Received: 1.3.2007 **Accepted: 7.5.2008**

Original Article

Assessment of sedation level in critically ill mechanically ventilated patients: Is bispectral index correlated with Richmond agitation–sedation scale?

Seyed Jalal Hashemi, Hassanali Soltani**, Reyhanak Talakoob***, Bahram Soleymani****, Khadije Zeraatkari*****, Samireh Shahin*******

Abstract

BACKGROUND: The intensivist should be avoided over or under sedation in mechanically ventilated patients. There are controversies in validity of bispectral index (BIS) in the management of intensive care unit (ICU) patients. The aim of this study was to evaluate sedation level in sedated and mechanically ventilated patients in our ICU using BIS and Richmond agitation–sedation scale (RASS, as a valid tool) and to determine the correlation between these two methods of evaluation.

METHODS: Following the institutional research committee approval, we prospectively determined the sedation level in 33 patients aged 20-75 years who were mechanically ventilated and sedated routinely using intravenous diazepam (0.05 – 0.1 mg/kg/6 hr) combined with intravenous morphine (0.05 – 0.1 mg/kg/6 hr) in central ICU of Al-Zahra hospital. In each patient, we assessed BIS (0 to 100) values and also RASS (-5 to +4) twice a day, two hours after receiving systemic sedation in the morning and evening during mechanical ventilation period. Appropriate sedation score was considered -2 and -3 on RASS and 70 to 80 in BIS. Lower or greater values were considered as under- or over-sedation, respectively. Data were analyzed using chi-square and spearman's correlation tests.

RESULTS: In this study, sedation level was assessed in patients using RASS (201 times) and BIS (201 times) methods. The frequency (percent) of under-sedated, appropriately sedated and over-sedated patients with BIS assessments were 121 (60.2%), 35 (17.4%) and 45 (22.4%), respectively. These values for RASS assessments were 196 (97.5%), zero, and 5 (2.5%), respectively. There was a weak correlation between BIS and RASS for determination of sedation level (P = 0, r = 0.245).

CONCLUSIONS: This study showed that most of our ICU patients were under-sedated. BIS was poorly correlated with RASS in assessing the depth of sedation in mechanically ventilated patients.

KEYWORDS: Richmond agitation–sedation scale, sedation, bispectral index, ICU, mechanical ventilation.

JRMS 2008; 13(4): 181-185

The assessment of sedation level in critically ill patients remains a challenge for the intensivists in order to avoid over- or under-sedation phenomena. An essential goal of all critical care physicians should be maintaining an optimal level of sedation for their patients. [1] In mechanically ventilated patients, over-sedation increases morbidity by prolongation of the duration of mechanical ventilation (MV) and under-sedation may

*Associate Professor, Department of Anesthesiology and critical care medicine, Isfahan University of Medical Sciences, Isfahan, Iran. e-mail: J_hashemi@med.mui.ac.ir (Corresponding Author)
**Professor, Department of Anesthesiology and critical care medicine, Isfahan University of Medical Sciences, Isfahan, Iran.
***Associate Professor, Department of Anesthesiology and critical care medicine, Isfahan University of Medical Sciences, Isfahan, Iran.
****Assistant Professor, Department of Biostatistics and Epidemiology, Isfahan University of Medical Sciences, Isfahan, Iran.
*****Scientific Member, Department of Medical Surgical Nursery, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.
******Head Nurse of Al-Zahra central ICU, Isfahan, Iran.

favour life-threatening events such as accidental extubation. [2] The monitoring of the desired level of sedation will help avoidance of over- and under-sedation and may ultimately improve the outcome of the patients. [3] Various scales to assess level of sedation in critically ill patients have been developed including: Ramsy sedation scale,[4,5] Richmond agitation–sedation scale (RASS),[6] sedation agitation scale (SAS),[7] Cook scale, modified GCS and alertness sedation scale.[8] The reliability of bispectral index (BIS) as an electroencephalographic device for assessment of sedation level in critically ill mechanically ventilated patients was confirmed in some studies.[4,7,9-11] Inversely, one study showed that BIS was not a valuable tool for assessment of sedation level in these patients.[8] BIS is a valid measure of wakefulness after cardiac surgery but electromyogram (EMG) interference may affect the accuracy of BIS for small percentage of patients not receiving neuromuscular blockade.[12] RASS has been proved to be a useful, reliable and valid bedside tool in the management of sedation in ventilated and nonventilated adult ICU patients.[13,14] Recently, Turkmen et al studied the correlation between the RASS and BIS during dexmedetomidine sedation. They concluded that RASS levels significantly correlated with BIS values during dexmedetomidine sedation in critically ill patients requiring mechanical ventilation in ICU.[15] The aim of this study was to assess sedation level in our central ICU patients under MV using RASS (as a valid tool) and to determine its correlation with BIS (as a trial tool) in these patients.

