Health Innovation
Kent Surrey Sussex

ApposHealth®

Sustainability review

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Contents

Introduction

The purpose of this report is to conduct a high-level assessment of the environmental impact and carbon savings associated with Apos®; an FDA-cleared medical device clinically proven to reduce the symptoms of knee osteoarthritis. In the UK, one in five people over 45 years suffer from knee osteoarthritis.[1] This costs the NHS an estimated £10.2 billion per year, which is expected to increase.[2]

Source: Apos Health

To address this significant health challenge, the Apos® medical device was developed. Apos® is a specially designed sport shoe with calibrated pods, offering a non-invasive, personalised treatment that alleviates pain by retraining gait and redistributing weight away from painful areas. The National Institute for Health and Care Excellence (NICE) has recently recognised Apos®, highlighting its safety, clinical effectiveness and cost-saving potential.[3] The intervention is particularly beneficial for patients with severe knee osteoarthritis as it can help avoid or delay the need for knee replacement surgery, and is recognised as an alternative for those eligible for surgery in the NHS England patient decision support tool for knee osteoarthritis.[4] Reflecting the clinical and real-world evidence for the device, in 2023 Apos® was selected for support by NHSE on the Med Tech Funding Mandate (MTFM) with support commencing in April 2024.[5] The MTFM aims to ensure patients and the NHS benefit from clinically effective and cost saving medical technologies faster and more equitably, with support from England's 15 Health Innovation Networks.

Given that climate change poses a major threat to public health, identifying pathways to achieve net zero emissions is imperative. Sustainable innovation is a crucial driver of this transformation and therefore it is essential that businesses ensure their products or services contribute to the NHS's net zero targets. This review outlines how, when adopted at scale, Apos® has the potential to significantly decrease the environmental impact associated with surgical procedures.

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[1] Felson, D. T., Naimark, A., Anderson, J., Kazis, L., Castelli, W., & Meenan, R. F. (1987). *The prevalence of knee osteoarthritis in the elderly.* The Framingham Osteoarthritis Study. Arthritis & Rheumatism, 30(8), 914–91.
[2] Woolf, A. D., & Pfleger, B. (2003). *Burden of major musculoskeletal conditions*. Bulletin of the World Health Organisation, 81(9), 646–656.
[3] NICE. (2023). AposHealth for knee osteoarthritis Medical technologies guidance.
[4] Decision tool found here: Making a decision about knew osteoarthritis (NHSE).
[5] Details in the Med Tech Funding Mandate here: NHS Accelerated Access Collaborative » Medical technology (MedTech) funding mandate and support (england.nhs.uk)

Methodology

This report aims to explore the environmental benefits of Apos® by examining both its carbon footprint and the potential carbon savings from reduced surgical interventions, thereby providing a holistic view of its net environmental impact.

While a full life cycle assessment (LCA) includes detailed data on raw materials, production processes and end-of-life disposal, such data was unavailable for Apos®. Therefore, this review does not constitute a LCA. Instead, we have utilised a combination of industry-standard estimates, data from similar products, relevant databases and published literature to approximate the environmental footprint of Apos®. This report aims to assess two objectives:

1. **To estimate the carbon footprint of Apos®** — This analysis aims to quantify the environmental footprint associated with the production, international and local shipping and patient appointments following use of Apos®
2. **To measure the carbon savings from surgery** — This analysis aims to evaluate the carbon savings from the reduced need for surgical interventions. Due to the therapeutic efficacy of Apos®, we anticipate a significant decrease in the number of surgeries and thus a decrease in carbon emissions, which will be quantified.

By assessing the environmental benefits of Apos®, this report also aims to evaluate its role in supporting sustainable healthcare practices and contributing to the NHS's net zero emissions targets. This approach, while not exhaustive, offers a meaningful evaluation of the device's impact based on the best available data.

This report was completed by Amelia James, Sustainability Lead for Health Innovation Kent, Surrey and Sussex and Oxford and Thames Valley, and reviewed by Peter Waddingham, Net Zero Lead for the Health Innovation Network.

