Bispectral Index Monitoring Reduces the Dosage of Propofol and Adverse Events in Sedation for Endobronchial Ultrasound

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Key Words

Adverse drug reactions · Anesthesia · Endobronchial ultrasound · Bispectral index

Abstract

Background: Current guidelines recommend monitoring the anesthetic depth of sedation during respiratory endoscopy by using clinical scales despite their subjective nature and the potential change in the level of sedation caused by frequent stimulation. Monitoring by means of the bispectral index (BIS) has shown its utility in reducing the use of drugs and their adverse events in general anesthesia, but evidence in prolonged sedation is insufficient. **Objective:** Our objective was to evaluate BIS in patients undergoing endobronchial ultrasound (EBUS). **Methods:** A randomized cohort study of 90 patients with mediastinal lymph node involvement and/or lung or mediastinal lesions for whom EBUS was indicated, comparing the modified observer's assessment of alertness/sedation scale clinical evaluation (n = 45) versus the BIS evaluation (n = 45) of sedation with propofol–remifentanyl, was conducted in order to evaluate the clinical parameters, doses used, adverse events, and tolerance of the procedure. **Results:** We found a shorter waking time and a significantly lower dose of total propofol in the BIS group.

Significantly fewer overall adverse events were recorded in the BIS group and included desaturation, hypotension, and bradypnea. Tolerance was better in the BIS group. No significant differences were found in terms of cough, memory of the procedure, or the level of difficulty of EBUS on the part of the pulmonologists. **Conclusions:** BIS monitoring of sedation in EBUS makes it possible to reduce the dosage of propofol, thereby shortening the waking time and reducing adverse events. This form of monitoring should be taken into consideration in the future for systematic use in prolonged sedation, as in the case of EBUS.

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Introduction

Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) has been shown to be an effective tool in the evaluation of malignant and benign enlarged mediastinal and hilar lymph nodes [1–4] and has become the procedure of choice [5–7].

Several studies have shown that EBUS-TBNA requires more time and greater sedation than conventional TBNA (without ultrasound) [3, 8]. Initially, general anesthesia (GA) or deep sedation was used, although moderate seda-

tion (MS) was later considered sufficient [9, 10], with some debate [11–14]. Casal et al. [13] showed no differences in patient tolerance or major complications associated with GA or MS; GA may therefore be a safe alternative in cases of comorbidities or intolerance to MS.

Improvement in the learning curve of pulmonologists has reduced the examination time, and GA is currently being replaced by MS [15, 16], although GA or deep sedation are both accepted in the case of inexperienced pulmonologists or for complete lymph node staging [9].

Two objectives must be achieved in sedation during EBUS: tolerance of the examination with the least possible movement and coughing, while, at the same time, preventing respiratory depression, as airway patency is not maintained by devices such as the endotracheal tube or laryngeal mask airway [17]. Mild-to-moderate sedation with benzodiazepines and opioids [18, 19] is the type of sedation commonly used by pulmonologists, whereas moderate-to-deep sedation with propofol, alone or in association with opioids [11, 20, 21], requires the presence of personnel trained to use these drugs, according to current guidelines [22–25]. Anesthesia protocols vary between hospitals and countries, and no protocol is applied uniformly.

In our hospital, sedation is carried out using propofol and remifentanyl in continuous infusion due to their pharmacokinetic and pharmacodynamic synergies and because these are the two drugs that are being used lately during endoscopy with a high level of satisfaction [17, 26]. Propofol has a narrow therapeutic window, and the addition of an opiate to reduce cough and the dose of propofol may increase the risk of respiratory depression. Appropriate monitoring to prevent the risks of deep sedation is therefore required [27].

Clinical monitoring of sedation using the modified observer's assessment of alertness/sedation (MOAA/S) scale [28] has the disadvantage of requiring frequent stimulation for evaluation as well as its subjectivity. Monitoring of the depth of anesthesia using the bispectral index (BIS) [29, 30] allows us to objectively evaluate the level of sedation achieved and prevent the adverse events of overdose [31, 32]. The BIS monitor has been found to be useful for dosing drugs and reducing recovery time in patients under sedation in diagnostic and therapeutic procedures [33–35]. In fiberoptic bronchoscopy, it has been estimated that BIS levels for appropriate sedation are between 65 and 85 [36–39], and its ability to reduce the dose of sedatives has not been demonstrated [39]. EBUS is a longer procedure that requires a higher level of sedation, and the only information available on the use of

Table 1. Modified observer's assessment of alertness/sedation scale

Responsiveness	Score
Agitated	6
Responds readily to name spoken in normal tone ('alert')	5
Lethargic response to name spoken in normal tone	4
Responds only after name is called loudly and/or repeatedly	3
Responds only after mild prodding or shaking	2
Does not respond to mild prodding or shaking	1
Does not respond to deep stimulus	0

BIS is limited to the control of the depth of sedation; its potential for reducing the dose of sedatives in a group of patients with respiratory disease, which may increase adverse events, has never been evaluated.

