Anesthesia in Remote Locations

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Chubby 8-month-old baby with history of intermittent vomiting presents for MRI under anesthesia

OBJECTIVES

1. Review the anesthesia concerns and American Society of Anesthesiology guidelines to delivering anesthesia outside of the operating room and in the magnetic resonance imaging suite
2. Review the modifications that must be made to the anesthesia equipment and monitoring devices in order to accommodate the magnetic environment.
3. Discuss the challenges and solutions to obtaining consistent, accurate monitoring (pulse oximetry, EKG) in the MRI scanner.
4. Discuss the different techniques, outcomes and JCAHO guidelines for providing anesthesia or sedation to infants and children for MRI scans
5. Review the management of a code scenario for an anesthetized child in the MRI scanner.

STEM CASE

ANESTHESIA PRE-OP EVALUATION

An 8-month-old infant is scheduled for an MRI with general anesthesia.

Past medical history: full term baby, uncomplicated perinatal course, Apgars 8/9. Birth weight 3.7 kg, NKDA, no medications, immunizations up to date. Recent history significant for new onset of seizures. Patient has had 2 seizures in the past month. CT scan performed 2 weeks ago suggests an intracerebral mass. Over the past 2 months, patient has been experiencing vomiting following feeds. No distress noted during episodes of emesis. Pediatrician feels that this post-prandial emesis is normal and does not feel that patient has gastroesophageal reflux.

Past anesthesia or sedation history: patient had sedation with intravenous pentobarbital for the CT scan. During recovery from sedation, the infant exhibited a “rage” behavior that lasted for 20 minutes. Patient has never had general anesthesia.

Family history: unremarkable, no history of problems with general anesthesia.

Physical Exam: chubby, healthy-appearing, active, smiling and engaging

Vital signs: weight 13 kg, pulse 120, respiratory rate 32, non-invasive blood pressure 92/56 crying, room air oxygen saturation 98%. Airway exam unable to be performed, but patient has normal appearing face with no apparent craniofacial abnormalities. Lungs are clear, cardiovascular exam unremarkable with no murmurs. Abdomen is chubby, soft, non-tender. No focal neurological findings.

The MRI scan is scheduled as a follow up to the CT scan. The referring pediatrician feels this child will need anesthesia.
Upon meeting this child, you are immediately struck by how chubby this 13-kilogram baby is. After careful discussion with the parents, you understand that the vomiting is always in the morning and always occurs only within 1 hour of mealtime. Careful examination of all extremities suggests that intravenous access may be very difficult, because you cannot even visualize a vein. Discussion with the radiologist and review of the CT scan reveals that this MRI is a follow-up to the CT scan that showed no mass effect and no evidence of increased intracranial pressure. After discussion with the radiologist, you realize that this patient will definitely require intravenous access (IV) because Gadolinium contrast will need to be administered during the scan. Looking at this child, you realize that IV access will be difficult. Had this child not required Gadolinium, you would have considered administering oral sedation in the form of either pentobarbital or chloral hydrate. Successful oral sedation would have eliminated the need for placing an IV. Since this child will require IV access, you realize that oral sedation is not the best alternative. If an IV is required for the MRI, then you could administer sedation through the IV. Sedation alternatives could include IV pentobarbital, versed or fentanyl. You consider all sedation and anesthesia options. The history of vomiting does not worry you because the child has been NPO 6 hours solids and 3 hours clears. Since the vomiting seems to occur within one hour of meals, you feel that this NPO child is not at an increased risk of vomiting. With no other active medical issues, you feel that sedation would be a viable alternative.

In reviewing sedation options, you present the family with your plan to administer intravenous pentobarbital for the sedation. The mother asks whether pentobarbital sedation is a good idea considering the “rage” that the child exhibited last time. She asks you whether this could happen again. Based on the child’s past response to pentobarbital, the parents refuse this method of sedation. Parents insist on a general anesthetic so that their baby is “asleep”.

Reconsidering the different options available, you consider an inhalation induction. You are not confident that you could quickly and easily find an IV after induction. An inhalation induction worries you because you fear that if the child has problems on induction (laryngospasm), you will not have IV access. You decide against the inhalation induction and decide to do a controlled IV induction instead. After great difficulty, you establish IV access and induce with propofol. Should you intubate or could you use a laryngeal mask airway (LMA)? You also consider a propofol infusion with spontaneous ventilation and oxygen face mask. You do not have a MRI compatible infusion pump for a propofol infusion, and you do not feel comfortable using a LMA for this small infant who will be quite distant from you during the scan. You decide to intubate the child and maintain him on inhalation agent. After an uneventful induction and intubation, the MRI scan is started. All the required anesthesia monitoring is functioning, and you are quite pleased.

As the scan progresses, the child receives intravenous gadolinium contrast. Within 10 minutes of receiving the contrast, you notice that the end-tidal CO2 levels are dropping and that the oxygen saturation has dropped precipitously to 60%. The EKG is difficult to read, likely (you hope) due to artifact generated during the scanning. You tell the techs to stop scanning and to call a code. You run into the scanner and notice that the child looks blue (although difficult to tell in the dark scanner room). You do not feel a pulse. With the help of the MRI techs and nurses, you quickly pick the baby up and run
out of the scanner. You place the child on the floor outside of the scanner and call for the code cart, defibrillator and portable monitors. You begin resuscitation as the code team arrives.

