Keywords Reusable tourniquet/Clinical products/ Circular economy

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In this article...

- Understanding the advantages of reusable tourniquets over single-use alternatives
- The importance of the 'triple bottom line' when evaluating any clinical product
- Appreciating nurse and patient involvement in the evaluation of clinical products

Reusable tourniquets: their impact on patients, planet and public purse

Key points

Staff must have training on any new clinical product before use to ensure any nuances are explained

Patient involvement is a critical part of evaluation and feedback when introducing new products

The reusable tourniquet and wipe's carbon footprint is 17.02 kgCO_2e per 1,200 procedures

A single-use tourniquet's carbon footprint is around four times greater than that of a reusable one per 1,200 procedures

The more uses healthcare professionals can get from a reusable product, the greater the carbon reduction

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Abstract The carbon emissions associated with using clinical products come from the extraction of the raw material(s) and the transport, manufacture, shipping, use and disposal of the final product. Sandwell and West Birmingham NHS Trust's clinical procurement team wanted to reduce the impact of single-use tourniquets on the planet and improve patient experience. As phlebotomy is one of the most undertaken invasive procedures in healthcare and the team was aware of a new medical-grade silicone wipeable reusable tourniquet, it applied for money from the Healthier Futures Action Fund. It secured £10,000 to purchase 450 reusable tourniquets, committing to fully evaluate the product in terms of its impact on the environment, society and the economy. The team evaluated around 1,000 phlebotomy and cannulation processes, and found the reusable tourniquet was preferred by patients and staff, saved money and reduced the overall carbon impact of the process by ~80%.

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Undertaking almost any patient care means using one or more clinical product. Choosing the right product is absolutely critical, not only for the patients and staff using the items, but also for the health of the planet – given that ~62% of the carbon footprint of the NHS comes from goods and services we purchase (NHS England (NHSE) and NHS Improvement (NHSI), 2020). This is further supported by the work of Al-Hadithy et al (2024), who urge clinicians to get involved with local and national decision making to support greener procurement.

Clinical procurement specialist nurses are centre stage when healthcare teams are making product choices, and must make sure that quality, safety, value and sustainability are considered with equal weighting during the selection process. Evaluating the impact of a clinical product should consider three aspects:

- Society;
- Environment;
- Economy.

This is known as the 'triple bottom line'. The tourniquet evaluation set out to measure all three aspects.

The problem

The carbon footprint of the NHS is the total greenhouse gas (GHG) emissions generated from the delivery of healthcare, and accounts for ~4% of the UK's emissions (NHSE and NHSI, 2020). Around 10% of these emissions come from the clinical products we use every day to care for patients (NHSE and NHSI, 2020).

In January 2020, a campaign for a greener NHS was launched to mobilise its 1.3 million staff and set an ambitious, evidence-based

route map and date for the NHS to reach net zero. NHSE recognised that ~62% of its carbon footprint was from the medicines, medical and non-medical equipment, and other supply chain activities needed to deliver patient care, and one of its key workstreams identified that reducing single-use plastics could remove ~224ktCO2e (NHS England and NHS Improvement, 2020). This is equivalent to about 383,212 passengers' roundtrip flights to Munich from the UK (OpenCO2net, 2024).

NHSE and NHSI (2020) went further to call for staff to evaluate alternatives to single-use products, moving to reusables and implementing the 'circular economy' model (Fig 1). A circular economy is concerned with reusing and recycling products to slow down the use of natural resources, reduce landscape and habitat disruption, and help to limit loss of biodiversity (European Parliament, 2023). Given the additional burden on supply chains after the Covid-19 pandemic and the challenges of Brexit at the UK borders, reusable solutions also secure greater resilience of supply.

Phlebotomy has been practised for centuries and is probably one of the most common invasive procedures in health care (Freitas and Alves, 2022). According to data obtained from NHS Supply Chain's (NHSSC's) (2023) usage reports, in 2022-23, a total of 61 million single-use tourniquets were purchased by English NHS trusts.

