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# The positive environmental impact of virtual isotretinoin management

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## Abstract

**Background/Objectives:** Other medical specialties have studied how their practices influence the environment, but environmental impact studies in the field of dermatology remain limited. With respect to dermatology, vehicle emissions by patients traveling to and from appointments are an important factor influencing climate change. This study was undertaken to determine the greenhouse gas emissions avoided by managing isotretinoin virtually at West Virginia University Hospital.

**Methods:** A retrospective cross-sectional study was conducted during the COVID-19 outbreak from March 25 to December 1, 2020, where travel data were acquired and converted to emission data.

**Results:** 5,137 kg of GHG emissions in CO<sub>2</sub> equivalents were prevented by managing isotretinoin virtually during the study period. 49 400 kg of GHG emissions in CO<sub>2</sub> equivalents would be prevented annually. This is the emission load released when 24 690 kg of coal are burned.

**Conclusions:** Environmental impact studies in the field of dermatology remain limited. GHG emissions were significantly reduced by virtually managing isotretinoin at a single institution. The practice of dermatology could reduce its carbon footprint by managing isotretinoin virtually, even in non-pandemic periods. Given that isotretinoin management represents a small percentage of the overall carbon footprint associated with dermatology, dermatologists should identify other conditions amenable to virtual medicine to produce greater environmental impact.

#### KEY WORDS

carbon footprint, isotretinoin, virtual medicine

## 1 | INTRODUCTION

The novel coronavirus (COVID-19) pandemic has had unprecedented environmental benefits. Stay-at-home orders caused a global reduction in daily commuter transit leading to improved air quality and decreased greenhouse gas (GHG) emissions. Conservative estimates indicate that 76 000 (95% CI 62 600–86 900) fatalities in China and 13 600 (95% CI

11 900–15 300) fatalities in Europe related to long-term impacts of fine particulate matter will be avoided due to these orders and resulting improvement of air quality in these regions.<sup>1</sup> The COVID-19 pandemic has also drastically changed health care, leading to rapid advancement in the field of virtual medicine. Virtual medicine reduces travel and therefore reduces GHG emissions. Little research has been done on the environmental impact of dermatology office visits. Transit to

and from clinical appointments is an important contributor of GHGs in dermatology. In this study, we estimate the environmental impact related to isotretinoin clinic visits. Specifically, we show how pandemic-associated conversion of all clinic visits for isotretinoin management to virtual visits reduced GHG emissions.

## 2 | METHODS

### 2.1 | Patient selection and travel calculation

From March 25 to May 29, 2020, West Virginia University Hospital (WVUH) recommended against all “non-urgent” in-person clinic visits to minimize the spread of COVID-19. Therefore, all established visits for isotretinoin management in the Department of Dermatology were converted to virtual visits. All patients who were taking isotretinoin as of March 25, 2020, and completed a visit for virtual isotretinoin management from March 25 to May 29 were identified and included in the study. Patients who initiated treatment during the identification period were not included. After the identification period, data for study patients were retrospectively collected to determine the total number of visits for isotretinoin management and laboratory monitoring events each patient required during their treatment course (this includes visits completed before and after the identification period). Retrospective analysis was completed on December 1, 2020. All virtual visits started as video calls with both patient and provider utilizing a webcam. If issues with connectivity were encountered, visits were converted to telephone calls. Patients were able to send photographs to providers through an online patient portal if video call quality was suboptimal. Total visits (175) and unique patient visits (113) for isotretinoin management were counted during the patient identification period (patients could be seen more than once during the identification period).

Google Maps navigation software was used to calculate the distance patients would have traveled round-trip for an in-person clinic visit. Mileage saved per unique patient visit accounting for round-trip travel was calculated as follows: distance from the residential address listed in the electronic medical records (EMR) to WVUH clinic  $\times 2$ . If phlebotomy was required, Google Maps navigation software was also used to determine the distance patients traveled to a preferred local laboratory. Laboratory monitoring included monthly pregnancy tests for females. Baseline AST, ALT, and lipid panel

were collected prior to therapy initiation and following any dosage increase.

The weekly 2019-2020 WVUH Dermatology patient census data were used to project the number of visits for isotretinoin management over a one-year period. Data collected during the study period were extrapolated to determine potential mileage saved annually by managing isotretinoin virtually.