Patients and Methods

A randomized cohort study was performed in the Miguel Servet Hospital, Zaragoza, Spain, from May 20, 2014, to March 31, 2015. Ninety patients with mediastinal lymph node involvement and/or lung or mediastinal lesions, in whom the EBUS-TBNA procedure was indicated, were studied to compare sedation between two groups: one group used BIS evaluation (BIS group) and the other used the MOAA/S [28] clinical scale (non-BIS group) (table 1). Patients with diseases or drug use with a potential effect on the central nervous system were excluded. The drug doses required, adverse events at different times, tolerance, and difficulty of the examination were evaluated in each group. The study was approved by the Ethics Committee of Hospital Universitario Miguel Servet, Zaragoza, Spain (approval number: 02/2014), and the patients provided written informed consent.

EBUS-TBNA was performed by experienced pulmonologists and pulmonary medicine residents, while sedation was performed by the same anesthesiologist. Patients were assigned to each group by means of simple random sampling. The BIS monitor was applied, and the values were recorded in both groups. However, the anesthetist was blinded to the BIS values in the non-BIS group. Hemodynamic variables and BIS values were recorded by a pulmonary nurse who was blinded to the patients' group allocation.

Demographic, comorbidity, and respiratory data were collected. While EBUS-TBNA was being performed, hemodynamic variables (arterial blood pressure and heart rate), respiratory variables (respiratory frequency, SpO₂, and EtCO₂), and BIS and MOAA/S values [28, 29] were recorded at each of the 9 different moments of the examination (t1, baseline; t2, 1–5 min; t3, 5–10 min; t4, insertion of fiberoptic bronchoscope; t5, puncture; t6, 30 min; t7, 60 min; t8, removal of fiberoptic bronchoscope; t9, response to spoken orders). Total doses of the different drugs (propofol, remifentanyl, and lidocaine) and different times were recorded: T_a: time between the start of sedation and loss of verbal contact in normal tones; T_b: time between the end of sedation and verbal response in normal tones; T_c: time between the end of sedation and BIS >90,

and T₄: duration of sedation. Finally, adverse events during the procedure and during the stay in the recovery unit, patient satisfaction, and difficulty experienced by the person performing the endoscopy were recorded. The cost of BIS is less than USD 15 per patient.

Sedation Protocol

- Propofol in continuous infusion by means of Alaris PK Carefusion Target Controlled Infusion pump; the infusion began with a plasma objective of 2 µg/ml until a site-effect concentration of 1 µg/ml was reached in the brain, increasing or reducing the plasma concentration by 0.3 µg/ml every minute to obtain a MOAA/S alertness/sedation score of 3 or 2 (MS [28]). Furthermore, in the BIS group, an effort was made to keep the BIS between 60 and 80 (MS [30]).
- Remifentanyl in continuous infusion, at 0.04 µg/kg/min, except in patients over 70 years of age or with an American Society of Anesthesiologists (ASA) score of 3, in whom the infusion rate was reduced to 0.02 µg/kg/min. Previously, the pulmonologist (who, as the nurse, was unaware of which group the patient had been assigned to) anesthetized the vocal cords, trachea, and both main bronchi with 2% lidocaine, as per usual procedure. All patients received supplemental oxygen at 6 liters/min via a nasal cannula, with end-tidal CO₂ monitoring.

Statistical Analysis

The results were reported using central tendency and dispersion for quantitative variables [mean, median, standard deviation (SD), and interquartile range (IQR)] and percentages for the qualitative variables. For the bivariate analysis, we used the χ^2 or Fisher exact tests for the association between qualitative variables and the t test, ANOVA, Mann-Whitney test, and Kruskal-Wallis test for quantitative variables, depending on whether or not data distribution was normal, as evaluated by the Kolmogorov-Smirnov test. Correlation was analyzed using the Spearman rank correlation.

