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Impact of power consumption and power saving for GI endoscopy (power on study) on reducing CO_2 emissions

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Received 29 December 2023
Accepted 9 January 2024
Published Online First 23 January 2024

Check for updates

To cite: Fichtl A, Tacheva V, Sturm N, *et al*. *Gut* 2024;**73**:892–896.

MESSAGE

Endoscopy is among the top three contributors to CO_2 emissions in hospitals, with power consumption being a key factor that can be directly addressed. Our multicentre study measured power consumption during endoscopic procedures, offering easily implementable approaches for energy conservation (figure 1). Comparing a 30-day period with special energy-saving measures to a baseline period, we observed an annual reduction of CO_2 emissions by 58.11 kg, 73.79 kg and 71.17 kg in three endoscopic centres, respectively, each representing approximately 0.1% of the total CO_2 emissions of a middle-sized endoscopy unit per year. An additional survey among endoscopy staff confirmed that implementing these energy-saving measures did not impose any significant individual burden.

DETAIL

Rising greenhouse gas emissions drive climate change,[1] necessitating a more urgent environmentally conscious approach. Healthcare systems significantly impact climate change, with high-material-consumption areas like gastrointestinal (GI) endoscopy contributing the most to CO_2 emissions due to caseloads, patient travel, waste and decontamination processes.[2] Patient and staff transportation tops CO_2 emissions in endoscopy units, followed by equipment and electricity use.[3] The European societies of GI endoscopy aim to eliminate GI endoscopy emissions by 2050.[4] In pursuit of this goal, we conducted a study on electricity savings in three high-volume endoscopy centres.

We monitored daily power consumption in three examination rooms per centre over 30 working days, focusing on the endoscopy tower. Each centre selected three rooms for standard procedures (gastroscopies, colonoscopies and endoscopic ultrasound), excluding those with radiological diagnostics such as endoscopic retrograde cholangiopancreatography (ERCP). The endoscopy towers featured advanced video processors: EVIS EXERA III, EVIS X1 and EPK-i7010, using Olympus or Pentax Medical endoscopes. Each tower included monitors, data transfer monitors, CO_2 regulation units, water flushers, suction pumps and patient monitors. No additional electronic equipment was integrated into the analysis. Power monitoring was obtained by Standby-Energy-Monitor SEM 16+ (NZR, Germany), accuracy class 1 in accordance with IEC 1036.

The number of procedures and the power consumption per examination were documented daily for 30 days and for another 30 days under specific standardised power-saving measures, including turning off the endoscope light source during idle times and disconnecting the endoscopy tower from the power supply in the evenings. To ensure accuracy, the measured power consumption was compared with the manufacturer's calculated consumption, revealing no significant differences in both standby and running operation consumption. The total number of examinations during the baseline-saving versus power-saving phase did not significantly differ within the three centres (figure 2).

In the power-saving phase, the daily average was 19.70 (±1.73) examinations for Centre 1, resulting in significantly lower power consumption at 132.36 (±20.51) Wh per examination ($p<0.0001$).

For Centre 2, the mean power consumption decreased from 367.0 (±40.65) Wh in the baseline phase to 332.4 (±62.2) Wh in the power-saving phase ($p=0.0135$).

Centre 3 observed a non-significant reduction in mean power consumption per examination during the power-saving phase (353.8 (±93.66) vs 327.5 (±74.51) Wh, $p=0.2323$).

The mean power consumption per examination, mean number of examinations per day and CO_2 emissions per examination are summarised in table 1.

The annual potential CO_2 emission reduction was calculated using an emission factor based on the German electricity generation average[5]: 58.11 kg CO_2 for Centre 1, 73.79 kg CO_2 for Centre 2 and 71.17 kg CO_2 for Centre 3 (figure 3). Based on calculations, the total CO_2 emissions per year in a medium-sized endoscopy unit are approximately 62 720 kg,[6] so the savings from each of the three centres amount to about 0.1% of the expected total CO_2 emissions.

