The Crofter: Sustainable Communications

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Editorial

Greetings from the croft. As a UN Sustainability Partner Organisation, EMWA supports the two UN Sustainable Development Goals (SDGs) SDG 3 – Good Health and Wellbeing and SDG 12 – Responsible Consumption and Production. Both are linked to the concept of a circular economy, in which products and materials are designed to be reused, remanufactured, recycled, or recovered and thus maintained in the economy for as long as possible. Waste generation is avoided or minimised, and greenhouse gas emissions are prevented or reduced.[1]

In recent years, the unintended negative impact of healthcare on the environment – and thus on human health – has gained attention.[2] Implementing circular economy principles can help tackle the healthcare industry's waste generation and make its procurement policies more sustainable.[3]

In this issue, Crofter co-section editor Louisa Ludwig-Begall shares her experience as part of a research team that developed a low-tech, low-cost, low-energy method for decontaminating single-use face masks and respirators.

Louisa's article briefly touches on an important tool in environmental impact research – the Life Cycle Assessment (LCA), a top-to-bottom analysis of the environmental impact of a given product throughout its entire "life". To illustrate the complexities and benefits of LCAs, Sofia Polcowñuk from the EMWA graphics team and co-section editor Sarah Kabani have created an amazing LCA infographic. This is an essential resource for medical writers working in sustainability. We recommend keeping it handy for future reference!

Best, Louisa and Sarah

References

1. UN Environment Programme. 2024. [cited 2024 Mar 11]. Available from: https://www.unep.org/explore-topics/sustainable-development-goals
2. Lenzen M, Malik A, Li M, et al. The environmental footprint of health care: a global assessment. Lancet Planet Heal. 2020;4(7):e271–9. doi:10.1016/S2542-5196(20)30121-2
3. Healthcare without harm. 2024 [cited 2024 Mar 11]. Available from: https://noharm-europe.org/issues/europe/circular-healthcare

The virologists in the reusable masks

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Introduction

Everyone in the Sustainability Special Interest Group (SUS-SIG) has a different story of what first sparked their interest in sustainability. My story involves a pandemic.

Recent history has seen a steady rise of throwaway culture within the healthcare sector, and disposable healthcare consumables have progressively replaced reusable staples since the 1960s.[1–3] This evolution went largely unremarked or may even have been feted by harassed healthcare professionals who no longer needed to bother sterilising much of their kit: don, doff, discard, done.

However, as the COVID-19 pandemic accelerated in 2020, it unmasked the unsustainable nature of such a generalised single-use-only approach. In early 2020, the global demand for personal protective equipment (PPE) far exceeded manufacturing capacities: the World Health Organization (WHO) anticipated a global monthly requirement of 89 million masks, 76 million gloves, and 1.6 million goggles.[4]

To combat critical shortages, the WHO issued interim guidance on PPE rationing and recommended PPE reuse in March 2020.[5] On the face of it (pun intended), a measure to augment the availability of surgical masks and respirators during the COVID-19 crisis, this call heralded an important step towards a more sustainable circular healthcare economy. It also galvanised virologists worldwide into action, since, if an item of PPE is to be safely reused, it must first be decontaminated, i.e., rid of such dangerous germs as SARS-CoV-2, the virus that causes COVID-19.

At the time, I was part of a team of virologists at the University of Liège in Belgium. Ours was one of many groups to begin trialling PPE decontamination techniques. In delving deeper into the subject matter, we increasingly prioritised sustainable and equitable methods of readying masks and respirators for reuse beyond the immediate emergency. We had been drawn to sustainability by some worrying trends.

The unsustainable face of disposable masks and respirators

The carbon footprint of a single mask has been calculated in life cycle analyses (which take into account greenhouse gas emissions from production to disposal) to lie between 32.7g – 65.5g of CO_2 equivalents per item.[6–9] The total global warming potential of all disposable surgical masks supplied in a single year of the COVID-19 pandemic has been calculated as 1.1 megatons of CO_2 equivalents.[10]

Incorrect disposal poses an additional environmental burden. Since the beginning of the pandemic, discarded single-use items have led to widespread environmental pollution [11,12] and a "shadow pandemic" of plastic PPE rubbish.[13] In 2020 alone, an astounding 1.56 billion surgical masks were reported to have entered the world's oceans.[14] There, they degrade into micro- and nano-plastics, leach toxic heavy metals, and pose significant dangers to flora and fauna.[15]

Finding masks or respirators in unusual places is now unfortunately commonplace. I have found masks in soggy little piles amongst the cobbles of my hometown, garlanding the hedgerows of the surrounding countryside, and – most bizarre of all – secreted under a rock on a mountaintop.

