# **AWARENESS DURING ANAESTHESIA**

DR. GANESH PRABU., HOD & Prof. Madurai Medical College

Awareness during anaesthesia can be very distressing for a patient, particularly if accompanied by recall of the painful nature of surgery. This article explores the types, incidence, consequences, causes, management and avoidance of intraoperative awareness.

# **TYPES OF AWARENESS**

There are different levels of awareness that can occur ranging from complete recall to no evidence of awareness

1. Conscious awareness with spontaneous recall – EXPLICIT recall
2. Conscious awareness with amnesia
3. Dreaming
4. Unconscious awareness with amnesia – IMPLICIT recall
5. No evidence of awareness

The formation of explicit and implicit memories during anaesthesia and surgery is considered potentially damaging to the human psyche. Explicit memory may be recalled spontaneously, or may be provoked by postoperative events or questioning. In contrast, implicit memory may not be consciously recalled, but may affect behaviour or performance at a later time. Awareness of conversations during surgery may be distressing for a patient, but awareness of total paralysis or the excruciating pain of surgical incision may alter a patient’s life permanently. The consequences of intraoperative awareness are discussed below.

**INCIDENCE:**

Most cited rate is .2% It varies with studies, patients characteristics and types of surgery.

Cardiac surgery : 1 .14 – 15%

Obstetric Surgery : 0.4%

Trauma Cases : 11 – 43%

Awareness with Pain: 0.01 – 0.5%

**RISK FACTORS:**

1. Light Anaesthesia (Low Inhalation)
2. Specific types of Surgery
3. Young age
4. Obesity
5. H/O Intra Operative awareness
6. Inadequate delivery system
7. Chronic use of CNS depressants

# **IMPLICATIONS**

Awareness may have psychological sequelae for the patient, which include: insomnia, depression, anxiety and post-traumatic stress disorder (PTSD) with distressing flashbacks. The majority of patients who have suffered intraoperative awareness fears future surgery and anaesthesia.

The occurrence of intraoperative awareness also has consequences for the anaesthetist. Recent examination of the American Society of Anesthesiologists’ (ASA) Closed Claim Project revealed that 2% of all claims were for awareness. Such claims are frequently successful, and poor anaesthetic technique is often blamed.

# **CAUSES**

The risk of awareness correlates with depth of anaesthesia. Light anaesthetics, particularly where the patient is paralysed by a neuromuscular blocking agent, are associated with the highest risk of awareness. The depth of anaesthesia may be unduly light for several reasons. These are described below.

## SELECTION OF INADEQUATE ANAESTHETIC DOSE

Awareness is frequently associated with poor anaesthetic technique. Errors include the omission or late commencement of a volatile agent, inadequate dosing or failure to recognize the signs of awareness. Under-dosing of anaesthetic agent may occur during hypotensive episodes, when anaesthetic is withheld in an attempt to maintain arterial pressure. A number of surgical scenarios are associated with a higher risk of intraoperative awareness. These include: cardiac surgery, emergency surgery, surgery associated with significant blood loss and Caesarean section.

The selection of anaesthetic dose is based upon the patient’s expected requirement. Patients vary significantly. Compared with young adults, there is a ~25% increase in minimum alveolar concentration (MAC) for volatile agents in young children, and a 25% reduction in the elderly. There is also a normally distributed variability in MAC that is independent of age. There is evidence that the equivalent MAC concept for intravenous agents, i.e. minimum inhibitory concentration (MIC), has a greater variability. Thus, i.v. anaesthesia may be associated with an increased risk of under-dosage and awareness. A further reason that awareness may be more likely during total i.v. anaesthesia (TIVA) than during inhalational anaesthesia is that it is not possible currently to monitor, in real-time, the concentration of i.v. agents in the blood, while it is possible to monitor exhaled nitrous oxide and volatile agents.

A volatile agent’s MAC value describes the concentration required, at 1 atm ambient pressure, to prevent 50% of subjects moving in response to a stimulus. It is clear that this definition does not embrace awareness or recall. Fortunately, clinical investigations have shown a reasonably reliable association between recall and MAC; patients exhaling more than 0.8 MAC are unlikely to recall intraoperative events, and spontaneous recall is virtually eliminated if >1 MAC is exhaled.

End-tidal volatile concentration is not necessarily equivalent to brain partial pressure, and factors affecting this relationship will be discussed below.

## RESISTANCE TO ANAESTHETIC AGENTS

Factors associated with a degree of resistance to anaesthetic agents include: pyrexia; hyperthyroidism; obesity; anxiety; young age; tobacco smoking; regular, heavy alcohol use; use of recreational drugs (e.g. opioids, amphetamines, cocaine); chronic use of sedatives (e.g. temazepam); and previous and repeated exposure to anaesthetic agents. Factors associated with a reduction in MAC include: hypocapnia, pregnancy, hypothyroidism, hypothermia, hypotension, increased atmospheric pressure and old age. Increased atmospheric pressure does not alter brain sensitivity to anaesthetic agents, but increases the inspired and brain partial pressures for given inspired concentration. Depth of anaesthesia is related to brain partial pressure of the agent.

## EQUIPMENT MALFUNCTION

Breathing system malfunctions and disconnections have been associated with awareness. Vaporizers may malfunction in a number of ways, each having the potential to deliver an inadequate dose of anaesthetic. These include: an empty vaporizer, miscalibration, impurities in the volatile agent (reducing its saturated vapour pressure) and disconnection from the anaesthetic machine. Blockage of an i.v. infusion pump or catheter, disconnection from the cannula or extravascular location of the cannula may risk awareness during TIVA.

## MASKING THE SIGNS OF AWARENESS

The clinical signs of awareness may be masked by some disease states and concurrent medications. These are described in Table.

