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Prevalence of Awareness in Total Intravenous Anesthesia: A Cross-Sectional Study

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ABSTRACT

Intravenous anesthesia is a multifaceted condition characterized by hypnosis, forgetfulness, suppression of the stress reaction to stimuli, and the establishment of a tranquil surgical environment. **Objective:** To determine the prevalence of total intravenous anesthesia (TIVA) among patients in a tertiary care hospital. **Methods:** The research was a descriptive cross-sectional study. Total intravenous anesthesia was performed on 217 male and female patients aged 18-60 year. The patient's history in the first two post-operative days revealed intraoperative consciousness. Data were gathered, from 17th June, to November 30th, 2022. Statistical analysis was performed using SPSS version 23.0. **Results:** The study found that the prevalence of awareness during total intravenous anesthesia (TIVA) was 15.7%, with a higher occurrence in patients with metabolic equivalent test scores ≤4 (45.4%, $p < 0.001$) and those with a previous history of awareness (80.0%, $p < 0.001$). Gender (16.4% in males vs. 14.1% in females, $p = 0.654$), age (15.2% in ≤45 vs. 16.0% in >45 years, $p = 0.865$), BMI (17.2% in ≤23.0 vs. 13.9% in >23.0 kg/m^2, $p = 0.494$), diabetes (13.3% in diabetics vs. 16.6% in non-diabetics, $p = 0.558$), alcoholism (25.0% in alcoholics vs. 15.1% in non-alcoholics, $p = 0.360$), and ejection fraction (20.0% in ≤40% vs. 14.7% in >40%, $p = 0.403$) did not show statistically significant associations with awareness prevalence. **Conclusions:** Metabolic equivalent scores and a prior history of awareness were significant predictors of intraoperative awareness during TIVA, highlighting the importance of tailored preoperative evaluations.

INTRODUCTION

A form of general anesthesia known as Total Intravenous Anesthesia (TIVA) is one that only uses intravenous anesthetics [1, 2]. Traditionally, volatile agent-based anesthesia has predominated in general anesthetic treatment. Since the discovery of propofol in the 1970s, there has been a heightened interest in intravenous anesthesia [3]. TIVA can be provided using numerous techniques, including as intermittent bolus dose, manual syringe-type infusion pumps, and Target-Controlled Infusion (TCI) devices. Propofol, an intravenous anesthetic produced from alkylphenol, is the most efficacious medication for Total Intravenous Anesthesia (TIVA) [4]. Dr. Oliver Wendell Holmes reintroduced anesthesia, a reversible condition of insanity created for surgical and medicinal purposes, from the old Greek word [5]. General anesthesia uses breathed gases and intravenous medications to induce amnesia, trance, and immobilization. Benzodiazepines, opioids, and neuromuscular blockers are also used for anxiolysis, analgesia, and surgical accuracy. General anesthetics are unique in their capacity to produce unconsciousness, a key aim for surgical patient comfort and safety [6, 7]. Both volatile anesthesia and TIVA aid in preventing intraoperative consciousness, but volatile anesthesia provides superior control by continuously delivering agents into the airways. To maintain the proper depth of anesthesia, however, TIVA necessitates precise dosage changes. While BIS monitoring is not required for every

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patient, it is advised in high-risk situations, such as those undergoing complicated procedures or having a history of awareness. To lower the danger of awareness, a BIS value of less than 60 is often recommended [3]. Propofol (1.5-4.5 mg/kg/hr) is the primary agent, often used in combination with the opioid analgesic remifentanil (0.5-1 mcg/kg/hr), delivered at titrated doses and specified flow rates according on patient and procedural requirements [8]. Sevoflurane anesthesia is associated with common postoperative problems. As many as 80% of children undergoing surgeries with sevoflurane may have developing delirium [9]. Intraoperative awareness unintended consciousness under anesthesia is a serious psychological and medical issue. Rare, occurring in 1 in 750 general anesthetics, it is generally connected to neuromuscular blockade and poor dosage. Such occurrences emphasize the need for patient-specific anesthetic monitoring and dosage titration [10, 11]. Manage and Avoid Accidental Awareness (AWR), one of the rarest consequences of general anesthesia, whether with CIIA or TIVA. The patient self-reports this AWR after surgery due to poor anesthetic depth [12]. Depth of Anesthesia (DOA) monitoring or Conscious state monitoring with Cerebral Function Monitoring or Bi-spectral Index (BIS) can be used to monitor such incidence intraoperatively and advise therapy. A postoperative interview or questionnaire can measure forgetfulness, analgesia, and awareness at the time of surgery. That might happen 24–72 hours after surgery [13]. TIVA use may not increase despite advances. Lack of faith in its administration, insufficient training, and inaccessibility of key equipment, intraoperative awareness problems, and perceived greater cost are some factors [14, 15]. TIVA requires a longer duration to achieve adequate anesthetic levels compared to volatile agent-based anesthesia. The familiarity with volatile agent-based anesthetic may be a contributing factor to the reluctance of most anesthetists to utilize TIVA [16]. Intraoperative consciousness is rare but stressful, causing patients mental anguish and anesthesiologists professional, personal, and financial consequences. Total Intravenous Anesthesia (TIVA) awareness is important despite anesthetic advances reducing its frequency. Data on TIVA training and practices among Pakistani anesthetists were not discovered despite a thorough search of published literature utilizing databases including PubMed, Google Scholar, and regional medical publications. The Hayatabad Medical Complex, a tertiary care teaching hospital, was chosen for this study because of its large patient volume, sophisticated anesthetic facilities, and skilled anesthetists with TIVA administration experience.

