EDITORIAL

Single-use duodenoscopes: How concerned should we be about the environment?

Infection outbreaks related to contaminated duodenoscopes have caused considerable concern. Worldwide, 490 cases were reported between 2008 and 2018, and 32 patients died as a consequence.[1] Although the overall mortality is extremely low (approximately 1:150,000),[2] transmission of infection and death seem avoidable. Most outbreaks were attributed to nonadherence to the cleaning protocol, but duodenoscope design flaws were also identified.[3,4] Consequently, industry and regulators looked for solutions to negate even the smallest risk of infection. In addition to enhanced reprocessing techniques, the U.S. Food and Drug Administration also recommends the attachment of a disposable protective disposable cap to the duodenoscopes or the use of a single-use disposable duodenoscope.[4]

Whereas disposable duodenoscopes would mitigate infection risk, their introduction has raised concerns about their environmental impact. Endoscopy has been reported to be the third largest generator of medical waste in a hospital, and transitioning to disposable endoscopes would increase the net waste of endoscopic procedures by 40%.[2,5] As a procedure-intense specialty, endoscopy also shares a considerable portion of the carbon footprint produced by health care. In the United States, the health care sector generates 8.5% of all greenhouse gas emissions, and if health care were a country, it would be the fifth largest emitter.[6,7] Undoubtedly, the health care sector is thereby a contributor to climate change and its devastating consequences—including a rise in extreme weather events, heat waves, wildfires, a change in vector ecology, and infectious diseases. With that in mind, the questions are whether single-use disposable duodenoscopes truly have a greater environmental footprint than reusable instruments, and if so, whether the benefit of negating infection risk outweighs the environmental harms.

The study by Nguyen et al[8] provides important answers to these questions. The authors performed a life cycle assessment of single-use and reusable duodenoscopes. This mathematical model accounts for all process steps of an instrument during its lifetime, from manufacturing to its use and its disposal. For the reusable duodenoscopes, it also included reprocessing. As the main results, the study finds that (1) single-use duodenoscopes had a 24 to 47 times greater carbon footprint than did reusable duodenoscopes (36 to 72 kilogram of CO_2 equivalent as a measure of greenhouse gas emission [kgCO_2eq] vs 1.5 kgCO_2eq) and (2) the overall health burden of a single-use duodenoscope was greater than that of a reusable duodenoscope with a protective cap (lower health burden of a reusable duodenoscope by a factor of 0.75). The study further provides a wealth of additional results on environmental and health effects that mirror the carbon footprint results (including freshwater ecotoxicity, marine ecotoxicity, resource consumption, and carcinogenic toxicity).

> Despite the challenges that need to be overcome, there is an increasing awareness and willingness to transition to a sustainable practice that at the same time affords high-quality care.

It should be noted that the detected superiority of a reusable duodenoscope with a cap is based on a 50% reduction in infection rate related to contaminated duodenoscopes when compared with the incidence in 2018. A reduction of at least 36% would gain superiority. Although data are lacking, such a reduction in infection rate seems plausible when we consider the introduction of enhanced reprocessing techniques and required postmarketing surveillance.

The study is a challenging read because most of us are not familiar with life cycle assessment. The analytic software is quite specialized, and the study is populated with data from sources on environmental impacts and health effects that are unfamiliar. These include, for instance, the carbon footprint of materials that are needed to manufacture a duodenoscope (eg, electronics or plastic) and processes (eg, incineration of medical waste). Health outcomes are also less tangible, and it is difficult to grasp the clinical meaning of the overall health impact, which represents a summary of the health consequences of the environmental effects on health (eg, asthma related to small particle pollution) and consequences of infections from contaminated duodenoscopes. Nevertheless, as a study that uses life cycle assessment within the field of medicine it seems exceptionally well done; it is comprehensive

0016-5107/$36.00
https://doi.org/10.1016/j.gie.2022.08.014

and detail oriented, and—what is rare—it includes a health outcome.

As with any model, the limitations are primarily related to the underlying assumptions. For instance, information on the material composition of a single-use duodenoscope could not be obtained from the manufacturer. Instead, the authors applied the material composition of a single-use ureteroscope, which they argue is likely similar. To account for uncertainty, they present the results within a plausible range as a best-case and worst-case scenario. In addition, the analysis is intentionally biased in favor of single-use duodenoscopes, which seems from a scientific perspective questionable. The model also applied the least environmentally impactful material composition and a 0% adverse event risk with single-use duodenoscopes. Furthermore, the assumed lifetime use of reusable duodenoscopes is lower than previously estimated (650 instead of 2000).[2] The study also did not account for packaging or transporting of disposed duodenoscopes. That means that even within the presented ranges, the obtained results likely underestimate the environmental and health impacts of single-use duodenoscopes.

