

Anaesthesia for children: towards safer practice

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Keywords: anaesthesia, children, safer practice

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S Afr Fam Pract 2012;54(3)(Suppl 1):S14-S16

Introduction

It has long been recognised that anaesthesia-related complications, including anaesthesia-related cardiac arrest and mortality, occur more frequently in children, than in adults.¹ While outcomes have improved over the last couple of decades, most likely as a result of better training and improved monitoring, and notably the introduction of pulse oximetry and capnography in the 1990s, paediatric anaesthesia-related cardiac arrests still occur. The incidence is 1.4-22:10 000 anaesthetics, and a subsequent mortality of approximately 30%. The incidence varies by centre,²⁻⁵ but is thought to be higher in South Africa as the studies in the literature derive either from the developed world, or from tertiary referral centres in the developing world.

Who is at risk?

The risk factors for paediatric anaesthesia-related complications, cardiac arrest, and mortality, are remarkably consistent across studies:

They are:

- **Age:** Half of the paediatric closed claims cases in the USA from the 1970s to the '90s involve children of three years and younger. The risk of anaesthetic complications in children is inversely proportional to age, with infants (< 1 year old) comprising over half of all paediatric anaesthesia-related cardiac arrests.
- **Pre-existing disease:** Having an ASA physical status of 3 or greater places children at a seven times higher risk for anaesthetic complications. This is especially true if a child has congenital heart disease, pulmonary disease, or an upper respiratory infection.
- **Emergency surgery:** Surgery performed in an emergency setting carries a 4 times higher risk for anaesthetic-related complications than elective surgery.

Why do these complications occur?

The mechanisms behind perioperative cardiac arrest have been well elucidated in several studies.

Respiratory complications

The common final pathway preceding cardiac arrest is usually hypoxia. Airway obstruction secondary to laryngospasm is the most common respiratory cause of hypoxia. It is more common in children under the age of two, and is frequently associated with upper respiratory infections and secretions. For an excellent review of laryngospasm, I would recommend *Pediatric Laryngospasm: Prevention and Treatment*, by Al-alami et al in *Current Opinion in Anaesthesiology*. (2009;22(3):388-395).

Other airway and respiratory causes of hypoxia include difficult or failed intubation, intubation of the oesophagus or right main bronchus, inadequate oxygenation or ventilation, inadvertent or premature extubation, bronchospasm, and aspiration. While most intra-operative cardiac arrests occur during the maintenance phase of anaesthesia, the anaesthetic-related arrests tend to occur at induction of anaesthesia. Most of these are due to loss of the airway, or difficult intubation.

Cardiovascular complications

In the absence of congenital heart disease, the single most common cause of death in this category is hypovolaemia related to blood loss. While the control of bleeding is usually the surgeon's domain, contributory anaesthesia-related factors include underestimation of blood loss, inadequate peripheral intravenous access, and lack of invasive lines and monitors (central and arterial lines) where required. These result in inadequate fluid replacement and hypovolaemia with ensuing shock.

Here are some important points to note:

- Better attention should be paid to the assessment of fluid and blood loss in paediatric patients.
- Adequate intravenous access must be secured prior to surgery.

- Hypotension may be a late sign of hypovolaemia, especially in infants, where it may indicate imminent cardiovascular collapse.
- Major surgery (spines, craniofacial and large vascular tumours) should not be undertaken in any centre without a blood bank, or immediate access to blood or blood products.

Medication-related complications

Medication-related complications include inappropriate dosing, including a local anaesthetic overdose, and errors caused by incorrectly labelled syringes.

Cardiovascular depression from inhalational agents seems to occur less now than it did before sevoflurane was introduced into routine paediatric practice. It is more likely to occur with the use of halothane, and in infants (who may be susceptible to cardiovascular depression, even with conventional doses of volatile agents).

Deaths from succinylcholine-induced hyperkalaemic cardiac arrest continue to be reported. Life-threatening hyperkalaemia can also occur after blood transfusion, especially in infants, with rapid transfusion, or with old, irradiated or whole blood.

Here are some important points to note:

- Ensure meticulous administration of paediatric drug doses and dilutions. (An excellent reference pocket guide, the "flipper", has recently been published by members of the Department of Emergency Medicine at the University of the Witwatersrand for R20. Contact Dr Goldstein at drg666@gmail.com).
- Ensure withdrawal before injecting a local anaesthetic to ensure that an intravascular dose is not given. A test dose should be given, and incremental injections for plexus or neuraxial blocks.
- Suxamethonium should only be used in an emergency or in full-stomach situations, and not for the routine intubation of children.
- "Fresh" packed cells (less than seven days old) should be used for transfusions in infants. Irradiated blood should not be used. Potassium levels should be checked if a massive transfusion (more than one of that child's blood volumes) is required.

