Outside the Operating Theatre Anaesthesia

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Abstracts

Modern hospital practice has seen the role of the anaesthesiogist expand beyond the operating theatre complex. While the operating theatres have experienced staff, adequate equipment and monitors, providing anaesthesian outside this complex is challenging and requires expertise and skill.

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Introduction

Over the past few decades, requests for these services in remote locations have been steadily increasing, and in many large hospitals today more anesthetics are routinely administered for procedures off -site than in the operating room suite. According to some estimates, nonoperating room anesthesia accounts for 12.4% of all anesthetic care in the United States. It is important to remember that the same basic standards for anesthesia care need to be met, regardless of the location. Furthermore, the challenges of unfamiliar environments that are far removed from the surgical suite, including anesthesia- naive personnel, require advance planning for the off -site anesthesiologist[1].

Definition of a remote location

Remote locations, where anaesthesiologists may be required to administer anaesthesia or sedation outside the operating theatres, include:

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

Who should provide sedation for the procedures performed in remote locations?

A trained anaesthesiologist should provide anaesthesia in remote locations 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) certified.

Recently, the Centers for Medicare and Medicaid Services has mandated that all sedation in a hospital be under the direction of a physician— generally, the anesthesia service chief. Consequently, anesthesiologists must not only from time to time provide anesthesia in a nonoperating room setting, but must also develop policies and quality assurance review mechanisms for nonanesthesia providers to safely provide sedation. Such policies should be focused on assuring that the "sedationist" has the necessary skills to provide for patient rescue, should mild or moderate sedation become deep sedation or general anesthesia[1].

Aims of the anaesthetist

Safety of the patient is the overiding goal of anaesthesia in remote locations and the standard of care should not differ from that offered in the operating theatre. Rapid recovery from anaestheisa 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
- Minimise physical discomfort and pain
- Control anxiety, minimise psychological trauma and maximize the potential for amnesia
- Control movement to allow safe completion of

the procedure

- Return the patient to a state in which safe discharge from medical supervision is possible.

Patient population

Many procedures undertaken in remote locations 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. These include:

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

Challenges of anaesthesia in remote locations

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 remote locations is often a very basic model with minimal monitors that may not be in regular use in the operating theatres. It is important that these machines are on the same service schedule as the anaesthetic machines in the main operating theatre. The design of the anaesthetic 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 anaesthetic 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 anaesthetic 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 remote site should have a reliable source of oxygen adequate for the duration of the procedure. In many remote locations, 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 remote location.

Cylinder keys

The key to open the cylinder should always be available with the machine. It is essential to check that the cylinder key is readily available prior to starting the induction of anaesthesia.

Electricity

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

Illumination

A means of illumination other than the laryngoscope is needed.

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

remote locations, 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 anaesthetic vapours are used the there should be a reliable system for scavenging waste gases.

Space constraints

Radiology suites 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 conducted: a pulse oximeter, non-invasive BP cuffs, ECG and endtidal 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 suite and specially shielded monitoring equipment is required that is MRI compatible and does not interfere with the MRI signal.

Special circumstances - Magnetic resonance imaging (MRI)

All equipment that is taken into the MRI suite 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 suite – deaths have resulted as the cylinder is sucked into the magnet coil. NEVER take any ferrous metal into the MRI suite – anaesthesiologists should remember that this includes laryngoscopes, scissors and stethoscopes and mobile phones. In an emergency, take the patient out of the MRI room, do not take the emergency equipment to the patient.[4]

Equipment checklist for sedation or anaesthesia in the MRI suite

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 (bira), 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, anaesthetic drugs, emergency drugs and the defibrillators and to identify an assitant to help them. In countries where it is usual to have a professional assistant providing support for the anaesthetist in theatres, these standards should be upheld in remote settings. Where this is not common practice it is sensible to have assistance in the form of a trainee anaesthetist. Where the anaesthetist works alone, ensure that rapid communication to colleagues in the main theatre suite is possible.

Personnel requirements for safe sedation and anesthesia outside the operating room.

Anesthesia staff

Trained in the clinical assessment of preanesthesia patients

Trained and experienced in airway management and cardiopulmonary resuscitation

Trained in the use of anesthetic and resuscitation drugs and equipment, and must ensure that the equipment is present and functional prior to induction

Dedicated to the continuous monitoring of the patient's physiologic parameters

Continuously present and vigilant

Nonanesthesia staff

Appropriately trained to help deal with a cardiopulmonary emergency

Assistant for the anesthesiologist—this person must be familiar with anesthetic procedures and equipment

Assistant to help with positioning

Staff trained in postprocedure observation and resuscitation[2]

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 interventioanal radiology or endoscopy that require video screening are carried out in darkened rooms. Ideally the anesthesia machine should have a fluorescent screen to visualise the flow meters and to check accurate gas flows. Remember that the safety of the patient is of paramount importance, and the lights should not be so low that you cannot monitor your patient.

