

On the Intraoperative Awareness General Anesthesia

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General anesthesia is a crucial component of modern medical practice, enabling surgeons to perform complex procedures and ensuring patient comfort. However, within the realm of general anesthesia, a rare but significant phenomenon called intraoperative awareness has garnered attention. Intraoperative awareness refers to the state of partial or complete consciousness experienced by some patients during surgery, despite being under anesthesia. This article aims to explore the concept of general anesthesia and intraoperative awareness, shedding light on its prevalence, causes, impact, and management strategies. Understanding this phenomenon is vital for healthcare professionals to improve patient outcomes and enhance the safety of surgical procedures.

Keywords: General Anesthesia; Intraoperative Awareness; Risk Factors; Health Effect; Prevention Techniques

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GENERAL anesthesia is a medical method employed to create a transient state of unconsciousness and alleviate discomfort during medical interventions. Nevertheless, it is worth noting that in exceptional instances, individuals may encounter a phenomenon referred to as intraoperative awareness, characterized by the reemergence of consciousness while undergoing a surgical procedure. The occurrence of intraoperative awareness is a profoundly disconcerting phenomenon that has the capacity to induce significant suffering among patients, potentially leading to enduring psychological consequences (1). Despite the significant progress made in the field of anesthesia, recent research has demonstrated that the occurrence of this phenomenon can be attributed to a range of variables, including equipment malfunction, inadequate dosage administration, and unique patient attributes.

Equipment failure or human errors during anesthetic delivery are significant contributing factors to intraoperative awareness (2). Anesthesiologists depend on a combination of intravenous medicine and inhaled anesthetic drugs to initiate and sustain a state of unconsciousness. Nevertheless, it is worth noting that in exceptional circumstances, the administration of these pharmaceuticals could encounter difficulties, leading to inadequate anesthetic and consequent consciousness during surgical procedures. This phenomenon may arise as a result of equipment malfunction, such as a breach in the delivery system, or inaccurate drug dosage calculations.

In addition, it should be noted that certain patient-specific factors may also play a role in the occurrence of intraoperative awareness. The efficacy of anesthesia can be influenced by various factors, including genetic variations in drug metabolism,

body mass index, and certain medical conditions. An instance of note involves patients with an elevated body mass index, who may necessitate more quantities of anesthesia in order to attain the intended outcome (3). This circumstance heightens the potential for insufficient sedation and intraoperative awareness. Likewise, individuals possessing specific genetic variants may exhibit varying metabolic responses to anesthetic medications, resulting in unexpected degrees of unconsciousness.

The occurrence of intraoperative awareness is a highly distressing phenomenon that has the potential to induce enduring psychological consequences in patients. Individuals who regain consciousness while undergoing surgical procedures may encounter various sensory perceptions such as discomfort, pressure, or a sense of confinement, all while being incapacitated and unable to communicate or mobilize (4). Traumatic experiences have the potential to induce symptoms of post-traumatic stress disorder (PTSD), which can manifest as anxiety, depression, and the occurrence of distressing nightmares. This highlights the significance of incorporating strategies to proactively address and alleviate the incidence of intraoperative awareness. These strategies encompass vigilant monitoring of anesthetic administration, precise determination of dosage quantities, and ongoing communication between the patient and the surgical team.

Although general anesthesia is widely regarded as a safe and effective method, the infrequent but notable incidence of intraoperative awareness presents considerable difficulties for those having surgical procedures. This phenomenon may manifest due to several circumstances, including equipment malfunction, human fallibility, or unique patient attributes. In order to safeguard the safety and welfare of patients, it is imperative for healthcare practitioners to proactively address and mitigate the potential occurrence of intraoperative awareness. This can be achieved through vigilant monitoring, accurate dosage calculation, and consistent communication with the patient. By implementing this approach, healthcare providers can enhance patient safety and improve the predictability of surgical procedures, hence reducing the incidence of this painful condition.

Understanding General Anesthesia: Mechanisms and Goals

Mechanisms of action in general anesthesia

General anesthesia refers to a condition characterized by the temporary loss of awareness and feeling, which is achieved through the administration of pharmaceutical substances. The process is characterized by its complexity, as it entails the coordinated interaction of multiple mechanisms of action in order to attain the intended outcome. The principal objective of general anesthesia is to facilitate surgical procedures by ensuring the absence of pain and consciousness. A comprehensive comprehension of the underlying mechanisms of general anesthesia is important for an anesthesiologist in order to guarantee the safe and efficient delivery of this medical intervention (5).