Meanwhile, depending on the reprocessing method used, reusing a mask or respirator reduces its carbon footprint by 58%–85%[6,8] and may help alleviate the burden of illegal – if often inventive – PPE fly-tipping.

Rendering masks and respirators reusable

Rendering a SARS-CoV-2-contaminated mask or respirator reusable requires prior decontamination. Figuring out what decontamination technique gets the job done requires a virologist (or rather a whole lot of virologists). Early in the pandemic, little was known of SARS-CoV-2, and even tried and tested techniques had to be re-tested against this new foe.

Tried and tested techniques

We initially trialled fairly traditional methods of ridding items of infectious viruses: we baked artificially contaminated masks and respirators in an oven (dry heat decontamination), exposed them to UV light (germicidal irradiation), and steamed them with bleach (hydrogen peroxide vaporisation). All these methods successfully inactivated not only a porcine coronavirus (standing in for its more dangerous relative SARS-CoV-2) but also a norovirus, the *bête noire* of all those attempting decontamination.[16,17] Noroviruses are notorious for their hardiness, and it is a fairly safe bet that any treatment able to inactivate one of their ilk will make short work of most other viruses.

Baked, irradiated, and oxidised – perhaps those viruses never stood a chance. But what of the hapless PPE simultaneously being exposed to these aggressive treatments? A disintegrated mask is no more useful than a contaminated one. To make sure the PPE was able to resist the onslaught, we teamed up with textile researchers who performed breathability and filtration efficiency tests; these showed that even thrice-decontaminated masks and respirators allowed wearers to breathe easily and protected them from airborne pathogens.[18] This was excellent news for all three traditional methods.

However, depending on both expensive equipment and a stable energy supply, traditional decontamination methods are costly and may not be feasible in low-resource settings. Electricity remains unavailable to nearly 16% of the world population and electricity prices have fluctuated greatly in recent years.[19] Equitable and *truly* sustainable PPE decontamination must be cheap and energy-independent.

Back to the future

In 2020, our team thus joined an interdisciplinary consortium of researchers pioneering a novel low-tech, low-cost, low-energy PPE decontamination technique. Supported by the WHO and the research and grantmaking foundation Open Philanthropy, this group united researchers from academia and industry to study antimicrobial photodynamic inactivation (aPDI). aPDI combines light with colourants (photosensitisers) to rout germs. The colourants transfer energy from light to oxygen in the air, thereby generating reactive singlet oxygen. Singlet oxygen, in turn, inactivates viruses and other pathogens by breaking apart their chemical bonds.[20] From the photosensitiser paintbox, the team chose methylene blue. Both a venerable textile dye used since the 1870s and a WHO-listed essential drug,[21] it was time for methylene blue to show its mettle: was it also a decontaminant?

The decontamination procedure itself was simple: we sprayed contaminated masks and respirators with a methylene blue solution and exposed them to light for half an hour. One gram of methylene blue is enough to spray over 3000 masks or respirators, so that a single item can be decontaminated for less than €0.01. Initially, the light was generated in custom-built LED light boxes, but we later found that sunlight does the job just as well. In fact, aPDI efficiently decontaminated our PPE even when the light emanated from a cloud-shrouded sun on an overcast day[22–24] – we had plenty of opportunity to test this in Belgium in 2022! After three years of research, we had found a near-energy-independent way to decontaminate masks and respirators.

Research into aPDI PPE decontamination continues.[25] I, however, have hung up my lab coat. After the conclusion of my postdoc in 2023, I pursued my dream of becoming a medical writer. I went to my first ever EMWA conference in Prague and, at the conference dinner, told this story to SUS- SIG members…

Lessons learned – sustainability for medical writers

I am convinced that the various decontamination projects and – in a wider sense – working in the field of sustainability helped prepare me for the challenges of medical writing. Acting throughout as the team's unofficial medical writer, I learned to tackle and write about new, hitherto unfamiliar, topics. Working with interdisciplinary and international teams was an object lesson in adapting your message to your audience. Sustainability ties many disciplines together; this opened up new collaborations with other teams, new funding options, and new journals to publish in – an excellent way to broaden a writing portfolio. Finally, I met a fantastic group of sustainability enthusiasts and continue to learn more about sustainability and medical writing from them.

