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LETTER TO THE EDITOR

USE OF DESFLURANE: CONSIDERATIONS AND CONTROVERSIES

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Abstract

Desflurane stands as a pivotal volatile anesthetic in contemporary anesthesia practice and has been a cornerstone of modern anesthesia practice due to its rapid onset and offset of action. Despite its clinical advantages, the environmental footprint of desflurane, characterized by significant greenhouse gas emissions, has sparked a debate on its continued use and potential regulatory measures. This article evaluates desflurane's clinical benefits, alongside its environmental implications, offering insights into possible regulation perspectives. Highlighting its favorable pharmacokinetic properties, rapid induction, hemodynamic stability and bronchodilator effects, against its contribution to climate change, the study aims to foster a balanced discourse on desflurane's role in healthcare, advocating for a harmonization of clinical needs with ecological stewardship.

Introduction

Desflurane is an essential component of modern anesthesia because for its clinical efficiency, and nowadays has garnered attention for its environmental consequences. Recent studies have shown the significant greenhouse gas emissions associated with desflurane administration and raising concerns about its sustainability. This study examines all the clinical indications for desflurane, assesses its environmental impact, and discusses the rationale behind proposals for its regulation and banning. Traditionally, inhalational techniques have been preferred for anesthesia because of their availability and familiarity (1). Desflurane is commonly chosen inhalational anesthetic because its faster offset, which is a result of its blood: gas partition coefficient, particularly in long cases, difficult airways and obese patients. Studies show that patients' responsiveness and time to extubating is more rapid with desflurane than with sevoflurane, and this is significant with obese and geriatric patients (2). Yet, growing awareness of its environmental footprint, has prompted discussions about its sustainability and potential regulatory measures.

Clinical Uses of Desflurane

Desflurane offers several advantages and benefits in clinical practice that contribute to its widespread use and one of the most significant advantages is its rapid onset and offset of action because of its low blood-gas solubility coefficient that allows rapid equilibration between alveolar gas and arterial blood. This characteristic leads to smooth induction of anesthesia, making it particularly suitable for ambulatory surgeries where quick recovery is desirable. However, the times to achieve lighter anesthetic levels when pharyngeal function is normalized, were notably different between isoflurane and sevoflurane when compared to desflurane with desflurane occurring more rapidly (3). Additionally, the fast offset of desflurane enables rapid emergence from anesthesia, minimizing postoperative recovery time and facilitating early discharge from the post anesthesia recovery unit. McKay et al. demonstrated that patients receiving desflurane had earlier awakening and were able better to protect their airway, as noted by not coughing or drooling when swallowing 20mL of water 2 minutes after following commands, when compared to sevoflurane. The findings were quite dramatic with 100% of the desflurane group having normal pharyngeal function, but <50% of the sevoflurane group achieving that level (4). Desflurane is known for its favorable hemodynamic stability, making it an excellent choice for patients with cardiovascular comorbidities and with patients undergoing cardiac surgeries. While some other inhalational agents may depress heart activity, desflurane only minimally depresses myocardial function and keeps cardiovascular stability intact even during periods of hemodynamic stress. This characteristic is due to desflurane ability to reduce myocardial depression in comparison to agents like isoflurane, making it safe for patients with compromised heart conditions. By stimulating bronchodilation, desflurane can prevent bronchospasm and maintain proper respiratory function during anesthesia. This is especially useful in patients with a history of airway hyperreactivity, where the maintenance of airway patency is important to ensure safe anesthesia administration. Unlike some other inhalational agents, desflurane is associated with minimal airway irritation and coughing during induction of anesthesia. Its low solubility in blood results in a lower concentration of desflurane in the airways, reducing the likelihood of respiratory irritation and this characteristic makes desflurane particularly well-tolerated in awake patients or those with a heightened airway sensitivity.

When looking at patients with significant comorbidities, Bilotta et al. demonstrated a quicker recovery of cognitive function and, more importantly, earlier normalization of pH and $PaCO_2$ in morbidly obese patients undergoing craniotomy when receiving desflurane (5). Desflurane undergoes minimal metabolism in the body, primarily through hepatic metabolism 0.02%, reduces the risk of drug interactions and ensures predictable pharmacokinetics. Additionally, desflurane's low metabolism contributes to its rapid elimination and allows precise titration of anesthetic depth during surgery.