The regulation of neurotransmitter systems in the brain is a primary mechanism of action in general anesthesia. Anesthesia medications commonly exhibit selectivity towards specific receptors within the central nervous system, including gamma-

aminobutyric acid (GABA) receptors and N-methyl-D-aspartate (NMDA) receptors (6, 7). Anesthesia medications augment the activity of GABA, a prominent inhibitory neurotransmitter, hence heightening the inhibitory state inside the brain. This ultimately results in sleepiness and loss of consciousness. Simultaneously, these substances impede the activation of the excitatory pathways facilitated by NMDA receptors, so diminishing the sense of pain.

Another factor implicated in the process of general anesthesia is the interference with neural transmission. Anesthesia medicines function by diminishing the passage of nerve impulses among neurons, effectively obstructing the signaling system accountable for pain perception and conscious awareness (8). This is accomplished by a range of processes, such as the suppression of voltage-gated sodium channels, modulation of neurotransmitter release and reuptake, and impact on ion channels that regulate membrane potential. Anesthesia medicines induce a profound sedative effect and diminish the perception of sensation by stopping signal transmission.

Furthermore, it is worth noting that general anesthesia has the capability to induce muscle relaxation, a crucial aspect in the context of surgical interventions. Anesthesia drugs exert their effects at the neuromuscular junction by impeding the release of acetylcholine and impeding its interaction with receptors located on the muscle cells (9). As a consequence, this phenomenon induces both muscular paralysis and relaxation, so enabling enhanced surgical accessibility.

In its entirety, the administration of general anesthesia encompasses a complex series of actions that encompass the modulation of neurotransmitter systems, interference with neural communication, and induction of muscular relaxation. Anesthesia medications exert their effects by modulation of many targets within the brain, resulting in the induction of drowsiness, unconsciousness, and attenuation of sensory perception. The comprehension of these modes of action empowers anesthesiologists to customize the delivery of anesthetic medications, so guaranteeing the welfare and well-being of patients throughout surgical interventions.

Goals and Objectives of General Anesthesia

General anesthesia is a medical intervention designed to create a profound state of unconsciousness, so preventing the patient from experiencing any pain or discomfort throughout surgical interventions. The principal objective of general anesthesia is to offer a secure and efficient approach for surgical procedures (10). The induction of coma enables surgeons to execute intricate and invasive procedures without being impeded by patient movements or pain reactions.

Another essential aim of general anesthesia is to ensure the preservation of the patient's welfare during the entirety of the surgical operation (10). The anesthetist maintains ongoing surveillance of essential physiological indicators, including heart rate, blood pressure, and oxygen saturation, in order to ascertain that the patient's vital parameters remain within acceptable thresholds. By employing this approach, individuals are able to reduce any possible hazards linked to surgical procedures, such as hypoxia or cardiovascular instabilities, which may otherwise result in difficulties and perhaps deadly outcomes.

In addition, the objective of general anesthesia is to induce a temporary and reversible state of unconsciousness, facilitating a seamless transition from unconsciousness to consciousness following the surgical procedure (11). The anesthetist meticulously delivers precise pharmacological agents to produce and sustain a state of unconsciousness, while attentively monitoring the patient's physiological and behavioral reactions and making appropriate adjustments to the drug dosage as required. Following the completion of the surgical procedure, the administration of anesthetic is progressively reversed in order to facilitate the patient's natural awakening, thereby mitigating any potential discomfort and postoperative adverse effects.

Finally, a pivotal objective of general anesthesia is to guarantee the comfort and contentment of patients throughout the surgical procedure (10). Through the alleviation of pain and discomfort, patients are able to undergo essential medical treatments with a sense of assurance, as they are assured that their overall welfare is being protected. Anesthesia specialists function as integral members of a specialized team, engaging in collaborative efforts with surgeons, nurses, and other healthcare practitioners to establish a patient-centric methodology. This entails the acknowledgment and resolution of any pre-existing concerns or anxieties experienced by the patient, as well as the implementation of effective pain management strategies following the surgical procedure.

Intraoperative Awareness: Definition and Prevalence

Defining Intraoperative Awareness

The phenomenon of intraoperative awareness, alternatively referred to as inadvertent awareness during general anesthesia, pertains to the unintentional perception or memory of occurrences that transpire throughout a surgical operation conducted under the influence of general anesthetic (12). In the context of surgical procedures, it is generally anticipated that patients will experience a state of unconsciousness, lack of awareness, and absence of memory as a result of the administration of anesthetic medicines. Nevertheless, it is worth noting that certain instances may arise where patients undergo surgery and encounter differing levels of consciousness, resulting in the occurrence of intraoperative awareness.

