

Sustainable anaesthetic practice for Europe: Briefing

Introduction and purpose

This briefing paper summarises the findings from a pilot project in five hospitals across five countries in Europe.

The project established a baseline carbon footprint of anaesthetic gases for each hospital and, in partnership with anaesthetists, identified some recommendations for clinical practice, anaesthetic societies, hospitals, and government agencies. These recommendations are based on the principles of maintaining quality and safety of care, whilst reducing carbon emissions where possible.

Further information on the project and the results are available here: <https://noharm-europe.org/issues/europe/fostering-low-carbon-healthcare-europe-euki-anaesthetic-gasses-project>

Global Warming Potential (GWP) of anaesthetic gases

Anaesthetic gases are highly potent greenhouse gases and hold a significant global warming potential as highlighted in the table below:

Global Warming Potential for anaesthetic gases

	IR absorption range (μm)	Tropospheric lifetime (yr)	GWP 100	Standard container	kg CO ₂ e for container	MAC ₄₀	Relative MAC CO ₂ e compared with Sevoflurane
Sevoflurane	7-10	1.1	130	250ml	49	1.8	1
Isoflurane	7.5-9.5	3.2	510	250ml	191	1.2	2.6
Desflurane	7.5-9.5	14	2540	240ml	893	6.6	72
Nitrous oxide	4.5, 7.6, 12.5	110	298	Cylinder size G	5066	104	132

References:

Lifetimes calculated from JPL <http://jpldataeval.jpl.nasa.gov>

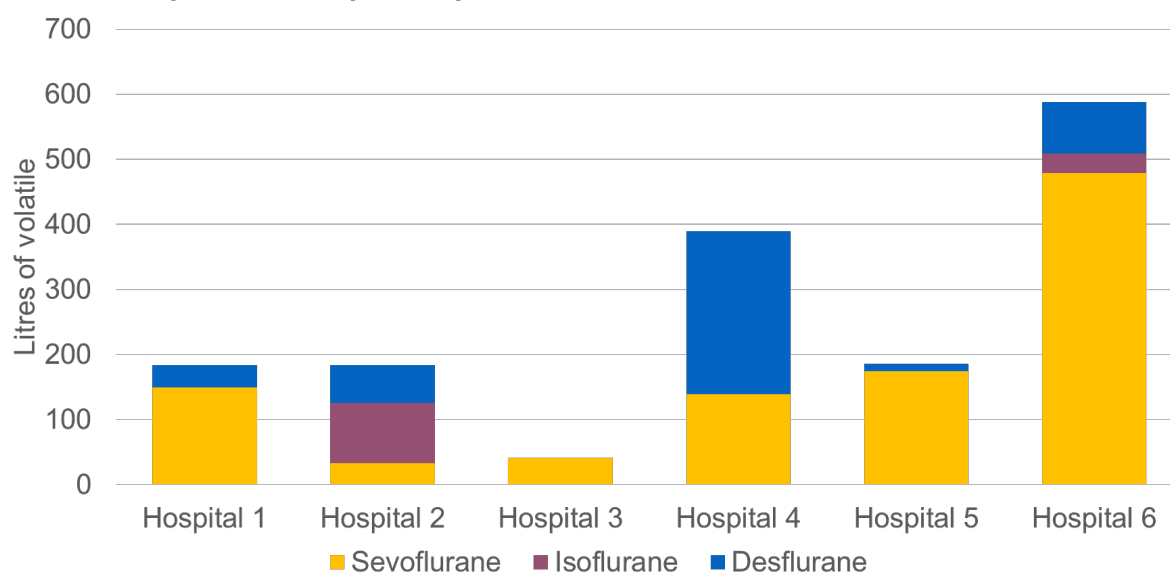
GWP 100 from Sulbaek Andersen 2012 <http://dx.doi.org/10.1021/jp2077598>

MAC₄₀ from Tom Pierce, Environmental Advisor to the Royal College of Anaesthetists, UK

Results of the pilot project

The baseline footprinting across the five hospitals highlights that there is a lot of variation in the volumes used, across benchmarks, and per hour of surgery. The three tables below illustrate these findings:

