BISPECTRAL INDEX IN ICU: CORRELATION WITH RAMSAY SCORE ON ASSESSMENT OF SEDATION LEVEL

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ABSTRACT. Objective. The assessment of sedation level in critically ill patient remains a challenge for the intensivists in order to avoid over- or under-sedation phenomena. Scoring systems commonly used still show some limitation; the introduction of Bispectral Index (an EEG parameter) could bring potential advantages in monitoring sedation. According to the reports, Bispectral Index correlates with levels of sedation on the Ramsay Scale. We report our personal experience in this topic. **Methods.** Twenty patients, diagnosed with chronic obstructive pulmonary disease (COPD), were involved in the study. For an optimal adaptation to respiratory prothesis, they were sedated (with Propofol by continuous infusion at an initial dose of 2 mg/kg/h, which could be modulated with steps of 0.5 mg/kg/h), in order to maintain a Ramsay score of 4–5. BIS value was continuously recorded, and manually calculated on a mean average of a minute during the measuring of Ramsay score (T0) and every 30′ for 24 hours on par with Ramsay score. EEG, SpO_2, non invasive arterial pressure, ventilatory module, $_{ET}CO_2$, F_IO_2 were also recorded. For the statistic analysis, Friedman test and Spearman coefficient were utilized. Values of $p < 0.05$ were considered significant. **Results.** 980 observations were carried out. The variation range of Ramsay Score was between 2 and 6. BIS range varied from 34 to 98. Statistic analysis of the data obtained pointed out some significative correlations, particularly between Ramsay Score and BIS ($p < 0.01$), and between BIS and dosage of Propofol ($p < 0.01$). **Conclusions.** The results of the study are consistent with those found in the literature on this topic of study. In fact, this study demonstrates the utility of BIS to track levels of consciousness in ICU patients while still maintaining the use of the score systems to care for ICU patients.

KEY WORDS. Sedation scores, intensive care unit, bispectral index.

INTRODUCTION

The patients who come to the intensive care unit need sedation for a variety of reasons which include anxiety, pain, tolerance of the endotracheal tube, tolerating the ventilator; in any case, the degree of sedation has to be constantly monitored and maintained at such a level so as not to depress the patient's response to therapy.

Therefore the main task of the intensivists is to find a proper pharmacologic balance mix to be adapted to the various clinical situations and to the different therapeutic stages of the critically ill patient so as to maintain a balance between the correct level of consciousness and the absence of anxiety and pain.

It is useful to consider a first distinction between:

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- A subpopulation who requires deep sedation (and eventual muscular paralysis);
- A subpopulation in which, for several reasons, it is necessary to carry out a certain degree of sedation, but whose target level varies from patient to patient due to pharmacodynamic variability.

In this sense, no "agreement" has been reached so far as regards the optimal cognitive level in the critically ill patient. The best possible solution seems to be that of dosing the pharmacological intervention on the basis of an objective clinical examination, but which is easily recognizable and can be catologued by the ICU staff.

In short, is it possible to establish whether a patient is over- or under-sedated and to define the reference limits to reach this defined end-point?

It is worthwhile to attempt to define scientific protocols which can be clinically validated as effective and predictive of reaching the clinical end point desired.

Numerous methods have been utilized in ICU and reported in literature:

– Subjective methods (scoring systems);
– Objective methods (measurement of the plasma concentration of the drug, measurement of the physiological variables and physical methods).

If we speak of sedation scores, the Ramsay score has been, and still is, the most commonly used to monitor the level of sedation in ICU [1–3] (Table 1).

This technique employs a numeric scale through which an observer can catalogue the patient's response to a verbal command. The method is efficacious for those patients who are able to respond to a stimulus whether it be vocal, tactile or nociceptive. The observer evaluates the modalities of the patient's response to the stimulus and gives him a score.

Other scoring systems have been developed near to the Ramsay one: the Sedation-Agitation-Scale (SAS) [4], the Bion Scale [5], the Addenbrooke Hospital Scale [6], the Cambridge Sedation Score [7], the Vancouver Sedative Recovery Scale [8], the Harris Scale [9], the Comfort Scale [10], the New Sheffield Sedation Scale [11], the Motor Assessment Activity Scale [12] and the Brussel Sedation Score [13].