A critical point that has been raised in the literature is that few, if any, cardiac arrests occur without warning. They are preceded by any, or all, of the following warning signs: desaturation, hypotension, bradycardia, alteration in end-tidal CO₂ (increased or decreased), cyanosis and arrhythmias. These warning signs should be acted on immediately to prevent a worsening situation.

The above data raises a couple of (possibly obvious) questions. How can these complications and poor outcomes be prevented? What are the recommendations for the provision of anaesthesia care for children?

Who anaesthetises children? The American Society of Anesthesiologists (ASA) statement on practice recommendations suggests that anaesthesiologists who provide and direct the supervision of anaesthetic care of children should be graduates of accredited registrar training programmes, and preferably of paediatric fellowship training programmes. The Royal College of Anaesthetists recommends that, at all times, anaesthesia in children should be undertaken or supervised by consultants who have undergone appropriate training in paediatric anaesthesia.

The South African Society of Anaesthesiologists, the national guiding body, has recognised that there are inadequate numbers of specialists to meet the needs of South Africa's paediatric surgical patients.

They have provided the following guidelines:

- *The community service doctor* is often placed in the unenviable position of having to provide anaesthetic care with minimal training (the two months provided during internship). It is recommended that he or she administer anaesthesia under supervision only. It is clear that in the South African setting, this supervision could be remote. It is not recommended that the community service doctor provides anaesthesia to a child.
- *The general practitioner* should not practice anaesthesia, unless under supervision and unless appropriately trained.
- *The diplomate anaesthetist* is "eligible for the independent practice of both regional and general anaesthesia for patients of ASA class I and II", and for "fit and healthy paediatric patients over the age of two years, provided the practitioner has maintained the necessary skills, and the nature of the intended surgery is minor and elective".

In the face of an emergency, or where no alternative exists, patients should be anaesthetised in consultation with a specialist.

Practically, how should the non-specialist proceed?

Preoperatively

A thorough preoperative assessment is vital. This includes taking a complete medical and surgical history, family history, examination, and evaluation of relevant investigations. Potential problems should be identified and discussed, and referral to a specialist considered.

Optimise where possible. Treat and postpone the child with an upper respiratory infection, manage preoperative hypovolaemia or anaemia. Murmurs that are identified during the preoperative visit should be investigated.

Internationally recognised fasting guidelines should be adhered to. These have been shown to be safe in terms of aspiration risk, and beneficial, by limiting hypovolaemia and the risk of hypoglycaemia.

The guidelines recommend the following:

- Six-hour fast for solids and cow's milk
- Four-hour fast for breast milk
- Two-hour fast for clear liquids.

A clear liquid is literally something that can be seen through, and includes apple juice, weak black tea with sugar and grape juice. Ask the parents to give their child a bottle of apple juice between 05h00 and 06h00 on the morning of surgery. They can drink it in the car on the way to the hospital. It makes a perfect 08h00 start to a list.

Intraoperatively

Full monitoring (SpO₂, NIBP, ECG, EtCO₂, O₂ and agent analysis) is mandatory. While it may be difficult in a wriggling or combative toddler, try to get a pulse oximeter on before commencing with induction. Temperature should be monitored for any major or prolonged surgery. Any time over half an hour is ideal, but this is obviously not practical for a long list of 40-minute tonsillectomies or orchidopexies. Place a temperature probe for any surgery that opens a cavity (all laparotomies), any surgery in a child with burns, and for any infants where a temperature drop is expected, especially in the case of surgery to the head. A three-degree temperature drop is not uncommon in a "straightforward" ventriculoperitoneal shunt insertion.

Check that all other equipment is appropriate for a child. This includes the anaesthetic nurse and recovery staff.

Have a backup airway plan to include smaller-sized endotracheal tubes, laryngeal mask and Guedel airways. Be prepared for laryngospasm, and know how to manage

it. Set the ventilator appropriately before starting. It prevents giving huge adult tidal volumes for a few breaths, before the mistake is realised.

Assess each child's hydration status, and have a fluid management plan. Supplement glucose if the child is at risk of hypoglycaemia. A rough guide would be in the setting of an overnight fast in a child under five years old, particularly if there may be delayed oral intake postoperatively. A 1% dextrose solution in Ringer's lactate is sufficient (4 ml of 50% dextrose into a 200 ml bag of Ringer's lactate).

Calculate each patient's estimated blood volume, and work out an approximate allowable blood loss. When in doubt, check haemoglobin regularly during any major case.

Follow a simple, but comprehensive, analgesic plan. For an easy approach, refer to *Postoperative analgesia in children: getting it right*, S Afr J Anaesh Analg. 2011;17(6):359-361.

Make clear, comprehensive notes. They may be needed.

Postoperatively

Follow well-communicated, clear criteria for discharge of a child, both from the recovery room, and from the hospital.

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