Greening the Healthcare Supply Chain:
Life Cycle Assessment of Disposable vs. Remanufactured Medical Devices

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Abstract

Healthcare delivery is harming human health by driving unnecessary greenhouse gas emissions higher at a time the world should be lowering emissions. For decades, nurses and practitioners have used "single-use" medical devices largely out of belief that the label meant the device should only be used once. But leading national regulatory authorities have found that hundreds of types of single-use devices can be commercially remanufactured and safely reused. While the reuse of these devices saves costs, the environmental benefits are only beginning to fully emerge. We gathered research findings from disparate sources to provide a roadmap for nurses and supply chain purchasing agents who wish to help reduce harmful emissions from hospitals, remove unnecessary disposable products to create a more efficient, less wasteful, and circular health sector supply chain.

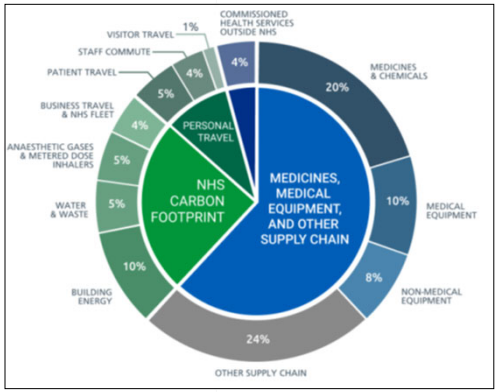

Figure 1. The UK NHS has found that the supply chain is responsible for 62% of its greenhouse gas emissions, and 10% of that comes from medical equipment,[1] often used once and discarded.

Hospitals Generate Outsized Share of Harmful Emissions

Hospitals accounts for a surprising 5% of all carbon dioxide emissions worldwide (more than that caused by all aviation and shipping)[2] and generate 43 pounds of waste per patient per day.[3]

Urgent action is needed, and governments are taking notice. Over 50 countries have committed to reducing greenhouse gas emissions from the healthcare sector, including the United States.[4] Given the impacts of the sector's environmental footprint on global health, government-run and government reimbursed healthcare facilities have a moral responsibility to pursue initiatives that not only identify sources of greenhouse gas emissions from the supply chain, but also find lower emission alternatives.

The Climate Emergency Is a Health Emergency

When the delivery of healthcare generates climate changing emissions, human lives are shortened. A study from the United States found a 388,000 reduction in disability-adjusted life years directly caused by greenhouse gas emissions from the health sector.[5]

Climate change increases water and air pollution which can cause and aggravate chronic respiratory disease, such as asthma.[6] Increased temperatures due to climate change lead to increased ground-level ozone, which cause airway inflammation and damages lung tissue.[7]

Health practitioners must uphold the Hippocratic oath to do no harm and have a moral obligation to bring the health sector as close to "net zero" emissions as soon as possible.

Use of regulated, remanufactured "single-use" medical devices is a relatively easy switch for hospitals and health systems in North America and Europe where over 300 types of remanufactured products have been found substantially equivalent to original devices.

Image 1. Remanufactured "single-use" devices are inspected at AMDR member Vanguard (Berlin, Germany). With the help of strong regulation, remanufactured devices are substantially equivalent to virgin, or original equipment.

A Case Study: Leeds Teaching Hospitals

Introducing a medical remanufacturing program to Leeds Teaching Hospitals started with the collection of used medical devices. The collection of used medical devices already made an important contribution to Leeds Teaching Hospitals' sustainability policy.

In 2021, 75.33 kg of clinical waste was diverted and saved the Trust £22,923 for the collected devices. Leeds Cath Labs are now using remanufactured EP catheters. Further reduction of 50.4% in the Trusts C02 footprint is realized from the use of remanufactured devices compared to emissions had original devices been used.

