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The Environmental Impact of Gastrointestinal Procedures: A Prospective Study of Waste Generation, Energy Consumption, and Auditing in an Endoscopy Unit

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BACKGROUND & AIMS: Gastrointestinal (GI) endoscopy procedures are critical for screening, diagnosis, and treatment of a variety of GI disorders. However, like the procedures in other medical disciplines, they are a source of environmental waste generation and energy consumption. **METHODS:** We prospectively collected data on total waste generation, energy consumption, and the role of intraprocedural inventory audit of a single tertiary care academic endoscopy unit over a 2-month period (May–June 2022). Detailed data on items used were collected, including procedure type (esophagogastroduodenoscopy or colonoscopy), accessories, intravenous tubing, biopsy jars, linen, and personal protective equipment use. Data on endoscope reprocessing-related waste generation and energy use in the endoscopy unit (equipment, lights, and computers) were also collected. We used an endoscopy staff-guided auditing and review of the items used during procedures to determine potentially recyclable items going to landfill waste. The waste generated was stratified into biohazardous, nonbiohazardous, or potentially recyclable items. **RESULTS:** A total of 450 consecutive procedures were analyzed for total waste management (generation and reprocessing) and energy consumption. The total waste generated during the study period was 1398.6 kg (61.6% directly going to landfill, 33.3% biohazard waste, and 5.1% sharps), averaging 3.03 kg/procedure. The average waste directly going to landfill was 219 kg per 100 procedures. The estimated total annual waste generation approximated the size of 2 football fields (1-foot-high layered waste). Endoscope reprocessing generated 194 gallons of liquid waste per day, averaging 13.85 gallons per procedure. Total energy consumption in the endoscopy unit was 277.1 kW·h energy per day; for every 100 procedures, amounting to 1200 miles of distance traveled by an average fuel efficiency car. The estimated carbon footprint for every 100 GI procedures was 1501 kg carbon dioxide (CO_2) equivalent (= 1680 lbs of coal burned), which would require 1.8 acres of forests to sequester. The recyclable waste audit and review demonstrated that 20% of total waste consisted of potentially recyclable items (8.6 kg/d) that could be avoided by appropriate waste segregation of these items. **CONCLUSIONS:** On average, every 100 GI endoscopy procedures (esophagogastroduodenoscopy/colonoscopy) are associated with 303 kg of solid waste and 1385 gallons of liquid waste generation, and 1980 kW·h energy consumption. Potentially recyclable materials account for 20% of the total waste. These data could serve as an actionable model for health systems to reduce total waste generation and decrease landfill waste and water waste toward environmentally sustainable endoscopy units.

Keywords: Green Endoscopy; Greenhouse Gas Emissions; Carbon Footprint.

Global warming and climate change throughout the world remain a significant challenge with deleterious consequences.[1] Health care remains an important area of waste generation.[2] For example, the carbon footprint generated by health care in the United States (US) is 8.5% compared with 7% in Australia, 5% in Canada, and 3% in England.[3–5] The greenhouse gas (GHG) emissions from health care could be from waste production from use of environmentally unfriendly materials, energy consumption in reprocessing and waste disposal, and supply chain related (~71%).[6] Although, the amount of GHG emissions from nonrenewable sources is lower compared with the supply chain, these areas could be a target for actionable interventions.[6]

Gastrointestinal (GI) endoscopy units, which are an integral component of any tertiary health care facility by providing screening, diagnostic, and therapeutic services, could be a major waste-producing area in the hospital.[7] Current estimates of waste production in the endoscopy unit range from 0.5 to 2 kg of waste per procedure.[8–12] Examples of this waste include plastic suctioning apparatus, personal protective equipment (PPE), and single-use plastic tools.[13] Approximately 18 million endoscopic procedures are performed each year in the US, which translates to 9000 to 27,000 metric tons of waste produced by these procedures, most of which is nonrecyclable.[6] A recent report estimated that the annual carbon dioxide (CO_2) emissions from all endoscopic procedures in the US equated to nearly 4 million gallons of gasoline burned.[7,14] However, the quantities of waste produced, water used, and energy consumed by an endoscopy unit have not been prospectively evaluated.

Abbreviations used in this paper: **CO_2, carbon dioxide; CO2e, carbon equivalents; EGD, esophagogastroduodenoscopy; EPA, Environmental Protection Agency; GHG, greenhouse gas; GI, gastrointestinal; PPE, personal protective equipment; US, United States.**

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WHAT YOU NEED TO KNOW

BACKGROUND AND CONTEXT

The performance of gastrointestinal endoscopy procedures could be a potential contributor to greenhouse gas emissions and increase the carbon footprint.

NEW FINDINGS

We found that every 100 gastrointestinal endoscopy procedures were associated with 303 kg of solid waste and 1385 gallons of liquid waste generation, and 1980 kW·h energy consumption. Potentially recyclable materials accounted for 20% of the total waste generation.

