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EDITORIAL

Reusable versus single-use ICU equipment: what's the environmental footprint?

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Many clinicians, concerned about climate change, have focussed their attention onto single-use medical items, given the large amounts of waste they produce [1]. Since the 1990s, the use of single-use items has swelled due to infection control concerns, especially due to the emergence of variant Creutzfeldt–Jakob disease (vCJD). Recent guidance, however, does not support the use of single-use items to reduce the risk of vCJD transmission in surgery [2], nor are reusable items considered to be a risk factor for surgical site infections [3]. Thus, provided that standard infection prevention concerns can be managed, choices between using single-use and reusable items can be focussed upon their respective economic and environmental costs.

When comparing the environmental impacts of alternatives, we tend to focus on those things that are most visible. For example, people often think that single-use coffee pods have a worse carbon impact compared to other options because we focus on their visible waste. In fact, based on typical serving volumes for cups of coffee, pods appear to have the lowest carbon footprint (home filtered > French press > espresso > pod) [4]. This is because the main impact from a cup of coffee arises from agriculture and growing coffee, with the impact of a pod's packaging being offset by the lower quantity of coffee that they contain to provide their typical serving volume.

To determine environmental impacts, we therefore need to consider whole systems. Environmental life cycle assessment (LCA), under an international standard (ISO 14040), wholistically quantifies emissions from all phases of the life cycle: raw material extraction (e.g., mining), material processing (e.g., steel mills) manufacturing materials into individual items (e.g., syringes), their use, and their disposal.

There have been several LCA studies investigating the carbon footprint of single-use vs. reusable medical items [5–7]. These have shown that single-use items have a greater impact from raw material extraction and manufacturing compared to reusables. As an example, based on 300 uses of an item such as scissors, a reusable item only needs to be manufactured once compared to the 300 times needed for the single-use item (Fig. 1). Using the same example, the same holds true at end-of-life, with 300 disposals (e.g. collection, incineration, etc.) being required for single-use items compared to the one for the reusable.

The environmental impact for reusable items primarily occurs during the less visible use phase, when instruments are washed and sterilised before reuse. Steam sterilisation, the most used sterilisation method, uses large quantities of energy to enable the phase change between liquid water to steam. For electric steam sterilisers, geographic location and the emissions intensity of the electricity grid running them (high-emission fossil fuels vs. low-emission renewable energy) is crucial in determining whether single-use or reusable items are better [8].

As an example, in Victoria, Australia, where the majority of electricity is generated by the combustion of brown coal (high CO_2 emissions per kilowatt-hour), single-use items are preferable to reusable because the impact from sterilising an item is greater than manufacturing and disposing a comparable single-use item. In locations where electricity grids contain less fossil fuels (coal and gas), and instead have higher concentrations of renewable and nuclear energy, reusable items are preferable. Renewable energy makes reusables better.

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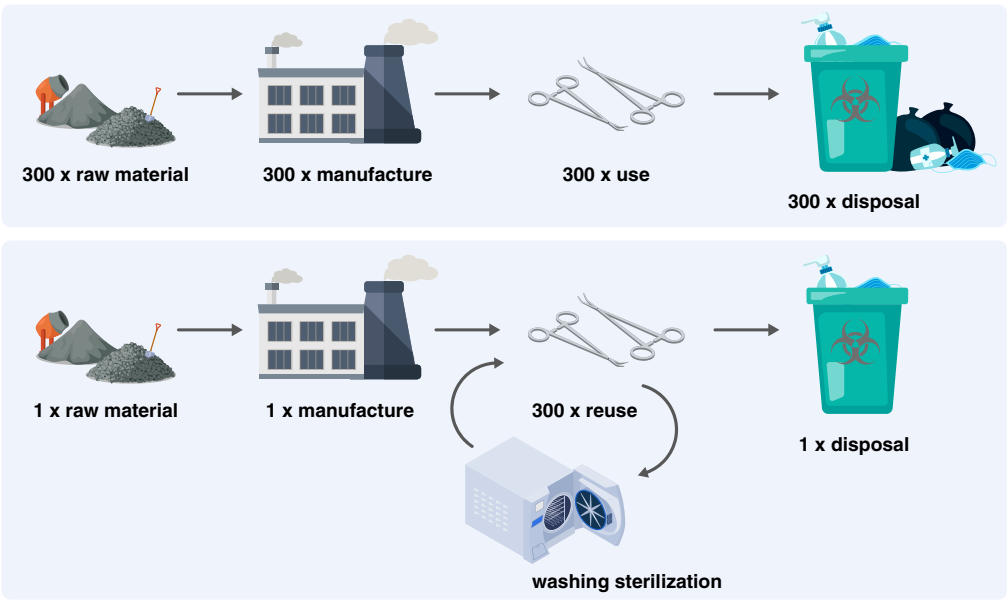

Fig. 1 Life cycle comparison of single use vs. reusable scissors for 300 uses

Of what relevance is this discussion about reusable equipment to the practising physician in the intensive care unit (ICU)? Well, not all ICUs are 100% single use. There are many ICUs across low-, middle-, and high-income countries where reusable devices still exist, including blood pressure cuffs, face masks, infection prevention and sterile surgical gowns, and laryngoscopes. For all four of these devices/items it is known that reusable variants can have a lower carbon footprint [1].

