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How Can We Reduce the Environmental Impact of Obstetric Anaesthesia?

An undeniable anthropogenic environmental catastrophe is upon us. Globally, the last decade has been nearly 1°C warmer than the 1961-1990 average; the nine warmest years of the UK have all happened since 2002.¹ Oceans are warming up, polar ice caps and glaciers are melting, sea levels are rising, animals are facing extinction, global poverty is increasing and extremities of weather is common. The well documented cause of this environmental perfect storm is rising levels of carbon dioxide (CO₂) and other greenhouse gases (GHG) in the atmosphere trapping the sun's energy and causing the temperature of the earth's atmosphere to rise. CO₂ levels have increased by nearly 50% since humans started burning fossil fuels and began widespread deforestation and manufacturing. If action is implemented GHG emissions can be reduced, and the average global temperature rise can be limited to 2°C; an increase that, although still severe, will provide us with more opportunity to limit the devastating floods, adapt to the droughts, and manage the crop failures.

We as a species need to take action now. We need to educate one another and enact a behavioral change and cultural shift. We need to lessen the intergenerational injustice we are causing. The NHS is the fifth biggest employer in the world,² and therefore is optimally positioned to help reduce the impact of this climate crisis. The carbon footprint for NHS England for 2015 is 22.8 million tonnes of CO₂ equivalents (Mt CO₂e). There has been an 11% reduction since 2007, despite an 18% increase in inpatient admissions.³ The health service is trying, but can, arguably, do more.

Below is an account of an obstetric anaesthetist trying their best. The story is fiction, but it highlights that many small interventions throughout a normal working day can add up. Some of what is told may seem farfetched, but it is all possible, even today:

I am an obstetric anaesthetist and I wake up in my home (if we are serious about climate change, then we have to tackle it from every angle). I wake up in an energy efficient rating A home. I have a one minute shower using water heated by renewable sources. I get dressed in organic material, not fast fashion that will only end up in landfill in a few months' time. I eat a vegetarian, locally sourced breakfast, and drink tea with soya milk. I turn all the lights off and lock the front door. I cycle and use reliable public transport to get to work. I feel safe on the cycle paths, and do not feel robbed when I buy a train ticket.

I cycle towards to the hospital, seeing its solar panels glistening in the morning sun. I lock my bike in a safe, secure, monitored courtyard where I do not need to worry about it all day until I leave. The courtyard is a pleasant place to be, with upcycled plant boxes containing butterfly and bee friendly native plants, and an insect hotel on the wall.

I walk into the hospital and can feel the rays of sun coming through the triple glazed windows. Windows save on lighting costs.

The hospital has up-to-date insulation, thermal insulation behind the radiators, an air source heat pump, and has ISO 1400 accreditation (a rigorous environmental management system standard).⁴

I walk into the changing room and the occupancy sensing LED lighting turns on. The toilets are low-flush and use collected rainwater, and the soap is biodegradable. The warm water flows from the aerated non-leaking tap, having been heated from electricity purchased from a renewable energy company. However, when it is sunny, like today, the hospital's solar panels generate enough energy for our use so we do not need to buy any.

I get changed into clean, laundered scrubs that have been sustainably procured. The whole lifecycle of these scrubs has been examined, taking into account the carbon emissions released and resources used at all stages of the products life; design, extraction, processing, manufacture, the use of low impact dyes, distribution and logistics, use, maintenance, reuse, recycling, and disposal, as well as the supplier's methods of dealing with issues throughout the supply chain. I put on a clean washable cotton hat, not a disposable viscous hat that results in environmental destruction.⁵

Every single item that I come into contact with, whether a syringe or a computer has been sustainably procured. I can use these items with confidence that I am balancing the delivery of obstetric care as an anaesthetist, with the global responsibility I have as a human.

