A Randomized Controlled Trial Comparison of NeuroSENSE and Bispectral Brain Monitors During Propofol-Based Versus Sevoflurane-Based General Anesthesia

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**BACKGROUND:** NeuroSENSE is a depth of anesthesia monitor that uses automated electroencephalogram quantification. The Wavelet-based Anesthetic Value for Central Nervous System (WAV CNS) index calculated by this monitor is based on wavelet analysis of a normalized electroencephalogram signal in the γ-frequency band. The aim of this study was to determine the extent of disagreement between the Bispectral Index (BIS) and the WAV CNS index during propofol-based and sevoflurane-based maintenance of general anesthesia in a routine surgical population.

METHODS: Patients undergoing elective surgery were enrolled in the study and randomly assigned to receive either propofol or sevoflurane for the maintenance of anesthesia and remifentanil in both groups. Anesthesiologists were blinded to monitors in both groups. Discordance between the 2 monitors was assessed by the count of discrepancy in recommendation (DR) (type I defined as one parameter <40 and the other >60, or type II defined as BIS and WAV CNS values on different sides of a threshold [40 or 60]) and also by the proportion of agreement (PO) between WAV CNS and BIS, obtained every 5 seconds, in 3 categories of index (<40, 40–60, and >60).

RESULTS: The analyzed data set consisted of 22 patients (36,872 data pairs) in the propofol group and 24 patients (32,826 data pairs) in the sevoflurane group. The type I DR rarely occurred in both the groups (<1%); however, the median (interquartile range) type II DR was significantly more frequent in the propofol group (20.6% [7.0–36.9] vs 4.5% [2.3–12.4]; P = 0.0005). The median difference in PO was 11.53% (95% confidence interval, 0.57–21.32). Major disagreement between WAV CNS index and BIS was related to the weight of burst suppression pattern for the index calculation.

CONCLUSIONS: Disagreement between BIS and NeuroSENSE during the maintenance of general anesthesia was worse in the propofol group than that in the sevoflurane groups. The disagreement increases during deep anesthesia or in the occurrence of burst suppression. (Anesth Analg 2015;121:1194–201)
regardless of the anesthetic used, despite the different EEG signature of the drugs.

The initial comparison between the NeuroSENSE and the BIS monitor was performed by the designers in 21 patients in short propofol anesthetic procedures. In this study, BIS and $WAV_{\text{CNS}}$ indicated similar depth of anesthesia. Another study performed by the designers compared BIS and NeuroSENSE in 25 mostly young and healthy patients during desflurane or sevoflurane anesthesia. In the latter study, the designers again found a strong correlation between BIS and $WAV_{\text{CNS}}$ in the 30 to 60 range.

The aim of this study was to determine, in a routine surgical population, the extent of disagreement between the BIS and the $WAV_{\text{CNS}}$ index during propofol-based and sevoflurane-based maintenance of general anesthesia.

**METHODS**

This prospective, single-center, randomized double-blinded trial (ClinicalTrials.gov Identifier: NCT00391963) was approved by the Ethics Committee (Ref. 080633; CPP Ile de France VIII, Boulogne-Billancourt, France), and written informed consent was obtained for each patient.

**Patients**

Upon obtaining written informed consent, patients (18 years or older, ASA physical status I–III) scheduled for elective major abdominal, gynecologic, otolaryngologic, or urologic surgery were enrolled in this study. Exclusion criteria were pregnancy, neurologic or psychiatric disorders, alcoholism, psychoactive or opiate medication, emergency surgery, procedure performed in prone or lateral decubitus position, presence of a pacemaker, or allergy to propofol, remifentanil, or atracurium. A random number generator assigned the eligible patients to the propofol or to the sevoflurane group in a 1:1 ratio.

**Anesthetic Procedure**

Patients received a standardized anesthetic according to the following protocol. Premedication included oral hydroxyzine (1 mg·kg$^{-1}$) 1 hour before the surgery.