The study concentrated on the modern comprehension of the pharmacological and molecular principles of general anesthetics, highlighting their mechanisms of action, clinical classification, and implications for anesthetic treatment at the Department of Anesthesiology, Hayatabad medical complex-MTI Peshawar.

METHODS

This descriptive cross-sectional was conducted in the operating theaters of Hayatabad medical complex-MTI Peshawar from 17th June to November 30, 2022. A total of 217 participants were included, determined using the WHO Sample Size Calculator, with a 17.5% incidence rate of consciousness under complete intravenous anesthetic, a 95% confidence interval, and a 5% margin of error [17]. Non-probability sequential sampling was employed. The study received ethical approval from the Hospital's Ethical Committee (Ref no. 748/HEC/BandPSC/2022) and the REU Department of CPSP Karachi. Written informed consent was obtained from all participants. Routine monitoring, including noninvasive blood pressure, electrocardiography (lead II), pulse oximetry, and end-tidal carbon dioxide monitoring, was established. Anesthesia induction was performed using propofol (1–2 mg/kg) with suxamethonium (100 mg) for rapid sequence induction, alongside pyrolate (0.2 mg), fentanyl (2 µg/kg) or nalbuphine (0.1–0.25 mg/kg), and ondansetron (4 mg) for antiemetic effects. Target-Controlled Infusion (TCI) with propofol (50–200 µg/kg/min) was used for maintenance, supplemented with muscle relaxants (rocuronium or cisatracurium) and incremental doses of fentanyl. BIS monitoring was utilized in high-risk surgical patients, including individuals with hypotension, elevated propofol demands, excessive BMI, decreased functional capacity, or at the patient's desire. Midazolam (2.5–5 mg) was used to reduce intraoperative consciousness when propofol dosages surpassed 6 µg/Kg. Ventilation was modified to sustain end-tidal CO_2 levels between 35 and 45 mmHg, while keeping airway pressures under 30 cm H_2O. The postoperative evaluation was performed within two days to test for intraoperative inadvertent awareness using structured interviews and standardized questionnaires. Data were evaluated utilizing SPSS version 23.0. Numerical data, including age, BMI, and operation time, were presented as means and standard deviations. Stratification was conducted to evaluate the correlation with intraoperative consciousness, followed by chi-square testing, with a significant threshold of $P < 0.05$. Results were displayed in graphical and tabular form.

RESULTS

A total 217 individuals were included in the study with an average participant age of 50 to 60 years and a standard deviation of 7.55 years, indicated a highly uniform age distribution. The mean weight was 75.14 ± 5.87 kg, and the average height was 172.89 ± 6.49 cm, indicated that the participants possess an average height relative to the

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general population. The computed Body Mass Index (BMI) was 25.20 ± 2.30 kg/m^2, categorized the average participant as overweight based on established BMI categories as shown in table 1.

