Anaesth Crit Care Pain Med 38 (2019) 63–68

SFAR Société Française d'Anesthésie et de Réanimation

Original article

Anaesthesia management by residents does not alter the incidence of self-reported anaesthesia awareness: A teaching hospital-based propensity score analysis

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ARTICLE INFO

Article history:
Available online 15 December 2017

Keywords:
Awareness
Anaesthesia resident
Academic medical centres

ABSTRACT

Background: Intraoperative awareness during general anaesthesia is rare but represents one of the major anaesthesia-related complications. Intraoperative awareness may be a result of inadequate anaesthesia management. Therefore, the incidence can be related with the experience of anaesthetists. To assess whether the incidence of intraoperative awareness is related to anaesthetists' experience, we compared the incidence of self-reported intraoperative awareness between patients managed by anaesthesia residents or by experienced anaesthetists.

Methods: This is a retrospective review of an institutional registry containing 21,606 general anaesthesia cases. It was conducted with the ethics board approval. Propensity score analysis was used to generate a set of matched cases (resident managements) and controls (anaesthetist managements), yielding 4940 matched patient pairs. The incidence of self-reported intraoperative awareness compared as primary outcomes. Additionally, a multivariate logistic analysis in the entire cohort, using the incidence of self-reported intraoperative awareness as dependent variable, was conducted to confirm the result of the primary outcome.

Results: In the unmatched population, contrary to our hypothesis, the incidence of self-reported intraoperative awareness was lower in resident management compared with anaesthetist management (1.1% vs. 1.5%, $P = 0.028$). However, after propensity score matching, there was no difference in incidences of self-reported intraoperative awareness (1.5% vs. 1.3%, 0.38). The multivariate analysis confirmed the result of the primary outcome from the matched pair analysis and showed that ASA physical status (OR = 1.40, 95% CI = 1.08 to 1.81), emergency case (CI = 2.05, 95% CI = 1.40 to 3.00), and application of postoperative analgesia (OR = 0.70, 95% CI = 0.50 to 0.97) were independently associated with incidence of self-reported intraoperative awareness.

Conclusion: In conclusion, when supervised by an anaesthetist, resident anaesthesia management is not more likely to result in complaints about intraoperative recall than anaesthetist management.

1. Introduction

Intraoperative awareness during general anaesthesia is rare but it is one of the major anaesthesia-related complications. In the preface of the fifth National Audit Project (NAP 5) report, it says that intraoperative awareness is an intraoperative complication greatly feared by patients, and is a concern frequently raised during preoperative visits [1]. Actually, preoperative patients occasionally request experienced anaesthetists to treat their anaesthesia management in our teaching hospital. It may be reasonable to think that intraoperative awareness is a result of inadequate anaesthesia management; therefore, the incidence can be related with the experience of anaesthetists. NAP 5 reports also showed that factors increasing the risk of accidental awareness included anaesthetist seniority (junior trainees) [2]. However, this analysis resulted from a simple Chi^2 test, which may be biased by confounding factors. Therefore, it is not clear whether or not anaesthetists' experience actually affects the incidence of intra-operative awareness.

In our institute, surgical patients managed by the anaesthesia department undergo a postoperative structured interview with consultant anaesthetists at the postoperative anaesthesia consultation clinic, where the occurrence of perioperative adverse events

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https://doi.org/10.1016/j.accpm.2017.11.015

is assessed and the patients can critique perioperative management based on the filled interview form. Using these interview data, we retrospectively investigated the incidence of self-reported intraoperative awareness. Finally, we evaluated the impact of anaesthesia management by residents in anaesthesiology on self-reported intraoperative awareness. To reduce the effect of selection bias, we compared the incidence of self-reported intraoperative awareness in propensity-matched pairs with anaesthesia management by residents or by consultant anaesthetists.

2. Patients and methods

Approval for the review of patient clinical charts, access to data of the institutional registry of anaesthesia and reporting the results were obtained from the Institutional Review Board. The requirement for written informed consent was waived by the Institutional Review Board (No. 964 approved on 3-19-2015).