LIMITATIONS

This was a single-center experience in an academic facility over a short period, and the carbon footprint of the entire life cycle of endoscopes was not estimated, probably underestimating the waste generation.

CLINICAL RESEARCH RELEVANCE

These findings could serve as a model for health systems to start measuring waste generation and energy consumption locally, implement changes to reduce total waste generation, and decrease landfill and water waste toward environmentally sustainable endoscopy units.

BASIC RESEARCH RELEVANCE

Our findings warrant further evaluation and efforts aimed at strategies for water-conserving cleaning methods for endoscopes, measures for saving energy, and environmentally friendly endoscopes, tools, and devices for use during gastrointestinal endoscopy.

We aimed to analyze the generation of solid and liquid waste and energy use practices in a tertiary care endoscopy unit. Furthermore, we assessed an endoscopy staff-guided recyclable waste audit and reviewed items used and discarded during each procedure to potentially identify areas of waste reduction.

Methods

Study Design

We prospectively assessed the waste management and energy consumption practices in a large academic Veterans Affairs-based endoscopy unit. The study was approved by the local Institutional Review Board and Ethics Committee (October 2021). Our objectives were to determine the total waste burden for commonly done GI procedures (esophagogastroduodenoscopy [EGD] and colonoscopy) and energy consumption for performance and cleaning. We also prepared an inventory of every item used during each case, waste produced for each procedure, waste segregation, and potentially recyclable items. The study did not involve any patient-related data collection or samples.

The study population included consecutive adult patients (aged ≥18 years) who underwent EGD or colonoscopy procedures for any indication during a 2-month period. Informed consent was obtained from each patient. We excluded patients who could not provide a written informed consent, required endoscopic ultrasound or endoscopic retrograde cholangiopancreatography, or who underwent endoscopy procedures outside the endoscopy unit location (eg, emergency department, operating room, and medical intensive care unit).

Data Collection

All general GI procedures performed in the endoscopy unit during the study period were included. We collected total waste generated, including the list of all devices, instruments, PPE, packaging and tubing for each case, including items that were eventually used during the procedures. In addition, data were collected from each procedure to evaluate the energy consumed (endoscopy tower, electrocautery machine, monitors) and liquid waste generated related to reprocessing of endoscopes and instruments. Furthermore, the following items were noted in detail: indication of procedure, device used, type of endoscope, accessories, and instruments, PPE, disposable and reusable items (per their packaging), water bottles, CO_2, specimen containers, and needles and other sharps used. The packaging of all accessories and material used in the preprocedure or intraprocedure area was reviewed by the research coordinator to verify whether those items were recyclable. All information was recorded on a data collection sheet for each day.

Energy consumption for each day was determined with the help of the institution's central electrical team of engineers who assisted by providing the total energy use for the specific day (24-hour period) from meter readings for the endoscopy unit. Research coordinators weighed the trash cans, recycle bins, and all disposable material (ie, sharps container, etc) on a weighing scale calculating the waste produced for the day. The central endoscope reprocessing team (high-level disinfection) provided information for instrument reprocessing, including the amount of water used, giving total liquid waste generation. No patients' medical records or procedure-related details were accessed other than type of procedure. Figure 1 demonstrates the measurements of 3 types of waste information collected in this study: procedural waste (solids and other), scope reprocessing-related liquid waste, and energy consumption.

Recyclable Waste Audit and Review

The endoscopy staff used an auditing form (consisting of a list of tools and accessories with information on items to mark if they were opened, used, and discarded) to record the use of particular item/tools for every GI procedure, such as biopsy forceps, snares, needles, medications, saline bags, electrocardiogram pads, and tubing for the procedure. This form also had information on whether each item was recyclable or not. Furthermore, the endoscopy staff verified the proportion of recyclable items used during the procedure but disposed as waste in the end to the landfill waste. Currently, all of the solid waste (if not biohazard and sharp) is disposed to landfill waste.

Outcomes and Data Analysis

The primary objective of the study was to calculate the waste generation (total and per day on individual categories) and energy consumption in prospectively conducted routine endoscopy procedures. We also stratified the total waste generated from EGD and colonoscopy per day to calculate average total waste per 100 procedures and annually. Waste was stratified according to biohazard, nonbiohazard, or recyclable status. We collected the total number of items and

