

Time to say goodbye to inhalational anaesthesia?

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Summary

Anaesthesiology also needs to answer the question as to how environmentally friendly its methods really are. In the following, (as a supplement to the article of Stefan Müller and Hinnerk Wulf in this copy) we will explain and evaluate the global aspects of climate impacts due to inhalation anaesthetics and the occupational exposures that ensue from these substances. Hence we will elaborate reasons in favour of an anaesthesia management doing without climate-damaging greenhouse gases and outline a potential path that could lead into that direction. Reasons favouring an opposite opinion are presented in the following article by Kai Zacharowski in terms of a pro-con debate as is just now beginning in other countries as well [1].

Introduction

There is no doubt that the self-image and image of the anaesthesiologist has changed over the last decades. We have undergone a metamorphosis from anaesthetists to perioperative physicians and as anaesthesiologists we are involved and leading in anaesthesia, theatre management, intensive care, emergency medicine, palliative and pain therapy and so we are far from being just “the gas man” (or “the gas woman”)¹.

The anaesthesiologist’s German nickname “gas man” is of course owed to the fact that for more than a century anaesthesia was almost exclusively per-

formed as inhalation anaesthesia (and is still practised almost exclusively in this form in a few institutions).

It is now probably time to end the era of pure gas men and their inhalation anaesthetics, not only because of the much broader scope of modern anaesthesiology, but also for other reasons. Inhalation anaesthetics are greenhouse gases (and damage the ozone layer in some cases) and are thus simply no longer up to date. Finally, global warming will affect all of us, but it will also have special effects on the healthcare system, e. g. through an increase in infectious diseases known so far only in the tropics (dengue fever), heat-wave-related circulatory morbidity and mortality among our patients (and us), or even just through the necessary installation of air-conditioning systems in our patients’ and doctors’ rooms, which have so far mostly been lacking!

Are inhalation anaesthetics harmful to the climate?

The main contributors to greenhouse gases are known to be CO₂, methane and nitrous oxide (N₂O). Nitrous oxide also damages the ozone layer. But the

¹ In the remainder of the text, the masculine form is used for reasons of better readability, since the term “gas man” is established, but the term “gas woman” has remained largely uncommon in Germany’s operation theatre jargon despite all efforts at equality.

Competing interests

The author declare no competing interests.

Keywords

Inhalation Anaesthetics – TIVA – Sustainability – Carbon Footprint – Green Anaesthesia – Greenhouse Gases

concentration of the other inhalation anaesthetics (in descending order of frequency of use, sevoflurane, desflurane and isoflurane), which also act as greenhouse gases, is constantly increasing in the atmosphere (while the concentration of halothane – which was mainly due to its use in the last millennium – is very slowly but measurably decreasing). They can be detected in annually increasing concentrations in the Arctic, the Antarctic and at the Jungfrauoch (Swiss Alps) [1]. This effect is caused by the increasing consumption worldwide in ORs, but above all by the long duration of stay in the atmosphere. More than a decade ago, this led to the call to abandon N₂O and reduce the flow of fresh gas [2]. The front-runner in terms of global warming potential (GWP) is undoubtedly desflurane (“atmospheric lifespan” >10 years) [3]. Therefore, many are calling for “Desflurane should Des-appear” [4]. Accordingly, the EU Commission published a proposal in April 2022 to update the “F-gas regulation”, which would ban or significantly restrict the use of desflurane in the future. The NHS in the UK also envisages a ban on desflurane from 2024 onwards.

Let’s look at a few more facts (“real fakes!”) on this. The healthcare system is held responsible for about 4.4 % of global CO₂ emissions. In other words: If the healthcare system were a country, it would rank 5th among the nations worldwide in terms of CO₂ emissions (due to energy consumption, transport, production, use, waste and exhaust gases, with energy consumption probably also accounting for the largest share in the healthcare system). 1 % of the environmental impact of the healthcare system comes from inhalation anaesthetics (0.6 %) and metered dose inhalers (0.3 %). As this sounds relatively abstract, more striking comparisons are often made: A “gas man” who performs anaesthesia at his workplace with des-

flurane (6 %) and nitrous oxide (50 %) at low-flow (fresh gas flow 0.5 l/min) thus causes the CO₂ pollution of a transatlantic flight every week [5]. If he chooses a fresh gas flow of 2 l/min, he can drive from the North Cape to Cape Town every day [3]. More detailed information on this can be found in the article by Stefan Müller in this issue of A&I [6].

Even if the dimension is probably different: To be fair, it should be taken into account that the “TIVAngelst” does not work in a climate-neutral way either, because propofol production, transport, plastic syringe disposal, discarding of unused substance etc. up to the excretion of the degradation products into the sewage system (and the oceans) have to be taken into account with regard to environmental pollution. However, the greenhouse gas impact of desflurane anaesthesia is probably about 70x higher than that of TIVA [5,7].

Certainly, there are many other environmentally harmful effects in the healthcare system, starting with a very high energy consumption of our hospitals, packaging waste orgies from sterile good wrappings up to an often still missing waste separation, so that often all single-use packaging coming from the operating theatre is disposed as “infectious waste”.² However, many of the issues are also very ambivalent: Should we renounce (recyclable) single-use products more often? How environmentally damaging is the reprocessing of reusable equipment? How do we balance patient safety (infection control through single-use products) against environmental aspects?

