

# Intraoperative awareness during general anaesthesia: results of an observational study

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## Abstract

**Background:** Intraoperative awareness is a rare but extremely unfavourable phenomenon affecting 0.1–0.2% of patients who undergo surgery under general anaesthesia. The event exposes patients to stress and its remote, severe outcomes. The aim of the present study was to determine the incidence of intraoperative awareness in patients undergoing general anaesthesia.

**Methods:** The observational questionnaire-based study was carried out in patients treated in one centre during a period of 8 months. Anaesthesia depth was monitored clinically using measurements of end-tidal concentration of volatile anaesthetic agent. After anaesthesia, accounts of patients regarding possible intraoperative awareness were analysed. Awareness was defined as recall events are confirmed or have a high likelihood of occurring in the intraoperative period.

**Results:** Data from 199 patients were analysed. None of them experienced awareness during general anaesthesia (category A). Possible intraoperative awareness was observed in one patient (0.5%) (category B), and 17 patients (8.5%) experienced intraoperative dreaming.

**Conclusion:** The incidence of intraoperative awareness in our study was low. The intraoperative monitoring including clinical analysis of anaesthetized patient as well as measurement of end-tidal concentration of volatile anaesthetic agent seems to be sufficient for prevention of episodes of awareness during general anaesthesia.

**Key words:** anaesthesia, general, intraoperative awareness; anaesthesia, general, depth monitoring

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Intraoperative awareness is a rare, albeit extremely unfavourable, event during general anaesthesia. Its incidence is estimated at 0.1% to 2% of anaesthetic procedures in the general population [1–12]. Analyses of intraoperative awareness usually exclude general anaesthesia for Caesarean sections and in severely ill patients where doses of anaesthetics are often reduced. Moreover, 4–56% of patients with intraoperative awareness develop posttraumatic stress disorder (PTSD) [2, 13–16]. The symptoms of PTSD can occur as much as 2 years after the episode of intraoperative awareness.

Intraoperative awareness during general anaesthesia is the second most common concern of patients, following anxiety associated with possible vomiting [17]. Moreover, awareness during anaesthesia is a frequent reason for compensation claims [18]. In the United States, 21 million ge-

neral anaesthesias are performed annually. Assuming the incidence of awareness mentioned above, the problem affects 20,000–40,000 patients annually, i.e., 100–200 patients daily [2]. In Germany (with an annual total of 8 million anaesthesias), 8,000–16,000 patients may experience intraoperative awareness each year; its consequences will develop in approximately 30–50% of them [19]. In Great Britain, amongst 1 067 litigation claims submitted to the National Health Service Litigation Authority in the years 1995–2007, 161 complaints concerned general anaesthesia, including 99 cases of intraoperative awareness during general anaesthesia and difficulties in breathing during surgery. The average compensation was 32,000 pounds [18]. In Poland, contrary to Anglo-Saxon countries, the literature concerning intraoperative awareness is scarce; moreover, there are no registers of such complications. Considering

the magnitude of the problem, in 2012, the Polish Society of Anaesthesiology and Intensive Therapy presented its stance on the issue and published guidelines [20].

In order to determine whether intraoperative awareness occurred during anaesthesia, it is essential to talk to patients during the postoperative period. Using the Internet, specialists in anaesthesiology were asked about visiting anaesthetised patients on the day following anaesthesia. Seventy-two physicians responded. In 71% of cases, patients were visited “when something was going on”; in 17%, rarely; and in 2%, always. The answer “never” was not chosen. The questionnaire results demonstrate that postoperative visits are not routine management in Poland, as opposed to some countries where such visits are obligatory [2].

Inspired by this issue, we conducted this study to evaluate intraoperative awareness in patients undergoing general anaesthesia.

## METHODS

The study design was approved by the Bioethics Committee of the Military Medical Institute (no. 8/WIM/2012). The study included patients (aged > 16 years, without neuropsychological disorders preventing them from responding to the questionnaire) who were scheduled for surgical procedures at the Military Medical Institute in Warsaw under general anaesthesia in the departments of general surgery, gynaecology, neurosurgery, traumatology, orthopaedics and laryngology over a period of 8 months (01.06.2011–31.01.2012).

The choice of anaesthesia for a given surgical procedure depended on the anaesthetist’s clinical experience, the patient’s condition and the type of surgery. In all patients, vital functions were monitored during anaesthesia according to the current recommendations. During inhalation anaesthesia, end-expiratory concentrations of volatile anaesthetics (sevoflurane or desflurane) were monitored. Nitrous oxide was not used. The depth of anaesthesia was assessed based on the patient’s clinical status and minimal alveolar concentrations (MAC) of volatile anaesthetics. Instrumental monitoring of anaesthesia depth was not carried out. Volatile anaesthetic concentrations were within the range of 0.5–1.2 MAC et MAC (end-tidal)

The incidence of intraoperative awareness was assessed using the Brice questionnaire [21], which was modified for the purposes of our study; i.e., the statistical portion that the physician completed during the visit was added, and questions for patients were extended to encourage them to provide accounts that were more descriptive. The questionnaire was structured similarly to questionnaires used in other studies focusing on detection of intraoperative awareness [1, 2, 4, 9].

