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Sustainable Anesthesia: State of Knowledge and Practices of Moroccan Anesthesiologists

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Abstract

Sustainable anesthesia is critical in reducing healthcare's environmental impact, as anesthetic gases significantly contribute to hospitals' carbon footprints. The healthcare sector is responsible for over 4% of global CO_2 emissions, prompting guidelines from organizations like the WFSA to support eco-friendly practices, including low-flow anesthesia and alternative agents. Emphasizing education and policy reform, these efforts aim to align clinical effectiveness with environmental stewardship, fostering a sustainable healthcare approach for future generations.

A professional survey was carried out via a questionnaire to doctors/nurses in anesthesia. Analysis of the survey results showed that nitrous oxide and Desflurane are used less by anesthesiologists and that this reduction has led to an increase in the consumption of Sevoflurane and Isoflurane. We also note that the use of anesthetic gases with a low flow of fresh gas is common practice. Furthermore, our survey highlighted a lack of knowledge of the environmental impact and atmospheric lifetimes of volatile anesthetics and that the notions of eco-design and eco-responsibility are little known.

Our results show that raising practitioners' awareness of the environmental impact is essential to move towards a more sustainable and eco-responsible practice.

Keywords: Sustainable anesthesia; Greenhouse gas anesthesia; Eco-responsible anesthesia

Introduction

Sustainable anesthesia is emerging as a vital component of environmentally responsible healthcare practices. The anesthesia sector is a significant contributor to the carbon footprint of hospitals, largely due to the use of volatile anesthetic agents, which are potent greenhouse gases [1]. As the healthcare industry grapples with its impact on climate change accounting for over 4% of global carbon dioxide emissions [2], there is an urgent need for the implementation of sustainable practices in anesthesia to mitigate environmental harm [3].

The growing awareness of climate change has prompted various international organizations, including the World Federation of Societies of Anesthesiologists (WFSA), to issue guidelines that promote environmentally sustainable practices in anesthesia (WFSA, 2022). These guidelines encourage the adoption of low-flow anesthesia techniques, the use of alternative anesthetic agents with lower global warming potential, and the reduction of waste generated in operating rooms [4]. By fostering education and advocating for policy changes, the anesthesia community can play a pivotal role in the broader movement towards sustainability in healthcare [5].

As we move forward, it is crucial to assess current practices, identify barriers to implementation, and develop strategies that align clinical efficacy with environmental stewardship, ensuring a healthier planet for future generations [1].

To better understand the current state of knowledge and practice in this area, we conducted a survey among Moroccan anesthesiologists. By analyzing their attitudes, knowledge, and practices concerning sustainable anesthesia, we aim to contribute to the ongoing global efforts to integrate sustainability into healthcare.

Materials and Methods

A professional survey was conducted among 150 anesthesia professionals (physicians and nurses) practicing in the Rabat-Salé region. The survey period lasted for two weeks. The link to the questionnaire was distributed to participants via email or WhatsApp.

Questionnaire

The anonymous questionnaire comprised 22 questions divided as follows:

- 5 questions regarding the demographic and professional characteristics of the participants,
- 2 questions on the general knowledge of sustainable development and environmental concepts,
- 15 questions related to the practices concerning the use of anesthetic gases and their environmental impact.

Participants could only complete the questionnaire once. The questions were organized into logical blocks grouped by topic to facilitate comprehension and enhance the flow of responses.

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Data Collection and Analysis

Responses were collected and analyzed using the Google Form platform, which provided visual results and graphs expressed in percentages or absolute numbers.

Study Objectives

The primary objective of this study was to assess the perception of anesthesia professionals regarding the ecological impact of their practice, particularly concerning the use of anesthetic gases. To achieve this, we defined three research axes:

1. To identify the criteria influencing the choice of halogenated agents and nitrous oxide.

2. To estimate the role of the ecological factor in selecting anesthetic gases.

3. To evaluate the knowledge of healthcare professionals about the environmental impact of anesthetic gases.

Results

The Demographic and Professional Characteristics

82 anesthetists who participated in the survey, reflecting a participation rate of approximately 54.66%. The majority of respondents were male (82.9%), while females constituted 17.1% of the sample.

