United Kingdom

Reducing the global impact of environmentally harmful anaesthetic gases using a medical device
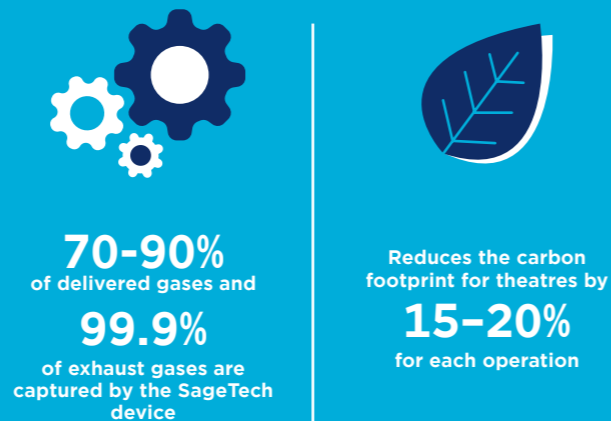
Challenge

95% of anaesthetic gases used in an operation are not metabolised by the patient so a significant proportion is released into the atmosphere.

The release of anaesthetic gases into the atmosphere means that operating theatres contribute to 15–20% of a hospital theatre's carbon footprint.

Approach

SageTech Medical developed a solution to capture waste anaesthetic inside a reusable canister, known as a 'SID-Can', to reduce the volume of gas released into the atmosphere.

Anaesthetic agents are recycled by SageTech Medical for redistribution into hospitals to reduce the impact on the NHS's wider carbon footprint.

70-90%
of delivered gases and

99.9%
of exhaust gases are captured by the SageTech device

Reduces the carbon footprint for theatres by
15–20%
for each operation

Introduction

It is estimated that anaesthetic gases account for around 100,000 tonnes of carbon dioxide per year across NHS and private hospitals across the UK (covering England, Scotland, Wales and Northern Ireland). These highly volatile gases make up 2% of the National Health Service's (NHS) total carbon footprint and 15-20% of a theatre's carbon footprint for each operation in England alone.

SageTech Medical's circular economy solution safely captures available volatile anaesthetic agents in a reusable capture canister (SID-Can). The agents are then recovered, processed and recycled back into a usable drug form to minimise the environmental impact.

The scale of the problem

Each time a patient is put to sleep for an operation, 95% of the anaesthetic gases used are wasted as the patient's body does not metabolise them. A significant proportion of this is released into the atmosphere via the anaesthetic gas scavenging system.

3 MILLION TONNES OF CO2 EQUIVALENT EMISSIONS ARE RELEASED FROM ANAESTHETIC GASES EVERY YEAR

Play video ▶

Not only are these gases highly volatile with an impact hundreds of times more than carbon dioxide, but they also make up 2% of the National Health Service's (NHS) total carbon footprint and 15-20% of a theatre's carbon footprint for each operation.

According to 2013 data, more than 10 million operations were estimated to have taken place each year in England in just over 3,000 operating theatres, with each theatre covering on average, more than 1,200 procedures during this time[1]. Accounting for operations in Wales, Scotland and Northern Ireland included for the UK, it is estimated that anaesthetic gases account for around 100,000 tonnes of carbon dioxide per year across NHS and private hospitals, with a predicted global impact of 3,000,000 tonnes.

The solution

In an effort to reduce the NHS's carbon footprint, the NHS became the "first health system to embed net zero into legislation, through the Health and Care Act 2022"[2]. The Act "places duties on NHS England, and all [NHS] trusts, foundation trusts, and integrated care boards, to contribute towards statutory emissions and environmental targets"[2].

VOLATILE ANAESTHETICS CONTRIBUTE OVER ONE FIFTH OF THE CARBON FOOTPRINT OF SURGICAL PROCEDURES

Play video ▶

NHS England have since released a strategy – Delivering a 'Net Zero' National Health Service[3] – for healthcare organisations in England required to collectively support targets in line for 2040.

SageTech Medical set out to develop a solution to capture waste anaesthetic onto a carbon filter contained inside a reusable canister, known as a 'SID-Can', to reduce the volume of highly volatile gases released into the atmosphere.

Once captured, the anaesthetic agents are recycled by SageTech Medical for redistribution into hospitals, creating a circular economy for inhalation anaesthesia and reducing the impact on the NHS's wider carbon footprint.

SageTech Medical developed a class I medical device as a solution to capture the unused gases directly at the point of use in theatres, and in 2023, the device was launched to NHS and private sector organisations in the UK.

An end-to-end recycling process

Anaesthetic drugs are originally produced in liquid form which is converted to a gas by an anaesthetic machine in the operating room where it is then delivered to the patient.

