

Mostly harmless? A survey of South African anaesthetists' knowledge and attitudes regarding environmental sustainability in the operating theatre

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Background: The healthcare industry has been shown to have a large negative environmental impact – producing vast amounts of waste and CO₂ emissions. Operating theatres demonstrate a disproportionately high waste production to floor space ratio, producing up to 33% of hospital waste. Furthermore, anaesthesia is responsible for 25% of operating theatre waste production.

Methods: This study assesses the opinions and knowledge of South African anaesthetists regarding the environmental impact of anaesthetic practice. A validated questionnaire was developed using an online survey tool, SurveyMonkey. The survey link requesting participation was published once in the South African Society of Anaesthetists' weekly newsletter, and thereafter snowballing was used to increase sample size.

Results: The survey was completed by 222 South African anaesthesia providers. Ninety-two per cent of respondents (189/205; CI 87.4–95.3%) agreed that environmental impact is an important factor to be taken into account when conducting anaesthesia practice. However, only 35.0% of South African anaesthetists felt that their knowledge was sufficient to guide such practice (72/206; CI 28.5–41.9). Although 65.2% of South African anaesthetists recycled at home (133/204; CI 58.2–71.6%), and 90.7% were keen to recycle at work (185/204; CI 85.6–94.1%); a mere 11.8% of respondents reported recycling at work (24/204; CI 7.8–17.2%). The greatest perceived barriers to recycling in South African operating theatres were lack of information, lack of recycling facilities and staff attitudes.

Conclusion: South African anaesthetists appear keen to adopt environmentally friendly practices in the operating theatre. However, there are several barriers that prevent implementation. Further, anaesthetists lack the knowledge and education necessary to guide sustainable practice. This requires redress in national curricula.

Keywords: environmental sustainability, operating theatre, recycling

Background

Climate change poses one of the greatest threats to human health in the 21st century.¹ As surface temperatures exceed two degrees above the pre-industrial average, several areas of health are likely to be impacted. These include an increasing burden from diarrhoea, malnutrition, infectious diseases as well as cardiovascular and respiratory disease.¹ The World Health Organization (WHO) attributes 150 000 annual deaths to climate change,² and predicts that between 2030 and 2050, an additional 250 000 annual deaths will occur as a result thereof.³ This provokes an urgent call for climate change mitigation through the drastic decrease of greenhouse gas (GHG) emissions. Of further concern, the greatest harmful environmental impact is affected by high- and middle-income countries, while the overwhelming burden of disease is suffered by developing countries.¹

Disappointingly, the healthcare sector continues to contribute to and exacerbate the situation through its own poor environmental stewardship. This is potently demonstrated by the example of GHG emissions in the United States of America (US). Over the decade spanning 2003–2013, overall GHG emissions in the US declined by 5.7%; while US health sector GHG emissions increased by a staggering 28.2%.⁴ A recent report on carbon emissions in the healthcare sector indicates that if global

healthcare were a country, it would be the fifth-largest carbon producer.⁵ Moreover, operating theatres (OTs) have been shown to produce up to 33% of hospital waste,⁶ with anaesthesiology being responsible for the production of 25% thereof.⁷

Internationally, healthcare professionals of various specialities are realising that the environmental impact of the healthcare system is no longer a fact which can be ignored. Eighty per cent of American Thoracic Society members feel that medical doctors should become involved in the response to climate change, specifically through advocating for an environmentally sustainable healthcare environment.⁸ Further, a recent paper outlines how plastic surgeons can decrease their environmental impact in the OT.⁹