It is important to note that whilst we report on UK data, the MedTech Funding Mandate's support for Apos® is only for England through NHS England.

Sustainability evaluation

The evaluation is structured into two distinct assessments. The first assessment aims to estimate the carbon footprint of the Apos® device, while the second assessment evaluates the carbon savings associated with the reduction in surgical procedures.

1) An estimation of the carbon footprint of Apos®

This analysis aims to quantify the environmental footprint associated with the production, international and local shipping and patient appointments following use of Apos®.

Production of sports shoe and plastic pods: Apos® is described as a sports shoe, made with a soft inside liner and breathable, lightweight mesh. An evaluation undertaken by the Massachusetts Institute of Technology found that a single sports shoe can contain

65 discrete parts that require 360 processing steps for assembly.[6] While brand dictates product design and material specifications, the manufacturing of footwear is typically contracted to manufacturers in emerging economies. Using the life cycle assessment methodology in accordance with the ISO 14040/14044 standards, research at Massachusetts Institute of Technology found that the carbon footprint of a pair of sports shoes made of synthetic materials equates to 14.27kg of CO_2e.[7]

The plastic pod on the base of the sports shoe weighs 60g. There are two pods per shoe, thus four pods per pair. The carbon footprint of plastic varies depending on the type of plastic and the production process. The carbon footprint of plastic production ranges from 1.7kg to 3.5kg of CO_2e per kg.[8] Given the additional impact of coal-based energy in Vietnam, the carbon footprint will likely be on the higher end of this range. Thus, it is predicted that the carbon footprint of 240g of plastic made in Vietnam would be close to 0.84kg of CO_2e.[9] Thus, for the purpose of this report, we will use **15.11kg of CO_2e** as an estimation of the footprint associated with production.

International and local shipping: Shipping operations contribute to the carbon footprint of a product. Apos® is manufactured in Vietnam and shipped to the UK. Therefore, we can presume products will need to travel c.6000 miles and their weight is c.2lbs based on the weight of an average pair of sports shoes with packaging. Therefore, based on the National Council for Air and Steam Improvement Industry Report, international shipping from Vietnam to the UK by ship produces the equivalent of 1.33kg of CO_2e.[10] The Apos® device is then posted to patients in the UK. We can presume postage distance on average is c.100 miles and their weight is 2lbs, producing the equivalent of 0.38kg of CO_2e.[11] Thus, the total shipping **footprint is 1.71kg of CO2e**.

Patient travel: Significant carbon emissions arise from patient travel, contributing to 14% of the NHS's carbon footprint.[12] The current recommended Apos® pathway involves patients travelling to a hospital or community healthcare provider for two appointments following use. The distance a patient may travel can vary significantly, dependent on the type of condition, availability of healthcare facilities, geography, rural or city based, country

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[6] Cheah, Lynette, Natalia Duque Ciceri, Elsa Olivetti, Seiko Matsumura, Dai Forterre, Richard Roth, and Randolph Kirchain. "*Manufacturing-Focused Emissions Reductions in Footwear Production*." Journal of Cleaner Production 44 (April 2013): 18–29.
[7] Cheah, Lynette, Natalia Duque Ciceri, Elsa Olivetti, Seiko Matsumura, Dai Forterre, Richard Roth, and Randolph Kirchain. "*Manufacturing-Focused Emissions Reductions in Footwear Production*." Journal of Cleaner Production 44 (April 2013): 18–29.
[8] Plastics Europe (2020). Plastics – the Facts 2020.
[9] Crippa, M., et al. (2019). A comprehensive global inventory of methane emissions from the oil and gas sector. Environmental Research Letters.
[10] National Council for Air and Stream Improvement: NCASI. (2017). 2014 *Life Cycle Assessment of U.S. Average Corrugated Product.*
EPA: Environmental Protection Agency. (2018B). Emission Factors for Greenhouse Gas Inventories.
[11]National Council for Air and Stream Improvement: NCASI. (2017). 2014 *Life Cycle Assessment of U.S. Average Corrugated Product.*
EPA: Environmental Protection Agency. (2018B). Emission Factors for Greenhouse Gas Inventories.
[12] Delivering a Net Zero NHS: *B1728-delivering-a-net-zero-nhs-july-2022.pdf (england.nhs.uk)*

size, density and a range of other factors.[13] In the UK, the Health Foundation and the Nuffield Trust published a report that calculated the average distance from home to hospital for an admission was 8.7km based on five million admissions[14]. Thus, for two appointments, 34.8km would be travelled.[15]