Intraoperative awareness encompasses various degrees of consciousness during surgery, spanning from partial awareness characterized by patients possessing indistinct memories of auditory stimuli or dialogues, to complete awareness when patients remain fully cognizant and capable of recollecting precise information pertaining to the surgical procedure. Intraoperative awareness is infrequent, with an estimated occurrence rate ranging from 0.1% to 0.2% across surgical instances (13). Intraoperative awareness, although infrequent, poses a substantial concern due to its potential to induce emotional suffering, post-traumatic stress disorder, and erode patient confidence in the healthcare system.

The etiology of intraoperative awareness may exhibit variability contingent upon patient-specific factors and the particular contextual elements of the surgical procedure. Several factors have been identified as potential contributors to the incidence of

Intraoperative awareness. These factors encompass inadequate administration of anesthetic, variations in anesthetic metabolism across individuals, drug interactions, malfunctioning equipment, and errors in the administration of anesthetic agents (14). Healthcare practitioners must possess a comprehensive understanding of the risk factors associated with intraoperative awareness and implement appropriate measures to prevent and effectively manage this phenomenon. The utilization of monitoring technology, such as bispectral index monitors, can facilitate the evaluation of anesthetic depth and the identification of alterations in patient consciousness throughout surgical procedures.

Prevalence Rates and Statistical Data

Intraoperative awareness is a rare but significant complication of general anesthesia. It refers to the experience of recalling events or sensations during surgery while under general anesthesia. The epidemiology of intraoperative awareness plays a vital role in understanding its incidence, risk factors, and associated outcomes.

It is important to establish the incidence of intraoperative awareness, which remains a subject of debate due to variations in study methodologies. Some researchers estimate the incidence to be as low as 0.13%, while others suggest it to be around 2% (15). Factors such as the patient population, type of surgery, anesthetic technique, and assessment methods contribute to this discrepancy. However, it is widely agreed that certain patient groups, such as those with cardiac surgeries or trauma, are at higher risk for intraoperative awareness. Furthermore, studies have shown that awareness tends to be more common during the induction and emergence phases of anesthesia, as well as in patients who receive inadequate anesthesia due to various reasons.

Causes and Risk Factors for Intraoperative Awareness

Several risk factors have been identified for intraoperative awareness. These include the use of neuromuscular blockade, incomplete anesthetic delivery, low volatile anesthetic concentration, high-stress surgeries, emergency surgeries, certain patient characteristics (e.g., young age, obesity), and the presence of specific medical conditions (e.g., ischemic heart disease). Additionally, patients with a history of prior awareness episodes are more likely to experience intraoperative awareness in subsequent surgeries. Understanding these risk factors helps anesthesiologists tailor their techniques and strategies to minimize the occurrence of intraoperative awareness.

Anesthesia-Related Factors

The causes of intraoperative awareness can vary, but anesthesia-related factors play a significant role. Sometimes, the dose of anesthesia may not be sufficient, or there could be issues with the delivery or metabolism of the drugs. It is a delicate balance, and sometimes things do not go as planned. While anesthesia-related factors play a crucial role in preventing intraoperative awareness, it is essential to understand and address these factors to ensure patient safety and well-being.

One of the primary anesthesia-related factors contributing

to intraoperative awareness is an inadequate depth of anesthesia (16). Anesthesiologists strive to achieve a delicate balance between ensuring the patient is adequately anesthetized and avoiding excessive sedation. However, factors such as individual patient metabolism, drug interactions, and equipment failure can lead to dose miscalculations or delivery errors. Failure to administer an adequate dosage of anesthetic agents may result in momentary consciousness, inadequate amnesia, or even a painful experience for the patient.

Another factor linked to intraoperative awareness is the improper monitoring of anesthesia (1). Anesthesia depth is typically monitored through an electroencephalogram (EEG), which measures brain activity and helps ensure patients are in an appropriately anesthetized state. However, technical errors, equipment malfunction, or improper placement of monitoring devices can compromise the accuracy of EEG readings. Inadequate monitoring can lead to delayed recognition of intraoperative awareness and subsequently delay in corrective measures, exacerbating the psychological trauma experienced by the patient.

Furthermore, patient-specific factors can also contribute to intraoperative awareness. For instance, patients with a history of substance abuse or tolerance to anesthetic medications may require higher or unconventional dosing regimens, increasing the risk of awareness (17). Patients with certain medical conditions, such as obesity or liver dysfunction, may also exhibit altered drug metabolism and elimination, necessitating adjustments in anesthesia delivery and monitoring. By comprehensively assessing patient-specific factors and tailoring anesthesia management accordingly, anesthesiologists can minimize the likelihood of intraoperative awareness.

