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Position Paper

Sustainability in gastroenterology and digestive endoscopy: Position Paper from the Italian association of hospital gastroenterologists and digestive endoscopists (AIGO)

Francesco Bortoluzzi[a,c,*], Andrea Sorge[b,*], Roberto Vassallo[c,d], Luigi Maria Montalbano[c,e], Fabio Monica[c,f], Sergio La Mura[g], Daniele Canova[c,h], Davide Checchin[a,c], Paolo Fedeli[c,i], Riccardo Marmo[c,j], Luca Elli[b,c,#], on behalf of the Italian association of hospital gastroenterologists and digestive endoscopists (AIGO)

[a] *Gastrointestinal Unit, Ospedale dell'Angelo, Venice, Italy*
[b] *Gastroenterology and Endoscopy Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy*
[c] *Quality Committee, Italian Association Hospital Gastroenterologists and Endoscopists (AIGO), Rome, Italy*
[d] *Gastroenterology and Endoscopy Unit, Buccheri la Ferla Hospital, Palermo, Italy*
[e] *Gastroenterology and Endoscopy Unit, Azienda Ospedaliera Ospedali Riuniti Villa Sofia Cervello, Palermo, Italy*
[f] *Gastroenterology and Digestive Endoscopy, Academic Hospital Cattinara, Trieste, Italy*
[g] *Contract Professor, Politecnico di Milano, Milan, Italy*
[h] *Gastroenterology and Endoscopy Unit, San Bortolo Hospital, Vicenza, Italy*
[i] *Gastroenterology and Endoscopy Unit, Santo Spirito Hospital, Rome, Italy*
[j] *Gastroenterology and Endoscopy Unit, PO Polla, ASL Salerno, Italy*

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ABSTRACT

Climate crisis is dramatically changing life on earth. Environmental sustainability and waste management are rapidly gaining centrality in quality improvement strategies of healthcare, especially in procedure-dominant fields such as gastroenterology and digestive endoscopy. Therefore, healthcare interventions and endoscopic procedures must be evaluated through the 'triple bottom line' of financial, social, and environmental impact. The purpose of the paper is to provide information on the carbon footprint of gastroenterology and digestive endoscopy and outline a set of measures that the sector can take to reduce the emission of greenhouse gases while improving patient outcomes. Scientific societies, hospital executives, single endoscopic units can structure health policies and investment to build a "green endoscopy". The AIGO study group reinforces the role of gastrointestinal endoscopy professionals as advocates of sustainability in digestive endoscopy. The "green endoscopy" can shape a more sustainable health service and lead to an equitable, climate-smart, and healthier future.

"As for the future, it is not a question of foreseeing it, but of making it possible."

Antoine de Saint Exupéry

1. Introduction

The rapid climate changes that are taking place, also known as "climate crisis," are affecting every single aspect of our world, from the economy to geopolitics and human health. Greenhouse gases (GHG) represent the critical connection between human activities and temperature increases due to their impact on energy retention in the atmosphere. The burning of fossil fuels and deforestation contribute in major part to GHG production and accumulation, which in turn lead to global warming, extreme weather events that threaten the survival of habitats and living beings. Carbon dioxide (CO_2) represents 85% of all GHG; other gases that contribute to cause the "greenhouse effect" are methane, nitrous oxide and fluorinated gases, often called CO_2 equivalents. The measure of the total amount of CO_2 equivalents released into the atmosphere as a result of the activities of an individual, a product, an institution or a service is termed "carbon footprint".

Global emissions need to reach net-zero by 2050 to maintain global temperature increases below 1.5°C above pre-industrial levels [1]. Rising temperatures due to global warming have a direct

Correspondening author at: Center for Prevention and Diagnosis of Celiac Disease-Gastroenterology and Endoscopy Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan 20122, Lombardia, Italy

E-mail address: luca.elli@policlinico.mi.it (L. Elli).