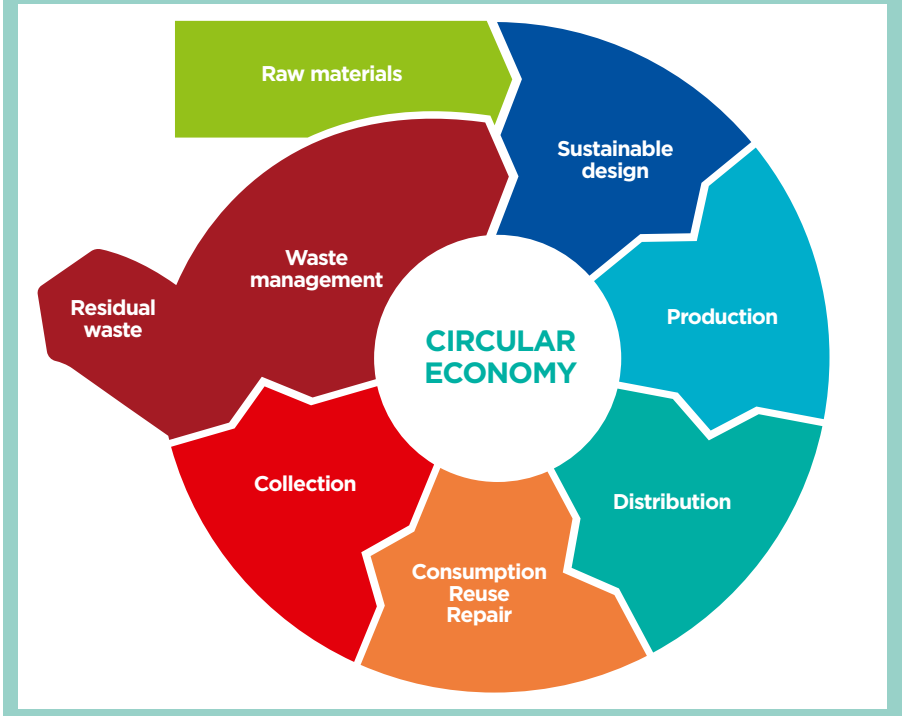
At the authors' NHS trust, purchasing data showed that ~340,000 single-use tie-band silicone tourniquets were being used per year. An innovative reusable silicone wipeable tourniquet had recently become available, which the team considered to be in line with the NHS's ask of moving to a circular economy. The team proposed to evaluate the reusable tourniquet by considering the triple bottom line.

Literature review and its impact

A review of the literature using Ovid and Embase was completed by Sandwell and West Birmingham NHS Trust's library service, looking back at papers written since the databases began, and limited to those written in English. The search terms used were 'phlebotomy', 'cannulation', 'single use', 'disposable', 'reusable' and 'tourniquets'.

A total of 20 papers were returned, of which 13 were relevant to this work; one paper appeared twice in the search. The earliest paper was from 2000, and the most up to date from 2021. A further review was conducted of papers sourced from secondary referencing.

Fig 1. **Circular economy model**



"In 2022/23, a total of 61 million single-use tourniquets were purchased by English NHS trusts"

One of the main concerns healthcare staff had when moving away from single-use tourniquets was the potential for contamination of the reusable device with blood and body fluids. Indeed, transmission of multi-drug resistant organisms in hospitals is a global concern (Schauer and Hammer, 2015).

In a meta-analysis looking at 20 papers that studied contamination of reusable tourniquets between 1986 and 2017, the contamination rate ranged from 9% to 100%, with 15 studies reporting rates ≥70% (Salgueiro-Oliveira et al, 2020). However, this analysis did not discuss the types of materials the tourniquets were made of. Given that the tourniquet being evaluated at Sandwell and West Birmingham NHS Trust was not available until 2019, it could be assumed that those studied in the meta-analysis by Salgueiro-Oliveira et al (2020) were the elastic material type. The elastic material is not easy to decontaminate as it needs to be washed to penetrate the material and remove any contaminants and blood that may have soaked into it; the silicone reusable tourniquet can be wiped clean. Indeed, Salgueiro-Oliveira et al (2020) went on to recommend that tourniquets be manufactured using a material with a low-risk for microbial contamination, which was supported in earlier work by the Royal College of Nursing (2016).

