HEAL Indicator Proposal

1. DESCRIPTION & IMPORTANCE

1.1 Name of the indicator

Australian Desflurane ($CF_3CHFOCHF_2$) use

1.2 Short description of indicator, including its units.

Desflurane is an inhalational general anaesthetic gas used for the induction and maintenance of general anaesthesia. This indicator will track the amount of desflurane purchased over time by geographic region and type of hospitals (public/ private) (as 240ml bottles and CO_2e emissions).

1.3 Provide a list of team members and short description of their relevant expertise and (lived) experience (if applicable).

Dr Krista Verlis[1,2], Prof Alex Barratt[1,2], Dr Jess Davies[3,4], A/Prof Forbes McGain[1,3,4], Dr Luise Kazda[1,2]

[1]NHMRC Healthy Environments and Lives (HEAL) National Research Network, University of Canberra, ACT, Australia

[2]Wiser Healthcare Research Collaboration, Sydney School of Public Health, Faculty of Medicine and Health, The University of Sydney, NSW, Australia

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- Dr Krista Verlis: obtained her PhD in 2016. She has undertaken research activities in the litter and marine debris space with a focus in monitoring, impacts and solutions for several years in both Australia and internationally. She has also worked in animal health and biosecurity. Obtaining a qualification in public health (2023) Krista has been working with Prof Barratt and her team since July 2022 as a research officer in projects related to sustainable healthcare. Krista has a great interest in understanding and reducing the impacts of anthropogenic activities on wildlife and the natural environment and in making healthcare more environmentally sustainable.
- Prof Alex Barratt: a Professor of Public Health at the University of Sydney, and lead investigator in Wiser Healthcare, a research collaboration to drive better value healthcare for all Australians. In the NHMRC Healthy Environments and Lives (HEAL) National Research Network, she is Co-Lead of the Health Systems Resilience and Sustainability theme. She also leads the research team which is the academic partner for NSW Health's Net Zero Leads program. In the last 5 years, she has led her team's research into the emergent field of measuring and reducing the carbon footprint of health. She has published world leading research using Life Cycle Assessment work to measure carbon emissions of pathology and imaging tests, and new methods to include carbon emissions into health technology assessment, including by monetizing carbon emissions. Her work has measured the carbon footprint of low value care (for example of unnecessary vitamin D testing) and considered how the carbon footprint of low value care may be reduced.
- Dr Jess Davies: A staff anaesthetist at Austin Health, honorary clinical fellow in the University of Melbourne's Department of Critical Care and co-founder of the TRA2SH Research Network, empowering others to make real-world changes to reduce the carbon footprint of healthcare. She is also a PhD candidate exploring how implementation science can improve the environmental sustainability of hospitals. She's passionate about improving the environmental footprint of healthcare and believes that we can deliver high quality care that doesn't cost the earth.

- A/Prof Forbes McGain: became a full-time anaesthetist and intensive care physician at Western Health, Melbourne in 2007, completing a PhD in 2015. Whilst continuing full-time clinical and organ donation efforts he has led several major research themes: healthcare sustainability, biotech engineering innovation, and studying infectious respiratory diseases (COVID-19). FM has 110 peer reviewed publications, a H-index of 30, and >3,000 citations. He has received >$750,000 as the lead investigator, and >$1million as a chief investigator.
- Dr Luise Kazda: A key member of the HEAL Health System Resilience and Sustainability Theme, researching ways to reduce the carbon footprint of the Australian health system. She has secured a HEAL Innovation grant to lead a multidisciplinary research program on reducing the carbon footprint of respiratory inhaler use in Australia; generating a baseline measure of the size of the issue, investigating variations in care, develop an updateable indicator to track carbon emissions; qualitative and quantitative analyses to explore consumer awareness and knowledge regarding the environmental impact of respiratory inhalers and to assess how environmental impact influences their choices. She is also leading the development of the HEAL Indicators and Observatory projects, priority action items for the Network, to provide relevant and accessible information to help Australian individuals and organisations with mitigation and adaptation efforts in the face of climate change. Luise is a qualified epidemiologist.

1.4 Which HEAL Theme(s) is the indicator suggested for?

Health Systems Resilience and Sustainability (HSRAS) Theme

1.5 How does this indicator relate to the objectives of the HEAL Theme(s)?

This indicator of desflurane use relates to the decarbonising aspect of clinical care in Australian healthcare. This aligns with the two main objectives of the HSRAS theme: (1) identifying and assessing components of the health system vulnerability, resilience, and environmental sustainability with health system stakeholders, and (2) Supporting clinical, health workforce, health service and community champions for change.