A very good overview of possible measures in hospitals can be found at KLUG, German Alliance on Climate Change & Health [8]. If the ambitious German and European climate targets are to be achieved, all sectors must make their contribution. Accordingly, the field of anaesthesiology should also be success-

ful by 2030. All this suggests – in view of the duration of time of inhalation anaesthetics in the atmosphere – that the use of inhalation anaesthetics – or at least desflurane and nitrous oxide – should be very largely or completely abandoned with immediate effect, at least as long as no practical, effective and truly climate-friendly recycling systems have been established.

Unfortunately, the current recycling systems for desflurane – among others with meaningful brand names such as “CONTRAflurane” – are still very problematic, e. g. malfunctions with leakages of anaesthetic gases, false alarms when using alcoholic disinfectants, etc. Above all, however, only 25 % of the desflurane used is recovered on average (presumably because a large proportion is not exhaled until the recovery room) [9]. As far as it can be seen, not a single millilitre of absorbed desflurane has been reused in patients in Germany so far, so no recycling, but only a “separate disposal”. Rather more, the absorbed substance would currently have to be flown back across the Atlantic to the production sites (e. g. to Puerto Rico) for reprocessing, and then flown back to us again – probably a not so good “eco-balance”.

Are inhalation anaesthetics dispensable?

Of the inhalation anaesthetics, only xenon does not appear to have a greenhouse gas effect. However, its production is energy-intensive and xenon is also considerably more expensive and not available in sufficient quantities, so it is not an alternative for replacing desflurane, sevoflurane and isoflurane in daily routine for the foreseeable future.

For general anaesthesia, intravenous anaesthesia (TIVA) is already a firmly established alternative. For a whole range of operations, regional anaesthesia (eco-keyword: “regional products”!) is available as an option instead of general anaesthesia. Some clinics have already proven that e. g. paediatric anaesthesia, traditionally considered a special indica-

² Remarkably, however, inhaled anaesthetics are the only specific item addressed in the Health Cares Global Climate Footprint Report, published by Health Care Without Harm (HCWH), an international NGO (Non-Governmental Organisation).

tion area for inhalation anaesthesia, can also be performed very well exclusively with TIVA.³

In addition, suction devices for inhalation anaesthetics are real “energy guzzlers”. But even apart of the climatic effects, there are good arguments to largely renounce inhalation anaesthetics in our operating theatres. Workplace exposure of staff to exhaled inhalation anaesthetics is still demonstrable – despite efforts to create effective suction devices – not only in operating theatres, but especially in recovery rooms. This is particularly relevant for all pregnant anaesthetists, surgeons and assistant staff who wish to continue working in the OR. Most of the responsible regional councils or authorities approve this on the condition that inhalation anaesthetics are forgone. The end of the “gas woman” has therefore also long since been heralded for these reasons.

The only thing that then remains to be considered is that alternatives to propofol must be available in the event of supply shortages in order to remain the ability to act. However, with Remimazolam, an alternative to Propofol seems to be approved for anaesthesia in Europe soon.

Is change feasible? From “gas man” to “tivangelist” or “block guy”?

“Change management” is feasible, especially if, as shown in this case, there is a high level of sensitivity with the society for the issue and personal benefits are apparent for the users themselves (keyword workplace stress). Anaesthesiology has also experienced several such transformations, the change from halothane to modern inhalation anaesthetics, from barbiturates to propofol as the standard induction hypnotic, from

succinylcholine to rocuronium as the standard muscle relaxant for intubation, from intubation to the laryngeal mask, from laryngoscope blades to video laryngoscopy, etc. In some cases, these transformations have taken decades or are still ongoing. The step away from inhalation anaesthesia and towards TIVA and/or regional anaesthesia is quickly feasible and urgently indicated.

What steps can we take?

Plan A

Complete renunciation of inhalation anaesthetics.

For those who do not (yet) want to take this complete step, the following recommendations can be found in literature (modified after [10]):

Plan B

Extensive abandonment of inhalation anaesthetics, use only for special indications (e. g. mask induction in children, cardioanaesthesia, obesity permagna, OSAS).

Avoid nitrous oxide, substitute e. g. with remifentanyl.

Plan C

Keep the fresh gas flow as low as possible during inhalation anaesthesia, reduce it very quickly already during induction, use closed systems if possible.

Do not use desflurane, prefer sevoflurane because of its lower “global warming potential”.

Plan for the future

In the future, complete recovery and reuse of inhalation anaesthetics from exhaust air could become another alternative. “Thus, the reduction, recapture and reuse of these gases can provide significant climate and health benefits” (WHO [11]).

Until this future becomes reality, we should finally transform ourselves as former “gas men and gas women” into anaesthesiologists who are environmentally aware of our atmosphere and health-conscious of ourselves. If you would like to get ideas for the transformation also in your field of work and discuss and exchange experiences with interested colleagues, the “Forum Sustainability” of the DGAI and BDA offers excellent opportunities [12]!

My conclusion: 177 years after “ether day”, the end of inhalation anaesthesia no longer seems out of question.

Yours

Hinnerk Wulf

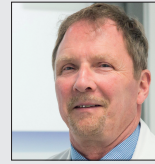
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3 At Marburg University Hospital, all operating theatres have been working without nitrous oxide for a long time. One of the central operating theatres with 10 operating rooms was built without nitrous oxide lines and has been operated completely without inhalation anaesthetics for 15 years. Short and long operations (up to 12-hour tumour operations) and anaesthesia in all age groups are performed there. This is a preferred work area for all pregnant anaesthetists and surgeons who wish to continue working in the operating theatre.

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