The age distribution highlights a diverse group of professionals, with the most represented age group being 30 to 39 years, comprising 50% of the respondents. This suggests a relatively younger cohort among the anesthetists surveyed.

In terms of professional categories, a range of roles is represented, including anesthesia nurses (25.6%), specialist anesthesia physicians (20.7%), and residents in training (20.7%).

This diversity indicates a broad spectrum of perspectives within the field, enhancing the study's relevance and depth in assessing the ecological impacts of anesthesia practices.

Overall, the demographic profile of the participants is crucial in understanding the varying attitudes, knowledge, and practices regarding sustainable anesthesia, as it allows for insights into how different factors, such as age and professional role, may influence perceptions of ecological impacts within this specialty (Table 1).

The participants range from younger to older anesthetists, with the majority (36.6%) having 3 to 10 years of professional experience. Notably, a large proportion (72.8%) primarily work in adult operating rooms. This suggests that they possess considerable experience in various clinical contexts, which may influence their awareness and adoption of eco-friendly practices.

Environmental Sensitivity

A striking finding is that 86.6% of participants consider themselves sensitive to environmental issues, with 50% being completely sensitive. This indicates a growing collective awareness among anesthetists regarding the impact of their practices on the environment.

Table 1: Demographic and Professional Characteristics of Survey Participants.

Category	Number Of Participants	Percentage (%)
Total anesthetists	82	100
Gender		
Male	68	82.9
Female	14	17.1
Age group		
20-29 years	(Data not provided)	(Data not provided)
30-39 years	41	50
40-49 years	(Data not provided)	(Data not provided)
50-59 years	(Data not provided)	(Data not provided)
60 years and above	(Data not provided)	(Data not provided)
Professional categories		
Anesthesia nurses	21	25.6
Specialist anesthesia physicians	17	20.7
Residents in training	17	20.7
Higher education professors	11	13.4
Full professors in anesthesia	9	11.0
Assistant professors in anesthesia	7	8.5

Table 2: Knowledge of Sustainable Development Concepts among Anesthetists.

Concept	*Yes (%)*	*No (%)*	*Vaguely (%)*	*No response(%)*
Greenhouse Gases	64.6	20.7	14.6	0
Environmental Risks	72	11	17	0
Sustainable Development	61	18,3	17	3.7
Waste Management	66	11	20,7	2.3
Work Quality	70.7	8.5	20.7	0
Environmental Health	53.6	20.7	25.6	0
Ecodesign	30.4	44	24.4	1.2
Eco-responsibility	44	29.3	24.4	2.3

Knowledge of Sustainable Development

The analysis of Table 2 shows that a majority of respondents (53% to 72%) are aware of key concepts related to sustainable development, including greenhouse gases, waste management, and work quality. However, knowledge about ecodesign and eco-responsibility remains low, with only 30% to 44% of respondents expressing a lack of awareness. Additionally, a significant percentage (11% to 29.3%) believe these concepts are vague, highlighting a need for ongoing education in these areas.

Use of Anesthetic Gases

Regarding anesthetic practices, 42.7% of anesthetists perform between 1 and 10 general anesthetics per week. The majority (72%) report using nitrous oxide less frequently, with 47.6% stating they rarely use it. When administered, nitrous oxide is primarily used for its analgesic effect (41 responses) or to optimize anesthesia.

Regarding the use of halogenated agents, a lower usage of Desflurane (1.2% to 8.5%) was noted across all ASA classes. This may be explained by the unavailability of this gas. Meanwhile, Sevoflurane is more commonly used in ASA 3 patients for both short and long-duration surgeries and in ASA 1 patients only for short-duration surgeries. In contrast, Isoflurane is exclusively used for long-duration surgeries in ASA 1 patients (Table 3).

