

ANAESTHESIA, IN NON-THEATRE ENVIRONMENT: SAFETY CONSIDERATION

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SUMMARY: In the recent time role of Anaesthesia has expanded beyond the operation theatre. Operation Theatre has trained and experienced staff, required equipments & monitors but providing Anaesthesia away from O.T. becomes a very challenging task.

DEFINITION OF A NON-THEATRE ENVIRONMENT: Non-theatre environment, where anaesthesiologists may be required to administer anaesthesia or sedation outside the operating theatres, include:

- Radiology department e.g. cardiac angiography, interventional radiology, CT scan, MRI
- Endoscopy clinic
- The dental clinic
- The burns unit
- Psychiatric unit for electroconvulsive therapy
- Renal unit for lithotripsy
- The gynaecology department for in vitro fertilisation.
- Radiotherapy and Chemotherapy unit.

ANAESTHESIA / SEDATION PROVIDER: A trained anaesthesiologist should provide anaesthesia.

In non-theatre environment within the hospital. However non\ anaesthesiologists are allowed to provide conscious sedation. It is mandatory that all providers should be Adult Cardiac Life Support (ACLS) certified¹.

AIMS OF THE ANAESTHETIST: Safety of the patient is of utmost importance in non-theatre environment and the standard of care should not differ from that offered in the operating theatre. Rapid recovery from anaesthesia or sedation is beneficial. In some circumstances, sedation may be chosen rather than general anaesthesia. The particular goals to consider when sedating patients are to:

- Guard the patient's safety and welfare
- Reduce physical discomfort and pain
- Control anxiety, reduce psychological trauma and maximize the potential for amnesia
- Control movement to allow safe completion of the procedure
- Return the patient to a condition in which safe discharge from hospital is possible. Some procedures may have special requirements dependent on the location (e.g. in the MRI department) or the procedure being undertaken (e.g. methods to reduce intracranial pressure in the interventional neuroradiology department).

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TYPE OF PATIENT POPULATION: Many procedures undertaken in non-theatre environment can be accomplished under light sedation, local anaesthesia, or with no sedation. However, there are groups of patients who may require deep sedation or general anaesthesia on a routine basis. They are:

- Children
- Uncooperative or anxious patients
- Claustrophobic patients (especially in MRI department)
- Elderly or confused patients
- Patients undergoing painful procedures
- Patients requiring burns dressings.

CHALLENGES OF ANAESTHESIA IN NON-THEATRE ENVIRONMENT: These can be classified as challenges related to:

- Equipment
- Staff
- The procedure
- The patient.

CHALLENGES – EQUIPMENT:

Anaesthesia machine: Ideally the anaesthesia machine should be equivalent in function to that employed in theatres. However the anaesthesia machine available for non-theatre environment is often a very basic model with minimal monitors. The design of the anaesthesia machine may not be familiar, for example the position of the oxygen flow meter may be on the left hand side (UK standard), rather than the right hand side (USA standard). It is important to do routine safety checks, such as ensuring that the oxygen failure alarm is working or that there is a hypoxic link if nitrous oxide is being used. Make sure that you can see your anaesthesia machine during the case - radiology procedures are invariably undertaken in darkened rooms and the anaesthesiologist must be vigilant to detect unexpected events such as cessation of oxygen delivery. There may be a light on the anaesthesia machine, otherwise a torch is essential. The light from a laryngoscope is insufficient. Where facilities are available an emergency trolley with a defibrillator should be immediately available.

Oxygen supply: Modern operating theatres are usually equipped with a central supply of oxygen, air and nitrous oxide. Each non-theatre environment should have a reliable source of oxygen adequate for the duration of the procedure. In many non-theatre environment, the anaesthesia machine may only have cylinders and therefore it is essential that extra cylinders are ready while the procedure is undertaken. These cylinders should be checked prior to the start of anaesthesia to ensure that they are full. A back-up of at least one full E type oxygen cylinder is advisable before starting any procedure in a non-theatre environment.