* Francesco Bortoluzzi and Andrea Sorge are co-first authors.

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Table 1
Main components of a hospital's carbon footprint [4].

Hospital carbon footprint
Electricity
Heating and cooling
Staff travel and products transportation
Equipment and supplies production and disposal

impact on health, causing a significantly increasing level of disease and deaths; they therefore have an impact on the efficacy of national healthcare systems, potentially pushing hospitals and health services to collapse.

Raising awareness about environmental issues and the need to keep the Earth's temperature stable led 197 countries to sign the Glasgow Climate Pact at the 2021 United Nations Climate Change Conference (COP26), with each country promising to reduce CO_2 emissions and strengthen the aims of their national decarbonisation plans.

In addition to transnational and government policy plans, individual citizens and organisations, such as healthcare systems, can also play a pivotal role in policy changes and social mobilisation to reduce CO2 emissions and global warming.

The mission of the healthcare sector is to enhance and protect human health and well-being. However, a healthcare intervention must be evaluated through the 'triple bottom line' of financial, social, and environmental impact to avoid the paradox of harming the health of humans, which we aim to protect [2]. The clinical benefit of a healthcare service/intervention has to be considered in a long-term scenario and weighed against economic implications, social impact on patients and their caregivers, and environmental costs in terms of carbon footprint. In fact, it is estimated that 4.4% of global GHG emissions is produced by healthcare systems (equivalent to the annual emissions from 514 coal-fired power plants) [3]. As an important contributor to climate change, the healthcare sector must take responsibility for its carbon footprint and radically reduce the impact of its activities, while maintaining high standards of care (Table 1).

2. Effects of the climate crisis in digestive diseases

Climate changes have important implications for digestive diseases and public health: a shift in epidemiology of gastrointestinal (GI) and liver diseases can be predicted due to their close connection with the environment [4]. For example, there is high geographical variation, in part attributable to environmental factors, in the incidence of inflammatory bowel disease (IBD) and colorectal cancer. Moreover, the climate crisis increases chronic and/or acute mental stress of populations, therefore fostering the onset and exacerbation of functional GI diseases, due to their connection with mental health [5]. Hampered access to medical assistance, uncontaminated water and food, alterations in humidity and temperature of endemic habitats, acute events like floods and storms are predicted to facilitate the spread of undernutrition and infections, such as diarrheal illnesses, in both developing and industrialised countries [6,7]. As a consequence, the climate crisis can increase the diffusion of viral liver diseases (mainly hepatitis A and E, but also B, C and Delta), hepatocellular carcinoma and metabolic liver disease due to the poor quality of the food consumed [8].

3. Contribution of digestive endoscopy to the climate crisis

Procedure-dominant fields, such as gastroenterology, and in particular, digestive endoscopy, by their intrinsic nature are bound to have a remarkable carbon footprint. In Italy, 45 endoscopic procedures per 1,000 persons are performed yearly, corresponding to a total of 2.6 million per year, which is comparable to the total amount of procedures carried out in England [9]. The exact assessment of the carbon footprint of a product, process, or service can be performed through a life cycle assessment (LCA), which calculates GHG emissions at all the stages of a product's life, from raw material extraction through processing, manufacturing, distribution, use and disposal. Albeit this complex and rigorous assessment has not yet been applied to evaluate the carbon footprint of digestive endoscopy, studies that estimate the entity of the problem are increasing. About 3.1 kilograms in waste are produced for each digestive endoscopy bed-day, making gastroenterology the third largest contributor to waste production in healthcare [10]. In a recent study, Namburar et al. estimated the environmental impact of a digestive endoscopy unit through the measurement of the volume and mass of trash in suites, pre-procedure and post-procedure areas [11]. In a high-volume endoscopic centre (13,000 procedures/year), the total waste generated during a 5-day routine was 546 kg, comprising direct landfill, biohazard and recycled waste. Conversely, in a low-volume centre (2,000 procedures/year), 73kg of total waste was generated during the same period. Considering the number of endoscopic procedures performed yearly in the USA (18 million), the authors estimated a production of disposable waste of 836,000 cubic meters per year, equivalent to covering approximately 117 soccer fields to a height of 1metre with trash. When also including the reprocessing of endoscopes in the analysis, the total waste volume would increase to 927,000 cubic meters. An emblematic difference between the two endoscopy units analysed emerged in the waste management process: while the high-volume hospital recycled approximately 29% of the total waste volume (16% of waste mass), no waste was recycled by the low-volume hospital. Regarding the main contributors to the current healthcare system's carbon footprint, surprisingly only 3% of hospital GHG emissions are due to waste, while the consumption of gas, electricity, heating and cooling are responsible for about 40% of total emissions [12]. Is estimated that the largest share of the healthcare system's emissions originates from the supply chain, while the direct delivery of care and personal travel are among the other main contributors [13].

