Communication from the ASGE Sustainable Endoscopy Task Force

WHITE PAPER

ASGE American Society for Gastrointestinal Endoscopy

Meeting the environmental challenges of endoscopy: a pathway from strategy to implementation

Prepared by: American Society for Gastrointestinal Endoscopy Sustainable Endoscopy Task Force

Lyndon V. Hernandez, MD, MPH,[1] Deepak Agrawal, MD, MPH,[2] Kevin S. Skole, MD,[3] Seth D. Crockett, MD, MPH,[4] Rahul A. Shimpi, MD,[5] Daniel von Renteln, MD,[6] Heiko Pohl, MD[7,8]

This document was reviewed and approved by the Governing Board of the American Society for Gastrointestinal Endoscopy.

Remarkable advances in endoscopic technology have dramatically altered the landscape of treating GI diseases. Yet it is becoming evident that our activities also have negative consequences to the environment and, ultimately, to public health. The American Society for Gastrointestinal Endoscopy (ASGE) recognizes that health care is a major contributor to greenhouse gas (GHG) emissions and thereby to global warming. In response, it has established a Task Force on Sustainable Endoscopy to propose ways to minimize the environmental impact of endoscopy. This initiative follows the recently outlined GI multisociety strategic plan on environmental sustainability that aims to "devise and foster clinical practices to reduce waste and carbon emission."[1] Recent societal position statements and commentaries have provided guidance on interventions to reduce the environmental impact of GI endoscopy.[2-11] However, it is essential to provide endoscopists and endoscopy units with guidance on *how* to implement practice changes.

There are 2 goals of this framing paper. The first is to review key concepts on how endoscopic practice leads to negative consequences to the environment and human health. The second is to propose core principles and strategies to reduce its environmental impact. This article introduces and lays the groundwork for a series of articles entitled "Practical Steps to Green Your Endoscopy Unit" that will provide actionable tips to decrease waste and the carbon footprint of GI endoscopy. The first of the series, "How to Get Started," is published in tandem with this article. These "Practical Steps" series articles will be accompanied by short videos posted on the ASGE website.

INTERACTION OF CLIMATE CHANGE, HEALTH, AND HEALTH CARE

Climate change is the greatest global health threat facing the world in the 21st century.[1] The effects of a changing climate are increasingly apparent.[12] Extreme weather events have given rise to wildfires, droughts, and floods, threatening human life and causing damages worth billions of dollars. Insecure water and food supplies are leading to malnutrition and famine in some parts of the world, unsanitary conditions result in diarrheal illnesses and hepatitis outbreaks, and a change in vector ecology increases the risk of tick- and mosquito-borne diseases.[12-20] Although climate change is at the center of public discourse, other environmental impacts of human activities—including air pollution, loss of biodiversity, and nitrogen runoff—also threaten our health and the health of our planet.[21] Globally, more than 8 million people die prematurely from air pollution each year, which is almost 10 times the death rate of colorectal cancer.[19] The effects of global warming disproportionally impact vulnerable populations, intensify inequalities, and may impair access to care.[12,15,20] For health care to provide appropriate and quality care, it must adapt to the health effects of a changing climate and environment.[22]

Ironically, provision of care generates GHGs and thereby contributes to global warming and to the detriment of human and planetary health. If health care was a country, it would be the fifth largest emitter worldwide; the healthcare sector generates 8.5% of all GHG emissions in the United States, representing 27% of all healthcare-generated GHGs worldwide.[23,24] North America is also the leading producer of healthcare waste in the world.[25] Procedure-intense specialties that use significant consumable materials such as gastroenterology, surgery, and anesthesia are major contributors to health care's carbon footprint and generate large amounts of landfill waste that can leak carcinogens and microplastics.[26] Recognizing the contribution of health care to climate change, the U.S. Department of Health and Human Services has committed to decarbonizing the federal healthcare system and taken deliberate measures to support decarbonizing nonfederal healthcare institutions that include steps for industry to support this transition.[27-30] As such, GI endoscopy has an opportunity and a responsibility to contribute to solutions. We as gastroenterologists are well positioned to lead the effort so that steps to mitigate the environmental impact of our practice can be seamlessly integrated into clinical care for our patients.