Induction was also similar in both groups. After preoxygenation, anesthesia was induced with a manual IV bolus of propofol (2–3 mg·kg$^{-1}$) in the sevoflurane group and via the propofol target-controlled infusion (TCI) device in the propofol group using the model of Minto et al. In both the cases, the dose or target was at the discretion of the anesthesiologist. IV remifentanil was administered using TCI mode Infusion Toolbox (version 4.8; Department of Computer Science, Faculty of Medicine, Free University of Brussels, Brussels, Belgium) implemented in a personal computer that served as a platform for calculating, displaying the effect-site concentration, and controlling infusion pumps (Asena GH; Alaris Medical, Hampshire, UK). After the loss of consciousness, patients received atracurium 0.5 mg·kg$^{-1}$ IV to facilitate tracheal intubation, after which the lungs were mechanically ventilated with a tidal volume of 8 to 10 mL·kg$^{-1}$, with the ventilatory rate adjusted to maintain end-tidal carbon dioxide between 30 and 35 mm Hg.

Maintenance of anesthesia differed between the 2 groups, with anesthesia TCI of propofol in the propofol group using the pharmacokinetic model of Schnider et al., while anesthesia maintenance was started using sevoflurane in the sevoflurane group. Remifentanil was continued in both groups. Atracurium was administered as repeated boluses if necessary. Anesthesiologists were instructed to guide the titration of general anesthesia (i.e., target effect-site concentrations of propofol and remifentanil, and end-expiratory sevoflurane concentration), administration of volume expansion, and vasoactive drugs using routine clinical signs and train-of-four monitoring. Anesthesiologists were blinded to both the NeuroSENSE and the BIS monitors.

Propofol and sevoflurane were discontinued at the beginning of skin closure and remifentanil at the end of surgery. Residual neuromuscular blockade was reversed with neostigmine 0.05 mg·kg$^{-1}$ IV and atropine 15 µg·kg$^{-1}$ IV, if necessary. Morphine, propacetamol, nefopam, or nonsteroidal anti-inflammatory drugs were given at the discretion of the physician.

All patients were visited on the first postoperative day and interviewed about any memories or recall of intraoperative awareness with the use of a standardized interview.

**Data Collection**

Standard monitor (S/5 monitor; GE Healthcare, Little Chalfont, UK) was used in the operating room. For EEG measurements, the skin on the forehead of the patient was first cleaned with an alcohol swab and then allowed to dry. A total of 6 sensors (FT9, FT10, above eye left, above eye right, Fpz as GND, and Fz as REF) were then applied to the forehead as shown in Figure 1. As per the manufacturer’s recommendations, 4 electrodes (FT9, FT10, GND, and REF) were connected to the NeuroSENSE module (NeuroSENSE v.2.1.1.0; NeuroWave Systems Inc.). For BIS, as per the manufacturer’s recommendations, F9, above eye left, GND, and REF electrodes were connected to the Datex module (BIS-XP; Datex Ohmeda, Helsinki, Finland), whereas FT10, above eye right, GND, and REF electrodes were connected to the Aspect module (BIS; CoviSion). Both BIS modules used the same algorithm version (BIS v. 4.0, XP). Electrode impedances <10 kΩ were considered as acceptable. Continuous impedance was disabled on all the monitors to allow for proper acquisition of the signals.

All monitored parameters from the Datex AS/5 and from the BIS monitor, including burst suppression ratio (BSR), were recorded every 5 seconds and saved on a standard personal computer using the specific software (Toolbox 95 ITB, version 4.8). The raw EEG signal was also recorded and saved on the NeuroSENSE module at a sampling rate of 900 Hz. The $WAV_{\text{CNS}}$ index was calculated with default automatic trending and was saved every second, whereas the BIS was calculated with a smoothing rate of 30 seconds and was saved every 5 seconds.