In that sense, it is surprising that the best-case scenario results (with the assumed least environmental effect) were the basis for the study conclusions. For instance, a key statement that single-use "disposable duodenoscopes provide an incremental public health benefit" seems contrary to the relevant results of the study (single-use duodenoscopes had worse health outcomes than did duodenoscopes with a protective cap). This statement also refers to the comparison of single-use duodenoscopes with traditional duodenoscopes without a cap—a practice that is no longer supported. Therefore, the stated conclusion should not mislead policy makers or administrators.

The study provides novel data in our field as well as important insights. It bridges the gap between our clinical practice and the environment. Importantly, it considers eventual health effects. The study is also the first to provide data on the environmental burden of reprocessing endoscopes, which is substantial and is related not only to a high carbon footprint (26% of the footprint of a reusable duodenoscope in this study) but also to the need for large amounts of fresh water and environmental toxins.

Despite the study limitations, the results have significant implications. The findings do not support the general adoption of an ERCP practice with single-use duodenoscopes. Proponents of single-use devices may highlight the shortcomings of the analysis and argue that the applied infection risk is too low, may point to recycling efforts (which currently lack transparency), and may emphasize the potential benefits of quick innovation cycles for single-use devices. Additional analyses that apply the true material composition would help in making more precise estimates, and industry partners are called on to provide such essential data. It seems unlikely, however, that such information would reverse the overall findings of the study.

For many, the amount of waste generated in endoscopy and its environmental impact is of growing concern. The debate of using single-use or reusable devices may be polarizing. But it also raises awareness about the environmental effects of our practice, and it inspires discussion and new questions. For instance, what are alternative environmental design options (eg, combining reusable with single-use components within a circular economy)? How can reprocessing be altered to be environmentally sustainable? Finally, the debate sheds some light on our human behavior and how we respond to events that are rare but threatening. We may lose sight of the magnitude of the problem and try to find a perfect solution (in this case infection) but with unintended consequences (ie, significant environmental impact with downstream health implications).

When we consider that "Climate change is the greatest global health threat facing the world in the 21st century,"[9] it is clear that we cannot continue our practice as usual. Despite the challenges that need to be overcome, there is an increasing awareness and willingness to transition to a sustainable practice that at the same time affords high-quality care. National and international societies have committed to this path,[10,11] and initiatives within GI societies in the United States are under way. Measuring the impact of our practice and understanding the differences between single-use and reusable instruments constitute one important step on this path, and this study is a valuable contribution to it.

DISCLOSURE

Dr Pohl is the recipient of research grants from Cosmo Pharmaceutical and Steris. The views expressed in this article are those of the authors and do not necessarily represent the views of the Department of Veterans Affairs or the U.S. government.

Heiko Pohl, MD, FASGE
Dartmouth Geisel School of Medicine
Hanover, New Hampshire
Department of Gastroenterology
Veterans Administration Medical Center
White River Junction, Vermont, USA

Abbreviation: kgCO2eq, kilogram of CO_2 equivalent as a measure of greenhouse gas emission.

REFERENCES

1. Balan GG, Sfarti CV, Chiriac SA, et al. Duodenoscope-associated infections: a review. Eur J Clin Microbiol Infect Dis 2019;38:2205-13.
2. Namburar S, von Renteln D, Damianos J, et al. Estimating the environmental impact of disposable endoscopic equipment and endoscopes. Gut 2022;71:1326-31.

3. Shimpi RA, Spaete JP. Quality assurance in endoscopic infection control, disposable duodenoscopes, and the environmental impact of endoscopy. Techniques and Innovations in Gastrointestinal Endoscopy 2022;24:290-9.
4. Use duodenoscopes with innovative designs to enhance safety: FDA Safety Communication. US Food and Drug Administration; 2022. https://www.fda.gov/medical-devices/safety-communications/use-duodenoscopes-innovative-designs-enhance-safety-fda-safety-communication. Accessed July 22, 2022.
5. Vaccari M, Tudor T, Perteghella A. Costs associated with the management of waste from healthcare facilities: an analysis at national and site level. Waste Manag Res 2018;36:39-47.
6. Eckelman MJ, Huang K, Lagasse R, et al. Health care pollution and public health damage in the United States: an update. Health Aff (Millwood) 2020;39:2071-9.
7. Karliner J, Slotterback S, Boyd R, et al. Health care's climate footprint. Health care without harm. 2019. https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf. Accessed July 22, 2022.
8. Le NNT, Hernandez LV, Vakil N, et al. Environmental and health outcomes of single-use versus reusable duodenoscopes. Gastrointest Endosc 2022;96:1002-8.
9. The Lancet countdown on health and climate change. The Lancet; 2022. https://www.thelancet.com/countdown-health-climate. Accessed May 31, 2022.
10. Rodriguez de Santiago E, Dinis-Ribeiro M, Pohl H, et al. Reducing the environmental footprint of gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) position statement. Endoscopy 2022;54:797-826.
11. AMA adopts new policy declaring climate change a public health crisis. American Medical Association; 2022. https://www.ama-assn.org/press-center/press-releases/ama-adopts-new-policy-declaring-climate-change-public-health-crisis. Accessed July 22, 2022.