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

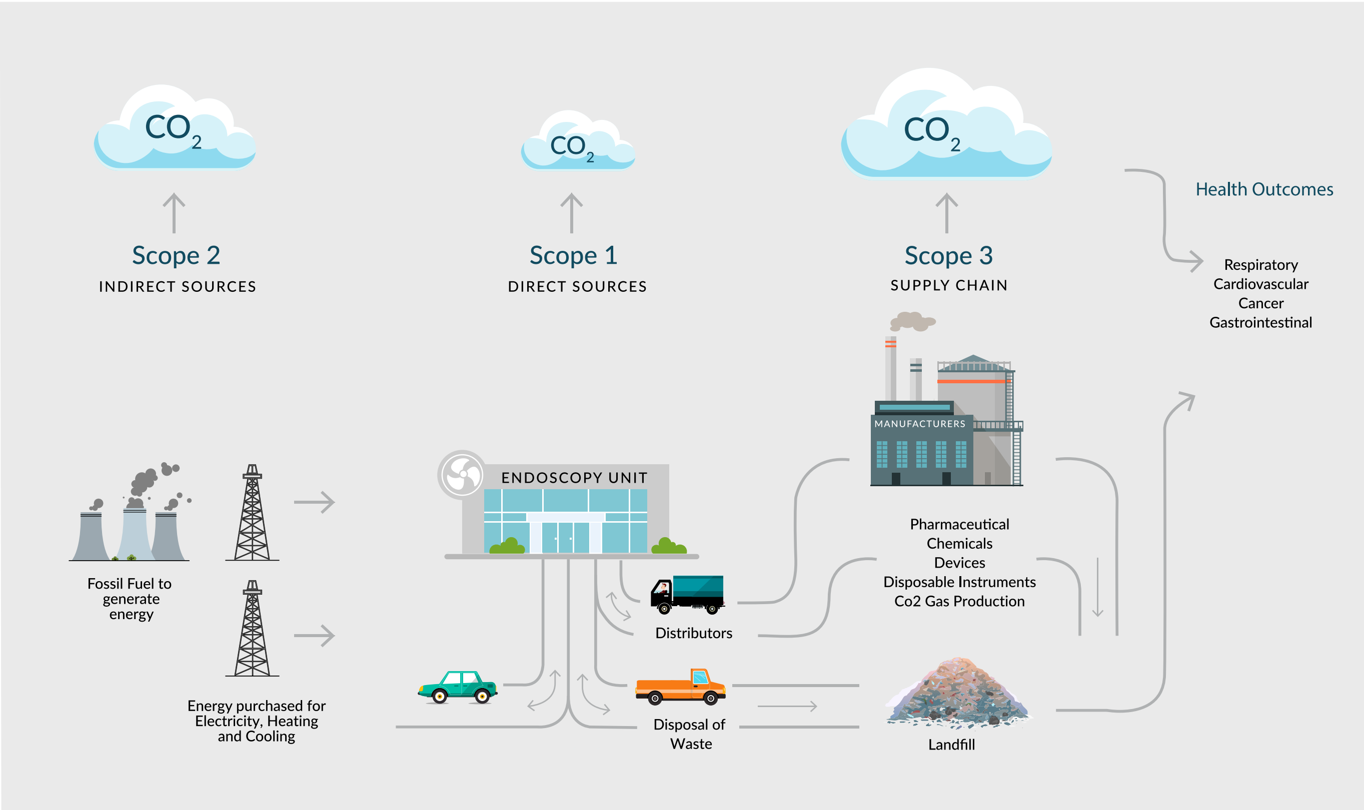

Figure 1. An endoscopy unit's greenhouse gas emissions profile according to scopes 1, 2, and 3.[24,32]

INTRODUCTION TO TERMINOLOGY

Climate change refers to an increase in global temperature because of GHG emissions. The "carbon footprint" of a particular entity can be defined as the total of all GHG emissions and is quantified as carbon dioxide equivalents (CO_2e). Although CO_2 makes up the bulk of GHGs, other gasses such as methane, hydrofluorocarbons, and anesthetic gasses used in the operating unit (eg, nitrous oxide or desflurane) are potent GHG contributors. The observed planetary 1.1°C temperature rise over the past 120 years parallels an increase in atmospheric CO_2, with the latter rising to a level unprecedented for the past 2 million years.[31]

GHG emissions are categorized into direct (scope 1) and indirect (scopes 2 and 3) emissions.[32] In endoscopy, scope 1 emissions come directly from the endoscopy unit such as those related to transportation of patients and staff or CO_2 for insufflation (Fig. 1). Scope 2 emissions are those emitted indirectly through purchased energy for electricity, heating, or cooling from combustion of fossil fuels. Scope 3 emissions are generated in the supply chain through manufacturing, transport, and disposal of goods (including endoscopic supplies) and services procured by the endoscopy unit. It is important to emphasize that in health care, scope 3 emissions comprise approximately 70% of all GHG emissions.[23,24,33]

Providing care without regard for the environment, its resources, and cost has reached its limit. To ensure high-quality health care for future generations, we need to deliver endoscopic care that is sustainable. Sustainability is widely defined as the ability to meet the needs of the present without compromising the ability of future generations to meet their own.[34,35] It considers not only the economic effects of our actions (eg, healthcare cost) but also social and environmental costs. Sustainable health care provides high-quality care for all and rests on prevention, patient empowerment, lean care pathways, and environmentally friendly practices.[36]

A glossary of key terms is provided in Table 1. Readers are encouraged to revisit this primer as they review subsequent papers in this series. Additional sources for information and further reading on climate change as it relates to human health and health care are provided in Appendix 1 (available online at www.giejournal.org).

MAIN DRIVERS OF CARBON FOOTPRINT AND WASTE IN GI ENDOSCOPY

GI endoscopy directly and indirectly impacts the environment. It is helpful to view its environmental cost as a continuum from manufacturing of supplies and instruments, their clinical use, need for disinfection, to their disposal (Fig. 1). Performing endoscopies consumes energy and a large amount of water and generates waste and toxins. Thereby, GI endoscopy not

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

TABLE 1. Glossary of key terminology related to climate change and green endoscopy