To mitigate the risk of intraoperative awareness, the advancement and use of technological innovations in anesthesia administration and monitoring are paramount. For example, the use of bispectral index (BIS) monitoring, which analyzes a patient's brainwave patterns to assess anesthesia depth, has proven effective in reducing the incidence of intraoperative awareness. The integration of closed-loop systems that automatically adjust anesthetic agent delivery based on patient parameters, such as response to surgical stimuli or heart rate, may also help prevent awareness. By embracing such advancements and regularly updating clinical practices, healthcare professionals can improve patient outcomes and minimize the occurrence of intraoperative awareness.

Patient-Related Factors

Several patient-related factors can contribute to the incidence of Intraoperative awareness, such as age, gender, medication utilization, and previous experiences.

Age is a crucial determinant in the incidence of intraoperative awareness. The likelihood of seeing this phenomenon is higher among older patients in comparison to younger persons. The insufficiency of sedation in older patients may be attributed to the diminished metabolism of anesthetic medications. Furthermore, it is worth noting that advanced age is frequently associated with a higher prevalence of comorbidities and a greater likelihood of undergoing high-risk surgical procedures, hence augmenting the probability of encountering Intraoperative

awareness (18).

Gender is another patient-related variable that has the potential to impact the occurrence of intraoperative awareness. Studies have provided evidence suggesting that females are more susceptible to encountering this phenomenon in comparison to males (19). The observed divergence could potentially be attributed to physiological changes, including variances in body composition and hormone profiles. In addition, it has been shown that women may necessitate increased dosages of anesthetic medications owing to their heightened sensitivity to pain, rendering them more prone to insufficient sedation during surgical procedures.

The administration of some drugs can potentially heighten the probability of experiencing intraoperative awareness. Several pharmacological agents, including benzodiazepines and muscle relaxants, have the potential to impede the efficacy of anesthesia, resulting in insufficient sedation (20). Furthermore, individuals with a documented background of substance addiction, encompassing alcohol or opioids, may exhibit modified tolerance thresholds, hence posing a greater difficulty in attaining the intended degree of sedation throughout surgical procedures.

The occurrence of intraoperative awareness might also be influenced by a patient's previous encounters with anesthesia and surgical procedures. Individuals who have previously undergone surgical procedures and encountered difficulties, such as anesthesia awareness, may develop an elevated level of anxiety or panic in relation to future anesthetic experiences. The heightened psychological stress experienced by individuals can have an impact on their reaction to anesthesia, which may result in insufficient sedation and the development of intraoperative awareness (10).

Finally, it is worth noting that variations in brain physiology and genetics across individuals may contribute to the occurrence of intraoperative awareness. Certain individuals may exhibit abnormalities in the metabolism of anesthetic drugs or an elevated susceptibility to the effects of these medications. Several variables may potentially contribute to the insufficient sedation that patients experience during surgery, leading to the occurrence of awareness.

Surgical Factors

While there are multiple causes for intraoperative awareness, surgical factors play a crucial role in its development.

One important factor is the administration of insufficient anesthesia. Anesthesia is typically administered by an anesthesiologist, who monitors the patient's vital signs throughout the surgery. However, there can be situations where the dosage may not be adequate, leading to the patient waking up during the procedure. Poor communication between the surgical team and the anesthesia team can also contribute to inadequate anesthesia administration (21). Therefore, it is crucial for the entire surgical team to establish effective communication and work together to prevent such mistakes.

Another factor is the use of muscle relaxants. Muscle relaxants are commonly used during surgery to facilitate intubation and improve surgical access. However, if the patient is not adequately anesthetized, these relaxants can paralyze the patient without preventing consciousness (22). Consequently, the pa-

tient may be aware of the surgical procedure, yet unable to move or communicate. This can be a distressing experience for the patient and highlights the importance of proper anesthetic management.

The duration and type of surgery can also influence the likelihood of intraoperative awareness. Prolonged surgeries and procedures involving major blood loss may necessitate the adjustment of anesthesia dosages or supportive medications (23). If these adjustments are not made appropriately, the risk of intraoperative awareness increases. Additionally, certain surgical procedures, such as cardiac surgeries or emergency procedures, may present additional challenges in maintaining adequate anesthesia levels due to the complexity and urgency of the situation.

The patient's physiological response to anesthesia can also influence the occurrence of intraoperative awareness. Factors such as age, medical conditions, or medication history can affect how the body metabolizes and responds to anesthesia. Patients with a history of drug tolerance or those on chronic pain medications may require higher doses of anesthesia to achieve the desired effect. Failure to account for individual patient variability can increase the risk of intraoperative awareness.