The tests were applied using the bilateral hypothesis, and the difference was considered to be statistically significant for values of $p < 0.5$. The confidence intervals included were 95% (95% CI). Data were analyzed using version 15 of the Statistical Package for Social Sciences (SPSS).

Results

Demographic variables and general reasons for requesting the procedure are shown in table 2. The mean (SD) duration of the procedure was 75.5 min (16.2).

No statistically significant differences were observed in the number of adverse events by sex, age 65 years or more, smoking, obesity, or ASA group; differences were significantly greater depending on whether patients had suffered from prior obstructive sleep apnea (OSA; 3.61 adverse events in OSA patients compared to 2.90 in non-OA patients; $p = 0.049$) and a significant positive linear correlation was found between the number of adverse

Table 2. Demographic variables and general reasons for requesting the procedure, by sedation group

	Non-BISa (MOAA/S)	BIS	p value
Sex			
Male	8 (17.8)	12 (26.7)	0.310
Female	37 (82.2)	33 (73.3)	
ASA			
1	2 (4.4)	2 (4.4)	0.977
2	24 (53.3)	25 (55.6)	
3	19 (42.2)	18 (40.0)	
O ₂			
Yes	1 (2.2)	1 (2.2)	1.000
Smoking			
Yes	11 (24.4)	17 (37.8)	0.172
Type of smoker			
No	08 (17.8)	07 (15.6)	
Ex-smoker >3 months	23 (51.1)	18 (40.0)	
Ex-smoker ≤3 months	3 (6.7)	3 (6.7)	
Smoker <10 c/day	4 (8.9)	4 (8.9)	
Smoker ≥10 c/day	7 (15.6)	13 (28.9)	
Cough			
Yes	28 (62.2)	25 (55.6)	0.520
OSA			
Yes	9 (20)	9 (20)	1.000
Previous fiberoptic bronchoscopy			
Yes	26 (57.8)	23 (51.1)	0.525
Indication			
Lung cancer	29 (64.4)	28 (62.2)	0.766
Metastasis	9 (20.0)	10 (22.2)	
Sarcoidosis/lymphoma	6 (13.3)	7 (15.6)	
Mediastinal mass	1 (2.2)	0 (0)	

Values are expressed as n (%). c = Cigarettes. ^a Non-BIS: group guided by MOAA/S sedation score but with BIS recorded.

events during the procedure and the duration of the procedure (ρ , 0.221; 95%CI, 0.005–0.401; $p = 0.045$).

Moreover, no statistically significant differences were observed between the BIS and non-BIS groups in any demographic or comorbidity variable: sex, ASA score, smoking, domiciliary oxygen, OSA, previous fiberoptic bronchoscopy, indication of the procedure, age, weight, height, BMI, O₂ saturation, level of anxiety, forced expiratory pressure in 1 s and forced vital capacity (tables 3, 4). Furthermore, the mean (SD) number of comorbidities in the non-BIS group was 3.64 (1.82) compared to 3.40 (1.70) in the BIS group; no statistically significant differences were found between the groups in any of the comorbidity variables taken into account ($p = 0.512$).

Oxygen saturation and BIS values were of note among the hemodynamic and respiratory variables. Oxygen sat-

Table 3. Sociodemographic, respiratory, and anxiety level variables by group

	Non-BIS (MOAA/S)		BIS		p value
	median	IQR	median	IQR	
Age, years	66.9	53.2–75.4	65.7	56.0–72.7	0.707
BMI	26.8	23.8–30.2	26.3	22.0–30.4	0.450
SaO ₂ , %	96	95.0–97.0	95	94.0–97.0	0.182
FEV ₁ , %	86	72.0–96.0	83	67.5–98.0	0.680
Forced vital capacity, %	91	82.0–104.8	91	82.0–114.0	0.836
Basal anxiety level (0–10)	4	3.0–5.0	5	3.0–7.0	0.087

FEV1 = Forced expiratory pressure in 1 s.