Term	Description
Carbon dioxide equivalent	Representative measure of the total amount of generated GHGs and how much it contributes to global warming, relative to carbon dioxide.[48]
Carbon footprint	Measure for GHG emissions and representing the total amount of GHGs generated directly or indirectly by an individual, organization, product, or event and their activities. Carbon footprint is the representative unit for measuring global warming (carbon dioxide equivalent).[48] The average carbon footprint per person in the United States is 16 tons compared with the global average carbon footprint per person of 5 tons.[49]
Carbon neutrality	Carbon neutrality is achieved when GHG emissions are offset by eliminating the same amount through other avenues. Although viewed as synonymous with net zero emission, the term *carbon neutrality*—in contrast to net zero emissions—may include offsetting carbon emissions by purchasing carbon certificates.[48]
Circular economy	A model of economy that involves activities that are restorative or regenerative by design and aims for the elimination of waste through the superior design of materials, products, and systems.[50]
Climate change	Long-term shifts in temperatures and weather patterns, mainly caused by human activities, especially the burning of fossil fuels, which produces heat-trapping gasses.[48,51]
Conference of Parties	The Conference of Parties is the supreme decision-making body of the UN Convention on Climate Change, which holds yearly conferences to address climate change.[52]
Ecosystem	A geographic unit of living organisms and their interaction with the physical environment in which they live.[48]
Earth Overshoot Day	This date corresponds to the moment when humans have consumed the resources that the planet can provide and replenish in 1 year. For 2022, Earth Overshoot Day was July 28. For the United States it was March 13.[53]
Global warming	Long-term temperature increase of the planet, caused mainly by the increase in GHGs, which trap heat.[48]
Greenhouse gasses	Gasses that absorb infrared radiation (heat energy) emitted from earth's surface and reradiate it backs to earth, thus raising the temperature. The 4 major GHGs are carbon dioxide, methane, nitrous oxide, and industrial gasses (eg, fluorinated gasses).[48]
Intergovernmental Panel on Climate Change	Established in 1988, the Intergovernmental Panel on Climate Change is a UN body that provides policymakers with regular scientific assessments on climate change, its impact and future risks, and options for reducing the rate at which climate change is taking place.[51]
Lancet Countdown	Annual report, since 2017, that tracks >40 indicators across key areas of health and climate change.[54]
Life cycle assessment	Cradle to grave or cradle to cradle analysis of environmental impacts associated with all the stages of a product's life, from material extraction through manufacturing, packaging, transportation, use, and disposal.[55]
Net zero carbon dioxide emissions	Net zero carbon dioxide emissions are achieved when anthropogenic carbon dioxide emissions are balanced globally by anthropogenic carbon dioxide removals over a specific period.[48] It does not imply offsetting carbon emissions by other means (eg, certificates).
Planetary health	Solutions-oriented, transdisciplinary field and social movement focused on analyzing and addressing the impacts of human disruptions to earth's natural systems on human health and all life on earth.[56,57]
Scopes 1, 2, and 3	As defined by the Greenhouse Gas Protocol: Scope 1: direct emissions (eg, emissions from onsite incineration or anesthetic gasses) Scope 2: indirect emissions from generation of electricity, heating, ventilation, air conditioning, or cooling Scope 3: indirect emissions, not reported in scope 2, with most originating from the supply chain (manufacturing and distribution of supplies); other sources include travel and services (eg, nutritional services and waste management)[24,32]
Sustainability	Ability to meet the needs of the present without compromising the ability of the future generations to meet their own needs. The 3 pillars of sustainability are environmental, economic, and social.[35]
Sustainable economy	An economy that provides for the greatest amount of general well-being without depleting natural resources and harming the environment.[58]
Sustainable health care	Health care that provides high-quality care for all that is based on patient empowerment and self-care, prevention, lean care pathways, and environmentally friendly practices.[36,59]
Sustainable value of care	Expanding the traditional value of care definition (patient outcomes relative to cost) to include benefits of care for the patient and larger population against environmental, social, and economic cost.[36]

GHG, Greenhouse gas.

only contributes to climate change, but also affects other essential environmental subsystems (eg, freshwater use, land use, aerosol pollution, and biodiversity).[21,37]

As a procedure-intense subspecialty, GI endoscopy has an enormous need for single-use disposable instruments. Although reusing accessories used to be common practice, over the past 2 decades endoscopy has become highly reliant on single-use instruments. Its carbon footprint related to the supply chain alone is therefore substantial. However, data on the precise carbon footprint of a given

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

TABLE 2. Considerations for transitioning from a current "gray" to a sustainable "green" practice

Gray practice		Green practice
Overly aggressive surveillance intervals, frequent low-value procedures	→	Minimize unnecessary and low value procedures (eg, 7- year surveillance colonoscopy for low-risk adenomas)
Exclusively in person visits	→	Optimized use of virtual visits
More than 5-day work week, no attention to commuting practices of staff	→	Four-day work week, responsible commuting
No attention to lights, electronic equipment, and heating, ventilation and air conditioning that may run at night and after hours	→	Environmentally conscious use of electricity and heating, ventilation and air conditioning (motion sensors, off at night, etc)
High use of paper documentation and subsequent scanning	→	Electronic consents, procedure reports, and discharge instructions
Overuse of medical waste disposal and landfill disposal	→	Appropriate waste segregation to maximize recycled waste and minimize landfill and medical waste
Single-use gowns	→	Reusable/laundered gowns
Overuse of sterile water and CO_2 insufflation	→	Use of tap water and room air when appropriate
Inconsiderable use of disposable single-use devices	→	Mindful use of disposable single-use devices
Performing upper endoscopy and colonoscopy for the same patient on separate days	→	Performing bidirectional endoscopies on the same day

endoscopic procedure and potential benefits from practice changes are lacking. First, suppliers do not currently provide such data for endoscopic devices and instruments. Second, we need to consider all relevant components and processes of performing an endoscopic procedure to understand its environmental impact. Aside from supplies and endoscopes, these include medications (eg, for sedation), administrative tasks (eg, scheduling patient, purchasing), travel needs for staff and patients, waste management, infrastructure of the endoscopy unit (eg, energy and heating/cooling sources), and educational and research activities.[2]

Recent studies have examined some of these aspects.[38] For instance, the energy needs to perform a single endoscopic procedure and the generated waste amounted to approximately 4.8 kg of CO_2 emissions.[7] Extrapolating this figure to the 18,000,000 annual endoscopy volume in the United States, carbon emissions would add up to approximately 86,000 metric tons of CO_2e, equivalent to burning 94 million pounds of coal.[7] However, this figure likely represents only a fraction because it does not consider heating and cooling the endoscopy unit and impactful supply chain components (scope 3 emissions).

