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EDITOR'S CHOICE

Sustainable practice in gastroenterology: travel-related CO_2 emissions for gastroenterology clinic appointments in Canada

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Abstract

Background: Telemedicine is increasingly common in gastroenterology and may represent an opportunity for improving sustainability in medical care. The purpose of this study was to determine the carbon emissions related to travel for in-person gastroenterology clinic appointments.

Methods: We conducted a cross-sectional analysis evaluating carbon emissions associated with travel to gastroenterology appointments over a 2-week period. We determined the average number of appointments per day and used patient's postal codes to estimate travel distances. We estimated carbon emissions based on these travel distances and completed sensitivity analyses to model methods for emissions reductions.

Results: We assessed 975 clinic appointments, of which 71 were excluded (eg, insufficient data, non-physician appointments), leaving 904 included appointments of which 75% were follow-up (678) and the remainder were new consultations (226). Sixteen different gastroenterologists had an average of 22.7 patients per clinic. The mean return distance travelled per appointment was 57.3 km which translates to 14.9 kg CO_2 per patient visit. An average day at our clinic was equal to burning 146.6 L of gasoline or the annual carbon capture of 15.5 trees. By changing follow-up appointments or those with a travel distance over 100 km to telehealth, emissions were reduced by 77%.

Conclusions: We demonstrate that a relatively modest change in the number of in-person visits can save thousands of litres of gasoline emissions annually from each practicing clinician. While we cannot avoid emissions related to travel for procedure-based appointments, the use of telemedicine is one potential strategy to reduce healthcare-related emissions.

Key words: telemedicine; carbon emissions; sustainability in gastroenterology.

Introduction

There is increasing recognition of the environmental implications of routine gastroenterology practice and a collective effort underway to make improvements in this domain.[1] One potential way to reduce emissions is the reduction of travel to appointments replacing this with telemedicine, much like what was popularized during the coronavirus disease 2019 (COVID-19) pandemic. This shift offered access to care for geographically isolated patients, enhanced patient convenience, and changed the nature of patient-physician encounters. Within the field of gastroenterology, telemedicine has been shown to maintain quality care, alleviate financial burdens, and improve quality of life, as well as reduce healthcare costs.[2,3] However, one lesser-explored implication of telemedicine is its impact on the environment. The medical sector has increasingly been recognized as a significant contributor to greenhouse gas emissions, with Canadian estimates suggesting it accounts for 4.6% of annual national emissions.[4] These emissions stem from various sources, including energy consumption in healthcare facilities, transportation for patients and providers, and the production and disposal of medical equipment and pharmaceuticals.[5,6]

While there is growing recognition of medicine's role in global emissions, there is a paucity of research investigating strategies healthcare providers can adopt to minimize their environmental footprint. This knowledge gap is also present in gastroenterology, a specialty that utilizes resource-intensive procedures and generates significant medical waste.[7] With the conversion of in-person appointments during the COVID-19 pandemic there were significant carbon emissions reductions though this has not been studied specifically within the context of gastroenterology.[6] While many encounters within gastroenterology require in-person visits (eg, endoscopic procedures), clinic visits can be performed virtually.

As such, the purpose of this study was to attempt to quantify the potential carbon emission savings achievable by transitioning from in-person to video-based gastroenterology appointments, with a focus on the reduction in carbon emissions associated with patient travel to and from the clinic saving thousands of litres of gasoline emissions annually.

Materials and methods

Study design

We conducted a cross-sectional analysis evaluating carbon emissions associated with travel to and from gastroenterology appointments at our academic gastroenterology clinic in Hamilton, Ontario. We used a representative 2-week sample of all appointments with gastroenterologists and excluded patients with incomplete data or presenting for appointments with non-physicians. The criteria for choosing this time period were that it did not include any national or religious holidays and was not in the summer, such that the clinic was open for all business days. We determined the average number of appointments per clinic and used postal codes for patients confirmed at patient registration to estimate travel distances via Google Maps. We estimated carbon emissions based on these travel distances using our assumptions (see estimates and assumptions). We then converted these emissions estimates to common items to allow readers to accurately interpret the impact such as the number of litres of gasoline burned, or the number of trees required for an equivalent carbon capture in a year (21.77 kg CO_2 per year for a mature tree).[8] We completed further sensitivity analyses to determine the impact of converting only certain appointment types or percentages to video-based visits.

