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Short communication

Patient transport greenhouse gas emissions from outpatient care at an integrated health care system in the Northwestern United States, 2015–2020

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ABSTRACT

Introduction: Climate change threatens human health, and health care as an industry is responsible for a significant fraction of greenhouse gas (GHG) emissions. We examine the reduction in GHG emissions from transportation to outpatient clinic visits with the growth in telehealth services.
Methods: This is a retrospective review of outpatient care at a health system serving over 600,000 members. Using average distances, we calculate transportation-related GHG emissions for ambulatory visits. The ambulatory visit carbon intensity is the total GHG emissions normalized by number of patient visits annually.
Results: From 2015 to 2020, total outpatient visits increased at 3.2% annually, to 2.7 million. Telehealth visits increased by an average of 53.2% annually while in-person visits saw modest gains of 1.5% annually until 2020, when they declined 46.2%. Transportation GHG emissions rose from 18.5 to 19.6 (in 2019) before declining to 10.5 kt CO2-eq in 2020. Ambulatory visit carbon intensity monotonically declined from 8 to 4 kg CO2-eq per visit.
Conclusion: Increasing telehealth use in an integrated health system in the Pacific northwest of the United States corresponded to a dramatic decrease in ambulatory visit carbon intensity.

1. Introduction

The devastating public health effects of global climate change are well known. Paradoxically, the healthcare sector is a significant source of greenhouse gas (GHG) emissions and other pollutants.

In 2018, pollution from the US healthcare sector resulted in the loss of an estimated 388,000 (244,000–531,000) disability-adjusted life years (DALYs), of which 111,000 to 343,000 DALYs were attributed to healthcare's contribution to global climate change and the remainder was predominantly due to particulate matter emissions [1]. From 2010 to 2018 US healthcare emissions rose 6 percent, to the highest rate among industrialized nations [1].

Telehealth has proven to be an effective strategy for healthcare systems to decrease GHG emissions [2–4]. Unexpectedly, the Coronavirus Disease 2019 (COVID-19) pandemic has caused an immense shift in healthcare delivery with many organizations emphasizing virtual care over in-person visits. To date, there are no large-scale studies of emissions reductions due to telehealth across an entire ambulatory system of a regional healthcare system in the United States, nor any studies showing the impact of COVID-19 on healthcare-associated GHG emissions as a result of rapid telehealth adoption.

We evaluate emissions reductions associated with COVID-19-related, high-volume transition to telehealth. To capture the climate related impact of this transition in a normalized fashion we used ambulatory visit carbon intensity, a metric that could be used to monitor and compare environmental performance within and among healthcare systems.

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2. Methods

This is a retrospective review of outpatient care at Kaiser Permanente Northwest (KPNW), an integrated healthcare system located in Oregon and Southwest Washington serving over 600,000 members. The scope of our study is the GHG emissions resulting from transportation to and from visits for primary care, specialty care, and mental health care. Emissions resulting from other activities related to patients' healthcare are excluded from this assessment. Total numbers of in-person and telehealth visits were compiled from administrative records for calendar years 2015 through 2020. For this study, telehealth visits are virtual appointments using audio-video or audio-only connections between clinicians and patients.

Estimated travel distance per appointment was derived from practice administrative data calculating the average of the distances between patients' home addresses and their assigned primary care clinics. We used Oregon Department of Transportation data that estimate the following travel modes for personal errands: 93% automobile, 5% walking, 1% bus, and 1% bicycle [5]. Total aggregate distance traveled by patients by each mode of transport each year was estimated from the number of in-person visits multiplied by the average distance to the clinic multiplied by the fraction of trips by mode of transport. Walking is estimated to contribute no pollutant emissions. Telehealth visits are assumed to replace in-person visits in a 1:1 ratio.

We used a life-cycle assessment approach to modeling GHG emissions. Total GHG emissions were modeled based on distances traveled using SimaPro 9.1.1 (PRé Sustainability, Amersfoot, The Netherlands) with ecoinvent 3.6 data (allocation, cut-off by classification). Emissions were calculated using the Tool for the Reduction and Assessment of Chemical and other environmental Impacts (TRACI) 2.1 life cycle impact assessment (characterization) methodology and United States 2008 normalization set. We define the ambulatory visit carbon intensity as the total GHG emissions normalized by the total number of patient visits each year.

This project was undertaken as a quality improvement initiative at our subject health system, and as such was not formally supervised by the institutional review board per its policies.