Likewise, emerging international literature indicates that anaesthetists are also beginning to focus on the climate crisis and are seeking to tackle the challenge of greening the OT. Audits of the intensive care unit (ICU), anaesthesia and the OT show that a large portion of waste is potentially recyclable, and that conscientious waste segregation minimises the environmental damage associated with disposal of hazardous waste.^{7,10} The life cycle assessment (LCA) is a tool which quantifies the financial and environmental cost of a product or procedure. While some anaesthetic interventions have been quantified in this way,^{11–13}

there is a paucity of literature on the subject, making it difficult for clinicians to consider environmental cost when making clinical decisions. More recently, a review of the environmental impacts of various anaesthesia and critical care interventions highlights several areas for future research and education and serves as a useful guide to anaesthetists in everyday practice.⁵

A 2018 study found a lack of publications detailing medical waste management in South Africa.¹⁴ No literature around environmental sustainability in South African OTs could be found during the literature review performed at the outset of this study. The current survey is therefore an important first step towards “greening” South African OTs.

The aim of this study was to determine the attitudes and knowledge of South African anaesthetists toward environmentally sustainable anaesthetic practice. Survey results were compared to those of similar international studies.

Methods

The survey questionnaire was derived from three prior international surveys.¹⁵⁻¹⁷ A pilot study was performed among five anaesthetists from the Port Elizabeth Hospital Complex, to ensure clarity of questions.

The survey consisted of 21 questions (Supplementary File 1). Question 1 contained an electronic link to the information and consent form. Question 21 was open-ended, inviting respondents to raise unanticipated themes not covered by the survey, thus gathering a small amount of qualitative data. The remainder of the questionnaire consisted of multiple-choice and Lickert-scale questions, gathering quantitative data regarding respondent demographics, recycling behaviour, conscientious use of anaesthetic gases, equipment reuse, and knowledge and education regarding environmental sustainability in the OT.

Data was gathered using the online survey tool, SurveyMonkey. A link to the survey was published in the South African Society of Anaesthesiologists newsletter (Issue 22/2020) and thereafter snowballed using email and WhatsApp Messenger.

Data analysis

Data tables and charts were generated using Microsoft Excel (Microsoft Software, Redmond, WA, USA). Data was summarised as proportions of responses for each question. Tables were generated to compare data to international studies. The VassarStats website (<http://vassarstats.net/>) was used to calculate 95% confidence intervals (CIs) for a proportion using the Wilson method.¹⁸

Results and discussion

A total of 222 responses were received, with a completion rate of 90%. For a sample size of 222, the margin of error with a 95% confidence level is 5.9%. For brevity, and due to the nature of the investigation, the results and discussion will be combined under the questionnaire headings to best present current results and compare these with other key studies.

Demographic data

The sample included anaesthetists of varying age and experience, and practising in a variety of settings. The demographic data of participants are summarised in Table I. The majority of respondents were between the ages of 25 and 44 (79.5%). Specialist anaesthetists represented 36.5% of the sample, and registrars 40.4%. Sixty-seven per cent of respondents worked in a tertiary hospital, and 23.8% in private practice. Females represented 55.3% of the sample.

Recycling

Sixty-five per cent of respondents ($n = 133$ of 204, CI 58.2–71.6%) agreed with the statement ‘I recycle at home’. Only 11.8% of respondents agreed with the statement ‘We recycle waste products in the OT I mostly work in’ ($n = 24$ of 204, CI 7.8–17.2%). In contrast, 90.7% of respondents agreed that they would like to recycle OT waste. Data around recycling are summarised in Table II, and compared to data from international surveys.