2.1. Perioperative patient treatment

No standardisation was made for the methods of induction and maintenance of anaesthesia. However, methods of anaesthesia did not differ so much because this study was performed in a single hospital. No premedication was used. General anaesthesia was usually induced with intravenous propofol (1–2.5 mg/kg) plus either fentanyl (1–2 μg/kg) or remifentanil (0.2–0.3 μg/kg/min), and neuromuscular blockade was achieved with rocuronium (0.6–0.9 mg/kg). In most cases, bispectral index monitoring was used; however, the decision of use depended on the attendant's preference. Tracheal intubation was performed using a Macintosh-type laryngoscope. Tracheal intubations were performed by residents under the guidance of the registered (consultant) anaesthetist or by the registered anaesthetist. A resident was defined as a medical school graduate, who had a medical qualification, in a two-year mandatory clinical training program currently on rotation in the anaesthesia department (for a couple of months) or a resident anaesthetist in a two-year training after the mandatory training. In Japan, anaesthetists can apply for registered anaesthetist status to the Ministry of Health, Labour and Welfare after two years of training as a member of the Japanese Society of Anaesthesiologists. All these residents have completed a simulation-based training course in anaesthesia and airway management and passed the practical examination about airway management. Anaesthesia management training course was also held according to the institutional anaesthesia protocol for anaesthesia residents. Anaesthesia was maintained with sevoflurane (1.5%–2%) in a 40% oxygen and air mixture or with propofol (6–10 mg/kg/h). Nitrous oxide was not used. Fentanyl (1–2 μg/kg/h) or remifentanil (0.1–0.2 μg/kg/min) were used for analgesia. Rocuronium (0.2–0.3 mg/kg/h) was used for neuromuscular blockade and sugammadex (2–4 mg/kg) since August 2010 or neostigmine (40 μg/kg) plus atropine (20 μg/kg) until July 2010 for reversal of neuromuscular blockade after evaluating the status of neuromuscular blockade by a nerve stimulator. In case of management by residents, consultant anaesthetists supervised anaesthesia management and residents could consult supervisors at any time. Immediately after patients regained consciousness, tracheal extubation was performed. Tracheal extubations were also performed by residents under the guidance of the consultant anaesthetist or by the consultant anaesthetist. Unless the trachea was extubated in the operating room, patients were transferred to the intensive care unit and managed under mechanical ventilation until tracheal extubation. Occasionally, postoperative analgesia was provided with intravenous fentanyl or epidural ropivacaine combined with fentanyl using a patient controlled analgesia device. After completion of the anaesthesia, the attendant in charge filled out the form for the institutional registry of anaesthesia, which includes the attendant's name, the name of the person who performed intubation, the patient's demographic variables, information on final diagnosis and surgical procedures (later categorised into three classes based on the modified surgical risk stratification) [3], background illnesses (hypertension, diabetes mellitus, coronary artery disease, history of heart failure, lung disease), duration of anaesthesia and surgery, American Society of Anesthesiologists (ASA) physical status, urgency of surgery (emergency or elective), anaesthesia technique (inhalational or intravenous with or without regional analgesia), intraoperative patient positioning, final airway assessment, requirement of transfusion, implementation of postoperative analgesia, requirement of postoperative intensive care, and adverse intraoperative events (cardiac events, hypotension, arrhythmia, hypoxia, etc.). The attendant in charge of the case also followed-up the patient and recorded any complication including any unpleasant experience during anaesthesia over several postoperative days. In addition, at discharge from our hospital, the patients completed a questionnaire using a self-report form, including items on intraoperative awareness. Patients were also requested to rate our perioperative care using a simplified patient satisfaction scale (very satisfactory, satisfactory, even, dissatisfactory). The incidence of intraoperative awareness was determined by referring to both the patient's report and the post-anaesthetic round record. Details of awareness were not investigated unless the patients complained, although intraoperative awareness was distinguished from the memory of tracheal extubation. Intensity of recall (implicit or explicit memory) was not distinguished either, but lumped together and treated as the final answer.

2.2. Data handling

Data were collected between January 2009 and December 2013, during which there were 21606 anaesthesia cases. The exclusion criteria for the current study (and reasons for consequent reductions in eligible patients) were as follows: [1] cases without general anaesthesia ($n = 2588$), [2] cases missing answers on the postoperative questionnaire or unable to answer the questionnaire due to disturbance of cognitive dysfunction ($n = 2285$), [3] cases < 15 years old ($n = 1525$), [4] cases missing data sets ($n = 89$) (Fig. 1).