**Statistical Analysis and Data Handling**

This article presents the results obtained by comparison of $WAV_{\text{CNS}}$ and BIS values obtained from the right hemisphere during the maintenance of anesthesia, which was defined as 10 minutes after tracheal intubation and its end at the discontinuation of propofol or sevoflurane. Analysis of data obtained from the left hemisphere showed similar results and is not presented.

Both the $WAV_{\text{CNS}}$ values and the BIS values were time synchronized to each other. The $WAV_{\text{CNS}}$ values, which were saved every second, were downsampled to match the BIS values that were only saved every 5 seconds. This resulted...
in a pair of WAV\textsubscript{CNS} index and BIS every 5 seconds. Both WAV\textsubscript{CNS} and BIS values were categorized using thresholds of 40 and 60, with the 3 resultant categories—<40 (or deep anesthesia), between 40 and 60 (or adequate anesthesia), and >60 (or too light anesthesia).

The main end point of the study was the proportion of agreement (P0) between WAV\textsubscript{CNS} index and BIS among the 3 categories defined earlier (<40, 40–60, and >60). This was calculated for each subject as the percentage of pairs where WAV\textsubscript{CNS} and BIS indices agreed with each other (for instance, both between 40 and 60).

Two parameters for evaluating the discrepancies in recommendation (DR) between WAV\textsubscript{CNS} index and BIS were also studied. Type 1 DR was defined as the percentage of pairs of WAV\textsubscript{CNS} index and BIS, where one of them is <40 (deep anesthesia) and the other is >60 (too light anesthesia), hence implying completely contradictory anesthetic management. DR was classified as type 2 if WAV\textsubscript{CNS} index and BIS were on different sides of a threshold (40 or 60) simultaneously; for example, BIS is <40 and WAV\textsubscript{CNS} is 40 to 60. To investigate the influence of this difference on the judgment outcome, 3 subtypes of type 2 DR were defined with minimal absolute differences (\(\Delta\)) of 5, 10, and 15 between WAV\textsubscript{CNS} index and BIS. In addition, the relationship between WAV\textsubscript{CNS} and BIS values with their suppression ratios (SR) (SR > 0) was investigated to evaluate the reasons for any discordance between the indices.

Sample size calculation was performed using the expected difference for the primary end point, that is, the proportion of agreement (P0), between the 2 groups (propofol and sevoflurane). Because there are very few data on the performance of depth of anesthesia monitoring according to the anesthetic drug used, we used results from a closed, but not similar, previously published study. For a power at 80\% (\(\alpha = 0.05\)), we made the assumption of an expected difference in P0 of 25\% between the 2 groups; therefore, the number of patients to include in each group was 100.

Data were expressed as count (percentage) or median (25–75 percentiles). The main outcome measure, P0, was compared between the 2 groups using the Wilcoxon-Mann-Whitney test, and the median difference in P0 with its 95\% confidence interval was estimated using the Hodges-Lehmann approach. This approach was used as the distribution of the parameter that appeared to be a shift, and thus, the interpretation as being a difference of median was applicable. Other continuous and categorical variables were compared among groups using the Wilcoxon test and \(\chi^2\) test as appropriate. Agreement between all paired values was calculated using crude proportion of agreement and the Bland-Altman approach for repeated measurements, which is appropriate and usable for analyses of an unequal number of collected points. Last, because values from both hemispheres were available for the 2 monitors, concordance between right and left hemisphere was assessed using the Bland-Altman approach adapted for repeated measurements. A P value <0.05 was considered statistically significant in all analyses. Data analysis was performed using MATLAB R2007a (MathWorks, Natick, MA).

**RESULTS**

Considering the difficulty in obtaining the special combined electrode, we decided to do an intermediate analysis after the first 50 patients studied. This analysis led us to stop the study prematurely.

