POLICY BRIEF

Telemedicine

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Project Description

This project reviews and summarizes empirical evidence for a selection of transportation and land use policies, infrastructure investments, demand management programs, and pricing policies for reducing vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions. The project explicitly considers social equity (fairness that accounts for differences in opportunity) and justice (equity of social systems) for the strategies and their outcomes. Each brief identifies the best available evidence in the peer-reviewed academic literature and has detailed discussions of study selection and methodological issues.

VMT and GHG emissions reduction is shown by effect size, defined as the amount of change in VMT (or other measures of travel behavior) per unit of the strategy, e.g., a unit increase in density. Effect sizes can be used to predict the outcome of a proposed policy or strategy. They can be in absolute terms (e.g., VMT reduced), but are more commonly in relative terms (e.g., percent VMT reduced). Relative effect sizes are often reported as the percent change in the outcome divided by the percent change in the strategy, also called an elasticity.

Summary

Strategy Description

Telemedicine (or telehealth) is the use of information communication technology (ICT) to provide healthcare services to patients. This service acts as a substitute for face-to-face (FTF) outpatient services which require travel by patients to medical facilities.

Behavioral Effect Size

The substitution of telemedicine visits for FTF visits can vary in the expected car use reduction based primarily on location (of home and service) and service type. The range in distance of travel reduction is extreme from 3.8 to 4,208 miles and 0.57 to 893 kg CO2e per telemedicine visit. The most relevant study to California suggests that telemedicine visits reduce approximately 17.6 miles of travel and 7.1 kg CO2e per telemedicine visit on average.

Strategy Extent

Telemedicine grew rapidly with the COVID-19 pandemic but growth has recently slowed. Some evidence suggests the rate of health care visits is roughly 18% virtual, and at least one study suggests that nearly 50 million additional telemedicine visits nationally (US) per year could be made if inequities were addressed.

Strategy Synergy

While no study pointed to land use and transportation synergies, there may be synergy with telecommuting if one or the other provides more comfort with meeting remotely.

Equity Effects

Urban residents use telehealth more than rural residents, even though VMT reduction benefits are greater per visit for rural residents. Use of telehealth is also lower for low-income patients and patients on Medicare. Inequities in telemedicine use may be tied to lower access to broadband internet, telemedicine opportunities, and other barriers.

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Strategy Description

Telemedicine (or telehealth), like telecommuting, has the potential to reduce VMT by participants achieving medical consultation remotely, by phone or computer. Telemedicine can include asynchronous communication (e.g., video or text) and can include clinician-to-clinician communication, but for the purposes of this brief we refer only to synchronous clinician-to-patient remote consultations which have the potential to replace face-to-face (FTF) consultations.

Telemedicine has a long history, with telephone communication replacing home-based health care visits as early as the late 19th century, and has grown in many sub-disciplines in medicine as information and communication technology (ICT) has advanced (Nesbitt, 2012). While ICT has improved several communications (e.g., clinician-to-clinician) within the field of medicine, remote clinician-to-patient telemedicine has been recently accelerated by the COVID-19 pandemic (Cantor et al., 2021).

Strategy Effects

Behavioral Effect Size

The evidence of the impacts of telemedicine on VMT and GHG is universally a reduction. The magnitude of the reduction ranges dramatically based on the type of medical service, the catchment area of the facility, and the location of the patient (Table 1).

Tertiary (Specialty) medical services often have long travel distances, and many studies have reported that telemedicine can reduce hundreds and in some cases thousands of miles of travel per visit (Beswick, et al., 2016; Dullet, et al., 2017; Purohit, et al., 2021; Donald and Irukulla, 2022). General outpatient telemedicine has more moderate effects (less than 20 miles of travel reduced per visit) (Schmitz-Grosz, et al., 2023; Sharma, et al., 2023). Sharma, et. al. (2023) is the largest single study reviewed, is set in California, considers all telehealth visits, and concludes that 17.6 miles of travel per visit was reduced, which had an associated reduction of 7.1 kgCO2e.

