



OPEN ACCESS

Assessment of the yearly carbon emission of a gastrointestinal endoscopy unit

Dorothea Henniger,¹ Max Windsheimer,² Hans Beck,³ Markus Brand,¹ Thomas Lux,¹ Alexander Hann ,¹ Alexander Meining ¹

¹Dept of Gastroenterology, Medical Clinic II, University Hospital Würzburg, Würzburg, Germany

²Intechnica Consult GmbH, Nuremberg, Germany

³Strategy Engineers GmbH & Co KG, Munich, Germany

Correspondence to

Professor Alexander Meining, Dept. of Gastroenterology, University of Würzburg, Würzburg, Germany; Meining_A@ukw.de

Received 24 March 2023

Accepted 1 May 2023

Published Online First

26 June 2023

MESSAGE

Despite 'green endoscopy' has meanwhile been regarded as a highly relevant topic, the scientific basis of ongoing discussions and various position statements is poor. We developed a tool for calculating the yearly emissions of a middle-sized gastrointestinal (GI) endoscopy unit in Germany (8000 procedures per year). Calculation was based on in-house energy consumption as well as emissions caused by production and transportation of consumables related to endoscopic procedures.

The total amount of emitted carbon dioxide equivalents in 2022 was 62.72 tons. Based on our data, a further reduction in emissions can be achieved primarily by reduction of the heating power and switching to alternative products for endoscopic accessories while avoiding long delivery routes by plane.

IN MORE DETAIL

Medicine significantly contributes to the emission of carbon dioxide, with GI endoscopy being one of the largest contributors.¹ Based on the Greenhouse Gas (GHG) Protocol, the carbon dioxide producing processes can be divided into three scopes²:

- ▶ Scope 1: Emissions that occur in places that are controlled by oneself.
- ▶ Scope 2: Emissions that arise during the production of the purchased energy.
- ▶ Scope 3: All indirect emissions that are not assigned to scope 2 (manufacturing, processing, packaging and transportation of purchased accessories).

For the present study, staff travel needs as well as capital goods such as endoscopes, processors, computers, washing machines were excluded from analyses (scope 3).

From 1 January 2022 to 31 December 2022, the following data were assessed for the endoscopy unit of the University Hospital of Würzburg, Germany: consumption of electrical power and gas used for heating (scopes 1 and 2); waste treatment of waste generated in the endoscopy unit as well as number of endoscopic instruments and protective materials (scope 3). For scope 3, we also aimed to acquire more information on delivery chains and materials used for manufacturing. Here, a detailed questionnaire was sent to 44 companies. In brief, companies were asked about the material composition of their products, the transport route, the delivery method (eg, aeroplane, ship), the products weight and the packaging dimensions. Further questions were composition of the packaging material (recycled

or recyclable), corporate carbon footprint of the company and/or respective products. Finally, the companies were able to mention implemented or planned carbon dioxide reduction interventions (eg, certificates).

To calculate the carbon footprint of the endoscopy in Würzburg, we used the following approaches for the different emission sources.

Regarding natural gas, we allocated the total consumption of the hospital to the endoscopy by comparing the areas of the hospital and the endoscopy (182 904 m² vs 224 m²). For electricity, the amount used by the endoscopy was determined by three electricity metres. In addition, we determined the amount of waste generated in the hospital by weighing the produced waste for several weeks and then extrapolating those values for the whole year.

Modelling the carbon footprint associated with consumables purchased by the endoscopy is more complex. We included emissions from resource extraction to the final product and its packaging, respectively. Also, we accounted for transportation from the manufacturing site to the endoscopy.

To calculate the footprint of those consumables, we identified 11 representative product categories and selected one reference product for each category. We weighed those reference products (including packaging) and analysed their material composition. Based on the product weight, material composition and the emission factors per type of material, we calculated the product carbon footprint of the reference products. In the same procedure, we calculated the packaging footprint of those reference products.

To account for the transportation from the manufacturing site to the endoscopy, we considered the three parameters product weight, transport distance and transport mode. Based on the feedback on the questionnaire, we concluded that about half of the products have been produced in Europe, while the remaining products have been manufactured in distant countries (America or Far East). For Europe, we estimated a transport distance of 1000 km and the transport mode truck. For goods produced in distant countries, we modelled a transport distance of 10 000 km and the transport modes ship (90%) and plane (10%).

By scaling the product carbon footprint of each reference product by weight, we calculated the footprints of other goods from the product categories considered. Given the number of products purchased, we could calculate the footprint associated with consumables in 2022. We used emission



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Henniger D, Windsheimer M, Beck H, et al. *Gut* 2023;**72**:1816–1818.