Apart from helping to highlight GI endoscopy's overall environmental impact, these data have limited utility. The provision of quality health care will invariably lead to some adverse impacts on carbon emissions. However, GI endoscopy can (and should) have a *lower* carbon footprint, arguably as low as we can make it without compromising patient care. Thus, rather than the total summations listed above, the most useful data on the carbon footprint of GI endoscopy are the nonessential or excess CO_2e from discretionary activities and the potential relative reductions in CO_2e that can be achieved with green practice changes (Table 2). Unfortunately, such data are not yet available.

With respect to waste, it has been estimated that endoscopy services are the third largest producer of medical waste among hospital departments.[39] On average, each endoscopic procedure generates 2.1 kg of waste, including 1.5 kg of plastic waste.[11,40] The total waste from all endoscopic procedures done in the United States each year weighs over 42,000 tons.[40] Most endoscopy-related waste ends up as municipal waste in landfills (64%) or is labeled as "biohazard" (regulated medical) waste and is either autoclaved or incinerated (28%), with less than 10% being recycled.[40] Disposable equipment and supplies make up the bulk of this waste, which includes items such as suction tubing, disposable endoscope buttons, bite blocks, intravenous and oxygen tubing and anesthesia supplies, personal protective equipment, disposable biopsy forceps, snares, polyp traps, and its packaging. As much as 35% of waste is potentially recyclable, and a large proportion of waste placed in biohazard bins may be disposed of as municipal waste,

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

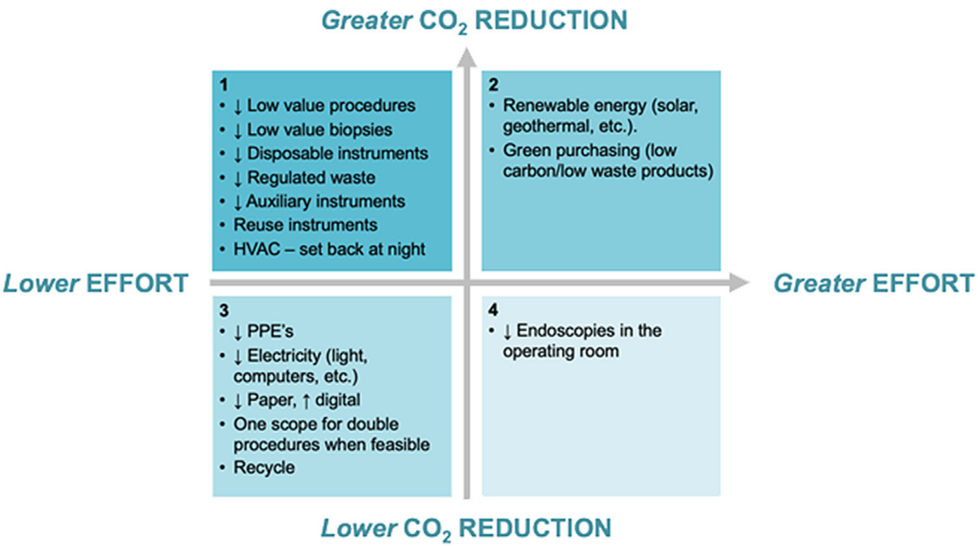

Figure 2. A 2 × 2 decision-prioritization matrix on the relative cost (effort) and benefits of reducing carbon emissions. *HVAC*, Heating, ventilation, and air conditioning; *PPEs*, personal protective equipment.

highlighting the potential for reducing the environmental impact and saving cost.[40] Reprocessing endoscopes also has important environmental effects with respect to water usage and waste generation.[41] However, the implementation of single-use endoscopes (which has been advocated primarily to mitigate infection concerns) would cause considerable harms to the environment and thus health.[37,40] Switching to single-use duodenoscopes would increase the carbon footprint more than 23-fold when compared with reusable duodenoscopes, and potential upfront health benefits would be outweighed by downstream harms.[37] In addition, adopting disposable endoscopes would increase net waste mass by 40%.[40] The problem of consumable equipment is further compounded by the fact that such items require shipping and storage and occasionally go unused before expiration dates.

PRINCIPLES TOWARD A SUSTAINABLE GREEN ENDOSCOPY PRACTICE

Our knowledge of reducing the environmental impact of endoscopy is at a nascent stage. Although we have scant data to explain cause-and-effect relationships, an opportunity exists to arrive at a logical approach to change our practice, recognizing that our old ways of doing things are not sustainable. An increasing number of commentaries and reviews on this topic focus on the enormity of the problem and a general call to arms.[5-8,42-44] Recent societal statements list opportunities to reduce the environmental impact of our practice.[1,2,4] Although these statements are helpful to highlight the need for reform and point to possible intervention, they will unlikely compel stakeholders to change unless we ask "how" our proposed solutions work in actual practice, how we can implement them, and how these steps impact cost savings.

