

## Paediatric Anaesthesia Outside the Operating Room in Children

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### Abstract

The increasing number of procedures carried out in children outside the operating room places a greater demand on anaesthesia care providers by expanding the scope of work and the need to maximize the often-inadequate equipment in the remote settings. The practice and approach in Non-Operating Room Anaesthesia differ between centres across the world largely due to the range of procedures and its indications, skill of personnel as well as available medication and equipment. Every practitioner however believes that adequate quality of care and safety of patients must be ensured just like in the main operating room. It is therefore essential to utilize appropriate protocols and guidelines on patient selection, monitoring and management of common complications for successful outcome.

### INTRODUCTION

There has been a significant increase in the number of procedures performed in children outside the operating room over recent years<sup>1</sup>. This increased ability to provide anaesthesia care outside the operating room is due to improved diagnostic techniques and skills of proceduralists as well as the availability of newer and safer drugs, better monitoring devices, new techniques and enhanced attention to safety and quality of care<sup>2,3</sup>. Basic equipment for interventional and diagnostic procedures are being provided in some centres where previously none was available, while in many established children's hospitals, the number of children requiring anaesthetic care outside the operating room is almost the same as for procedures in the operating room<sup>4</sup>.

Anaesthesia outside the operating room also referred to Anaesthesia in Remote area or Non-Operating room Anaesthesia (NORA) involves provision of care for a wide range of procedures which may require a form of anaesthesia technique from monitored care to deep sedation or general anaesthesia outside the normal work environment of anaesthetic care provider. While the practice and approach in NORA differ between centres across the world largely due to the range of procedures and its indications, the skill of personnel as well as available medication and equipment, every practitioner believes that maximum efficiency and safety of patient must be ensured just like in the main operating room. Paediatric NORA may be required more frequently than in adults as children are unlikely to be calm and cooperative hence the need for deep sedation and general anaesthesia.

### Locations for Anaesthesia Outside the Operating Room

Anaesthesia is provided outside the operating room largely because the procedures may require equipment that is not available in the operating room or is not compatible with the OR setting.

An advantage of carrying out procedures in remote areas is that the OR is made available for other major and lengthy procedures.

Locations for NORA may include:

- Radiology suites for CT scan, MRI, Interventional radiology
- Cardiac catheterization laboratory
- Burns unit
- Dental clinic
- Mental Health Unit for modified electroconvulsive therapy
- Endoscopy suites
- Radiotherapy and chemotherapy units.

### Anaesthetic Considerations and Challenges

Anaesthesia outside the operating room can be demanding. Possible challenges must be anticipated and prepared for. If adequate preparation is not ensured, critical incidences may occur in a remote location where appropriate help and intervention may not be readily available. Factors related to the patient, staff, procedure and equipment should be considered and optimized to ensure a safe and quality outcome.

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## Patient Factors

Attention to detail in patient selection is key to a successful outcome. A detailed medical including signs and symptoms of current illness as well as respiratory and cardiovascular symptoms should be obtained. Previous anaesthesia, surgery, history suggestive of allergy and medications may provide additional and beneficial information. The period from last meal should be noted since the patient in most instances will come from home on the morning of the procedure. Vital signs and weight of patient should be obtained and documented. Airway assessment is mandatory even when endotracheal intubation or use of supraglottic devices is not intended.

Chest auscultation and heart sounds may reveal cardiac or respiratory pathology with no overt symptoms and signs. Risk assessment and patient selection should be meticulous and well guided considering the clinical skills of practitioners and available equipment and support.

Informed consent must be obtained, and fasting guideline ensured. The likelihood of prolonged fasting with its attendant challenges of dehydration, restlessness and haemodynamic disturbance should be anticipated and prevented. Plans should be made to make venous cannulation as bearable as possible.

## Staff

Adequate skills in airway management and the ability to intervene when required is a prerequisite for anaesthesia providers delivering NORA. Many considerations and guidelines have been outlined for non-anaesthetists delivering sedation because the mortality rate due to failed resuscitation were found to be greater when care was not directed by anaesthetists. Procedures in remote areas have been associated with increased morbidity and critical incidents largely due to human error, inability to recognise impending crisis, inability to manage emergencies and the lack of a trained, skilled assistant<sup>5,6</sup>.

The importance of a familiar assistant cannot be overemphasized while working in a remote setting. Necessary help must be secured before it is needed. Knowing in advance where to get help in case one needs it is key to success in handling unanticipated crises in NORA. The place of well functioning teams in NORA cannot be over emphasized and ideally, the team should have worked effectively in an operating room environment before undertaking procedures outside the OR. Communication among the team members needs to be succinct with regular simulation of crisis handling to perfect the performance of the team in a real emergency scenario. Work location outside the operating room will not be a good place to start interacting or orienting a new staff. The informed assistant must be able to anticipate plan and communicate effectively. Anaesthesia staff must be trained and have experience with pre anaesthesia assessment of patients, airway management and cardiopulmonary resuscitation and use of anaesthetic and resuscitation drugs. Non-anaesthesia staff are expected to be knowledgeable in cardiopulmonary emergencies, anaesthetic procedures, equipment and post-operative care and resuscitation<sup>6</sup>.