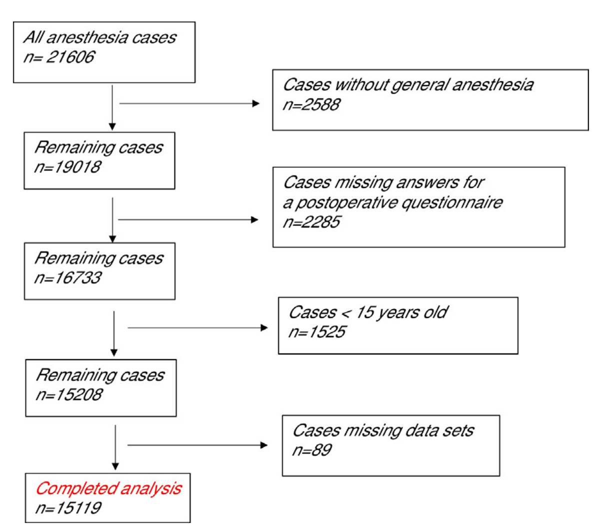

Fig. 1. Flow diagram for patient inclusion and exclusion.

2.3. Statistical analysis

Continuous variables are presented as mean ± standard deviation (SD) if normally distributed or median and interquartile range (IQR) if nonparametric. Categorical variables are presented as the number of patients and frequencies (%). Outcomes of patients managed by residents or consultant anaesthetists were compared using the initial 15,119 patients. For overall incident rate, the Fisher's exact test was used to estimate the odds ratio and 95% confidence interval (CI) of incidence (resident management vs. consultant anaesthetist management).

Next, to avoid channelling bias, we used propensity score analysis to generate a set of matched cases (resident managements) and controls (anaesthetist managements). Ultimately, 5239 patients were excluded from the analysis. A propensity score was generated for each patient from a multivariable logistic regression model based on the covariates, which included the institutional registry data items such as the patient's demographic variables, surgical risk, background illnesses, duration of anaesthesia and surgery, ASA physical status, urgency of surgery, anaesthesia technique, intraoperative patient positioning and preventive measures for deep vein thrombosis, requirement of transfusion, implementation of postoperative analgesia, postoperative ICU admission, and adverse intraoperative events, as independent variables, with treatment type (resident management vs. anaesthetist management) as a binary dependent variable. Difficult airway may influence the incidence of intraoperative awareness [4]; however, it was removed from the covariates because quite a number of patients were missing this description. As suggested by a review of statistical research on propensity score development, we used a structured iterative approach to refine this model, with the goal of achieving covariate balance between the matched pairs [5]. Covariate balance was measured using the standardised difference, where an absolute difference above 0.1 was taken as a meaningful covariate imbalance [6]. We matched patients using a greedy-matching algorithm with a caliper width 0.001 of the estimated propensity score. A matching ratio of 1:1 was used. This procedure yielded 4940 patients managed by residents propensity matched to 4940 patients managed by consultant anaesthetists. For statistical inference, methods that account for the matched nature of the samples were used. For overall incident rate, the Cochran–Mantel–Haenszel test, stratified on the matched pair, was used to estimate the odds ratio and 95 CI of incidence (resident management vs. consultant anaesthetist management). In addition, we conducted an additional multivariate logistic analysis in the entire cohort (15,119 patients) using the incidence of self-reported intraoperative awareness as dependent variable and other co-variates including experience of anaesthetists as independent variables to confirm that the experience of anaesthetists would or would not significantly associate with the risk of self-reported intraoperative awareness. Univariate analysis was used to identify factors associated with self-reported intraoperative awareness. Candidate factors having a significant univariate association ($P < 0.15$) with self-reported intraoperative awareness were used to perform multivariable logistic regression analysis by forced-entry methods. All candidate variables were entered in the initial model and presented as adjusted odds ratios with 95% confidential intervals (CI). Interactions between variables were systematically searched and collinearity was considered for r or rho > 0.8 using Pearson or Spearman coefficient matrix correlation, respectively. Discrimination of the final model for self-reported intraoperative awareness was assessed using the likelihood ratio test. Calibration of the model was tested using the Hosmer–Lemeshow statistic. Finally, in the simplified patient satisfaction scale, patients with and without self-reported intraoperative awareness were compared using the Mann-Whitney U test. Analyses were computed using R (version 3.0.3, R Foundation for Statistical Computing, Vienna, Austria). A $P < 0.05$ was considered statistically significant.