SageTech Medical's circular economy solution safely captures available volatile anaesthetic agents (sevoflurane, isoflurane, desflurane) onto a reusable capture canister (SID-Can) which is then recovered, processed and recycled back into a usable drug form. In real world clinical practice, not all waste anaesthetic is available for capture. Independent published studies demonstrate that 70-90% of waste anaesthetic is available for capture with SageTech's solution, which is in part determined by anaesthetic practice and the individual patient.
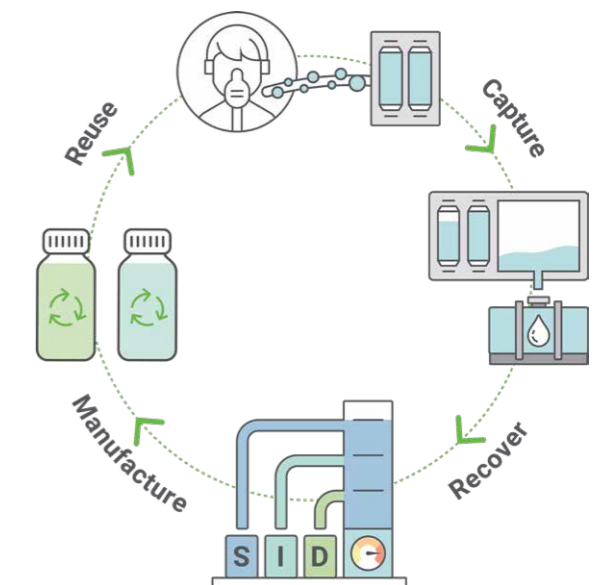
How it works in practice:

1. The medical device fits universally into the hospital's existing anaesthetic equipment without the need for adaptation

2. The SID-Dock houses two SID-Can filters and is connected at the 'exhaust' of the anaesthetic machine to intercept waste anaesthetic breathed out by the patient, preventing its release into the atmosphere

3. The drug molecules (which are highly volatile hazardous waste materials) are captured onto the filter material within the SID-Can canisters

4. Each canister is then transported to a local extraction hub which collects waste from across the local region

5. The captured waste anaesthetic is removed from the filter and the canisters are returned to the hospital for reuse

6. A waste liquid product is generated which contains the drug molecules and other waste materials

7. The liquid product is then transported in bulk to the central recycling and manufacturing facility to reduce the travel carbon footprint

8. The recycling process removes contaminants from the mixed waste and separates out the required active pharmaceutical ingredients into a reusable form before being redistributed back to the market for use

Using GTINs for traceability

The canisters use a GS1 Global Trade Item Number (GTIN) as the unique device identifier (UDI-DI). Since the GTIN is only issued to the organisation, it enables the business to differentiate between the types of canisters. Each individual canister is then issued with a serial number (UDI-PI) to make it globally unique which is critical for traceability. The GTIN and the serial number together are captured in a 2D GS1 DataMatrix barcode enabling the canister to be easily scanned and identified throughout the supply chain.

Traceability is key for three main reasons:

1. Regulatory and policy compliance

EU medical device regulations
GTINs provide a global framework to identify, capture and share medical device product information. By using serialised GTINs, the organisation can ensure compliance with the EU MDR requirements for UDI, thereby enabling a consistent worldwide implementation of UDI for traceability across global supply chains.

Hazardous waste regulations
The Hazardous Waste (England and Wales) Regulations 2005 state that organisations need to know where the hazardous waste was produced, as well as be able to account for where it has travelled throughout the logistic journey before it is processed. Once full of waste anaesthetic, the canister is classified as hazardous waste, so the serialised GTIN is used to track the product through the supply chain from end to end.

European F-gas regulations
The European F-gas regulations have been introduced to control emissions from fluorinated greenhouse gases (F-gases). It requires any organisation, healthcare or otherwise, to very clearly, manage and report on their F-gas releases. For the first time as of April 2024, volatile anaesthetic gases will be included. This will soon become legislation for hospitals, so a solution will be required to monitor and track the capture of these gases for reporting.

NHS Net Zero strategy
The NHS Net Zero plans outline anaesthetic gas emissions as a scope one target to be addressed. Tracking capture and usage will enable hospitals to report capture volumes as required by the plan.

2. Lifecycle maintenance

The SID-Dock capture machine has a serviceable life of 10 years. The SID-Can canisters are reusable for many years and are function checked on every cycle of reuse. The organisation needs to be able to monitor service schedules for routine maintenance. For this, the team needs to keep up to date records of when the machine was purchased, by who, and when maintenance is due as part of the product lifecycle.

3. Reporting

Using the GTIN and serial number captured in a 2D GS1 DataMatrix barcode, it is possible to track and trace each canister as to where it has been over a particular time period. With this, it is then possible to measure how much waste is captured at a canister level. Hospitals can then be provided with a report on what volumes of waste anaesthetic have been captured which in turn allows them to calculate an accurate estimate of the carbon saving.

Implementation / development challenges

1. Technical product development and integration

The medical device uses a highly innovative filter mechanism and development required a high level of detail to determine how the volatile gases would interact with filter mechanisms. This entailed scientific modelling through work with materials scientists to create an effective system. The model also needed to be standardised to integrate with existing systems without requiring bespoke configuration.