After the power-saving period, endoscopy staff completed a questionnaire with seven questions on power consumption in both private and endoscopy settings (figure 4). The Likert scale, with 5-point options for Centres 1 and 3 and 3-point options for Centre 2, gauged responses from 11 participants in

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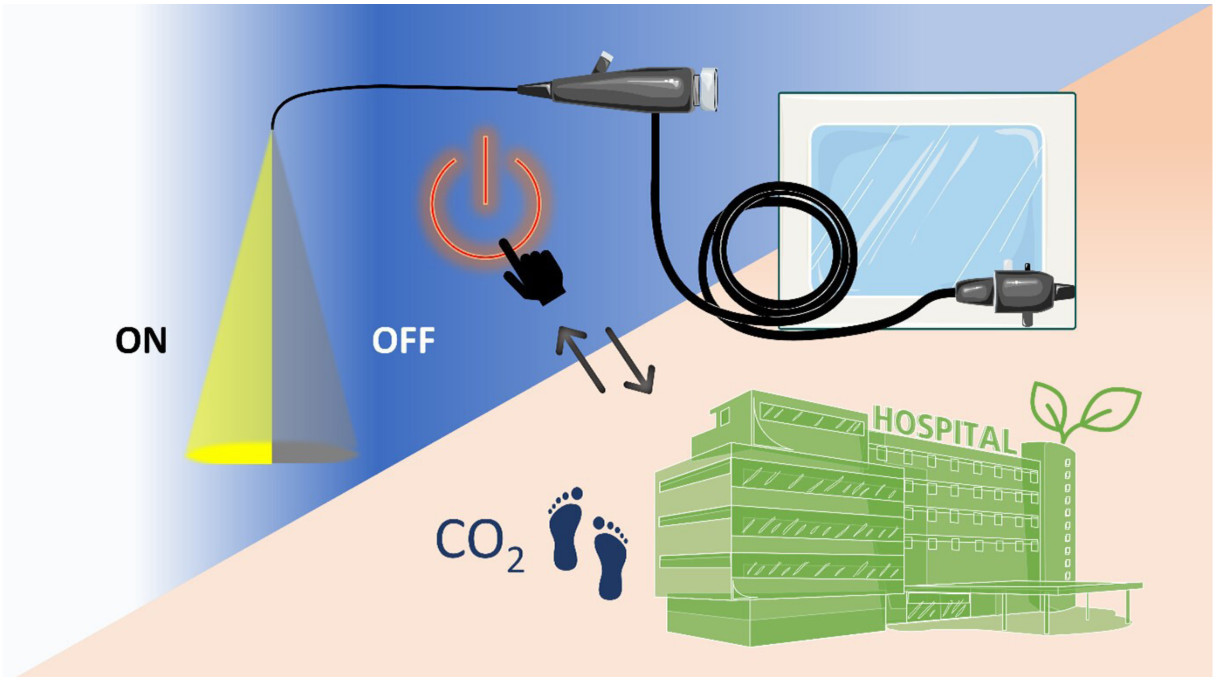

Figure 1 Summary of the study setting as a graphical abstract: in the context of a study conducted in three endoscopy centres, the impact of turning off the light source on the endoscope during waiting times and shutting down the endoscopy tower in the evening (top left image) on power consumption and annual CO_2 footprint is investigated. The results of this study contribute to a more environmentally friendly hospital (bottom right image).

Centre 1, 14 in Centre 2 and 25 in Centre 3. 92% of the participants reported that the additional effort for power savings did not burden them (figure 4H).

COMMENTS

An international position statement recommends steps towards 'green endoscopy'.[4] On this behalf, the medical industry has a duty to reduce waste and CO_2. However, in daily practice, the question arises about individual and endoscopy centre contributions to greener endoscopy development. This study is the first to explore power-saving options for endoscopy units, potentially contributing to a more active role in raising awareness and reducing CO_2 emissions.