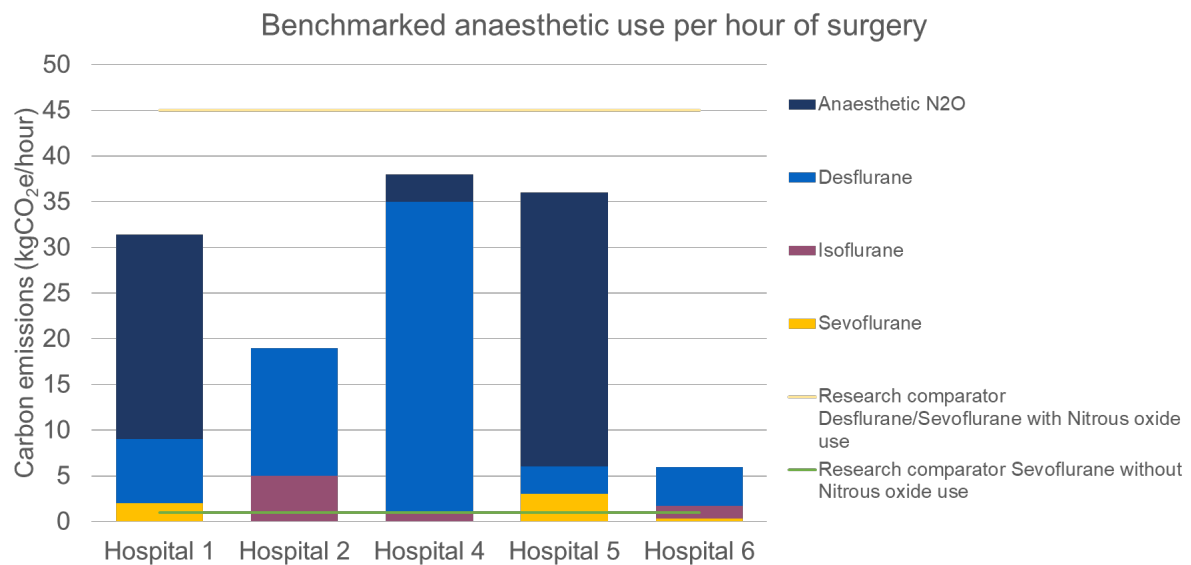
Anaesthetic gas volumes per hospital



Benchmarked surgical anaesthetic gases

Benchmarked surgical anaesthetic gases carbon footprint						
Benchmark	Hospital 1	Hospital 2	Hospital 4	Hospital 5	Hospital 6	Unit
Number of hours of surgery/operations	31	19	38	36	6	kgCO2e/hour
Number of hours of anaesthetic gases use	-	13	-	-	-	kgCO2e/hour
Number of operations/surgical procedures	99	14	64	41	8	kgCO2e/operation

Benchmarked anaesthetic gas use per hour of surgery



There was consensus amongst the anaesthetists that the following advice could be suggested in order to reduce the carbon footprint without hindering the quality of patient care:

Advice for sustainable anaesthetic practice

1. Whenever possible use Sevoflurane and only use Desflurane when clinically necessary
2. Reduce or eliminate the use of nitrous oxide during surgery, obstetrics, paediatrics, and dental procedures
3. Reduce fresh gas flow rates and train in the use of Closed Circuit Anaesthesia - which confers clinical benefits as well as saving costs and reducing carbon emissions
4. Reconsider the use of Isoflurane as this is an ozone-depleting substance
5. Consider the use of intravenous and regional anaesthesia whenever possible At least to reduce carbon footprint, but yet not shown to reduce overall environmental impact

Further advice for practitioners:

- Encourage the introduction of closed circuit and avoid open circuits on anaesthesia machines
 - [More info here](#)
 - Clinical benefits include reduced dehydration and reduced heat loss
- Consider total intravenous anaesthesia
 - Jodi Sherman 2012: <https://www.ncbi.nlm.nih.gov/pubmed/22492186>
 - Susan Ryan 2010: <https://www.ncbi.nlm.nih.gov/pubmed/20519425>
- Increase awareness e.g. through the use of measurement

- There are also apps available which convert the flow rate etc. into carbon used per MAC hour.
 - <https://play.google.com/store/apps/details?id=com.sleekwater.anaesthesia>
 - <https://itunes.apple.com/gb/app/anesthetic-impact-calculator/id1070999985?mt=8>
 - <https://itunes.apple.com/us/app/yale-gassing-greener/id1152700062?mt=8>
 - https://play.google.com/store/apps/details?id=com.app_octeens1234.layout

In addition, some recommendations emerged for hospitals, local and national government and anaesthetic colleges and societies.

Advice for hospitals to improve anaesthetic practice

1. Identify a lead or champion with knowledge of reducing use of anaesthetic gases
2. Update training based on best practice information
3. Teach students in training to use low flow and about other environmental issues in anaesthesia
4. Encourage the use of tools for carbon footprinting understanding and measurement of gas concentration
5. Ensure the use of air cleaners where feasible and that anaesthesia machines are well maintained
6. When selecting new anaesthesia machines, opt for ones that have an automatic closed circuit
7. Measure and report on carbon emissions for instance by using the tool being built into [Hippocrates](#)

Advice for local, national, and international governments

1. Share information and spread good practice
2. Support policy and accident evaluation procedures
3. Consider sponsorship and support for research into lower-environmental impact anaesthetic gases
4. Investigate or recommend that any new build theatre/operating rooms include scrubbing or air cleaners
5. Introduce closed circuit anaesthesia and lower flow rates in national guidelines to improve patient safety, reduce costs and reduce environmental impacts

Advice for anaesthetist societies

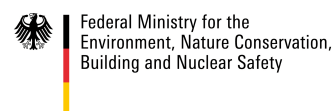
1. Produce guidance to steer updates of anaesthetic practice
2. Develop a programme to inform professionals and show leadership in sustainability
3. Hold regular meetings to ensure progress is made and new practice highlighted
4. Raise awareness at national and international congresses
5. Consider outreach to international anaesthetic societies

Considerations for anaesthetic machine manufacture and technology procurement requests

1. Alarm when fresh flow rate is more than 2 litres per minute for more than 2 minutes, sound alarm
2. Something to capture gases, similar to <https://www.gasrecycler.com/news-events-articles/>
3. Explore the possibilities for recycling of drugs, would this need a new licence?
4. Ensuring the machine responds quickly to the change in the desired concentration even in low flow situations
5. Make the exhaust gases less harmful by exploring options such as:
 - i) Chemically neutralising the agents
 - ii) Reduce volumes and therefore costs for inhaled anaesthetics
 - iii) Reusing captured volatile anaesthetic agents if safe to do so
6. Display the use of agents graphically on the machine e.g. a column showing the actual flow rate and the minimum objective desired flow rate
7. Show carbon emissions from anaesthetics on the machine
8. Automatically set the machine to closed circuit anaesthesia when the desired concentration is met unless override is set by anaesthetist
9. Request that anaesthetic machine makers reduce the time taken for the machine to change concentrations

An alternative model to consider

1. Anaesthesia service model where hospital requests a service from the anaesthetic machine providers. Contract would include:
 - i) Minimise costs
 - ii) Reduce 'tailpipe' emissions through appropriate technologies including machine design, interface design, and gas capture technologies



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