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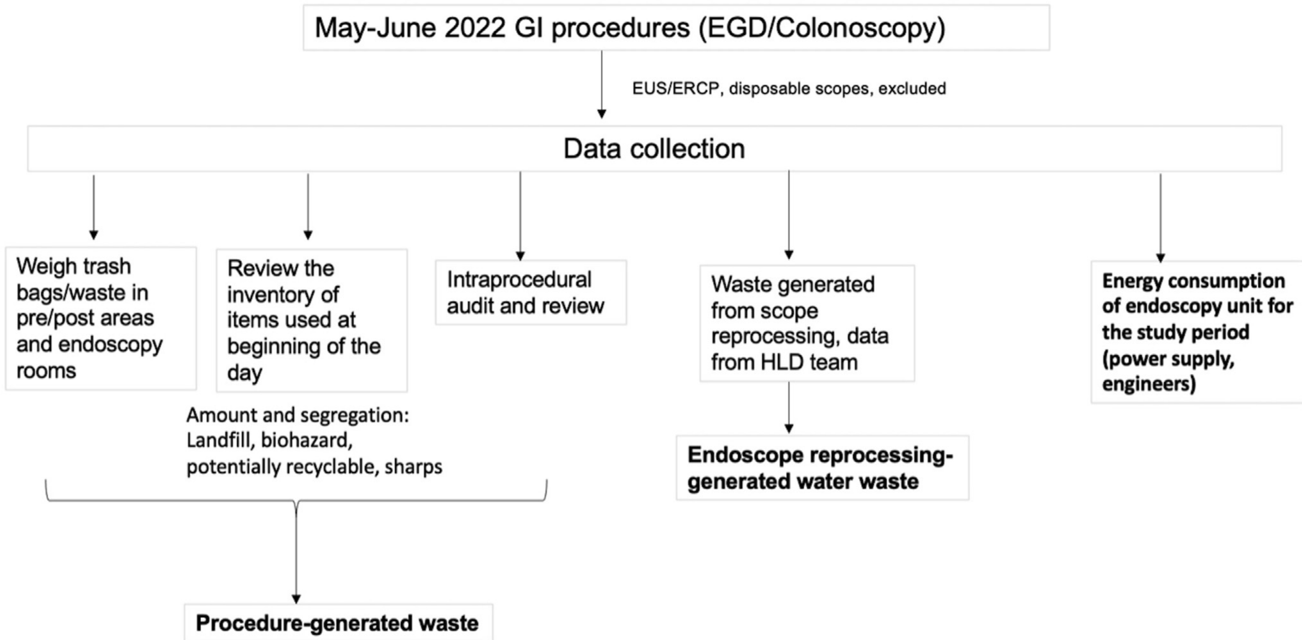

Figure 1. Study methodology detailing collection of different types of waste. HLD, high-level disinfection.

accessories used for each procedure separately and calculated potentially recyclable waste that could be minimized using an audit of the materials from the daily inventory. Finally, we calculated the energy use for each day from the available data and the reprocessing-related waste generation for each procedure to calculate the final total waste.

We calculated the total procedure-related waste, scope reprocessing-related liquid waste, and energy consumption in units of kilograms (solids), gallons (liquids), and kilowatts per hour (kW·h) as appropriate. We reported total waste generation for 100 procedures for generalization. Considering 1 gallon of gas equivalent to 33.7 kW·h energy, we examined how much distance can be traveled by an average fuel-efficient car (20–25 miles/gallon fuel efficiency). Using the US Environmental Protection Agency (EPA) data (https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references), we estimated the amount of carbon footprint from the amount of waste generated from this study. Based on EPA data, the carbon footprint for 1 kg of US landfill waste = 3.5 kg CO_2 equivalents (CO_2e) and 0.371 kg CO_2e per kW·h, which was used for the final conversion. We only calculated the carbon footprint associated with the production of total solid waste and energy consumption (excluding generation of the materials, including endoscopes and disposable of waste, because these were not measured). All collected data were entered from the paper case report forms into REDCap (Vanderbilt University) and Excel software (Microsoft Corp) for analysis.

Results

Waste Generation From the Endoscopy Unit

During the study period, 450 general GI procedures (EGDs and colonoscopies) were performed on 400 patients in our GI endoscopy suite and included in this prospective study. Total solid waste generated during study period was 1398.6 kg; of this, 1010.65 kg was direct landfill waste, followed by biohazard waste (336.34 kg) and sharps (51.57 kg) (Table 1). The average waste generation per day was as follows: waste going to landfill, 30.63 kg (~9189 kg/y), whereas sharps consisted of 1.56 kg (~468 kg/y), and biohazard waste was 10.19 kg (3057 kg/y). The average per procedure solid waste was 3.03 kg: directly going to landfill, 2.19 kg; biohazard, 0.73 kg; and sharps, 0.11 kg. Supplementary Table 1 lists the details of waste generation per day for each category. Average daily waste distribution in the endoscopy unit based on their disposal pattern and based on recyclable status (going to landfill) is shown in Figure 2.