Methods

Following ethics committee approval, in this cross-sectional study we determined the sedation level in 33 patients aged 20 to 75 years who were mechanically ventilated and sedated routinely in central ICU of Al-Zahra medical center. The exclusion criteria were as follow: need to MV less than 24 hours, full support MV, administration of muscle relaxants, history of visual, auditory, musculoskeletal and CNS disturbances, drug abuse and addiction. In each patient we assessed BIS values and also RASS twice a day at times two hours after receiving systemic sedation. Routine systemic sedation was performed using intravenous morphine (0.05 - 0.1 mg/kg/6 hr) and diazepam (0.05 - 0.1 mg/kg/6 hr) based on intensivist clinical judgment. Patients were received both drugs at 8 am and 2 pm and sedation scores were assessed and recorded at 10 am and 4 pm using BIS and RASS till weaning the patients from mechanical ventilation. The BIS and RASS were measured alternatively by 15 minutes intervals for each recording; for example, if the sedation level was first assessed by RASS, the next recording would begin by BIS assessment. After wiping the skin by alcohol, the BIS sensor probe was placed on the patient's forehead and was connected to the BIS monitor (model A-2000, XP platform; Aspect Medical Systems, USA) and impedance test was confirmed. Data were collected by a nurse who was not directly involved in patients care. The BIS is a numeric value from zero (deep sedation) to 100 (awake) derived from complex mathematical analysis of the electroencephalogram. [11] The RASS use a 10 point scale from – 5 (unarousable) to + 4 (combative) (table 1). [13] Appropriate sedation score was considered -2 and -3 on RASS and 70 to 80 on BIS. Lower or greater values were considered as under- or over-sedation, respectively. Data were analyzed using chi-square test, and Spearman and Pierson correlations. Values for quantitative variables were reported as mean ± standard deviation, and for qualitative variables as count and percent. For all tests, statistical significance was assumed if $P<0.05$. SPSS version 12 was used for statistical analysis.

Results

In this cross-sectional study, sedation level was assessed in 33 mechanically ventilated patients using RASS (201 times) and BIS (201 times) till weaning the patients from ventilator in ICU. None of the patients were excluded from the study. The mean age of patients was 51.27 ± 19.38 years and the female to male ratio was 14/19. The two most common underling prob-

lems were thoracotomy (n = 11, 32%) and cardiopulmonary bypass (n = 5, 14%). The other underling problems were included systemic lupus erythematosus, myasthenia gravis, laparotomy, gun shot injury, pancreatitis, diabetes mellitus, lung contusion, ascitis, hyperparathyroidism, gastrointestinal bleeding, blunt trauma, core pulmonale, peritoneal mass and pheochromocytoma. The frequency distribution of sedation scores in two methods of assessment is shown in table 1 and figure 1. According to table 1 and figure 1, there was a significant difference between RASS and BIS in frequency distribution of sedation scores (P = 0), and there was a weak correlation between RASS and BIS too (P = 0, r = 0.136). The frequencies of appropriate, over- and under-sedation levels in the two methods of assessment are presented in table 2. This table shows that there was a weak correlation between data reported from BIS and RASS according to the sedation level.

Table 1. The frequency of distributions of sedation scores using RASS and BIS.

RASS		BIS	
Score	**N (%)**	**Score**	**N (%)**
-5	3 (1.5)	0-9	0
-4	2 (1)	10-19	0
-3	0	20-29	0
-2	0	30-39	2 (1)
-1	1 (0.5)	40-49	9 (4.5)
0	82 (40.6)	50-59	9 (4.5)
+1	102 (51)	60-69	25 (12.4)
+2	7 (3.5)	70-79	35 (17.4)
+3	4 (2)	80-89	67 (33.8)
+4	0	90-100	53 (26.4)
Total	201 (100)	Total	201 (100)

P = 0.000 (chi-square), r = 0.136 (Spearman correlation).