1.6 What is the relevance of this indicator for HEAL stakeholders?

Desflurane is a commonly used anaesthetic gas. There is evidence of slightly faster wake up times using desflurane in shorter duration procedures (<3hr) but for longer surgeries wake up times are comparable to other volatile anaesthetics [1] and minimal differences compared to propofol-based total intravenous anaesthetics (TIVA) [2]. Desflurane is a highly potent greenhouse gas with a global warming potential (GWP) of 2540 over 100 years or 6810 over 20 years)[3] and is recognised as a significant 'carbon hotspot' in public and private hospitals.

A great deal of action is occurring globally around the continued use of desflurane. In Scotland, for example, a ban was introduced in 2023 and the European Union is looking to ban desflurane from 2026 (except in exceptional circumstances)[4]. Professional colleges and organisations, such as the Association of Anaesthetists and the Royal College of Anaesthetists in England and Ireland support a 2024 phase-out of the gas[5].

In October 2023, Western Australia was the first Australian state/territory to ban desflurane use in public hospitals, following a clinician-led movement to switch to safer and more effective drugs that were also better for the environment as part of delivering a low carbon health system[6]. Desflurane was formally removed from the WA State-wide Medicines Formulary (SMF). This decision came about as in comparison to other volatile anaesthetics such as sevoflurane, desflurane creates significantly more carbon emissions for the same period of anaesthesia use, at greater financial cost and with no clinical superiority[6]. NSW

Health has now also decided to remove desflurane from formulary by April 2024. To date, other states and territories have not moved similarly, though QLD Health does suggest a decrease in its use in public hospitals[7]. Furthermore, while desflurane use appears to be declining in public hospitals around the country, anecdotal evidence suggests it is still being widely used in the private sector, and that there are pockets of significant resistance to phasing it out. This indicator is important because even if only relatively few private hospitals are using desflurane, its enormous carbon footprint could mean it could still be responsible for a significant percentage of healthcare's emissions.

The Australian and New Zealand College of Anaesthetists (ANZCA) issued a position statement that encourages use of anaesthesia with lower environmental impacts and created an environmental sustainability audit tool for clinical practice that discourages the use of desflurane (and N_2O) through initiatives like staff education and by-request only access to desflurane vaporisers [8].

Desflurane is more expensive than other volatile anaesthetics and has little evidence of clinical benefit[9]. Most recently, desflurane was one of only two mitigation priorities identified for reduction in clinical care in the draft Australian Government's National Health and Climate Strategy Consultation[10]. Moreover, environmentally, and economically sustainable alternative anaesthetics that are clinically equivalent and appropriate for most individuals already exist (e.g., Propofol TIVA) [11].

An understanding of current desflurane usage in all Australian hospitals is necessary to provide a baseline from which measures to reduce clinical use can be developed and measured and can help inform possible policy and educational / advocacy initiatives [1 11].

1.7 How did you/ will you engage with relevant stakeholders in the design and development process of this indicator?

During the decision making and design process of this indicator a variety of key stakeholders (e.g., anaesthetists, healthcare researchers, healthcare professionals) have already been consulted. We will continue to engage with them during the course of this project to ensure suitability of the indicator to key collaborators and other stakeholders (Table 1).

Table 1: Stakeholder group engagement

Stakeholder Group	Level of Engagement	Means of Engagement
Clinicians (esp anaesthetists)	Collaborate	Part of team and others engaged through networks
Hospital managers/ bureaucrats/ Purchasing managers	Consult	Connecting with hospital networks and utilising clinician contacts
Data custodians (IQVIA)	Consult	Obtain feedback and advice via correspondence
Policy makers (federal and state level)	Involve	Regular formal and informal meetings with policy makers. i.e., LK, AB meetings with Dr Kate Charlesworth, Head Climate Risk and Net Zero Unit, NSW Ministry of Health.

		AB meetings with Dr Madeleine Skellern, Director National Health, Sustainability and Climate Unit.
Patients	Inform	Through communication and collaboration with consumer groups and representatives via our networks
HEAL HSRAS Theme group	Collaborate	Indicator is raised in quarterly theme meetings
Other HEAL themes	Consult and inform	Engage with Rural and Remote Theme and Data and Decision Support Theme
HEAL Indicators working group	Consult	LK & AB are members of the working group
HEAL Observatory Steering Committee	Consult	LK, FMG & AB are members of the OSC

1.8 Has this indicator been published previously or is it similar to or adapted from an indicator used elsewhere?

We are not aware of a publicly available and accessible indicator on desflurane use for Australia. Through stakeholder consultation we know that various hospitals and network have tracked their desflurane use for certain periods of time, but no national dataset of public and private hospital use exists.