I enter theatre. I check the emergency drugs are available, for both emergency general anaesthetic and epidural top-up. There is no wastage, I do not need to dispose of yesterdays unused drugs, as all the drugs come in pre-filled syringes (with the added benefit of reducing drug labeling errors), or vials that have not been opened, but are ready and waiting.

I start preparing the drugs for today, taking vials from boxes at the front of the cupboard as their expiration date is closer than boxes at the back. Since more astute checking and management of drug procurement volumes, there has been substantially less drug expiration and wastage, which additionally has patient safety implications.

I dispose of any medicinal waste into a Bio-bin®⁶ in lieu of plastic rigid yellow containers. It is 96% paper, lighter, and produces less carbon dioxide, both when being transported to the incinerator, and when incinerated, compared to the yellow plastic containers. All the sharps go into a reusable sharps bin. The sharps are incinerated, and the bin is washed using recycled water to reduce the environmental impact, and is disinfected with non-environmentally damaging chemicals.

These reusable bins were introduced due to a 2011 before-after intervention study to determine their effect in a 500 bed hospital which demonstrated a reduction of GHG by 109.8 tonnes CO₂e per year; 13 tonne reduction of plastic landfill waste and 1.3 tonnes of cardboard waste annually; a reduction in sharps injuries (as the bins are less likely to be over filled); and a reduction in sharps container and disposal costs.⁷ All the plastic and paper syringe packaging is placed into a recycling bin.

The anaesthetic machine has its morning check. I still check the hypoxic guard is working, but cannot remember the last time I used nitrous oxide (N₂O) during a general anaesthetic. Its use, including for emergency induction of general anaesthesia in category one sections, and even as Entonox, has dramatically reduced since a widespread educational programme highlighting its environmental consequences. N₂O has a global warming potential (GWP) 310 times that of CO₂.⁸ Moreover, desflurane is no longer purchased by the hospital. A lifecycle GHG assessment was conducted for desflurane, encompassing data pertaining to resource extraction, manufacturing, transport, use, and waste. Desflurane emits 15 times more GHG than isoflurane and 20 times that of sevoflurane on a MAC per hour basis, and has an atmospheric lifetime of 21.4 years, compared to 1.4 years for sevoflurane.⁸

I turn on the computer (which was turned off yesterday by the last user) and start reading the patient notes for the elective caesarean list today. It is a completely digitilised notes system which has dramatically reduced the paper usage. If any paper is used, which is rare, then it is either from a Forrest Stewardship Council (FSC) certified forest or 100% recycled. The previous monetary advantages of buying non-recycled paper has been scrapped. My hospital uses the NHS Sustainability Development Unit excel tool entitled 'How to buy paper a low carbon way'⁹ and recognises that if the NHS procurement had been from 100% recycled sources the carbon emissions associated with manufacturing would have been halved. The hospital team were shocked to learn

that of the 3.6 million reams of paper procured, only 29000 were produced from a recycled source, and so my hospital vowed to work towards improving this.¹⁰

If any printing is done it is on HP printers, due to their environmental credentials. HP printers are built using 30% recycled plastics, and the black toners come with lower melt temperatures that require less energy consumption. Additionally HP-branded paper and packaging is completely recycled or derived from FSC certified forests that have been specifically planted for their use. The company has a zero virgin deforestation policy. HP printers can even detect whether the paper fed into then has been planted to become paper, or not, and if it was not from an FSC certified forest, then HP will actually plant trees to compensate.¹¹

Due to the paper-free work environment, the carbon footprint attributable to non-medical items is reduced. Binders, folders, paper clips, staples are no longer amongst the worst CO₂ producing offenders in the hospital.³

When the ink cartridges are empty they are re-filled by the manufacturer or recycled, whichever at the moment in time is the most sustainable, as determined via on-going sustainability procurement audits actioned by the NHS sustainability department.