I am sharing this experience in the hope that it may embolden other medical writers to explore sustainability. Perhaps someone reading this article will join the SUS-SIG and share their origin story.

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Disclaimers

The opinions expressed in this article are the author's own and are not necessarily shared by her employer or EMWA.

Disclosures and conflicts of interest

The author declares no conflicts of interest.

References

1. Strasser BJ, Schlich T. A history of the medical mask and the rise of throwaway culture. Lancet. 2020;396(10243):19–20. doi:10.1016/S0140-6736(20)31207-1
2. MacNeill AJ, Hopf H, Khanuja A, et al.

Transforming the medical device industry: road map to a circular economy. Health Aff (Millwood). 2020;39(12):2088–97. doi:10.1377/hlthaff.2020.01118
3. Lenzen M, Malik A, Li M, et al. The environmental footprint of health care: a global assessment. Lancet Planet Health. 2020;4(7):e271–9. doi:10.1016/S2542-5196(20)30121-2
4. WHO. Shortage of personal protective equipment endangering health workers worldwide. World Heal Organ. 2020;1–3. https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide.
5. WHO. Rational use of personal protective equipment for coronavirus disease 2019 (COVID-19)and considerations during severe shortages. Vol 2019; 2020. Available from:https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages.
6. Giungato P, Rana RL, Nitti N, et al. Carbon footprint of surgical masks made in Taranto to prevent SARS-CoV-2 diffusion: a preliminary assessment. Sustain. 2021;13(11):1–9. doi:10.3390/su13116296
7. Klemes JJ, Fan YV, Jiang P. The energy and environmental footprints of COVID-19 fighting measures – PPE, disinfection, supply chains. Energy. 2020;211(January):118701. doi:10.1016/j.energy.2020.118701
8. van Straten B, Ligtelijn S, Droog L, et al. A life cycle assessment of reprocessing face masks during the Covid-19 pandemic. Sci Rep. 2021;11(1):1–9. doi:10.1038/s41598-021-97188-5
9. Luo Y, Yu M, Wu X, et al. Carbon footprint assessment of face masks in the context of the COVID-19 pandemic: based on different protective performance and applicable scenarios. 2020;(January). Journal of Cleaner Production. 2023;387;135854. doi: 10.1016/j.jclepro.2023.135854
10. Atılgan Türkmen B. Life cycle environmental impacts of disposable medical masks. Environ Sci Pollut Res Int. 2022;29(17):25496–506. doi:10.1007/s11356-021-17430-5
11. Tesfaldet YT, Ndeh NT. Assessing face masks in the environment by means of the DPSIR framework. Sci Total Environ. 2022;814:152859. doi:10.1016/j.scitotenv.2021.152859
12. Anastopoulos I, Pashalidis I. Single-use surgical face masks, as a potential source of microplastics: Do they act as pollutant carriers? J Mol Liq. 2021;326:115247. doi:10.1016/j.molliq.2020.115247
13. Nghiem LD, Iqbal HMN, Zdarta J. The shadow pandemic of single use personal protective equipment plastic waste: A blue print for suppression and eradication. Case Stud Chem Environ Eng. 2021;4. doi:10.1016/j.cscee.2021.100125
14. Ma J, Chen F, Xu H, et al. Fate of face masks after being discarded into seawater: Aging and microbial colonization. J Hazard Mater. 2022;436:129084. doi:10.1016/j.jhazmat.2022.129084
15. Dharmaraj S, Ashokkumar V, Hariharan S, et al. The COVID-19 pandemic face mask waste: a blooming threat to the marine environment. Chemosphere. 2021;272:(129601). doi:10.1016/j.chemosphere.2021.129601
16. Ludwig-Begall LF, Wielick C, Dams L, et al. The use of germicidal ultraviolet light, vaporized hydrogen peroxide and dry heat to decontaminate face masks and filtering respirators contaminated with a SARS-CoV-2 surrogate virus. J Hosp Infect. 2020;106(3):577–84. doi:10.1016/j.jhin.2020.08.025
17. Wielick C, Ludwig-Begall LF, Dams L, et al. The use of germicidal ultraviolet light, vaporised hydrogen peroxide and dry heat to decontaminate face masks and filtering respirators contaminated with an infectious norovirus. Infect Prev Pract. 2020;3:100111. doi:10.1016/j.infpip.2020.100111
18. Ludwig-Begall LF, Wielick C, Jolois O, et al. “Don, doff, discard” to “don, doff, decontaminate” – FFR and mask integrity and inactivation of a SARS-CoV-2 surrogate and a norovirus following multiple vaporised hydrogen peroxide-, ultraviolet germicidal irradiation-, and dry heat decontaminations. PLoS One. 2021;16(5);e0251872. doi: 0.1371/journal.pone.0251872
19. Cozzi L, Gould T. World Energy Outlook 2021; 2021. Available from: www.iea.org/weo
20. Costa L, Faustino MAF, Neves MGPMS, et al. Photodynamic inactivation of mammalian viruses and bacteriophages. Viruses. 2012;4(7):1034–74. doi:10.3390/v4071034
21. WHO. World Health Organization Model List of Essential Medicines 22nd List. Available from: https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2021.02
22. Lendvay TS, Chen J, Harcourt BH, et al. Addressing personal protective equipment (PPE) decontamination: Methylene blue and light inactivates SARS-CoV-2 on N95 respirators and medical masks with maintenance of integrity and fit. Infect Control Hosp Epidemiol. 2021;2019:1-10. doi:10.1017/ice.2021.230
23. Wielick C, Fries A, Dams L, et al. Of masks and methylene blue – the use of methylene blue photochemical treatment to decontaminate surgical masks contaminated with a tenacious small non-enveloped norovirus. Am J Infect Control. 2021;50:871–7. doi:10.1016/j.ajic.2022.01.024
24. Fries A, Wielick C, Heyne B, et al. Here comes the sun – methylene blue in combination with sunlight sanitises surgical masks contaminated with a coronavirus and a tenacious small non-enveloped virus. 2022;14(15040). doi:10.3390/su142215040
25. Ludwig-Begall LF, Heyne B. aPDI meets PPE: photochemical decontamination in healthcare using methylene blue—where are we now, where will we go? Photochem Photobiol Sci. 2024;(2):215–23. doi:10.1007/s43630-023-00514-1