The variety of these scores highlights the different methods used to evaluate sedation. There is no universally used method to evaluate sedation which has been demonstrated to be the most cost-effective for this purpose.

On the other hand, turning to the physiological variables, the pupillary reactions or tearing, the perspiration, the depth and the breathing frequency, which are useful indicators of adequate anaesthesia, can be misleading in the critically ill patient, where those elements can be the result of underlying pathological processes or of therapeutic regimes.

Table 1. Ramsay sedation score (1974)

Awake
1. Patient anxious, agitated or restless
2. Patient cooperative, orientated or tranquil
3. Patient responds to command only
Asleep levels depend on the patient's response to a light glabellar tap
4. Brisk response
5. Sluggish response
6. No response

But it is in the light of recent technological progress that the analysis of the objective methods merits particular attention.

A new method, based on the EEG called "Bispectral Index" (BIS) is available today to measure the patient's response to the hypnotic/sedative effects of the drugs.

It deals with a parameter derived from the electroencephalographic analysis rapresented by a numeric value between 0 (deeply sedated patient) and 100 (awake state). It is an empiric measurement, statistically derived, based on a large EEG database, which also includes the electromyographic activity of the facial muscles [14], recorded in volunteers and patients who were given one or more anaesthetic drugs.

A multicenter study of volunteers has examined the correlation between BIS and sedative scores, BIS and memory tests during the administering of propofol, midazolam, opiates and isoflurane, utilized as the only anaesthetic agents or in combination [15].

A BIS value between 50 and 60 has been associated with a very low probability of response to verbal commands [16]. The loss of consciousness threshold was higher and corresponded to a value of about 70. The patients who maintain BIS values under 70 have a low probability of wakening. Therefore maintaining a range between 45 and 60, a high degree of probability that the patient is unconscious. BIS values under 45 probably show an excessive depth of hypnosis, at least if correlated to the aim of avoiding intraoperative wakening [17].

This new method also presents potential advantages in the monitoring of sedation. Preliminary studies on its use in the ICU reveal a good correlation between BIS and Ramsay score [18].

In reality, few data are available today on the validity of BIS in the evaluation of the degree of sedation in ICU: even if they did not make any reference to the type and to the quantity of sedative administered, Shah et al. [19], found that the Ramsay value equal to 6 corresponded to a mean value of BIS at 61.7 (± 3.1) from which it can be deduced that the values under 60 would correspond to a degree of excessive sedation. Other studies point out the great interindividual variability of the Bispectral Index within the same level of sedation, measured with scoring systems which would make its employment of little use in monitoring sedation in ICU [20].

In conclusion De Deyne et al. [21] affirm the need to carry out further studies in order to define better the future role of BIS in giving a measurement of the sedation level and of the pharmacological effects of sedatives in critically ill patients.

In our study we wanted to evaluate the correlations existing between Ramsay score and BIS and the fluctuations of this with the variations of the dosage of sedatives for its possible employment in ICU.

MATERIALS AND METHODS

Twenty patients were involved in the study; they came to our Intensive Care Unit for COPD, and underwent mechanical ventilation.

The patients (13 males and 7 females; mean age ± SD: 63 ± 5 years) have undergone a standardized sedation regime for 24 hrs.

The aim of sedation was maintaining a Ramsay score (Table 1) equal to 4–5, in order to make the mechanical ventilation possible without creating any discomfort to the patients.

All the patients were sedated with Propofol by continuous infusion at an initial dose of 2 mg/kg/h, which could be modulated with steps of 0.5 mg/kg/h, to satisfy the above requirements.

No patient demonstrated any signs of neurological damage, kidney or hepatic failure or any metabolic derangements that would alter the clearance of drugs.

The BIS score was measured by means of an Aspect-2000 BIS monitor with frontal assemblage. The quality index of the signal, automatically calculated by the Aspect-2000 monitor was used to evaluate the quality of the measured signal considering only those measurements in which the SQI was between 80 and 100%.

Besides the continuous recording, the BIS value was calculated manually on a mean average of a minute during the measuring of the Ramsay score (T0) and every 30′ for 24 hrs on par with the Ramsay score.