Inclusion and exclusion criteria for appointments

We included appointments with an attending gastroenterologist at the McMaster University Gastroenterology clinic over a 2-week period at the end of 2023 (exact dates excluded per request of the ethics review board to protect patient confidentiality). All patients were being seen by a specialist in adult gastroenterology and as such were expected to be 17 years of age or older. All subspecialties of gastroenterology were included such as hepatology, inflammatory bowel disease, nutrition, therapeutics, and general gastroenterology. We included both follow-up appointments and new consultations for the purpose of modelling strategies for emissions reductions and in consideration of the fact that some physicians may prefer to have at least one in-person encounter when they take on a patient's care.

We excluded patients who were missing key data such as a missing postal code. Appointments for carbon-14 breath tests, dietitian consultations, and clinics with fewer than 5 booked patients were excluded, as they represent atypical scenarios and do not reflect typical care by gastroenterologists. We excluded outliers with return travel distances of over 200 km (range 278-1436 km) because at that distance these emissions were less likely to be fully attributable to attending the appointment, and may have been from alternate means of travel (eg, airplane) requiring altered carbon emissions calculations and may have lead to overestimates.

Estimates and assumptions

We made several assumptions in making calculated estimates for associated carbon emissions related to travel for gastroenterology appointments. Firstly, we did not ascribe any emissions to telemedicine as prior studies have found the emissions comparatively negligible to emissions for in-person appointments (<0.01%-2.5%).[9] For the studies ascribing emissions to be as 2.5%, they included life-cycle assessments (the process of design, construction, and recycling of video-based technologies) or emissions related to travel to a clinic with video-conferencing technology as a bridge to the appointment.[10–13] We also did not include the emissions related to staff commuting to the clinic, both clinical and non-clinical or emissions associated with clinic maintenance such as heating or supplies.

We utilized Environmental Protection Agency (EPA) data indicating 400 g CO_2 per mile or 249 g CO_2 per kilometre travelled by car (average size).[14] We then factored in a 10% increase to account for non-tailpipe emissions and road life-cycle assessments.[15,16] We then applied a 5% reduction to account for 10% of Canadians predominantly using public transit and a small percentage of Canadians who currently use electric vehicles (3% of registrations in 2022) both of which are associated with lower direct emissions.[17,18] Our final emissions of CO_2 in kilograms per kilometre was 0.260. We assumed the emissions from video-based appointments to be 0 based on prior data suggesting emissions are approximately 0.03 kg per visit, which is less than 0.01% of the emissions from our average in-person visit.[9]

We calculated emissions based on the mean distance travelled to the clinic, accepting that this is above the median due to some outliers with significantly larger travel distances. We determined the average number of appointments per physician per day and then, assuming 2 clinic days per week and 30 weeks of outpatient clinic work per year, we derived an annual estimate per physician. We determined this would be a conservative estimate that would be highly variable by the clinician and practice environment.

Ethics

We used the first half of the patient's postal codes to maintain confidentiality and did not record names, illnesses, treatments, or other identifiable data. By using 3 digits of the postal code, we maintained accuracy and confidentiality. This study was approved upon formal review by the Hamilton Integrated Research Ethics Board at McMaster University (ID: 17286).

Statistics

We used Excel for data compilation and analysis. We completed multiple sensitivity analyses to determine emissions reductions including visit types, percentage of total visits, etc. We used standard conversions of CO_2 emissions equivalents for coal and gasoline as well as offsets that would be required in terms of carbon captured in a year by trees.[8,19,20] We present data in standard tables and figures.

Results

Appointments

Over the 2-week study period, there was a total of 975 appointments. Among these, 71 appointments were excluded, comprising reasons such as no postal code (n = 30), outlier distance (n = 3), short-list clinic appointments (3 clinics with a total of 10 appointments), 16 carbon-14 breath tests, and 12 dietitian appointments (Figure 1). The remaining 904 appointments were included with 680 (75.2%) categorized as follow-up appointments and 224 (24.8%) as new consultations. These were divided variably among 16 different gastroenterologists who had at least 1 day of clinic over this 2-week study period and an average of 22.7 appointments per physician per day.