### 2.2 | Converting miles saved into environmental impact

This study analyzed the most common GHG vehicle emissions including carbon dioxide ( $\text{CO}_2$ ), methane ( $\text{CH}_4$ ), nitrous oxide ( $\text{N}_2\text{O}$ ), and hydrofluorocarbons (HFC), which are released from combustion of fuels and air conditioning units in vehicles as reported by the United States Environmental Protection Agency (US EPA).<sup>2</sup> Estimated emission factors (grams of  $\text{CO}_2$  equivalents of gas emitted per mile driven) for each GHG were based on the most recent US EPA and Federal Highway Administration (FHWA) data from 2017 for light-duty vehicles in West Virginia and are the following:  $\text{CO}_2$ -344.85,  $\text{CH}_4$ -0.36,  $\text{N}_2\text{O}$ -2.84, and HFC-7.47.<sup>3,4</sup> All patients were assumed to have traveled to and from appointments in light-duty vehicles. Light-duty vehicles are defined by the US EPA as any passenger vehicle with a gross vehicle weight rating less than 3,856 kg.<sup>5</sup> All GHG emissions were converted to  $\text{CO}_2$  equivalents based on their global warming potential (GWP) using US EPA standards. GWP is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of  $\text{CO}_2$ .<sup>6</sup> Conversion of emission reductions into other terms of environmental impact was carried out using the US EPA GHG Equivalencies Calculator.<sup>7</sup> IRB approval was obtained. This study was reviewed and approved as NCSR/Flex by West Virginia University IRB, approval #2012196802.

## 3 | RESULTS

113 unique patients taking isotretinoin were seen during the identification period. All female patients had monthly pregnancy tests in accordance with iPLEDGE, and no pregnancies occurred during the study period. Virtual management of isotretinoin saved 37.80 miles per visit. Patients traveled 5.80 miles if phlebotomy was required at

**TABLE 1** Mileage data for study patients receiving isotretinoin therapy

Round-trip distance (miles)	N	Mean	Median	Standard Deviation	Range	Percentiles		
						25	50	75
To WVUH clinic	113	82.36	37.80	112.75	4.60-596.00	19.20	37.80	80.60
To preferred local lab	110 <sup>a</sup>	6.83	5.800	5.64	0.40-27.20	2.58	5.80	9.83

Note: Median value used for mileage calculations due to non-normal data distribution.

<sup>a</sup>Unable to identify preferred local laboratory for three participants.

**TABLE 2** GHG emission reduction from virtual isotretinoin monitoring

GHG	Emission reduction (kg of CO <sub>2</sub> equivalents)	
	Study period	Annual (95% CI)
CO <sub>2</sub>	4,983	47 900 (45 900-49 700)
CH <sub>4</sub>	5	50.0 (47.9-51.8)
N <sub>2</sub> O	41	395 (376-409)
HFC	108	1,040 (994-1080)
Total	5,137	49 400 (47 300-51 200)

Abbreviations: CH<sub>4</sub>, methane; CO<sub>2</sub>, carbon dioxide; GHG, greenhouse gas; HFC, hydrofluorocarbons; N<sub>2</sub>O, nitrous oxide.

a local laboratory (Table 1). Patients seen during the identification period required an average 6.28 visits (SD 1.238) and 2.4 (SD 0.78) phlebotomy events over their treatment course. By virtually managing isotretinoin during the study period, 14 450.2 miles of total travel were reduced.

The most recent WVUH Dermatology census data modeling projects 3670 (95% CI 3520-3810) annual visits for isotretinoin management. Extrapolation of data from the study period equates to reduction of 139 000 miles (95% CI 133 000-144 000) of travel annually at WVUH if visits for isotretinoin management are performed virtually. GHG emission reduction achieved by making visits for isotretinoin management virtual during the study period and annual extrapolation of these data are presented in Table 2. During the study period, an estimated 4,983 kg of CO<sub>2</sub>, 5 kg of CH<sub>4</sub> (in CO<sub>2</sub> equivalents), 41 kg of N<sub>2</sub>O (in CO<sub>2</sub> equivalents), and 108 kg of HFC (in CO<sub>2</sub> equivalents) were saved from the 175 virtual visits. By extrapolating data from the study period to a full year at WVUH dermatology, an estimated 49 400 kg (95% CI 47 300-51 200) of GHG emissions in CO<sub>2</sub> equivalents could be prevented by converting all in-person follow-up visits for isotretinoin management to virtual visits.

## 4 | DISCUSSION

Medical specialties, such as anesthesiology, urology, and gastroenterology have evaluated their environmental impact,<sup>8-10</sup> but minimal research has been done on the environmental impact of dermatology.<sup>11</sup> Given the serious consequences of global climate change, analysis of the environmental impact of all fields of medicine, including dermatology, is warranted. Our study analyzed the environmental impact of a limited aspect of dermatology, the management of isotretinoin.