EEG, SpO_2, non invasive arterial pressure, ventilatory module, $_{ET}CO_2$ and F_IO_2 were the other parameters recorded during the study.

In regards to the statistical analysis, the data are presented as mean and SD. For the assessment of the hypothesis, statistical non parametric methods were utilized. In particular, Friedman test was utilized among detection times for all parameters, and non parametric multiple comparisons were utilized in presence of significant correlations. The Spearman coefficient was utilized to measure the degree of association among the series of data measured on a categorial scale.

Values of $p < 0.05$ were considered significant.

RESULTS

A total of 980 observations were carried out.

All patients were maintained in an IPPV ventilatory modality.

The variation range of the Ramsay score (in the course of the 980 observations was between 2 (co-operating, oriented and tranquil patients) and 6 (unrousable patients)).

The BIS range obtained varied from 34 to 98.

That patients adapted well to the ventilatory module applied to them is pointed out by a significant reduction, over 24 hrs, of the $_{ET}CO_2$ (from 54 ± 7 mmHg to 39 ± 6 mmHg) and a significant increase of the SaO_2 (from 88 ± 4% to 96 ± 1.9%) (Table 2).

The statistic analysis of all the data obtained from the study, pointed out the following significant correlations ($p < 0.01$):

- Between Ramsay score and BIS (Figure 1): with the increase of the Ramsay score there was a progressive decrease in the BIS score (Ramsay score = 2, BIS = 88 ± 15.1; Ramsay score = 6, BIS = 52.2 ± 10.7);
- Between BIS and dosage of Propofol (Figure 2);
- Between Ramsay score and maximum arterial blood pressure (MABP) (Figure 3): with a Ramsay score = 2, PA = 143.4 ± 18.7 mmHg; with a Ramsay score = 6, PA = 120 ± 9.5 mmHg;
- Finally, the existence of a coefficient of significant negative correlation between the values of Ramsay Score and of BIS was observed. This finding is not retrieved in three observations only (12th–14th and 19th hours), however not significant (Figure 4).

DISCUSSION

The importance of adapting the various methods of scoring sedation in a cost-effective and accurate manner has been noted by Ramsay [22] and Rosser [23]. They have identified the need to develop a scoring system that is universally accepted and used.

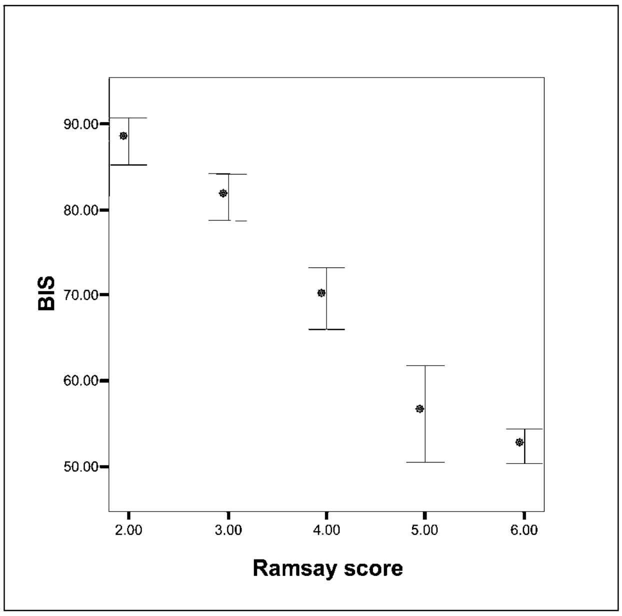
Table 2. Statistical analysis: mean, SD and CI 95% of SaO_2 and ETCO$_2$ values during the detection