Table I: Demographic characteristics of respondents

| Characteristic | n (%) |
|--|-------------|
| Gender (n = 208) | |
| Male | 93 (44.7%) |
| Female | 115 (55.3%) |
| Age (n = 210) | |
| 18–24 | 0 (0%) |
| 25–34 | 100 (47.6%) |
| 35–44 | 67 (31.9%) |
| 45–54 | 27 (12.9%) |
| 55–64 | 9 (4.3%) |
| 65–74 | 7 (3.3%) |
| 75+ | 0 (0%) |
| Number of years in anaesthetic practice (n = 209) | |
| 0–5 | 83 (39.7%) |
| 6–10 | 63 (30.1%) |
| 11–20 | 38 (18.2%) |
| 21–40 | 23 (18.2%) |
| > 40 | 2 (1.0%) |
| Current position (n = 208) | |
| Specialist anaesthetist | 76 (36.5%) |
| Registrar | 84 (40.4%) |
| Medical officer | 36 (17.3%) |
| General practitioner | 7 (3.4%) |
| Other | 5 (2.4%) |
| Hospital setting (n = 210) | |
| Private hospital | 50 (23.8%) |
| Tertiary centre | 141 (67.1%) |
| Secondary hospital | 9 (4.3%) |
| District hospital | 6 (2.9%) |
| Public private partnership | 4 (1.9%) |

Barriers to sustainability

Lack of information, staff attitudes and lack of recycling facilities were the most commonly perceived barriers to the recycling of OT waste. Several respondents commented on these issues, expressing their frustration with the failings of the current system. One respondent stated: 'A common problem I see as anaesthetist is that some carefully separate our waste to red [medical] and clear [general waste] yet cleaners often just combine everything into the red bins therefore incinerating everything at additional cost and unnecessary pollution'. This highlights the need for staff engagement and education if hospitals are to improve their environmental impact.

Interestingly, these three aspects (lack of information, staff attitudes and lack of facilities) were also the most commonly identified barriers to recycling OT waste in the UKNZA and US.^{15,16} The obstacles faced in the developing world are clearly not that far removed from the first world, and while we can certainly look to them for guidance, there is much room for research and innovation to emerge from the developing world.

In the study performed among Canadian anaesthetists, the single greatest perceived barrier to recycling OT waste was a lack of support from hospital and OT leadership.¹⁷ This was not one of the answer choices in the current study, but several respondents highlighted the lack of management engagement around environmental sustainability in hospitals, indicating that this certainly is an area for future improvement in SA.

Reuse

SA anaesthetists reported frequently reusing anaesthetic equipment, including blood pressure cuffs, anaesthetic masks and drug trays. Only 13.6% of respondents felt that appropriate reuse would constitute an infection risk to their patients ($n = 27$ of 198; CI 9.3–19.4%).

Environmental consideration

Ninety-two per cent of South African anaesthetic providers agreed or strongly agreed that the environmental impact of anaesthesia-related products, agents and equipment should be taken into account when making clinical decisions. This

Table II: Recycling attitudes and behaviour

| Survey question | Number of respondents who agree or strongly agree presented as n (%) | | | |
|--|--|---|---|--|
| | SA* ($n = 204$) | UKNZA† ($n = 780$) | CAS‡ ($n = 403$) | ASA§ ($n = 2 036$) |
| 11. I recycle at home | 133 (65.2%) | 739 (94.7%) | 393 (97.5%) | 1455/1 787 (81.4%) |
| 12. We recycle waste products (i.e. packaging; syringes; paper) in the operating theatre I mostly work in | 24 (11.8%) | 87 (11.2%) | 122 (30.3%) | 497/1 791 (27.7%) |
| 13. I would like to recycle operating room waste | 185 (90.7%) | 725 (92.9%) | 382 (94.8%) | 1431/1 786 (80.1%) |
| 14. I consider the following factors to be barriers to recycling anaesthesia waste (select all applicable) | 1) Lack of information (165, 80.9%) | 1) Inadequate/lack of recycling facilities ^l | 1) Lack of support from hospital/OR leadership (254/400, 63.5%) | 1) Inadequate information on recycling (67%) |
| | 2) Lack of recycling facilities (164, 80.4%) | 2) Inadequate information on recycling ^l | 2) Inadequate information/education (251/400, 62.8%) | 2) Lack of recycling facilities (50%) |
| | 3) Staff attitudes (160, 78.4%) | 3) Staff attitudes ^l | 3) Staff attitudes (209/400, 52.2%) | 3) Staff attitudes (47.5%) |
| 15. I consider the following to be the greatest barrier to recycling in the operating theatre (select one) | Inadequate information (64/204, 31.4%) | Lack of recycling facilities (381, 48.8%) | Lack of support from hospital/OR leadership (130/400, 32.5%) | Inadequate information on recycling ^l |
| 16. To increase recycling in operating theatres I would be willing to contribute the following: n (%) | | | | |
| Time to educate myself | 171 (83.8%) | 571 (73.2%) | 340 (84.4%) | 73.9% |
| Time to educate others | 137 (67.1%) | 435 (55.8%) | 231 (57.3%) | 49.9% |
| Funds to educate myself | 34 (16.7%) | (5.3%/8.8%) [¶] | 60 (14.9%) | 8.0% |
| Funds to educate others | 24 (11.8%) | (3.1%/7.4%) [¶] | 31 (7.7%) | 6.9% |