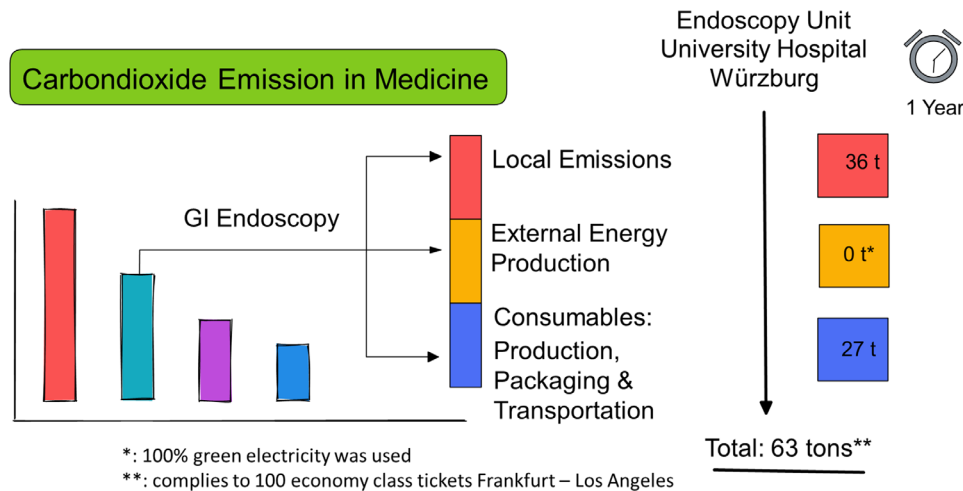


Figure 2 Graphical abstract. GI, gastrointestinal.

factors from the database EcoInvent 3.8 and the UK Government GHG Conversion Factors for Company Reporting (2022, V.2.0). A simplified product carbon footprints based on a cradle to gate approach was applied. Hence, those product carbon footprints are similar to an International Organization for Standardization (ISO) 14040 methodology.

Overall, our calculations resulted in a total yearly production of 62.72 tons of carbon dioxide equivalents. For scope 1, 35.91 tons were related to the consumption of natural gas used for heating. Electrical energy attributable to the unit was 46 622 kWh. Of note, 100% of electrical energy used by the University Hospital Würzburg came from regenerative sources (solar, water or wind energy). Hence, carbon dioxide emissions can be regarded 0.00% for scope 2. If the usual German electricity mix of sources for generating electricity was used, emissions would increase by 20 tons (32%).

For scope 3, the overall emission was 26.81 tons. A total of 14.15 tons were at the expense of the materials used in manufacture, 8.47 tons were attributed to the extraction, processing and transport of natural gas and electricity to the endoscopy unit, 0.89 tons to packaging, 2.75 tons to transportation, and 0.55 tons to handling the waste generated doing endoscopic procedures. Figure 1 shows the corporate carbon footprint of grouped items related to production, packaging and transportation of used items.

COMMENTS

So far, studies aimed to assess the yearly carbon dioxide emission caused by GI endoscopy have focused on waste production.³ However, carbon emissions from waste disposal are rather imprecise to calculate, since burning waste may also be used to

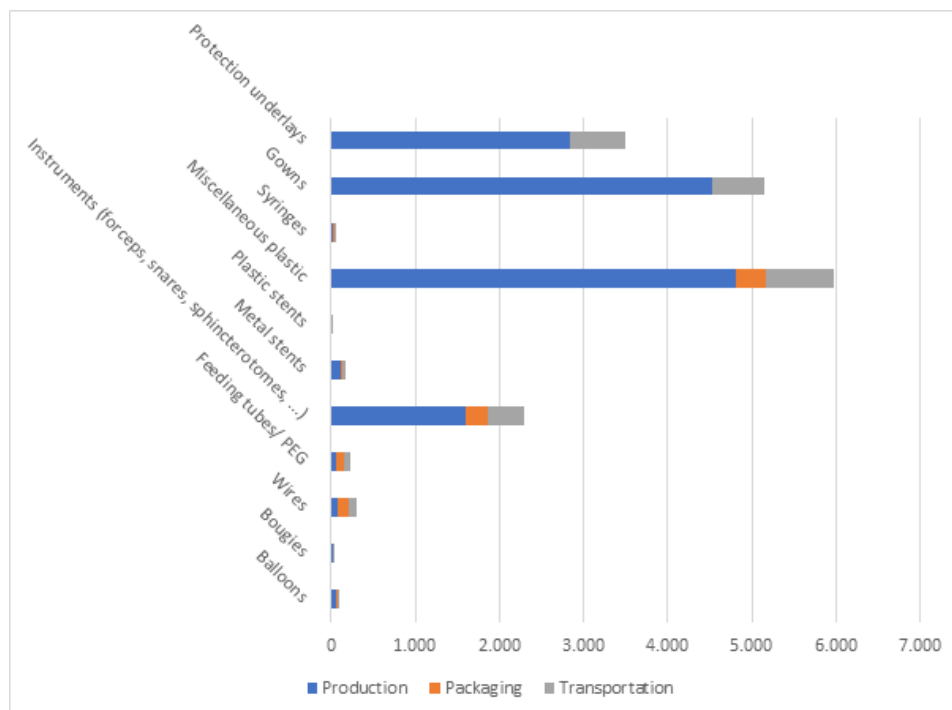


Figure 1 Carbon emission (in tons per year) of grouped accessories used for endoscopic procedures. PEG, percutaneous endoscopic gastrostomy.