Cylinder keys: It is essential to check that the cylinder key is readily available prior to starting the induction of anaesthesia.

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Electricity: There must be sufficient electrical outlets for the anaesthesia and monitoring equipment.

Illumination: A means of illumination other than the laryngoscope is needed.

Soda lime canister: When using a circle system it is advisable to put fresh soda lime in the canister before undertaking a procedure.

Anaesthesia circuit: Certain procedures require the anaesthesia machine to be at a distance from the patient; therefore circuits and monitors with long extension tubings are necessary. If using a long Bains circuit, a leak test is essential. A self-inflating bag should also be available to provide positive pressure ventilation in case of oxygen failure.

Drugs and supplies: Since these locations are visited infrequently by the anaesthesia team, there is often no regular check up of the anaesthesia inventory. Check that you have all the drugs that you may require during anaesthesia (including emergency and resuscitation drugs), and that these drugs have not exceeded their expiry date.

Working suction: Central suction may not always be available in non-theatre environment, and therefore it is essential to ensure that a working suction machine is always available along with an electrical extension boards. A foot operated suction machine is handy as a back up and may be mobilized from the operating theatres.

Scavenging: If these anaesthesia vapours are used then there should be a reliable system for scavenging waste gases.

Space constraints: Radiology department often contain very bulky equipment and it is often difficult to accommodate the anaesthesia machine - make sure that there is enough space in the working environment.

Operating tables: An operating theatre table with the expected range of positions may not be available in these locations, so the various position adjustments including the height of the table may be difficult to achieve.

Monitoring equipment: Mandatory monitors should be as for any location where anaesthesia is administered: a pulse oximeter, non-invasive BP cuffs, ECG and end tidal CO₂ are a minimum requirement. Where muscle relaxants are used, a peripheral nerve stimulator is recommended. Check that BP cuffs of the appropriate size are available. If possible, mobilise end-tidal CO₂ monitoring from the operating theatres. Monitoring may be a particular challenge in the MRI department and specially shielded monitoring equipment is required that is MRI compatible and does not interfere with the MRI signal.

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Special circumstances - Magnetic resonance imaging (MRI): All equipment that is taken into the MRI department should be MRI compatible, or should be fixed at a safe distance from the magnet. Of particular importance – NEVER take an oxygen cylinder into the MRI department – deaths have resulted as the cylinder is sucked into the magnet coil. NEVER take any ferrous metal into the MRI department – anaesthesiologists should remember that this includes laryngoscopes, scissors and stethoscopes, watches and mobile phones. In an emergency, take the patient out of the MRI room; do not take the emergency equipment to the patient.

Equipment checklist for sedation or anaesthesia in the MRI department.

- a. Anaesthesia drugs.
- b. Resuscitation drugs.
- c. Defibrillator.
- d. A difficult airway trolley containing oropharyngeal and nasal airways, laryngeal mask airways, ETT of different sizes, bougies and stilettes should be available.
- e. Simple positioning equipment for instance head rings, shoulder rolls, etc.
- f. Infusion pumps with the extension tubing.
- g. Warming devices - the temperature in the radiology suites is often cool as their equipment requires low temperature for its maintenance. For prolonged procedures, patients may become hypothermic and warming devices will have to be brought from the operating theatres.
- h. Lead aprons, thyroid collars and dosimeters need to be worn in the radiology suites to reduce and monitor the exposure to radiation.

Challenges – staff: Staff that work in these areas are trained only in their speciality and so may not be familiar with the requirements for safe anaesthesia and may not be able to provide assistance to the anaesthesiologist. It is the sole responsibility of the anaesthesiologist conducting the cases to check the machine, anaesthesia drugs, emergency drugs and the defibrillators and to identify an assistant to help them. Where the anaesthesiologist works alone, ensure that rapid communication to colleagues in the main theatre suite is possible.

Communication: Planning is essential. Anticipate problems before starting the case; communication with theatre from a distance may be difficult and help may be slow to arrive.

