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Recognised standards of monitoring during anaesthesia and recovery

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Abbreviations: PA, physician assistant; NIBP, non-invasive blood pressure; TIVA, total intravenous anesthesia technique; BLS, basic life support

Introduction

Monitoring Patients under anesthesia and during recovery should be standardized and should fulfil the basic requirements to safely cover this critical period of anesthesia and surgery, not only this time but also during recovery from the anesthesia and muscle relaxants

The essential minimum standards of monitoring are adhered to whenever a patient is anaesthetized. These minimum standards should be uniform regardless of duration, location or mode of anesthesia.

a. The anesthetist must be present and care for the patient throughout the conduct of an anaesthetic. *

b. Minimum monitoring devices (as defined in the recommendations) must be attached before induction of anesthesia and their use continued until the patient has recovered from the effects of anesthesia. The same standards of monitoring is applied when the anesthetist is responsible for local/regional anesthesia or sedative techniques. **

c. A summary of information provided by all monitoring devices should be recorded on the anesthetic record. Automated electronic anesthetic record systems that also provide a printed copy are recommended.

d. The anesthetist must ensure that all anesthetic equipment, including relevant monitoring equipment, has been checked before use. Alarm limits for all equipment must be set appropriately before use. The appropriate audible alarms should be enabled during anesthesia.

e. These recommendations state the monitoring devices that are essential ('minimum' monitoring) and those that must be immediately available during anesthesia. If it is absolutely necessary to continue anesthesia without an essential monitor, the anesthetist should note the reasons in the anesthetic record.

f. Additional monitoring may be necessary as judged appropriate by the anesthetist.

g. Minimum monitoring should be used during the transfer of anaesthetized patients.

h. Provision, maintenance, calibration and renewal of equipment are the responsibilities of the institution in which anesthesia is delivered. The institution should have processes for taking advice from departments of anesthesia in matters of equipment procurement and maintenance.

i. All patient monitoring equipment should be checked before use.[1] The presence of an appropriately trained and experienced anesthetist is the main determinant of patient safety during anesthesia. However, human error is inevitable, and many studies have shown that adverse incidents and accidents are frequently attributable, at least in part, to error by anaesthetists.[2–4]

Monitoring will not prevent all adverse incidents or accidents in the peri-operative period. However, there is substantial evidence that it reduces the risks of incidents and accidents both by detecting the consequences of errors, and by giving early warning that the condition of a patient is deteriorating.[5–11]

The anaesthetist's presence during anesthesia

An anesthetist of appropriate experience, or fully trained Physician Assistant (Anesthesia) PA (A) under the supervision of a consultant anesthetist, must be present throughout general anesthesia. Using both clinical skills and monitoring equipment, the anesthetist must care for the patient continuously. The same standards must apply when an anesthetist is responsible for a local/regional anesthetic or sedative technique for an operative procedure. In certain well-defined circumstances,[12] intra-operative patient monitoring can be delegated to a suitably trained non-physician health care worker during certain procedures performed under regional or local anesthesia. When there is a known potential hazard to the anesthetist, for example during x-ray imaging, facilities for remotely observing and monitoring the patient must be available.

Accurate records of the values determined by monitors must be kept. Minimum monitoring data (heart rate, blood pressure, peripheral oxygen saturation, end-tidal carbon dioxide and anesthetic vapour concentration, if volatile anesthetic agents or nitrous oxide are used) must be recorded at least every five minutes, and more frequently if the patient is clinically unstable. It is recognized that contemporaneous records may be difficult to keep in emergency circumstances, but modern patient monitoring devices allow accurate

records to be completed or downloaded later from stored data. Automated electronic anesthetic record systems that can also make hard copies for the medical notes are recommended.