Personal protective equipment (PPE) is an important contributor to the production of waste in hospitals. Since the start of the COVID-19 pandemic, the use of PPE has markedly increased in digestive endoscopy suites, leading accordingly to significant environmental implications [14]. In addition, ancillary disposable supplies used during endoscopic examinations are numerous, often disposable and made in plastic: their use generates approximately 2kg of waste per procedure [11].

Furthermore, digestive endoscopy generates relevant quantities of highly polluting elements, such as synthetic polymers (polyethylene, polyurethanes, Teflon®), nickel and titanium, which are components of stents [15,16].

3.1. Single-use endoscopes and consumables

In recent years, the primary focus of research in single-use endoscopes has been restricted to reducing infectious complications, principally linked to the contamination of duodenoscopes, and the economic costs of the devices. A recent meta-analysis reported a 15% contamination rate of reusable duodenoscopes from 13,100 samples analysed, albeit the clinical impact of contaminated endoscopes remains a matter of debate [17,18]. However, awareness of the environmental and social impact of disposable devices is increasing since their use has relevant implications [19]. To date, recyclable metal represents only a smaller part of the endoscope and, therefore, the main part of the device is incinerated, similar to other waste [20]. It is estimated that if all endoscopic retrograde cholangiopancreatographies (ERCP) and colonoscopies were per-