Table 3: Anesthetic Practices among Participants.

Practice	Percentage (%)
General anesthetics per week	
1-10	42.7
Use of nitrous oxide	
Less frequently	72
Never	47.6
Rarely	24.4
Primary use of nitrous oxide	
Analgesic effect	67.2
Optimize anesthesia	55.7
Reduce mac	50.8

Table 4: Awareness of Environmental Impact of Halogenated Agents.

Awareness Level	Percentage (%)
Aware of greenhouse gas impact	63.4
Unaware	34.1
Consider impact very significant	11.3

Table 5: Knowledge of Atmospheric Lifetimes of Anesthetic Gases.

Gas	Correct Response (%)
Nitrous oxide	19.8
Desflurane	5
Sevoflurane	8.8

Knowledge of Environmental Impact

Concerning knowledge about the environmental impact of halogenated agents, 63.4% of anesthetists are aware that they contribute to greenhouse gases, while 34.1% are completely unaware of this effect. Furthermore, few (11.3%) consider this impact to be very significant. Alarmingly, awareness of the atmospheric lifetimes of anesthetic gases is very limited, with only 19.8% correctly identifying the half-life of nitrous oxide, and even lower percentages for Desflurane (5%) and Sevoflurane (8.8%) (Table 4 & Table 5).

Change in Practices

Finally, when asked whether they would change their anesthetic gas usage habits based solely on ecological arguments, 76.6% responded positively, indicating a significant openness among Moroccan anesthetists to adopt eco-friendly practices.

These results emphasize the need for ongoing education regarding environmental impacts and sustainable practices within the anesthesia field and underscore the importance of fostering a culture of sustainability among professionals.

Discussion

Surgery performed under general anesthesia produces greenhouse gases, particularly halogenated gases, which have the capacity to absorb and re-emit infrared radiation in the Earth's atmosphere [6,7]. These gases have a much greater Global Warming Potential (GWP) than carbon dioxide (CO2), the most significant anthropogenic greenhouse gas. For instance, desflurane has a GWP of 2540, making it 2500 times more potent than CO2, with a long atmospheric lifetime of 114 years, compared to 14 years for desflurane and 1.1 years for sevoflurane [8]. Therefore, it is recommended to reduce fresh gas flow rates and utilize source capture devices to mitigate anesthesia gas emissions into the atmosphere.

The anesthetic gases employed in the medical field significantly impact the environment. A study conducted by Jane Muret et al. in 2020 [9] indicated that one hour of anesthesia with a fresh gas flow of 1 liter and 30% oxygen concentration equates to driving 10 km in a car with sevoflurane (2.5%) or 376 km with desflurane (5%). When the mixture contains 30% nitrous oxide (N2O), this impact can rise to 77 km for sevoflurane and 443 km for desflurane. Over an 8 hour operating room day, the use of these gases could lead to a journey across France with sevoflurane (from Oujda to Agadir) or even to Moscow with desflurane (from Bouarfa to Lagouira). The environmental impact can be easily calculated based on halogenated gas consumption in an anesthesia department: thus, using a 240 ml desflurane bottle emits 886 kg CO2 equivalents, while a 250 ml sevoflurane bottle emits 44 kg CO2 equivalents [10].

The biodegradation and biotransformation of nitrous oxide are very slow, with its atmospheric half-life estimated at between 100 and 150 years. N2O has an Ozone Depletion Potential (ODP) of 0.016, indicating that it depletes the ozone layer that protects us from ultraviolet radiation from the sun and contributes to the greenhouse effect in conjunction with CO2 [11]. Although it accounts for only 1% to 3% of global N2O emissions [12,13], its use in anesthesia is considered significant as it increases the environmental impact of other anesthetic gases used in conjunction. Indeed, using N2O as a carrier gas Indeed, the use of N_2O as a carrier gas increases the CDE20 and CDE100 (CO2 equivalent over 20 and 100 years) values of sevoflurane and isoflurane by 6 and 3 times, respectively. However, eliminating N2O from anesthetic mixtures, combined with reducing fresh gas flow, can reduce greenhouse gas emissions by up to 20 times at 1 MAC per hour [14,15].