Strategy Extent

Scale of Application: Sharma et al. (2023) suggests that approximately 18% of visits to the University of California health care systems were by telehealth. Excluding hospital visits, data from the California Health and Human Services database in 2022 estimates total visits to all clinics in California to be approximately 10.5 million (CAHHS, 2022). If the telehealth rate and travel reductions from Sharma, et al. (2023) are consistent across the state, that would equate to 332.6 million miles and 134,190 metric tons CO2e reduction annually in California. For context, in 2021, emissions from GHG emitting activities statewide represented 381.3 million metric tons of CO2e, 48.4% of which were from the transportation sector (CARB, 2023). This suggests telehealth already has a substantial impact on statewide emissions.

Efficiency or Cost: The cost of implementing telehealth software is likely in the hundreds of thousands of dollars. Most providers build telehealth software as a cost cutting and value added service to patients, not as an intervention to reduce car travel.

Time / Speed of Change: The rate of telemedicine use grew rapidly with the onset of COVID-19 from about 1% to 17% nationally practically overnight (Eastburn, et al., 2023).

Location within the Region: All studies that examine location report greater VMT reduction effects on telemedicine in rural environments where distances to medical facilities are longer (Ravindrane and Patel, 2022). Further, at least one report suggests that nearly 50 million additional telemedicine visits could occur if telemedicine was more equitably distributed across population segments, since rural and low-income residents use telemedicine at much lower rates suggesting structural biases against those most at need and those most likely to reduce car use to the greatest extent (Eastburn, et. al., 2023).

Differences between Regions: While few studies report differences between regions, our review suggests widespread differences between US and European studies. The US studies show much greater potential VMT reduction from telemedicine (Table 1). This may be due to differences in general accessibility to medical facilities.

Equity Effects

Telemedicine rates vary by population segments and location. Urban residents use telehealth for approximately 18% of visits while rural residences only 14% (Eastburn, et. al., 2023; Shama et al., 2023). Behavioral health visits have the largest within-class share of telemedicine visits, and the largest urban and rural gap. Additionally, lower income residents use telehealth at lower rates (-3 percentage points, and -6 percentage points by median income and Medicare, respectively (Eastburn, et. al., 2023)).

The inequitable use of telemedicine is likely tied to inequitable access to broadband internet, familiarity with technology, availability by providers, poorer health outcomes, digital literacy, and other systemic barriers (Rivera et al., 2020; Wagermann et al., 2022). Additionally, the burdens of the lack of telemedicine access for lower income, rural, and Medicaid patients has downstream costs such as the costs of travel, travel time, and even additional risks, such as crashes. For example, Sharma et al. (2023) estimates that telemedicine of over 3 million visits over three years saved approximately 42 traffic crashes and 0.72 fatalities from traffic crashes, which could be an equity concern depending on the nature of the crashes.

The potential for telehealth to break down inequities to healthcare delivery is also great. One review of inequities in healthcare for rural Native Americans suggested telemedicine has the potential to decrease healthcare costs and increase medical access and quality of treatment (Kruse et al., 2016).

Strategy Synergy

Because telemedicine is not generally considered a land use and transportation strategy, the synergy between it and other strategies is uncertain. Synergy with telecommuting may be possible, where remote workers become more comfortable with remote medical visits.

Confidence

Evidence Quality

All evidence comes from retrospective cross-sectional data of medical visit types. Most studies report travel distance savings, not broken out by mode. When multiple modes are considered, usually commute travel mode split from sources like the American Community Survey is assumed, which may not be appropriate for healthcare visits specifically. Nearly all the evidence reviewed either used phase or life cycle GHG reductions (Table 1).

All the studies reviewed used existing telehealth use compared to total health care visits. Many assumed 100% replacement, but some studies conducted sensitivity analysis for some fractional share of FTF visits. When a fractional share was assumed, results were nearly linearly associated with the effect size of travel reduction (Sharma et al., 2023).

Caveats

Because all the existing evidence is cross-sectional, there is some doubt whether some portion of the telemedicine visits would not have occurred, and if the FTF visits made would have been to the same location. This is a particularly strong assumption for the long-distance specialty clinic studies where travel distances were at times substantial (Beswick et al., 2016). For example, the US Department of Veterans Affairs (VA) is a recognized leader in telemedicine having adopted models more than two decades ago, with mental health the primary driver of implementation for conditions such as depression and post-traumatic stress disorder (Darkins, 2012). The Beswick et al. (2016) study assumes travel distances from New Mexico to California for the VA telemedicine specialty clinic, yet it is not clear that this is a reasonable counterfactual health care delivery. This example points to the need for before and after longitudinal studies of telemedicine use at the individual level. With changes in behavior at the individual level, we can be more certain of the VMT reduction.