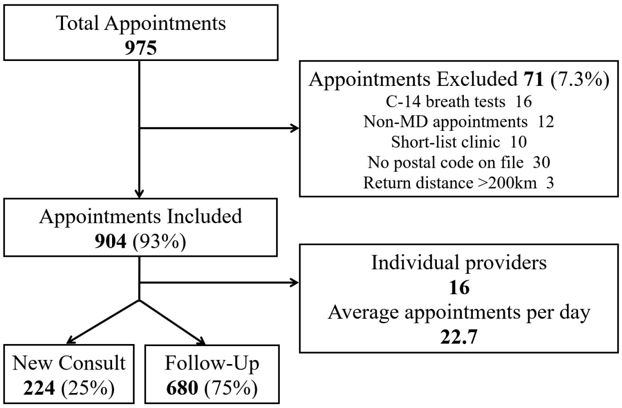

Figure 1. Flow diagram of appointment inclusion.

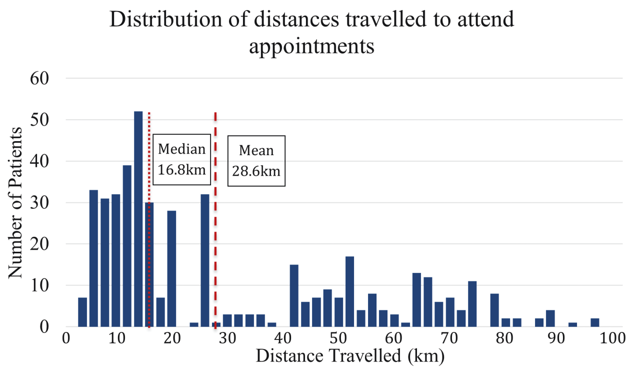

Figure 2. Distribution of one-way distances travelled to attend gastroenterology appointments over a 2-week period.

Distances travelled and emissions equivalents

The mean 1-way travel distance to the clinic was 28.6 km (median 16.8 km), with a total distance of 57.3 km (Figure 2). With an average of 22.7 appointments per day, this amounts to approximately 1299 km travelled by patients in total per clinic day. Over the course of a year, the total allotted travel per physician would be 77 954 km. Looking only at follow-up appointments the average distance travelled to the clinic is 29.1 km and 26.8 km for new consultations.

Per patient visit, the estimated emissions were 14.9 kg CO_2. At our institution with over 22 visits on an average day per physician, the travel-related emissions would be equivalent to the annual carbon capture of 15.5 trees or burning 146.6 L of gasoline or 107.5 kg of coal (Figure 3). Extrapolating to a yearly basis for one physician reveals a substantial increase in emissions to 20 239 kg CO_2, equivalent to burning 8800 L of gasoline, and 6.4 tons of coal or requiring 930 trees to offset the emissions.

Models for reduction of emissions

Figure 4 demonstrates various models by which travel distances and related emissions can be reduced, given that 100% conversion to telemedicine is not likely. Firstly, converting a random 25% of appointments to telemedicine results in 5060 kg CO_2 saved over a year or 232 trees. By converting only those with 1-way distances of over 50 km, which was 23.7% of appointments, the new mean travel distance was adjusted to 17.0 km, resulting in a total reduction of 77.4%. Similarly, if all follow-up appointments were converted to video-based platforms, we see a reduction of 77.1%. By using a blended model converting all follow-ups and all new consults if the return distance exceeded 100 km we found a reduction of 88.6%. These models correlate with impressive annual savings per physician.

Discussion

Models of emission reduction

In our study, we determined that the average in-person gastroenterology clinic appointment has an associated 14.9 kg production of CO_2 emissions. Over the course of an average clinic day at our institution, this is equivalent to using 107.5 kg of coal or 146.6 L of gasoline. Conversion of just 25% of clinic visits to telemedicine results in a reduction of CO_2 emissions by 5060 kg CO_2 emissions per year, a considerable impact equivalent to the amount offset by 232 trees. Alternatively, models such as those including the conversion of only follow-up appointments or those with higher travel distances (>100 km return) to telemedicine resulted in emissions reductions of over 75%. By combining these appointment conversion strategies, emissions savings could be as high as 88%.