Local circumstances may dictate that handing over of responsibility for patient care under anesthesia to another anesthetist may be necessary. If so, a detailed handover must be delivered to the incoming anesthetist and this should be recorded in the anesthetic record. A handover checklist is useful,[13–15] When taking over care of a patient (including when returning after relief for a break), the incoming anesthetist should conduct a check to ensure that all appropriate monitoring is in place with suitable alarm limits.

Very occasionally, an anesthetist working single-handedly may be called on briefly to assist with or perform a life-saving procedure nearby. Leaving an anaesthetized patient in these circumstances is a matter for individual judgement, but another anesthetist or trained PA (A) should be sought to continue close observation of the patient. If this is not possible in an emergency situation, a trained anesthetic assistant must continue observation of the patient and monitoring devices. Any problems should be reported to other available medical staff in the area. Anesthesia departments should therefore work towards having an additional experienced anesthetist available (e.g. a 'Duty Consultant' or 'floating registrar' of appropriate seniority) to provide cover in such situations.

Anesthesia departments should make arrangements to allow anaesthetists working solo during long surgical procedures to be relieved by a colleague or PA (A) for meal and comfort breaks.[16] The 1998 European Working Time Regulation Legislation states that an individual should have an uninterrupted break of not less than 20 minutes if the working day exceeds six hours.[17] To meet this requirement, the presence of an additional experienced anesthetist in the theatre suite, as described above is desirable.

Anesthetic equipment

It is the responsibility of the anesthetist to check all equipment before use.[1] Anaesthetists must ensure that they are familiar with all the equipment they intend to use and that they have followed any specific checking procedures recommended by individual manufacturers.

Oxygen supply

The use of an oxygen analyzer with an audible alarm is essential during anesthesia. The anesthetist should check and set appropriate oxygen concentration alarm limits. The analyzer must be placed in such a position that the composition of the gas mixture delivered to the patient is monitored continuously. Most modern anesthetic machines have built-in oxygen analyzers that monitor both inspired and expired oxygen concentrations. Also the main Oxygen supply to the Machine should have an Audible alarm if the pressure reaching the machine is low. The low pressure or oxygen supply failure alarm will go off when there is a significant increase or decrease of the O2 supply pressure. This occurs when there is a sudden loss of cylinder or pipeline pressure or when the anesthesia machine is turned on or off.

Breathing systems

During spontaneous ventilation, observation of the reservoir bag may reveal a leak, disconnection, high pressure or abnormalities of ventilation. Before use the breathing circuit a leakage test must be performed to guarantee the safe optimally working breathing circuit. Continuous waveform carbon dioxide concentration monitoring will detect most of these problems, so this is an essential part of routine monitoring during anaesthesia.[18]

Vapour analyzer

The use of a vapour analyzer is essential during anesthesia whenever a volatile anesthetic agent or nitrous oxide is in use. The end-tidal concentration should be documented on the anesthetic record.

Infusion devices

When any component of anesthesia (hypnotic, analgesic, neuromuscular blockade) is administered by infusion, the infusion device must be checked before use. Alarm settings (including infusion pressure alarm levels) and infusion limits must be verified and set to appropriate levels before commencing anesthesia. It is recommended that the intravenous cannula should be visible throughout the procedure, when this is practical. When not practical, increased vigilance is required and correct functioning of the cannula should be regularly confirmed. It is recommended that infusion devices are connected to mains power whenever possible. When using a total intravenous anesthesia technique (TIVA) with neuromuscular blockade, a depth of anesthesia monitor is recommended (see below).

Alarms

Anaesthetists must ensure that all alarms are set to appropriate values. The default alarm settings incorporated by the manufacturer are often inappropriate. During the checking procedure, the anesthetist must review and reset the upper and lower limits as necessary. It is recommended that anesthetic departments agree consensus-based alarm limits for their monitors and ask their medical physics technicians to set these up. Audible alarms must be enabled before anesthesia commences.

When intermittent positive pressure ventilation is used during anesthesia, airway pressure alarms must also be used to detect high pressure within the airway and to give warning of disconnection or leaks.

