

Bispectral analysis in medical-surgical ICU

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ABSTRACT

The effectiveness of sedation in the ICU is routinely assessed by subjective monitoring of the patient's clinical condition or by using the monitors. The aim of our study was to review the monitoring of sedation using bispectral analysis (BIS) in medical-surgical ICU. A retrospective analysis of patients who were treated in the ICU from 2008 to 2014 was made. The data of 104 patients were analyzed. The average values of age are 54.38 (SD \pm 18.93; median 58). 39 (37.5%) of the patients died. The patients were referred to the ICU from medical (37), surgical departments (23) and traumatology (44). The patients were treated in the ICU for 13.84 days (SD \pm 17.29; median 8). The burst suppression pattern was noticed in 31 (29.8%) patients. Delirium occurred in 3 patients after the separation from the ventilator. In heterogeneous groups of patients, in which BIS was applied, it is not possible to make certain conclusions. The cost of the method unfortunately limits its wider usage. It is necessary to wait for the results of future studies which will set clear indications for the use of BIS in certain groups of patients.

INTRODUCTION

The state of hypnosis, analgesia and areflexia is one segment of treating a patient connected to the respirator in the intensive care unit (ICU). (1) Patients in the ICU often need to be well-sedated and the sedation has to be monitored. The effectiveness of the sedation is routinely assessed by subjective monitoring of the patient's clinical condition or by using different monitors (EEG, evoked potentials, bispectral analysis, entropy). Signs such as tachycardia,

bradycardia, hypertension, hypotension, sweating, tearing, changes in pupil width, the appearance of movement of body parts, opening the eyes (position of eyelids?) can be the result of a disease, the administration of drugs, but also a consequence of present wakefulness. These signs are especially important for clinicians if a patient is relaxed. The patient may be awake despite the applied sedation. The causes of patients' wakefulness in the ICU are associated with sedation and sedation procedures, technical problems with devices for drug delivery, wrong administration of sedation, increased need for sedation and other reasons. Deep sedation is often associated with various complications that are observed after waking the patients. The aim of our study was to review the monitoring of sedation using bispectral analysis in the medical-surgical ICU of General Hospital Karlovac.

Key words: bispectral index, critical care, monitoring, sedation

MATERIALS AND METHODS

A retrospective analysis of patients who were treated in the medical-surgical ICU from 2008 to 2014 was made. The methods of descriptive statistics covered the demographic characteristics of the patients (age, sex, body weight, height, BMI), diagnosis, scores at the admission and discharge, the outcomes of treatment, diagnosis of patients, a number of days of treatment in the hospital and in the ICU. We will analyze the flow of BIS values in some patients with reference to burst suppression and the development of psychomotor restlessness and delirium.

RESULTS

The number of patients on which BIS analysis had been applied from 2009 to 2014 is shown in table 1.

The data of 104 patients (32 women and 72 men) were analyzed. The average values of age were 54.38 (SD \pm 18.93; median 58). 39 (37.5%) of the 104 patients died. The patients were referred to the ICU from medical (37), surgical departments (23) and traumatology (44). BIS was analyzed in 104 patients, burst suppression was noticed in 31 (29.8%) patients. After the separation from the ventilator delirium occurred in 3 patients in which burst suppression was noticed. SASP II score at admission was 42.43 (SD \pm 13.79; median 43) and at discharge it was 26.85 (SD \pm 19.63; median 19). The patients were treated in the ICU for 13.84 days (SD \pm 17.29; median 8), and in the hospital for 23.06 days (SD \pm 25.30; median 13).

DISCUSSION

The degree of sedation depends on pathological disorders and forms of treatment of the patients in the ICU. Clinical practice uses different scales of sedation for the assessment of sedation, which means that there is no one best scale for this. The oldest, and the best known here, as well as the most widely used assessment scale of the degree of sedation is the Ramsay scale. After the Ramsay scale, with the introduction of other parameters, a number of new and extended (according to the parameters) scales emerged for assessing the depth of sedation.

The sedation has to, often in the critically ill, who are intubated and connected to a ventilator, ensure a complete loss of con-

nection between the patient and the environment or decrease the patient's response to external stimuli. Insufficiently sedated patients who were connected to a ventilator or had been subjected to unpleasant and painful diagnostic and therapeutic procedures have unpleasant experiences. It is obvious that a detailed clinical assessment of the state of consciousness is not possible without measuring cortical electrical activity because of a number of subjective reasons (personal, professional, social, others). Measuring the electrical activity of the cortex will allow a more detailed and precise evaluation of the efficiency of sedatives and anaesthetics. For many years, applying the EEG in the ICU was not possible because of poor technical solutions of the devices themselves. Technical development has enabled the application of the EEG in the ICU, which allowed the clinician to monitor the state of consciousness during sedation and apply general anaesthesia. The complex processing of electroencephalograms (bispectral analysis, power spectral analysis, time domain analysis) created a device that can present drug-depressed electrical activity of the frontal part of the brain as a number - the bispectral index.

The comparison of two techniques (state entropy and the bispectral index during the analysis of identical electroencephalogram signals) showed that there is an influence of muscle electrical activity in both methods. In comparison with BIS, the entropy showed more false information about the clinical condition of the transition between consciousness and unconsciousness. (2) The bispectral index which monitors the depth of sedation and the state of mind is the main landmark for the doctors in the ICU. The bispectral index is the result of the hypnotic effect of intravenous and inhalation anaesthetics and correlates with the depth of sedation. The range of values of the BIS score is from 100 (conscious state of mind) to 0 (no electrical activity of the cortex of the brain - burst suppression). The reason for BIS is maintaining and monitoring the necessary depth of anaesthesia and avoiding waking. Values between 70 and 80 present the sedation state and 40 to 60 present the clinical state of anaesthesia.