Table 1: Mean of Patients According to Age, Weight, Height and BMI of Individual

Demographics and Baseline Characteristics	Mean ± S.D
Age (Years)	50.60 ± 7.548
Weight (Kg)	75.14 ± 5.874
Height (cm)	172.89 ± 6.493
BMI (Kg/m2)	25.20 ± 2.299

The study included 217 individuals, with 67.3% reporting as male and 32.7% as female. The age distribution was about comparable, with 48.4% of those aged 45 years or younger and 51.6% aged over 45 years. Concerning BMI, 53.4% exhibited a BMI ≤23.0 kg/m^2, whilst 46.6% shown a BMI >23.0 kg/m^2. Diabetes history was documented in 27.6% of patients, whereas 72.4% were non-diabetic. Only 5.5% of individuals indicated a history of alcoholism, whereas the majority (94.5%) remained abstinent. Cardiac assessments revealed that 18.4% of participants had an ejection fraction ≤40%, while 81.6% had an ejection fraction >40%. The metabolic equivalent test showed that 10.1% scored ≤4, whereas 89.9% scored >4. Regarding intraoperative awareness, 4.6% had a history of awareness, and 15.7% experienced awareness during anesthesia in the study, while 84.3% reported no such event shown in the table 2.

Table 2: Demographic and Clinical Characteristics of Study Participants (n = 217)

S. No.	Variables	Category	Frequency (%)
01	Gender	Male	146 (67.3%)
		Female	71 (32.7%)
02	Age	≤45 Years	105 (48.4%)
		>45 Years	112 (51.6%)
03	BMI (Kg/m^2)	≤23.0	116 (53.4%)
		>23.0	101 (46.6%)
04	Diabetes	Yes	60 (27.6%)
		No	175 (72.4%)
05	Alcoholism	Yes	12 (5.5%)
		No	205 (94.5%)
06	Ejection Fraction	≤40	40 (18.4%)
		>40	167 (81.6%)
07	Metabolic Equivalent Test	≤4	22 (10.1%)
		>4	195 (89.9%)
08	History of Awareness	Yes	10 (4.6%)
		No	207 (95.4%)
09	Awareness	Yes	34 (15.7%)
		No	183 (84.3%)

The awareness rates for both males and females (16.4% and 14.1% reported being aware), and the p-value of 0.654 shows that there was no significant difference between the sexes. Awareness was reported by 15.2% of patients aged ≤45 years and 16.0% of those aged >45 years, with a p-value of 0.865, indicating no significant age-related variations in awareness. Concerning BMI, 17.2% of patients with a BMI ≤23.0 kg/m^2 and 13.9% of patients with a BMI >23.0 kg/m^2 expressed awareness, with a p-value of 0.494 signifying no significant correlation between BMI and awareness. The history of diabetes shown no significant correlation, with 13.3% of diabetic patients and 16.6% of non-diabetic patients being aware, as indicated by a p-value of 0.558. In cases of alcoholism, awareness was noted in 25.0% of individuals with a history of alcoholism, in contrast to 15.1% among those without such a history; nonetheless, the p-value of 0.360 indicates an absence of a meaningful correlation. Ejection fraction levels exhibited comparable tendencies, with 20.0% of patients with an ejection fraction ≤40% experiencing consciousness, in contrast to 14.7% with an ejection fraction >40%, and a p-value of 0.403 signifying no significant difference. Nonetheless, a prior history of consciousness shown a robust correlation, with 80.0% of patients with such a history reporting awareness, in contrast to just 12.6% of those without, yielding a p-value of <0.001, signifying statistical significance. Finally, metabolic equivalent tests demonstrated a notable correlation with consciousness, as 45.4% of those with a MET ≤4 reported awareness, in contrast to just 12.3% of those with MET >4, yielding a p-value of <0.001 as shown in the table 3.

Table 3: Stratification of Awareness across Demographic and Clinical Variables in Patients Undergoing Total Intravenous Anesthesia

Variables	Category	Awareness		Total Frequency (%)	p-Value
		Yes Frequency (%)	No Frequency (%)		
Patient Gender	Male	24 (16.4%)	122 (83.6%)	146 (100.0%)	0.654
	Female	10 (14.1%)	61 (85.9%)	71 (100.0%)	
Age (Years)	≤45	16 (15.2%)	89 (84.8%)	105 (100.0%)	0.865
	>45	18 (16.0%)	94 (84.0%)	112 (100.0%)	
BMI (kg/m^2)	≤23.0	20 (17.2%)	96 (82.8%)	116 (100.0%)	0.494
	>23.0	14 (13.9%)	87 (86.1%)	101 (100.0%)	
Diabetes	Yes	08 (13.3%)	52 (86.7%)	60 (100.0%)	0.558
	No	26 (16.6%)	131 (83.4%)	157 (100.0%)	
Alcoholism	Yes	03 (25.0%)	09 (75.0%)	12 (100.0%)	0.360
	No	31 (15.1%)	174 (84.9%)	205 (100.0%)	
Ejection Fraction	≤40%	08 (20.0%)	32 (80.0%)	40 (100.0%)	0.403
	>40%	26 (14.7%)	151 (85.3%)	177 (100.0%)	
Previous History of Awareness	Yes	08 (80.0%)	02 (20.0%)	10 (100.0%)	<0.001
	No	26 (12.6%)	181 (87.4%)	207 (100.0%)	
Metabolic Equivalent Tests	≤4	10 (45.4%)	12 (54.6%)	22 (100.0%)	<0.001
	>4	24 (12.3%)	171 (87.7%)	195 (100.0%)	