Provision, maintenance, calibration and renewal of equipment are the responsibilities of the institution in which anesthesia is delivered. Institutions should take into account the views of the anesthetic department on matters relating to acquisition and maintenance of equipment.

Monitor displays

Care should be taken to configure the display setup, with attention to both the size and arrangement of on-screen data with regular updating of displayed values. An appropriate automatic non-invasive blood pressure (NIBP) recording interval should be set; NIBP monitors should not continue to display readings for longer than 5 minutes to reduce the risk of an older reading being mistaken for a recent reading. For ECG setup standard monitoring with the use of lead II, for better identification for changes if any in P wave, QRS wave, S-T segment and T wave.

Monitoring the devices

Many devices used in anesthetic practice need their own checks and monitoring. This includes monitoring the cuff pressure of tracheal tubes and cuffed supra-glottic airway devices. Cuff pressure manometers should be used to avoid exceeding manufacturers' recommended intra-cuff pressures which can be associated with increased patient morbidity. When using devices where manufacturers do not specify or recommended a maximum cuff pressure, there may still be benefit in avoiding high pressure inflation, as this is associated with reduced morbidity and improved device performance.[19]

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Monitoring the patient

During anesthesia, the patient's physiological state and adequacy of anesthesia need continual assessment. Monitoring devices supplement clinical observation in order to achieve this. Appropriate clinical observations may include mucosal colon, pupil size, response to surgical stimuli and movements of the chest wall and/or the reservoir bag. The anesthetist may undertake palpation of the pulse, auscultation of breath sounds and, where appropriate, measurement of urine output and blood loss. A stethoscope must always be available.

Monitoring devices

The monitoring devices described above are essential to the safe conduct of anesthesia. If it is necessary to continue anesthesia without a particular device, the anesthetist must record the reasons for this in the anesthetic record and only proceed where the benefits or clinical urgency outweigh the risks. The following are considered minimum monitoring for anesthesia:

a. Pulse oximeter

b. NIBP

c. ECG

d. Inspired and expired oxygen, carbon dioxide, nitrous oxide and volatile anesthetic agent if used (see below).

e. Airway pressure

f. Peripheral nerve stimulator if neuromuscular blocking drugs used

g. Temperature for any procedure > 30 min duration.[20]

Monitoring must continue until the patient has recovered from anaesthesia. Anaesthesia departments must work towards providing capnography monitoring throughout the whole period of anaesthesia from induction to full recovery of consciousness.[21,22]

During induction of anesthesia in children and in uncooperative adults, it may not be feasible to attach all monitoring before induction. In these circumstances, monitoring must be attached as soon as possible and the reasons for delay recorded.

Recovery from anesthesia

Minimum monitoring should be maintained until the patient has recovered fully from anesthesia, means that the patient no longer needs any form of airway support, is breathing spontaneously, alert, responding to commands and speaking. Until this point, monitoring must be maintained to enable rapid detection of airway, ventilatory and cardiovascular disturbance. Departments should work towards providing full monitoring, including capnography, in patients with a tracheal tube or supraglottic airway in situ, for these transfers and in the recovery area. Supplemental oxygen should routinely be given to patients during transfer to the recovery room and in the recovery room until at least after full recovery.

Conclusion

In summary, the minimum monitoring for recovery from anesthesia[21] includes:

i. Pulse oximeter

ii. NIBP

iii. ECG

iv. Capnography if the patient has a tracheal tube, supraglottic airway device in situ or is deeply sedated.[17]

v. Temperature

Regional techniques and sedation for operative procedures

Patients must have appropriate monitoring, including pulse oximeter, NIBP, ECG and end-tidal carbon dioxide monitor if the patient is sedated. For the seditionist who will perform the task should be certified to do so and hold certificate for air way management, Basic life support (BLS provider).[23]

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Conflicts of interest

Author declare that there is no conflict of interest.

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