Challenges - the procedure:

Poor illumination: Many procedures such as interventional radiology or endoscopy that require video screening are carried out in darkened rooms. Ideally the Anaesthesia machine should have a fluorescent screen to visualize the flow meters and to check accurate gas flows.

Unplanned procedures: Beware the situation where the anaesthesiologist is called after the intervention has started and the patient is found to be uncooperative. It is better to abort the procedure and come back another day.

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Setting for the procedure: Burns dressings are commonly done at the bedside and these sites are usually poorly equipped to deal with any kind of emergency.

Patient position: Patients undergoing endoscopy and CT guided biopsies may be positioned in the lateral or prone position. Ensure that pillows are available for safe prone positioning (i.e. under the chest and pelvis to allow for free diaphragmatic excursion). Prone position becomes difficult if the patient requires resuscitation – reposition the patient rapidly if this is the case.

Duration of the procedure: The duration of these procedures is difficult to predict and they may finish very abruptly (e.g. cerebral angiography with coiling of cerebral aneurysms). Avoid long-acting muscle relaxants and maintain close communication with the specialist performing the procedure.

Post-procedure care: Patients who have had a procedure under general anaesthesia require expert recovery - this may be either in the procedure room or the patient may be transferred to the recovery room of operating theatres. The availability of an ICU bed has to be confirmed prior to the procedure.

Consent forms: Many procedures in non-theatre environment are performed as day care procedures. The patient needs to be registered with the hospital in the usual way and consent taken. Day case procedures should not entail a change in the usual standard of care for the patient.

Challenges - the patient:

Assessment: Patients are often admitted as a day case and include all age groups. A careful anaesthesia assessment is essential, even if this is done a few minutes prior to the procedure. In particular, the patient requires careful assessment for the reason that they require the intervention, as well as look for any associated co-morbidities. Presence of dentures should be noted. Be particularly careful with airway assessment as an unanticipated difficult airway is very challenging for the anaesthesiologist in non-theatre environment if skilled help is unavailable.

Instructions: Patients who are planned for procedures under Anaesthesia should be given clear instructions regarding:

- Fasting
- Consent forms
- Medications for co-morbidities
- A careful metal check needs to be performed by the radiographer prior to MRI scans.

choice of anesthetic technique

- Monitoring only
- Sedation
- Regional anaesthesia
- Total intravenous anaesthesia
- General anaesthesia.

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Monitoring only: The Anesthesiologists is there and performs Monitored Anaesthesia Care (MAC).

SEDATION:

Conscious sedation: This describes a depressed state of consciousness where the patient is able to respond to commands, maintains his/her airway and the airway reflexes are well preserved.

Deep sedation: The consciousness of the patient is depressed to an extent that the protective airway reflexes are obtunded and airway maintenance may become an issue. The degree of safety in conscious sedation is much higher than deep sedation. The patient can easily drift from a state of conscious sedation to deep sedation, depending on his age, sensitivity to drugs, health status etc. Titration and adjustment of the doses of the sedative agents requires skill and experience.

Total intravenous anaesthesia (TIVA): It is usual to choose drugs to provide a combination of hypnosis and analgesia. Drugs are used intravenously, and some adjunct is often required to maintain a patent airway. The airway can be maintained by chin lift/jaw thrust, or an oropharyngeal airway or laryngeal mask airway may be used if the patient is deeply anaesthetized. Procedures suitable for TIVA include lithotripsy, oocyte retrieval, in vitro fertilization and foetal reduction in ultrasound rooms.

General anaesthesia: General anaesthesia with controlled ventilation is the choice of anaesthesia in many situations, particularly interventions such as for patients undergoing coiling of cerebral aneurysms. The goals of anaesthetic management are adequate depth of anaesthesia, methods to decrease intracranial tension, along with maintenance of normothermia (avoidance of hyperthermia). In the MRI centre, an MRI compatible anaesthesia machine is essential if the machine is in the MRI room. Anaesthesia is induced outside the MRI compatible room and the patient is transferred to the MRI compatible machine in the room. It is possible to maintain anaesthesia if the machine is outside the MRI room with the help of long anaesthesia circuits, but this is far from ideal and the patient is at greater risk of circuit disconnections. Monitors must always be kept outside the MRI room.