generate energy, which in turn can be used at least partially for heating or electricity. In addition, it should also be considered that about one quarter of all waste is related to liquids in suction bags (own data not shown).

Here, for the first time, we were able to present a detailed analysis of various factors involved in the corporate carbon footprint of a middle-sized GI endoscopy unit (7500–8000 examinations per year). Furthermore, a tool was developed that gives a precise amount of carbon dioxide emissions related to scopes 1 and 2 (emissions that occur in the endoscopy unit) and scope 3 (emissions caused by instruments and tools applied during endoscopic procedures). To our surprise, the overall amount of emission in tons of carbon dioxide was rather low with 62.72 tons per year. This sum roughly corresponds to the average CO₂ consumption footprint of five German citizens per year⁴ or 100 persons flying economy class from Frankfurt to Los Angeles⁵ (figure 2). Reason for the difference compared with previous estimations may be the utilisation of different models for waste treatment/different system boundaries. In accordance to the GHG protocol,² we have cut-off the emissions for waste treatment as soon as the waste left the endoscopy (cut-off model). Prior data might have used a different standard for calculation.

For scopes 1 and 2, the greatest impact reducing carbon dioxide emissions is due to the fact that the University Hospital Würzburg consumes only green electricity. For scope 3, it should be noted that the fairly low amount of generated carbon dioxide equivalents is related to the low weight of endoscopic accessories (between 2 and 413 g). In addition, the overall proportion of materials (such as nitinol) that require a lot of energy during manufacturing is relatively small. Of interest, and as shown in figure 1, protection materials rather than endoscopic instruments account for a high amount of emission. Furthermore, it is also noteworthy that protection materials may not be recycled for hygienic issues.

Nevertheless, despite that the overall carbon dioxide emissions appear to be rather low, considering the global climate crisis, there is still room for further improvement. However, based on our data, advice on the corporate CO₂ footprint should be given depending on local situations. For scope 2, it is certainly advisable to check which type of electricity is used. If no green electricity was procured, emissions would increase by more than 30%. In addition, for countries with cold winters, reduction of the room temperature might be another reasonable approach (scope 1). For scope 3, it is worth mentioning that apart from reducing procedures and thereby lowering the number of consumed tools and devices, the length of delivery chains might have an impact as well. Based on our questionnaire, about half of all devices were produced in countries with a distance of more

than 5000 km and 10% of all goods were delivered by plane. Avoiding unnecessary emissions caused by transportation might have an impact of 7%–8% and should, therefore, be taken into account as well. Hence, from an ecological point of view instruments and devices produced in proximity should be preferred.

In summary, we were able to generate a tool that precisely calculates carbon dioxide emission of GI endoscopy units. Various parameters (type and weight of instruments, length of delivery chains, source of electricity, need for heating) can be individually assessed now. Based on our data as presented, a prospective study is currently performed at our institution to evaluate whether mentioned measures are indeed effective. Furthermore, to obtain robust data, we established a reliable and accurate calculator tool that may also be used by others, based on respective local situations. We are currently working on a user friendly web-based solution that may be used by others via our website once our prospective study is finished.

Contributors AM and DH planned the study. Data were analysed by DH, MB, TL, AH, AM, MW and HB. Writing and critically revising manuscript was done by all.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Alexander Hann <http://orcid.org/0000-0001-8035-3559>

Alexander Meining <http://orcid.org/0009-0001-3773-138X>

REFERENCES

- Rodríguez 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.
- Available: ghgprotocol.org/corporate-standard
- Nambur S, Damianos J, Renteln D. Estimating the environmental impact of disposable endoscopic equipment and Endoscopes. *Gut* 2023;72:407–8.
- Available: www.umweltbundesamt.de/themen/wirtschaft-konsum/konsum-umwelt-zentrale-handlungsfelder/klimaneutral-leben-verbraucher-starten-durch-beim-20-20textpart-2#bedarfsfelder
- Available: www.iata.org/en/services/statistics/intelligence/co2-connect/iata-co2-connect-passenger-calculator/