Waste Generation From Endoscope Reprocessing

We obtained information on the liquid waste generation by endoscope cleaning and reprocessing. This generated

Table 1. Waste Production and Energy Consumption

Variable	Total	Per day	For 100 procedures
All waste, *kg*	1398.56	42.38	303
Direct landfill waste, *kg*	1010.65	30.62	219
Biohazard, *kg*	336.34	10.19	72.8
Sharps, *kg*	51.57	1.56	11.1
Recyclable items, *kg*	282.98	8.56	61
Scope reprocessing, *gallons*	6402	194	1385
Energy consumption, *kW·h*	9144.3	277.1	1980

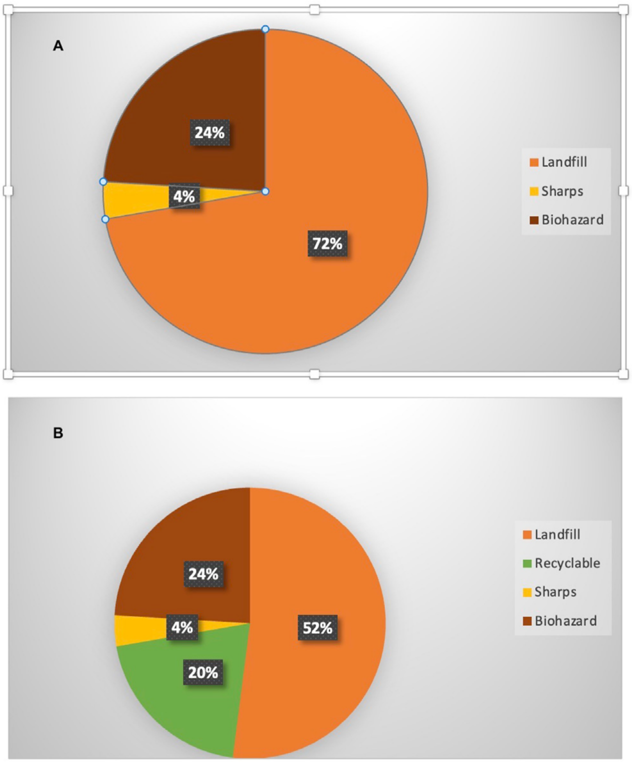

Figure 2. Average daily waste distribution in the endoscopy unit (*A*) based on their disposal pattern and (*B*) based on recyclable status (going to landfill)

194 gallons of liquid waste (in addition to solid waste from procedure itself), which was ∼735.26 kg of liquid waste per day from reprocessing of endoscopes. When the total waste generated from endoscopy (∼42 kg/d = 15,330 kg/y) and the waste produced from endoscope reprocessing (∼194 gallons or 735 kg/d = 268,275 kg/y) was calculated for an entire year, we found that it would require the size of 2 football fields with the waste layered 1 foot high (Figure 3).

Energy Consumption

On average, 277.1 kW·h energy was used in the endoscopy unit per day, which equaled ∼8.2 gallons of gasoline use per day. There was ∼1980 kW·h energy consumption per 100 procedures (∼58–60 gallons of gas). This energy consumption for 100 procedures amounts to 1200 miles of distance (eg, distance from Seattle, Washington, to San Diego, California) traveled by an average fuel-efficiency car (providing 20-25 miles per gallon fuel efficiency) (Figure 3). Two back-and-forth trips could have been made by an average fuel-efficiency car for the number of procedures evaluated during the study duration. The estimated amount of energy consumption for an entire year (101,105 kW·h) approximates the distance of 75,650 miles. This is circling the globe at the equator 3 times.

Carbon Footprint of Gastrointestinal Endoscopy

For 100 GI procedures, the estimated carbon footprint from landfill waste was 766.5 kg CO_2e and from energy