A patient may travel using a variety of modes including car, van, motorcycle, taxi, bus, rail, ferry, walking or cycling. The UK department for Transport publishes statistics on the different modes of transport used for certain activities.[16] The category titled *Personal Business* includes medical consultations or treatment. These are captured below with the corresponding grams of carbon per km according to the 2023 Department of Transport conversion factors.[17] Without knowledge of the specific mode of transport, we would expect an average of 159g of CO_2e to be produced per km taken from the table below.[18] Thus, the total travel footprint per patient is **5.53kg of CO_2e**.[19]

Travel Mode	Percentage of patients who travel	Grams of CO_2e per km
Car[20]	80.8%	178
Bus	9.5%	102
Rail	3.6%	35
Walk	3%	0
Taxi	2.7%	149
Motorcycle	0.4%	101
Bicycle	0.2%[21]	0

Therefore, the estimated carbon footprint of manufacturing, shipping and patient travel for one Apos® medical device is **22.35 kg of CO_2e**.

It is important to note that clinicians have the capability to conduct follow-up assessments digitally by utilising information from the device's app and via telephone consultations. This digital approach presents opportunities to significantly reduce the carbon footprint associated with patient travel. Additionally, there are likely further carbon savings from a reduction in appointments related to pain management, as the device effectively alleviates

[13] Care Pathways: Guidance on Appraising Sustainability, Patient Travel Module: *Normal template (shcoalition.org)*
[14] Focus on: Distance from home to emergency care: *1540325897_qualitywatch-distance-emergency-care.pdf (nuffieldtrust.org.uk)*
[15] Calculation: 8.7km x 4 = 34.8km.
[16] Focus on: Distance from home to emergency care: *1540325897_qualitywatch-distance-emergency-care.pdf (nuffieldtrust.org.uk).*
[17] 2023 Conversion factors: ghg-conversion-factors-2023-condensed-set-update.xlsx (live.com)
[18] Calculation: 80 x 178 = 14382, 9. 5 x 102 = 969, 3.6 x 35 = 126, 2.7 x 149 = 402.3, 0.4 x 101 = 40.4, = 15,919.7 / 100 = 159kg of CO_2e per km.
[19] Calculation: 34.8km travelled x 159kg of CO_2e = 5.53kg of CO_2e.
[20] The findings of the UK Department for Transport propose that 2.3% will be travelling by ferry or plane. We do not believe this will be likely in the UK, and therefore have allocated that percentage to car travel as is the most common form of travel.
[21] The percentages in the *Guidance on Appraising Sustainability Report* add up to 100.2 due to rounding up. We have kept the same figures in this report for continuity, thus the total equals 100.2.

symptoms. It is also necessary to consider the potential additional travel required for healthcare professionals to receive training in the use of the Apos® device. Accurately predicting the carbon cost of this training requires detailed information, including the location of training sessions, the number of professionals trained and the number of patients each clinician will subsequently educate. However, we anticipate that the carbon footprint associated with training would be minimal and predominantly a one-time cost per clinician.

2) Carbon savings from surgery

This analysis aims to evaluate the subsequent carbon savings from the reduced need for surgical interventions.