Prioritizing initiatives

Although multiple potential interventions promote sustainability in endoscopy, there is currently no guiding framework for initiating and managing a sustainable program. To address this problem, we present prioritized interventions that intersect between reducing waste and carbon footprint and ease of implementation. The 2 × 2 prioritization matrix (Fig. 2) illustrates how the relative benefit of carbon emission reduction compares with the effort (including cost) required to implement changes in the endoscopy suite. Although carbon emission levels can be quantified and are reasonably replicable, the amount of work it takes to apply these initiatives depends on the local context. For example, it will be much easier for a practicing endoscopist to meaningfully reduce GHG emissions in a facility that is already using sustainable energy compared with a coal-based energy-dependent hospital.

Implementing at the ground level

There is rarely one perfect solution for any organization, and there are often several alternatives to choose from. An often overlooked but critical component for successful implementation is to allow ample deliberation and autonomy at the ground level by actively engaging the entire endoscopy team as opposed to simply handing down an executive decision. It is apparent that not everyone will be fully onboard with concerns about the environmental impact of our practice, but some level of cooperation can be reached by framing the discussion in terms of reducing pollution and saving costs.

Quadrant 1 represents high-impact strategies for reducing GHG emissions with relatively low effort. After weighing the pros and cons, the endoscopy team may prioritize these strategies that can be immediately executed in the endoscopy unit. Examples include minimizing unnecessary endoscopies and

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

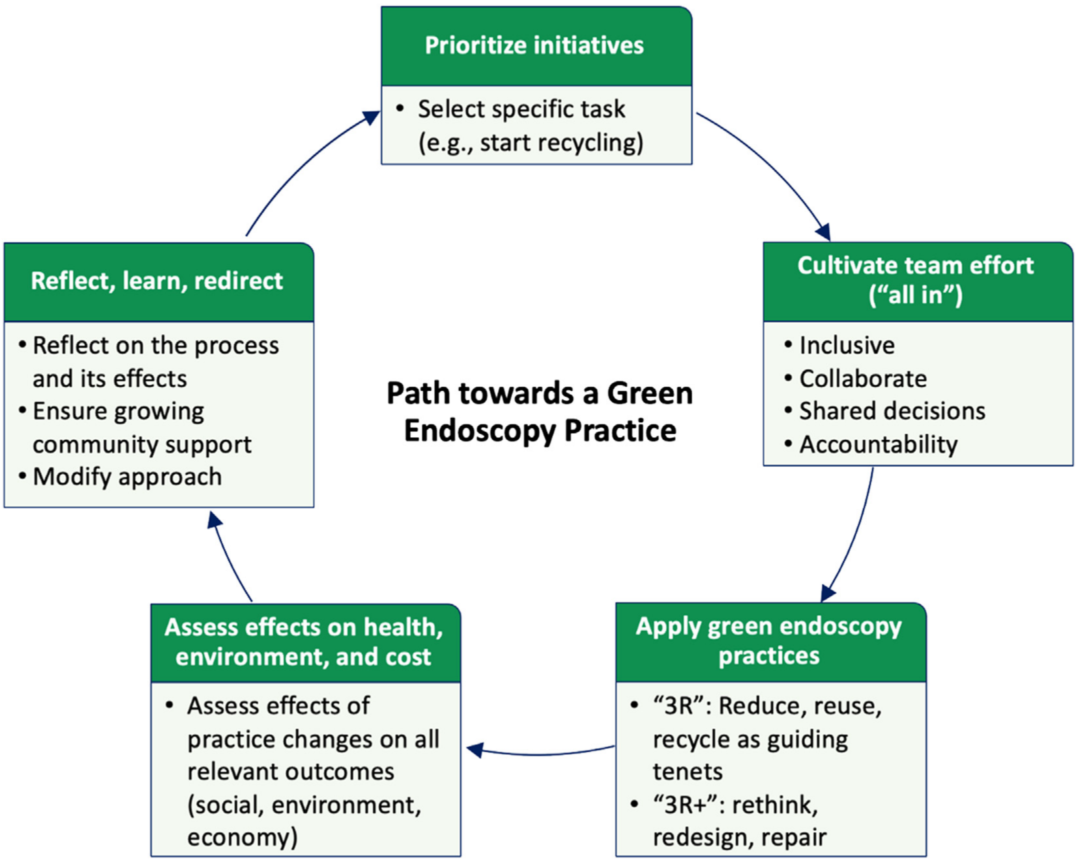

Figure 3. A path toward a green endoscopy practice that rests on team effort, collaboration, and community support to gauge outcomes, adapt the approach, and redirect the course as needed.

reducing auxiliary instrumentations, both providing obvious economic savings. *Quadrant 2* includes the greatest value projects that will take long-term collaboration with multiple stakeholders, including the medical device industry, endoscopy societies, and policymakers. *Quadrant 3* lists simple solutions that could bring incremental benefits if brought to scale. *Quadrant 4* contains initiatives that may require considerable local political capital in exchange for small environmental benefits.

Over the course of this series, we focus on the general concepts with which most are familiar: reduce, reuse, recycle. The environmental savings follow the same order—reducing is more effective than reusing, which is more effective than recycling. For instance, the most effective intervention is to not perform the procedure that does not need to be done. Reusing equipment minimizes environmental harms of manufacturing (scope 3 emissions), but reuse needs to be balanced against potential harms from reprocessing. Although recycling may be the most obvious and perhaps satisfying intervention to reduce waste, the environmental savings are less profound. Contrary to common knowledge on plastic waste disposal, only 12% is recycled and the rest is incinerated or ends up in landfills.[45] Indeed, finding practice alternatives may be cumbersome and require us to overcome old habits. Some examples of sustainable practices are outlined in Table 2.