Detection times	SaO_2 (%)				ETCO$_2$ (mmHg)			
	Mean	SD	CI 95%	CI 95%	Mean	SD	CI 95%	CI 95%
Basal	88.50	4.77	85.09	91.91	52.50	7.22	47.34	57.66
1/2	90.40	4.35	87.29	93.51	50.80	6.41	46.22	55.38
1 h	91.80	3.08	89.59	94.01	47.90	6.15	43.50	52.30
1 h 1/2	93.10	2.96	90.98	95.22	45.00	5.31	41.20	48.80
2 h	93.80	3.22	91.49	96.11	41.40	5.91	37.17	45.63
2 h 1/2	95.10	3.25	92.78	97.42	40.30	5.83	36.13	44.47
3 h	95.00	2.75	93.03	96.97	40.10	5.45	36.20	44.00
3 h 1/2	95.11	2.77	93.12	97.08	40.90	5.43	37.02	44.78
4 h	95.66	2.41	93.87	97.33	40.10	5.90	35.88	44.32
4 h 1/2	94.62	3.34	92.21	96.99	39.70	5.21	35.97	43.43
5 h	94.50	3.37	92.09	96.91	38.60	5.99	34.32	42.88
5 h 1/2	95.64	2.46	93.84	97.36	39.50	5.91	35.27	43.73
6 h	95.16	3.07	92.90	97.30	38.80	5.87	34.60	43.00
6 h 1/2	95.20	2.62	93.33	97.07	38.70	5.70	34.62	42.78
7 h	95.20	3.49	92.70	97.70	37.40	4.88	33.91	40.89
7 h 1/2	95.01	3.46	92.52	97.48	37.90	3.98	35.05	40.75
8 h	95.16	3.28	92.75	97.45	37.40	6.00	33.11	41.69
8 h 1/2	94.76	3.20	92.41	96.99	37.70	5.03	34.10	41.30
9 h	94.44	3.31	92.03	96.77	37.40	4.81	33.96	40.84
9 h 1/2	94.75	3.09	92.49	96.91	36.80	5.03	33.20	40.40
10 h	95.00	3.86	92.24	97.76	38.00	5.10	34.35	41.65
10 h 1/2	94.91	3.28	92.55	97.25	37.70	5.58	33.71	41.69
11 h	94.68	3.53	92.07	97.13	38.70	5.14	35.02	42.38
11 h 1/2	96.79	2.11	95.19	98.21	39.70	6.15	35.30	44.10
12 h	95.64	1.90	94.24	96.96	37.50	5.42	33.62	41.38
12 h 1/2	95.56	2.46	93.74	97.26	38.10	5.00	34.52	41.68
13 h	95.44	2.32	93.74	97.06	37.50	5.34	33.68	41.32
13 h 1/2	94.66	3.50	92.09	97.11	38.10	5.86	33.91	42.29
14 h	94.51	4.01	91.63	97.37	39.60	6.85	34.70	44.50
14 h 1/2	95.01	2.83	92.98	97.02	38.80	6.44	34.19	43.41
15 h	94.82	2.66	92.90	96.70	36.80	5.92	32.56	41.04
15 h 1/2	95.34	2.21	93.72	96.88	37.70	5.31	33.90	41.50
16 h	95.10	2.28	93.47	96.73	38.00	5.58	34.01	41.99
16 h 1/2	95.22	2.04	93.74	96.66	39.40	5.36	35.57	43.23
17 h	95.14	2.60	93.24	96.96	37.70	5.62	33.68	41.72
17 h 1/2	95.66	2.37	93.91	97.29	37.70	6.00	33.41	41.99
18 h	95.78	2.50	93.91	97.49	39.70	6.80	34.84	44.56
18 h 1/2	93.86	4.26	90.75	96.85	41.70	9.72	34.75	48.65
19 h	95.54	2.42	93.77	97.23	40.70	8.30	34.76	46.64
19 h 1/2	95.05	3.37	92.59	97.41	40.60	8.36	34.62	46.58
20 h	95.51	2.72	93.56	97.44	41.60	9.29	34.96	48.24
20 h 1/2	95.48	2.80	93.40	97.40	43.00	10.76	35.30	50.70
21 h	96.09	2.36	94.31	97.69	40.10	7.98	4.39	45.81
21 h 1/2	95.37	2.50	93.51	97.09	40.00	7.83	34.40	45.60
22 h	95.06	3.13	92.76	97.24	38.80	7.39	33.51	44.09
22 h 1/2	95.41	2.59	93.55	97.25	40.20	7.44	34.88	45.52
23 h	95.79	3.06	93.51	97.89	40.80	8.47	34.74	46.86
23 h 1/2	95.81	2.57	93.96	97.64	39.10	7.08	34.04	44.16
24 h	96.27	1.93	94.82	97.58	39.80	6.78	34.95	44.65

The table shows a significant increase of SaO_2 and significant decrease of ETCO$_2$.