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Life Cycle Assessment (LCA)

LCAs are powerful tools in healthcare sustainability research, assessing the environmental impact of products such as medications and medical devices. They can take a "cradle-to-grave" approach considering every step of the manufacturing, use, and disposal.

Use of LCAs in healthcare

Comparing products

- Reusable vs. single use
- Different packaging
- Different sterilisation processes

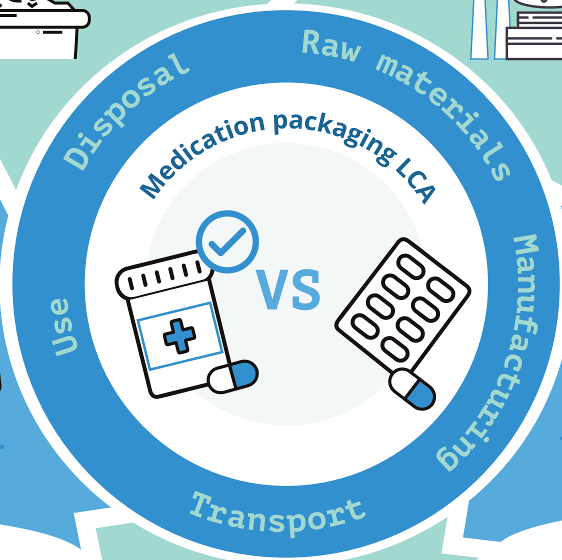
Weaknesses of LCAs

- Need extensive data
- Suppliers often reluctant to share information
- Rely on assumptions – remedy with sensitivity analysis
- Rapidly become outdated

Example LCA: Comparing medication packaging[1]

- **Recycling**
- **Incineration**
- **Sterilisation**
- **Landfill**

- **Air pollution**
- **Land use**
- **Water use**



- **Storage**
- **Adherence**

Country regulations

- **Sea**
- **Air**
- **Road**

Plastic bottles had a lower environmental impact than blister packs or glass bottles

Worst step: consumer's car trip to the pharmacy

Production, France vs China: **22%** lower CO_2 footprint in France

Concluding remark

An **LCA** is only as robust as its methodology, so medical writers should interpret LCAs cautiously.

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References

1. Cooreman-Algoed, M. et al. Environmental life cycle assessment of nutraceuticals: A case study on methylcobalamin in different packaging types. Science of The Total Environment 893, 164780 (2023).