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Monitoring regional anaesthesia

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Abstract

Monitoring patients under regional anaesthesia is more challenging than patients under general anaesthesia but it has been somewhat neglected in anaesthesia literature. The fundamental differences are that during regional anaesthesia.

1. The patient is often awake.
2. Respiration is more difficult to measure.
3. Autonomic changes influence information obtained by pulse oximetry.
4. Monitoring personnel are at a greater risk of vigilance decrement.

A review of reported complications during regional anaesthesia enabled conclusions to be reached regarding monitoring policies in an institution. These include particular reference to spontaneous respiration and cerebral function. The need for an appropriately skilled person monitoring the patient in the operating room at all times is emphasized, as is the necessity for education appropriate for the skills they may have to exercise even on rare occasions. Specific instruction in vigilance decrement avoidance should be part of that curriculum.

The process of monitoring is defined as the maintenance of surveillance by the anaesthetist over the patient and equipment, the use of instruments to assist this, and the analysis and interpretation of the information so obtained. Its importance is recognized in anaesthesia literature but, in contrast to general anaesthesia, regional anaesthesia has received scant attention. A recent study failed to provide evidence that regional anaesthesia is inherently safer than general anaesthesia [1]. It demonstrated a need for more additional monitoring and though the statistical validity of attributing morbidity and mortality to factors in the environment has been questioned [2] the need for more careful consideration of monitoring processes during regional anaesthesia has not been doubted [3]. There are fundamental differences between monitoring situations during regional and general anaesthesia. During regional anaesthesia patients are often conscious, though partially deafferented, and autonomic nervous changes vary in different parts of the body. The anaesthetist or supervising nurse is more at risk for vigilance decrement because sensory input and duties regarding an anaesthesia delivery system are lacking. There is a greater temptation to be outside the operating room because of the illusion that once surgery is in progress a critical incident will never occur. Thus when planning for monitoring during regional anaesthesia it is appropriate to base conclusions on the published chro-

nology of critical events, monitoring methods, and the educational requirements for persons conducting the monitoring process.

Chronology of critical incidents

During the period from the induction of regional anaesthesia to the termination of surgery and the anaesthetic effect, patients having surgery under regional anaesthesia – whether or not psychoactive drugs have been administered – are influenced by a wide variety of factors. These comprise local and systemic effects of anaesthetic and vasoactive drugs, posture, the surgical process, and the environment. All may alter physiological function individually and in combination. A recent review described the clinical circumstances in which critical events suddenly occurred [4]. The rarity of such events tends to lull anaesthetists into a false sense of security and changes that could soon be detected by careful monitoring are only noticed later – suddenly by the anaesthetist. A classic combination is the slowly developing hypoxia resulting from respiratory depression and depletion of circulating fluids, this situation being compounded by a gradual cardiovascular depression or by a sudden autonomic stimulus from the surgical site. It is not surprising that events threatening patient outcome have occured on occasions from the onset of attempted neural blockade until surgery has been in progress several hours or even terminated [5–33]. Thus it is prudent to monitor patients carefully from the time neural blockade is attempted until the effects of the blockade have ended.

Monitoring methods

Events culminating in cardiopulmonary failure, brain damage, or death – the final common denominator of adverse events prior to or during surgery under regional anaesthesia – have much in common with general anaesthesia and so there will be many similarities in the monitoring processes during regional and general anaesthesia. However there are important contrasts. During regional anaesthesia the human sensing capability of the anaesthetist, supplemented by monitoring devices, is assisted by the patient. Thus for many patients under regional anaesthesia simple opportunities exist to monitor brain function as well as cardiopulmonary, renal, and muscle function. Also as the patients are not usually attached to a breathing circuit of any kind direct measurement of respiratory events is more difficult than in the patient under general anaesthesia.

Induction of regional anaesthesia

Immediately prior to the induction of regional anaesthesia the patient should be told of sensations they may experience and about which they should immediately inform the anaesthetist. These are associated with relative overdose of local anaesthetic drug, reaction to a vasoconstrictor drug, undesirable spread of local anaesthetic, allergy, a vasovagal attack, or a concomitant medical episode [34] (Table 1). Specific descriptions of symptoms that may follow retrobulbar injections [21] and those of brain stem anaesthesia [35] exist (Table 1) and

Table 1. Symptoms associated with complications during regional anaesthesia.