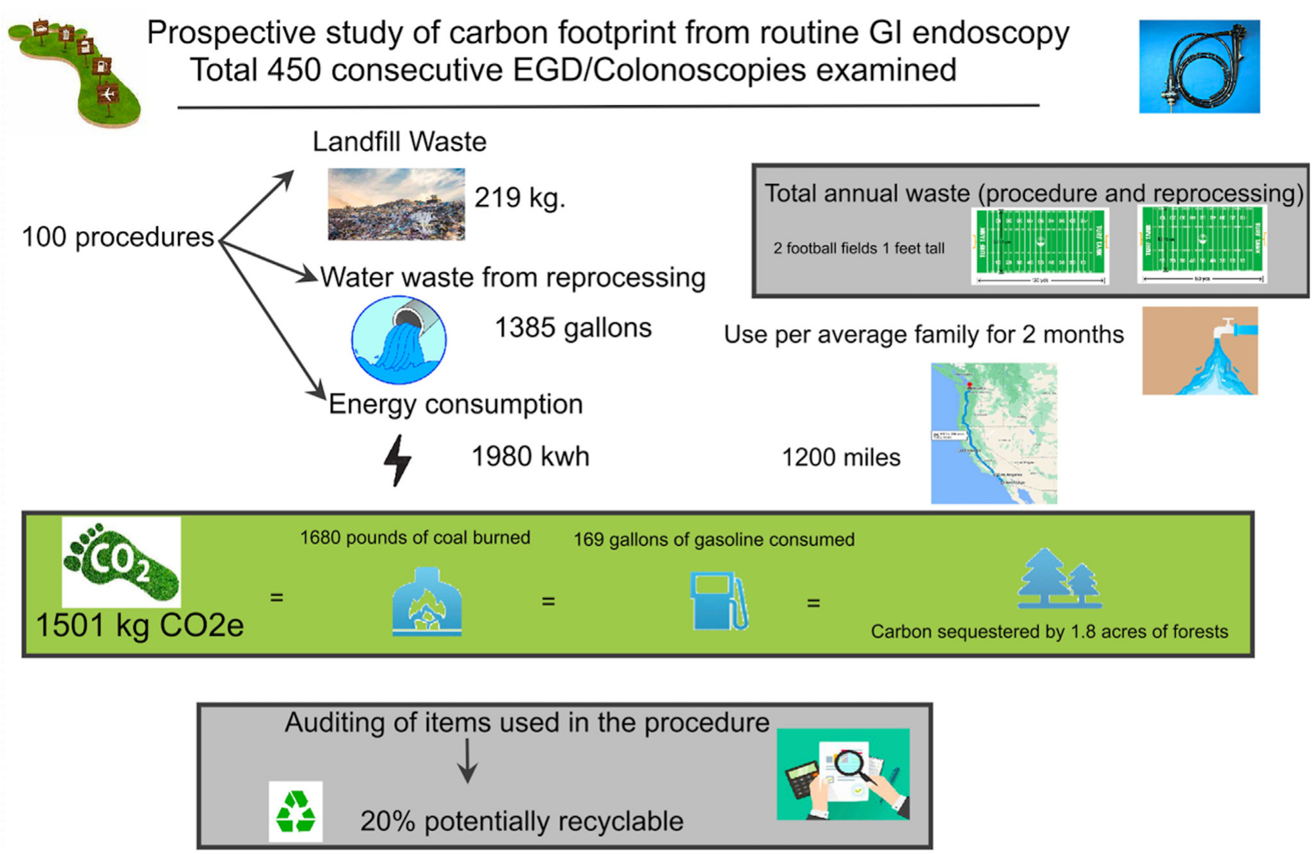

Figure 3. Carbon footprint from GI endoscopy.

consumption was 734.58kg CO_2e according to EPA estimates. Therefore, every 100 GI procedures produced 1501 kg CO_2e. This corresponds to 1680 pounds of coal burned, or 169 gallons of gasoline consumed, or 69 propane cylinders used for home barbeques (per EPA charts). This is equivalent to GHG emissions avoided by 0.5 tons of waste recycled instead of landfilled. Additionally, this is estimated to the carbon sequestered by 1.8 acres of forests in 1 year (Figure 3).

Recyclable Waste Review and Auditing

The audit process revealed that 282.98 kg of items/accessories were potentially recyclable (8.58 kg/d) (Table 1) based on product specifications per manufacturer—yet, were going to landfill as waste. These potentially recyclable items consisted of 20% of the total waste that could be reduced (Figure 2). Of the items in the inventory, 44% were listed as potentially recyclable; however, the intraprocedure audit revealed that only 28% of the items used in the procedure were recyclable. Supplementary Table 2 provides list of all items used in GI procedures during the study and whether they were recyclable or not according to the manufacturer's label.

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Discussion

In this prospective study from a tertiary academic endoscopy unit, we showed that routine GI endoscopy procedures are associated with a significant amount of solid waste generation, water use, and energy consumption. On average, every 100 GI endoscopy procedures (EGD or colonoscopy) are associated with 219 kg of landfill waste generation, 194 gallons of water waste, and 1980 kW·h energy consumption. An estimated 1500 kg CO_2e of carbon footprint from 100 routine GI procedures was generated that would require 1.8 acres of forest land to sequester. An intraprocedural review of items and audit showed that potentially recyclable materials account for 20% of the total waste that could be avoided by appropriate waste disposal. Therefore, a quality control measure that can be immediately incorporated at each endoscopy unit is to decrease solid waste going to landfills.

Although a substantial source of the carbon footprint is generated from materials, including the endoscopes themselves (more with disposable scopes), the procedures themselves are also an important source of waste generation and energy consumption. There are limited data on waste generation from GI endoscopy.[7,15–18]

A recent systematic review identified 9 articles discussing waste generation during endoscopy, of which only 3 were cross-sectional, whereas the remaining 6 were review articles.[6] Namburar et al[8] studied endoscopy-related waste generation from 2 academic medical centers (only a 5-day audit of GI endoscopy procedures) and concluded that each endoscopy procedure generated 2.1 kg of disposable waste. Our study findings are in line with Namburar et al,[8] with an average waste generation of 2.11 kg per procedure compared with 3.1 kg per procedure in our study. We obtained the data over a longer duration (study period of 2 months), evaluated energy use and liquid waste generated related to endoscope reprocessing, and conducted an intraprocedural audit, something not done in previously published studies.

Previous studies have also reported the GHG emissions related to GI biopsy samples and intraprocedural equipment use,[9,10] whereas our study demonstrated that waste produced not only during the procedure but also before (such as intravenous tubing) and after the endoscopy procedures and then reprocessing of the scope all contribute to GHG emissions.

