

Awareness during anesthesia: the results of a questionnaire survey in Japan

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Received: 16 April 2010 / Accepted: 1 November 2010 / Published online: 14 December 2010
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Abstract

Purpose We planned a survey to evaluate the current incidence and risk factors of intraoperative awareness.

Methods A questionnaire survey was conducted via the Internet. The survey was designed to obtain information regarding cases involving intraoperative awareness in 2008.

Results A total of 172 anesthesiologists answered the survey. The total number of reported anesthetic cases was 85,156. Twenty-four cases of definite or possible awareness were reported by 21 anesthesiologists, of which 14 were cases of definite awareness and ten of possible awareness. The incidence of awareness, including possible awareness, was 0.028%. Propofol was used in 21 cases, sevoflurane in two, and a high dose of fentanyl in one. Bispectral index (BIS) monitoring was used in seven cases (29%). Sixteen patients (67%) were <50 years old, six (26%) were men, and 17 (74%) were women. As the type of surgery, three cases (13%) involved gynecological surgeries and seven (30%) involved cervicofacial surgeries. During surgery, the memory at postural change was preserved in two cases.

Conclusion The most surprising finding of this study is that total intravenous anesthesia (TIVA) was used in 21 of the 24 (88%) cases of definite and possible awareness. Although the incidence of intraoperative awareness was compatible with the previous studies, meticulous care should be taken when anesthesia is performed by TIVA for high-risk patients. The results of this survey should be verified, as well as further continuous survey and prospective study, because this study was performed by an anonymous questionnaire survey conducted over only 1-year period.

Keywords Awareness · BIS · TIVA

Introduction

Intraoperative awareness is the explicit recall of sensory perceptions during general anesthesia. Awareness occurs in about 0.1–0.2% of general anesthesia cases [1, 2]. A recent study using data from hospitals' quality improvement systems reported an incidence of 0.007% [3]. Whereas most cases of awareness are inconsequential, some patients experience prolonged negative side effects, including posttraumatic stress disorder. Since the introduction of remifentanyl in Japan in 2007, widespread changes have occurred, including a reduction in the maintenance dose of anesthetics. Our survey showed 4% of anesthesiologists experienced awareness in their patients and 23% experienced possible awareness during remifentanyl anesthesia [4]. The fact that overall 27% of anesthesiologists experienced definite or possible awareness indicated that intraoperative awareness might be high during remifentanyl anesthesia. However, the incidence of intraoperative awareness in Japan has not yet been studied. Therefore, we

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planned a detailed survey to evaluate the current incidence and risk factors of intraoperative awareness.

Methods

For better understanding the use of anesthesia in Japan and the possible risk factors for intraoperative awareness, a questionnaire survey was conducted via the Internet from 15 February to 31 March 31 in 2008. Letters were sent to hospitals with staff anesthesiologists to encourage survey responses. The responder could answer the survey on the open-access Web site anonymously. The survey was designed to obtain information regarding daily anesthesia practices, including the use of remifentanyl and bispectral index (BIS) monitors, as well as choice of anesthetics. The survey also solicited information regarding cases involving intraoperative awareness (Table 1). No personal information about awareness cases except for the gender and ages were obtained. The determination of definite or possible awareness was left to the judgment of each respondent. Then, the respondent who reported awareness was requested to provide details by e-mail. Final judgment of awareness was done in agreement of two authors (YM and TT).

Results

A total of 172 anesthesiologists answered the survey. The total number of reported anesthetic cases was 85,156. Twenty-seven cases of definite or possible awareness cases were reported. Two were excluded for lack of detailed information. One was excluded because the case was not performed within the study period. Finally, 24 cases of definite or possible awareness were reported by 21 (12%) anesthesiologists, of which 14 were cases of definite awareness and ten were of possible awareness. The incidence of awareness, including possible awareness, was 0.028%. Detailed information about the awareness cases is shown in Tables 2 and 3. One patient suffered definite awareness twice, and another patient suffered possible awareness three times. The patient demographics are shown in Fig. 1. Sixteen cases (67%) were <50 years old, six (26%) were men, and 17 (74%) were women.