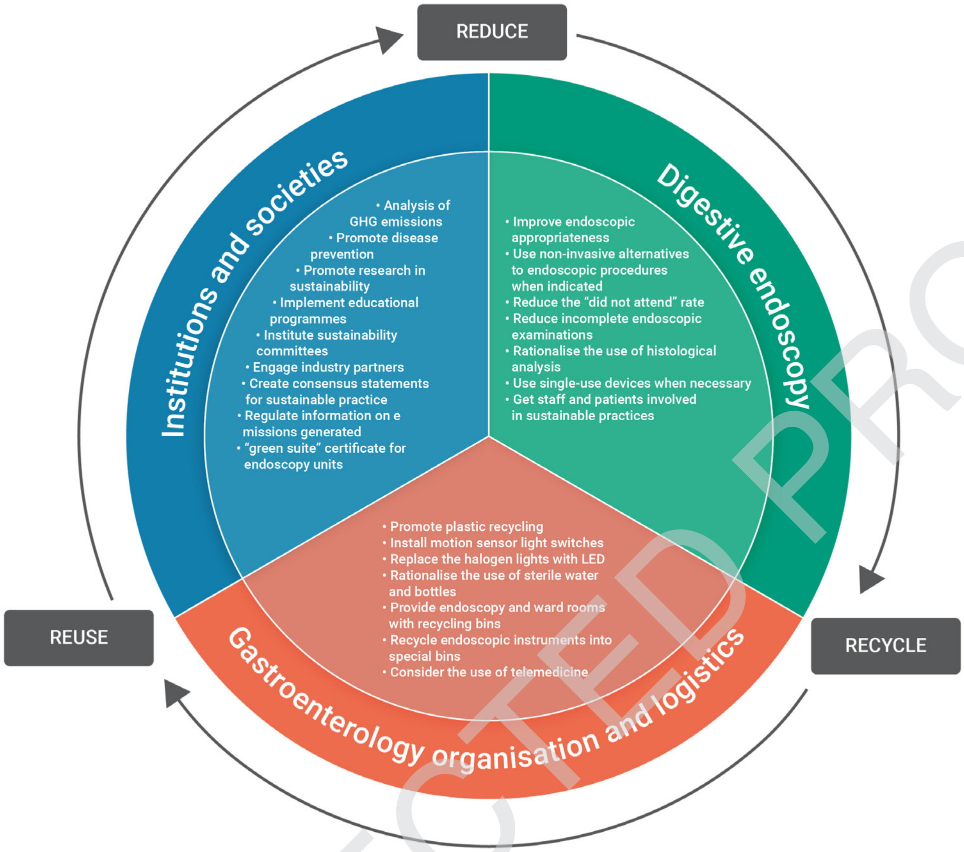

Fig. 1. Solutions to reduce the environmental impact of gastrointestinal endoscopy.

formed with disposable instead of reusable devices, the net waste mass per endoscopic procedure would increase by 25%, even if waste mass generated for reprocessing would decrease [11]. From a social standpoint, underprivileged and indigent communities and patients are more likely to bear the financial and environmental burdens of single-use endoscopes without enjoying the benefits of their use. In fact, the main part of endoscopic equipment is produced in low-income countries, where territories might be at risk of excessive exploitation and inequal or unhealthy work conditions due to the high demand of these products. Further, disposable devices are cost prohibitive for smaller hospitals with a low volume of procedures [20].

4. Carbon footprint reduction strategy in gastroenterology and digestive endoscopy

As gastroenterologists and healthcare providers in digestive health, we must consider our daily activities in a new light, give more consideration to issues of sustainability and work to create a "green endoscopy". Scientific societies, hospital executives and single endoscopic units can provide leadership to structure government and healthcare policy and practice. The general strategies for GHG emissions reduction can be summarised in the "3 Rs": "Reduce, Reuse, Recycle" [21]. These principles can be applied in endoscopy, with an approach oriented at all levels, from individuals to institutions (Fig. 1).

4.1. Role of institutions and scientific societies

At the institutional level, national governments should liaise closely with scientific societies advocating measures to achieve net-zero carbon emissions by 2050. Following the virtuous example of the National Institute for Health and Care Excellence (NICE), sustainability and resource stewardship should be placed at the heart of quality improvement strategies in healthcare [2]. What does it really mean to be sustainable today? According to the Royal College of Physicians, sustainability is defined today as the ability of a healthcare service to deliver healthcare over time, while considering future generations [22].

To make the healthcare sector more sustainable, institutions could adopt laws and allocate funds for eco-friendly projects, engage industry partners, implement educational programmes (articles, websites, webinars and meetings), develop analyses of GHG production of daily professional activities, and design strategies for minimising carbon footprints. Creating consensus statements for sustainable practice promotion and diagnostic and therapeutic care pathways (PDTA) will minimise the environmental impacts of hospitals, institutions and their supply chain [22].

For this purpose, the World Gastroenterology Organisation (WGO), representing the gastroenterological societies of 108 countries, has created the Working Group on Climate Change, with delegates from 18 different countries reviewing the scientific literature on climate changes and gastrointestinal health, encouraging educational models and promoting further research in the gastroenterological community [4]. The National institute of health (NHS) has recently created the "NHS Sustainability Board": a team that will work with staff, hospitals and partners to empower sustainable measures to reach net-zero carbon emissions. Taking the virtuous example of the NHS as a model, national and international societies should institute "sustainability committees" to coordinate and support "greener" actions across the entire healthcare system. Cooperating with other national committees, industries and patients' societies, the committees would assure the production of dedicated guidelines, information campaigns and monitor progress across all healthcare levels.

