatric practice”, an unsafe statement would be “the NICE guidelines… …“. This is a topic sure to trigger a heated debate amongst any group of anaesthetists.

Success rates for paediatric central vein cannulation are often lower than those in adults with a higher carotid puncture rate in IJV cannulation. Reasons given include, less experience in children, smaller calibre vessels and more variation in anatomy. The NICE guidelines state “two dimensional imaging ultrasound guidance is recommended as the preferred method for insertion of CVCs into the IJV in adults and children in elective situations”. This statement was based on a limited amount of published material and has been challenged in certain quarters. There findings were largely based on 3 studies.

Verghese et al (16) in a randomised trial involving 95 children found in the ultrasound group a higher success rate, lower carotid puncture rate and a quicker cannulation time compared with a landmark technique. In a second

study looking at the 3 techniques of anatomical, 2-D ultrasound and audio-guided doppler ultrasound (17) they found 2-D ultrasound superior for minimising time to place the cannula and number of attempts. While the success rate in their study was 94% in the ultrasound group and 80% in the other groups it did not reach statistical significance in this study. One article challenges these findings. Grebenik et al (18) initially found a higher success rate with a landmark based technique in children but later admitted 1) a statistical error meant there results had not met statistical significance and 2) many patients in the ultrasound group dropped out because of battery failure and 3) there experience level with ultrasound at the time was very low.

Ultrasound is also useful for arterial line placement. Schwemmer et al (19) found success rate and speed of insertion higher in the ultrasound group compared with the palpation method. In my practice while not always using it as first line I have found it valuable for rescue.

While little is published on the use of ultrasound for PICC line insertion in children, this is probably the area we have found it has influenced our practice the most with the ability to find and cannulate suitable vessels in children that have had multiple punctures before coming to us.

Other useful references: (20, 21, (22)

One Lung Ventilation in Paediatrics

Paediatric surgeons performing thoracic surgery are now aware of the possibilities of one lung ventilation and the opportunities this may provide. In our institution we are performing more thoracic surgery than previously and with a younger cohort of patients. Advantages of one lung ventilation particularly for CCAM surgery may include shorter surgical time, lower incidence of post operative air leak, less haemorrhage and a higher rate of complete primary resection. (23) Our surgeons have described the difference in operating conditions as being like operating with the lights on or off. Much of what is written about one lung ventilation in children is anecdote and hearsay, given the obvious lack of randomised outcome data. Options in infants include endobronchial intubation, use of joined single lumen infant tubes, and some form of bronchial blocker. In older children Univent (24) and smaller double lumen tubes are an option (size 26 is available from Rusch, Duluth, GA, USA and can be used in 8yr olds). Endobronchial intubation with a standard ETT has the advantage of being relatively simple to perform, usually without the need for specialised equipment and is often the choice in the emergency situation. Disadvantages include difficulty getting a seal in the mainstem bronchus and hence optimal isolation and protection, inability to suction the operative lung and occlusion of the upper lobe of the non operative lung with consequent increased shunt and hypoxia.

Our preference for infants and toddlers is to use some form of bronchial blocker. We believe this has several advantages. Firstly the upper lobe bronchus of the ventilated lung is not occluded, avoiding further falls in oxygen saturation. Secondly the cuff can be inserted for a precise fit rather than relying on an endobronchial tube that may be too tight and damages the mucosal wall, or too loose, leading to an air leak or possible lung soiling. Thirdly the blocker can be left in place and deflated and re-inflated to allow temporary expansion of the operative lung as needed by the surgeons. Disadvantages of this technique include the need for a paediatric fibre optic scope, a learning curve and possibly more time for placement. You do need to be vigilant with this technique as the blocker can fall back into the trachea and occlude ventilation entirely. In children older than 18-24months a through the tube kit called the Arndt bronchial blocker can be used. In younger children the tube is usually passed beside the endotracheal tube. Both techniques rely on a fibreoptic for placement although image intensifier has been used. The options for a blocker include a fogarty catheter, embolectomy catheter or a purpose built blocker such as that supplied with the Arndt blocker set supplied by Cook. Our preference is the blocker from the Arndt kit. This catheter is easy to manipulate, has a central lumen that can be used to assist lung deflation if needed and a high volume low pressure cuff that is easy to see with the fibre optic for accurate placement and inflation. In theory the high volume low pressure cuff should increase the safety of the blocker with less chance of damage to the bronchus. Passing both the tube and the blocker through the nostrils we believe allows for more accurate fixation and less chance of the blocker moving and potentially compromising ventilation (25). For children over than 6-8yrs small Univent or double lumen tubes may be used in a similar manner to their use in adults.

Additional reference: (26)

General Anaesthetics and the Developing Brain

"Doctors are destroying our children's brains."

These are the sort of headlines that have appeared in the popular press over the last 10yrs as results of largely animal studies have been published.

Why should we be concerned?

