Impact of a Medical Clinic Relocation on Travel Time: A Tale of 2 Modes of Transportation

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Abstract
The aim of this study was to quantify access disparities by examining the impact of a medical clinic relocation on travel time differences for patients using private cars versus public transit. Longitude and latitude of patient home addresses were extracted from electronic medical records for the 4 years before the clinic move. Using offline, open-source, and HIPAA-compliant routing software, roundtrip travel times were computed from each home address to the old and new clinic locations via car and bus. Mean roundtrip travel time by a car changed from 41.3 (IQR 16.1-80.7) to 45.4 (IQR 25.9-78.1) minutes, a 9.9% increase. Mean roundtrip travel time by public transit changed from 67.5 (IQR 51.5-100.2) to 120.8 (100.3-156.1) minutes, a 78.9% increase. Even clinic relocations that minimally impact car travel times can nevertheless yield substantial changes to those traveling by public transit. Clinics and health systems that wish to reduce barriers to accessing health care, especially among those already facing structural inequities, would benefit from utilizing the analytic approach described here.

Keywords
access, equity, travel time, public transit, patient experience, measurement

Introduction
Studies have shown that consistent preventative and follow-up visits are vital to ensuring continuity of care (1,2). Yet, long travel time can act as a barrier to accessing care (3,4) and patients living farther from healthcare facilities tend to have worse health outcomes (5).

While existing work demonstrates the usefulness of geographic analysis when rationally locating phlebotomy sites or consolidating public health clinics, these analyses were limited by their use of “as-the-crow-flies” distances (6,7). Research instead supports the intuitive notion that travel duration trumps distance in the cognition of distance (8) and hence in real-world decision-making. While correlated over long distances and straightforward geographies, travel distance and duration are poorly correlated in dense urban settings, routes that are variably impacted by traffic congestion, or geographies involving waterways and mountain ranges that make direct routes impossible.

Further, examining travel distance alone ignores any differences in travel modality, an especially strong limitation if one wishes to understand the impact on patients facing one of the most challenging barriers to clinic attendance, dependence on public transit. Because public transit is bound to set routes and schedules, computing travel times can be technically complicated, and they can also vary dramatically and unexpectedly (eg, no direct route exists but travel must be pieced together with 2 indirect routes).

Online mapping and routing services from providers such as Google make it incredibly easy for an individual to determine estimated travel times from their homes to their medical providers. But, for a researcher to do so in the United States would constitute sharing of protected health information (PHI) and hence require written consent from each patient and a formal Business Associate Agreement contract between the sharing institution and the routing service.

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provider beforehand or else be in violation of the Health Insurance Portability and Accountability Act (HIPAA). Further, a secondary though logistically important point, these online services are relatively slow and expensive at scale. A preferable approach would be to analyze travel time using hardware and software existing safely within the treating institution such that PHI never leaves the digital milieu. This also has the benefit of being essentially free and approaching 100 times faster.

In 2021, a large pulmonary clinic in Connecticut, serving approximately 2600 patients annually, moved from a downtown location to a new suburban location less than 10 miles away. In this study, we sought to understand what impact moving the clinic had on travel time for patients traveling by either car or public transit using only open-source software, public data, and methods that were easily reproduced and HIPAA compliant.

Methods

Longitudes and latitudes of home addresses for patients residing within Connecticut who had visited the clinic for at least one in-person visit between January 1, 2017, and December 31, 2020, were requested from the hospital system’s electronic medical record joint data analytics team. Road network routing, Open-Source Routing Machine was used to estimate roundtrip car travel time from patients’ home addresses to both the old and new clinic locations (9). Similarly, public transit routing, OpenTripPlanner, was used to estimate roundtrip travel time using public transit (10). Both routing engines were run on a local server. Because public transit runs on predetermined schedules and routes, travel times can vary by time of day and can be different coming and going to an appointment. To accommodate this, we computed each transit route as arriving at 8 different times throughout the day and then returning home 1 hour later, with the mean of these 8 roundtrip times (excluding the 1 hour at the clinic) used for analysis. Given patients were seen for pulmonary diagnoses in this clinic, transit routes that required the patient to walk for more than 600 meters or roundtrips of more than 5.5 hours were excluded for real-world validity (11). This project was deemed IRB-exempt by the Yale Human Research Protection Program.

Results

A total of 6713 unique home addresses of those who visited the clinic between January 1, 2017, and December 31, 2020, were analyzed. For the previous clinic location, the median roundtrip travel time by car was 41.3 minutes (IQR 16.1-80.7) and the longest was 229.8 minutes. Median roundtrip travel time by public transit was 67.5 minutes.

![Figure 1](image_url)

Figure 1. Mean roundtrip travel time changes per census tract via public transit (top) and car (bottom) after clinic move from downtown (triangle) to suburban (square) location. Smaller dots represent census tracts that did not have a viable public transit route to the clinic.
relocation could have on their patients, especially those who face transportation challenges. Given that geographic access is a major driver of healthcare utilization, it is crucial for providers to consider the impact of relocation moves in a patient-centered way.

Discussion
In this study, we analyzed travel time change following a location move of a medical clinic that focuses on pulmonary care. We found the move had a potentially outsized negative impact on travel time for those dependent on public transit. The relocation led to a 79% increase in median roundtrip travel time by public transit compared to only a 10% increase for travel by car. Given that geographic access is a major driver of healthcare disparities, it is crucial for providers to consider the impact a relocation could have on their patients, especially those who already face transportation challenges (12,13).

Limitations
Limitations of this study include analysis of a single clinic in a relatively urban area in a state with a relatively robust public transit system. We did not include parking time in our analysis, often a major difference between downtown and suburban locations. Additionally, individual patient’s travel methods were not obtained, meaning we could not compute the actual travel time changes to clinic patients, only the potential, relative impact on the 2 travel methods holistically. To establish a robust baseline, our patient cohort consisted of the 4 years before the move only. As more time passes, comparing before and after move clinic attendance would be another valuable metric of the impact of the clinic move.

Conclusions
While our analysis pertains to only one clinic, the approach is highly reproducible and generalizable. With geographically coded patient data more readily available and HIPAA-compliant, open-source software packages free and increasingly easy to use, the barriers to implementing these methods in real-world settings rapidly grow smaller.

We believe patient travel time should be a necessary consideration for healthcare leaders to quantify and reduce travel-related healthcare access disparities. For policymakers and practitioners alike, prospective and retrospective use of travel time analysis tools have the potential to provide important insights and their use should be considered in operational as well as further research contexts. Collecting data on how patients get to clinic, perhaps as part of social determinants of health screeners, would provide valuable information for clinics for understanding patient transportation burden and how it impacts health outcomes. Additionally, this will allow us to better understand how to best support and advocate for policy changes, and ultimately how to best plan clinic location moves in a patient-centered way.

Declaration of Conflicting Interests
XY and WSM have no financial conflicts to report.

PK reports equity in Serca Science, FVC Health, Coaptech, TEO Science and Quantum Labs. He reports consulting fees from Biohaven and Chronius within the past 36 months, all outside the scope of the submitted work.

Ethical Approval
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Statement of Human and Animal Rights
This article does not contain any studies with human or animal subjects.

Statement of Informed Consent
There are no human subjects in this article and informed consent is not applicable.

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