Unplanned procedures

Beware the situation where the anesthesiologist is called after the intervention has started and the patient is found to be uncooperative. Without a prior plan or airway assessment the situation is hazardous – it is better to abort the procedure and come back another day when things can be planned properly. With the growth of acute cardiological intervention for acute coronary syndromes, emergencycalls to the catheter laboratory for anaesthesic assistance are increasingly common.

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. Patients undergoing aneurysm coiling may need to be ventilated in the postoperative period. The availability of an ICU bed has to be confirmed prior to the procedure.

Consent forms

Many procedures in remote locations are performed as day care procedures. The patient needs to be registered with the hospital in the usual way, an admission clerking should be performed 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 anaesthetic 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 any associated co-morbidities. Fasting status of the patient should be noted and a quick airway assessment should be done. Presence of dentures should be noted. Be particularly careful with airway assessment as an

unanticipated difficult airway is very challenging for the anaesthesiologist in remote locations if skilled help is unavailable.

Instructions

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

- Fasting
- Consent forms
- Medications for comorbidities
- A careful metal check needs to be performed by the radiographer prior to MRI scans – for instance, no hairclips, jewellery, safety pins, mobile phones, credit cards or coins.

Specific conditions that warrant special care when providing anesthesia or sedation outside the operating room.

- Patient unable to cooperate, e.g. severe intellectual disability
- Severe gastroesophageal reflux
- Medical conditions predisposing patients to reflux, e.g.gastroparesis secondary to diabetes mellitus
- Orthopnea
- Severe increased intracranial pressure
- Decreased level of consciousness/depression of protective airway reflexes
- Known difficult intubation especially when procedure is outside the operating room
- Dental, oral, craniofacial, neck or thoracic abnormalities that could compromise the airway
- Presence of respiratory tract infection or unexplained fever
- Obstructive sleep apnea
- Morbid obesity
- Procedures limiting access to the airway
- Lengthy, complex or painful procedures
- Uncomfortable position
- Prone position
- Acute trauma
- Extremes of age[2]

Choice of anesthetic technique

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

Monitoring only

The procedure specialist monitors the patient with the help of their staff and do not require an anaesthesiologist.

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 anaesthetised. Procedures suitable for TIVA include lithotripsy, oocyte retrieval, in vitro fertilisation 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 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 remote locations, for example for EVAR - Endovascular aneurysym 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 anaesthesiologist at all times, monitoring various parameters such as level of consciousness, oxygenation, ventilation, and haemodynamics. Minimum monitoring includes pulse oximetry, ECG, NIBP and endtidal 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. In our centre, we do not have MRI compatible monitors and the anaesthesiologist sits inside the MRI suite along with the patient and monitors the radial/dorsalis pedis pulse. A cotton wick is placed on the patient's chest. The chest movements are assessed by the movement of the cotton wick when the patient is inside the "tunnel" and is sedated. Vigilence is essential. Ideally, MRI compatible monitors should be available - an MRI compatible pulse oximeter lead can be trailed out of the room and monitored in the control room.

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

- Drugs administered – time and dose
- SaO2
- 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 proedure being performed, and whether this is painful or painless. (e.g. MRI scan compared to endoscopy compared to a change of burns dressings). Examples of commonly used agents include:

Midazolam
In paediatric patients, intranasal midazolam has also been tried successfully.

Fentanyl
0.25-0.5mcg.kg-1 is usually sufficient.

Propofol
A careful and slow intravenous injection of propofol is an ideal choice.

Ketamine
Used in children. Use in adults has decreased with the availability of propofol.

Ketofol
A combination of ketamine and propofol has also been used and it provides good hemodynamic stability.

Remifentanil
An ideal drug but not available in Bangladesh and many other parts of the world.

Prilox cream has been used successfully in cases for lithotripsy.

There is substantial variability in the response to each agent between individuals, and so carefully administration of drugs, titrated to effect is essential.

Equipment check list for anaesthesia or sedation in a remote location away from the operating theatre[4]

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)
- 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.

Complications associated with sedation and analgesia.

Airway

Airway obstruction
Aspiration
Regurgitation
Dental/soft tissue injury

Respiratory

Respiratory depression
Hypoxemia
Hypercarbia
Apnea

Cardiovascular

Hypotension
Cardiac arrhythmias

Neurologic

Deeper level of sedation
Unresponsiveness

Other

Undesirable patient movement
Drug interactions
Adverse reactions
Unanticipated admission[3]

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 remote locations is the skilled anaesthesiologist with the appropriate equipment and drugs, along with adequate back up facilities.

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