3. Results

From 2015 to 2020, inclusive, the medical group completed 15.6 million outpatient visits, averaging 2.6 million per year. Although the COVID-19 pandemic reduced visits in 2020, overall the period saw a 15.9% increase in visits over those 6 years, an average of 3.2% per year. In-person outpatient visits had been increasing at 1.5% per year through 2019, only to decline by 46.2% in 2020 during the COVID-19 pandemic, yielding an overall decline during the study period of 43.0% (8.1% per year). At the same time, telehealth visits had been growing quickly, at 39.3% per year through 2019, and then jumped in 2020 by 108.5%, for an overall increase of 669.6% or 53.2% per year during 2015–2020.

The average distance traveled by patients from home to their clinics was 17.42 miles, resulting in 194 million automobile miles, 2.1 million bus miles, and 2.1 million bicycle miles traveled by patients for in-person visits in 2015–2020.

Greenhouse gas emissions from patient transport due to these visits is shown in Fig. 1, increasing from 18,473 tonnes CO_2-eq in 2015 to 19,569 tonnes CO_2-eq in 2019 before falling to 10,537 tonnes CO_2-eq in 2020. The carbon-intensity of outpatient visits monotonically decreased from 8.03 kg CO_2-eq per visit in 2015 to 3.95 kg CO_2-eq in 2020, a reduction of 51%. As shown, while carbon-intensity was dropping from 2015 to 2019, the greatest reduction was in 2020,

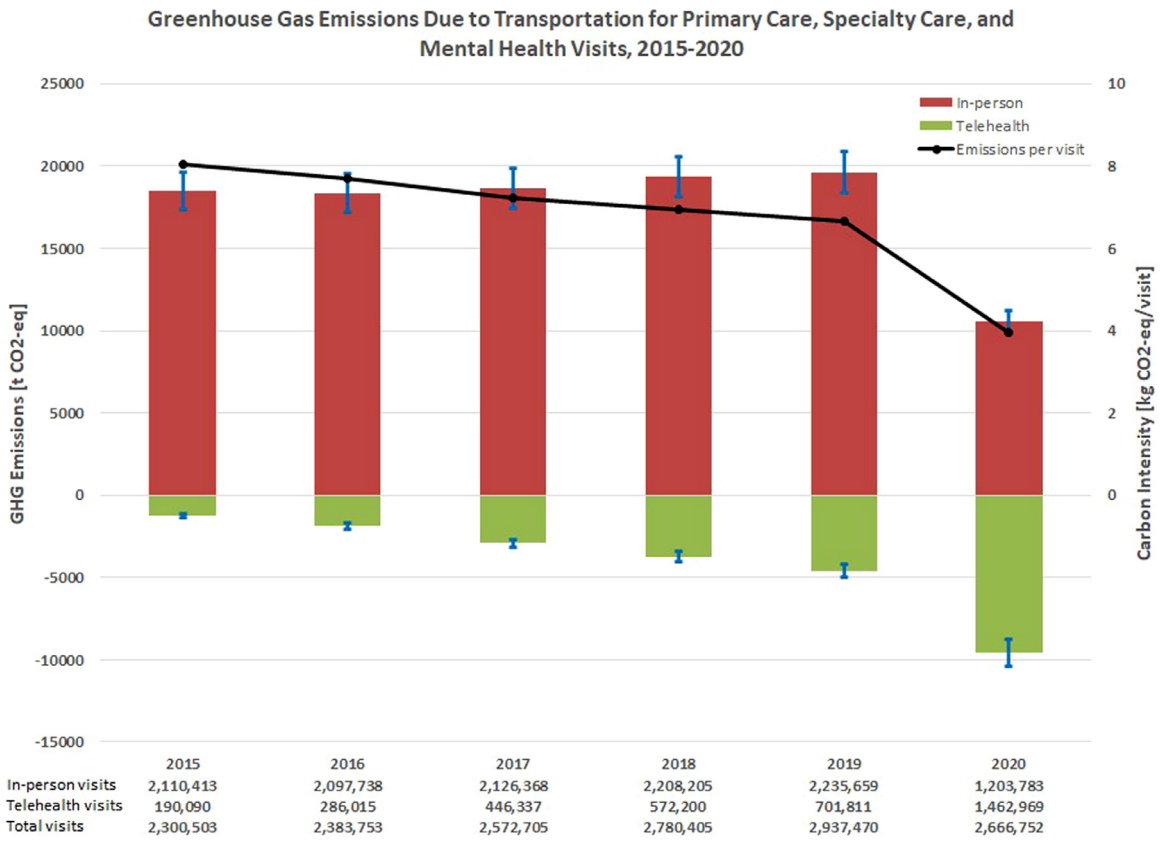

Fig. 1. Total GHG emitted (positive values) and avoided (negative values) due to patient transportation for clinic visits and carbon intensity per ambulatory visit, 2015–2020.

corresponding to a much greater proportion of telehealth visits in that year.