Visits for isotretinoin management are ideally suited to virtual health care. Unlike skin cancer screening, a more common reason to visit a dermatologist, virtual isotretinoin management does not require high-resolution computer images to assess improvement in acne or detect side effects. Under ideal conditions, evaluating drug efficacy, screening patients for adverse drug reactions, and review

of local laboratory results including pregnancy tests can all be carried out during a video visit. Additionally, systematic review and meta-analysis have indicated that monthly laboratory testing for patients with acne on a standard dose of isotretinoin is not beneficial.<sup>12</sup> The trend toward decreased laboratory evaluation of patients taking isotretinoin further supports the utility of virtual management. These factors make isotretinoin management a suitable candidate for virtual medicine.

Our study noted that 49 400 kg of GHG emissions in CO<sub>2</sub> equivalents could be prevented by converting all in-person isotretinoin visits to virtual visits over a one-year period. 49 400 kg of GHGs in CO<sub>2</sub> equivalents are emitted when 24 690 kg of coal are burned or 6 300 092 smartphones are charged. A total of 64.5 acres of United States forest would be needed to sequester this amount of carbon. To prevent the equivalent GHG emissions, 2,102 bags of waste would need to be recycled instead of being landfilled. Considering that more than 1 000 000 prescriptions of isotretinoin are authorized annually in the United States, the environmental impact could be magnified if virtual delivery of isotretinoin care is adopted on a national scale.<sup>13</sup>

Our study has notable limitations. Patients still require an in-person visit to register for iPLEDGE and initiate isotretinoin. Travel to a local laboratory for phlebotomy would offset some environmental benefits. Retrospective analysis revealed patients traveled to a preferred local laboratory 2.4 (SD 0.78) times during their treatment course. Median distance traveled to a local laboratory was 5.80 miles. If patients performed a home pregnancy test, travel to a preferred pharmacy to obtain a pregnancy test would also be necessary. Distance traveled to a local pharmacy was not included in our study. Travel to a local laboratory or pharmacy would reduce the reported environmental benefit of virtual isotretinoin management. Computer energy consumption also diminishes the environmental benefit of virtual isotretinoin management; however, in-person visits also utilize computer documentation, and the difference in computer energy consumption for virtual versus in-person visits is likely insignificant.

Our study may not be generalizable, as our study was conducted in rural/suburban America. West Virginia is a predominately rural state. Due to medically underserved regions throughout the state, patients treated at WVUH dermatology clinic travel significant distances to receive care. In comparison to a dermatology office in urban settings, patient travel to WVUH dermatology likely results in a greater magnitude of emissions on a per-patient basis. Further, patients in some urban settings are more likely to use alternative types of transport that emit less GHGs than light-duty vehicles when considering passenger load. If patients walk, take public transport, or drive hybrid/electric vehicles, their GHG emissions would be less than calculated here. However, traffic congestion in urban settings may also contribute to higher GHG emissions due to the increased travel times. Nevertheless, the environmental benefit of virtual isotretinoin management may be less in predominantly urban areas.

Virtual isotretinoin management may not be feasible in all areas. Limited broadband internet access prevents patients from

participating in virtual health care. Dermatology offices may not have access to a virtual health care platform. Additionally, subtle clinical examination findings and psychiatric comorbidities may be more easily detected during an in-person visit. The authors of this study noted no differences in side effects compared to in-person isotretinoin management; however, formal statistical evaluation of isotretinoin side effects was not performed. Finally, though no pregnancies occurred during our data collection period, and all female patients had monthly pregnancy tests, formal assessment of pregnancy risk with virtual isotretinoin management would be warranted.

Climate change is considered by some to be the greatest threat to global health. Our study is novel as one of the first studies to evaluate the environmental impact of any aspect of dermatology. The authors acknowledge that isotretinoin management represents a limited percentage of the overall carbon footprint of dermatology. However, we hope this study will demonstrate potential environmental benefits of virtual medicine in dermatology and stimulate dermatologists to recognize other diagnoses amenable to virtual management. Our study suggests that dermatologists should consider monitoring isotretinoin virtually owing to the positive environmental benefits and seek other opportunities to reduce the environmental footprint of dermatology.

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## AUTHOR CONTRIBUTIONS

Justin Lee aided in data interpretation and drafted the article. Ahmed Yousaf and Samantha Jenkins aided in data interpretation, data acquisition, and conceptualization of the project. Mohammed Tamim Zaki and Omar Abdul-Aziz conducted statistical analysis of data. Ceclia Napier aided in data acquisition. Zachary Zinn conceptualized and led the study. All authors contributed to reviewing and editing the article. Mohammed Tamim Zaki and Omar Abdul-Aziz aided in GHG data acquisition/interpretations and conducted statistical analysis.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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