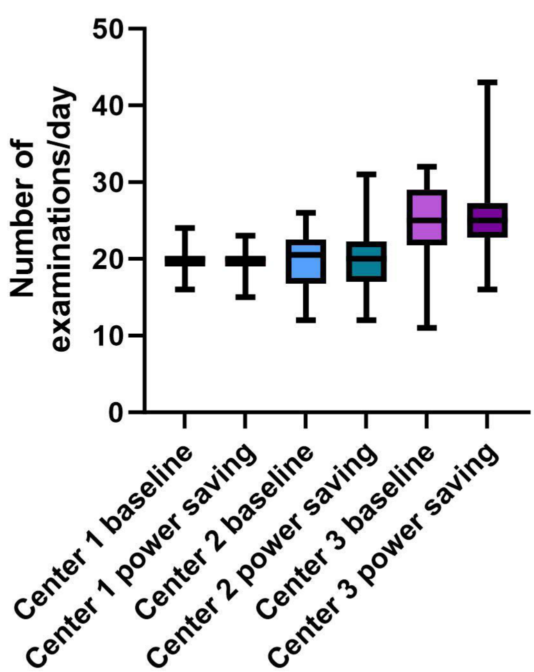

Figure 2 Number of examinations within a respective 30-day baseline and power-saving phase in three different high-volume endoscopy centres. Depicted as whisker box plots indicating mean, minimum to maximum and 25th–75th percentile.

In all three high-volume endoscopy units, power savings were achieved through simple measures. Although Centres 1 and 2 had similar numbers of daily examinations, Centre 1 used significantly less electricity both during the baseline and power-saving phase compared with Centre 2. This could be due to shorter examination times, the use of less electricity-intense video processors and possibly fewer electricity-intensive examinations like endoscopic ultrasound in Centre 1 compared with Centre 2. The type and duration of each examination were not systematically recorded during the 30-day phases within the scope of this study. The fact that the power savings per examination in Centres 2 and 3 were not significant may be due to the condition that in Centres 2 and 3 on some days, extraordinarily more examinations took place during the power-saving phase than during the baseline phase (figure 2). This likely resulted in shorter waiting times during the day and a later shutdown of the endoscopy tower on some days. Although the demonstrated reduction in annual CO_2 emissions by only 0.1% is not substantial for individual centres, the effect would be significantly more pronounced if all available endoscopy rooms per centre and all interventions such as ERCP were included and if more endoscopic units across the country were to participate in these straightforward energy-saving measures.

Opinions on power consumption in endoscopy, appropriate healthcare power use and individual knowledge varied significantly among centres in the survey (figure 4A,C,E), possibly influenced by in-house regulations, professional experiences and environmental attitudes. However, most participants demonstrated a high motivation for environmentally conscious and

Table 1 Mean power consumption per examination, mean number of examinations per day and mean CO_2 emission per examination of three high-volume endoscopy centres during a 30-day baseline phase compared with a 30-day power-saving phase. Based on the mean number of examinations per day, the annual potential for the reduction of CO_2 emissions was calculated.

Centre	1		2		3	
Phase	Baseline	Power saving	Baseline	Power saving	Baseline	Power saving
Mean power consumption per examination (Wh)	159.56	132.36	367.01	332.44	353.84	327.46
SD for power consumption	23.19	20.51	40.65	62.20	93.66	74.51
P value (unpaired t-test)	<0.0001		0.0135		0.2323	
Mean number of examinations per day	19.83	19.70	19.90	19.60	24.27	25.67
SD for examinations	1.78	1.73	3.95	4.11	5.78	5.75
P value (Mann-Whitney U test)	0.7652		0.6293		0.8053	
CO_2 emissions per examination (g)	69.25	57.44	159.28	144.28	153.57	142.12
Delta CO_2 (g)	−11.81		−15.01		−11.45	
Annual reduction of CO_2 emission (kg) based on mean number of examinations	−58.11		−73.79		−71.17	

economical behaviour, as evidenced by efforts to save electricity in both private and professional settings (figure 4B,F). Since the endoscopy staff in the present study mostly did not perceive individual additional burden from the power-saving measures (figure 4G,H), widespread implementation is likely considered unproblematic in other endoscopy units as well.

The present study has some limitations. First, the measured power consumption might be biased by the heterogeneity of electronic equipment used in the different endoscopy centres, thereby impairing direct comparability. Second, the overall power consumption is underestimated, as room light, air condition, additional electronic equipment (eg, high-frequency generator and washing machines) and examinations based on X-ray (like ERCP) were excluded from power measurement. Third, the participants' answers could have been influenced by the psychological aspect of social desirability.