We most commonly used BIS in critically ill neurological patients or in critical patients connected to a ventilator in the state of sepsis and MODS. De Deyn and his colleagues wrote in the historical overview in

1999 that BIS is the best predictor of the depth of anaesthesia during surgery. (3) They noticed that BIS gave a good insight into the state of deep sedation (BIS scores <60) in 15 out of 18 patients who did not respond to standard clinical stimulation in the ICU. The comparison of the clinical Richmond agitation sedation scale (RASS) with paraclinical methods (BIS, entropy) showed a good correlation in patients on mechanical ventilation. (4) A strong correlation between EEG spectral and bispectral parameters was proven. The use of BIS improved (slightly improves) the assessment of a shallow or deep level of sedation in ICU patients. Monitoring the sedation with BIS in polytraumatized patients can reduce the agitation, the risk of extubation and the number of days in the ICU treatment. It was noted that the discrepancy in values of clinical score, which indicates deep sedation in patients on mechanical ventilation, and a high value of BIS in these patients may suggest a faster weaning from the respirator.

It was shown that the use of BIS during neuromuscular blockade and deep sedation, when the clinical evaluation of the depth of sedation is not possible, can help to determine the degree of sedation. (1) However, the research in a heterogeneous group of patients with low levels of consciousness showed no correlation of the Sedation-Agitation Scale (SAS) with BIS, so the authors did not recommend the routine use of BIS. (5) The causes of low correlation of SAS and BIS are present muscle activity of patients, artefacts and monitor software. Even after cardiac surgery the application of processed EEG monitors for monitoring patients is not recommended. BIS electrodes are placed frontally (on the forehead). A significant difference was observed between the BIS scores of frontally and occipitally (back of the head) placed BIS electrodes during the induction and maintenance of propofol-remifentanyl anaesthesia. (6)

The difference of BIS score during the recovery from anaesthesia was not observed. This research may help in clinical practice in the intensive care cases when it is not possible to set a frontal BIS electrode.

We observed burst suppression in 15 cases. 9 patients died and 6 survived. In 3 patients, we observed a delirium after the separation from the ventilator. A prolonged exposure to anaesthetics can cause neurotoxicity and postoperative cognitive dysfunction (POCD). The application of

the bispectral index (BIS) facilitates anaesthetic titration and was showed to reduce propofol delivery by 21%. (7) It was estimated that in 1,000 elderly patients the titration of anaesthesia using the BIS monitoring (BIS score 40-60) would be prevented in 23 patients with POCD, and delirium in 83. The titration of anaesthetics with BIS during the sedation is associated with a lower incidence of postoperative delirium than in the patients whose depth of anaesthesia was assessed using clinical parameters. The period of electric silencing (burst suppression) during a coma, which is measured by EEG, is an independent factor that indicates the frequency of incidence of neurological disorders, such as delirium, but also the recovery period from a coma. (8) The frequency of post-comatose delirium is common. 61% of patients with post-comatose delirium were observed in the medical and surgical ICU. Short-term condition of burst suppression that lasted 6.4 minutes (range: 1 to 58 minutes) was observed in most of these patients during the treatment. In the group of patients who developed delirium a significantly higher mortality rate was observed and the length of stay in the ICU and the hospital treatment are longer. We used BIS in a heterogeneous group of patients in our medical-surgical ICU. We monitored the neurological condition of sedated patients with different pathologies. BIS was used in monitoring sedated patients after acute cardiac arrest as well as in the application of therapeutic hypothermia. (9) It was observed that in 48% of patients with favourable neurological outcome after 6 months BIS values during the first 24 hours of surveillance were significantly higher (38 ± 9) than in patients with poor outcome (17 ± 12). The results of multivariate analyses (in multivariable analyses including clinical characteristics) showed that BIS may be a predictor of neurological outcome in patients after cardiac arrest and the application of therapeutic hypothermia. The continuous measuring of BIS, over the first 12.5h after the ICU admission, potentially predicts a 6-month neurological outcome after cardiac arrest. The combination of biochemical analyses and BIS pointed towards new possibilities for assessing clinical outcomes of the critically ill in the ICU. BIS may be a better predictor of clinical outcomes than serum neuron-specific enolase (NSE) and S100 protein. However, the evaluation of multimodal prognostication in patients after cardiac arrest showed

that the combined determination of serum level of S100 β and BIS monitoring accurately predicts the outcome after cardiac arrest. (10)

CONCLUSION

The results of research and views on the implementation of BIS differ. Some researchers claim the method has surely improved clinical practice, while others feel that it does not deserve any special attention because they have not noticed its benefit for the patients. It is expected that the application of BIS titration of sedation would be simpler and safer, with less

likelihood of an overdose of anaesthetics and CNS depression, and that the separation from the ventilator and the recovery would be faster. The use of BIS would have to provide cheaper treatment as well. New research which, in addition to the well-being of patients, will take into account the financial results of the method will have to clearly define indications for applying the method in the ICU.

Table 1. The application of bispectral analysis from 2008 to 2014

Years	2008.	2009.	2010.	2011.	2012.	2013.	2014.	2008. - 2014.
Patients BIS	18 (3,28%)	15 (2,86%)	22 (4,20%)	8 (1,73%)	8 (1,86%)	6 (1,47%)	27 (6,63%)	104 (3,15%)
Patients Total	549	524	524	463	430	407	407	3304

BIS - bispectral analysis

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