Fifty-two patients were approached; 2 patients refused to participate. Randomization concerned 50 patients, 25 in the propofol group and 25 in the sevoflurane group. Finally, we analyzed 22 patients with completed data in the propofol group and 24 in the sevoflurane group (see Supplemental Digital Content 1, http://links.lww.com/AA/B196). The data from 4 patients could not be analyzed because WAV\textsubscript{CNS} and/or BIS values were not available because of artefacts, loss of contact from the electrodes, or loss of connection with the computer during the maintenance. Demographic characteristics for analyzed patients, 22 in the propofol group and 24 in the sevoflurane group, are summarized in Table 1. No patient reported intraoperative awareness at the follow-up interviews.

Typical figures are presented in Figure 2, one for a patient with similar WAV\textsubscript{CNS}/BIS data pairs and the other with dissimilar ones. The analyzed data set consisted of 36,872 WAV\textsubscript{CNS}/BIS data pairs in the propofol group and 32,826 WAV\textsubscript{CNS}/BIS data pairs in the sevoflurane group.

The distribution of WAV\textsubscript{CNS} and BIS values, categorized using the threshold values of 40 and 60, for both propofol and sevoflurane groups is presented in Table 2. The overall proportion of concordant pairs for the propofol and sevoflurane groups was 65\% and 75\%, respectively. Most of the
discordance in both propofol (26%) and sevoflurane (16%) groups was observed when BIS was <40 or deep anesthesia and WAV_CNS was between 40 and 60 or adequate anesthesia.

The type 1 DR rarely occurred in both the groups (<1% with no significant difference; P = 0.27). However, the median type 2 DR was significantly different between the 2 groups for the 3 levels of difference considered. For instance, median type 2 DR when considering a difference between BIS and WAV_CNS of 10 was 20.6% in propofol group versus 4.5% in sevoflurane group (P = 0.0005; Table 3).

The relationship between WAV_CNS and BIS values with their SRs (>0), for both propofol and sevoflurane groups, is shown in Figure 3. The correlation coefficients between index values and SRs (>0) for propofol (sevoflurane) group were obtained as 0.77 (0.88) and 0.31 (0.48) for WAV_CNS and BIS, respectively.

The median proportion of agreement (P0) for each subject was significantly different in the propofol (64% [interquartile range, 52–77]) and sevoflurane (76% [interquartile range, 64–87]) groups (Table 3; Fig. 4). Accordingly, the median difference in P0 between the 2 groups was 11.53% (95% confidence interval, 0.57–21.32). Figure 5 illustrates the discordance of the 2 monitors in the global studied population and in the 2 groups of patients.

BIS, lower, and upper limits of agreement between the 2 hemispheres were −0.9, −1.7, and 9.9 for BIS and 0.7, −6.6, and 8.1 for WAV_CNS, respectively (see Supplemental Digital Content 2, http://links.lww.com/AA/B197).

**DISCUSSION**

The results demonstrated that BIS and WAV_CNS showed higher disagreement in the propofol group than in the sevoflurane group. Most of the discordance was observed when BIS was <40 and WAV_CNS between 40 and 60 (type 2 error). The situation where the 2 indices suggested completely contradictory anesthetic management (type 1 error, i.e., when one of the indices is <40 or deep and the other is >60) occurred in <1% of the cases. The differences between WAV_CNS and BIS cannot be due to the positioning of the sensors because EEG signals were recorded by the same sensors and then transmitted to each monitor. Moreover, it seems that the side (right or left) where the sensors were placed does not affect the signal recorded with both monitors (see Supplemental Digital Content 3, http://links.lww.com/AA/B198).

These differences may be attributed to dissimilarities in (a) EEG signals induced by different pharmacologic effects of inhaled and IV anesthetics; and/or (b) response/
relationship of WAV\textsubscript{CNS} index and BIS to certain types of EEG patterns.