Table 4. Comorbidity variables by group

	Non-BIS (MOAA/S)		BIS		p value
	n	%	n	%	
Hypertension	25	55.6	17	37.8	0.091
Atrial fibrillation	3	6.7	5	11.1	0.714
Cerebrovascular accident	3	6.7	5	11.1	0.714
COPD	15	33.3	17	37.8	0.660
OSA	9	20.0	9	20.0	1.000
Neoplasm	37	82.2	34	75.6	0.438
Diabetes	12	26.7	12	26.7	1.000
Dyslipidemia	17	37.8	16	35.6	0.764
Obesity (BMI ≥30)	1	2.2	2	4.4	1.000
Ischemic heart disease	6	13.3	5	11.1	0.748
Renal failure	3	6.7	2	4.4	1.000
Heart failure	0	0.0	1	2.2	1.000
Anxiety	2	4.4	2	4.4	1.000
Other diseases	14	31.1	19	42.2	0.274

COPD = Chronic obstructive pulmonary disease.

Fig. 1. BIS values at the 9 times during the procedure, by sedation group (non-BIS and BIS).

Fig. 2. Oxygen saturation values (SaO_2) at the 9 times during the procedure, by sedation group (non-BIS and BIS).

uration was significantly lower at all times (except at t1 and t9) in the non-BIS group, whereas the values in the BIS group were significantly higher at t6 and t9 in the BIS groups (fig. 1, 2). Figure 3 shows the percentage of patients within the target range (MOAA/S 2–3), recorded at t3–t7 of the procedure. We did not include t1, t2, t8, and t9 because they are related with the induction and end of sedation.

Except for the time to loss of verbal contact, all times were greater in the non-BIS group; the difference in the time between the end of sedation and awakening (verbal response in a normal tone) was statistically significant ($p = 0.033$). The mean doses of total propofol and propofol in mg/kg were significantly higher in the non-BIS group, and the doses of lidocaine in mg/kg were significantly higher in the BIS group (table 5).

The non-BIS group presented more adverse events [total, 164; mean (SD), 3.64 (1.20)] than the BIS group [total, 102; mean (SD), 2.27 (0.86)]; ($p < 0.001$) (table 6). Twenty-seven (60%) patients in the non-BIS group and 7 (15.6%) in the BIS group required measures to counteract desaturation ($p < 0.001$). Thus, the number of maneuvers carried out was higher in the first group [total, 54; mean (SD) per patient, 1.20 (1.27)] than in the second group [total, 18; mean (SD) per patient, 0.40 (0.96)] ($p < 0.001$).

Most patients (91.1% in the non-BIS group and 84.4% in the BIS group) presented at least one cough attack (table 6). We found no significant differences in the number of cough attacks between the 2 groups [median (IQR), 4.0

Fig. 3. Percent of patients within the target range (MOAA/S 2–3) at 5 times during the procedure (t3–t7), by sedation group (non-BIS and BIS).

(2.0–6.5) in the non-BIS group and 3.0 (1.0–5.0) in the BIS group; $p = 0.115$]. Figure 4 shows patients with cough at each time in the procedure.

The mean (SD) number of adverse events in the post-anesthesia care unit (PACU) in patients in the non-BIS

Table 5. Statistics of the different procedure times and total and by-weight amounts of the drugs used during the procedure, by sedation group

	Mean	Median	SD	IQR	p value
T _a , min					
Non-BIS	5.1	5	2.5	3.0–7.0	0.407
BIS	5.6	5	2.5	3.5–7.0	
T _b , min					
Non-BIS	4.4	4	1.9	3.0–6.0	0.033
BIS	3.6	3	1.9	2.0–5.0	
T _c , min					
Non-BIS	8.4	8	3.3	6.5–11.5	0.299
BIS	7.6	7	3.0	5.0–10.0	
T _d , min					
Non-BIS	77.4	74	18.7	61.5–91.5	0.275
BIS	73.6	74	13.5	62.0–86.5	
Propofol, mg					
Non-BIS	534.4	475	206.5	367.0–679.0	0.001
BIS	397.8	395	98.6	335.0–468.5	
Propofol, mg/kg					
Non-BIS	6.8	6.4	2.2	4.9–8.5	0.006
BIS	5.6	5.3	1.8	4.4–6.4	
Remifentanyl, µg					
Non-BIS	180.5	147	86.6	117.5–220.5	0.347
BIS	167.7	141	91.7	110.0–205.0	
Remifentanyl, µg/kg					
Non-BIS	2.31	2.12	0.97	1.54–2.83	0.672
BIS	2.29	1.84	1.09	1.44–3.09	
Lidocaine, ml					
Non-BIS	33.9	32.0	13.1	25.0–45.0	0.171
BIS	37.5	40.0	11.1	30.0–45.0	
Lidocaine, mg/kg ^a					
Non-BIS	8.87	8.82	3.39	6.67–11.16	0.021
BIS	10.76	10.00	4.18	8.00–14.26	

^a Normal variables.

group was 1.42 (0.99), which was higher than that in the BIS group [mean (SD), 1.02 (0.78); $p = 0.036$]. Only 2 patients from each group had any memory of the procedure. Tolerance of the procedure was better ($p = 0.03$) in the BIS group, whereas the difficulty experienced by the endoscopist was similar in both groups (table 7).