## Procedure

The attending anaesthesia provider should have good understanding

of the procedure. When in doubt communicating with the surgeon or proceduralist involved is crucial to effective pre-anaesthetic preparation. The required information should include but not limited to the following;

- Nature of the procedure and any special requirements that will influence anaesthesia
- Position
- How long the procedure is anticipated to take
- Associated pain
- Possible side effects
- Equipment and devices to be used.

Adequate communication and cooperation of the various specialists is of utmost importance.

The steps involved should be explained and role(s) to be played by individuals must be clearly understood. This should be explained and documented before the procedure.

## Equipment

Many of the remote clinical areas where procedures are carried out may not have been designed with anaesthetic requirement in mind. In many instances these areas were converted from other uses out of demand and necessity. Often the basic and required equipment and facilities for anaesthetic care are overlooked. Where such equipment is provided, it may be old, having previously been used in other suites. Appropriate sizes of devices and adjuncts for paediatric age group should be made available. The anaesthetists working in a remote setting will have to check the anaesthesia machine and be familiar with the design and components which may be more basic compared with the one they are accustomed with in the OR. The safety devices on the machine should also be confirmed. Equipment and monitoring standard must meet the main OR requirements and are outlined below<sup>7</sup>.

## Physical Structure

- Adequate lighting
- Oxygen and backup
- Wall gases
- Suction and evacuation
- Visual access
- Thermostatic control
- Safe electrical outlets

## Environment

- Anaesthesia machine
- Oxygen delivery
- Suction catheters
- Size appropriate airway equipment
- Difficult airway trolley
- Crash cart that is well stocked and regularly checked
- Venous access supplies
- Intravenous pumps/ drip stands

- Basic drugs and drugs for resuscitation
- Defibrillator with both paediatric and adult paddles

### Monitors

- Pulse oximetry with audible pulse tone and low threshold alarm
- Capnography
- Blood pressure
- Temperature
- EKG

### Transport capability

- Oxygen delivery
- Oxygen tanks
- Portable monitors

There might be specific equipment needs for instance for procedures in the MRI suite.

### Conduct of Anaesthesia

Anaesthetists and other providers offer care in its various forms for procedures outside the operating room. They consider the co-morbid condition of the child, the planned procedure, available drugs as well as their expertise, experience and comfort in handling the particular procedure before deciding the anaesthetic technique.

### Fasting

Duration of fasting required before procedures requiring various forms of anaesthesia has been a subject of many debates in recent years. The standard of care is to allow enough time for gastric emptying. For elective procedure the fasting guidelines of intake of are the same as for normal procedures with solids at 6 hours, breast milk at 4 hours or one missed feed for those feeding more regularly and one to two hours for clear fluids. This is still widely used in many centres. In emergency procedures requiring sedation and anaesthesia the risks and benefits should be weighed and communicated to the parent or guardian. Clear documentation of NPO status and exceptions for example oral medications should be well stated.

### Informed Consent

Basic information about the procedure as well as the need for intravenous catheters and use of medications, anaesthetics and analgesics to facilitate patient's cooperation, ensure calmness and prevent pain and discomfort during procedure should be provided to parent or guardian as well as the patient depending on their age. The use of information leaflets or videos at the clinic and during preoperative assessment might be useful. Available options of anaesthesia and associated risks should also be explained. It is essential that informed consent is obtained and documented.

### Equipment Check

This should be carried out and clearly documented at the beginning of the day stating the location to be used precisely. Required equipment include although not limited to those listed above. Charts and checklists must be made available at different locations where anaesthesia is provided outside the OR to ensure every mandatory

device or adjunct is in place. Routine maintenance and service of equipment and appropriate notifications is mandatory just like for those in the main OR. The support of biomedical staff is essential and will enhance timely intervention in case of equipment failure and prevent avoidable complications.

### Induction

The choice of induction agent should be individualized for every patient. Factors to be considered will include patient clinical condition, the duration of the procedure, intensity of pain involved, side effects of the agent and level of calmness needed for the procedure. The latter is especially important in MRI where motion artefact is a major concern. Managing children with special needs especially those with neurologic deficits and major anomalies can be quite challenging. They often have indications for repeat anaesthesia and display increasing anxiety. Such patients may refuse drugs and can become combative. Principles of care include early recognition, parental support, multidisciplinary planning, clear guidelines about perioperative management of uncooperative children and ethical use of restraint has been found to be successful<sup>8</sup>. Various routes of drug administration are being used to induce anaesthesia including intravenous, inhalational, intramuscular and oral. Maintenance is often by inhalational agent or intravenous infusion. A single dose intravenous induction may suffice for brief non-invasive procedures in a few instances.

There are specific guidelines for various procedures outside the operating room, however anaesthetic agents commonly used include the following:

### Midazolam

Provides anxiolysis, sedation and amnesia. It is administered mostly for premedication

*Dosages:* Oral 0.3-1mg.kg<sup>-1</sup>, Intranasal 0.2mg.kg<sup>-1</sup>, Rectally 0.3-1mg.kg<sup>-1</sup>, Intravenously 0.05-0.1mg.kg<sup>-1</sup>.