Some EEG changes occurring during propofol and sevoflurane anesthesia were proposed as invariant; this allows the use of EEG-derived indices to monitor anesthetic delivery.\textsuperscript{15} However, propofol has a specific signature by the occurrence of \(\alpha\)-activity and slow oscillations that could explain the difference in analysis by the 2 monitors.\textsuperscript{16} Both the analyzed frequency bands, \(\beta\) by BIS and \(\gamma\) (also called \(\beta_2\)) by WAV\textsubscript{CNS}, are high-frequency waves observed during loss of consciousness and reported to vary independently from the anesthetic.\textsuperscript{17} With deeper sedation, the \(\beta\)-activity slows to spindle-like and \(\alpha\)-waves, then to \(\theta\)- and \(\delta\)-waves.\textsuperscript{18}

In the range of BIS from 60 to 100, BIS can be calculated from the anesthetic.

Discrepancies in Recommendation (DR) Between WAV\textsubscript{CNS} and BIS Values

Table 3. Proportion of Agreement (P0) and Discrepancies in Recommendation (DR) Between WAV\textsubscript{CNS} and BIS Values

<table>
<thead>
<tr>
<th>WAV\textsubscript{CNS} Group</th>
<th>Propofol</th>
<th>Sevoflurane</th>
<th>Propofol - BIS</th>
<th>Sevoflurane - BIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 DR (%)</td>
<td>0.0 (0.0–0.3)</td>
<td>0.0 (0.0–0.3)</td>
<td>0.2717</td>
<td></td>
</tr>
<tr>
<td>Type 2 DR (%)</td>
<td>24.7 (10.2–45.8)</td>
<td>15.6 (6.7–24.2)</td>
<td>0.0060</td>
<td></td>
</tr>
<tr>
<td>Type 0 (%)</td>
<td>64.4 (52.0–76.6)</td>
<td>75.8 (63.9–86.5)</td>
<td>0.0398</td>
<td></td>
</tr>
</tbody>
</table>

PO = proportion of agreement.

Type 1 DR = percentage of pairs of WAV\textsubscript{CNS} and BIS indices where one of them is <40 and the other is >60.

Type 2 DR = percentage of pairs of WAV\textsubscript{CNS} and BIS indices which were on different sides of a threshold (40 or 60) simultaneously.

\(\Delta\) = minimum absolute differences (\(\Delta\)) of 5, 10, and 15 between WAV\textsubscript{CNS} and BIS indices (these differences concern only type 2 DR).

All values in median (interquartile range, 25–75 percentiles).

Another explanation of the differences between BIS and WAV\textsubscript{CNS} index may be their different relationships with SR. Burst suppression is defined as periods of flat or isoelectric EEG separated by relatively shorter periods of fast and large amplitude activity. Increasing doses of anesthetics cause progressive slowing until the EEG achieves burst suppression and, finally, electrical silence.\textsuperscript{3,20} The way the SR is integrated into the depth of anesthesia index is different for each algorithm and each monitor. Because of the dose–response relationship between the anesthetic drug concentration and the duration of cortical suppression, most calculated indexes decrease monotonically, with increasing SR values. The BIS has been shown to exhibit a

as Synch-FastSlow (a parameter derived from bispectral analysis) or burst-compensated Spectral Edge Frequency 95 Percentile (derived from burst suppression and power spectral analysis).\textsuperscript{19} However, it is unclear how the different subparameters calculated by the device are integrated within the BIS. On the contrary, how NeuroSENSE algorithm analyzes EEG pattern in the absence of \(\gamma\)-waves has not been disclosed. According to the NeuroSENSE manufacturer, the wavelet information associated with the \(\gamma\)-band is statistically represented in a form of a probability density function (PDF). The \(\gamma\)-wavelet coefficients have typically large amplitudes while the patient is awake and tend to reduce with increasing drug administration. Once all cortical activity has ceased, the coefficients are all “0.” In terms of the PDF shape, this translates into a flat and wide envelope in a fully awake subject, which evolves into a sharp and narrow spike when all cortical activity is suppressed.\textsuperscript{8} The evolution between these 2 shapes is supposed to be consistent with an increasing anesthetic drug effect on the cortical state. However, the weighting factors influencing the evolution of the PDF are not precisely known. These factors could explain the differences in BIS values when depth of anesthesia increases.