Ramsay score	Mean	SD	95% C.I.	
2	88.0085	15.1440	85.2475	90.7695
3	81.4234	14.8517	78.6298	84.2170
4	69.6598	17.9013	66.0519	73.2677
5	56.0714	20.9925	50.4496	61.6933
6	52.2870	10.7304	50.2402	54.3339

The differences are statistically significant.

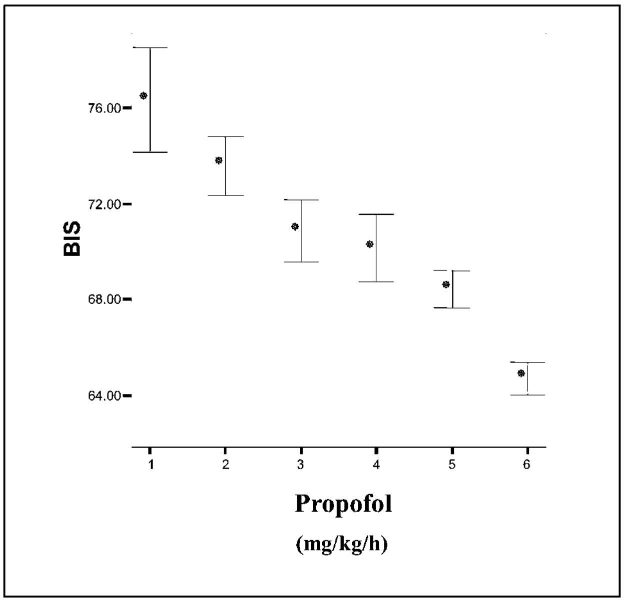


Medium decreasing and correlation of the BIS for different Ramsay Score levels.
The graphic shows a significant correlation (p<0,01) for all levels of Ramsay score except for level 2.

Fig. 1. Mean, SD and CI 95% of Bispectral Index values for each Ramsay Score level.

P (mg/kg/h)	Mean	SD	95% C.I.	
1	76.3566	10.2270	71.8222	80.8911
1.5	73.5900	10.6021	71.1673	76.0127
2	70.8695	11.3335	68.3142	73.4248
2.5	70.1456	9.3628	67.2641	73.0270
3	68.4392	8.9422	66.9284	69.9500
3.5	64.6811	7.9713	63.3191	66.0432

The differences are statistically significant.



Medium decreasing and correlation of the BIS for different level of Propofol dosage.
The graphic shows a significant correlation (p<0,01).

Fig. 2. Mean, SD and CI 95% of Bispectral Index values for each Propofol (P) dosage.

The scoring systems present some problems regarding the reproducibility and validity of results and the difficulty in interpretation of results across studies.

The employment of an objective method, which can give an immediate indication of the sedation level of the patient could resolve this important issue.

Sigl and Chaumon [24] in a review of the main features of BIS, concluded that, in general, a BIS score of 100 reflects the awake state, 80 reflects some sedation, 60 reflects a moderate hypnotic level and 40 a deep hypnotic level.

But the data available so far were for the most part carried out on healthy volunteers [14] or post surgical patients [18, 25] and therefore the conclusions reached in regards to the range of BIS to be considered "optimal" cannot be applied without clinical validation in critically ill patients.

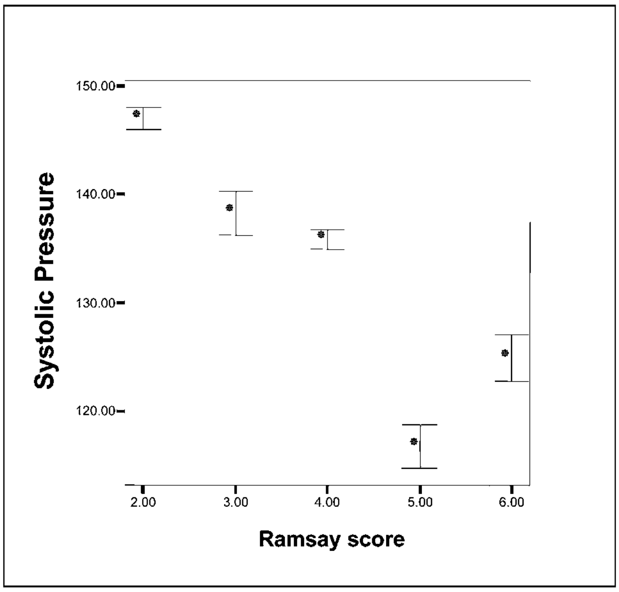
De Deyne et al. [21] in a study carried out on critically ill patients affirm that a BIS of 50–60 is correlated well to the Ramsay score of 6 and that a BIS value under 60 could be "too" deep of a sedation index.