Discussion

This prospective cohort study compares sedation during ultrasound-guided bronchoscopy with propofol and remifentanyl using BIS versus the MOAA/S clinical scale and shows that BIS not only controls the depth of sedation but also reduces the adverse events associated with sedatives, particularly hypotension, desaturation, and bradypnea, by making it possible to reduce the dose of these drugs. It also improves tolerance and reduces the waking time.

Table 6. Comparison of adverse events during the procedure between the sedation groups

Adverse events	Non-BIS		BIS		p value
	n	%	n	%	
Cough attacks	41	91.1	38	84.4	0.334
Oral aspiration	9	20.0	5	11.1	0.245
Desaturation	27	60.0	7	15.6	<0.001
Bradypnea	18	40.0	5	11.1	0.002
ETCO ₂ ≥50	9	20.0	3	6.7	0.063
Hypotension	45	100.0	27	60.0	<0.001
Hypertension	2	4.4	1	2.2	0.557
Bradycardia	13	28.9	14	31.1	0.818
Tachycardia	0	0.0	2	4.4	0.494

Bradypnea: breathing rate <8 breaths/min. Desaturation: oxygen saturation <90% for more than 1 min. Arterial hypotension: <20% baseline mean blood pressure. Arterial hypertension: >20% baseline mean blood pressure. Bradycardia: fall of 15 bpm below baseline. Tachycardia: rise of 30 bpm above baseline.

Fig. 4. Percent of patients with cough attacks in both groups at 9 times during the procedure. n.a. = Not applicable.

Table 7. Adverse events in the postanesthesia recovery unit, tolerance, and difficulty perceived by the endoscopist

	Non-BIS		BIS		p value
	n, median	%, IQR	n, median	%, IQR	
Sore throat in PARU ^{a, b}	18	40.0	13	28.9	0.267
Chest pain in PARU ^b	8	17.8	1	2.2	0.030
Cough in PARU ^b	30	66.7	26	57.8	0.384
Dyspnea in PARU ^b	5	11.1	3	6.7	0.714
Memory ^b	2	4.4	2	4.4	1.000
Would not repeat ^b	1	2.2	1	2.2	1.000
Not discharged ^b	0	0.0	0	0.0	–
Patient tolerance ^c	9.0	8.0–10.0	10.0	9.0–10.0	0.003
Difficulty perceived by endoscopist ^d	9.0	7.0–9.5	9.0	8.0–9.0	0.466

^a PARU = Postanesthesia recovery unit. ^b Categorical variables (yes/no). ^c Patient tolerance: ordinal variable from 0 (uncomfortable) to 10 (comfortable). ^d Difficulty perceived by the endoscopist: ordinal variable from 0 (very difficult) to 10 (very easy).

As in previous studies on digestive endoscopy [40], we found a positive linear correlation between the number of adverse events and the duration of the procedure (mean 75.5 min). These adverse events with the longer duration are considered to be linked to the higher doses of sedatives, and it has been suggested that doses of ≥ 100 mg of propofol lead to more adverse events. Other authors found no relationship between adverse events and the duration of EBUS-TBNA [10, 21], but the mean duration of their procedures was shorter. Our longer mean

duration may have been due to the learning curve of the residents and the systematic triple puncture of all lymph node stations punctured, which included lymph nodes not captured on the positron emission tomography scan. As in our study, other authors have found no correlation between adverse events and advanced age or higher ASA scores [10, 13, 41], although OSA did correlate with adverse events. Our results, which made it possible to reduce the dose of drugs in the BIS group, suggest that the lower incidence of adverse events in this group is linked

to the lower dose of the drugs used. No previous studies have evaluated monitoring with BIS and its effect on the dose of propofol during EBUS. In our study, patients monitored using BIS required significantly lower total mean doses of propofol throughout the procedure, and it was also subsequently shown that patients monitored without BIS reached deeper levels of sedation, related to the larger doses of drugs, and required more time to wake up.