To achieve a more environmentally friendly endoscopy, the following aspects besides the power-saving measures demonstrated in the present study should be considered:

1. Endoscopic equipment: currently, device manufacturers are more focused on developing innovative techniques (eg, light settings for adenoma detection). If, from now on, the power consumption of these devices was significantly taken into consideration in the purchasing decisions of all endoscopy centres, it would prompt the industry to develop energy-efficient alternatives.
2. Energy sources: questioning the source of electricity should be considered. The extrapolation of electricity consumption for a medium-sized endoscopy unit in Germany revealed that using 100% renewable energy sources, as opposed to the typical German energy mix, could achieve a 32% annual reduction in CO_2 emissions.[6]
3. Single-use consumables: wherever hygienically feasible, single-use items should be avoided to reduce the overall amount of waste.[7–9] However, further investigation is needed to determine whether the overall energy consumption for using single-use products is indeed higher since there is no need for cleaning or repair in comparison with multiuse equipment.[10]

In conclusion, electricity-saving measures such as turning off the endoscope light source during idle times and shutting down the endoscopy tower in the evenings are basic but easily implementable. Future studies are mandatory to analyse further strategies for CO_2 reduction. We advocate for the widespread

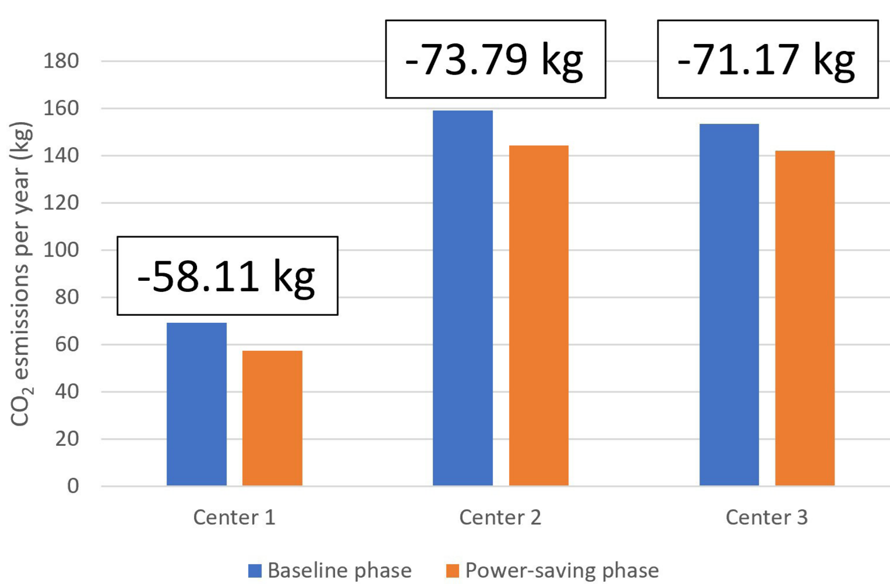

Figure 3 Potential annual CO_2 emission reductions in kilograms from three high-volume endoscopy centres using data from 30-day baseline and power-saving phases.