Simmons et al. [26] also conclude that a SAS of 1–2 is correlated to an average BIS of 66 (with a 95% confidence interval (CI) of 60 to 72), similar to the values reported in literature for general anaesthesia, and show how, in the absence of protocols that guide the sedation, the critically ill patients are more deeply sedated.

It can be deduced that higher levels of the Ramsay score are correlated to the low BIS values from the data of our studies. In fact, the mean BIS values for a Ramsay score of 6 were always under 6 (Ramsay = 6, CI of 50.24 to 54.33). For Ramsay score levels equal to 4 and 5, the comparison of a wide BIS variability (with a Ramsay = 4, the CI is of 66.05 to 73.26; with a Ramsay score = 5, the CI is of 50.44 to 61.69) could be explained by the presence of an electromyographic activity in

Ramsay score	Mean	SD	95% C.I.	
2	143.4661	18.7314	140.0511	146.8811
3	135.7658	15.4866	132.8527	138.6788
4	131.4742	17.9066	127.8652	135.0832
5	129.3796	14.9352	126.5307	132.2286
6	120.4286	9.5173	117.3442	123.5129

The differences are statistically significant.



Medium decreasing and correlation of the Systolic Pressure for each Ramsay Score level.
The graphic shows a significant correlation (p<0,01).

Fig. 3. Mean, SD and CI 95% of Systolic pressure (MABP) values for each Ramsay score level.

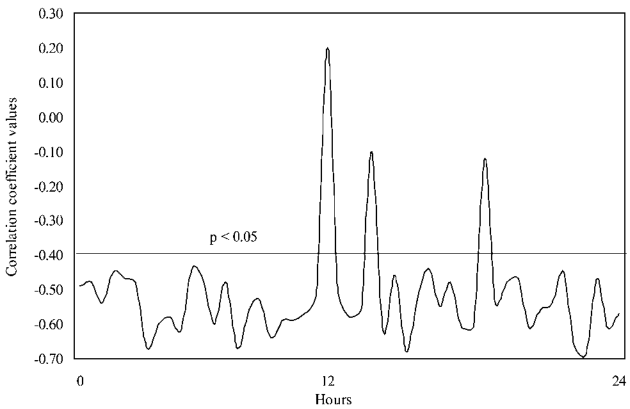


Fig. 4. Rate of the correlation coefficients values of Ramsay score vs BIS during the detection. Correlation values under significance line ($p < 0.05$) show a significant negative correlation.

those patients which alters the data obtained (see the inversion of tendency, even if not significant, at 12th hour). Besides, the correlation with the increasing dosage of Propofol pointed out a progressive and parallele reduction of the BIS score, given that which could constitute an input for the future employment of BIS in the evaluation of the effect of sedative drugs in ICU.

In conclusion, the data obtained from the study, following what has already been presented in literature, seem to demonstrate that BIS can be useful in defining an appropriate sedation level in ICU patients.

Its characteristics, in regards to practicality, accuracy and non invasiveness make it a good method to evaluate the sedation level of ICU patients. More specifically, it can be used to identify potentially dangerous clinical situations of oversedation, notwithstanding the score systems ability to maintain their fundamental role in the management of the critically ill patient.