Reducing or eliminating nitrous oxide can be achieved through several actions. Firstly, constructing new "N2O-free" operating rooms and technical platforms can completely eliminate the gas. Secondly, removing N2O systems and shutting down existing installations can also reduce exposure to the gas. If the use of N2O must continue, greenhouse gas emissions can be minimized by utilizing very low fresh gas flow rates, either manually or through applications that allow for carbon cost calculation, or by using ventilators that permit target concentration inhalation anesthesia. Additionally, to compensate for the loss of N2O's antihyperalgesic effects, alternatives such as medications (ketamine, regional anesthesia) and non-pharmacological methods (hypnosis) can be considered [16,17]. It is recommended to limit the use of equimolar O2/N2O mixtures outside of technical platforms and to adhere to usage guidelines for painful procedures [18], particularly in emergency departments.

Although the hospital use of nitrous oxide is currently decreasing, its atmospheric emissions remain high, raising questions about its use relative to its benefits [19], and its elimination should be considered. In this regard, the authors Mehdi Hafiani et al. [20] proposed practical actions to organize the definitive cessation of nitrous oxide use and the removal of the N2O circuit. The actions to cease N2O use in hospitals occur in ten steps. First, assess the practices regarding N2O use in the relevant hospital center to raise awareness and mobilize the anesthesia team around sustainable development initiatives. Next, evaluate N2O consumption over a reference period and identify user units in the N2O network. The fluid committee should hold an initial meeting to officially terminate N2O use and establish an action

plan leading to the removal of N2O systems and the shutting down of N2O circuits. It is essential to reprogram the hospital's anesthesia ventilators to no longer be dependent on N2O and disconnect all anesthetic ventilators from N2O outlets. A 10-to-15-day trial period with N2O valves shut off should follow, along with monitoring and notifying of any alarms related to this shutdown. The removal of N2O systems must be conducted, followed by sealing and closing the circuit and decommissioning N2O outlets. Finally, it is necessary to evaluate the reduction in greenhouse gas emissions linked to the cessation of N2O use.

Anesthetic gases are released into the atmosphere as patients metabolize only a small fraction of these gases during the procedure, and they are evacuated via the SEGA outlet. To reduce their environmental impact, several actions can be undertaken, including selecting the least polluting gas, reducing or eliminating N2O use, working with the lowest possible fresh gas flow rates, optimizing the delivered fraction of halogenated agents by monitoring anesthesia depth, using concentration-targeted inhalation anesthesia modes, and calculating daily consumption via smartphone applications. Additionally, it is crucial to ensure preventive maintenance of anesthesia systems, adapt localized capture devices, control general ventilation, and provide gas evacuation systems during work facility design. Finally, training and informing staff and ensuring appropriate medical monitoring of pollution levels is essential [19,21,22].

The results of our survey indicate that practitioners have a limited understanding of various concepts related to sustainable development. This underscores the need for measures to reduce the carbon footprint of anesthetic activity and achieve financial savings through appropriate selection of anesthetic gases and optimization of fresh gas flow settings in the operating room. To achieve this goal, it is essential to raise awareness, inform, and train medical and nursing staff on sustainable development in anesthesia. The ultimate aim is to integrate these concepts into daily healthcare practices without compromising care quality or the comfort of healthcare professionals in performing their duties.

Conclusion

Hospitals, particularly operating rooms, bear the responsibility of implementing sustainable development strategies. Anesthetic activities generate a significant amount of waste and pollution due to the use of polluting gases, posing health issues for professionals. Efforts must be made to raise awareness and train staff to integrate sustainable development into their practices without compromising care quality or the comfort of caregivers.

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