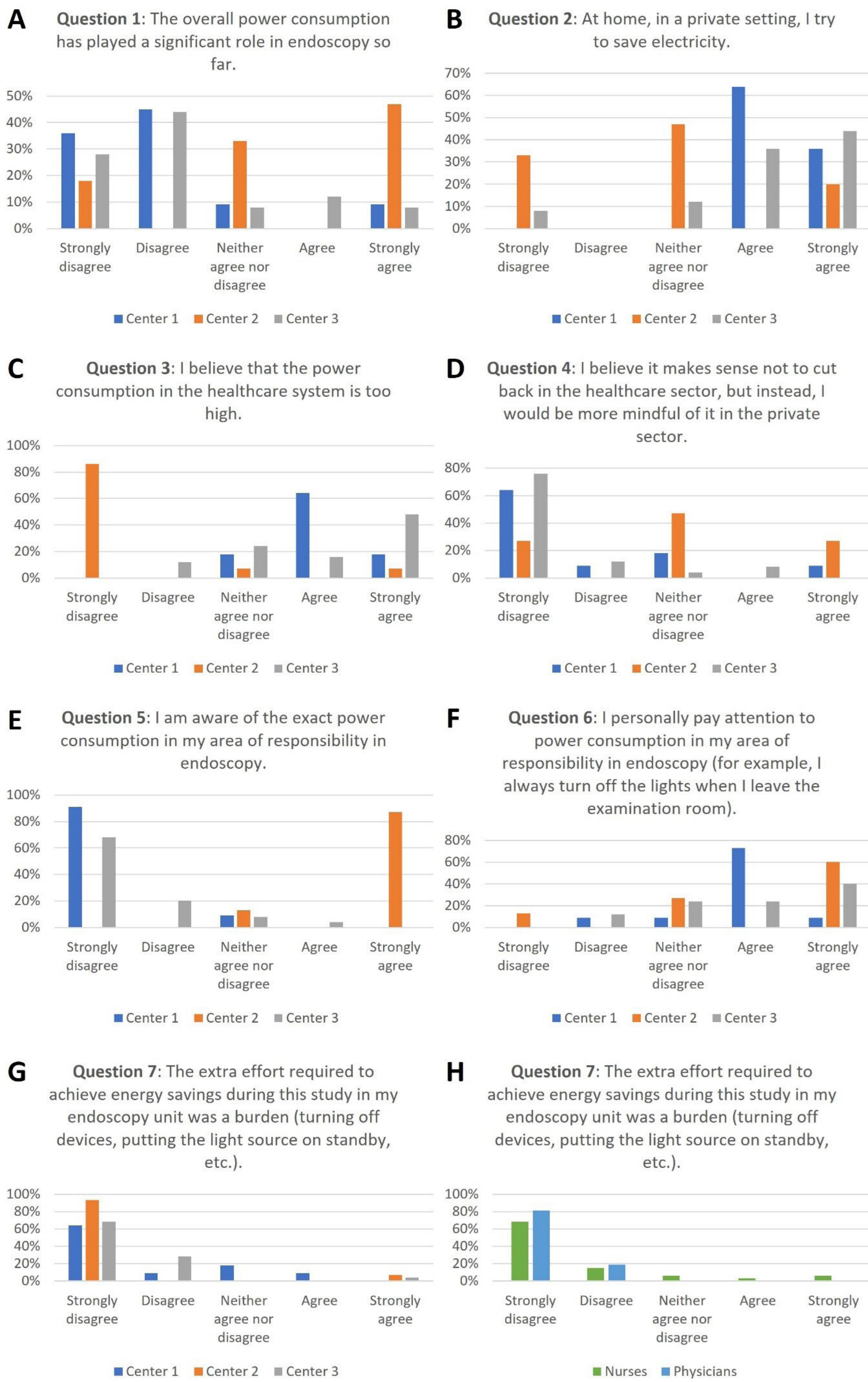

Figure 4 Results of an opinion survey among nursing and medical staff from three high-volume endoscopy centres regarding the importance of power consumption and power-saving measures in both personal and professional contexts (A–F), as well as specific to the power-saving measures in the current study (G–H). The chart title consists of the wording of the question, with the response options on the X-axis and the percentage of responses given on the Y-axis. The grey bars represent Centre 1, the orange bars represent Centre 2 and the dark-blue bars represent Centre 3 (A–F). The responses to question 7 are presented both for the three centres (G) and for the differentiation between nursing staff (green bars) and physicians (light-blue bars) (H).

adoption of these demonstrated measures as 'green' should not be only a label; it should become an attitude in endoscopy.

Acknowledgements The authors wish to thank the staff of the centres for their assistance in facilitating the data collection for this study. The graphical abstract was partly generated using Servier Medical Art, provided by Servier, licensed under a Creative Commons Attribution 3.0 unported license.

Contributors AF created the manuscript and the illustrations. VT consolidated the data generated from all three endoscopy centres in a comparative analysis. BMW conceptualised the study. AF, VT, MM, MW, KH, DW, NS, TS and BMW were involved in data acquisition and corrected the manuscript. BM provided support in the statistical part of the work.

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.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; internally peer reviewed.

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