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| **Sign of Awareness** | **Factors masking the sign** |
| Tachycardia | Heart block, b-blockers, hypothyroidism, autonomic neuropathy (e.g. diabetes, renal failure) |
| Hypertension | Heart block, b-blockers, hypothyroidism, vasodilators, epidural analgesia, blood loss, autonomic neuropathy |
| Sweating | Anti-muscarinic drugs (e.g. atropine, glycopyrrolate) |
| Tear production | Anti-muscarinic drugs, eye tape/ointment |
| Movement/ grimacing | Neuromuscular blocking agents, sheets covering the patient |
| Tachypnoea | Neuromuscular blocking agents |
| Pupillary dilatation and reactivity to light | Anti – muscarinnic drugs, opioids, ocular pathology, eye tape / ointment. |

# **RECOGNIZING AWARENESS**

The signs of awareness are generated through sympathetic activation. These signs include: sweating, tachycardia, hypertension, tear formation, pupil dilatation and pupil reactivity to light (see the table). Apparently anaesthetized, unparalysed, patients experiencing noxious stimulation may move or grimace and this may be associated with postoperative recall of intraoperative events.

Awareness during anaesthesia may also be recognized through the use of a monitor of depth of anaesthesia

**MONITORING THE DEPTH OF ANAESTHESIA**

Depth of anaesthesia may be assessed through clinical examination. Intermittent checking for clinical signs has a low sensitivity and specificity for detecting awareness but, when used in combination with one of the other methods described below, the sensitivity and specificity are increased.

The most commonly used method of monitoring for awareness (or at least monitoring for the most important risk-factor for awareness) is measurement of the patient’s end-tidal volatile agent concentration. Assurance of 0.8–1 MAC of exhaled anaesthetic agent is likely to assure lack of awareness. However, certain factors may cause the end-tidal concentration to misrepresent the brain partial pressure of volatile agent. Factors increasing alveolar dead space (e.g. hypotension, bronchodilators, emphysema) cause the end tidal concentration to tend towards the inhaled concentration because some of the inhaled gas is exhaled unchanged. Thus, if inhaled volatile concentration is higher than brain concentration, alveolar dead space will cause end-tidal tension to overestimate brain tension.

Specialized monitoring equipment has been developed to assist in the assessment of depth of anaesthesia. Such equipment includes processed electro-encephalography such as Bispectral Index Scale (BIS) and auditory evoked-potential assessment. These monitors have been shown to reduce the incidence of awareness, particularly in situations of high-risk. Forehead galvanometry, the isolated forearm technique and lower oesophageal motility assessment are of historical interest; they are unreliable techniques for routine monitoring of depth of anaesthesia keeping the BIS value around 40 to 60 will be ideal

**INTRAOPERATIVE MANAGEMENT OF AWARENESS**

If intraoperative clinical signs or monitored values suggest that a patient may be experiencing noxious stimuli that may be recalled, anaesthesia should be deepened immediately. If hypotension is present, despite insufficient anaesthetic agent, anaesthesia should be deepened whilst supporting arterial pressure with i.v. fluids, modification of ventilatory pattern or i.v. vasopressors. Administration of an i.v. benzodiazepine (e.g. midazolam 5 mg) may reduce postoperative recall. Retrograde amnesia has never been demonstrated in association with benzodiazepines (despite it being sought in several investigations), but further recall is made less likely through the anterograde amnesic effect.

**MEDICAL LEGAL ASPECTS**

To keep an adequate written record of the anaesthetic procedure and of physiologic monitoring data.

* It should be labeled with the patients name and date to demonstrate the anaesthesiologist’s diligence.
* The Medical Protection Society to voice the following weaning in its 1987 Annual reports.
* If members (wherever possible) ensure that they adhere to accepted techniques, and keep full anaesthetic notes (including details of preoperative assessment, gas flows, delivery volumes, physiological parameters, circuit used and the concentration of volatile agents selected, together with timing and usage), then and only then, may it be possible to defend a claim that awareness was due to negligence on the part of the anaesthetist.

**Prevention of Awareness**

* Premedication with benzodiazepines, or administration of benzo- diazepines during induction, reduces the incidence of awareness, particularly in the high-risk period a few minutes after induction. Adequate doses of anaesthetic agents should be given. If cardio- vascular or respiratory depression occurs then these systems may require support (e.g. mechanical ventilation, inotropes). Titration of anaesthetic agents to arterial pressure risks intraoperative awareness.
* Assurance that at least 0.8–1 MAC of anaesthetic agent is exhaled greatly decreases the risk of awareness. Using the assumption of linear dose–response curves, it is usually considered acceptable to add together the MAC fractions of concurrently administered agents (e.g. 53% nitrous oxide , 0.58% isoflurane is considered to represent 1 MAC at 1 atm pressure in an otherwise healthy and unmedicated 30-yr-old). Adjusting MAC for the individual patient reduces the incidence of awareness and minimizes the risk of side-effects of anaesthetic agents. For example, a young, anxious patient requires more anaesthetic than an elderly, hypo- thyroid patient.
* The use of neuromuscular blocking agents increases the risk of intraoperative awareness. They should be used only when necessary and in doses that provide sufficient neuromuscular block. Complete paralysis is very rarely required.
* In high-risk situations, the use of a monitor of depth of anaesthesia (e.g. BIS) is probably justified. BIS value of 40 to 60 is preferable. Such situations include Caesarean section, emergency surgery, surgery associated with large blood loss and patients with a history of previous intraoperative awareness. The use of such monitoring may also be advis- able in patients in whom clinical signs of light anaesthesia may be masked (e.g. concurrent b-blockers, diabetes).
* Occasionally, awareness occurs despite apparently excellent practice in the apparent absence of equipment malfunction.