Local anaesthetic toxicity [31]	Light headedness, dizziness	Visual focussing difficulty	Disorientation, drowsiness
Reaction to vasoconstrictor [31]	Tachycardia		
	Headache, apprehension		
Vasovagal problem [31]	Faintness		
Allergy [31]	Difficult breathing, faintness		
High spinal or epidural block [31]	Faintness, difficult breathing		
	Nausea		
Retrobulbar injectate spread [18]	Difficult swallowing, numb throat, difficult breathing and hearing, drowsiness and tachycardia		
Brain stem anaesthesia [32]	Diminishing consciousness, nausea, visual disturbance, confusion, hemiparesis		

there is always the possibility that the progress of the needle produces paraesthesia. So useful can report of these symptoms to the anaesthetist be that the wisdom of heavy sedation or anaesthesia during the induction of regional anaesthesia is doubtful [36].

It is unlikely that any patient could learn a large list of sensations to report during a neural blockade so it is helpful if these are categorized in a manner the patient can understand and remember. The patient can be requested to tell the anaesthetist immediately they experience: (1) Any change in sensation associated with consciousness, vision, hearing or taste. (2) Any feeling that they cannot breathe, swallow or move limbs normally. (3) Any feeling of pins or needles anywhere. It then becomes the task of the anaesthetist to interpret the significance of the symptoms with reference to the patients behaviour, his own activities, and monitored physiological measurements. Indeed it is prudent to simultaneously monitor physiological, behavioural and verbal changes while the neural blockade is performed. The anaesthetist should have information as frequently as possible about systemic blood pressure, pulse rate, cardiac rhythm, tidal volume, respiratory frequency, character of respiration, hemoglobin oxygen saturation, carbon dioxide elimination, brain function, muscle activity, and autonomic nervous system activity (Table 2). In some instances delivery of this information may be automated. However, under these circumstances the alarms must be audible and appropriately set. Alternatively, an assistant must employ human sensing to acquire this information and report to the anaesthetist.

Perioperative period

Surgical events and renal function are important additions to the monitored requirements described for the induction period. However, particular emphasis must be placed on the assessment of Sa02, spontaneous respiration, and consciousness because opportunities and problems exist that are peculiar to the regional anaesthesia situation.

Pulse oximetry is well established as a monitor of oxygenation [37–39] albeit with practical limitations [40]. One is the paucity of information about the accuracy of commercial instruments [40]. An-

Table 2.

Cardiopulmonary system function	Monitor: human/instrument	Potential for detection
Systemic B.F.	Automated sphygmomanometer (1 min setting)	Slow
	Human finger (continuous)	Rapid
	Patients symptoms	Variable
Pulse rate	Pulse oximeter & audio alarm set	Rapid
	Human finger	Rapid
	Patients symptoms	Slow
Cardiac rhythm	ECG with audio alarm set	Rapid
	Human finger	None
	Patients symptoms	Slow
Tidal volume	Human observation	Rapid
Sa02	Pulse oximeter with audio alarm set	Rapid
	Human observation	Slow
C02 elimination	ETC02	Slow
Cerebral function	Human questioning	Rapid
Muscle activity	Human observation	Rapid
Autonomic nervous system activity	Human observation	Variable
sweating		
pallor		
cold		

other is that changes in oxygenation are not detected until the Pa02 falls below the 70–80 mm range, approaching the steep portion of the oxyhemoglobin dissociation curve. Thus it is vitally important that the person responsible for the patient realizes that changes detected by pulse oximetry can be a fairly late change in the evolution of morbidity and mortality and attention must be paid to precipetating events. Finally, particular reference must be made to the use of pulse oximetry during regional anaesthesia. Oxygen saturation measurements made at the body peripheries are influenced by blood perfusion which in turn is influenced by autonomic activity. There is a zone of differential sympathetic blockade extending six or seven spinal segments cephalad to the level of analgesia produced by subarachnoid blockade. Thus the location of the pulse oximeter sensor should be taken into account when conclusions are drawn from the measurements delivered.

Spontaneous respiration must result in an adequate exchange of air – oxygen enriched or otherwise – and the need for continuous respiratory monitoring is paramount. It must be as accurate as possible and here lies a challenge during supervision of the patient under regional anaesthesia. Classical methods such as a piece of cotton wool by a nostril are apnoea monitors rather than indicators of tidal volume. It has been shown that among a population of recovery room nurses listening closely with the ear or feeling exhalations with the palm of the hand can make reliable estimates of tidal volume, particularly if learned initially from a mechanical model. Another alternative, observation of abdominal and thoracic movement, is a notoriously unreliable indicator of tidal volume. However even if sufficiently accurate it is unlikely that these forms of monitoring can be conducted continuously over long periods of time. A well fitting light plastic mask with an observable reservoir bag is likely to be more helpful.