Governments should enact laws that regulate information on emissions generated from the industry. Best practices in the supply chain of hospital equipment can be enhanced to promote sustainability through their entire life cycle [23]. The carbon footprint of industrial products could be calculated though the life cycle assessment methodology and it should be indicated on labels and provided to key stakeholders favouring a conscious choice of instruments and supplies. Encouraging relations with health industries that adopt greener solutions (e.g., avoiding the print of scientific journals or high polluting, excess packaging for journals and devices) and rewarding the mitigation policies of companies that produce waste (e.g., reforestation, use of recyclable materials or recycled sources) represent other valuable efforts. Is important that governments and societies encourage industries to produce in countries where social equity and fair work conditions are guaranteed.

Today, endoscopy services should be evaluated by the scientific gastroenterological societies, institutions, and hospital administrations not only in terms of their efficiency (outcome for patient and population), but also in terms of their economic, social and environmental costs. Four "principles of sustainable clinical practice" were identified by the Campaign for Greener Healthcare with the aim of decreasing the need for healthcare interventions and the ecological footprint of necessary activities, while maintaining high standards of care [24]. These four sustainable principles are: disease prevention and health promotion, patient education and empowerment, lean systems and pathways and preferential use of technologies and interventions with lower environmental impact [22,24]. To embed sustainable principles into every day clinical practice, gastroenterological scientific societies should also create quality certificates for the accreditation of endoscopy services that also provide a "green suite" certificate, indicating the protocols and sustainability standards adopted. The "green suite" certificate would be easy to institute, inexpensive and would promote lower production levels and higher recycling levels of waste [10].

Another aspect to consider is the importance of prevention, which is the most effective measure to promote sustainability and health. Disease prevention is vital and must be promoted by institutions and single physicians because it reduces the incidence of diseases and mortality and, as a consequence, leads to an effective reduction of costs for national health services, to the reduction of the social impact of diseases for patients and families and the reduction of the environmental effects of medical care.

Scientific societies and pharmaceutical companies can also promote hybrid conferences and meetings, giving the possibility of attending sessions also in remote modality, as already successfully experienced during the COVID-19 pandemic.

4.2. Telemedicine

A relevant number of patients travel long distances to attend their exams and visits, especially at large referral centres. Telemedicine is, therefore, a formidable tool for reducing the environmental impact of medical care [25,26]. Telemedicine represents a useful tool for follow-up visits in subjects with chronic diseases, for second-opinion visits of patients that live far from a tertiary hospital, to send commented reports or to evaluate instrumental examinations and lab tests in patients who have already been visited [27]. An additional measure is to use electronic health records for prescriptions and the scheduling of endoscopic examinations, according to shared and verifiable criteria of appropriateness and priority. Electronic systems can also be used for tele-consultation (virtual consultation between physicians) and tele-cooperation (a remote collaboration between health professionals in order to perform a medical procedure) [27]. Similarly, the online availability of medical and histological reports and their virtual comment with the physician favours the reduction of both the risk of inappropriateness and the carbon footprint generated by the movement of people.

4.3. Role of gastroenterology and digestive endoscopy

Single endoscopy units play a crucial role in promoting sustainable practice in gastroenterology: they have a consistent buying power with industries and, improving their organisation and adherence to guidelines, can counteract the referral for inappropriate examinations, the incorrect disposal of waste and the poor awareness of the carbon footprint concept among colleagues, staff, and patients.

Inappropriateness involves about 52% of upper GI tract examinations and between 23% and 52% of colonoscopies [28]. International guidelines for improving endoscopic appropriateness and the "Choosing wisely" initiative should guide clinical practice on indications for surveillance and diagnostic endoscopy (Tables 2 and 3) [29,30]. Reducing the number of low-yield procedures is the single measure with the greatest impact on GHG emissions (Table 2, Table 3).