REFERENCES

1. Avramon MN, White PF. Methods for monitoring the level of sedation. Crit Care Clin 1995; 11: 803–826
2. Ramsay MA, Savage TM, Simpson BR, Goodwin R. Controlled sedation with alphaxone-alphadone. Br Med J 1974; 2: 656–659
3. Riker R, Fraser GL, Cox PM. Continuous infusion of haloperidol controls agitation in critically ill patients. Crit Care Med 1994; 22: 433–440
4. Riker R, Picard ST, Fraser GL. Prospective evaluation of the Sedation-Agitation Scale in adults ICU patients. Chest 1997; 112: 3S: 32–33
5. Bion JF. Sedation and analgesia in the intensive care unit. Hosp Update 1988; 14: 1272–1286
6. Shelly M, Dodds P, Park GR. Assessing sedation. Care of the Critically Ill 1986; 2: 170
7. O'Sullivan G, Park GR. The assessment of sedation in critically ill patients. Clin Intensive Care 1991; 2: 116–122
8. Macnab AJ, Levine M, Glick N, Susan L, Baker-Brown G. A research tool for measurement of recovery from sedation: The Vancouver Sedative Recovery Scale. J Pediatr Surg 1991; 26: 1263–1267
9. Harris CE, O'Donnel C, Macmillan RR, Mostafa SB. Use of propofol by infusion for sedation of patients undergoing haemofiltration: Assessment of the effects of haemofiltration on the level of sedation and on blood propofol concentration. J Drug Dev 1991; 4 (Suppl. 3): 37–39
10. Ambuel B, Hamlett KW, Marx CM, Blumer JL. Assessing distress in pediatric intensive care environments: The COMFORT scale. J Pediatr Psychol 1992; 17: 95–109
11. Laing AS. The applicability of a new sedation scale for intensive care. Intensive Crit Care Nurs 1992; 8: 149–152
12. Devlin JW, Boleski G, Mlynarek M, Nerenz DR, Peterson E, Jankowski M, Horst HM, Zarowitz BJ. Motor Activity Assessment Scale: A valid and reliable sedation

scale for use with mechanically ventilated patients in an adult surgical intensive care unit. Crit Care Med 1999; 27: 1271–1275
13. Detriche O, Berrè J, Massaut J, Vincent J-L. The Brussels sedation scale: Use of a simple clinical sedation scale can avoid excessive sedation in patients undergoing mechanical ventilation in the intensive care unit. Br J Anaesth 1999; 83: 698–701
14. Glass PS, Bloom M, Kearse L, Rosow C, Sebel P, Manberg P. Bispectral analysis measures sedation and memory effects of propofol, midazolam, isoflurane and alfentanil in healthy volunteers. Anesthesiology 1997; 86: 836–847
15. Sebel PS, Lang E, Rampil IJ, White PF, Cork R, Jopling M, Smith NT, Glass PS, Manberg P. A multicenter study of bispectral electroencephalogram analysis for monitoring anesthetic effect. Anesth Analg 1997; 84: 891–899
16. BIS Clinical Reference Manual. Newton Mass: Aspect Medical Systems; 1998
17. Bowdle TA. Bispectral index monitoring. SAMBA www.sambahq.org
18. Shah N, Clack S, Chea F, Tayong M, Anderson C. Does bispectral index of EEG (BIS) correlate with Ramsay sedation score in ICU patients? Anesthesiology 1996; 85: A469
19. Anid YS, Southwood RL, Williams DB, Manghram D, Fitzgerald DJ, Speir WA. Facilitation of early withdrawal from neuromuscular paralysis by bispectral electroencephalographic monitoring of level of sedation [abstract]. Chest 1997; 112: 32S
20. Hidestal J, Luttrop H-H, Reinstrup P. Bispectral index during propofol sedation. Anesthesiology 1999; 91 (3A): A613
21. 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
22. Ramsay MA. Measuring level of sedation in the Intensive Care Unit. JAMA 2000; 284 (4): 441
23. Rosser D, Bion J. Measuring sedation in the ICU: Guidelines on the scales? British Journal of Anaesthesia 1999; 83 (5): 93–94
24. Sigl JC, Chaumon NG. An introduction to bispectral analysis for the electroencephalogram. J Clin Monit 1994; 10: 392–404
25. Triltsch A, Spies C, Lenhart A et al. Bispectral index (BIS) corelates with the Ramsay Sedation Scores in neurosurgical ICU patients. Anesthesiology 1996; 91 (3A): A295
26. 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 (8): 1499–1504