Energy use remains a significant component of GHG emissions in GI endoscopy. Gayam et al[9] reported that the total energy consumption of a typical GI endoscopy unit with 40 procedures per day amounts to 101.5 kW·h per day. In our study, an average of 277.1 kW·h energy was used alone per day, which was almost 3-times higher than previously reported. Although the precise reason for this is unclear, it could be related to the number of electric equipment (television monitors, computer stations, lighting, heating and cooling), insulation of the endoscopy unit, age of the building, plug loads in the endoscopy unit, and other technical factors.[15] Furthermore, use of smart sensors (not available at our facility) could change the use of energy by automatic switching off during periods of nonuse.

In addition, we assessed energy consumption for the entire unit for the 24-hour periods during the assessment. This included preprocedure and postprocedure (recovery) areas, which could have played a role in higher energy consumption data found compared with prior data.[9] The amount and cost of this energy consumption could be minimized by eco-friendly alternatives, which require further study.

There is lack of evidence on the interventions to reduce GI endoscopy-related waste generation.[6,7] We examined a simple intraprocedural audit by the endoscopy nursing staff. We restricted the audit to the intraprocedural phase of the endoscopic procedure and found that 8.6 kg/d of waste related to endoscopic procedures was potentially recyclable. Because this was a single-center intervention, our results could have been affected by the practice and operations at this facility, and further confirmation is required. However, this could be an area of focus for all endoscopy units as a quality improvement project—record all items/accessories used per procedure and keep a log to examine the waste generation (ie, carbon footprint) and amount of potentially recyclable items used or wasted.

We found that 20% of items that were potentially recyclable were going to the landfill, thus increasing the total amount of waste. Prior studies have noted the use of check list to reduce the waste in primary care and assess for potentially recyclable substances,[16,17] so this is possible and can be implemented in the endoscopy units by accurate segregation of items at disposal during the case by endoscopy staff, installation of trash cans for recyclable items, and using items that are recyclable over nonrecyclable items from different manufacturers.

The manufacturer's label of whether the item is recyclable or not can guide the endoscopy staff before items are disposed to the landfill. Appropriate selection of suppliers with recyclable items or environmentally sustainable products is important. Endoscopy unit managers or dedicated personnel should review whether items are environmentally sustainable, recyclable, accompanied by excess plastic casing and materials that go to waste without any patient care use. The area that needs immediate attention, however, is to reduce water waste by finding alternate scope reprocessing methods. Using disposable scopes could increase landfill waste, and that itself requires further research.[8] Above all, one of the most important steps would be to follow GI society guidelines because there are multiple studies showing unnecessary GI endoscopies done for various reasons.[18–22]

Landfilling is a GHG-emission intensive waste management option emitting nearly 400 kg CO_2e per ton of waste.[23] With increasing waste generation from modern era humans and shortage of space and resources, this is expected to be a huge burden on the ecosystem. The results of our prospective data collection have significant implications given global warming and waste generation in health care. The annual waste generation from our endoscopy unit alone would require space the size of 2 football fields. Considering the shortage of landfill volumes, the annual waste volume of this size from a single endoscopy center is enormous and warrants urgent solutions.

Finally, endoscope cleaning and reprocessing generated enormous volume of liquid waste, almost 200 gallons/d. Most of this is clean water along with small quantities of detergent material per the manufacturer's instructions. At the current time, there is significant water shortage around the world, and several major US cities are facing draught conditions, and thus, there is an urgent need for cleaning solutions that conserve water. Solutions involve adopting water-efficient technologies, promoting water conservation among health care professionals, and optimizing water use protocols. Collaboration between endoscopy units and environmental experts can lead to innovative water-saving solutions while maintaining procedural effectiveness. Subsequent research should delve into these initiatives and their sustainability impact.

Our study has important limitations. Our study was conducted at a single Veterans Affairs-based academic center during later part of the coronavirus disease 2019 pandemic. The pandemic has led to all institutions developing multiple enhanced cleaning procedures with increased use of PPE and disposable products as a part of pandemic preparedness and response.[24] A trainee is involved for most of the procedures, with the potential use of additional equipment/PPE. We assessed the routine GI procedures (EGD/colonoscopy) performed in our endoscopy unit. The use of the equipment/accessories is heavily dependent on the indication and endoscopist, which could confound the findings. Advanced endoscopic procedures, such as endoscopic retrograde cholangiopancreatography, endoscopic ultrasound, balloon enteroscopy, and procedures performed outside the endoscopy unit (such as operating room, bedside procedures) were excluded from the study.[6]

Potential confounders of energy consumption of an endoscopy unit include outside temperature, insulation of the building, age of the construction, and circuit load, which could alter the findings and were beyond the scope of our study. Further, our unit lacked the use of smart motion sensor lights (halogen lights), which could change the energy use.[25] Most of the units in the US are not equipped with these sensors, which makes our findings more generalizable.