The series will provide practical guidance to questions of pre-, intra-, and postprocedure care. How can we minimize unnecessary procedures or interventions? How can we optimize the use of our endoscopy tools, and could we use reusable instead of disposable equipment (eg, Savary dilators vs balloon dilators)? How can we cut down on waste and appropriately dispose to not only lessen the environmental impact but also to reduce cost? What can we do to reduce environmental harms of reprocessing? What situations would favor digital documentation or virtual communication? Where available, the suggested steps will be supported by data, realizing that data in this field are still sparse. For transparency, we will point out such limitations and attempt to provide supporting arguments for suggested changes. We will also point to potential challenges of practical implementation with recommendations on how to overcome those.

Taking deliberate steps to reduce GHG emissions and waste

Recognizing practices that are amenable to change along with data collection are essential to reducing waste and GHG emissions. The first paper in the series will therefore provide a guide on "how to get started." It will highlight how to build a team, how to approach a project, and how to implement it. At its core, reduce, reuse, and recycle are the guiding tenets of green practice changes. Implementation of any practice changes, however, cannot be successful without a continuous cycle of shared decision-making within the endoscopy

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

team and cultivating a culture of accountability that welcomes change and improvement. Assessing prospectively how changes affected not only the environment but also quality of care and economic cost will encourage support from colleagues, leadership, and community that is essential to scale further initiatives (Fig. 3).

On a broader level, suppliers should be increasingly incentivized to evaluate the environmental impacts of their products and consider environmental designs following principles of a circular economy.[27,46,47] Green product design and transparency on instruments' GHG emissions will allow local procurement teams to select supplies not only based on price and quality but also on their environmental impact, which in turn will further incentivize suppliers to design environmentally friendly supplies and support implementation of a green endoscopy practice.

FUTURE DIRECTIONS

The traditional focus on health outcomes alone is shifting toward value-based care that accounts for indirect costs to the environment and society. There is an inherent tension between the tenets of evidence-based medicine and environmental science, with the latter depending on mathematical modeling of numerous complex permutations that cannot be answered immediately in a conventional clinical trial or population-based study. Addressing the challenges of climate change by cutting GHG emissions and waste requires a lengthy time horizon. The upcoming series of articles on "Practical Steps to Green Your Endoscopy Unit" provides a practical framework with prioritization of initiatives that can be implemented now, based on quality of care and environmental sustainability. We also look forward to the growth of environmental outcomes research that will continue to reshape our practice. Finally, we hope there will be a collaborative effort among healthcare providers, medical device companies, and policymakers to move toward providing environmentally sustainable, economically viable, and effective high-quality endoscopy services.

DISCLOSURE

The following authors disclosed financial relationships: S. D. Crockett: Clinical trial agreements with Guardant, Exact Sciences, and Freenome. L. V. Hernandez: Stock options in Iterative Health and Liquiglide. H. Pohl: Research support from Steris and Cosmo; advisory board for InterVenn. All other authors disclosed no financial relationships.

REFERENCES

1. Pohl H, de Latour R, Reuben A, et al. GI multisociety strategic plan on environmental sustainability. Gastrointest Endosc 2022;96:881-6.e2.
2. 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.
3. Veitch A, Hacker M, Hayee B, et al. BSG strategy on climate change and sustainability 2021. Available at: https://www.bsg.org.uk/strategic-areas/climate-change-and-sustainability/. Accessed December 17, 2021.
4. Sebastian S, Dhar A, Baddeley R, et al. Green endoscopy: British Society of Gastroenterology (BSG), Joint Accreditation Group (JAG) and Centre for Sustainable Health (CSH) joint consensus on practical measures for environmental sustainability in endoscopy. Gut 2023;72:12-26.
5. Baddeley R, Aabakken L, Veitch A, et al. Green endoscopy: counting the carbon cost of our practice. Gastroenterology 2022;162:1556-60.
6. Siddhi S, Dhar A, Sebastian S. Best practices in environmental advocacy and research in endoscopy. Tech Innov Gastrointest Endosc 2021;23:376-84.
7. Siau K, Hayee BH, Gayam S. Endoscopy's current carbon footprint. Tech Innov Gastrointest Endosc 2021;23:344-52.
8. Maurice JB, Rochford A, Marshall S, et al. Green endoscopy: using quality improvement to develop sustainable practice. BMJ 2021;13:342-5.
9. Haddock R, Gopfert A, van Hove M, et al. The case for sustainable endoscopy as a professional priority. Tech Innov Gastrointest Endosc 2021;23:337-43.
10. Maurice JB, Siau K, Sebastian S, et al. Green endoscopy: a call for sustainability in the midst of COVID-19. Lancet Gastroenterol Hepatol 2020;5:636-8.
11. Gayam S. Environmental impact of endoscopy: "scope" of the problem. Am J Gastroenterol 2020;115:1931-2.
12. Romanello M, Di Napoli C, Drummond P, et al. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. Lancet 2022;400:1619-54.
13. Climate effects on health. 2021. Available at: https://www.cdc.gov/climateandhealth/effects/default.htm. Accessed April 3, 2022.
14. World Health Organization. Climate change and health. 2022. Available at: https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health. Accessed November 29, 2022.
15. Ebi KL, Hess JJ. Health risks due to climate change: inequity in causes and consequences: study examines health risks due to climate change. Health Affairs 2020;39:2056-62.
16. Setoguchi S, Leddin D, Metz G, et al. Climate change, health, and health care systems: a global perspective. Gastroenterology 2022;162:1549-55.
17. Salas RN, Solomon CG. The climate crisis—health and care delivery. N Engl J Med 2019;381:e13.
18. Leddin D, Macrae F. Climate change: implications for gastrointestinal health and disease. J Clin Gastroenterol 2020;54:393-7.
19. Vohra K, Vodonos A, Schwartz J, et al. Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: results from GEOS-Chem. Environ Res 2021;195:110754.
20. Reich A, Ulman A, Berkower C. Communities, climate change, and health equity: proceedings of a workshop—in brief. National Academies Press, 2022.
21. Steffen W, Richardson K, Rockstrom J, et al. Sustainability. Planetary boundaries: guiding human development on a changing planet. Science 2015;347:1259855.
22. WHO guidance for climate resilient and environmentally sustainable health care facilities. 2020. Available at: https://www.who.int/publications/i/item/9789240012226. Accessed April 3, 2020.
23. Eckelman MJ, Huang K, Lagasse R, et al. Health care pollution and public health damage in the united states: an update. Health Aff 2020;39:2071-9.
24. Karliner J, Slotterback S, Boyd R, et al. Health care's climate footprint. health care without harm. 2019. Available at: https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf. Accessed August 27, 2021.
25. Mol MPG, Zolnikov TR, Neves AC, et al. Healthcare waste generation in hospitals per continent: a systematic review. Environ Sci Pollut Res Int 2022;29:42466-75.
26. Siddiqua A, Hahladakis JN, Al-Attiya W. An overview of the environmental pollution and health effects associated with waste landfilling and open dumping. Environ Sci Pollut Res Int 2022;29:58514-36.
27. U.S. Department of Health and Human Services. HHS shares health sector emissions reduction and climate resilience announcements at COP27. 2022. Available at: https://www.hhs.gov/about/news/2022/11/