During my pre-operative assessment the patient tells me how smooth the whole process leading up to her elective caesarean has been. She had fewer repetitive journeys to hospital this pregnancy than her last, especially due to the combining of clinics, teleconferencing, and improved communication between teams, partly helped by the digitilised notes. Combining clinics was actioned following feedback from mothers that arranging childcare for their other children while they attend their blood tests one day, their scans another, their tour of theatres another day was proving very stressful, and expensive, and wasteful, with repeated car journeys, car park charges and childcare costs.

Furthermore, a cradle-to-grave analysis on pre-medication drugs and the common prescriptions that a patient takes was undertaken and highlighted the need for constant script review. Ranitidine is a commonly prescribed pre-medication prior to elective sections. It is also one of the top 20 pharmacological contributors to GHG emissions, along with co-codamol, naproxen, tramadol, metformin, and tiotropium, all commonly use in obstetrics. It is estimated that the annual NHS pharmaceutical expenditure of £13.1 billion results in GHG emissions of 5.1Mt CO₂e.¹²

Additionally, a lower blood volume is now taken from the high risk patients as the department has started using paediatric blood bottles to reduce plastic used and iatrogenic anaemia, which has both clinical, and environmental consequences. For example, if the patient is anaemic due to iatrogenic causes, they need to attend hospital more regularly (more journeys), they need more investigations (more plastic), and they need treatment, especially if they are to receive intravenous iron instead of oral iron due to intolerable side effects. The sterilisation of intravenous drugs increases their carbon footprint.

I notice by the side of the bed a pair of crutches, previously used for Pubic Symphysis Dysfunction, but now being returned. One pair of crutches costs a minimum of £20. My hospital started asking patients to return NHS equipment that was no longer required, saving £608,500 per month.¹⁰

Following my assessment, the obstetrician consents the patient and discusses post-delivery contraception plans. Contraception has been at the forefront of a recent environmental movement in the USA, headed by politician Alexandria Ocasio-Cortez, who believes it is legitimate for millennials to consider not having children because of the state of the earth.¹³ The greatest gift we can give to the environment is to not have children.¹⁴

I check my airway equipment. There are substantially fewer single use pieces of medical equipment on the trolley than previously. The laryngoscope and handles get autoclaved now, instead of being incinerated after one use. Autoclave machines do require a lot of energy to work, approximately 600 watts to boil one litre of water. However, there are benefits of reusing equipment over disposing of it since the introduction of hospital solar panels, the procurement of energy from only renewable sources, and the purchasing of a reverse osmosis system (which produces distilled water without using energy.) And where metal instruments cannot get autoclaved, they are recycled.

The patient and their birthing partner walk into theatre. The birthing partner is wearing scrubs and theatre shoes, not plastic shoe coverings over their normal shoes. The WHO Sign-In is completed digitally, and we begin to attach monitoring to the patient, including a reusable blood pressure cuff. The patient is cannulated. A sterling attempt is made to 'get it right first time' to reduce plastic waste from repeated cannulation, as well as patient satisfaction. When there is a drop of blood on removing the needle, I grab just one gauze to mop up the spill, and not a handful, conscious of the waste that would produce.

I attached the pre-prepared vasopressor and crystalloid in a recyclable PVC bag to the cannula via a recyclable PVC administration set, and begin to wash my hands as the patient is positioned expertly by the anaesthetic nurse. Once finished I ensure the taps are turned off and put on sterile gloves. A 'no touch' technique is performed, using the glove packet as a sterile surface for equipment,¹⁵ vasopressor commenced, and the patient positioned in a left lateral tilt.

Ethyl chloride spray is used to indicate whether the block is developing. It has a low GWP and an ozone depletion potential of zero. It is however on the National Emission Standards for Hazardous Air Pollutants list. The aerosol container is made of tin-plated steel and aluminium, and is safe for recycling once the container is empty. If everyone in the UK recycled their empty aerosols, 30000

tonnes of metal could be reclaimed. However, if the cans contain any product then they must be treated as hazardous waste.¹⁶

Appropriate surgical prophylactic antibiotics are administered in line with current guidelines.