As our organisation was using a silicone, wipeable, reusable tourniquet, it was felt that the risk of contamination would be less as it was easy to wipe clean and, due to its form factor, less likely to be a medium for bacterial growth over time. This is supported by research from Grohmann et al (2020), who evidenced that significantly fewer bacteria were found on silicone than on conventional (that is, polyester and Lycra) tourniquets after decontamination between patients.

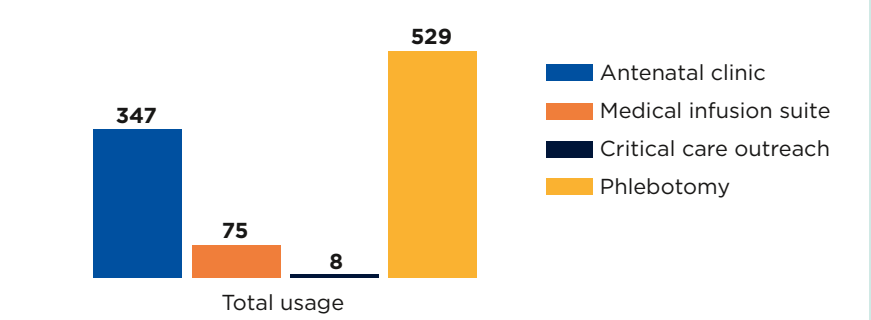
Sandwell and West Birmingham NHS Trust's infection prevention and control (IPC) team supported the evaluation after undertaking a quality-impact assessment, risk categorisation and review of the literature and of the device itself, and agreed a decontamination standard to be adhered to between each patient.

Triple bottom line evaluations

Society/patients

The evaluation of the reusable tourniquet was scoped in line with the trust's standard operating procedure. Approval to evaluate was given by the clinical product evaluation group members, consisting of representatives from IPC, tissue viability, health

Fig 2. **Use of reusable tourniquets by evaluating department**



and safety, and clinical experts including phlebotomists, midwives and critical care outreach nurses.

Arrangements were made to evaluate in four clinical areas that have high usage of the product; this is double the number that is recommended by the trust's standard operating procedure. Due to the level of clinical interest and funding secured, the areas selected were:

- Antenatal clinic;
- Phlebotomy;
- Critical care outreach;
- Medical infusion suite.

A task and finish group was created to include representation from:

- Clinical areas evaluating the product;
- The deputy director of IPC;
- The supplier;
- Clinical procurement.

Agreement for the evaluation included the following:

- Familiarisation training before evaluation of the tourniquet – a supplier training video was circulated to the clinical teams, followed by visits to each department by clinical procurement and the supplier. Training included clinicians practising tourniquet application, decontamination and storage. Before evaluation commenced, the authors insisted that clinicians watch the video, then practise applying the tourniquet to minimise incidences of it pinching the patient's skin. The authors then asked them to demonstrate how they would decontaminate the device after use, in line with the manufacturer's instructions, approved by our IPC team;
- Tourniquets being given to each clinician after they had completed training – clinical teams were encouraged to secure and store the tourniquets in a safe place that would work for their processes;
- A risk assessment being undertaken by staff on each patient before use of the tourniquet and agreement of an exclusion criterion (patients with flaking skin conditions that could make the buckle zone harder to decontaminate).;
- A questionnaire gathering staff and patient feedback – each clinician was asked to complete a questionnaire at the end of each shift. When possible, the clinician would ask patients to comment on the comfort and application of the tourniquet compared with their previous experience of a single-use tourniquet;
- Evaluation duration of a minimum of two weeks;
- Weekly update teams meetings – these were attended by all of the evaluating clinical areas to capture learning, and identify and address any concerns as they occurred.

An evaluation form was used to gather staff and patient feedback – each clinician was asked to complete an evaluation form at the end of each shift. Where possible, the clinician would ask patients to comment on the comfort and application of the tourniquet compared with their previous experience of a single-use tourniquet. Fig 2 shows the number of tourniquets used by each clinical area.