2. Barcode compliance
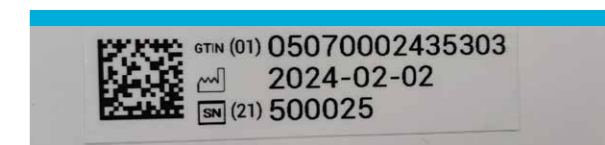
The SageTech team worked with GS1 UK to ensure the device barcodes met requirements for regulatory compliance. They worked through understanding the options for different barcode types, how the data captured would be structured and how the human readable text would be displayed. Using the verification service several editions of the physical barcode label were submitted for review. This enabled the team to receive feedback on what changes and improvements were required so both GS1 standards and the highest ISO quality standards were met. Now the team are confident that using well maintained printers will retain the high quality and will ensure consistent compliance with necessary requirements.

Challenges in practice

3. Administration of anaesthetics

Within existing anaesthetic practice and systems, gas leakage varies based on the delivery method. Where it is delivered by mask, there are often gaps around the sides which then leak the gas into the surroundings. The SageTech solution captures all waste volatile anaesthetic received from the exhaust of the anaesthetic machine which has come from the patient.

Infusion anaesthesia (TIVA) is often considered to be more environmentally sustainable as it does not expose volatile gases. However, this method produces a significantly higher volume of plastic waste by comparison to gas administration and has environmental risk to waterways when unused drug (propofol) is discarded or excreted by patients in urine. The current narrative that anaesthesia by TIVA is greener than gas does not consider the new paradigm of being able to repeatedly capture and recycle gas, which in turn also reduces the carbon footprint associated with virgin anaesthetic drug manufacture.

4. Patient transfers

When the patient is moved out of theatres to recovery, a proportion of the gases travel with them. When it is then exhaled into other areas of the hospital, a direct risk is posed to extended clinical teams and hospital staff.

Results and benefits

• 70-90% of delivered gases and 99.9% of exhaust gases are captured by the SageTech device

• Reduces the carbon footprint for theatres by 15–20% for each operation

• High safety profile, ensuring no change to existing equipment and continuity of care

• Using GS1 GTINs for UDI means that the solution in futureproofed for compliance with forthcoming medical device regulations such as those for Great Britain

• Compliance with existing green policies and legislation

• Fully traceable circular solution (with the use of the GTIN) which minimises waste production

95% OF ANAESTHETIC GAS IS WASTED

ONLY 5% OF THE ANAESTHETIC ADMINISTERED DURING SURGERY IS USED BY THE PATIENT

Play video ▶

Conclusion and next steps:

The team continue to explore other areas and sectors where anaesthetic gases pose a significant risk to health and the environment. The organisation is currently conducting an impact assessment on wider clinical teams and is reviewing what measures could be taken within the recovery room to minimise risk.

With growing emphasis on green agendas built into European and international legislation, the organisation continues to see growing interest in the solution from across Europe and beyond, including, the USA, Middle East, India, and Australasia. Having recently gained the CE mark, there is ambition to rapidly expand rollout in Europe.

Outside of healthcare settings, the team are exploring other similar markets which also mirror the health sector in terms of anaesthetic gas emissions to broaden their impact.

About the authors

Luke Rawlinson,
Head of commercial, SageTech Medical

Luke joined SageTech Medical in June 2021 and brings with him over 20 years of commercial experience in medical device and equipment sales and marketing.

As the Head of Commercial, Luke is responsible for commercialising SageTech Medical from its early development as an R&D company into a global medical device and services business. He also supports product development from both a clinical and commercial standpoint, and has the responsibility of working with customers, institutions and organisations to raise awareness of the company's volatile gas capture and recycling solutions.

Steve Wileman,
Head of research, SageTech Medical

Steve joined SageTech Medical in January 2016, bringing with him a multi-disciplinary background and many years of experience across a range of sectors including financial and business management. He has worked closely with the company's founders from the initial stages and has played a vital role in managing the research and development programme to create SageTech Medical's innovative technology.

As the Head of Research at SageTech Medical, Steve drives development in the key areas of analytical, engineering and quality research. His unique experience at SageTech Medical puts him in a position to coordinate and manage progress across all areas of the company.

Hannah Dale,
MarComms associate, SageTech Medical

Hannah joined SageTech Medical in May 2022. With over 10 years of experience in marketing, videography, photography and design, she was brought on board to support the commercialisation of SageTech Medical and to increase customer engagement.

As the Marketing & Communications Associate for SageTech Medical, Hannah is responsible for maintaining, managing and developing the company's social media platforms and online presence. She works with the Head of Commercial in customer communication, lead generation and sales as well as event organisation and the production of marketing materials and collateral.

[1] https://nhsproviders.org/media/1128/operating-theatres-final.pdf
[2] https://www.england.nhs.uk/greenernhs/a-net-zero-nhs
[3] https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2022/07/B1728-delivering-a-net-zero-nhs-july-2022.pdf