*SA – current South African study; †UKNZA – United Kingdom, New Zealand, Australia; ‡CAS – Canadian Anaesthesiologists' Society; §ASA – American Society of Anaesthetists; ¶Data reported as percentages without numerators or denominators by McGain et al., 16 shown here as (percentage of UK respondents/percentage of ANZCA respondents); ^lData reported without figures or percentages.

Table III: Knowledge and education on sustainable anaesthesia practice

| Survey question | SA* | 95% CI SA | CAS† |
|---|-----------------|------------|-----------------|
| 7. The environmental impact of anaesthesia-related products and procedures is an important factor that should be taken into account when conducting anaesthesia practice. | 189/205 (92.2%) | 87.4–95.3% | 357/403 (88.6%) |
| 8. My level of knowledge on the environmental impact of anaesthesia-related agents, products, and procedures is sufficient to guide my practice. | 72/206 (35.0%) | 28.5–41.9% | 182/403 (45.2%) |

*Current South African study; †Canadian survey conducted by Petre et al.¹⁷

figure corresponds well to the 88% of Canadian anaesthetists who share these sentiments¹⁷ indicating that South African anaesthetists are aligning themselves with the international community in thinking 'green' for the future of anaesthesiology. As yet, there seems to be poor correlation between these good intentions and the practical implementation of environmentally sustainable practice.

Knowledge and education

Only 35.0% of respondents felt that they have an appropriate level of knowledge regarding environmental sustainability to guide their clinical practice and 73.5% had received no education or training on the subject at all (Table III). Most education had been obtained in the form of independent reading (54.6%; *n* = 54 of 99) and peer-to-peer discussions (28.3%, *n* = 28 of 99), with only 14.1% of respondents having received formal training as part of a curriculum (*n* = 14 of 99). This shows that while many South African anaesthetists feel concerned about the environmental impact of their profession, training institutions have not yet taken on the onus of incorporating environmental sustainability in anaesthesia into curriculums. Several respondents emphasised the urgent need for education regarding sustainable practice. One respondent lamented 'I feel that we are falling very short in this regard. It is not taken seriously – we have not been educated at all on the topic'. A second respondent bemoaned the lack of local data comparing the environmental impact of different anaesthetic techniques. It would appear that this education gap on environmental sustainability is not unique to South African curriculums. A recent survey among Canadian anaesthetic department chiefs and residency programme directors indicated that only 29% of participating anaesthesiology curriculums include environmental sustainability, despite 87% of residency programme directors indicating that they felt candidates would benefit from education on the topic.¹⁹

Anaesthetic agents

Volatile anaesthetic agents are used on a daily basis by most anaesthetists and the environmental impact of these agents is well documented.^{5,11} However, only 27.0% of anaesthetists