Much of gastroenterology involves endoscopic procedures for which travel-related emissions are unavoidable thus we must seek alternate areas to reduce emissions in routine practice.[21] While the technology required for telemedicine still exists, policy changes and reverting to traditional practices may have prompted a transition back to predominantly in-person care. Since many physicians successfully converted a proportion of their clinical practice to video or telephone visits during the pandemic, telemedicine represents a feasible and relatively simple way for gastroenterology providers to reduce the environmental impact of their practice.

Estimations of the average emissions related to telemedicine appointments can be highly variable depending on what factors are included but are generally only <0.01%-2.5% of those equivalent appointments held in person.[10,11,13] The use of telemedicine by healthcare providers dramatically increased during the COVID-19 pandemic, constituting 50%-60% of healthcare visits.[22] This change was associated with a considerable reduction in CO_2 emissions—one study estimated that in the initial 22 months of the pandemic, telemedicine was associated with an avoidance of 545-658 million kilograms of CO_2 emissions in Ontario alone.[6] Indeed, the use of telemedicine in clinics has been shown to reduce carbon footprint in other medical and surgical specialties, such as nephrology and general surgery, and patient and provider satisfaction with telemedicine has proven favourable overall.[23–25] Our study similarly found that 1 year of clinic visits (ie, excluding appointments for endoscopy) to a single gastroenterology provider was associated with a distance of 78 000 km (equivalent to circling the Earth twice) and emissions of 20 239 kg of CO_2, an amount that would require 930 mature trees to offset. Given that there are approximately 800 practicing gastroenterologists in Canada alone, the impact of patient transportation to and from visits becomes considerable.[26] Since the infrastructure for the provision of telemedicine already exists within the field, conversion of a proportion of clinical visits to a video-based model therefore

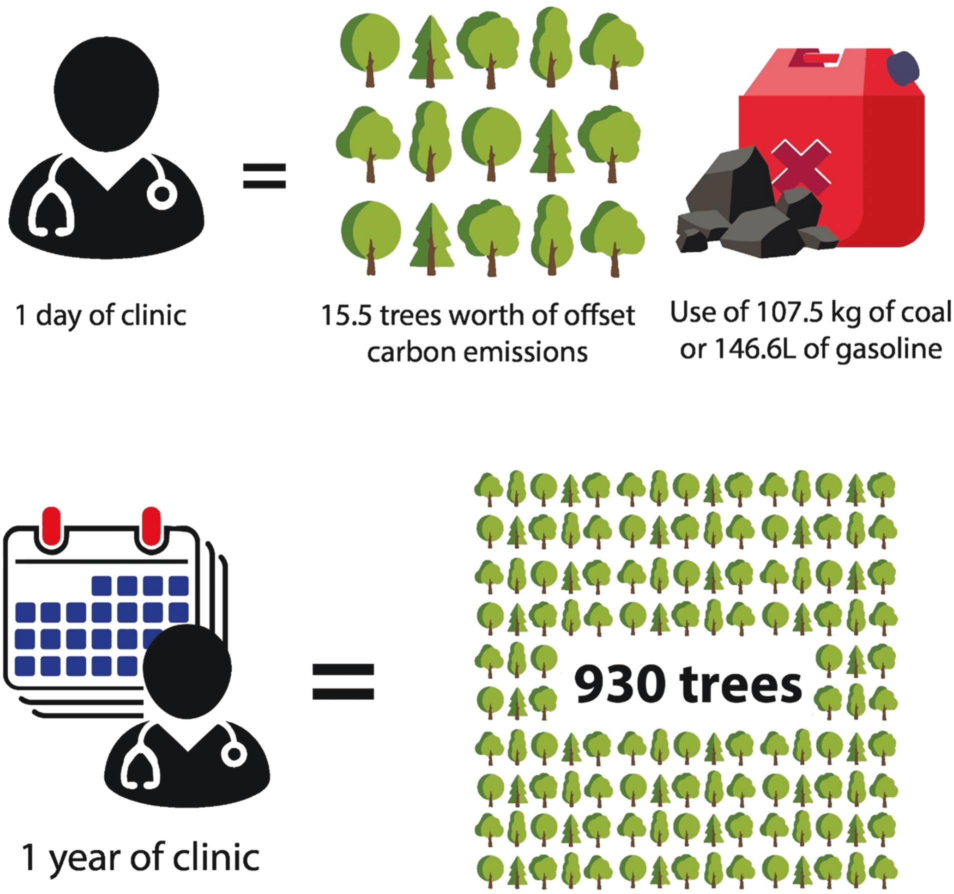

Figure 3. Estimated daily and annual emission equivalents for travel to a gastroenterology clinic.