Our study did not include the impact of single-use disposable endoscopes. Prior studies reported that the use of single-use endoscopy could increase waste generation by almost 40%.[8] Additionally, we were not able to separate the items used before the procedure from total waste measured at the end of everything due to weighing the trash cans at the end of the procedures.

A major source of carbon footprint (ie, preparation of materials and scopes used for the case; supply chain–related GHG emissions from health care) was not examined, but our focus was on endoscopy-related waste generation as part of clinical care.

Finally, the reprocessing energy costs related to extra personnel, space requirements, and washer and dryer use were not assessed, which remains a limitation. Nevertheless, the use of EGDs and colonoscopies, which are the most common types of procedure performed in an endoscopy unit and hence the findings of our study, could be generalizable to average size unit, including ambulatory surgery centers.

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Conclusions

In this single, tertiary-care, academic endoscopy unit–based prospective study, for every 100 procedures, total solid waste of 303 kg and 1385 gallons of liquid waste were generated, and energy consumption was 1980 kW·h. We also determined that an intraprocedural audit of items identified 20% of items going to the total waste generation that were potentially recyclable. This inexpensive, simple initiative could eventually help reduce landfill waste. These data based on the endoscopy unit functioning, waste production, landfill waste, and energy consumption could provide ways to develop environmentally effective and sustainable ways to improve energy efficiency. Our study also points to an urgent need to find water-conserving strategies for endoscope cleaning and reprocessing in an effort to save water for the planet.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of *Gastroenterology* at www.gastrojournal.org, and at https://doi.org/10.1053/j.gastro.2023.12.006.

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Prateek Sharma, MD (Conceptualization: Equal; Data curation: Equal; Formal analysis: Equal; Investigation: Equal; Writing – original draft: Equal; Writing – review & editing: Equal)

Conflicts of interest
The authors disclose no conflicts.

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This was an investigator-initiated study, and there are no external funding sources to disclose.

Data Availability
Study data, analytic methods, and study materials will not be made available to other researchers.

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Supplementary Table 1. List of Waste Generation Per Day for Each Category

Day	Total patients	Trash		Sharps		Biohazard		Black bin	Yellow container
		(*lb*)	(*kg*)	(*lbs*)	(*kg*)	(*lbs*)	(*kg*)		
1	10	48	21.7724338	2.5	1.13398093	16.1	7.302837157	0	0
2	14	77	34.9266125	3.7	1.67829177	23.3	10.56870222	0	0
3	11	61.6	27.94129	3	1.36077711	23.1	10.47798375	0	0
4	15	81.4	36.9224189	5.2	2.35868032	24.5	11.11301307	0	0.1
5	8	34.5	15.6489368	1.6	0.72574779	20.5	9.298643585	0	0
6	12	66.6	30.2092518	3	1.36077711	19.5	8.845051215	0	0
7	12	78.5	35.607001	5.7	2.58547651	23.7	10.75013917	0	0
8	12	64	29.0299117	3.3	1.49685482	19.3	8.754332741	0	0
9	14	78.4	35.5616418	8.6	3.90089438	12.4	5.624545388	0	0
10	9	47.5	21.5456376	2.7	1.2246994	19.4	8.799691978	0	0
11	20	105.3	47.7632766	6.2	2.81227269	42.5	19.27767573	0	0
12	10	55.9	25.3558135	3.3	1.49685482	16.1	7.302837157	0	0
13	11	54.7	24.8115026	4.1	1.85972872	25.1	11.38516849	0.1	0
14	12	68.8	31.2071551	2.5	1.13398093	24.8	11.24909078	0	0
15	12	61.1	27.7144938	2.8	1.27005864	21.9	9.933672903	0	0
16	14	84.9	38.5099922	4.7	2.13188414	25	11.33980925	0	0
17	8	44.6	20.2302197	1.9	0.8618255	15.7	7.121400209	0	0
18	14	85.2	38.6460699	4.7	2.13188414	27.6	12.51914941	0	0
19	9	59	26.7619498	1.8	0.81646627	20.2	9.162565874	0	0
20	13	68.1	30.8896404	3.6	1.63293253	20.2	9.162565874	0	0
21	10	63.2	28.6670378	2.2	0.99790321	16.1	7.302837157	0	0
22	9	41.2	18.6880056	2.1	0.95254398	18.4	8.346099608	0	0
23	13	81.1	36.7863412	3.2	1.45149558	26.8	12.15627552	0	0
24	13	67.9	30.7989219	2.7	1.2246994	21.3	9.661517481	0.1	0
25	14	89.1	40.4150802	3.4	1.54221406	26.3	11.92947933	0	0
26	12	78.4	35.5616418	2.8	1.27005864	30.4	13.78920805	0	0
27	12	64.5	29.2567079	4.5	2.04116567	22.4	10.16046909	0	0
28	13	69.4	31.4793105	1.7	0.77110703	23.2	10.52334298	0	0
29	13	80.1	36.3327488	2.2	0.99790321	24	10.88621688	0	0
30	18	97.4	44.1798968	5.2	2.35868032	30.8	13.970645	0	0
31	10	35.5	16.1025291	2.5	1.13398093	17.6	7.983225712	0	0
32	16	106.6	48.3529466	4.5	2.04116567	30.5	13.83456729	0	0
33	7	28.6	12.9727418	1.8	0.81646627	12.8	5.805982336	0	0
Totals	400	2228.1	1010.64916	113.7	51.5734525	741.5	336.3387424	0.2	0.1
Daily average		67.52	30.63	3.45	1.57	22.47	10.2	0.006	0.003