Anesthesia conditions in awareness cases

Propofol was used in 21 cases, sevoflurane in two, and a high dose of fentanyl in one. BIS monitoring was used in seven cases (29%). In three cases, trouble in the infusion line for propofol was considered as the cause of awareness. In another, the patient's incorrect weight was entered into

Table 1 Questionnaire used in this survey

(1) Do you use remifentanyl during anesthesia?	Almost all cases 50–99% of cases 1–49% of cases No
(2) Which anesthetics do you use with remifentanyl?	Sevoflurane Sevoflurane > propofol Sevoflurane = propofol Propofol > sevoflurane Propofol
(3) Do you use BIS monitoring?	Almost all cases 50–99% of cases 1–49% of cases No
(4) Please answer your standard sevoflurane concentration with remifentanyl during maintenance period.	0.7% 1.0% 1.2% 1.5% 2.0%
(5) Do you use nitrous oxide?	Almost all cases 50–99% of cases 1–49% of cases No
(6) Did you observe increased awareness in the patient after the introduction of remifentanyl?	Yes Possibly yes No I do not know
(7) How many general anesthesia cases have you performed in 2008?	
(8) Have you observed intraoperative awareness in 2008? If yes, please describe the case in detail, including anesthetics administered, use of BIS monitoring, and patient's age and gender	

the target-controlled infusion (TCI) pump. The anesthesiologist did not use actual body weight but ideal body weight for a morbidly obese patient.

Type of surgery and timing of memory

Information regarding the type of surgery was obtained in 17 cases. Three cases (13%) involved gynecological surgeries and seven (30%) involved cervicofacial surgeries. During surgery, memory at postural change was preserved in two cases (nos. 12 and 21).

Table 2 Descriptions of definite awareness cases

Patient no.	Sex and age (years)	Anesthetic agent	Surgery	Use of BIS monitor	Comment
1	F, 20	Propofol, remifentanyl and epidural anesthesia	Fracture of lower leg bone	–	
2	F, 20	Propofol, remifentanyl and epidural anesthesia	Removal of implant of lower leg	–	Same patient as no. 1
3	F, 20	Propofol and remifentanyl	Orthopedic surgery	–	
4	F, 20	Propofol and remifentanyl	Fracture of mandibular bone	–	
5	F, 20	Propofol and fentanyl	Oral surgery	–	
6	F, 30	Propofol and remifentanyl	Resection of ovary tumor	+	
7	F, 40	Propofol and remifentanyl	Correction of deviation septi nasi	–	
8	F, 40	Propofol and remifentanyl	Endoscopic maxillary sinus surgery	+	
9	F, 40	Sevoflurane, remifentanyl and epidural anesthesia	Gynecologic surgery	–	
10	F, 60	Propofol and remifentanyl	Partial resection of thyroid	–	
11	M, 60	High dose fentanyl	Cardiac surgery	–	
12	M, 60	Propofol and epidural anesthesia	Lung surgery	+	Memory at changing body position
13	M, 80	Propofol and remifentanyl	Brain tumor surgery	+	
14	NA	Propofol	NA	+	

BIS bispectral index, *NA* not acquired

Table 3 Descriptions of possible awareness cases

Patient no.	Sex and age (years)	Anesthetic agent	Surgery	Use of BIS monitor	Comment
15	F, 40	Propofol and remifentanyl	Fracture of clavicle	–	
16	F, 40	Propofol and remifentanyl	Fracture of clavicle	–	Same patient as no. 15
17	F, 40	Propofol and remifentanyl	Fracture of clavicle	–	Same patient as no. 15
18	F, 40	Propofol, remifentanyl and ketamine	Mammary cancer surgery	–	
19	F, 50	Propofol and remifentanyl	Spinal surgery	+	
20	F, 50	Propofol, remifentanyl and ketamine	Gynecologic surgery	+	Wake up during surgery but no memory retention after surgery
21	F, 60	Propofol and remifentanyl	Spinal surgery	–	Memory at changing body position (supine → prone position)
22	M, 10	Propofol and remifentanyl	Appendectomy	–	
23	M, 20	Sevoflurane	Resection of lung bulla	–	Wake up during surgery but no memory retention after surgery
24	M, 40	Propofol and remifentanyl	Ophthalmologic surgery	–	Morbid obesity patient