The carbon impact of surgery: A baseline scenario has been established, representing the standard treatment pathway for knee osteoarthritis involving surgical intervention. The overall Life Cycle Assessment of a total knee replacement was estimated at 190.5kg of CO_2e.[22] Conservative estimates project that by 2035 there will be 120,000 total knee replacements annually in the UK.[23] If the conversative estimate is true, without any intervention, it would be expected that **22,860 tonnes of CO_2e** would be produced from those surgeries.[24]

The carbon footprint of Apos®: We estimate that one Apos® device produces 22.35kg of CO_2e. Thus, if every patient received a device who needed surgery, we would anticipate an additional carbon footprint of **2,682 tonnes of CO_2e**.[25]

Potential carbon savings of Apos®: According to the primary study underpinning the NICE guidance, 74% of 365 patients avoided surgery over a three-year period.[26] A separate study from Israel reported comparable outcomes over five years, with 82% of 414 patients avoiding surgery.[27]

While the long-term implications and the potential need for surgery at a later date remain uncertain, current evidence indicates that Apos® has been effective in helping patients

[22] Delaie, Camille, et al. "Ecological Burden of Modern Surgery: An Analysis of Total Knee Replacement's Life Cycle." *Arthroplasty Today* 23 (2023): 101187: This consisted of 53.7 kg CO_2 (28%) for the manufacture of the prosthesis, 50.9 kg CO_2 (27%) for travel, 57.1 kg CO_2 (30%) for surgery, and 28.8 kg CO_2 (15%) for waste management.
[23] Life Cycle Assessment found here: Long-term outcomes on the rates of total knee replacement amongst patients with end-stage knee osteoarthritis who meet surgical criteria and received a non-invasive biomechanical intervention - Greene - 2023 - Musculoskeletal Care - Wiley Online Library
[24] Calculation: 190.5kg of CO_2e x 120,000 patients = 22,860 tonnes of CO_2e.
[25] Calculation: 22.35 kg of CO_2e x 120,000 patients = 2,682 tonnes of CO_2e.
[26] Primary study found here: Long-term outcomes on the rates of total knee replacement amongst patients with end-stage knee osteoarthritis who meet surgical criteria and received a non-invasive biomechanical intervention - Greene - 2023 - Musculoskeletal Care - Wiley Online Library
Overview | AposHealth for knee osteoarthritis | Guidance | NICE
[27] Shema-Shiratzky et al study found here: Non-Invasive Biomechanical Intervention Leads to Low Rates of Total Knee Replacement and Reduced Utilization of Healthcare Resources among Older Adults with Chronic Knee Pain: A 5-Year Follow-Up Study (clinmedjournals.org)

avoid surgical interventions thus far. From early adopters using the shared decision making when surgery is offered alongside Apos®, we project that 25% of surgeries will be prevented at this early stage of implementation in England.

If a conservative estimate of 25% of surgeries were avoided, this would lead to a carbon saving of **3,033 tonnes of CO_2e**. At 15% of surgeries saved, carbon savings from the Apos® device are observed, but at lower levels up uptake, Apos® will add additional carbon to the pathway. This modelling assumes that all Apos® users will have surgery eventually, in the absence of long-term UK data (over six years) which might evidence complete avoidance over time.

To illustrate the range of carbon savings, the table below highlights potential surgery savings ranging from 5% to 50%.

Percentage of surgeries saved	Total number of surgeries saved	Total carbon savings in tonnes of CO_2e	Net carbon impact of using Apos® device
5%	6,000	1,143	-1,539 *(additional carbon)*
10%	12,000	2,286	-396 *(additional carbon)*
15%	**18,000**	**3,429**	**747**
20%	24,000	4,572	1,890
25%	**30,000**	**5,715**	**3,033**
30%	36,000	6,858	4,176
35%	42,000	8,001	5,319
40%	48,000	9,144	6,462
45%	54,000	10,287	7,605
50%	60,000	11,430	8,748

Conclusion

Apos® presents a significant opportunity for carbon savings within the NHS. Given the high carbon footprint associated with surgical procedures, Apos® offers a low-carbon alternative for managing knee osteoarthritis. By reducing the need for replacement surgeries, Apos® can substantially alleviate the current burden on the healthcare system.

Furthermore, Apos® can contribute to addressing the pressing issue of long elective care waiting lists, which have not fully recovered since the COVID-19 pandemic. By providing an effective, non-invasive treatment option, Apos® not only mitigates the environmental impact of surgical interventions but also enhances healthcare efficiency. This dual benefit underscores the potential of Apos® to support both sustainability goals and improved patient care outcomes in the UK.