Figure 3. Relationship of BIS and WAV\textsubscript{CNS} indices with their corresponding SR values.
linear relationship with the SR (BIS = 50 − SR/2) when SR is >40%\(^{19,21}\); however, for SR values <40%, its relationship is less clearly established.\(^{21,22}\) In contrast, WAV\(_{\text{CNS}}\) has been shown to exhibit a linear relationship with SR for SR values >5%.\(^7\) These previously reported relationships of BIS and WAV\(_{\text{CNS}}\) index with SRs are supported by the results obtained in this study. The different relationships of BIS and WAV\(_{\text{CNS}}\) with the SR, especially for SR <40%, could explain why most of the discordance between them was observed when BIS was <40 and WAV\(_{\text{CNS}}\) was between 40 and 60. Furthermore, in our study, SR values were observed for 14.9% of the total time in the propofol group, but only for 4.9% of total time in the sevoflurane group. Hence, the effect of SR relationship on WAV\(_{\text{CNS}}\) versus BIS comparison was possibly much greater in the propofol group compared with the sevoflurane group, resulting in higher discordance between WAV\(_{\text{CNS}}\) index and BIS in the propofol group.

This last observation raises the question of the relevance of SR integration to index calculation. The designers and developers of the BIS monitor considered that the burst suppression pattern was mainly a sign of too deep anesthesia or deep suppression of cortical activity related to increasing effects of anesthetics. As a consequence, even short periods of suppression greatly influence the BIS values. The BIS makes a “judgment call” for the clinician, where any presence of BSR is a sign that anesthesia is too deep. However, other causes of reduced cerebral metabolism can also produce burst suppression, such as hypothermia,\(^{23}\) hypoxemia,\(^{24}\) anoxic coma,\(^{25}\) or reduction of cerebral perfusion.\(^{26,27}\) As a consequence, it is theoretically possible to have an EEG waveform corresponding to an adapted sedation and BSR corresponding to another clinical situation. Low BIS during maintenance should be considered as an alarm signal, and it should lead the anesthesiologist to find its reason. However, the NeuroSENSE monitor does not make any such assumption and allows the suppression periods and the frequency content of EEG patterns between the suppression periods to interplay with each other to result in an index value. Although there is increasing evidence in the literature that BSR should be avoided,\(^{28-32}\) there is still a debate over whether a state with BSR of 5% is same as a state with BSR of 40%. Clearly, the response of the NeuroSENSE and BIS monitors is different for these 2 states.

The purpose of this article was not to decide which strategy is better. However, this study demonstrates clearly that for a same clinical depth of anesthesia, the WAV\(_{\text{CNS}}\) decreases less than BIS, more particularly in the propofol group and in the presence of burst suppression. We think that designers of both the monitors should explain clearly the impact of burst suppression on their index, so that clinicians know how to interpret the index value. Furthermore, the actual recommended range of BIS from 40 to 60 regardless of the

Figure 4. Proportion of agreement (PO) between WAV\(_{\text{CNS}}\) and BIS values. Values are presented for both groups as individual values and using box plot representation. The box has lines at the lower quartile, median, and upper quartile values. Whiskers extend from each end of the box to the most extreme values within 1.5 times the interquartile range from the ends of the box.

Figure 5. Concordance of values displayed by the 2 monitors in the global studied population and in the 2 groups of patients. Representation according to Bland–Altman approach for repeated measurements.\(^{14}\) The continuous line represents the bias and the dashed lines, the upper and lower limits of agreement. Each circle represents one subject and their relative area is proportional to the number of measure per subject.
anesthetic may not correspond to the same range of WAV\textsubscript{CNS} from 40 to 60, especially under propofol anesthesia.