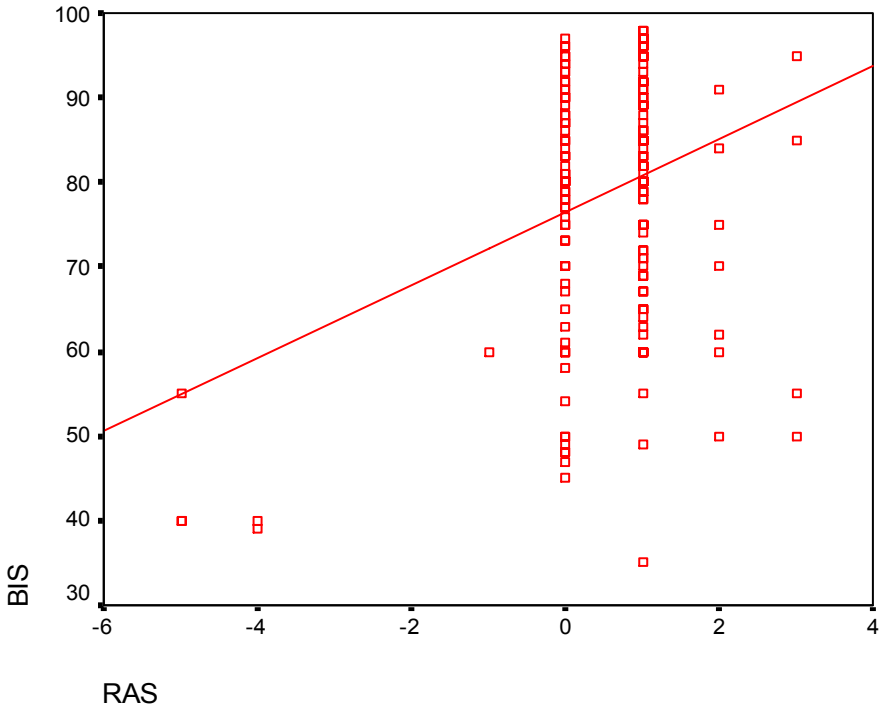

Figure 1. Scatter graph of distribution of sedation scores in RASS and BIS. P = 0.000, r = 0.136 (Spearman correlation).

Table 2. The frequency of appropriate, over- and under- sedation levels in RASS and BIS (N, %).

RASS \ BIS	Over-sedation	Appropriate sedation	Under-sedation	Total
Over sedation	5 (100)	0	0	5 (100)
Appropriation sedation	0	0	0	0
Under sedation	40 (20.4)	35 (17.9)	121 (61.7)	196 (100)
Total	45 (22.4)	35 (17.4)	121 (60.2)	201 (100)

P = 0.001 (chi-square), r=0.245 (Pierson correlation).

Discussion

The current study demonstrated that the sedation level in mechanically ventilated patients in our ICU was mostly inappropriate and the patients were commonly under-sedated. Pronovost and co-workers showed that the median percentage of days in which mechanically ventilated patients received appropriate sedation was 64%. Therefore, they stated that in order to improve quality of care, we must measure our performance. By improving performance on these measures, we may reduce mortality, morbidity and, duration of ICU stay.[16] Providing an optimal level of sedation is an important part of the management of mechanically ventilated, critically ill patients. Given these facts, revision of pharmacological sedation protocols should be considered in our ICU. In this study, data extracted from BIS and RASS tools showed a poor correlation between the two methods of sedation assessment. Our results are comparable with the findings of De Deyne et al that critical illness itself may alter the BIS and that target BIS values may differ between anesthesia and critical care-based applications.[17] The correlation between clinical assessment and BIS for determination of sedation level in critically ill patients is controversial. Some authors believed that BIS is a useful tool for assessment of patients' sedation.[4,9,18,19] Frenzel et al evaluated the validity of BIS on 19 mechanically ventilated patients and concluded that BIS is not suitable for monitoring sedation in this heterogeneous group of surgical ICU patients.[8] A recent study reported a good correlation between BIS and SAS in assessing the depth of sedation in patients under MV and sedated using propofol infusion.[11] The difference between the results of the present study and the above-mentioned report may be due to application of different clinical assessments of patients sedation. Our study compared RASS with BIS, but the above-mentioned study reported comparison between SAS and BIS. There are some studies that do not confirm our results.[6,12-14] However, interpreting the literature on the usefulness of the BIS as an electronic tool for patients sedation evaluation in the ICU is difficult for some reasons including heterogeneous population, different methods of collecting BIS data, and use of different versions of BIS software and hardware.[20] Unavailability for more frequent measurements of BIS and RASS during each day was the major limitation of our study.

Conclusions

This study demonstrated that most of our central ICU patients were under-sedated. BIS was poorly correlated with RASS in assessing the depth of sedation in mechanically ventilated patients. More studies should be done in this regard on similar patients.