Additionally, the sample size of some of the studies and the location in dissimilar environments (both in terms of transportation and land use, and in terms of health care access and delivery) may make many studies less helpful in the California context.

Technical & Background Information

Study Selection

The number of studies measuring the effect of telemedicine on VMT and GHG reduction is high and seems to be growing rapidly since the COVID-19 pandemic. We selected review papers and empirical studies most relevant to California and a few outlier studies of specialty services to provide a range of effects. Because recent studies better accounted for mode choice and tended to have larger samples, we relied on those when providing the overall estimates in the brief.

Methodological Considerations

Service location and health care service type

The wide range of effect sizes in Table 1 suggests that location has a strong effect on the relationship between telemedicine and VMT reduction. This variation is observed within studies of a single country or state and between studies of different countries. More impactful is the effect of health care service type observed in many studies. Travel distances to tertiary (specialty) clinics are considerably longer than primary and secondary clinics, resulting in much larger estimates of travel reduction for telehealth (Blenkinsop, et al., 2021). These variations should be considered for estimating future potential VMT reductions from expanding telemedicine in California.

Assumptions of counterfactual behavior

All studies assume either 100% or some fraction of telemedicine would have been made FTF if telemedicine was not available. Without longitudinal data with before and after measurement, it is impossible to validate the assumptions of counterfactual travel behavior. It is likely that the studies that assume 100% reduction overrepresent the travel by patients had telemedicine not been available (i.e., at least a small fraction of patients are likely to have forgone their appointment or used another provider).

Assumptions of mode choice and fleet mix

Most studies assume that all the travel distance that would have occurred if telemedicine was not available was made by car (Dullet et al., 2017; Sharma et al., 2023). At least one study used local travel mode shares to improve the estimates of GHG reductions, but they do not report the specific VMT reduction, only the aggregated distance reduction (Schmitz-Grosz et al., 2023). Further, Schmitz-Grosz et al. (2023) used local fleet mix to further refine GHG reduction along with life cycle emission rates. These choices may have consequential effects on the GHG reductions reported, although not on the travel distance reduction reported.

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Table 1. Telemedicine and VMT/GHGs

Study	Study Location	Study Year	Sample Size	Telemedicine Type	VMT/GHG Variable	Reduction per visit
Beswick, et al., 2016	Fresno, CA and Albuquerque, NM	2013-2015	21 patients, 39 visits	Long distance tertiary head and neck oncologic care	VMT	Frenso average: 594 Albuquerque average: 4,208
Dullet, et al., 2017	California	1996-2013	11,281 patients, 19,246 visits	All outpatient care	Travel distance (miles)	278 +/- 228
					kgCO2	~ 100*
Purohit, et al., 2021	Multiple, Review		14 studies	Varies	Travel distance (miles)	9.3 – 862
Blenkinsop, et al., 2021	UK	2020	1,277 patients, 1,567 visits	Long distance adult epilepsy services	Travel distance (miles)	83.5*
					GHGs	~ 0.5% GHGs of clinic
Barlett and Keir, 2022	UK	Unknown	87 visits	Geriatric outpatient	kgCO2e	3.8*
Ravindrane and Patel, 2022	Multiple, Review		14 studies		Travel distance (miles)	9.3 – 480
					kgCO2e	0.7 – 190
Donald and Irukulla, 2022	Multiple, Review		31 studies, 57,000 patients	Varies	Travel distance (miles)	3.8 – 2,104
					kgCO2e	0.7 – 893
Schmitz-Grosz, et al., 2023	Switzerland	2020-2021	433,890 visits	General outpatient	Travel distance (miles)	4.9 (completion), 2.6 (all)*
					kgCO2e	1.1 (completion), 0.57 (all)*
King, et al., 2023	UK	2019-2020	2,140 visits	Gastroenterology outpatient (telephone only)	kgCO2e	5.35
Sharma et al., 2023	California	2020-2022	3,043,369 visits	General outpatient	Travel distance (miles)	17.6
					kgCO2	7.1

*Author calculated. “Completion” refers to visits where treatment was completed, and “all” refers to all telemedicine visits.