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Novel Online Endoscopy Education Video Platform Reduces Carbon Footprint Associated with Endoscopy Related Patient Travel

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1. Abstract

1.1. Aims

Endoscopy units are resource intensive and contribute to a significant part of healthcare's carbon footprint and greenhouse gas (GHG) emissions. Sustainability measures is at the forefront of shifting towards carbon neutral endoscopy practices. In 2019, our department introduced an online endoscopy education video series to replace in person pre-procedural education, minimising patient travel associated emission. This study aims to quantify the reduction in pre-procedural travel-associated carbon dioxide emission using a digital health education intervention.

1.2. Methods

Outpatient procedural activity between January 2019 to May 2022 at a single tertiary endoscopy unit was collated. Total distance of patient travel (kilometres) to hospital was calculated using postcode geodata coordinates between home postcodes to the hospital. The primary outcome was tonnes of CO_2 emission averted from avoided travel.

1.3. Results

During the study period, 803316 kilometres of patient travel was avoided, equating to 115.8 tonnes of CO_2 emission averted. Patients travelling from locations beyond 500 kilometres from hospital (26.4%) accounted for a majority of the total carbon footprint.

1.4. Conclusion

By avoiding unnecessary patient travel, utilisation of a digital educational platform led to significant reduction in our unit's preventable carbon emission. As healthcare sectors scrutinise their own sustainability practices, consideration should be given to use of innovative interventions to minimise unnecessary patient travel.

2. Introduction

The World Health Organisation has declared climate change to be the greatest health threat to humanity [1]. The consequences of accelerating concentrations of atmospheric greenhouse gases (GHG) are displayed through impressive weather events and extremes of rainfall [2]. This carries major implications on biodiversity, water scarcity, and food security [3,4]. At the 27th United Nations Climate Change Conference "COP27", the United Nations Secretary-General warned world leaders that the world was "on a highway to climate hell with our foot on the accelerator" [5]. Delivery of healthcare produces considerable amounts of GHG, accounting for 4.4% of global GHG emissions through a combination of energy generation, temperature management and transport [6]. Gastroenterology and endoscopy services have a particular duty to the environment being the third largest generator of hazardous waste in healthcare [7]. The carbon footprint (CF) of endoscopy activity in the United States in one year is estimated to be 85,768 tonnes from a combination of energy generation and waste disposal [8]. The annual carbon footprint of endoscopy activity in one ambulatory unit has been calculated to be 241.4 tonnes carbon dioxide (CO_2) equivalent [9].

Our endoscopy department introduced a novel online endoscopy and colonoscopy education video platform for patients and carers in 2019 with the intent of improving patient experience as well as bowel preparation quality. Endoscopy-related patient travel has been identified as a modifiable contributor of GHG emission which should be minimised [10]. To date, studies examining pragmatic interventions aimed towards minimising patient travel associated emission for endoscopy remains scarce [11]. We aim to quantify the reduction of GHG emission in a single tertiary endoscopy service which uses an online endoscopy education platform to minimise patient travel.

3. Materials & Methods

We conducted a retrospective, single centre observational study using de-identified, encrypted data stored on endoscopy documentation software Provation® MD (Provation, Minneapolis, MN, USA). Our endoscopy unit is based in a metropolitan teaching hospital which performs over six thousand colonoscopies annually. All elective, outpatient endoscopies and colonoscopies for any clinical indication performed between January 2019 to May 2022 were included in the analysis. Repeat procedures performed for the same patient during the study period were included. Procedure performed for inpatients or acute indications were excluded. Baseline deidentified demographic data including age, sex, and home address postcodes were obtained from chart review of encrypted electronic medical records. Exemption from full ethical review for this study was granted by the Metro North Health Human Research Ethics Committee B (EC00168). Prior to 2019, our department's standard of care pre-endoscopy education required patients and oftentimes a relative or carer to attend an in-person appointment in a nurse led clinic. During the same session a hospital pharmacist would also conduct a medication review. Thus, completion of any endoscopic procedure would require at least two separate trips to the hospital. The most common patient transport methods are private vehicle or taxi. In 2015, our department commissioned a professional digital health education media team to create a patient-centred endoscopy focused educational video series (Website S1). The video series was introduced for clinical application in 2018. Emphasis was placed on following the journeys of real patients from understanding their procedure indication to the bowel preparation process and post-colonoscopy patient experiences. Scripts for videos were developed by several of the authors (AV, KL, TR) with input and feedback from the endoscopy paramedical staff. Video content, which were acted or narrated in direct-to-camera fashion, was divided into 'chapters' discussing the purpose of colonoscopy, potential findings and procedural risks. Scenes of patients narrating their bowel preparation process in their own words were included to coach viewers who were preparing for their own procedure.