Physicians involved in the survey visited patients postoperatively; after conversations with the patients, they completed the questionnaire, which was subsequently verified by anaesthesiologists in charge of assessing intraoperative awareness. The following questions were included:

1. What is the last thing you remember before going to sleep?
2. What is the first thing you remember after waking up?
3. Do you remember anything between going to sleep and waking up? (possible answers: yes, no); If you do, what is it? (light, sound, pain, dyspnoea, etc.).
4. Did you dream during surgery? (yes, no), If so, what did you dream about?
5. What was the worst thing that you remember about surgery and anaesthesia?

The second part of the questionnaire was used to collect data concerning patients and anaesthetic procedures required for statistical analysis: age, gender, ASA score, type of anaesthesia and premedication, muscle relaxants used, time between anaesthesia and administration of the questionnaire, data regarding possible earlier awareness, and substances or drugs used.

The patients’ reports were classified as definite awareness (A), possible awareness (B) and no awareness (C), which is consistent with the classifications commonly used in the literature [2, 4, 8, 9, 22]. A recalled event occurring during anaesthesia/surgery that was confirmed (or otherwise) by the attending personnel present in the operating room was considered awareness (A). A situation in which the patient was unable to remember any particular event during anaesthesia/surgery, yet memories could have been associated with the surgical procedure was defined as possible awareness (B). A lack of recalled intraoperative events with probable memories of situations associated with the immediate pre- or postoperative period was classified as no awareness (C).

Moreover, the incidence of dreaming during surgery was assessed. As in other studies, intraoperative dreaming was classified as a separate event and not as awareness [2, 5, 21, 23, 24].

The results were archived using Microsoft Office 2010. Statistical analysis was performed using the R software package [25]. Distribution of data on the interval scale was analysed using the Shapiro-Wilk test.

## RESULTS

Forty-four of 263 invited patients refused to take part in the study. Twenty patients were excluded, including 2 who did not complete the statistical portion (no data about the type of anaesthesia), 2 who underwent sedation and not general anaesthesia, 2 below the age of 16 years, and 14 patients subjected to total intravenous anaesthesia.

The data from 199 patients were analysed, including 73 (36.7%) men and 126 (63.3%) women. The median age of the participants was 46 years (95% CI: 39–52). The physical status of the participants was assessed as follows: ASA I: 101 (50.8%); ASA II: 75 (37.7%); and ASA III: 20 (10.1%). In the case of 3 (1.5%) patients, there were no data about preoperative ASA physical status.

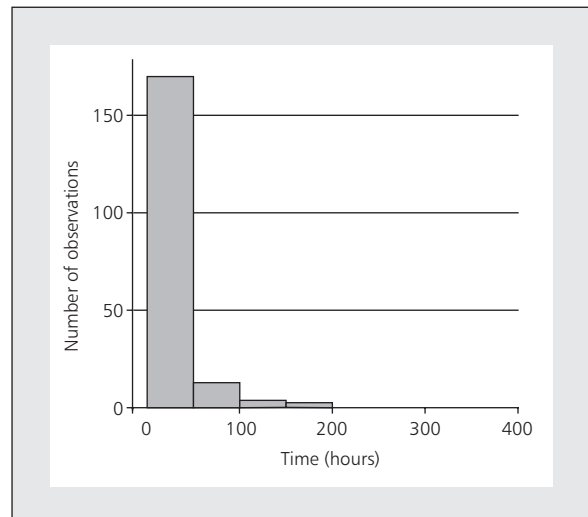
One hundred and two patients (51.2%) were premedicated with benzodiazepines. Other drugs were administered to 19 (9.5%) patients, and 72 (36.7%) individuals were not pharmacologically premedicated. There were no data concerning premedication in 5 (2.52%) cases. Thirty-five (17.6%) patients underwent volatile induction and maintenance of anaesthesia (VIMA); 163 (81.9%) individuals had intravenous induction and volatile maintenance of anaesthesia (using sevoflurane or desflurane). Muscle relaxants were used in 182 (91.5%) patients.

The median of time from anaesthesia completion to questionnaire completion was 24 hours (95% CI: 24–26). The data concerning this time are presented in Figure 1.