Animal studies have shown neuronal cell death in the developing brain with pretty much every sedative/anaesthetic drug that we use including benzodiazepines, barbiturates, ketamine, propofol, nitrous oxide and volatile anaesthetics. In most of these studies the neurodegeneration was increased with increased dose, exposure, and number of agents. The neurodegeneration has been shown to be caused by apoptosis or programmed cell death. Apoptosis is a normal and integral part of brain development whereby redundant or potentially detrimental cells are eliminated. Up to 70% of neurons are eliminated during normal brain development. The exact cause of this increased apoptosis is unclear. One argument is that the GABA agonist and NMDA antagonist effects, cause neuronal inhibition which triggers apoptosis in susceptible neurons ie it is activity dependent. (27) As well as histological demonstration of increased neurodegeneration some studies also showed learning difficulties in the exposed animals. (28) Although most of the early studies were looking at the developing rat brain, a recent study has shown similar effects in the primate brain. (29)

While there are as yet no randomised trials looking at the effects of anaesthetic agents on the developing human brain, some epidemiological studies have raised concerns. Neonates and children who have had repair of major congenital heart disease not surprisingly have an increased incidence of learning disorders. Wilder et al (30) retrospectively looked at a huge medical and educational database from Olmsted County in Minnesota. They looked at over 5000 children of whom nearly 600 had had anaesthetic exposure before the age of 4rs.They concluded that children who had been exposed to multiple anaesthetics had an increased risk of learning disorders.

On the other hand what do we have to reassure us that the evidence is not there for our anaesthetics damaging children's brains?

For a start apoptosis is a normal part of brain development and we do not know whether the neurones that undergo apoptosis with anaesthetic agents are the susceptible neurones that would have undergone the process at a later date anyway.

The MAC used in animal studies is unknown and we may be giving much higher MAC equivalents than are given in paediatric patients. In some studies doses given to animals were 100 times those used in humans. In the animal studies airway management techniques and monitoring were generally limited or non-existent, a major difference to paediatric anaesthetic practice. Looking at the time course of brain development in rodents some of the rats were anaesthetised for the equivalent of weeks at a time, again far from equivalent from what would happen in paediatric anaesthesia. In addition extrapolating the period of neuronal susceptibility to humans is controversial. At one extreme, some believe the period of susceptibility may stretch to 3yrs while others believe the period only extends up to 26 weeks gestation. (31)

The results of animal studies have also not been consistent with some studies failing to show histological changes and some showing no learning deficits. One study showed decreased neurodegeneration and improved memory in the isoflurane group. (32) The other point worth considering is what the other options are. Animals subjected to unmodulated pain exhibit learning difficulties and in one study this effect was decreased when the animals were given ketamine. (33)

The human studies already mentioned are also open to speculation. The studies adjusted for some factors shown to be associated with learning difficulties but not others and at best only showed that children who required multiple surgeries and were exposed to trauma, hospitalisation and anaesthesia unsurprisingly had a higher incidence of leaning difficulties.

So at the moment if I was asked if anaesthesia has any effect on the development on a child's brain the answer I would give would be that we don't know but if there is an effect it is mild and likely to be less than the effects of having the surgery without an anaesthetic.

Additional reference: (34)

Honourable Mentions

Emergence Phenomenon

Receives a lot of press but its significance is still unclear. The incidence varies hugely due to not only differences in the population and drugs studied but also due to the definition of emergence agitation/delirium used. Figures published vary from 10% to 80%. While pain can increase the incidence of emergence phenomenon it exists in children who have no pain at all. Risk factors include age 2-5yrs, pre-op anxiety and temperament, anaesthetic agent, surgical site and pain. In general the incidence is increased from halothane to isoflurane to sevoflurane with the place of desflurane varying markedly in the literature. Fast wakeup however is not a clear cause with propofol, remifentanil, nitrous oxide and mixtures of these agents providing fast yet smooth emergence in a number of studies. In terms of prevention most sedative drugs have been shown to decrease the measured incidence of emergence delirium. Whether they merely delay waking until the at risk time period has passed is unclear. Agents shown to be effective include opioids, clonidine, benzodiazepines, ketamine, melatonin and propofol. Interestingly although there have been many previous studies showing a decreased incidence of emergence phenomenon with midazolam premedication, there have been some recent studies showing no effect or an increased incidence. Results of changing maintenance agent after induction have been conflicting. The answer to the big question “is it a big deal?” is unknown. It definitely upsets recovery nurses and parents who witness it and some have suggested there may be an increased incidence of patient injury. However we have no idea whether preventing or treating it will benefit the child or just increase our drug bill. (35)

Propofol Infusion Syndrome

Acute bradycardia associated with lipemic plasma, fatty liver, metabolic acidosis and rhabdomyolysis while on a propofol infusion. Risk factors from case reports include younger age, airway infection, severe head injury, low carbohydrate supply and propofol infusion of more than 5mg/kg /hr for more than 48hrs. The pathological finding is cytolysis of skeletal and cardiac muscle fibres. The mechanism appears to be an impairment of fatty acid oxidation by propofol at the same time as the patient receives a fat load. This results in muscle damage from the toxic fatty acid intermediates and cellular hypoxia. Inadequate delivery of carbohydrates will exacerbate this process by switching on fat metabolism. Therefore current guidelines are to decrease the propofol infusion to less than 4mg/kg/hr if used for more than a “few hours” and provide a source of carbohydrates. (36) (37)

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