The measurement of end tidal carbon dioxide concentration in expired gases and display of the waveform is widely accepted in the conduct of general anaesthesia [41]. However, values from samples obtained from the conscious patient lacking an artificial airway and whose spontaneous breathing may be supplemented with oxygen are difficult to interpret. The sample source can be from inside a plastic oxygen mask [42] but the relationship with arterial sample values may be tenuous. Even samples from the top of an endotracheal in a conventional anaesthesia breathing system differ by 1–5 mm from arterial sample values in healthy patients and by 15–20 mm in patients with cardiopulmonary disease. Samples taken from the nasal oxygen cannulae commonly used during regional anaesthesia [43] are contraversial in their interpretation [44–46]. It appears likely that such samples are not true end tidal gas mixtures and even a misleadingly low carbon dioxide concentration may be measured. Thus there is a risk that these convenient techniques function only as a respiratory rate or apnoea monitors. Whatever system of sampling is adopted the user should calibrate it against arterial blood samples taken from a wide variety of patients before adopting it as a reliable technique for monitoring carbon dioxide as an indicator of respiratory function.

Consciousness of patients during regional anaesthesia is an important advantage claimed for regional anaesthesia and conversation is an indication of brain function. However, the eyelids of a partially deafferented patient lacking environmental stimulation are likely to close and even the most astute anaesthetist cannot predict just how rousable is the patient. Though the conscious and obviously anxious patient is at risk the sleeping patient is not necessarily in a benign situation. There is an association between sleep stages and cardiac arhythmias, probably related to the changes in autonomic nervous system balance that occur [47]. During surgery the supplementary factors of surgical events, drugs, temperature change, and the physiological results of neural blockade and posture, may interact to cause changes in cardiac rhythm and rate ranging from ventricular fibrillation to asystole. The potentiation of morphine induced respiratory depression by sleep [48] is also important and a similar effect can probably occur with other depressant drugs.

Accordingly, light sedation that does not prevent the patient from maintaining his own airway patent is beneficial for some patients but with certain pro-

visos. Monitoring must be conducted continuously and vigilantly employing instruments for physiological measurement to supplement human sensing. If such an arrangement is impossible routine sedation of patients during regional anaesthesia is likely to increase critical incidents.

Post anaesthesia recovery period

This is a complex period when the effects of a waning neural blockade may be complicated by the waning influence of cardiovascular supportive drugs previously administered by the anaesthetist, manifestations of hypovolemia, a low haematocrit, fluid overload or electrolyte disturbance. Sedative and analgesic administration can contribute to hypoxia resulting from a variety of causes. The monitoring during this time should be similar to that employed during surgery and where possible the human sense monitoring capability should be supplemented by automated sphygmomanometry, ECG, pulse oximetry, and body temperature measurement. This must be continued until the autonomic effects of residual neural blockade have disappeared and the patient is perceived not to be at risk from residual sensory deficit or muscle weakness.

Education

Monitoring requires an organized approach to collecting information, recording it, and identifying problems. It is important to ensure that the educational level of the person entrusted with monitoring is appropriate for the task. A fully trained anaesthetist in the immediate vicinity of the patient is most likely to analyze complex situations accurately and skillfully initiate appropriate action. If this kind of staffing is deemed impossible or inappropriate the person supervising the patient must be trained to a level consistent with the availability of the more skilled personnel that can be called to the scene. This training includes a classification of items of information, their significance, behavioural algorithms based on them, and skills.

When the foregoing has been learned it can be assumed that competence to monitor has been attained but an understanding of the factors influencing future performance in the operating room are an essential part of education for the person taking care of the patient during surgery under regional anaesthesia. Monitoring under these circumstances is a situation in which sensory input to the supervising physician or nurse is likely to be small and regardless of its magnitude there is probably little that needs to be done. Boredom, preoccupation and distraction may develop and an error, slip or mistake occurs. A mistake is when the action itself is wrong. This occurs when, following recognition of a pattern of problem as similar to one met before, only confirmatory evidence for that conclusion is sought rather than seriously, considering other possibilities [46]. Accordingly, an essential part of education for persons monitoring patients under regional anaesthesia is an understanding of the circumstances by which vigilance decrement occurs its manifestations, and personal efforts that can be made to retard its development.

Conclusion

Monitoring with human sensing must be an essential feature of well conducted regional anaesthesia. It must be performed by a person functioning continuously and in a vigilant manner within a few meters of the patient. They must have been trained to perform all the tasks that may be required of them in the particular work environment of their institution. That training should inculcate an understanding of the significance of the kinds of information monitored within the framework of the evolution of patient morbidity and mortality as well as the evolution and characteristics of vigilance decrement. Instrumental sensing and displays are valuable adjuncts to human sensing and additionally in the regional anaesthesia situation the increased sensory input they provide is more likely to help keep the anaesthetist alert than cause information overload. Existing devices are valuable but an accurate way of measuring the spontaneous breathing of a conscious patient in a busy operating

room with surgery in progress would be a valuable advance in patient care.

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