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

10/hhs-shares-health-sector-emissions-reduction-climate-resilience-announcements-at-cop27.html. Accessed December 4, 2022.
28. Federal sustainability plan. 2021. Available at: https://www.sustainability.gov/pdfs/federal-sustainability-plan.pdf. Accessed January 26, 2022.
29. 2021 Climate action plan. Available at: https://www.hhs.gov/sites/default/files/hhs-climate-action-plan-9-28-2021.pdf. Accessed December 8, 2021.
30. Fact Sheet: President Biden announces new initiatives at COP27 to strengthen U.S. leadership in tackling climate change. 2022. Available at: https://www.whitehouse.gov/briefing-room/statements-releases/2022/11/11/fact-sheet-president-biden-announces-new-initiatives-at-cop27-to-strengthen-u-s-leadership-in-tackling-climate-change/. Accessed January 7, 2023.
31. Hönisch B, Hemming NG, Archer D, et al. Atmospheric carbon dioxide concentration across the mid-pleistocene transition. Science 2009;324:1551-4.
32. Institute WR. Greenhouse gas protocol. 2022. Available at: https://www.wri.org/initiatives/greenhouse-gas-protocol. Accessed November 29, 2022.
33. Tennison I, Roschnik S, Ashby B, et al. Health care's response to climate change: a carbon footprint assessment of the NHS in England. Lancet Planet Health 2021;5:e84-92.
34. Brundtland GH, Khalid M. Our common future. Oxford, UK: Oxford University Press; 1987.
35. United Nations. Sustainability. 2022. Available at: https://www.un.org/en/academic-impact/sustainability. Accessed November 29, 2022.
36. Mortimer F, Isherwood J, Wilkinson A, et al. Sustainability in quality improvement: redefining value. Future Healthc J 2018;5:88-93.
37. Le NNT, Hernandez LV, Vakil N, et al. Environmental and health outcomes of single-use versus reusable duodenoscopes. Gastrointest Endosc 2022;96:1002-8.
38. Perisetti A, Desai M, Bourke MJ, et al. Production and possible reduction of greenhouse gases produced during GI endoscopy activity: a systematic review of available literature. Gut 2022;72:493-500.
39. Vaccari M, Tudor T, Perteghella A. Costs associated with the management of waste from healthcare facilities: an analysis at national and site level. Waste Manage Res 2018;36:39-47.
40. Namburar S, von Renteln D, Damianos J, et al. Estimating the environmental impact of disposable endoscopic equipment and endoscopes. Gut 2022;71:1326-31.
41. Shimpi RA, Spaete JP. Quality assurance in endoscopic infection control, disposable duodenoscopes, and the environmental impact of endoscopy. Tech Innov Gastrointest Endosc 2022;24:290-9.
42. Baddeley R, de Santiago ER, Maurice J, et al. Sustainability in gastrointestinal endoscopy. Lancet Gastroenterol Hepatol 2022;7:9-12.
43. Donnelly MC, Stableforth W, Krag A, et al. The negative bidirectional interaction between climate change and the prevalence and care of liver disease: a joint BSG, BASL, EASL, and AASLD commentary. Gastroenterology 2022;76:995-1000.
44. Leddin D, Omary MB, Veitch A, et al. Uniting the global gastroenterology community to meet the challenge of climate change and non-recyclable waste. Gastroenterology 2021;161:1354-60.
45. Hundertmark T, Mayer M, McNally C, et al. How plastics waste recycling could transform. 2018. Available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Chemicals/Our%20Insights/How%20plastics%20waste%20recycling%20could%20transform%20the%20chemical%20industry/How-plastics-waste-recycling-could-transform.pdf. Accessed November 29, 2022.
46. Delivering a "net zero" National Health Service. 2021. Available at: https://www.england.nhs.uk/greenernhs/publication/delivering-a-net-zero-national-health-service/. Accessed October 26, 2021.
47. MacNeill AJ, Hopf H, Khanuja A, et al. Transforming the medical device industry: road map to a circular economy. Health Aff 2020;39:2088-97.
48. Intergovernmental Panel on Climate Change. Glossary, annex I. 2018. Available at: https://www.ipcc.ch/sr15/chapter/glossary/. Accessed April 5, 2022.
49. Crippa M, Guizzardi D, Muntean M, et al. Fossil CO_2 emissions of all world countries—2020 report. Publications Office of the European Union, Luxembourg, 2020.
50. What is a circular economy? 2021. Available at: https://www.epa.gov/recyclingstrategy/what-circular-econome. Accessed April 5, 2022.
51. Intergovernmental Panel on Climate Change. Summary for policymakers. 2018. Available at: https://www.ipcc.ch/sr15/. Accessed December 8, 2021.
52. United Nations. Conference of Parties (COP). 2022. Available at: https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop?gclid=Cj0KCQiA-JacBhC0ARIsAIxybyPU6eRoFI2bJSlP5A9RdE9S8__CzjjvN8rJsWx2C3gcFbrAMzMzsMcaAjEbEALw_wcB. Accessed September 20, 2023.
53. This year, Earth Overshoot Day fell on July 28. 2022. Available at: https://www.overshootday.org/. Accessed November 29, 2022.
54. The Lancet Countdown on health and climate change. Available at: https://www.thelancet.com/countdown-health-climate. Accessed May 31, 2022.
55. Finkbeiner M. The international standards as the constitution of life cycle assessment: the ISO 14040 series and its offspring. Background and future prospects in life cycle assessment. Heidelberg: Springer Netherlands; 2014. p. 85-106.
56. Whitmee S, Haines A, Beyrer C, et al. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health. Lancet 2015;386:1973-2028.
57. Barna S, Maric F, Simons J, et al. Education for the Anthropocene: planetary health, sustainable health care, and the health workforce. Med Teach 2020;42:1091-6.
58. Sustainable economy. 2022. Available at: https://econation.one/sustainable-economy. Accessed April 5, 2022.
59. Ganatra S, Dani SS, Al-Kindi SG, et al. Health care and climate change: challenges and pathways to sustainable health care. Ann Intern Med 2022;175:1598-600.
60. The first carbon neutral health system in the U.S. 2020. Available at: https://about.kaiserpermanente.org/community-health/news/first-carbon-neutral-health-system-in-us. Accessed December 4, 2022.
61. IPCC Sixth assessment report. Available at: https://www.ipcc.ch/report/ar6/wg1/. Accessed September 20, 2023.