Interest is growing in non-invasive alternatives to endoscopic procedures and screening tools that enhance endoscopic diagnostic yield when invasive procedures are indicated. Faecal calprotectin is useful to avoid colonoscopy in IBD monitoring and in symptomatic patients with functional gastrointestinal diseases referred for suspected organic disease [31]. Faecal immunochemical test (FIT) is useful in colorectal cancer screening to reduce the number of invasive and expensive procedures and indicated only for this purpose [32,33]. Concerning oesophageal diseases, Cytosponge, though not yet validated in clinical practice, has a lower environmental impact than upper endoscopy and is showing efficacy for prioritising invasive surveillance in non-dysplastic Barrett's disease [34,35].

Endoscopy units must reduce as much as possible their "did not attend" rates and incomplete endoscopic examinations, which therefore need to be reprogrammed. This goal can be achieved by improving communication with patients and the scheduling of appointment times, providing precise information on bowel preparation for colonoscopy and the management of antiplatelet and/or anticoagulant drugs.

Histological analysis is one of the components of the high "carbon footprint" of digestive endoscopy. Processing a biopsy involves about 11 steps. The contributors to GHG emissions are the production of supplies, which is the largest contributor; the production of chemicals and reagents; electrical energy consumption for the laboratory; staff travels; and waste management. Emissions from biopsy processing are estimated to be about 0.28 kg CO2 when 1 jar is used for multiple samples and 0.79 kg CO2 when 3 jars are used, one for each sample [36]. These GHG levels are equivalent to those produced driving a passenger car for 1.1 kilometres (0.28 kg CO2) and 3.2 kilometres (0.79 kg CO2), respectively. In this regard, adherence to guidelines on the adequate collection and handling of endoscopic tissue sampling allows for the reduction in the number of endoscopic procedures performed and unnecessary biopsies [37,38].

The use of advanced endoscopic imaging (e.g., traditional or virtual chromoendoscopy, magnification) improves mucosal visualisation and endoscopic diagnosis and, as a consequence, allows for the more accurate selection of the sites to sample. This is useful to identify lesions without developmental risk (e.g., small rectal hyperplastic polyps), which do not require resection, and diminutive ($\leq$ 5 mm) colorectal polyps which, under strictly controlled con-

Table 2
Measures to improve endoscopic appropriateness.

• Avoid the prescription of EGDS in young subjects (<45 years) in the absence of risk factors or alarm symptoms
• Avoid routine "second-look" endoscopy after previous EGDS performed for digestive haemorrhage
• Avoid EGDS for variceal screening and surveillance patients with cirrhosis and a very low risk of varices requiring treatment
• Avoid the prescription of screening colonoscopies in low-risk subjects or in subjects of advanced age and poor general health status
• Identify digestive findings that do not require endoscopic surveillance (Table 3)
• Use non-invasive tests when indicated in place of endoscopic examinations

Table 3
Digestive findings that do not require endoscopic surveillance.

Oesophagus	Inlet patches
	Los Angeles grade A or B erosive oesophagitis
	< 1 cm Barrett's oesophagus
Stomach	Intestinal metaplasia at a single location (i.e. antrum or corpus only) without additional risk factors
	Fundic gland polyps
	Antral pancreatic rests
Subepithelial lesions	Leiomyomas, lipomas
Duodenum	Duodenal peptic ulcer
Pancreas	Serous cystic neoplasms
Colon	Low-risk colorectal polyps

Adapted from Rodríguez-de-Santiago et al. [26].

ditions, can be removed without histological analysis ("resect-and-discard" technique) [39].

The environmental impact of disposable and reusable devices should be taken into consideration when planning an endoscopic procedure. Furthermore, when purchasing medical accessories, endoscopic instruments and washing machines, those with a lower carbon footprint (which should be therefore clearly indicated by the manufacturer on product labels) or those made with recyclable materials should be preferred.