There were no events that could be classified as intraoperative awareness (category A). One of the patients (0.5%) remembered conversations “just before waking up”. This patient was a 21-year-old man without addictions or a history of earlier episodes of awareness whose pre-operative physical status was assessed as ASA I. The patient was not premedicated. He was anaesthetised by a resident under the supervision of a specialist. Anaesthesia was induced intravenously and maintained with inhalational desflurane. The patient did not dream during anaesthesia. His report was classified as possible awareness during anaesthesia (category B). Five patients (2.5%) recalled the sensation of “light”; in two cases (1%), this sensation was associated with the lamp hanging above the operating table they remembered before going to sleep. One patient (0.5%) remembered some sounds; one female patient (0.5%) reported pain associated with the urinary catheter, which was also her recall from the period immediately following the completion of anaesthesia. The above descriptions were classified as category C. The remaining patients (96%) did not remember anything between going to sleep and waking up.

Dreaming during anaesthesia was noted in 17 (8.5%) patients. Dreams were reported by one patient who had intraoperative recall of a “light” sensation. This patient was a 21-year-old ASA I man who was not premedicated and who underwent inhalation anaesthesia using a laryngeal mask. Muscle relaxants were not used during anaesthesia.

The memories of patients from the period immediately before going to sleep, dreaming during anaesthesia, situations remembered immediately after waking up and a summary of the perioperative situations remembered by patients as unpleasant are listed in Tables 1, 2, 3 and 4, respectively.



**Figure 1.** Time to filling out the postoperative questionnaire

## DISCUSSION

Intraoperative awareness is a subjective sensation, whereas verification and classification of patient's reports are based on the criteria selected by the physician assessing

**Table 1.** Events remembered by respondents before going to sleep

Event	Number (%)
None	28 (14.07)
Preparation for surgery/anaesthesia	38 (19.10)
Mask/breathing through a mask	26 (13.07)
Conversation with an anaesthesiologist	24 (12.06)
Operating room/personnel	20 (10.05)
Anaesthesiologist	13 (6.54)
Conversations in the operating room	10 (5.01)
Lamp above the operating table	9 (4.52)
Insertion of iv line	6 (3.02)
Administration of drugs	5 (2.51)
Fear	4 (2.01)
Dizziness	2 (1.01)
Clock	2 (1.01)
Sensation of falling asleep	2 (1.01)
“Hand stinging” associated with a drip	2 (1.01)
Singing a song	1 (0.50)
Entering the operating room	1 (0.50)
Need to go to the toilet	1 (0.50)
Fear of surgery outcome	1 (0.50)
Birthday wishes	1 (0.50)
Anxiety	1 (0.50)
Cold	1 (0.50)
Intubation (fibroscopic under local anaesthesia and sedation)	1 (0.50)

**Table 2.** Nature of dreams during general anaesthesia

Category	Number (%)
Nothing	182 (91.46)
I don't remember what, but I dreamed	7 (3.52)
Vacation	3 (1.51)
Motorcycle	1 (0.50)
Friends	1 (0.50)
Cinema	1 (0.50)
Digging holes	1 (0.50)
Designing a garden	1 (0.50)
Something pleasant	1 (0.50)
Strange dream	1 (0.50)

**Table 3.** Events remembered by patients after recovery from anaesthesia

Category	Number (%)
Nothing	30 (15.07)
Recovery room	51 (25.63)
Calling of the anaesthesiologist	17 (8.54)
Wheeling to the recovery room	15 (7.54)
Pain	14 (7.03)
Transfer to the bed	10 (5.03)
Conversation with the physician about surgery	9 (4.52)
Waking up in the operating room	7 (3.52)
Family	7 (3.52)
Conversations in the operating room	3 (1.51)
Anaesthesiologist	6 (3.02)
Personnel of the operating room	4 (2.01)
Light of the lamp above the operating table	3 (1.51)
Breathing through a mask	3 (1.51)
Coldness	2 (1.01)
Pain in the throat	2 (1.01)
Nausea	2 (1.01)
"I felt well"	2 (1.01)
"I am dead"	1 (0.50)
Dyspnoea	1 (0.50)
Desire to smoke	1 (0.50)
Sun in the sky	1 (0.50)
Dressing	1 (0.50)
Fog	1 (0.50)
administration of drugs	1 (0.50)
"Do I have a leg?"	1 (0.50)
Dream	1 (0.50)
Operating room	1 (0.50)
Paralysis	1 (0.50)
Answer "yes" but without more precise description	1 (0.50)