The forms included a question on using the tourniquet with a single-handed

Fig 3. **The clinical response to the questionnaire**

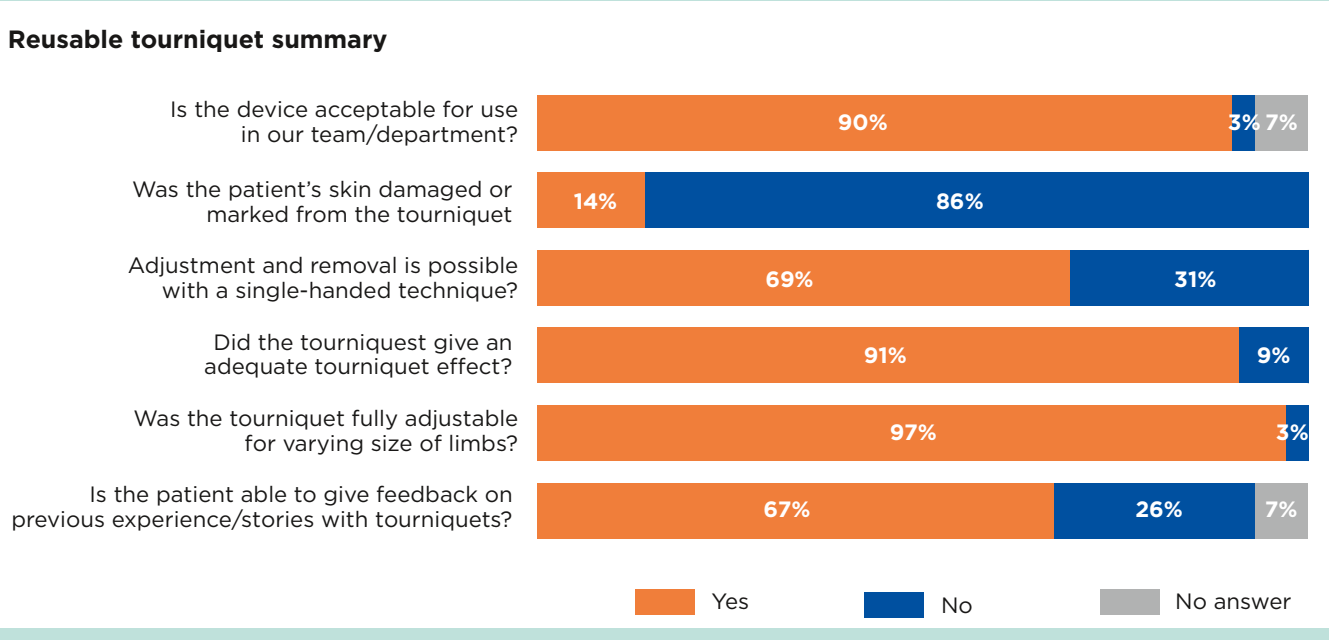
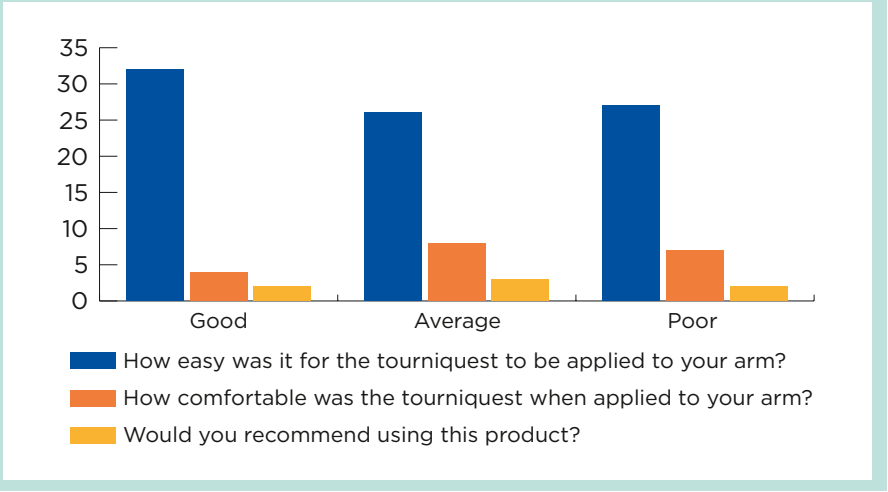


Fig 4. **Patient feedback on the reusable tourniquet (n=111)**



"Anecdotally, staff told us that the single-use, tie-band tourniquets are often uncomfortable for patients to have applied and can often pinch or mark their skin"

technique but, on reflection, this would not be necessary in future as it does not affect the quality or performance of the reusable tourniquet, and the current single-use tourniquets cannot be applied with one hand.