2.4. Sample size calculation

We finally conducted a sample size calculation. We assumed a 1.5% incidence of self-reported intraoperative awareness based on our clinical practice, which was quite higher than the current summary [7]. The reason is because the questionnaire used in this study just relied on patients' self-reports to determine the symptoms. We estimated that 4032 patients in each group were required to provide 95% power to detect a 1% difference in the incidence of intraoperative awareness (with an overall incidence of 1.5%) between resident management and consultant anaesthetist management, with a type I error probability of 0.05. Thus, it was safe to say that our sample size was sufficient to detect a difference in outcome.

3. Results

Median (IQR) years of experience was 1.8 (1 − 2.7) for residents and 13 (9 − 18) for consultant anaesthetists. Self-reported intraoperative awareness was observed in 184 of 15,119 patients, which comes to 1.2% of the overall incident rate. There was no patient with intraoperative awareness who resulted in a serious psychological sequelae or lawsuit case as far as the investigation was conducted through medical records. The clinical characteristics of the two groups (patients managed by residents) based on 15,119 patients are presented in Table 1.

Many of the variables were similar between groups (standardised difference < 0.1) before matching. However, variables including sex, sites of surgery, presence of co-existing disease, emergency case, implementation of regional analgesia, reports of intraoperative incident, application of compression stocking, and ICU admission were imbalanced, some of which were previously reported factors associated with intraoperative awareness. Patient outcomes are summarised in Table 2. The incidence of self-reported intraoperative awareness was lower in anaesthesia management by residents than in anaesthesia management by consultant anaesthetists (1.1% vs. 1.5%, $P = 0.028$).

The clinical characteristics of the two matched groups (patients who were managed by residents and patients who were managed by consultant anaesthetists) extracted by propensity analysis are presented in Table 3. According to the standardised difference, covariate balance between the matched pairs was confirmed. Patient outcomes are summarised in Table 4. The incidence of self-reported intraoperative awareness did not differ between anaesthesia management by residents and anaesthesia management by consultant anaesthetists after propensity matching (1.3% vs. 1.5%, 0.38).

As candidate factors associated with self-reported intraoperative awareness, 9 items were used to perform multivariable logistic regression analysis by a forced-entry method. On conducting this analysis, days taken for completion of the questionnaire were categorised into quartile intervals, assuming that the risk increased in a linear fashion among the categories as data obtained from variables were not assumed to be normally distributed. The multivariate analysis found that ASA physical status, emergency case, and application of postoperative analgesia were independently associated with incidence of self-reported intraoperative awareness (Table 5). However, anaesthesia management by residents was not associated with incidence of self-reported intraoperative awareness. Discrimination of the final model assessed by the likelihood ratio test was significant

Table 1
Clinical characteristics of the two unmatched study groups.

	Resident management (n = 9965)	Anaesthetist management (n = 5154)	Standardised difference
Age (years)	57.8 (17.6)	59.2 (17.1)	0.08
Height (cm)	159.7 (9.0)	160.3 (9.0)	0.07
Weight (kg)	58.5 (11.9)	59.1 (12.2)	0.05
BMI (kg/m^2)	22.9 (3.8)	22.9 (3.8)	0
Duration of anaesthesia (min)	259.2 (152.1)	265.3 (150.7)	0.04
Duration of surgery (min)	195.2 (141.6)	200.9 (139.5)	0.04
Days taken for completion of the questionnaire	6 [4–11]	8 [5–12]	−0.09
ASA physical status [IQR], I–V	2 [1,2]	2 [2]	−0.06
Surgical risk stratification [IQR], I–III	2 [2]	2 [1,2]	−0.05
Sex (F/M)	5567/4398	2509/2643	−0.214
Body tract surgery (no/yes)	5880/4085	2658/2496	−0.156
Supine position (no/yes)	2924/7041	1704/3450	0.096
Coexisting disease (no/yes)	3521/6444	1579/3575	−0.112
Ear-Head-Cardio-Thoracic-Gyneco (no/yes)	5757/4208	3130/2024	0.064
Emergency (no/yes)	9165/800	4503/651	−0.15
Inhalational (no/yes)	2059/7906	960/4194	−0.061
Postoperative analgesia provided by PCA (No/Yes)	6122/3843	3039/2115	−0.053
With regional analgesia (no/yes)	7918/2047	3800/1354	−0.135
Intraoperative incident (No/Yes)	9933/32	5133/21	0.765
IPC (no/yes)	3771/6194	2029/3125	0.036
Stocking (no/yes)	906/9059	718/4436	0.203
Transfusion (no/yes)	8545/1420	4274/880	−0.077
ICU admission (no/yes)	8526/1439	3864/1290	−0.265