Lastly, the surgical environment and equipment can contribute to intraoperative awareness. Noisy operating rooms or malfunctioning anesthesia delivery systems can disrupt the administration of anesthesia, leading to inadequate levels and the possibility of patient awareness (24). It is important for surgeons and anesthesiologists to be vigilant in monitoring the operating environment and promptly addressing any issues that may compromise patient safety and comfort.

Detecting and Monitoring Intraoperative Awareness

Clinical Signs and Symptoms

Clinical signs and symptoms of intraoperative awareness can vary from mild to severe and depend on the level of consciousness and the individual's ability to perceive and remember the experience. When a patient experiences intraoperative awareness, they may exhibit certain signs and symptoms that can help detect it. These can include vague memories of the surgery, feeling pain or discomfort, hearing conversations or sounds in the operating room, and a sense of being awake during the procedure (25). It's important for healthcare providers to be attentive to these subjective experiences reported by the patient.

One common sign of intraoperative awareness is the recall of specific details or sensations during surgery (1, 10). Patients may report hearing conversations between the surgical team, feeling pain or pressure, and even being aware of their surroundings. They may also experience auditory or visual hallucinations, which can be frightening and confusing. These memories often persist long after the surgery, leading to significant psychological distress and even PTSD in some cases.

Another clinical symptom of intraoperative awareness is increased heart rate and blood pressure (11). As the patient becomes aware of the pain or discomfort during the surgery, the sympathetic nervous system is activated, leading to physiological responses such as increased heart rate, blood pressure, and

sweating. These physiological changes can be monitored during surgery and may be an indication of the patient's consciousness and awareness.

Utilizing Monitoring Techniques

Hence, it is imperative for healthcare practitioners to utilize efficient monitoring methodologies in order to identify and mitigate instances of intraoperative awareness. This essay aims to explore the diverse monitoring approaches employed inside the operating room setting, with the primary objective of safeguarding patient well-being and mitigating the risk of intraoperative awareness.

One of the often-employed methods for monitoring is the utilization of EEG monitors. EEG monitors are utilized to quantify the electrical activity of the brain, enabling anesthesiologists to assess the level of anesthesia (26). Through the examination and interpretation of the EEG waveforms and oscillatory patterns, healthcare practitioners are able to ascertain and maintain the appropriate level of anesthesia for patients throughout surgical procedures. In the event of an abrupt surge in cerebral activity, suggestive of the potential occurrence of intraoperative awareness, prompt measures can be implemented to augment the level of anesthetic and avert the patient from attaining consciousness throughout the surgical intervention.

The utilization of BIS monitors is an additional efficacious method for monitoring. BIS monitors offer a quantitative measure ranging from 0 to 100, which serves to assess the level of anesthesia and sedation (27). The determination of this number is achieved through the analysis of multiple characteristics, including brain activity, muscular tone, and eye movement. Anesthesiologists can promptly detect potential insufficiencies in anesthesia by closely monitoring the BIS value. The utilization of real-time feedback enables medical practitioners to make necessary adjustments in the administration of anesthetic drugs, so ensuring the maintenance of an ideal state of unconsciousness. This practice serves to minimize the potential occurrence of intraoperative awareness, thereby reducing associated risks.

Moreover, the surveillance of end-tidal carbon dioxide (EtCO₂) levels is a crucial method for ensuring the adequacy of anesthetic depth (28). The measurement of EtCO₂ offers significant insights on a patient's respiratory condition throughout the course of a surgical procedure. The device quantifies the exhaled carbon dioxide levels during expiration, enabling anesthesiologists to evaluate the sufficiency of ventilation. An abrupt rise or fall in EtCO₂ levels may suggest insufficient administration of anesthetic, which could result in the occurrence of intraoperative awareness. Hence, the ongoing surveillance of EtCO₂ levels plays a pivotal role in promptly detecting any alterations that necessitate additional inquiry or modification of anesthetic drugs.

In addition, the utilization of electromyography (EMG) monitors can prove advantageous in the identification of intraoperative awareness (29). EMG monitors are utilized to assess the electrical activity exhibited by muscles, with a primary focus on the facial muscles. Muscle relaxation is a critical component of anesthesia since it plays a pivotal role in preventing patient movement and maintaining optimal operative circumstances to ensure safety. An elevation in EMG activity may sug-

gest that the patient is exhibiting signs of consciousness recovery or encountering insufficient anesthetic. Through meticulous observation of EMG activity, anesthesiologists possess the ability to promptly intervene by intensifying anesthesia, so mitigating the risk of intraoperative awareness.