The patient's gown is lifted up onto her chest to prevent it from needing to be changed after the operation, and once she is draped surgery begins. Seven minutes into the operation, before the uterus is breached, the patient experiences pain. The surgeons pause, analgesia is given, however the pain does not settle. Discussions are had, decisions made, and I start preparing for a general anaesthetic whilst informing the birthing partner, and the neonatal doctor of developments.

The patient receives oral sodium citrate due to her increased aspiration risk, and pre-oxygenation via an anaesthetic PVC facemask which is recycled once the patient is stable in recovery. It is no longer necessary to remove the plastic hook ring from the mask before use as the manufacturers have stopped producing them, thanks to a study that showed 98% of anaesthetists had never used it.¹⁷

Processed EEG monitoring is placed on the patient's forehead, and cricoid pressure applied by the anaesthetic nurse. Due to the superior wake profile, the patient's co-morbidities, along with the environmental impact of our drug decisions, a modified rapid sequence induction (RSI) is performed via target controlled infusion with muscle paralysis. At no point is there a compromise in patient safety due to environmental consideration.

Propofol produces nearly 10000 times less GHG emissions than desflurane, even taking into consideration the energy required to power the infusion pump, disposable syringes and infusion sets, and the amount of propofol wasted.⁸ Wasted propofol needs to be disposed of in a safe manner, taking into consideration the relationship between drug disposal methods and the environmental

impact of pharmacologically active ingredients in the ecosystem. Propofol, which is toxic to aquatic life, has been isolated from streams in both America and Sweden.¹⁸

There is currently no formal consensus on how to perform an RSI. Anaesthetists still have autonomy to decide what is best for their patient at that time, weighing the facts presented to them, along with their personal preference, and if I wanted, I could have equally use a halogenated volatile such as isoflurane or sevoflurane in this situation. A novel sustainable development called Deltasorb® consisting of a canister attached before the scavenging, has allowed for anaesthetic volatiles, which undergo very little in vivo metabolisation, to be captured onto an absorbent, taken to a specialised recycling facility, and purified ready for reuse.¹⁹

Once the operation is over and the patient is awake and cleaned with biodegradable wipes she is transferred to recovery. She is wearing a sanitary pad made with over 70% renewable materials, compared to the 40% industry standard. Freda, a Scandinavian company manufactures tampons and sanitary pads in a sustainable, eco-friendly facility, using 100% renewable energy with zero landfill waste. The pad's absorbent core is made from totally chlorine-free, renewable and sustainable wood pulp. The products from this company are hypoallergenic, cruelty free, chemical free, rayon free, polyester free, pesticide free and chlorine free.²⁰

As the patient settles down, takes oral analgesia, eats and drinks using crockery and plant-based compostable products by Vegware™,²¹ attempts to establish breast feeding, and places her baby in a washable reusable nappy, the clean-up operation in theatre begins.

There is judicious segregation of waste into appropriate reciprocals. Few mistakes are made in this regard since widespread Trust training took place. The sharps bins are used for sharps and non-tempered glass. Tempered glass is appropriate for glass recycling as the heat process easily destroys

any residue to drug. Domestic waste goes into black bags, non-infective clinical waste goes into yellow bags with black stripes, infective waste goes into orange bags, and recycling into a clear bag. Batteries, for example from the laryngoscope, either go into the battery recycling when they stop working, or if they are rechargeable they are recharged ready for next time.

We are faced with a multitude of options every day, however there is really only one choice. The environmental impact of anaesthesia has to be mitigated in every decision we make; from our Royal College investing in fossil fuels,²² to the deodorant we use. We are living on this planet as if we had another to go to. There is no Planet B.²³ We need to change. Time is running out. We did not inherit the earth from our ancestors, we are borrowing it from our children.

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