Values are mean (SD), median [IQR], or number. BMI: body mass index; ASA: American Society of Anesthesiologists; PCA: patient controlled analgesia; IPC: intermittent pneumatic compression; ICU: intensive care unit. Body tract surgery includes surgical procedures reach the pleural cavity, mediastinum, peritoneal cavity, or retroperitoneum. Ear-Head-Cardio-Thoracic-Gyneco means surgical procedures in the fields of otorhinolaryngology, neurosurgery, cardiothoracic surgery, gynaecology, which have been reported to have a higher incidence of intraoperative awareness. IPC was used for a preventive measure of deep vein thrombosis. We assumed that this device might disturb patient's sleep. Stocking means compression stockings for a preventive measure of deep vein thrombosis. We arbitrarily assumed that wearing stockings might affect patient's sleep.

Table 2
Patient outcome prior to matching.

	Resident management	Anaesthetist management	Odds ratio (95%CI)	Effect size	P value
Incidence of self-reported intraoperative awareness (n = no/yes)	9858/107	5077/77	0.72 (0.52–1.97)	−0.036	0.28

Table 3
Clinical characteristics of the two study groups after propensity score matching.

	Resident management (n = 4940)	Anaesthetist management (n = 4940)	Standardised difference
Age (years)	58.7 (17.5)	59.1 (17.1)	0.02
Height (cm)	160.2 (9.1)	159.9 (8.9)	−0.03
Weight (kg)	59.0 (12.2)	58.8 (11.0)	−0.02
BMI (kg m^{-2})	22.9 (3.8)	22.9 (3.8)	0
Duration of anaesthesia (min)	263.8 (155.2)	262.7 (147.2)	−0.01
Duration of surgery (min)	199.5 (144.3)	198.3 (136.2)	−0.01
Days taken for completion of the questionnaire	7 [5–12]	8 [5.12]	−0.03
ASA physical status [IQR], I–V	2 [2]	2 [2]	0
Surgical risk stratification [IQR], I–III	2 [2]	2 [2]	0
Sex (F/M)	2451/2489	2486/2454	0.014
Body tract surgery (no/yes)	2609/2331	2612/2328	0.001
Supine position (no/yes)	1650/3290	1627/3313	−0.01
Coexisting disease (no/yes)	1532/3408	1551/3389	0.008
Ear-Head-Cardio-Thoracic-Gyneco (no/yes)	3085/1855	3027/1913	−0.024
Emergency (no/yes)	4397/543	4385/555	−0.008
Inhalational (no/yes)	917/4023	935/4005	0.009
Postoperative analgesia provided by PCA (no/yes)	2893/2047	2916/2024	0.009
With regional analgesia (no/yes)	3632/1308	3663/1277	0.014
Intraoperative incident (no/yes)	4919/21	4923/17	0.013
IPC (no/yes)	1852/3088	1896/3044	0.018
Stocking (no/yes)	599/4341	618/4322	0.012
Transfusion (no/yes)	4144/796	4158/782	0.008
ICU admission (no/yes)	3855/1085	3841/1099	−0.007

Values are mean (SD), median [IQR], or number. BMI: body mass index; ASA: American Society of Anesthesiologists; PCA: patient controlled analgesia; IPC: intermittent pneumatic compression; ICU: intensive care unit. Body tract surgery includes surgical procedures reach the pleural cavity, mediastinum, peritoneal cavity, or retroperitoneum. Ear-Head-Cardio-Thoracic-Gynaeco means surgical procedures in the fields of otorhinolaryngology, neurosurgery, cardiothoracic surgery, gynaecology, which have been reported to have a higher incidence of intraoperative awareness. IPC was used for a preventive measure of deep vein thrombosis. We assumed that this device might disturb patient's sleep. Stocking means compression stockings for a preventive measure of deep vein thrombosis. We arbitrarily assumed that wearing stockings might affect patient's sleep.