### Propofol

Widely used for intravenous induction. It has a fast onset and short duration of action providing rapid recovery with less residual effect. Additional benefit is its anti-emetic effect.

*Dose:* 2-4mg.kg<sup>-1</sup>.

### Ketamine

Intravenous induction agent with analgesic effect at its subanaesthetic dose. A potent bronchodilator useful in asthmatic. It causes tachycardia, hypertension and excessive secretion.

It can be administered intramuscularly in instances like burns dressing changes. Oral ketamine has been used in dental procedures as well.

*Dose:* Intravenous 1-2mg.kg<sup>-1</sup>, Intramuscular 2-5mg.kg<sup>-1</sup>, Oral 5-10mg.kg<sup>-1</sup> (mixed with sweet beverage, administered about 30 minutes before procedure), Rectal 5-10mg.kg<sup>-1</sup>.

### Ketofol

Combination of ketamine and propofol. Popular for short procedural

sedation and analgesia. It has haemodynamic stability effect and less respiratory depression. It has been used as an infusion for diagnostic and interventional cardiac catheterization procedures. The optimal combination of ketamine and propofol has been much investigated.

### **Fentanyl**

Potent analgesia often used with other anaesthetic. Can cause hypotension, respiratory depression, apnoea, muscle rigidity, postanaesthetic nausea and vomiting.

*Dose:* 0.5-2 $\mu\text{g}\cdot\text{kg}^{-1}$ .

### **Dexmedetomidine**

A newer drug becoming popular for sedation because it does not cause respiratory depression and has haemodynamic stability. It is not readily available in many of the low resource setting but when available the dose is 0.1-1 $\mu\text{g}\cdot\text{kg}^{-1}$  as a slow infusion or bolus. It is usually given with glycopyrrolate as it tends to cause bradycardia

### **Regional Anaesthesia Technique**

Regional anaesthesia is a safe and effective method of pain control often used as an adjunct general anaesthesia. Its use in non-operating room setting among children include provision of analgesia in the emergency room before surgery, relieve of intractable and chronic pain and insertion of percutaneous peripherally inserted central line<sup>9</sup>. With an experienced anaesthetist, availability of equipment for ultrasound guided block and a well-organized monitoring protocol, more children will benefit from regional technique outside the operating room.

### **Monitoring**

Monitoring devices must be appropriate for the environment with appropriate sizes of probes and blood pressure cuffs readily available. Basic monitoring for anaesthesia outside the operating room is same as appropriate for the main OR. The ASA standards for Basic Anaesthetic Monitoring include the following.

- Pulse oximetry with audible pulse tone and low threshold alarm
- Adequate illumination and exposure of the patient to assess colour
- Anaesthesia machine with O<sub>2</sub> analyser
- Continuous end tidal carbon dioxide analyser with audible alarm
- Continuous ECG
- Temperature monitor

The personnel in charge should closely observe the child's face and chest wall movement and continuously assess the level of sedation and physiologic changes. They should be vigilant for signs of respiratory depression and airway obstruction. Documentation of vital signs throughout the procedure is important. Where electronic recording is not available this should be completed in the chart and kept with patients records. Every handwritten note must be meticulous and clear, ensuring that the characters, digits and symbols used are consistent.

### **Recovery and Discharge**

Many locations where procedures are carried out outside the OR lack a designated area for recovery. Where such facilities exist the appropriate equipment and trained staff may not be available. Depending on the settings anaesthesia care provider may have to observe and monitor the patients in the suite until satisfactorily recovered. Close vigilance to discover any signs of airway obstruction, respiratory depression or haemodynamic disturbances is prudent.

Recovery and discharge protocols are same with other procedures in the OR. Important factors to be considered before discharge include the following<sup>4</sup>.

- Patient has pre-procedural mental status restored and can be aroused easily
- Stable cardiorespiratory status, intact protective reflexes and patent airway
- Intact motor function
- A responsible adult must accompany the patient
- Written instructions and emergency number

### **Complications**

Providing anaesthesia in a remote setting may be associated with higher risk compared with procedures inside the OR due to a lot of factors which include:

- Lack of vigilance
- No back up plans
- Inadequate pre-procedural evaluation
- Multiple medications
- Inappropriate choice of anaesthetic technique
- Use of non-anaesthesia staff in complex medical cases
- Poor monitoring

Most reported anaesthesia related complications result from respiration depression or airway obstruction. Cardiac events are often limited to bradycardia secondary to hypoxia.

Hypothermia, aspiration and post-operative nausea and vomiting are also potential challenges which when anticipated can be prevented with adequate preparation and proactive care. Other complications are procedure related and specific for the various diagnostic or interventional operations and techniques used.

### **Conclusion**

There is an increasing request and need to provide anaesthesia for children undergoing procedures outside the familiar operating room environment. It is therefore important to establish system and protocol to enhance safety and quality of care. Guidelines on patient selection, improved monitoring and management of common complications is essential to minimise the potential adverse outcomes. The place of good communications among care providers involved in procedures outside the operating theatre and robust commitment and support of the institution is required for a safe and successful outcome.

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