Finally, the act of communicating with patients might be regarded as a beneficial method of monitoring. While infrequent, it is possible for certain individuals to express their awareness during surgical procedures. Consequently, anesthesiologists frequently implement a pre-procedural communication system with patients, including techniques such as hand signals or eye motions (30). This feature enables patients to express their level of consciousness, hence facilitating timely intervention by medical practitioners to adjust anesthetic depth as necessary.

Psychological and Physiological Impact of Intraoperative Awareness

Psychological Effects on Patients

The psychological ramifications of intraoperative awareness, sometimes referred to as waking up during surgery, can have profound and enduring consequences. This occurrence is characterized by the patient experiencing a state of consciousness and environmental awareness throughout a surgical procedure, despite the ongoing administration of anesthetic. The occurrence of Intraoperative awareness can result in notable psychological consequences, such as heightened anxiety, the development of PTSD, depressive symptoms, and potentially a diminished sense of faith in the medical field (31). Comprehending these impacts is crucial in delivering appropriate care and assistance to individuals who have undergone this distressing occurrence.

The development of anxiety is a prevalent psychological consequence frequently associated with intraoperative awareness. Individuals who have encountered this particular encounter may suffer a persistent apprehension towards undergoing subsequent surgical interventions, given the highly unpleasant nature of the recollection of regaining consciousness during operation. The presence of anxiety can have a significant impact on all facets of individuals' lives, so impeding their ability to place trust in healthcare providers and potentially dissuading them from pursuing essential medical interventions in subsequent instances.

Moreover, the occurrence of intraoperative awareness has the potential to contribute to the onset of PTSD. PTSD is a psychological disorder that manifests through the presence of intrusive thoughts, nightmares, flashbacks, and profound emotional suffering subsequent to experiencing a terrible experience. Patients who have encountered the phenomenon of intraoperative awareness may face persistent symptoms that provide a daily challenge, so adversely affecting their overall well-being and capacity to engage in routine activities. The persistent apprehension of relapse and the consequent psychological distress can lead to social seclusion, evasive conduct, and a general decline in their overall state of welfare.

Intraoperative awareness might give rise to depression, which is a psychological impact. The perception of helplessness and vulnerability can elicit a range of negative psychological outcomes in patients, including diminished interest in formerly

pleasurable activities, persistent depressive symptoms, and even suicidal ideation. The persistent nature of depression can pose additional challenges to the process of recovery, underscoring the importance for healthcare professionals to recognize and tackle these symptoms in order to prevent further decline in the patient's psychological well-being.

Patients who have undergone intraoperative awareness may feel not only anxiety, PTSD, and depression, but also a diminished sense of faith in the medical profession. Patients may experience a sense of betrayal from their healthcare professionals, leading to the development of emotions such as anger and resentment towards the individuals responsible for their treatment (32). The erosion of trust might impede forthcoming healthcare interactions, as patients may exhibit reluctance in divulging essential medical details or adhering to prescribed therapies, so exacerbating the risk to their overall health.

In order to address the psychological consequences of intraoperative awareness, it is imperative for healthcare professionals to give utmost importance to fostering open dialogue, demonstrating empathy, and providing emotional support. Facilitating a secure environment for patients to engage in open dialogue regarding their experiences and emotions helps facilitate the psychological processing of trauma and facilitate the restoration of a sense of agency. Psychosocial therapies, including cognitive-behavioral therapy, have demonstrated efficacy in the management of anxiety, PTSD, and depression subsequent to intraoperative awareness.

Long-Term Physiological Consequences

The enduring physiological consequences of intraoperative awareness might bear notable ramifications for patients. Intraoperative awareness, as its name implies, denotes the phenomenon wherein a patient maintains consciousness throughout a surgical procedure while being under general anesthetic. Although seldom, empirical research has demonstrated that this phenomenon can result in enduring physiological consequences.

Intraoperative awareness has the potential to induce physiological alterations, in addition to its psychological implications. Patients have reported the subjective experience of pain and discomfort during surgical procedures, as well as the subsequent development of heightened pain sensitivity over an extended period of time (33). The increased sensitivity to pain experienced by individuals can pose difficulties in subsequent medical interventions, as it may necessitate the administration of larger quantities of anesthetic in order to attain the required degree of patient comfort.

Furthermore, the occurrence of intraoperative awareness has the potential to result in disturbances in sleep patterns and the development of insomnia (34). Sleep difficulties frequently afflict patients following a stressful incident, exacerbating both their physical and emotional pain. The absence of sufficient sleep of high quality might impede the process of recuperation and have adverse effects on an individual's overall well-being.