References

1. Liu LL, Gropper MA. **Postoperative analgesia and sedation in the adult intensive care unit: a guide to drug selection.** *Drugs* 2003; 63**:** 755-767.
2. Mantz J. **[Evaluation of the depth of sedation in neurocritical care: clinical scales, electrophysiological methods and BIS].** *Ann Fr Anesth Reanim* 2004; 23**:** 535-540.
3. Tonner PH, Weiler N, Paris A, Scholz J. **Sedation and analgesia in the intensive care unit.** *Curr Opin Anaesthesiol* 2003; 16**:** 113-121.
4. Mondello E, Panasiti R, Siliotti R, Floridia D, David A, Trimarchi G. **BIS and Ramsay score in critically ill patient: what future?** *Minerva Anestesiol* 2002; 68**:** 37-43.
5. Ramsay MA, Savege TM, Simpson BR, Goodwin R. **Controlled sedation with alphaxalone-alphadolone.** *Br Med J* 1974; 2**:** 656-659.
6. Hogarth DK, Hall J. **Management of sedation in mechanically ventilated patients.** *Curr Opin Crit Care* 2004; 10**:** 40-46.
7. Simmons LE, Riker RR, Prato BS, Fraser GL. **Assessing sedation during intensive care unit mechanical ventilation with the Bispectral Index and the Sedation-Agitation Scale.** *Crit Care Med* 1999; 27**:** 1499-1504.
8. Frenzel D, Greim CA, Sommer C, Bauerle K, Roewer N. **Is the bispectral index appropriate for monitoring the sedation level of mechanically ventilated surgical ICU patients?** *Intensive Care Med* 2002; 28**:** 178-183.
9. Berkenbosch JW, Fichter CR, Tobias JD. **The correlation of the bispectral index monitor with clinical sedation scores during mechanical ventilation in the pediatric intensive care unit.** *Anesth Analg* 2002; 94**:** 506-511.
10. Riker RR, Fraser GL, Wilkins ML. **Comparing the bispectral index and suppression ratio with burst suppression of the electroencephalogram during pentobarbital infusions in adult intensive care patients.** *Pharmacotherapy* 2003; 23**:** 1087-1093.
11. Ma PL, Zhao JZ, Su JW, Li Q, Wang Y. **[Comparison of reliability of bispectral index and sedation-agitation scale in assessing the depth of sedation in patients treated with mechanical ventilation].** *Zhongguo Wei Zhong Bing Ji Jiu Yi Xue* 2006; 18**:** 323-326.
12. Riker RR, Fraser GL, Simmons LE, Wilkins ML. **Validating the Sedation-Agitation Scale with the Bispectral Index and Visual Analog Scale in adult ICU patients after cardiac surgery.** *Intensive Care Med* 2001; 27**:** 853-858.
13. Sessler CN, Gosnell MS, Grap MJ, Brophy GM, O'Neal PV, Keane KA *et al*. **The Richmond Agitation-Sedation Scale: validity and reliability in adult intensive care unit patients.** *Am J Respir Crit Care Med* 2002; 166**:** 1338-1344.
14. Ely EW, Truman B, Shintani A, Thomason JW, Wheeler AP, Gordon S *et al*. **Monitoring sedation status over time in ICU patients: reliability and validity of the Richmond Agitation-Sedation Scale (RASS).** *JAMA* 2003; 289**:** 2983-2991.
15. Turkmen A, Altan A, Turgut N, Vatansever S, Gokkaya S. **The correlation between the Richmond agitation-sedation scale and bispectral index during dexmedetomidine sedation.** *Eur J Anaesthesiol* 2006; 23**:** 300-304.
16. Pronovost PJ, Berenholtz SM, Ngo K, McDowell M, Holzmueller C, Haraden C *et al*. **Developing and pilot testing quality indicators in the intensive care unit.** *J Crit Care* 2003; 18**:** 145-155.
17. De Deyne C, Struys M, Decruyenaere J, Creupelandt J, Hoste E, Colardyn F. **Use of continuous bispectral EEG monitoring to assess depth of sedation in ICU patients.** *Intensive Care Med* 1998; 24**:** 1294-1298.
18. Ball J. **How useful is the bispectral index in the management of ICU patients?** *Minerva Anestesiol* 2002; 68**:** 248-251.
19. Adam N, Sebel PS. **BIS monitoring: awareness and catastrophic events.** *Semin Cardiothorac Vasc Anesth* 2004; 8**:** 9-12.
20. LeBlanc JM, Dasta JF, Kane-Gill SL. **Role of the bispectral index in sedation monitoring in the ICU.** *Ann Pharmacother* 2006; 40**:** 490-500.