Regional anaesthesia: Combined spinal-epidural anaesthesia has been used successfully in non-theatre environment, for example for EVAR - Endovascular aneurysm repair. The conscious patient can communicate and this is a major safety consideration. Monitoring should be to the same standard as for general anaesthesia.

Monitoring: The essential monitor for patient safety is the presence of a trained vigilant anesthesiologist at all times, monitoring various parameters such as level of consciousness, oxygenation, ventilation, and haemodynamics. Minimum monitoring includes pulse oximetry, ECG, NIBP and end tidal CO₂. In a non-intubated patient, end-tidal CO₂ monitoring can be achieved by taping the sampling line to the patient's upper lip. The expired CO₂ is sensed along with the graphic display of respiration.

DOCUMENTATION OF ANAESTHESIA

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A time-based anaesthesia flow sheet should be available to record the following:

- Drugs administered – time and dose
- SpO₂
- Heart rate
- Respiratory rate
- NIBP – can omit if minimal sedation, e.g. during MRI/CT
- Level of sedation

Observations should be performed at 15 minute intervals for conscious sedation, and 5 minute intervals for deep sedation and general anaesthesia.

CHOICE OF DRUGS: This depends on the procedure being performed, and whether this is painful or painless. (E.g. MRI scan compared to endoscopy compared to a change of burns dressings). Details for different procedures is outside the scope of this article, however examples of commonly used drugs are:

1. Midazolam
2. Fentanyl
3. Propofol
4. Ketamine
5. Ketofol
6. Remifentanyl
7. Prilox cream has been used successfully in cases for lithotripsy. There is substantial variability in the response to each agent between individuals, and so careful administration of drugs, titrated to effect is essential.
8. Midazolam syrup

Equipment check list for anaesthesia or sedation in a non-theatre environment.

Remember the acronym **SOAPME**.

S (suction) – Appropriate size suction catheters and functioning suction apparatus.

O (oxygen) – Reliable oxygen sources with a functioning flow meter. At least one spare E - type oxygen cylinder.

A (airway) – Size appropriate airway equipment:

- Face mask
- Nasopharyngeal and oropharyngeal airways
- Laryngoscope blades
- ETT
- Stylets
- Bag-valve-mask or equivalent device.

P (pharmacy) – Basic drugs needed for life support during emergency:

- Epinephrine (adrenaline)
- Atropine
- Glucose
- Naloxone (reversal agent for opioid drugs)

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- Flumazenil (reversal agent for benzodiazepines).

M (monitors):

- Pulse oximeter
- NIBP
- End-tidal CO₂ (capnography)
- Temperature
- ECG

E (equipment):

- Defibrillator with paddles
- Gas scavenging
- Safe electrical outlets (earthed)
- Adequate lighting (torch with battery backup)
- Means of reliable communication to main theatre site.

Further detail on sedation for children can be found in the Further reading section.

SPECIAL CONSIDERATIONS

- Anaphylaxis to iodinated dyes is possible. All the drugs for management of anaphylaxis should always be immediately available.
- Techniques to measure temperature and avoid hypothermia are essential.
- Radiation exposure - anaesthesia personnel should be aware of the radiation hazards and take precautions to avoid radiation exposure.

POST-PROCEDURE CARE: Transport of the patients to a standard recovery room accompanied by the monitors along with the accompanying anaesthesiologist is the safest practice for post-procedural care. Most patients require oxygen during transport. Patients who require elective postoperative ventilation must be transferred with continuous monitoring.

DISCHARGE CRITERIA: The discharge criteria of these patients are the same as for any patient after surgery.

CONCLUSION: The secret of success in anaesthesia for non-theatre environment is the skilled anaesthesiologist with the appropriate equipment and drugs, along with adequate back up facilities.

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