It is crucial to acknowledge that the physiological consequences of Intraoperative awareness can exhibit variability among individual patients. While certain individuals may encounter persistent pain and disruptions in sleep patterns over an extended period, others may not undergo any substantial altera-

tions. However, it is crucial to acknowledge the potential negative consequences associated with these effects, as it highlights the significance of both preventing and effectively controlling instances of Intraoperative awareness.

In order to mitigate the occurrence of Intraoperative awareness, it is imperative to implement proactive strategies during surgical procedures. The implementation of proper anesthetic dosing and monitoring, together with effective pre- and post-procedure patient communication, are essential measures in mitigating this uncomfortable phenomenon. Moreover, the provision of assistance and access to various resources for those who have encountered Intraoperative awareness might contribute to their recuperation process and mitigate the probability of enduring lasting physiological consequences.

Prevention and Management Strategies for Intraoperative Awareness

Pharmacological Interventions

To avoid or reduce the incidence of Intraoperative awareness, a range of pharmacological therapies have been devised and implemented in clinical settings.

A frequently employed pharmacological intervention involves the utilization of anesthetic drugs, such as propofol or volatile anesthetics. These medications exert their effects on the central nervous system in order to create a state of unconsciousness, so assuring that the patient stays devoid of awareness throughout the entirety of the surgical process. Nevertheless, it is imperative to meticulously check the level of anesthetic in order to avert insufficient sedation, since this can potentially result in patient consciousness throughout the procedure (35).

Another pharmacological technique employed for the purpose of preventing Intraoperative awareness involves the utilization of neuromuscular blocking drugs. These pharmaceutical substances induce transient paralysis by obstructing the passage of neural signals to the muscular system, hence impeding patient mobility throughout surgical procedures. Nonetheless, it is crucial to bear in mind that the exclusive administration of neuromuscular blocking drugs does not suffice to induce anesthesia or provide analgesia, necessitating their concurrent use with other anesthetic agents (36).

Furthermore, the utilization of specific adjunct drugs can effectively augment the level of anesthetic and mitigate the potential occurrence of intraoperative awareness. As an illustration, opioids such as fentanyl or sufentanil are frequently employed in medical settings to induce analgesia and mitigate patient recollection. Opioids exert their pharmacological effects by the process of attaching to particular receptors located in the brain, hence eliciting analgesic, and sedative properties (37, 38).

Notwithstanding these pharmaceutical measures, intraoperative awareness may still manifest. In instances of this nature, supplementary interventions may be implemented, such as the administration of sedatives and anti-anxiety drugs following a surgical procedure, with the aim of mitigating psychological suffering. Effective communication and support from healthcare providers play a crucial role in assisting patients in managing the distressing phenomenon of Intraoperative awareness.

Anesthesia Techniques

To mitigate the occurrence of intraoperative awareness, anesthesiologists have devised a range of anesthetic treatments with the objective of maintaining the patient in a state of unconsciousness for the duration of the surgical process.

A frequently employed method is general anesthesia, when a combination of drugs is administered to induce a state of unconsciousness, forgetfulness, analgesia, and muscle relaxation. The administration of anesthesia medicines, such as propofol, sevoflurane, and opioids, is commonly employed in a combined manner to attain the desired results. The anesthesiologist diligently observes the patient's physiological parameters and modifies the dosage of medication as necessary to sustain the intended depth of anesthesia.

Another often utilized approach is total intravenous anesthesia (TIVA). In contrast to general anesthesia, which entails the inhalation of volatile anesthetics, TIVA exclusively relies on the intravenous delivery of medicines (39). The administration of a continuous infusion of medications, such as propofol and remifentanyl, by the anesthesiologist is performed with the intention of changing the dosages in order to maintain an appropriate level of unconsciousness throughout the duration of the medical treatment.

A more recent method known as processed EEG monitoring has been implemented as a means to reduce the potential occurrence of intraoperative awareness. EEG monitors are utilized to quantify the electrical activity of the brain, so furnishing the anesthesiologist with instantaneous data pertaining to the patient's state of awareness. Through the examination and interpretation of the EEG waveform, the anesthesiologist possesses the ability to promptly modify the administration of anesthesia in order to sustain an optimal state of unconsciousness.

Furthermore, the implementation of regional anesthesia can serve as a supplementary measure to general anesthetic, effectively mitigating the potential occurrence of intraoperative awareness and enhancing patient safety (40). Regional anesthesia is a medical procedure that entails the administration of local anesthetics in close proximity to certain nerves or nerve plexuses, with the objective of inhibiting sensory perception in a designated body part or region. Various techniques, such as spinal anesthetic, epidural anesthesia, and peripheral nerve blocks, might be employed based on the specific nature and site of the surgical procedure.