Abbreviations: CO_2e, carbon dioxide equivalents; GHG, greenhouse gas.

Copyright © 2023 by the American Society for Gastrointestinal Endoscopy
0016-5107/$36.00
https://doi.org/10.1016/j.gie.2023.07.031

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.

Current affiliations: Division of Gastroenterology and Hepatology, Oregon Health & Science University, Portland, Oregon, USA (1), Division of Gastroenterology, Duke University Medical Center, Durham, North Carolina, USA (2), Department of Gastroenterology, Penn Medicine Princeton Medical Center, Plainsboro, New Jersey, USA (3), GI Associates, Milwaukee, Wisconsin, USA (4), Division of Gastroenterology, Montreal University Hospital Center (CHUM) and Montreal University Hospital Research Center (CRCHUM), Montreal, Quebec, Canada (5), Division of Gastroenterology and Hepatology, Dell Medical School, University Texas at Austin, Austin, Texas, USA (6), Department of Gastroenterology, VA Medical Center, White River Junction, Vermont, USA (7), Department of Gastroenterology, VA Medical Center, White River Junction, Vermont; Dartmouth Hitchcock Medical Center, New Hampshire, USA (8).

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.

APPENDIX 1

Important sources of information related to the intersection of climate change and health care are as follows:

- World Gastroenterology Organization on Climate and Health.[14]
- United Nations on Sustainability.[35]
- *Lancet Countdown on health climate change* provides an annual update on the changing climate and the effects on health.[12,54]
- The Intergovernmental Panel on Climate Change, an intergovernmental body of the United Nations, conducts systematic reviews of all published literature and compiles the key findings in their regularly updated assessment reports.[61] In 2015, 196 countries signed the *Paris Agreement* and committed to pursuing efforts to limit the global temperature increase to 1.5°C compared with preindustrial levels. The agreement also called for a 50% reduction in greenhouse gas emissions by 2030 and to levels of the preindustrial age by 2050.[19,20]
- Within health care, numerous organizations and institutions have committed to a net zero path by 2050:
  - The UK National Health System is committed to reach a net zero status by 2045, which includes all scopes of emission, including the largest contributor of emissions, the supply chain (scope 3).[46]
  - Kaiser Permanente is the first healthcare system in the United States to achieve a carbon neutral status in 2020.[60] Carbon neutrality refers to their scope 1 and 2 emissions but not scope 3 emissions (supply chain). This achievement serves as a role model for other institutions. Refer to the glossary in Table 1 for differences between carbon neutrality and net zero carbon emissions.
  - The U.S. Department for Health and Human Services has committed to decarbonize the federal healthcare system by 2050.[27,29]
  - More than 100 healthcare institutions have committed to half their carbon emissions by 2030 and reach a net zero practice by 2050.[27]

Downloaded for AdminAigo AdminAigo (rcozzolongo@gmail.com) at Italian Hospital Gastroenterologists and Endoscopists Association from ClinicalKey.com by Elsevier on December 11, 2023. For personal use only. No other uses without permission. Copyright ©2023. Elsevier Inc. All rights reserved.