BIS bispectral index

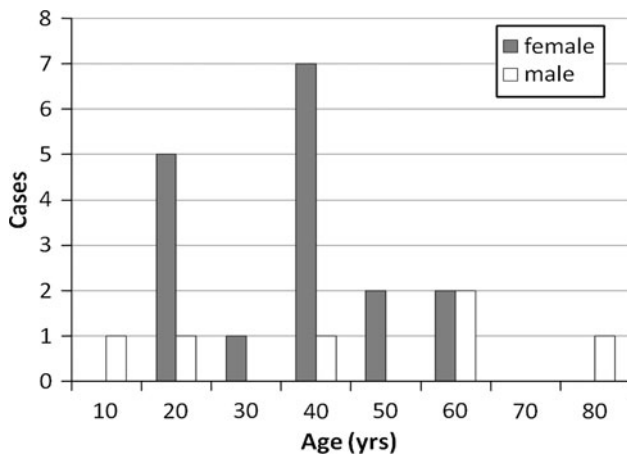


Fig. 1 Patient demographics of definite and possible awareness cases, Sixteen (67%) were <50 years old, six (26%) were men, and 17 (74%) were women

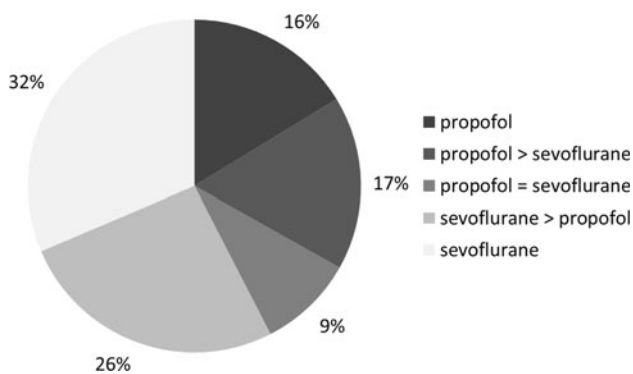


Fig. 2 Anesthetics used for daily anesthesia practice with remifentanyl. Twenty-eight (16%) anesthesiologists reported using mostly propofol, 29 (17%) used it less than volatile anesthetics, 16 (9%) used propofol and volatile anesthetics equally, 44 (26%) used more volatile anesthetics than propofol, and 54 (32%) used volatile anesthetics mainly for maintenance of general anesthesia

General anesthesia status

Information about daily anesthesia practice was obtained from 172 anesthesiologists. With regard to their use of remifentanyl, 51% of respondents reported it was used in all cases, 27% reported it was used in 50–99% of cases, and 22% reported it was used in 1–49% of cases. Twenty-eight (16%) anesthesiologists reported using mostly propofol, 29 (17%) used it less than volatile anesthetics, 16 (9%) used propofol and volatile anesthetics equally, 44 (26%) used more volatile anesthetics than propofol, and 54 (32%) used volatile anesthetics mainly for maintenance of general anesthesia (Fig. 2).

With regard to their use of BIS monitoring, 44 (26%) anesthesiologists reported that it was used in all cases, 19 (11%) that it was used in 50–99% of cases, 50 (29%) that it was used in 1–49% of cases, and 62 (34%) reported it was not used at all (Fig. 3).

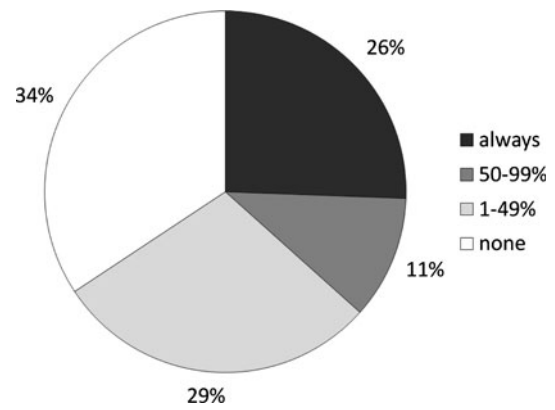


Fig. 3 Use of bispectral index (BIS) monitoring in daily anesthesia practice: 44 (26%) anesthesiologists used it in all cases, 19 (11%) used it in 50–99% of cases, 50 (29%) used it in 1–49% of cases, and 62 (34%) did not use it at all