An overwhelming 90% of questionnaire responses showed that clinicians felt the device was acceptable for use (Fig 3), and patient feedback was similarly positive, exceeding our 80% requirement for a product to be acceptable for clinical use.

One of the interesting points to note from the staff evaluation was the feedback on skin being marked or damaged. Some patients did have a temporary indentation on their skin after the device was removed; however, as we did not have any similar metrics on skin marking or damage from the single-use device, we were unable to compare feedback. It is important to note that no patients had any lasting device-related skin damage; tissue viability and clinical teams continue to monitor this carefully.

The feedback highlights the importance of applying the tourniquet in accordance with the manufacturer's instructions, and loosening then removing it as soon as venepuncture has been completed.

Anecdotally, staff told us that the single-use tie-band tourniquets are often uncomfortable for patients to have applied and can often pinch or mark their skin. Of the patients who were able to give their feedback, the majority found the reusable tourniquet easy to be applied and comfortable when applied, and 34 out of 36 patients (94%) responded 'good' or 'average' when asked if they would recommend the product (Fig 4).

Environment

Carbon footprinting is extremely time consuming and has its own International Organization for Standardization (ISO) standard clearly setting out the steps required to undertake the process (ISO 14067:2018). Despite its complexity, it is a vital and powerful step to quantify environmental impacts thoroughly and accurately (McGinnis et al, 2021). To simplify this, a process-based carbon footprint approach was used following the learning taken from a Centre for Sustainable Health course on carbon footprinting, which was completed by one of the authors.

The change (moving from a single-use to a reusable tourniquet and detergent wipe) was mapped, with some assumptions and generalisations made. It is important to note the following:

- A detergent wipe would be used between each reusable tourniquet use;
- The wipe was weighed dry and the carbon analysis of the detergent in the wipe could not be calculated due to lack of availability of emissions data on the detergent solutions;
- The reusable silicone tourniquet would be used at least 1,200 times, at which point the cost of the wipe and reusable tourniquet would equal the cost of 1,200 single-use silicone tourniquets. Any more than 1,200 uses (up to a maximum of 10,000 uses) would give greater financial and carbon savings;
- The packaging and disposal of the single-use device and wipe was included, and it was assumed the correct waste streams were used in accordance with guidance in Health Technical Memorandum 07-01 (NHSE, 2024);
- The transport and remanufacturing of the reusable tourniquet, at the end of its useful life, for recycling was not counted because the carbon of this process is not known and the trust has not yet needed to return any;
- Silicone emissions factor assumptions are based on the work by Brandt et al (no date), who looked at baby teats and bakeware – these were the closest materials found to the single-use and reusable silicone, as described by Casco Bay Molding (no date);
- Department for Energy Security and Net Zero (2023) conversion factors were used in the plastic and carboard calculations;
- Nickel data was taken from work by Mistry et al (2016);

Copolyesters contain at least 90% polyethylene terephthalate (PET) (Hu and Yang, 2020). For the purposes of emissions calculations, the authors used the conversion factors data for PET for both the copolyester in the reusable tourniquet and the detergent wipe, which is also made from PET (Rizan et. al, 2021). Table 1 shows the weight and cost of different tourniquet types. Table 2 shows the results of the calculations done for each portion of the product's life cycle – namely, manufacturing, packaging, transport and disposal. The weights of each component/material of

Table 1. **Weight and cost of different tourniquet types**

Tourniquet type	Cost	Material	Weight (g)
Single-use tourniquet	4p	Silicone	6
Reusable	£26.40	Silicone/Nickel/copolyester	27/20/20 = 67 (total)
Detergent wipe	0.018p	PET/PTFE	2