4. Discussion

We demonstrated a dramatic reduction in transportation-associated GHG emissions at a large US regional health system during the COVID-19 pandemic. This reduction is primarily due to increased use of telehealth services as opposed to a decline in total annual visits during the pandemic and is evidenced by the total number of visits in 2020 being greater than prior years that had much larger total emissions. Nor is this reduction attributable to changes in fuel efficiency or transportation mode share over time, which are likely minimal on this time scale and were not modeled in this analysis. Prior to the pandemic, despite rising total visit volume, transportation-associated emissions were already declining due to a greater proportion of telehealth visits.

Reductions in transportation GHG emissions greatly eclipse the much smaller potential increase in emissions associated with the use of computer equipment by patients and internet bandwidth for video conferencing. A rough estimate of those emissions using the same modeling methods (SimaPro with ecoinvent inventory data on computer and internet use) and an average of 15 min per visit show a net increase in 2020 of 55 tonnes CO_2-eq compared to 9604 tonnes CO_2-eq avoided from patient transportation for telehealth visits in that year.

Our study likely underestimates emissions reductions as we did not account for decreased commuting by healthcare providers conducting telehealth visits from home. Furthermore, the environmental benefit of telehealth may not be limited to reductions in transportation-associated emissions if increased virtual care permits healthcare systems to care for more patients without increasing outpatient clinic space.

Normalizing emissions to total visit volume through the use of ambulatory visit carbon intensity permits useful insight into the environmental impacts of different models of care. While we only measured carbon intensity associated with patient transportation, this same metric could be made more robust through application of a broader lifecycle approach to ambulatory care. Measurement of ambulatory visit carbon intensity permits comparison of environmental performance across all scales of ambulatory care, from individual practices to healthcare systems.

This study has limitations. We used distance from patients' homes to their primary care physician's office to estimate distance traveled, when in fact some visits would have been conducted at other locations. Oregon DOT estimates of transportation mode share for errands may not be representative of visits to medical appointments. Our model also assumes equal probability of modes of transport regardless of distance, which introduces uncertainty. We also assumed that all virtual visits replaced an office visit, consistent with previous studies' methodology [4,6]. Northwest Permanente, as a payor-provider organization, is not incentivized to monetize routine phone calls by converting them to telehealth visits. However, it is possible that clinicians increasingly use telehealth visits for more time-consuming conversations that don't require an office visit.

The rapid and widespread adoption of telehealth during the COVID-19 pandemic [7] has had significant environmental health benefits, primarily through reduction in transportation-associated emissions. If the US healthcare system were to maintain or expand upon current levels of telehealth utilization, additional reductions in GHG emissions would potentially be achieved through impacts on practice design. Ambulatory visit carbon intensity would be an effective way to measure these changes.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Eckelman MJ, Huang K, Lagasse R, Senay E, Dubrow R, Sherman JD. Health care pollution and public health damage in the United States: an update. Health Aff (Millwood) 2020(12):2071–9 Dec; 39.
[2] Masino C, Rubenstein E, Lem L, Purdy B, Rossos PG. The impact of telemedicine on greenhouse gas emissions at an academic health science center in Canada. Telemed J E Health 2010(9):973–6 Nov; 16.
[3] Oliveira TC, Barlow J, Gonçalves L, Bayer S. Teleconsultations reduce greenhouse gas emissions. J Health Serv Res Policy 2013(4):209–14 Oct; 18.
[4] Paquette S, Lin JC. Outpatient telemedicine program in vascular surgery reduces patient travel time, cost, and environmental pollutant emissions. Ann Vasc Surg 2019:167–72 Aug; 59.
[5] Bricka SG. Personal travel in Oregon: a snapshot of daily household patterns. Oregon Department of Transportation; 2019. https://www.oregon.gov/ODOT/Planning/Documents/OHAS-Daily-Travel-In-Oregon-Report.pdf. [last accessed 6/10/2021].
[6] Dullet NW, Geraghty EM, Kaufman T, Kissee JL, King J, Dharmar M, et al. Impact of a university-based outpatient telemedicine program on time savings, travel costs, and environmental pollutants. Value Health 2017(4):542–6 Apr; 20.
[7] Patel SY, Mehrotra A, Huskamp HA, Uscher-Pines L, Ganguli I, Barnett ML. Variation in telemedicine use and outpatient care during the COVID-19 pandemic in the United States. Health Aff (Millwood) 2021(2):349–58 Feb; 40.