**Limitations of the Study**

The first limitation of our study is that we present preliminary results. Only the first 50 patients enrolled in the study were analyzed, because we were not able to include the originally calculated number of patients. The analysis of the included patients demonstrated a significant result. However, the precision of our estimate could have been affected by the limited sample size, which limits the external validity of our results.

The second limitation is that we used the BIS as a reference monitor, even though its algorithm has not been completely disclosed. We are aware that this monitor may not always correlate to the real depth of anesthesia. We chose it because the BIS monitor is the most frequently used index in clinical practice and is often used as a reference when evaluating new technologies. However, in our study, patient depth of anesthesia was estimated after clinical parameters, and anesthesiologists were blinded for both monitors when the indices were recorded. So, the indices reflected real conditions of anesthesia.

The third limitation is that burst suppression occurred more frequently in the propofol group, which favored disagreement in this group. Two factors may explain this: the first is the absence of spinal effect of propofol, which favored disagreement in the propofol group because anesthesiologists may have increased the dose to achieve immobility in patients with incomplete myorelaxation.\textsuperscript{33} The second is the plateau effect of halogenated agents, which favored agreement in the sevoflurane group.\textsuperscript{34} The attending anesthesiologist was blinded to the EEG indices, implying that the anesthetic drugs were titrated by clinical signs and hemodynamic values. In the study, complete myorelaxation was not required for every surgery, so patients could have moved and motor-evoked potentials recorded in muscle appear to be abolished most easily by inhaled halogenated drugs.\textsuperscript{35} This effect of halogenated inhaled agents at the spinal level can explain why the average depth of anesthesia was higher in the propofol group. Propofol produces dose-dependent depression of the EEG and cortical activity but has no spinal effect.\textsuperscript{36} To prevent patient movements, the attending anesthesiologist probably increased the dose of propofol during maintenance, resulting in burst suppression patterns occurring more frequently in the propofol group. Unfortunately, we did not record EEG during maintenance.

**CONCLUSIONS**

Our study demonstrated that disagreement between BIS and NeuroSENSE during the maintenance of general anesthesia was worse in the propofol group than in the sevoflurane group. The disagreement increases during deep anesthesia or in the occurrence of burst suppression. The monitors rarely indicated complete contradictory results (<1% of cases). However, the recommendation of a range from 40 to 60 regardless of the anesthesia may not correspond to the same depth of anesthesia using a BIS or a NeuroSENSE. To substantiate our results, a further clinical study should be performed comparing drug doses and recovery times in 2 populations monitored one with the BIS monitor and the other with the NeuroSENSE monitor.

**DISCLOSURES**

Name: Julie Bresson, MD.

Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript.

Attestation: Julie Bresson has seen the original study data, reviewed the analysis of the data, and approved the final manuscript.

Conflicts of Interest: None.

Name: Etienne Gayat, MD, PhD.

Contribution: This author helped analyze the data.

Attestation: Etienne Gayat has seen the original study data, reviewed the analysis of the data, and approved the final manuscript.

Conflicts of Interest: None.

Name: Ngai Liu, MD, PhD.

Contribution: This author helped design the study and write the manuscript.

Attestation: Ngai Liu approved the final manuscript.

Conflicts of Interest: None.

Name: Chantal Hausser-Haw, MD.

Contribution: This author helped design the study.

Attestation: Chantal Hausser-Haw approved the final manuscript.

Conflicts of Interest: Chantal Hausser-Haw reported no conflicts of interest.

Name: Marc Fischler, MD.

Contribution: This author helped design the study and write the manuscript.

Attestation: Marc Fischler approved the final manuscript and is the author responsible for archiving the study files.

Conflicts of Interest: None.

This manuscript was handled by: Maxime Cannesson, MD, PhD.

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