2. MEANING

2.1 What will the indicator be able to detect?

Monitoring of desflurane purchasing data within public and private hospitals will demonstrate the effectiveness of any measures introduced to reduce and/or eliminate desflurane use. Purchasing data denotes use and lower values can be interpreted as a positive result.

2.2 What does a higher or lower value of the indicator tell us?

Decreasing numbers of desflurane bottles purchased will indicate decreasing use of desflurane in hospitals and, thus, a shift away from this anaesthetic agent in clinical practice. Conversely, an increase in desflurane purchased would indicate higher use in clinical practice.

2.3 Which Australian jurisdictions or populations will be included in this indicator?

This indicator measures desflurane purchasing across all Australian hospitals both public and private in all states and territories. Desflurane is not used outside of hospitals, thus, it will capture all use of desflurane in Australia.

2.4 Can the indicator be disaggregated/stratified by group/area of interest?

This indicator will be able to be disaggregated or stratified by healthcare facility type (public or private) and by geographical region (including rurality, region and state or territory) which can facilitate measured and focused or tailored responses to address desflurane use.

2.5 Can the implications of the indicator results be effectively communicated to, and appreciated by the target audience? How?

This indicator will be put onto the HEAL Observatory and made available to target groups (e.g., policy makers, hospital procurement managers, anaesthetists). The early involvement of these key stakeholders will ideally aid in supporting this indicator's development and use, especially into the long term. As this is a simple, straightforward indicator (described in Section 3.1), it should be readily understood by interested stakeholders.

3. VALIDITY

3.1 Provide a description of the methods used to generate the indicator.

This will be a very simple indicator reporting on the number of 240ml bottles of desflurane purchased over time.

3.2 Please specify any strengths and limitations of the proposed indicator.

The environmental impact of desflurane depends on the total annual consumption. In turn, consumption levels can be influenced by use of alternative anaesthesia (other gasses or intravenous) or, if using desflurane, by the fresh gas flow rate used with desflurane when administering anaesthesia[11]. Therefore, any reduction in consumption of desflurane will be covered be the indicator.

Strengths:

- Clearly indicates volumes of desflurane being purchased for use.
- Will clearly show purchasing activity (increases/decreases/trends).
- Easy to understand and follow.
- Volumes of purchased desflurane can easily be converted to a Global Warming Potential (GWP_{20}). The GWP_{20} value measures how much a given mass of desflurane contributes to global warming, as compared to the same mass of CO_2, over a specific time (in this instance, due to the short atmospheric life of desflurane, a shorter time period of 20-years will be utilised).

Limitations:

- Does not indicate how/if the bottles are used, disposed of, and/or if they remain available for use.
- Currently relies on purchased data.
- Is limited to one anaesthetic gas and does not reflect use of other anaesthetic gasses that are emitters of GHG (e.g., Sevoflurane)

3.3 Is the indicator based on a specific framework (e.g. the DPSEEA framework)?

The proposed indicator is not based on a specific framework. However, it has been designed using the HEAL Indicator Criteria as well as key principles of developing indicators as suggested by "The Good Indicators Guide" developed for NHS England (Pencheon, D).

3.4 What does the proposed indicator measure?

Driving force ☐	Pressure ☐	State ☐	Exposure ☐
Effect ☐	Action ☒	Other ☐	

Please specify, if other:

4. POSSIBILITY

4.1 Please provide the name, short description and link of the data source(s) used for this indicator.

Initially, IQVIA health consultancy [12] will provide the desflurane data. This dataset contains all purchasing data of desflurane for both public and private hospitals across Australia over ten years. The data is currently not publicly available but team members and other organisations such as AIHW have previously used IQVIA to purchase data for other projects. This data is provided in spreadsheet form.

4.2 Are the data freely and openly available?

This data is currently not freely available and must be purchased from IQVIA. Firstly, we will advocate the federal government to make this data available to us for free. Advocacy has already begun for release of this data put forward in the National Health and Climate strategy consultation response submitted by HEAL Investigators McGain and Barratt. If this data does not become freely available through the government, it is anticipated that a registry will then be created and promoted to facilitate free collection of this data directly from hospital sites, public and private, from locations around Australia. Already existing registries, such as the. Balanced scorecards (BSCs) are a tool that can be used by pharmacists in healthcare to measure performance metrics and can provide a broad view of medicine use and pharmacy performance [13]. The use of BSCs could be explored to help in the development of this registry. Furthermore, previously developed registries in other fields will also be consulted (e.g., clinical quality registries that collect longitudinal health outcome data, see ACSQHC link below) and the Australian New Zealand Breast Surgeons Quality Data Audit could be used as models in the development of this registry.