In spite of the notable progress made in anesthetic procedures, instances of intraoperative awareness can still manifest albeit infrequently. The occurrence of consciousness during anesthesia can be influenced by patient-related factors, such as genetic abnormalities in drug metabolism or an abnormally elevated tolerance to anesthetic medicines. Furthermore, it is important to consider the potential influence of human error in medical contexts, such instances of improper drug administration or insufficient monitoring protocols during surgical procedures. In order to effectively tackle these concerns, it is imperative for anesthesiologists to engage in transparent communication with patients prior to surgical procedures, meticulously assess their medical backgrounds, and use a variety of safety protocols to mitigate the potential occurrence of intraoperative awareness.

Patient Communication and Education

Effective patient communication and education are essential in the prevention and management of intraoperative awareness. This essay aims to examine the significance of patient communication and education in reducing the occurrence of intraoperative awareness and enhancing patient outcomes.

The importance of patient communication cannot be overstated when it comes to mitigating the risk of intraoperative awareness (41). Engaging in transparent and candid dialogues with patients is of utmost importance for anesthesiologists and nurses in the preoperative phase, wherein they thoroughly address the associated hazards and potential complexities, encompassing the prospect of intraoperative awareness. Patients might enhance their comprehension and sense of agency over their circumstances by receiving comprehensive explanations regarding the anesthetic process, the pharmacological agents employed, and the monitoring apparatus utilized throughout surgical procedures. This understanding has the potential to mitigate anxiety and enhance patient satisfaction.

In addition, the use of appropriate communication strategies might serve as a catalyst for patients to articulate their apprehensions or anxieties pertaining to intraoperative awareness. Healthcare practitioners can effectively manage patient anxiety and provide reassurance and comfort by establishing a secure and nurturing environment where patients feel comfortable expressing their concerns. The establishment of an open line of communication between patients and the surgical team is crucial in cultivating trust, hence facilitating a robust patient-provider connection that plays a pivotal role throughout the entirety of the surgical process (42).

The significance of education is equally paramount when it comes to tackling the issue of intraoperative awareness. It is critical to provide patients with comprehensive knowledge regarding the indicators and manifestations of consciousness, including auditory or visual perceptions, as well as instructing them on the appropriate procedure for reporting any such occurrences during the surgical process. By equipping patients with this information, they are empowered to actively engage in their own healthcare. Individuals have the capacity to actively participate in the identification and expression of their own awareness, thereby facilitating healthcare professionals in implementing suitable interventions to mitigate trauma or swiftly address any issues that may arise.

Furthermore, it is crucial to acknowledge that education assumes a pivotal role in adequately preparing patients for the process of surgery and anesthesia. Patients can enhance their comprehension of the complete surgical procedure by receiving comprehensive preoperative instructions and being informed about drugs, dietary limitations, and after care. The acquisition of this knowledge enables patients to assume an active role in their recuperation, resulting in enhanced compliance with surgical directives and ultimately, improved overall results (43).

Finally, effective patient communication and education play crucial roles in the continuous monitoring and treatment of intraoperative awareness. In the event that a patient's consciousness is suspected during a surgical procedure, anesthesiologists and nurses are compelled to depend on the patient's capacity to convey nuanced indications, such as eye movements or hand gestures, in order to launch suitable interventions. Consequently, it is imperative to establish efficient communication and provide proper instruction to patients in order to facilitate their comprehension and proficient utilization of non-verbal communication techniques.

Conclusion

Intraoperative awareness refers to the rare but devastating occurrence of a patient regaining consciousness or becoming aware during surgery while under general anesthesia. This phenomenon is a significant concern and can have severe psychological consequences for patients who experience it. The causes of intraoperative awareness can vary, including inadequate dosing or timing of anesthetic drugs, individual factors such as heightened susceptibility to anesthesia, or technical errors. Ensuring patient safety and preventing intraoperative awareness require a multidisciplinary approach involving close monitoring by vigilant anesthesiologists, adherence to evidence-based practices, and advancements in technology such as brain monitoring devices. Additionally, proper pre-operative assessment and communication with patients regarding the possibility of accidental awareness during general anesthesia can minimize anxiety and enhance trust in the healthcare team. Continuous education and training for healthcare professionals are crucial to improve understanding and management of this complex phenomenon. Overall, minimizing the risk of intraoperative awareness is vital for improving patient outcomes and maintaining patient confidence in surgical procedures requiring general anesthesia. ■

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