When using chemical sterilisation, such as ethylene-oxide gas or glutaraldehyde solution for bronchoscopes, reusable equipment will typically always have a lower carbon footprint compared to single use. The only time that reusable ICU equipment, such as central venous catheter insertion kits, will have a higher carbon footprint than single use is when steam sterilisers are used inefficiently, and/or coal is used as a steriliser electricity source [9]. This is also the case when plasma sterilisers are used, given they also use large quantities of electricity. Thus, as we transition away from fossil fuels it becomes more and more beneficial from a carbon perspective to replace disposable equipment with reusables. In fact, given Europe's high renewable and nuclear electricity generation (61.3%) [10], the time to commence that transition to reusable ICU equipment is already here. As Hemberg et al. have recently shown, in a country such as Sweden, with a very high renewable electricity source, the carbon emissions from inserting a central line with a reusable insertion kit and gown is less than 1/5th that of a single use kit and gown [11]. And yet, even in Sweden the use of such reusable equipment appears relatively infrequent [11].

Focusing on ICU equipment, there are large gaps in our knowledge of the extent of potential savings moving from single use to reusables. A recent meta-analysis of single vs. reusable healthcare products found only 27 studies for healthcare in total, five of which were relevant to ICU medical devices, and a further eight for personal protective equipment (PPE) [12]. Because of this paucity of knowledge, detailed LCA's need to be performed quantifying the carbon footprints of all ICU equipment and their reusable alternatives, so lower carbon models of care can be identified. Initiatives such as the HealthcareLCA database seek to provide such data [13], but currently it only acts as a repository for published information, and does not include any critical evaluation of the reported studies. As such, and as HealthcareLCA itself states "Recorded impact values should therefore be interpreted with caution" [13].

The United Nations (UN) secretary general recently stated "The era of global warming has ended; the era of global boiling has arrived" [14]. It's time for every clinician to head towards more environmentally sound practice. Avoiding unnecessary and low value healthcare is a vital part of that transition, alongside encouraging reusable equipment sterilised with renewable energy!

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Declarations

Conflicts of interest
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References

1. Baid H, Damm E, Trent L, McGain F (2023) Towards net zero: critical care. BMJ 381:e069044. https://doi.org/10.1136/bmj-2021-069044
2. NICE (2020) Reducing the risk of transmission of Creutzfeldt–Jakob disease (CJD) from surgical instruments used for interventional procedures on high-risk tissues. Interventional procedures guidance [IPG666]
3. Ban KA, Minei JP, Laronga C et al (2017) American College of surgeons and surgical infection society: surgical site infection guidelines, 2016 update. J Am Coll Surg 224:59–74. https://doi.org/10.1016/j.jamcollsurg.2016.10.029
4. Tavares MPF, Mourad AL (2020) Coffee beverage preparation by different methods from an environmental perspective. Int J Life Cycle Assess 25:1356–1367. https://doi.org/10.1007/s11367-019-01719-2
5. Rizan C, Bhutta MF (2022) Environmental impact and life cycle financial cost of hybrid (reusable/single-use) instruments versus single-use equivalents in laparoscopic cholecystectomy. Surg Endosc 36:4067–4078. https://doi.org/10.1007/s00464-021-08728-z
6. Donahue LM, Hilton S, Bell SG et al (2020) A comparative carbon footprint analysis of disposable and reusable vaginal specula. Am J Obstet Gynecol 223:225.e1-225.e7. https://doi.org/10.1016/j.ajog.2020.02.007
7. McGain F, Story D, Lim T, McAlister S (2017) Financial and environmental costs of reusable and single-use anaesthetic equipment. Br J Anaesth 118:862–869. https://doi.org/10.1093/bja/aex098
8. McGain F, Moore G, Black J (2016) Steam sterilisation's energy and water footprint. Aust Health Rev 41:26. https://doi.org/10.1071/ah15142
9. McGain F, McAlister S, McGavin A, Story D (2012) A life cycle assessment of reusable and single-use central venous catheter insertion kits. Anesth Analg 114:1073–1080. https://doi.org/10.1213/ane.0b013e31824e9b69
10. European Council, Council of the European Union (2023) Infographic - How is EU electricity produced and sold? https://www.consilium.europa.eu/en/infographics/how-is-eu-electricity-produced-and-sold/#:~:text=In%202022%2C%2039.4%25%20of%20electricity,Coal%3A%2015.8%25. Accessed 30 Jul 2023
11. Hemberg L, Wessberg N, Leire C, Bentzer P (2023) Environmental impact of single-use and reusable items in central venous catheter insertion kits: a life cycle assessment. Intensive Care Med 49:662–664. https://doi.org/10.1007/s00134-023-07078-9
12. Keil M, Viere T, Helms K, Rogowski W (2022) The impact of switching from single-use to reusable healthcare products: a transparency checklist and systematic review of life-cycle assessments. Eur J Public Health 33:56–63. https://doi.org/10.1093/eurpub/ckac174
13. HealthcareLCA (2023) HealthcareLCA. https://healthcarelca.com/. Accessed 25 Sep 2023
14. Niranjan A (2023) 'Era of global boiling has arrived,' says UN chief as July set to be hottest month on record. In: The Guardian. https://www.theguardian.com/science/2023/jul/27/scientists-july-world-hottest-month-record-climate-temperatures#:~:text=Karsten%20Haustein%20at%20Leipzig%20University,it%20was%20over%2C%20he%20said. Accessed 30 Jul 2023