Table IV: Anaesthetic gas usage

| Inhalational agent most frequently used | | |
|---|-------------------|----------------------|
| Data presented as % (<i>n</i>) | | |
| | SA <i>n</i> = 203 | ASA <i>n</i> = 1 829 |
| Sevoflurane | 62.6% (127) | 66.4% (1 215) |
| Isoflurane | 28.6% (58) | 10.5% (192) |
| Desflurane | 8.9% (18) | 22.3% (408) |
| Do you consider environmental impact when choosing a volatile anaesthetic agent | | |
| | SA <i>n</i> = 204 | ASA <i>n</i> = 1 816 |
| Yes | 27.0% (55) | 13.4%* |
| I am unaware of the environmental impact of these agents | 24.0% (49) | 30.3%* |

**n* not reported in literature

surveyed considered said impact when choosing a volatile agent, and 24.0% were entirely unaware of the environmental impact of these agents. Table IV shows that while American respondents were likely to use the same anaesthetic gases as South African anaesthetists, an even larger proportion were ignorant of the environmental impact of these agents. Shockingly, only 13.4% of American respondents considered the environment when selecting an anaesthetic gas.¹⁵

Open-ended responses

The final question was open-ended and invited respondents to comment on topics covered in the study. Thirty relevant responses were thematically analysed. Six themes emerged. These were as follows, in order of frequency: missed opportunities for recycling/sustainability and suggestions on improvements (*n* = 10); emphasis on the importance of education (*n* = 9); lack of management buy-in and appropriate policies (*n* = 7); lack of appropriate facilities and equipment to improve sustainability efforts (*n* = 5); the ethical imperative of healthcare providers to engage with environmental sustainability (*n* = 4); and finally, the impact of the COVID-19 pandemic on environmentally friendly practice (*n* = 3).

Study limitations

The sample included mainly respondents from tertiary academic institutions and private practice. Results may therefore not accurately reflect data from the wider anaesthetic community, as district and rural hospitals are underrepresented.

Conclusion

Results of the current study show that South African anaesthetic providers are eager to incorporate environmentally sustainable practices into their daily work. They are keen to recycle OT waste and would be willing to contribute time to educate

Table V: The five Rs of 'green' operating rooms

| | |
|----------|---|
| Reduce | <ul style="list-style-type: none"> • Energy consumption (i.e. by switching off lights and air-conditioning at night) • Low-flow anaesthetic techniques • Avoid nitrous oxide and desflurane where not indicated • Judicious waste separation into infectious and non-infectious streams • Minimise layers of packaging |
| Reuse | <ul style="list-style-type: none"> • Encourage safe anaesthetic equipment reuse |
| Recycle | <ul style="list-style-type: none"> • Develop locally sustainable hospital recycling programmes |
| Rethink | <ul style="list-style-type: none"> • Consider environmental impact when making clinical choices • Educate staff, students, colleagues • Encourage management engagement with environmental sustainability • Sustainable packaging of pharmaceuticals and equipment |
| Research | <ul style="list-style-type: none"> • Life cycle assessments detailing environmental impact of equipment and medication • Sustainable anaesthetic techniques • Environmental footprint tracking at a micro- and macrolevel |

themselves and others on environmental sustainability in the workplace. However, there are several barriers which prevent the implementation of 'green' practices in South African OTs and these warrant attention at various levels. Finally, South African anaesthetists lack information regarding specific aspects of sustainability in anaesthetic practice and the environmental impact of each treatment option needs to be explored, studied and incorporated into curricula.

It is time for South African anaesthetists, as a professional community, to rethink our approach to healthcare: it is time to think beyond the one patient asleep on the table, and consider the world we are waking all our patients up to. Will we choose to contribute to a greener future for all?

Through ongoing education, industry engagement and policy institution, environmental sustainability can become 'a golden thread intertwined in our everyday practice' as one survey respondent so eloquently suggested.