PET = polyethylene terephthalate; PTFE = polytetrafluoroethylene

Table 2. **Carbon footprint by tourniquet type**

	Product				
	Detergent wipe	Reusable tourniquet – packaging goes into domestic waste, closed-loop remanufacturing for the tourniquet			Single-use tourniquet
		Silicone	Nickel	Copolyester	
Weight (tons)	0.000002	0.000032	0.00000375	0.00003	0.000006
Uses	1,200	1	1	1	1,200
Item (manufacture)					
Weight in tons	0.0024	0.000032	0.00000375	0.00003	0.0072
Material	PET/PFTE	32g	3.75g	30g	Silicone
Emissions factor in $kgCO_2e$	4,018	6,300	8,530	4,018	6,300
Total GHG emissions in $kgCO_2e$	9.64	0.20	0.03	0.12	45.36
Packaging					
Packaging material	PET	LDPE	Paper	–	Cardboard
Weight in kg	1.32	0.003	0.007	–	8.16
Weight in tons	0.00132	0.000003	0.000007	–	0.00816
Emissions factor in $kgCO_2e$	4,018	2,586.73	910.48	–	801.52
Total packaging GHG emissions in $kgCO_2e$	5.30	0.01	0.01	–	6.54
Transport (freight)					
Distance from manufacturer to site in km	22,000	760	–	–	22,000
Total weight including packaging in tons	0.00732	0.00008	–	–	0.00816
Transport emissions factor in $KgCO_2e$	0.009	0.872	–	–	0.01900
Total Transport emissions in $kgCO_2e$	1.44936	0.0502039	–	–	3.41088
Disposal					
Weight in tons	0.00732	0.00008	0.000007		0.00816
Material	PET	LDPE	Paper		Cardboard
Emissions factor in $kgCO_2e$	21.28	446.2	1,164		1,164
Total disposal emissions ($kgCO_2e$)	0.156	0.036	0.008		9.501
Total in $kgCO_2e$					
Product/process carbon emissions	**16.55**	**0.30**	**0.05**	**0.12**	**64.81**
Carbon footprint of the process	**17.02**				**64.81**

GHG = greenhouse gas; LDPE = low-density polyethylene; PTFE = polytetrafluoroethylene; PET = polyethylene terephthalate

the products and packaging have been multiplied by the associated emissions factor using conversion factors from the Department for Energy Security and Net Zero (2023), and were used to calculate the total emissions per product, per 1,200 uses.

The results showed that the reusable tourniquet and wipes' carbon footprint was 17.02$kgCO_2e$ per 1,200 procedures, while that of the single-use tourniquet was almost five times more at 64.81$kgCO_2e$ per 1,200 procedures. This is further evidence that reusable products have a lower impact on planetary resources than their single-use counterparts. This finding supports that of Drew et al (2022) whose meta-analysis of clinical product LCA papers showed that almost all carbon footprint data undertaken to date evidences that reusables have a lower CO_2e.

QUICK FACT **£193.60** Saving that can be made by using reusable instead of single-use tourniquets

It is important to note that this is a best estimate, based on the stated assumptions and the data available for calculating emissions factors, but it is as accurate as we can

Table 3. **Tourniquet usage costs**

Tourniquet type	Cost per tourniquet/ use in £	Cost per 1,200 uses (point of financial cost neutrality, excluding disposal cost) in £	Cost per 10,000 uses in £	Maximum saving per tourniquet
Single-use tourniquet	0.04	48.00	400.00	£400 minus £206.40 = £193.60
Reusable tourniquet and detergent wipe	26.40 (tourniquet) + 0.018 (wipe)	26.40 (tourniquet) + 21.60 (wipe) = 48.00	26.40 (tourniquet) + 180.00 (wipe) = 206.40	

achieve given the resources we have as end users, as well as the age and scarcity of references for the emissions factors for silicone and nickel.

Economy

The reusable tourniquets have now been in use for over a year and, to date, none have been misplaced or had to be returned to the manufacturer. The manufacturer states that the device can be used up to 10,000 times before being collected in batches and remanufactured into other devices to create a circular economy.

Clearly, the more uses we get from a reusable device, the better the carbon offsetting and, after analysis of the costs that include a wipe between uses, we need to use the reusable tourniquet at least 1,200 times for it to be cost neutral; the calculations for this are shown in Table 3. If we can use it to its full capability and maximise its longevity, this would save almost £200 per reusable tourniquet purchase, excluding the cost of incinerating the waste of the single-use tourniquets.