DISCUSSION

This study's findings offer significant insights into the variables affecting intraoperative consciousness,

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emphasizing numerous demographic and clinical features that may contribute to its incidence. The frequency of Total Intravenous Anesthesia (TIVA) in the study group was quite low, with only 15.7% of patients experiencing consciousness during the operation [18]. Another research indicated that 1.8% of individuals had consciousness under anesthesia with postoperative recall. Patients exhibiting potential consciousness will also be incorporated into the analysis, elevating the incidence of awareness under anesthesia to 0.78% [19-21]. Notably, despite the little prevalence of TIVA utilization, a significant majority of participants (88.9%) expressed a desire for increased application of TIVA, while 99.3% regarded it as a crucial competency to acquire. Comparable results were reiterated by Arevalo *et al.*, in 2016 [22]. Other domains in which TIVA was perceived as superior than volatile anesthesia encompassed: environmental pollution (89.5%), diminished Postoperative Nausea and Vomiting (PONV) (86.9%), and decreased emerging delirium (75.2%). This suggested that the theoretical understanding of the indications and advantages of TIVA is adequate in the department [2, 23]. All patients were anesthetized with the Sleep-Awake-Sleep method (SAS). Dexmedetomidine was primarily utilized for conscious sedation. The Bispectral Index monitor (BIS) was employed to assess sedation depth, maintaining levels between 70 and 85 during the sedative period. All patients had effective intraoperative neurological monitoring, stimulation, and electrode implantation. The total duration of anesthesia exhibited considerable variation among the participants. The maximum duration was 600 minutes. None of the patients experienced any intraoperative incidents associated with anesthetic treatment [24]. According to the study, TIVA made patients more conscious of the hospital during their procedure (95% CI: 1.8–3.4, $p < 0.001$) is compared parallel findings by Yu H and Wu D showed that patients serviced by CIIA had lower awareness rates than those who got TIVA [25]. Compared to the 8.8% rate reported in the Priyadharsini *et al.*, in 2023 studied that the patient group's overall rate of patient consciousness during surgery was 15.7% (95% CI: 12.1%–19.3%) [26]. The direct expenses of TIVA are typically regarded as superior to those of volatile agent-based anesthesia (27). Although the department operates under budget constraints in a poor nation, only 56.9% of participants in the research identified cost as a barrier [28]. Likewise, several further research indicated that cost was perceived as a minor impediment to usage relative to other considerations [29]. The rationale for this may be that the perceived advantages of TIVA, including decreased PONV and enhanced patient satisfaction, warrant its application despite the increased expenses [30]. This confirms that the study's findings may be applicable to daily life. Administering an amnestic drug before to surgery and closely monitoring stress reactions indicative of a lighter anesthetic level is essential for avoiding alertness. This study has some limitations. The awareness interview was conducted only once. Owing to logistical constraints, it was unable to follow up on patient's post-hospital release. Research indicates that doing numerous interviews at different time intervals enhances the detection rate of awareness. Certain individuals can recall consciousness soon post-surgery, but others may not recognize it until month's after.

CONCLUSIONS

The study's findings showed that the frequency of intraoperative consciousness when utilizing TIVA is determined by certain hazards related to patient profiles. According to research, people with restricted physical ability or prior consciousness experiences need special attention when receiving expert anesthetic treatment. Although TIVA does not allow for direct anesthetic depth monitoring, individual medication dosage strategies in conjunction with depth-of-anesthesia monitoring techniques should lessen the likelihood that patients may become conscious throughout the treatment. Future studies should concentrate on this subject in order to determine long-term impacts and the most effective TIVA treatments that improve patient safety.

Authors Contribution

Conceptualization: MT
Methodology: MT, K
Formal analysis: BZ, MAK, K, FAQ
Writing, review and editing: BZ, MAK, SR, K, FAQ

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

The authors declare no conflict of interest.

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