Table 4
Patient outcome after propensity matching.

	Resident management	Anaesthetist management	Odds ratio (95%CI)	Effect size	P value
Incidence of self-reported intraoperative awareness (n = no/yes)	4879/61	4868/72	0.84 (0.60–1.19)	−0.019	0.38

Table 5
Multivariate logistic regression model for self-reported intraoperative awareness.

Variable	Odds ratio	95%CI	P value
ASA physical status (I–V)	1.3983	1.0781 to 1.8136	0.0115
Height (cm)	0.9855	0.9697 to 1.0016	0.0764
Days taken for completion of the questionnaire	1.0394	0.8992 to 1.2015	0.6008
Resident (yes)	0.8179	0.6043 to 1.1069	0.1929
Compression stocking (yes)	0.6857	0.4616 to 1.0187	0.0618
Emergency (yes)	2.0477	1.4001 to 2.9950	0.0002
Postoperative analgesia provided by PCA (yes)	0.6967	0.5026 to 0.9658	0.0301
Transfusion (yes)	1.1339	0.7559 to 1.7009	0.5435
ICU admission (yes)	1.0623	0.7152 to 1.5780	0.7645

ICU: intensive care unit; ASA: American Society of Anesthesiologist; PCA: patient controlled analgesia. Days taken for completion of the questionnaire were categorised into quartile intervals. Compression stocking; we arbitrarily assumed that wearing stockings might affect patient's sleep.

($P < 0.0001$). Furthermore, the Hosmer–Lemeshow statistic did not reject a logistic regression model fit ($P = 0.6916$). Post-hoc power calculations were performed for this forced entry multivariate logistic regression model using 9 variables in the model. We followed standard methods to estimate the sample size for multivariate logistic regression, with at least ten outcomes needed for each included independent variable [8]. With a 1.2% (184/15,119) incidence of self-reported intraoperative awareness in the study population, we required 7500 patients to appropriately perform multivariate logistic regression. This demonstrates that our sample sizes were sufficient to build the models.

Finally, patients with self-reported intraoperative awareness rated significantly lower satisfaction scores (3 [3,4]) than patients without awareness (4 [3,4]: $P < 0.00001$).

4. Discussion

In the present study, we investigated whether anaesthesia management by residents could increase the incidence of self-reported intraoperative awareness compared with anaesthesia management by anaesthetists. Based on the patients' raw data, contrary to our hypothesis, anaesthesia management by anaesthetists increased the incidence of self-reported intraoperative awareness compared with anaesthesia management by residents. However, based on this propensity score analysis of patient data, anaesthesia management by anaesthetists did not increase the incidence of awareness. This was confirmed with the additional multivariate logistic analysis in the entire cohort. Additionally, patient satisfaction was lower in patients with self-reported intraoperative awareness than in patients without self-reported intraoperative awareness.

The incident rate of awareness in our population was 1.2%, which is up to tenfold higher than the previous reports [7]. It has been reported that prospective methods using questionnaires detect substantially more event awareness than approaches based on spontaneous patient reports [9]. Simultaneously, however, a concern regarding prospective methods using questionnaires is that they might have the potential to elicit false reports or memories [10]. Most previous reports judged the cases and only included certain/probable and possible accidental awareness cases in their analysis. However, we included all self-reported intraoperative awareness cases based on questionnaires but without any specific validation in our analysis. Therefore, it is highly probable that the majority of our awareness cases were not true intraoperative awareness cases, which means that such patients might have misunderstood that their experience had happened during anaesthesia, for example, such patients might have been dreaming intraoperatively or postoperatively [11,12]. However, awareness is a very subjective feeling. Thus, we would like to investigate the self-reported intraoperative awareness as one of patients' complaints related with perioperative management. In addition, the secondary reason why we chose this unusual population for this kind of study was because our data are historical cohort, which there were no case notes available to verify [13]. Therefore, it is not unreasonable to obtain 1.2% of the overall incident rate of self-reported intraoperative awareness from our historical cohort.