Conclusion

The successes of the tourniquet evaluations to date are down to the diligence at every step of the process, and it is recommended that any team wishing to implement this pay the same attention to detail as described above.

It has been widely evidenced that reusable tourniquets of the past were heavily contaminated and presented as a potential fomite for passing on of multi-drug resistant organisms, but the reusable tourniquet used by Sandwell and West Birmingham NHS Trust is made of medical-grade silicone and easily wipeable; as such, it is a very different material to those of tourniquets featured in earlier studies. With adherence to a clear decontamination standard operating procedure, diligent introduction of the tourniquets and ownership of the device for each competent staff member, risk of cross-contamination to patients should be no more than that which occurs when the staff member's hands touch the patient's bare skin.

Moving from single-use clinical products to reusable alternatives is one solution that can reduce the impact of healthcare on our planet. The move to a more circular economy, in which we no longer use once and throw away, can be greener, safe, better for patients – or, at least, present no greater risk – and more cost effective. **NT**

References

Al-Hadithy N et al (2024) Vital role of clinicians in reducing the NHS carbon footprint through smarter procurement decisions. *BMJ Leader;* 8: 43-48.

Brandt B et al (no date) *Silicone-chemistry Carbon Balance: An Assessment of Greenhouse Gas Emissions and Reductions.* Global Silicones Council.

Casco Bay Molding (no date) What is liquid silicone rubber (LSR)? *cascobaymolding.com* (accessed 26 June 2024).

Department for Energy Security and Net Zero (2023) Greenhouse gas reporting: conversion factors 2023. *gov.uk,* 28 June (accessed 26 June 2024).

Drew J et al (2022) HealthcareLCA: an open-access living database of health-care environmental impact assessments. *The Lancet: Planetary Health;* 6: 12, E1000-E1012.

European Parliament (2023) Circular economy: definition, importance and benefits. *europarl.europa.eu,* 24 May (accessed 26 June 2024).

Freitas F, Alves M (2022) Improving the quality of venous blood sampling procedure (phlebotomy): avoiding tourniquet use. *Journal of Laboratory Physicians;* 14: 2, 218-222.

Grohmann M et al (2020) Reduced bacterial contamination rates detected on silicone tourniquets compared to conventional tourniquets in clinical routine. *BMC Infectious Diseases;* 20: 247.

Hu XC, Yang HH (2000) *Polyamide and Polyester Fibers.* Elsevier.

McGinnis S et al (2021) Environmental life cycle assessment in medical practice: a user's guide. *Obstetrical and Gynecological Survey;* 76: 7, 417-428.

Mistry M et al (2016) Life cycle assessment of nickel products. *The International Journal of Life Cycle Assessment;* 21: 1559-1572.

NHS England and NHS Improvement (2020) *Delivering a 'Net Zero' National Health Service.* NHSE and NHSI.

NHS England (2024) Health Technical Memorandum 07-01: safe and sustainable management of healthcare waste. *england.nhs.uk,* 26 January (accessed 26 June 2024).

NHS Supply Chain (2023) TR Report on use of single use tourniquets (Available on request via paper authors).

OpenCO$_2$net (no date) Put the amount of your emissions into perspective with easily understandable, everyday things. *openco2.net* (accessed 26 June 2024).

Rizan et al (2021) Environmental impact of personal protective equipment distributed for use by health and social care services in England in the first six months of the COVID-19 pandemic. *Journal of the Royal Society of Medicine*; 114: 5, 250-263.

Royal College of Nursing (2016) *Standards for Infusion Therapy.* RCN.

Salgueiro-Oliveira A et al (2020) Tourniquets used in peripheral venipuncture as a potential vehicle for transmission of microorganisms: scoping review. *Infectio;* 24: 2, 94-99.

Schauer CKMW, Hammer DA (2015) Quantifying patient bacterial exposure risk from reusable phlebotomy tourniquets in a New Zealand secondary level hospital. *Journal of Infection Prevention;* 16: 6, 262-265.