4.4. Sustainable waste disposal and logistic

According to the World Health Organization (WHO), a safe, sustainable and affordable management of health-care waste should be guided by the 'waste hierarchy' (Fig. 2) [40]. The best sustainable waste management strategy will be therefore mainly based on the 3Rs (reduce, reuse and recycle). The most preferable approach, when feasible, consists in disease prevention and waste minimization. It is estimated that safe management strategies for medical waste disposal are lacking in most healthcare facilities worldwide [41,42]; the subsequent COVID-19 pandemic has, unfortunately, greatly increased the amount of medical waste which needs to be disposed of, significantly aggravating the problem [14]. In fact, it is estimated that the pandemic has led to a doubling of plastic used in healthcare, with short-term (impact on water and air quality) and long-term (nanoplastic production) consequences. Globally, around 3.4 billion disposable face masks are consumed per day and these are mostly made of plastic [43]. To counteract this surge in discarded waste, endoscopy examination rooms and gastroenterology wards should be equipped with different bins for the separate collection of rubbish (plastic, paper and glass); in addition, traceability and the correct separation of different kinds of waste by the hospital must be guaranteed to improve dynamic waste management strategies. Correct waste stream management is fundamental to empowering recycling, to reduce the amount of waste unnecessary incinerated or sent to landfill, and to help improve hospital sustainability and production of less harmful air and toxic chemicals.

Other measures to reduce the environmental impact of endoscopy and the amount of disposed waste could be:

- use of lower volume packaging for hospital supplies
- development of easy to disinfect and reusable PPE or PPE made with biodegradable or recyclable material
- investment in structured waste recycling systems
- reduction of the impact of global transport through local production of PPE

4.5. Reorganisation of hospital and endoscopic rooms

In endoscopic suites, the implementation of simple changes can rapidly make our examination rooms "greener" and reduce energy use:

Structural measures:

- replace halogen with LED lights and use soft lighting during endoscopic procedures
- increase renewable energy sources (e.g., solar or photovoltaic panels)
- install sensors for automatic switching on and off of the lights

Organisational measures:

- turn the lights off during extended breaks
- collect instruments (biopsy forceps, snares, and spray catheters) into special bins for both metals and hard plastics. Equip the breakroom with compost bins for food and organic waste.
- rationalise the use of water (sinks, taps, flushing systems with flow meters) and sterile bottles. It is estimated that 100 bottles per day are used in an endoscopy unit, are all these bottles really necessary? The use of reusable bottles and filtration systems would reduce the use of unnecessary sterile plastic bottles, especially for intraprocedural water supply in nonsterile procedures like colonscopy [44]. Evidence from clinical trials has demonstrated the safety of tap water, compared with sterile water, during endoscopy [45,46]. The use of reusable water bottles and filtered tap water instead of sterile water in the irrigation bottle for colonoscopies would lead to considerable cost savings [47]. Hence, the current American Society for Gastrointestinal Endoscopy (ASGE) guidelines support the safety of tap water in the irrigation bottle and specifically recommend the use of sterile water when endoscopy is performed on subjects vulnerable to infections (e.g. immunocompromised patients) [48].

Fig. 2. The waste-management hierarchy.

5. Conclusions

The climate crisis is, perhaps, the biggest global health threat of the 21st century. Growing awareness about climate change and the carbon footprint of digestive endoscopy will help identify strategies to increase the sustainability of gastroenterology and endoscopy services across the world. Industries, scientific societies, national health services, single hospitals and health care providers should work together and take steps towards carbon neutrality. Sustainability should be now considered a central domain of quality in healthcare, extending the responsibility of health services to both the patients of today and those of the future. In summary, we are facing an enormous challenge, but the path leading to potential solutions is starting to be drawn.

Conflict of interest

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