Patients receive access to the video platform via a text message link to the website. Four text messages containing links are sent in total over the period from when their procedure date is confirmed until the day before the scheduled procedure. This ensures patients and carers have ample opportunities to view the videos. Since the video platform was employed, both the nurse led clinic and pharmacist have changed to telephone consultations. Patients have unlimited and indefinite access to allow repeat viewing.

To estimate the distance travelled by patients from their home to the hospital, we used Australia Post geodata to calculate the straight-line distance (in kilometres) between their home address postcode coordinates and our hospital. The single direction distance was doubled to calculate the final roundtrip travel distance. Patients undergoing combined procedures (upper gastrointestinal endoscopies and colonoscopies) were included as one roundtrip under the 'colonoscopy' group for calculation. The Australian National Transport Commission estimates that light passenger vehicles emit an average of 149.5 grams of CO_2 per kilometre travelled [12]. Air travel was assumed as the mode of transport for patients who were travelling from another state or from a location over 250 kilometres from the hospital. The estimated emission from aviation fuel was 115 grams per kilometre for each passenger [13]. Therefore, vehicle related CO_2 emission (tonnes) is the product of total patient vehicle travel distance (kilometres) multiplied by the estimated average CO_2 emission of passenger vehicles (grams per kilometre). Air travel CO_2 emission (tonnes) is the product of air travel distance (kilometres) multiplied by average CO_2 emission of air travel (grams per kilometre). The primary outcome was the amount of pre-endoscopy patient travel emission avoided in tonnes of carbon dioxide (tCO_2).

4. Results

Between January 2019 to May 2022, after exclusions, 20,333 procedures were performed at our centre and included in the analysis. There were 14,187 outpatient colonoscopies (including combined procedures) and 6,146 upper gastrointestinal endoscopies performed by 35 endoscopists (including gastroenterologists and surgeons). Baseline demographic data is shown in Table 1. The study population undertook travel from 280 unique Australian postcodes. Using the total of straight-line distances between patient home postcodes and our hospital, total round trip patient travel averted for all procedures was 803,316 kilometres (544,697.1 kilometres for colonoscopies and 258,618.9 kilometres for upper gastrointestinal endoscopies). Including CO_2 emission contributions from vehicles and air travel, the primary outcome of tonnes of CO_2 emission averted was 78.3 for colonoscopies and 37.5 for endoscopies, totalling 115.8 tCO_2. When stratifying by round trip travel distance, 114 patients (accounting for 0.56% of study population) who lived more than 500 kilometres from the hospital (1000 kilometres round trip) accounted for 30.6 tCO_2 saved (26.4% of total CO_2 savings). By comparison, patients who resided within a five kilometre radius from the hospital contributed to 6.9 tCO_2, or 6% of total CO_2 emission (Table 2). To contextualise the volume of CO_2 emission prevented, the United States Government's Environmental Protection Agency online carbon emissions calculator provides comparison of CO_2 quantity with other modalities of GHG production. The calculator illustrated 115.8 tCO_2 as equivalent to burning approximately 58,000 kilograms of coal, consumption of 49,000 litres of gasoline and CO_2 emission from 14.6 homes' energy use for one year [14].

Table 1: Baseline demographic data. Patients who underwent combined upper gastrointestinal endoscopy and colonoscopy in tandem on the same day were included under 'Colonoscopy'.

Total Procedures (n = 20,333)	**Sex**	**Mean age**
Colonoscopy (14187)	Female 51.6% (7326/14187)	56
	Male 48.4% (6861/14187)	57.9
Endoscopy (6146)	Female 55.9% (3433/6146)	54.3
	Male 44.1% (2713/6146)	54.9

Table 2: Tonnes of CO_2 (tCO_2) emission avoided, categorised by round trip travel distance (kilometres). A significant portion of emission is accounted by patients using long distance travel to attend pre-procedure education.