Environmental Impact

The environmental impact of anesthesia agents, particularly volatile inhalational agents like desflurane, has gained increased attention in recent years. Desflurane, like other halogenated volatile anesthetics, contributes to greenhouse gas emissions through the release of fluorinated compounds during their production, administration and disposal. These fluorinated compounds are trifluoroacetic acid (TFA) and hexafluoroisopropan-2-ol (HFIP) that have long atmospheric lifetime that contributes to global warming potential. The production and disposal of desflurane create greenhouse gas emissions that are exacerbating climate change and environmental degradation. Fluorinated metabolites released during desflurane metabolism persist in the atmosphere for extended periods which has a cumulative effect on climate change. These metabolites have long atmospheric lifetimes that contributes to the persistence of greenhouse gases and ozone depletion. The global warming potential is a measurement of the radiative forces of a gas compared to carbon dioxide, it encompasses the wavelength and quantity of infrared absorption and the atmospheric longevity of the gas (6). Desflurane is a potent greenhouse gas, and 1kg of desflurane is equivalent to 2540kg of CO_2. This means that every hour of desflurane usage, running at 5% with flows of 1L, is the equivalent of producing 56kg of CO_2 emissions. Running a 7h case would produce the equivalent of 392kg of CO_2 emissions. While desflurane atmospheric impact is relatively lower compared to older volatile anesthetics like halothane, its widespread use in anesthesia practice significantly increases the environmental consequences. As a result, desflurane not only affects the environment during its anesthesia usage but also has long-lasting effects on the atmosphere. The production of desflurane requires significant resources like energy and raw materials that contribute to carbon emissions and environmental degradation. It involves the use of fluorinated compounds and organic solvents, which can have detrimental environmental effects if not managed properly. Additionally, the disposal of unused desflurane and its packaging materials can lead to pollution of soil and water bodies, and that poses risks to ecosystems and human health. Because of its low blood-gas solubility, higher fresh gas flow rates are needed during administration, leading to increased waste gas emissions. These waste gases contain volatile organic compounds, including desflurane and its metabolites, that contribute to air pollution and environmental degradation. The release of waste gases into the atmosphere further exacerbates desflurane environmental impact, particularly in hospitals with inadequate waste gas management systems. Environmental agencies and healthcare organizations are increasingly recognizing the need to reduce the environmental consequences of anesthesia practices, and have cautioned regulatory investigation and calls for stricter controls on its use. Proposals for regulating desflurane include implementing low flow anesthesia techniques, promoting the use of alternative anesthesia agents with lower environmental footprints, and investing in sustainable anesthesia practices.

The Use of Desflurane: Considerations and Controversies

Desflurane offers several advantages in clinical practice, including rapid induction of anesthesia, precise titration, and favorable hemodynamic stability. Its rapid offset also facilitates fast emergence, recovery and enables early discharge from the post anesthesia care unit also making it particularly suitable for ambulatory surgeries. Desflurane is generally well-tolerated from patients and has a predictable pharmacokinetic profile. Its minimal metabolism reduces the risk of drug interactions, has a minimal organ toxicity ensuring safer anesthesia administration, and ensures optimal patients' outcomes. In certain surgeries like neurosurgical procedures and laparoscopic surgeries, desflurane has unique properties that make it the preferred anesthetic agent for ensuring patient's comfort and surgical success. Additionally, desflurane is more suitable for low flow anesthesia by regulatory agencies like the US FDA due to its low solubility and minimal reaction with soda lime and this characteristic allows for efficient use of anesthetic gases because of reducing resource consumption and waste gas emissions. Regarding the environmental effects of desflurane, it was reported that healthcare accounted for 4.6% of greenhouse gas emissions worldwide, with anesthetics representing 2% of that total. Hence, anesthetics contribute 0.09% to global greenhouse gas emissions. Even though it may be a very small percentage, it is a significant amount. However, it is of a size that allows for the consideration of methods and tools to further reduce it, instead of completely getting rid of a widely used anesthetic. The impact to the environment of other anesthetics which will likely be utilized in larger quantities if desflurane is removed. First, sevoflurane, although to a lesser extent, has a negative environmental impact. More importantly, the negative environmental effects of the intravenous anesthetics (e.g., propofol) with the creation of medical waste including syringes, plastic tubing and needles, as well as the utilization of electrical devices for their delivery leading to a small but present greenhouse gas impact. Propofol is spilled at high amounts into our environment, is not naturally degraded, and is toxic to wildlife (7). Therefore, there is a negative environmental impact with the use of anesthetics as a whole, but to attribute all of it to one anesthetic with devices already in place to reduce that impact ignores many other contributors to the problem.

Conclusion

The decision of whether desflurane should or should not be used in anesthesia practice requires careful consideration of its clinical benefits, environmental impact, and ethical implications. While desflurane has undeniable advantages because of its clinical efficacy and safety, its environmental footprint and ethical concerns calls for a reevaluation of its role in modern anesthesiology. Placing all the blame on one anesthetic and neglecting the beneficial qualities of the agent that enable us to care for our complex patients is unjust. Data suggests that desflurane should remain available for clinical use due to its ability to provide faster awakening and earlier airway protection, particularly in patients with significant comorbidities, obese patients and in geriatric anesthesia, as well as its potential cost effectiveness and environmentally friendly properties. Anesthesia providers, regulatory agencies and healthcare institutions must collaborate, and together to find a balance between clinical needs and environmental responsibility and ensure optimal patients' care while minimizing ecological harm. Ultimately, the use of desflurane should be coupled with efforts to promote greener alternatives and sustainable anesthesia practices and can pave the way towards a more environmentally conscious healthcare system.

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