Supplementary Table 2. List of Items Used During the Study Based on Recyclable Status

Item	Yes/no	No.
Intake		
Normal saline flush	No	388
Intravenous catheter	No	389
Intravenous start kit	No	394
CO_2 tubing	Yes	387
Adult electrodes	Yes	382
O_2 sensors	No	385
Blood pressure cuff	Yes	388
Intravenous tubing	No	386
1000-mL normal saline bag	Yes	384
Self-adherent wrap (Coban)	No	299
Plastic tape	No	118
Paper tape	No	2
Band aids	No	3
Marking pen	No	0
3-mL syringe	Yes	454
5-mL syringe	Yes	1
10-mL syringe	Yes	93
Filter needle	No	1
2 × 2 gauze	No	301
Alcohol pad	No	623
Ready care oral suction	Yes	3
Yanker suctions	Yes	11
O_2 connectors	Yes	16
Nasal cannula	Yes	14
Face tent mask	No	0
Adult O_2 mask	Yes	3
Adult aerosol mask	Yes	8
Nebulizer	No	10
Oral airway	No	1
Lubricating jelly	No	23
Nasopharyngeal airway	No	0
Drawer suction canister	No	1
Urinal	Yes	5
Bath wipes	Yes	3
3/4 Tegaderm	No	0
Emesis bag	No	11
Suction tubing	Yes	7
Washcloths	No	0
4 × 4 gauze	No	14
Plastic gown	Yes	21
Styrofoam cup	No	154
Paper cup	Yes	151
Straw	No	29
Gloves	No	2419
Gowns	No	1412
Eye shield with mask attached	Yes	59
Colored eye shield	Yes	52
Shoe covers	No	20
Chux pad	No	44
Gauze	No	353
Sani-Cloths	No	3850
Graduated cylinder	Yes	376
Sterile water (1000 mL)	Yes	375
Scope preclean kit	No	376
Bite blocks	Yes	121
Suction tips	Yes	71
Large forceps	Yes	129
Hot forceps	Yes	4
Teal cup with lid	Yes	26
Balloon dilation catheter	No	11
Big 60 inflation device	No	9
Hemostat	Yes	1
Endotracheal tube	No	1
Peds forcep	Yes	1
Jumbo forceps	Yes	130
Cook banding kit	No	2
Ovesco clip	Yes	1
Specimen jar	No	400
Air/water suction valve	Yes	377
ERBE biopsy valve	Yes	376
Single-use injector	No	7
Grasping forceps	Yes	0
360 clip	Yes	12
Instinct clip	Yes	2
Roth net	No	6
Single-use cleaning brush	No	5
Ligating device	Yes	0
Biovac	Yes	0

Supplementary Table 2. Continued

Item	Yes/no	No.
Polyp trap	Yes	105
Aquashield endo pump tubing	No	132
Snares	Yes	129
Gold probe	No	0
Olympus forceps	Yes	1
Suction tubing	Yes	398
Suction canister	No	391
ERBE flow 2	No	376
Syringe with blunt tip	No	376
PillCam	No	1
PillCam deployer	No	1
Grounding pad	No	12
Eleview	No	5
Pleurex placement tray	No	1
Pleurex removal tray	No	1
Wrist restraints	No	2
Oral suction	Yes	2
Pull peg kit	No	1
Cap	Yes	22
Hybrid argon plasma coagulation probe	No	1
Methylene blue	No	1
30-mL syringe	Yes	1
Achalasia balloon	No	2
Savary guidewire	Yes	1
Vizishot needles	No	4
Fine-needle aspirator	No	3
Tracheostomy suction	No	2
Nebulizer mask	No	1
Anesthesia circuit	No	49
LMA reg	No	22
LMA gastro	No	30
Intravenous pump syringe tubing	Yes	60
60-mL syringe	Yes	63
50-mL syringe	Yes	6
20-mL syringe	Yes	79
10-mL syringe	Yes	1
5-mL syringe	Yes	52
3-mL syringe	Yes	82
Alcohol pledget	No	53

Supplementary Table 2. Continued

Item	Yes/no	No.
Suction tubing/canister	Yes	18
Plastic tape	No	39
Procedural oxygen mask	No	18
O_2 cannula	No	3
Microtubing	No	3