KEY QUESTIONS:
1. Are there any special concerns to anesthetizing such an overweight baby?
2. Are there any specific questions you would like to ask parents about the nature, frequency, relation to mealtime of this vomiting?
3. After thorough enquiry as to the nature of the vomiting, is it absolutely necessary that full stomach precautions be taken with this infant?
4. This patient is scheduled for a 3 PM MRI scan and has been NPO since 7 AM… given the history of AM vomiting, always within 1 hour of meals, do you still feel that full stomach (rapid sequence intubation) precautions are necessary?
5. Do the NPO guidelines differ for sedation versus anesthesia?
6. Does the potential for difficult intravenous access affect your decision on management?
7. Would you like to know what type of MRI scan is scheduled?
8. Would you like to know any other information about the CT scan?
9. Why is it important that you know whether the patient will receive intravenous contrast?
10. What are the risks of contrast reaction with gadolinium?
11. If you had administered oral sedation, would you have been required to start an intravenous line if this patient had not required intravenous contrast?
12. What are the American Academy of Pediatrics and JCAHO requirements for monitoring a patient during sedation?
13. Discussion on how to set up a sedation program- largely based on my own experience at developing a nursing sedation program in the Department of Radiology. Currently we sedate almost 300 children/month.
14. What are the different medications available for sedation and what are the risks and side effects of each?
15. What monitoring would this child require during the MRI if he only receives pentobarbital.
16. Is rage a potential side effect of pentobarbital?
17. If you decide to do a general anesthetic, what are the different methods available?
18. What are the American Society of Anesthesiologist recommendations for monitoring during a general anesthetic?
19. If MRI compatible anesthesia machine and ventilator are not available, are there any other ways to modify the anesthesia equipment to provide anesthesia to a patient in the MRI suite?
20. How is cardiac resuscitation performed when a patient arrests in the scanner? Are there MRI compatible defibrillators and code carts?
21. In an emergency, should the anesthesiologist “quench” the magnet?
MODEL DISCUSSION

In leading this discussion, I plan to present this patient in the form of a pre-op anesthesia evaluation. I will make a slide of this child’s pre-op evaluation.

Key points and information will be available in the form of slide presentation. I will use the slides whenever appropriate.

It is important to know the standards for delivering anesthesia outside of the operating room, as set forth by the American Society of Anesthesiology (ASA). When setting up anesthesia delivery in the MRI scanner environment, it is important to adhere to these standards. These ASA standards for the outfield setting include a source of piped oxygen, oxygen in the anesthesia machine cylinders, suction for the scavenging system and patient, anesthesia machine and monitoring, adequate electrical outlets, adequate illumination, sufficient space, emergency cart and reliable two-way communication to summon help. Providing anesthesia in the MRI suite can be an additional challenge: in addition to a MRI compatible anesthesia machine, ventilator and monitors, some of the anesthesia equipment needs to be modified (stethoscope, temperature probe, laryngoscope, stylet, flashlight).

If there is not enough patient volume or financial backing to support an investment in MRI-compatible anesthesia equipment, then special planning must be instituted: the equipment or environment can be modified to provide anesthesia to a patient in the MRI scanner. No ferrous containing objects should be brought into the MRI scanner. A standard anesthesia machine (ferrous containing) and ventilator can be set up outside of the magnetic field (outside the 30-50 gauss line). Keeping the anesthesia machine outside the MRI scanner, a Bain circuit can be passed through the wall of the MRI scanner and hooked directly to the patient inside.

The limitations to anesthesia delivery in the MRI scanner need to be appreciated: for example, MRI compatible fiberoptic bronchoscopes do not exist. Importantly, no codes should be carried out in the scanner unless the magnet is quenched. Your decision on the management of the patient will also depend on your understanding of the nuances of MRI imaging: which patients will require intravenous contrast, what is the required positioning on the MRI scanner table, will the patient need to change positions during the scan, the anticipated duration of the scan and does the patient have any “devices” that are not MRI compatible or need to be modified (bivona trach, vagal nerve stimulator, patient controlled analgesia etc).

Anesthetic management of children in the MRI suite is highly dependent on the availability of support personnel, the personal style and comfort level of the anesthesiologist and the patient’s particular medical history. Most children under the age of 5 years will require either sedation or anesthesia in order to ensure immobility for completion of the MRI scan. Not all patients require anesthesia for immobility. Some children with limited medical conditions may be appropriate candidates for nursing sedation. In this learning discussion I will review the nursing sedation program at
Children’s Hospital and the medical criteria for eligibility for nursing sedation. I will also review the sedation protocols, options, success and adverse event rates. It is important to recognize that there are different options for nursing sedation—these usually include pentobarbital (oral, intravenous, intramuscular), midazolam, chloral hydrate and fentanyl.

It is important for the anesthesiologist to recognize that the JCAHO mandates that hospital sedation programs be overseen by the department of anesthesia. Salient features from the JCAHO guidelines for anesthesia and sedation will be reviewed. Hospitals that do not have pediatric sedation programs can develop sedation protocols for administration by anesthesia personnel. Pediatric sedation may be a good alternative to anesthesia. The different JCAHO requirements for NPO status, pre-op evaluation, monitoring and recovery for anesthetized versus sedated patients will be reviewed.

In this panel I would hope to explore not only the different methods of providing anesthesia, but also the different medications available for administering sedation. Especially in settings that lack MRI compatible anesthesia equipment, sedation can be a safe alternative. It is important for the anesthesiologist to recognize that not all children require anesthesia for immobility. Together we will explore all the options …

REFERENCES