Recommendations

Table V recommends several simple ways of improving the environmental impact of anaesthetic practice, guided by the five Rs: Reduce, Reuse, Recycle, Rethink and Research.^{6,20,21}

Further reading

World Health Organisation fact sheets:

<https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

<https://www.who.int/heli/risks/climate/climatechange/en/>

ASA committee on equipment and facilities guidelines around greening the operating room:

<https://www.asahq.org/about-asa/governance-and-committees/asa-committees/committee-on-equipment-and-facilities/environmental-sustainability/greening-the-operating-room>

Yale gassing greener project and app:

<https://ysph.yale.edu/climate/phes/challenge/>

Conflict of interest

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Ethical approval

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Supplement

1) Introduction and consent – participants proceed to survey if consent granted

Demographic data:

2) What is your gender?

- Female
 Male

3) What is your age?

- 18–24
 25–34
 35–44
 45–54
 55–64
 65–74
 > 75

4) I have been practising anaesthesia for _____ years

- 0–5
 6–10
 11–20
 21–40
 > 40

5) I am currently employed as a:

- Specialist anaesthetist
 Registrar
 Medical officer
 General practitioner

6) The hospital where I work most of the time is a:

- Private hospital
 Tertiary centre
 Secondary hospital
 District hospital
 Public private partnership

Environmental sustainability:

7) To what extent do you agree with the following statement: The environmental impact of anaesthesia-related products and procedures is an important factor that should be taken into account when conducting anaesthesia practice.

- Strongly agree
 Agree
 Neither agree nor disagree
 Disagree
 Strongly disagree

8) To what extent do you agree with the following statement: My level of knowledge on the environmental impact of anaesthesia-related agents, products, and procedures is sufficient to guide my practice.

- Strongly agree
 Agree
 Neither agree nor disagree
 Disagree
 Strongly disagree

9) Have you received any training/education on environmental sustainability in anaesthesia?

- Yes
 No

10) What format did this training take? (Select all that apply)

- Formal curriculum training during training
 Workshop
 Online e-module
 Conference lecture
 Journal club
 Peer-to-peer discussions
 Independent reading
 Other (please specify)

Recycling:

11) I recycle at home:

- Strongly agree
 Agree
 Neither agree nor disagree
 Disagree
 Strongly disagree

12) We recycle waste products (i.e. Packaging; syringes; paper) in the operating theatre I mostly work in:

- Strongly agree
 Agree
 Neither agree nor disagree
 Disagree
 Strongly disagree

13) I would like to recycle operating theatre waste:

- Strongly agree
 Agree
 Neither agree nor disagree
 Disagree
 Strongly disagree

14) I consider the following factors to be barriers to recycling anaesthesia waste (select **all** applicable):

- Staff attitudes
 Cost
 Lack of information
 Safety
 Time
 Lack of space
 Lack of recycling facilities

15) Which of the following do you consider to be the single greatest barrier to recycling in the operating theatre? (select **one**)

- Staff attitudes
 Cost
 Lack of information
 Safety
 Time
 Lack of space
 Lack of recycling facilities

16) To increase recycling in operating theatres I would be willing to contribute the following (select one or more):

- Time to educate others
 Time to educate myself
 Funds to educate others
 Funds to educate myself

Anaesthetic gases:

17) Which anaesthetic gas do you use most often:

- Sevoflurane
 Isoflurane
 Desflurane

18) Does the environmental impact (global-warming potential and ozone depleting effect) of inhalational agents affect your choice of anaesthetic?

- Yes
 No
 I am unaware of the environmental impact of these agents

Equipment reuse:

19) We routinely reuse the following anaesthetic equipment in the hospital I mostly work at (select all applicable):

- Anaesthetic masks
 LMAs
 Blood pressure cuffs
 Anaesthetic trays
 Other (please specify)

20) I consider the reuse of appropriately cleaned/sterilised anaesthetic equipment to constitute an infection risk to patients:

- Strongly agree
 Agree
 Neither agree nor disagree
 Disagree
 Strongly disagree

21) Do you have any additional comments regarding recycling, environmental sustainability or any other topics covered in this survey?