**Table 4.** Unpleasant events connected with surgery and anaesthesia remembered by patients

Category	Number (%)
None (there was no such event)	124 (62.31)
Insertion of iv line	14 (7.04)
Pain	11 (5.53)
Stress	11 (5.53)
Fear	8 (4.02)
Vomiting	7 (3.52)
Difficulties in breathing through the nose (tamponade)	5 (2.51)
Cold	4 (2.01)
Waking up	3 (1.51)
Removal of a surgical drain after surgery	2 (1.01)
Dyspnoea	2 (1.01)
Provision of regional anaesthesia	1 (0.50)
Recovery room	1 (0.50)
Presence of a gastric probe in the nose	1 (0.50)
Dizziness	1 (0.50)
Disorientation	1 (0.50)
Fainting after surgery	1 (0.50)
Comments of surgeons about surgery	1 (0.50)
"That I had to wake up"	1 (0.50)

the event. In our analysis, we used the recommendations that are most commonly accepted in the literature [2, 4, 8, 9, 22, 26]. According to these criteria, patients with perioperative recall can be divided into those who recall concrete events associated with the surgery (awareness) and those who cannot describe their sensations precisely enough to consider them as fragments of events that occurred during surgery [4, 8, 9, 22]. The opinion that each anaesthesia-related memory, both real and possible, should be considered as unintended awareness is less common [1, 5, 6], and such assumptions were not used in our study.

Analysis of the material has indicated that only one patient can be classified as category B (possible intraoperative awareness). Researchers from Great Britain and the United States define intraoperative awareness as situations in which patients describe events that actually occurred during surgery; possible yet unconfirmed incidents are considered separately [2, 4, 8, 9, 22]. According to the above criteria, which are those most commonly used, we did not confirm any adverse events, i.e., intraoperative awareness. Considering the size of the population studied and the incidence of intraoperative awareness reported by other authors, the result is likely.

Intraoperative awareness is more common in patients undergoing total intravenous anaesthesia [6, 10] and those receiving muscle relaxants [1, 2, 27]. Determinations of

anaesthetic concentrations during intravenous anaesthesia in the real-time are not possible. Due to administration of striated muscle relaxants, patients cannot signal adverse events during anaesthesia. In our study, patients undergoing total intravenous anaesthesia were not included; muscle relaxants were used in 91.5% of the cases. The patient whom we considered as having possible intraoperative awareness underwent inhalation anaesthesia. The available literature describes a higher incidence of intraoperative awareness with total intravenous anaesthesia [1, 6, 10]. In 2012, was published a large randomized clinical trial involving 30,000 people. [26] It has been shown that in patients anaesthetized without the use of instrumental monitoring, and without the use of standardized (based on MAC) protocol anaesthesia – definite and possible intraoperative awareness during anaesthesia occur almost fivefold higher [26].

In our study, one patient underwent endotracheal intubation that was defined as difficult. Following the administration of sedatives, the trachea was intubated using a bronchofiberscope under local anaesthesia. The patient did not remember this situation as unpleasant; he mentioned it as the last event he remembered before going to sleep.

In 71% of the cases, anaesthesia was performed by residents who were supervised by specialists. Monitoring of anaesthesia depth was based on observation of vital parameters and activity of the vegetative system. All anaesthetic procedures were maintained with an inhalation anaesthetic, and the end-expiratory anaesthetic concentration, the parameter essential for assessment of anaesthesia depth, was monitored [4, 26, 28]. Analysis of the results reveals that the incidence of intraoperative awareness in the study group can be considered low and the study findings satisfactory.

Some limitations, however, can reduce the study's objectivity. Conversations with patients in the postoperative period were carried out only once and at various time intervals following the completion of anaesthesia. In the majority of studies, such assessments are performed twice or three times: in the operating room, on day 1–3 after anaesthesia and 2–4 weeks after anaesthesia [1–5, 8, 9, 16, 26, 28], which is likely to increase the detection rates of adverse events [1, 2, 4].

The authors of this study reported by patient's dreams (like most of researchers) classified as a separate category of events unrelated to the intraoperative awareness. The occurrence of dreams is sometimes associated with too little depth of anaesthesia [2, 5, 21, 23, 24]. Dreaming during anaesthesia is reported by 1–22% of anaesthetised patients [2, 5, 24]. In our study group, 8.5% of patients undergoing inhalation anaesthesia reported dreaming. According to Samuelsson and co-workers [5], the incidence of intraoperative awareness is as much as 19 times higher in patients who had dreams during general anaesthesia.

Our results confirm that clinical evaluation of anaesthesia depth together with monitoring of end-tidal concentration of volatile anaesthetic agent are effective measures to prevent intraoperative awareness. We found no cases of the most unpleasant sensations, such as pain and choking with concomitant anxiety and terror.

The development and common use of non-invasive techniques of anaesthesia monitoring, such as entropy, bispectral index and evoked auditory potentials combined with clinical observation of patients and experience of anaesthesiologists should further reduce the incidence of intraoperative awareness and its adverse sequelae [3, 8, 26].

## CONCLUSIONS

1. The incidence of awareness with recall during general anaesthesia is low.
2. The intraoperative monitoring including clinical analysis of anaesthetized patient as well as measurement of end-tidal concentration of volatile anaesthetic agent seems to be sufficient for prevention of episodes of awareness during general anaesthesia.

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