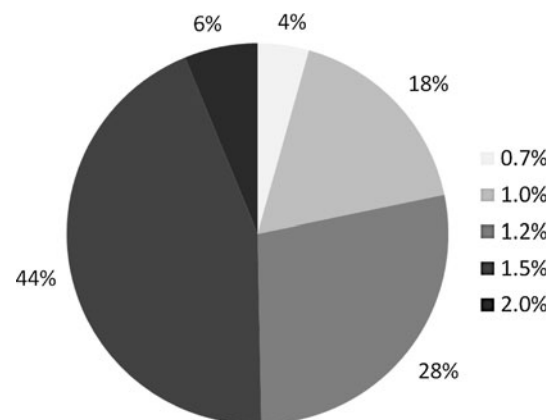


Fig. 4 Standard sevoflurane concentrations during maintenance period. Seventy-eight percent of anesthesiologists used >1.2% of sevoflurane

With regard to standard maintenance with sevoflurane concentration with remifentanyl, 161 answers were obtained: 78% used >1.2% of sevoflurane (Fig. 4).

As for nitrous oxide, eight (5%) anesthesiologists reported it was used in all cases, 13 (8%) used it in 50–99% of cases, six (3%) used it in 1–49% of cases, and 145 (84%) did not use it at all. In addition, 120 (70%) anesthesiologists felt that the introduction of remifentanyl in Japan did not increase the incidence of awareness. In fact, only ten (6%) felt that the incidence of awareness had increased with its introduction.

Discussion

Awareness during general anesthesia is a serious problem that is gaining the attention of anesthesiologists. In this survey, we found that the incidence of intraoperative

awareness during general anesthesia was 0.028%, which is compatible with the result of 0.023% reported by Mashour et al. [3] in their retrospective study. Most prospective studies show a higher incidence of approximately 0.2% [2, 5]. We acknowledge that the results in this survey represent an underestimation of the actual incidence of awareness. In this survey, the determination of awareness depends on the anesthesiologists' experience of daily postoperative care. However, Sebel et al. [2] noted that a single short postoperative visit by an anesthesiologist without the use of a structured interview is not likely to help identify cases of awareness.

The most surprising finding in this study is that in 21 (88%) of the 24 definite and possible awareness cases, total intravenous anesthesia (TIVA) was used, whereas sevoflurane was used in only two cases (9%). Although the actual rate of TIVA in this survey population is unknown, this survey shows that volatile anesthetics are used more frequently than propofol. This result should be verified by further investigation, including how anesthesia was performed by the anesthesiologist in awareness cases. Whether TIVA is a risk factor for awareness is controversial. There has been no strong evidence that the incidence of awareness is higher with TIVA [6]. Errando et al. [5] reported a higher incidence of awareness in cases in which TIVA (1.1%) was used than in those in which balanced volatile anesthesia (0.59%) was used. However, no prospective studies have compared the incidence of awareness between volatile anesthesia and TIVA. Several studies have pointed to TIVA as a contributing factor for awareness [7]. Presumably, some of these cases are related to malfunctions in pumps or intravenous lines. The lack of a real-time feedback of blood anesthetic concentration may also be a contributing factor. Another aspect is very low incidence of awareness with volatile anesthetics. Real-time feedback of blood anesthetic concentration is possible by monitoring the end-tidal anesthetic gas concentration of the volatile agents. This prevents awareness arising due to the malfunction or misuse of the anesthesia delivery system. As for the sevoflurane concentrations during the maintenance period, 78% of anesthesiologists use >1.2% (0.7 MAC). In our previous survey [4], 49% of anesthesiologists used >1.2% of sevoflurane. The anesthesiologists who experienced definite or possible awareness were 27%. The sevoflurane concentration used was lower and incidence of awareness experience in the previous survey was higher than in this survey. Avidan et al. [8] reported the incidence of awareness in patients who maintained end-tidal volatile anesthetic concentration between 0.7 and 1.3 MAC was 0.1%, which is compatible with those who maintained target BIS values between 40 and 60. Increase in maintenance sevoflurane concentration from our previous survey [4] might be one factor for the low awareness rate when volatile anesthetics

are used. Moreover, the interindividual variability in drug concentration required to prevent movement response to noxious stimulation may be less with volatile anesthetics than with TIVA [9]. The TCI systems predict the drug plasma concentration on the basis of population pharmacokinetics, which will differ from the actual concentration in the individual patient. Therefore, the use of a cerebral-function monitor with TIVA should be considered.