4.3 Are the data updated annually or at other regular intervals?

This data will initially present annual totals for the past ten years and be broken down by month. This initial presentation will allow the indicator to illustrate any past trends in purchasing from the outset. It is envisaged that the indicator will be updated at least annually. However, this may not be possible initially and will depend on data availability from Federal Government or registry, as described above.

5. IMPLICATIONS

5.1 What actions might be possible as a result of the indicator?

Desflurane use can indicate successes in reducing the carbon footprint of healthcare, especially as it relates to surgical procedures which are identified as being some of the most carbon intensive areas. Inhaled anaesthetic agents possibly contribute up to 5% of a hospitals total carbon footprint[7]. Publishing of desflurane use data could encourage behaviour change and/or identify areas where targeted interventions through government or hospital policy need to occur to reduce desflurane usage.

5.2 Which groups/ stakeholders will be best placed to act on this indicator?

Policy makers, hospital/network managers, pharmaceutical purchasing managers and anaesthetists are best placed to act, as they decide on what pharmaceuticals are available to be used and anaesthetist ultimately dictate what anaesthetic agent they want to employ in a procedure. However, other clinical staff, such as surgical nurses, surgeons, pharmacists, or other specialties can also work to educate staff and build up pressure to change policies and procedures to reduce usage. Additionally, advocacy groups such as Doctors for the Environment (DEA)[14] and TRA_2SH[15] are already lobbying and undertaking on-the ground actions to educate and advocate reducing and eliminating desflurane use, pressure from these initiatives and the limited data available has already led to the phasing out of desflurane in public hospitals in two states (WA and NSW). Easily accessible data through the proposed indicator will be a powerful tool in future lobbying to remaining state health departments and private hospital groups.

5.3 Is there good evidence on how to act?

Safe and clinically effective and equivalent alternatives to desflurane (e.g., Propofol TIVA) are readily available[16] with proficiency in Propofol TIVA an established technique and an ANZCA (Australian and New Zealand College of Anaesthetists) requirement in Australia[15]. Furthermore, propofol has been shown to reduce post-operative delirium and postoperative nausea and vomiting with smoother emergence[16]. Desflurane is also potentially not benign with the potential to lower blood pressure by a magnitude potentially associated with harm due to its more potent vasodilatory properties[17]. Correct disposal of unused propofol through incineration is required to reduce the environmental risk of bioaccumulation and environmental toxicity[18].

If TIVA is not a practical option, lesser polluting alternatives such as sevoflurane can be considered using lowest possible fresh gas flows to reduce environmental exposure and the potential deleterious effects to healthcare workers inadvertently exposed to these volatile gases [16 19]. In comparison to desflurane, sevoflurane has significantly lower carbon emissions, with the shortest atmospheric lifetime and Global warming potential (GWP_{20}) at 1.1 years and 349 compared to desflurane at 14 years and 3,714 [3 20 21] and can be purchased at a significantly lower cost than desflurane [6 7 22].

5.4 Are the results likely to induce perverse incentives and unintentional consequences or will action be able/likely to address the root of the issue?

If desflurane is not being utilised, alternative anaesthetic agents will need to be used instead. It is imperative that these alternatives are not the same or worse than desflurane in their carbon output and environmental harm. Research has been conducted on alternatives such as Propofol TIVA (first choice) and sevoflurane (second choice). The carbon footprint of Propofol TIVA is significantly lower than both desflurane and sevoflurane, at for example, 1% the GWP of sevoflurane[23]. Detractors point out the potential harm of propofol to the aquatic environment if released, with this agent quantified in hospital wastewater[24]. As propofol is administered intravenously, there are also increased amount of (visible) waste in the form of lines and needles. Strategies to reuse and recycle should be advanced and considered and further developed to reduce the environmental footprint of these consumables and

their packaging[21]. Furthermore, to reduce the environmental hazard of propofol, education is key. At present an estimated 45% of propofol is wasted[25]. Education of clinicians in preparing only the amount needed should be stressed to reduce waste[21] as well as on the harms involved in drug disposal so that unused and pharmaceutically contaminated consumables are disposed of appropriately[18 21 24].

6. REFERENCES

6.1 Please add supporting references here.

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