Overall desaturation observed in our patients was 37.8%, with statistically significant differences between the groups (non-BIS, 60.0%; BIS, 15.6%; $p = 0.001$); sedation was not as deep in the BIS group (levels of 70–75 compared to 60–70 in the non-BIS group), and this was associated with less desaturation. The incidence in the BIS group was far lower than that reported by Jensen [20] (50%), who used only propofol, though at higher doses, and by Vila [17] (47.8%), who also used remifentanyl. The incidence in the Cases Viedma et al. [21] series, with a combination of propofol and remifentanyl, was similar to that in our BIS group (12.9%), although this multicenter study did not specify the dose or level of sedation. This lower hypoxemia is attributable to less severe respiratory depression, with less compromising of the airway, due to the more limited use of propofol and, therefore, less severe relaxation of the pharyngeal muscles, and to the lower incidence of bradypnea in the BIS group. Other potential causes of hypoxemia, common to both groups, include obstruction of the tracheal lumen by the endoscope and cough. However, no intubation was performed, and no procedure was suspended due to desaturation, as these events were considered to be transitory because the patients improved as a result of the actions carried out, particularly elevation of the jaw, continuous positive airway pressure (CPAP), and placement of a Valentín Madrid oropharyngeal cannula (VAMA®). In most cases, conventional fiberoptic bronchoscopy was performed before the EBUS procedure, and we were able to manage possible desaturation events. CPAP or VAMA were applied before starting the EBUS procedure. In other cases, we rarely had to interrupt the procedure to apply CPAP or to place VAMA. We used CPAP and VAMA in our OSA patients, but GA may be a safer alternative in these patients. The greater use of lidocaine in the BIS group may be related to the lower doses of propofol in these patients, but our dose of lidocaine was, in both groups, above the maximum recommended (8.3 mg/kg). However, lidocaine absorption can be unpredictable due to frequent aspirations during the procedure, and we

found no objective toxic effects of lidocaine. Nevertheless, the patients from both groups showed a high cough rate but a limited number of cough attacks, and we should probably have used a lower dose of lidocaine. However, it does not seem logical to increase propofol or remifentanyl infusion due to cough alone because of a higher risk of major side effects such as hypotension, bradypnea, and desaturation.

The overall incidence of hypotension in our study was 80%, although it was much lower in the BIS group (non-BIS, 100%; BIS, 60%; $p = 0.001$). This percentage is greater than in other studies, as our criterion for hypotension was a reduction of 20% from the baseline mean blood pressure, not a 30% drop [21]. Hypotension events resolved spontaneously after adjusting sedative doses in accordance with sedation protocol (BIS and clinical in non-BIS, respectively) or increasing fluid therapy. We did not need to use vasoactive drugs in any case. Propofol has been linked to hypotension in moderate and deep sedation [42]. The lower incidence of hypotension in the BIS group, associated with the use of less propofol, is another advantage of this monitoring. Our awakening time (verbal response in normal tones, or Tb) was 4.4 min (non-BIS) and 3.6 min (BIS), shorter than in another study [38] that assessed ‘time for orientation’.

In the PACU, the mean number of different adverse events per patient in the non-BIS group was significantly greater than in the BIS group; the most frequent events were cough and sore throat. Of our patients, 98% did not remember the procedure, and there were no differences between the groups. It has been established that, with BIS scores of between 70 and 75, 95% of the patients have no memory of the procedure [29, 30]. Our patients in the BIS group only presented a significantly higher BIS score at some of the recorded times (30 min and on responding to verbal orders), but there were no differences between the two groups in the overall scores, which were sufficient to generate amnesia. Although the overall satisfaction (patients who would repeat the procedure) was very high (98%), a rate similar to that found by other authors [10, 19] and with no differences between the groups, the tolerance assessed using a numerical scale was higher in the BIS group ($p = 0.003$), which led to a higher level of comfort in these patients, probably in relationship to a shorter recovery time, and to a lower degree of dizziness.

The main limitations of this study include the limited number of patients, as the study was carried out in a single hospital. However, this meant that it was possible for the same team (the same anesthetist, the same pulmon-

ologists, and the same nurses) to carry out all procedures, allowing for little variability.

In conclusion, our study shows the utility of BIS in EBUS, not only for monitoring sedation but also for reducing the dose of drugs and thus their adverse events, at a very low cost. Studies with a larger number of patients may help with the systematic implementation of this form of monitoring.

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The authors declare that they have no conflicts of interest to disclose.

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