It is reasonable to suppose that intraoperative awareness is a result of inadequate anaesthesia management. Therefore, we hypothesised that the incidence of self-reported intraoperative awareness can be also related with the experience of anaesthetists. According to the NAP5 report, inexperience of anaesthesia could increase the incident rate [7]. However, contrary to our hypothesis, anaesthesia management by anaesthetists increased the incidence of self-reported intraoperative awareness compared with anaesthesia management by residents based on the raw data analysis. This might be explained by the nature of the raw data analysis. It has been reported that the incidence of intraoperative awareness is associated with surgical and anaesthetic settings and patient's pathophysiological status as well as environmental factors [7]. Patient's background in the raw data analysis was not well balanced before matching. Therefore, we can understand that the incidence of awareness in anaesthesia management by anaesthetists was higher than residents because the background of anaesthetists' patients included relatively more risk factors than that of residents' patients in the entire cohort.

In the results from the matching data, the incidence of self-reported intraoperative awareness cannot be related with the experience of anaesthetists, either. As mentioned in the Methods section, all the residents had been well trained in advance of their clinical debut as resident anaesthetists. Therefore, it is not unreasonable to think that the completion of our simulation-based training program before the beginning of clinical activity and anaesthesia management under supervision by consultant anaesthetists favourably affected the outcomes. Although the usage rate for the bispectral index monitor is not available in our cohort, the recommendation for its use in the standard protocol might have affected the study results. Because this monitor must have been used in not a few cases, it should have worked favourably in preventing intraoperative awareness compared with clinical signs [9] and could have compensated inexperience of anaesthesia.

Incidentally, our logistic model for incidence of self-reported intraoperative awareness revealed ASA physical status, emergency case, and application of postoperative analgesia, but not the inexperience of anaesthesia, were independently related with self-reported intraoperative awareness. Regarding the factors of intraoperative awareness, they are still a matter of debate; however, it seems reasonable that intraoperative awareness could happen more frequently in patients with poorer physical conditions and emergency cases because they should be managed at a lower dose of general anaesthetic drug to reduce the probability of serious side effects [4,7]. However, the majority of our cases might not be true intraoperative cases. Therefore, this explanation is unaccountable. A recent review suggested that major patient factors for sleep disorder in critically ill patients are the type and severity of underlying illness, the pathophysiology of the acute illness, pain [14]. Our majority of patients might have misunderstood their postoperative dreams as intraoperative experience because of their sleep disorder. Application of postoperative analgesia was significantly related with a low incidence of self-reported awareness. Postoperative pain control might have prevented sleep disorder, resulting in reducing their misperception of postoperative experience.

With regard to outcomes of self-reported intraoperative awareness in our population, we reported that there was no patient with intraoperative awareness who resulted in a serious psychological sequelae or lawsuit case. However, in case of true intraoperative awareness, there could be no room for anyone to oppose that true intraoperative awareness can lead to post-traumatic stress disorder [9]. Even though we treated self-reported intraoperative awareness, the majority of which may not true intraoperative awareness, patients with self-reported intraoperative awareness rated significantly lower satisfaction scores than patients without awareness. We need to recognise that self-reported intraoperative awareness can spoil the quality of anaesthesia whether or not it is true.

There are several limitations of the study that merit discussion. There is a growing interest in the use of propensity score-based methods in observational studies to estimate treatment effects. The propensity score is defined as the conditional probability of assigning a subject to a particular treatment protocol given a vector of measured covariates [15,16]. To minimise the effect of selection bias on outcomes, we used a propensity score matching for clinical characteristics to reduce distortion by confounding factors. However, this study was retrospective in nature; thus, unmeasured variables could still confound the results. We used data from the institutional registry of anaesthesia, which includes only minimum essential information about each case but does not include precise details. Therefore, we did not obtain several variables, which might have affected recall of intraoperative awareness. However, our anaesthesia practices were relatively constant during the sampling period, so the effects of unmeasured variables were likely minimal. Finally, a considerable number of patients was excluded from the study. However, the excluded patients might not have affected the results because the exclusion was performed according to the objective criteria and the missing data were at least missing at random.

5. Conclusions

When supervised by an anaesthetist, anaesthesia management by resident is no more likely to result in complaint about intraoperative recall than anaesthesia management by anaesthetist although this conclusion was derived from the results of a retrospective observational study.

Ethical statement

Approval for review of patient clinical charts and access to data of the institutional registry of anaesthesia, and reporting the results was obtained from the Institutional Review Board (Chairman Prof. Kurumatani). The requirement for written informed consent was waived by the Institutional Review Board (No. 964 approved on 3-19-2015).

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosure of interest

The authors declare that they have no competing interest.

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