By using just 604 devices, Leeds Teaching Hospitals reduced their C02 footprint by 524.88 kg and saved £76,610 because the remanufactured products cost circa 50 % less than the OEM products.[8]

Life Cycle Assessment Finds Nearly 90% Reduction in Ozone Depletion from Remanufactured Device

Well-designed, peer reviewed, published LCAs are vital to determine which products have the lowest impact across environmental impact categories. A comparison of virgin and remanufactured EP catheters found substantial environmental benefits in 12 of 15 categories for the remanufactured device. Notably, ozone depletion was reduced by 89.7%, resource use declined 69.2%, and climate change (kg CO2-eq) was cut in half (50.4%) with the use of remanufactured catheters compared to use of an original device.[9]

Impact Category	Virgin Production Route	Medical Remanufacturing Route	Savings from Medical Remanufacturing Compared to Virgin Production per Catheter
Acidification terrestrial and freshwater [Mole of H^+ eq.]	4.73×10^{-3}	1.18×10^{-3}	75.1%
Cancer human health effects [CTUh]	3.30×10^{-10}	1.29×10^{-10}	60.9%
Climate Change [kg CO_2-eq.]	1.75	0.87	50.4%
Ecotoxicity freshwater [CTUe]	11.9	4.69	60.6%
Eutrophication freshwater [kg P eq.]	6.29×10^{-6}	7.87×10^{-6}	−25.1%
Eutrophication marine [kg N eq.]	1.36×10^{-3}	4.12×10^{-3}	69.7%
Eutrophication terrestrial [Mole of N eq.]	1.44×10^{-2}	4.41×10^{-3}	69.4%
Ionising radiation—human health [kBq U235 eq.]	5.37×10^{-2}	4.20×10^{-2}	21.8%
Land Use [Pt]	9.03	10.4	−15.2%
Non-cancer human health effects [CTUh]	1.56×10^{-8}	7.39×10^{-9}	52.6%
Ozone depletion [kg CFC-11-eq.]	1.96×10^{-11}	2.01×10^{-12}	89.7%
Photochemical ozone formation—human health [kg NMVOC eq.]	3.89×10^{-3}	1.06×10^{-3}	72.8%
Resource use, energy carriers [MJ]	29.3	9.02	69.2%
Resource use, mineral and metals [kg Sb eq.]	2.78×10^{-7}	1.98×10^{-7}	28.8%
Respiratory inorganics [Disease incidences]	4.22×10^{-8}	1.40×10^{-8}	66.8%
Water scarcity [m^3 world equiv.]	1.09×10^{-1}	1.13×10^{-1}	−3.7%

Figure 2. Life Cycle Assessment Published in Journal Sustainability Indicates Use of Remanufactured EP Catheter Cuts Greenhouse Gas Emissions in Half, Compared to Use of Original Devices9

References

1. Zils, M., et. al, "Accelerating the Transition to a Net Zero NHS," University of Exeter, Philips, Koninklijke Philips, March 2022.
2. Gabbatis, J., "Healthcare in world's largest economies 'accounts for 4%' of global emissions," CarbonBrief, June 19, 2019
3. Choi-Schagrin, W. "How Hospitals Fuel Climate Change," The New York Times, November 25, 2021.
4. "Countries commit to develop climate-smart health care at COP26 UN climate conference," News Release, World Health Organization, November 9, 2021
5. Eckelman, M., et. al, "Health Care Pollution And Public Health Damage In The United States: An Update," Health Affairs 2020 39:12, 2071-2079
6. Amato G, Cecchi L, Amato M, etct. Climate change and respiratory diseases. European Respiratory Review. 2014; 23(132):161-69.
7. Amato G, Cagani Ca, Cecchi L, etc. Climate change, air pollution, and extreme events leading to increasing prevalence of allergic respiratory diseases. Multidisciplinary Respiratory Medicine.2013:12
8. Vanguard Medical Devices, "Single Use Devices Don't Need to Be Single Use; Leeds Case Study," 2022.
9. Schulte, A., et. al, "Combining Life Cycle Assessment and Circularity Assessment to Analyze Environmental Impacts of the Medical Remanufacturing of Electrophysiology Catheters," Sustainability, 2021, 13(2), 898