Round trip travel distance (Kilometres)	**Number of patients**	**Emission avoided (tCO_2)**
<5	1195	0.3
5 – 9.9	5491	6.6
10 – 19	5165	11.6
20 – 29	3690	14.1
30 – 39	1759	8.9
40 – 49	568	3.9
50 – 99	1821	18.1
100 – 999	530	21.7
> 1000	114	30.6

5. Discussion

To our knowledge, this is the first study to evaluate the impact of an intervention on reducing endoscopy's modifiable carbon footprint through limiting patient travel. Our study quantifies the carbon footprint of pre-endoscopy travel in a high throughput endoscopy unit and highlights the GHG emission prevented with the use of a novel online education platform. Carbon footprint generated from non-clinical purpose travel such as educational activities and research conferences is being increasingly recognised in literature and appropriately questioned [15-17]. There is less room to minimise emission generated in the provision of patient care while ensuring no compromise to quality of care. As the COVID pandemic rapidly increased the acceptability of telemedicine for patients and clinicians, healthcare sectors where virtual delivery is appropriate should do so with urgency [18]. This study highlights the substantive role for online conduits of pre-endoscopy activities. Moreover, the benefit of augmenting colonoscopy education with another method such as smartphone applications, social media, online videos, or pamphlets is well described in enhancing bowel preparation quality compared to standard instructions [19-21].

Our results show that patients who use long distance air travel, a small group constituting less than one percent of the study population, accounted for one quarter of the total carbon footprint of pre-endoscopy travel. As our hospital is the only heart and lung transplant centre in Queensland, Australia, patients who have received organ transplantation remain under the transplant team's care irrespective of their place of residence. As this cohort of patients frequently attend hospital for other investigations and appointments, there is potential for telemedicine to minimise a considerable volume of GHG emission. A systematic review evaluating carbon footprint minimisation using telemedicine noted that the magnitude of emission reduction was particularly dependent on geography and level of medical specialisation [22]. While smaller hospitals and endoscopy units may see smaller saving in GHG, it is nevertheless paramount to scrutinise every stream of contribution to our footprint. Moreover, the criticism of telemedicine's utility mostly pertains to concerns of 'digital exclusion' of people from socioeconomically disadvantaged backgrounds or the elderly [23]. However, many nations have seen a growth in smart phone ownership recently, with 88% of the Australian population owning a mobile phone [24]. As an overwhelming majority of the population gain internet access, the perceived disadvantage towards digitalisation of healthcare is diminished.

The unrelenting environmental symptoms of climate change is a recurring theme in Australia, not dissimilar to occurrences throughout the rest of the world. This stands in contrasts with the enormous inertia within governments to develop a coordinated strategy to achieve net zero emission. Unfortunately, the global health threat created by the COVID pandemic had temporarily diverted public and government attention away from the less apparent challenges of mitigating GHG emission [25]. Alarmingly, the window of opportunity for action on climate change continues to diminish despite other competing health crises. Australia is uniquely placed with an ecological system that is highly vulnerable to climate change. A rise of 3°C would lead to the extinction of thousands of species [26]. Australia also has a notable asymmetrical concentration of specialist care in metropolitan cities. Remote populations must therefore negotiate long distance travel to access specialist care, encouraging reliance on private motor vehicle usage and air travel [27].

There were several limitations to our study. The retrospective nature of the analysis negates any means to account for the portion of patients travelling via public transport or electric vehicles. The study period included 2020 to 2021 where our unit operated at attenuated capacity due to staff redeployment, health resource diversion, and interruption of elective non-urgent procedures as a consequence of the COVID pandemic. Therefore, the actual amount of GHG emission prevented when operating at usual clinical activity volume is likely greater. Furthermore, the primary outcome likely underestimates the actual travel associated emission, as the travel distance was calculated based on straight line distance between two points. Use of straight-line geodata distance was intended to provide a conservative estimate of travel distance without introducing additional variables or assumptions during calculation, as can be the case when estimating travel related carbon emission [15]. Finally, our findings may not be generalisable to other endoscopy units as our hospital serves a wide geographic catchment being the statewide heart-lung transplant centre. Contribution from long distance air travel is more likely representative of the carbon footprint of a specialist referral centre.

7. Conclusion

Our study demonstrates that pre-endoscopy travel related emission can be effectively mitigated through an accessible alternative to in person clinical appointments. Many of the contributors to endoscopy's carbon footprint, such as energy generation and non-recyclable waste, require enormous efforts from national and international governing bodies to affect change. Given the great potential to prevent unnecessary carbon emission from patient travel, we advocate for the implementation of a similar virtual healthcare model at other endoscopy services. With increasing acceptance of telemedicine, it is imperative to consider innovative interventions in an era of healthcare where our duty is to our patients and our environment.

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Supplementary Files

Website S1. https://pocketmedic.org/colonoscopy/