BIS monitoring in this survey was used in 29% of the awareness cases and in all cases predicted <50%, and the advantage of BIS for preventing awareness was not evident. BIS is a complex electroencephalograph (EEG) derivative that assigns a numerical value to the probability of consciousness [10]. Previous reports [11, 12] suggest that BIS monitoring is effective in reducing the incidence of awareness. Myles et al. [11] found that BIS-guided anesthesia resulted in an 82% reduction in the incidence of awareness in a double-blind study of patients at high risk for awareness. Ekman et al. [12] investigated the incidence of awareness when the anesthetic was guided with BIS and found a 77% reduction in the incidence of awareness. Because, volatile anesthetics were used in these studies, the usefulness of BIS for preventing awareness during TIVA was not evaluated. Moreover, even if BIS monitoring were used, and BIS was maintained between 40 and 60, awareness could not be completely avoided [8].

Processed EEG indices have been shown to correlate with serum propofol concentrations [13], but there are no randomized controlled trials assessing whether BIS can decrease the incidence of awareness with TIVA. Indeed, awareness despite low-spectral entropy values, which is another processed EEG monitor, was reported during TIVA [14]. We note that BIS monitoring is not a perfect method for avoiding patient awareness when using not only volatile anesthetics but also TIVA. Whereas other risk factors for awareness were observed in this survey, most were associated with TIVA.

In this survey, female patients accounted for the majority of the awareness cases. Similarly, previous studies have reported a higher incidence of awareness in women patients [15]. Women recover more rapidly from propofol anesthesia than men [16], which may suggest that they are less sensitive to propofol. Closed-claim analysis also shows a high number of awareness cases in women and young patients [15]. In this survey, 67% of the awareness cases involved patients <50 years. One patient experienced awareness twice, and one patient experienced awareness thrice. This suggests the presence of a history of awareness is a risk factor. Therefore, a previous history of intraoperative awareness should be treated seriously, and more care should be taken when administering anesthetics.

With regard to the type of surgery, 41% of the reported incidents of awareness occurred during cervicofacial

surgery. Previous research has implied an association between anesthesia administered for cardiac, trauma, and obstetrics surgery and a high incidence of awareness because the dose of anesthesia tends to be lighter during such surgeries [6]. There have been few reports about high incidence of awareness in cervicofacial surgery. In the multicenter study conducted by Sebel et al. [2], six (24%) of the 25 reported incidents of awareness occurred during ophthalmologic surgery, the most common type of surgery. Although the reasons for cervicofacial surgery being a risk factor for awareness are unclear, it is thought that the direct visual or acoustic stimulation during such surgeries may play a role. Moreover, noxious inputs mediated by trigeminal nerves are rather resistant to opioids. Similarly, in our survey, memory at postural change was preserved in two cases. Although there have been no reports about postural change and awareness, the stimuli associated with postural change might induce awakening. It is recommended that the hypnotic level be deepened during postural change.

This study was performed by an anonymous questionnaire survey conducted over a 1-year period. The decision of determining awareness was mainly based on each anesthesiologist's judgments without structured interview. As for the study design, this survey was performed in an open-access Web site. The anesthesiologists who experienced awareness by their patients or who have interest in such awareness might have tended to answer this survey at a higher rate than other anesthesiologists. This bias might influence the incidence of awareness. Therefore, the results of this survey should be verified by further continuous survey and prospective study, especially for the relationship between TIVA and awareness.

In conclusion, we conducted a survey to evaluate the status of anesthesia practices and the associated risk factors for awareness in Japan by a questionnaire survey. The most surprising finding was that TIVA was used in 21 of the 24 (88%) cases of definite and possible awareness. Although the incidence of intraoperative awareness was comparable with previous studies, meticulous care should be taken when anesthesia is performed by TIVA for high-risk patients. Other risk factors, including female gender, young age, history of awareness, and cervicofacial surgery, were also noted. The study also demonstrated that the use of BIS monitoring could not prevent awareness. Further continuous surveys and a large prospective study are required to validate the findings of this study.

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