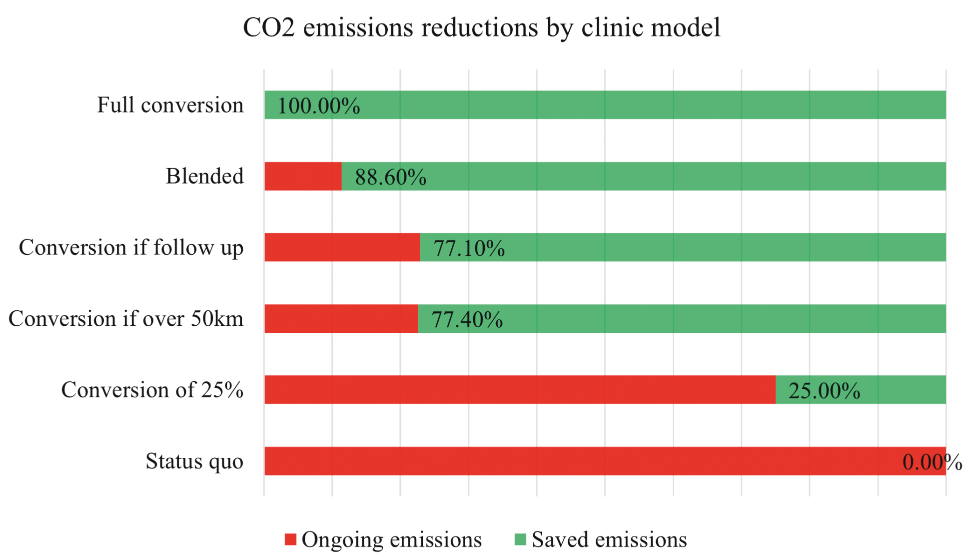

Figure 4. Various models of emissions reductions are based on the conversion of appointment types from in-person to virtual visits. Blended signifies the conversion of all follow-up appointments and new consults for patients who live over 50 km from the clinic.

represents a readily available way to reduce carbon emissions. Taken together, incorporating telemedicine into routine clinical visits is a promising solution that can improve patient access and healthcare equity, cut costs, and reduce environmental impact.[3]

Limitations and future directions

Our study focuses only on travel-related emissions for in-person care using estimates for travel distances at our academic centre. Additionally, the calculations inherently involve assumptions regarding various factors, such as the use of public transit, electric vehicles, non-tailpipe emissions, and energy consumption of telemedicine though we use reputable sources to inform these estimates. We would welcome further research from other centres demonstrating travel-related emissions to inform the degree of variability that may exist. Additionally, research focusing on the energy consumption of telemedicine infrastructure and potential changes in healthcare resource utilization is warranted. Addressing these research gaps will provide a more nuanced understanding of the environmental implications of telemedicine adoption and inform evidence-based strategies to promote sustainable healthcare practices.

Our study likely has applicability to specialties beyond just gastroenterology and jurisdictions beyond our institution, but there are multiple complex variables across specialties and regional differences that may introduce different results.

Conclusion

Overall, this study highlights the potential for broader adoption of telemedicine to reduce carbon emissions associated with gastroenterology appointments. While full-scale implementation of video-based clinic appointments is not realistic when considering unique patient and provider preferences, our findings demonstrate that a relatively modest change in the number of in-person visits can have a significant environmental impact, saving thousands of litres of gasoline emissions annually. Our findings underscore the importance of integrating sustainability-informed decision-making into healthcare delivery. By leveraging telemedicine technologies and promoting sustainable healthcare practices, healthcare systems can mitigate their environmental impact while potentially improving patient access and overall health outcomes.

Author contributions

CG: study design, data collection, data analysis, writing the article, and final approval. SA: data collection, data analysis, and writing the article. AK: data collection and data analysis. GL: data analysis and writing the article. DA: study design, data analysis, and writing the article.

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Conflicts of interest

No conflicts to declare. Conflict of interest disclosure forms (ICMJE) have been collected for all co-authors and can be accessed as supplementary material here.

Data availability

Data and analytic methods can be made available upon request to the corresponding author. There are no relevant study materials.

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