Value of bispectral index monitoring during cardiopulmonary resuscitation

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A 67-yr-old man, undergoing pulmonary metastasis resection, experienced a postoperative cardiopulmonary arrest as a result of severe bleeding. Cardiopulmonary resuscitation (CPR) was initiated, then bispectral index (BIS) monitoring was used which reassured the medical team of the adequacy of the resuscitation.

Br J Anaesth 2002; 88: 443–4

Keywords: heart, cardiopulmonary resuscitation; monitoring, bispectral index

Accepted for publication: October 23, 2001

Success of cardiopulmonary resuscitation (CPR) in a patient following cardiopulmonary arrest depends mainly on early initiation of advanced cardiac life support and on knowledge of the underlying cause of the arrest. Tenacity of the medical team is also crucial. Although the standard of care for CPR is defined by guidelines,1 the efficacy of resuscitation would be improved if a device for evaluation of cerebral oxygenation was available.

We present a case in which the use of a device monitoring the bispectral index (BIS) reassured the medical team of the adequacy of CPR.

Case report

The patient was a 67-yr-old man classified as ASA III and undergoing pulmonary metastasis resection. Surgery was performed via a left thoracotomy under general anaesthesia combined with thoracic epidural anaesthesia. A left upper lobectomy was performed with concomitant resection of metastases located in the left lower lobe. During the procedure, the pulmonary artery was lacerated leading to an estimated blood loss of 2000 ml. The patient received 4 units of packed red blood cells (packed RBCs) intraoperatively and was extubated at the end of surgery.

The immediate postoperative period was uneventful and postoperatively, epidural analgesia was initiated. During the first 6 h post-operation, 800 ml of blood drained through the chest tubes. During this period the patient received 2 units of packed RBCs, and after transfusion the haemoglobin level was 8.9 g dl⁻¹. Suddenly, the nurses were alerted to a bradycardia (heart rate of 45 beats min⁻¹): the patient was tachypnoeic, his arterial pressure was unmeasurable, and he became comatose within a few seconds. Intubation, ventilation, and external chest compression were initiated. Physical examination revealed no jugular venous distension but dullness to percussion over the left side of the chest. Extensive bleeding was noted through and around the chest tubes. Major intravascular volume loading was initiated (first with colloid solutions then with packed RBCs) together with the i.v. administration of several boluses of epinephrine 1 mg followed by a continuous epinephrine infusion of 8 mg h⁻¹. Fluctuations in end-tidal carbon dioxide between 10 and 15 mm Hg demonstrated the relative efficacy of resuscitation. Immediately after tracheal intubation, arterial blood gases revealed a metabolic acidosis (pH=7.14, \( P_{aCO_2}=44.3 \) mm Hg, \( P_{aO_2}=454 \) mm Hg, base excess=−13.3, alkali reserve=14.5 mmol litre⁻¹ and lactate concentration=7.1 mmol litre⁻¹ serum). Potassium was 6.3 mmol litre⁻¹ and the haemoglobin level was 8.6 g dl⁻¹. While CPR continued, the patient, whose pupils were unreactive and fully dilated, was transferred to the operating room. Surgery began without anaesthesia. CPR was continued as effectively as possible given the technical difficulties, first by manual external chest compression and then by internal cardiac compression. The surgeon clamped the left pulmonary artery with his fingers. At this time, a member of the team considered placement of Bispectral Index monitoring (Aspect, A-2000Ô BIS® Monitor) which displayed an initial value of 80. Pupillary light reflexes were still absent bilaterally. As a BIS of 80 corresponds to a ‘normal’ level of awakening, the patient received etomidate 10 mg and sufentanil 75 \( \mu \)g intravenously resulting in a decrease of the BIS to 40. Bleeding stopped, and with CPR haemodynamic stabilization was achieved 15 min later. At the end of surgery, both pupils were still fully dilated and not reacting to light. The
Continuous infusion of epinephrine was progressively reduced to 1.5 mg h⁻¹. One hour later, clinical signs of improvement (limb mobility) were apparent along with an increase in BIS to 90. The patient was transferred to the intensive care unit, weaned from mechanical ventilation at day 4, discharged from the ICU on day 10, and discharged home on the 48th postoperative day. Neurological examination was normal but no psychomotor tests have been performed.

Discussion

This case report shows the potential benefit of BIS monitoring during resuscitation from cardiopulmonary arrest.

The efficacy of CPR is usually based on recovery of consciousness and on the return of neurological signs indicating normal cerebral function. In the absence of such signs, restoration of adequate arterial pressure and a normal end-tidal carbon dioxide level indicate that CPR manoeuvres are effective. The clinical finding of bilateral pupillary dilation with loss of pupillary light reflexes is a late sign of ischaemic brain injury but was of little prognostic value in this case as it may be due to epinephrine administration. The availability of a device providing direct signs of cerebral oxygenation would be useful.

It is uncommon for cardiac arrest to occur in a patient being monitored by an electroencephalogram (EEG). Such a case was reported by Losasso and colleagues, in a patient undergoing carotid endarterectomy who developed asystole during surgical manipulation of the carotid artery. The EEG showed generalized suppression approximately 20 s after the onset of asystole, and low-voltage high-frequency activity after initiation of manual chest compression. Successful resuscitation was associated with the return of an EEG similar to the recording obtained just before the asystole, which had lasted 2 min. The same 10- to 15-s delay between cardiac arrest and the onset of EEG changes had been reported previously. The use of compressed spectral array EEG monitoring during cardiac arrest and resuscitation has also been reported by Young and colleagues.

Recently, changes in the BIS during a hypovolaemic cardiac arrest occurring 4 min after the start of sternotomy were reported. Acute changes in the EEG spectrum lagged behind the decrease in arterial pressure, probably because of the smoothing algorithm used to calculate the BIS cerebral autoregulation causing a lag between the decrease in arterial pressure, the decrease in cerebral blood flow and brain dysfunction may have also been responsible. In the report by England, the BIS returned to the pre-cardiac arrest value once adequate cerebral blood flow had been restored.

The BIS used during this incident is widely available in the operating theatre and provides useful information on the patient’s hypnotic state. While there is no proven correlation between the postoperative condition of the patient condition and to BIS values recorded during an emergency, our case report emphasizes the potential value of BIS monitoring during cardiac arrest.

A high BIS value reflects cerebral activity and should encourage the team to continue CPR; a low BIS is much more difficult to interpret and cannot be used as a reason to stop it.

References

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