

## Anesthesia for Remote Sites (Including MRI)

Provision of anesthesia in nonoperative sites requires an awareness of available equipment, emergency/resuscitation equipment and personnel in an unfamiliar and remote environment, as well as an awareness regarding the specific hazards of the environment.

### ANESTHETIC CONSIDERATIONS

1. Unfamiliar personnel and equipment in unfamiliar surroundings
  - methodical safety checks (equipment and medications)
  - access to necessary equipment and emergency carts
  - assessment of the technical training of available assistants
2. Assessment of the appropriateness of:
  - Patient
  - Procedure
  - Recovery and disposition options available for the remote site
3. Anesthetic Options:
  - monitored anaesthesia care
  - sedation (light, moderate, heavy)
  - GA with LMA or ETT
4. Specific considerations of particular locations:
  - MRI
    - i. avoidance of ferromagnetic equipment within the Gauss line
    - ii. no pacemakers, Hx of penetrating eye injury
    - iii. MRI compatible monitors
    - iv. inaccessibility of patient with machine renders ongoing confirmation of tube placement, securing of the tube and extensions on all monitoring and IV lines difficult
    - v. earplugs for noise pollution eliminates auditory checks
    - vi. particular attention to patient temperature (MRI suites are kept cool)
  - Angiography
    - i. prolonged procedure in a room with ionising radiation requires appropriate precautions for patient and anaesthetist

### A THREE-STEP APPROACH TO ANESTHESIA AT ALTERNATE SITES (BARASH)

#### 1. Environment

- Anesthetic equipment
- Anesthesia monitors
- Suction
- Resuscitation equipment
- Personnel
- Technical equipment
- Radiation hazard
- Magnetic fields
- Ambient temperature
- Warming blankets

#### 2. Procedure

- Diagnostic or therapeutic
- Duration
- Level of discomfort/pain
- Position of patient
- Special requirements (e.g., functional monitoring)
- Potential complications
- Surgical support

#### 3. Patient

- Ability to tolerate sedation versus general anesthesia
- ASA grade and comorbidity
- Airway assessment
- Allergies—IV contrast
- Monitoring requirements—simple versus advanced

### American Society of Anesthesiologists (ASA) Guidelines for Nonoperating Room Anesthetizing Locations

1. Oxygen
  - Reliable source
  - Backup E-cylinder—full
2. Suction
  - Adequate and reliable
3. Scavenging system if inhalational agents are administered
4. Anesthetic equipment
  - Backup self-inflating bag to deliver positive-pressure ventilation
  - Adequate anesthetic drugs and supplies
  - Anesthesia machine with equivalent function to those in the operating rooms and maintained to the same standards
  - Adequate monitoring equipment to allow adherence to the ASA Standards for Basic Monitoring
5. Electrical outlets
  - Sufficient for anesthesia machine and monitors
  - Isolated electrical power or ground fault circuit interrupters if “wet location”
6. Adequate illumination
  - Battery-operated backups (other than laryngoscope)
7. Sufficient space for

- Personnel and equipment
- Easy and expeditious access to patient, anesthesia machine, and monitoring
- 8. Resuscitation equipment immediately available
  - Defibrillator
  - Emergency drugs
  - Cardiopulmonary resuscitation equipment
- 9. Adequately trained staff to support anesthesia team
- 10. All building and safety codes and facility standards should be observed
- 11. Postanesthesia care facilities
  - Adequately trained staff to provide postanesthesia care
  - Appropriate equipment to allow safe transport to main postanesthesia care unit

#### COMMON PROCEDURES REQUIRING ANESTHESIA AT ALTERNATE SITES

##### Radiology

- ☞ Computed Tomography
- ☞ Magnetic Resonance Imaging
- ☞ Interventional radiology (vascular and non-vascular)
- ☞ Interventional neuroradiology
- ☞ Functional brain imaging
- ☞ Positron emission tomography
- ☞ Radiofrequency ablation

##### Radiotherapy

- ☞ Radiation therapy
- ☞ Intraoperative radiotherapy
- ☞ Radiosurgery

##### Gastroenterology

- ☞ Upper gastroenterology endoscopy
- ☞ Endoscopic retrograde cholangiopancreatography
- ☞ Colonoscopy
- ☞ Liver biopsy
- ☞ Transjugular intrahepatic portosystemic shunt

##### Cardiology

- ☞ Cardiac catheterization
- ☞ Radiofrequency ablation
- ☞ Cardioversion
- ☞ Transesophageal echocardiography

##### Psychiatry

- ☞ Electroconvulsive therapy

#### MAGNETIC RESONANCE IMAGING

- **when atoms with an odd number of protons in their nuclei, notably hydrogen, are subjected to a powerful static magnetic field, they align themselves with the magnetic field.**
- **If they are then intermittently exposed to a radiofrequency wave, the nuclei change their alignment. As the radiofrequency pulses are discontinued, the protons return to their original alignment (i.e. they relax) within the original magnetic field and as they do, they release energy.**
- **The release of energy over time (the relaxation time) is specific for given tissues and is used to generate the MRI signal**
- **Magnetic field strengths are measured in tesla (T: 1T = 10 000 gauss)**
  - **The earth's magnetic field is approx. 0.5 gauss**
  - **MRI scanners used for clinical purposes generate a field of 0.15-2.0T**
  - **Machines generate magnetic fields from 4-8T used in research**
- **Deaths related to MRI scanners are entirely related to the presence of ferrometallic foreign bodies such as pacemakers, aneurysm clips or implanted devices**
- **The magnetic field takes several days to establish and is constantly presence.**
- **It decreases in strength with the distance from the center of the magnet (gauss lines)**
- **MRI compatible monitors and anesthetic machines are available**
- Within the 5 gauss line pacemakers will malfunction
- Within the 50 gauss line ferromagnetic gas cylinders become potentially lethal projectiles
- Most infusion pumps can be used outside the 30 gauss line
- ECG is sensitive to the changing magnetic signals and it is nearly impossible to eliminate all artefacts (electrodes should be placed close together and toward the center of the magnetic field); leads should be insulated from the patients skin because they may heat up and cause thermal injury
- All cables and wires should run in a straight line and not be wound in loops to avoid induction heating effects
- Temperatures within the coil of the magnet can reach 26c
- Noise inside the scanner can reach 90 dB
- 10% of patients will experience severe panic and claustrophobia
- 4% of adult patients will terminate the procedure prematurely
- 14% will require some form of sedation
- 22% of children undergoing MRI will experience some sort of adverse event
  - O<sub>2</sub> desaturation occurred in 2.9% of cases
  - Inadequate sedation in 15%
  - Adverse events are more common in children with higher ASA classification
  - Oral sedation techniques if administered appropriately, have success rate of >93% (i.e. chloral hydrate 80-100mg/kg in patients <3yo)
  - Benzodiazepines (oral midazolam 0.25-0.75mg/kg) have also been used with success
  - Deep sedation with propofol infusion, oxygen administration via nasal cannula and ETCO<sub>2</sub> monitoring is a successful technique

#### REFERENCES:

Barash 6<sup>th</sup> Edition Chapter 34 Anesthesia Provided at Alternate Sites  
 ASA Statement on Nonoperating Room Anesthetizing Locations 2008