2022

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Open Forum Infectious Diseases
MAJOR ARTICLE

Perceptions of Telemedicine and Costs Incurred by a Visit to a General Infectious Diseases Clinic: A Survey

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Background. The costs of attending in-person general infectious diseases clinics and preferences for visit type (telemedicine vs in-person) are not well known. We aimed to measure the time-related, monetary, social, and societal costs associated with travel to an in-person clinic visit and to assess patients' preferences, questions, and concerns regarding telemedicine.

Methods. Patients (≥18 years, living ≥25 miles from clinic at time of clinic visit) were recruited for this survey study from the general infectious diseases (ID) clinic at Washington University from June 2019 to February 2020. We calculated time and money potentially saved by telemedicine, as well as carbon dioxide emissions, with the assistance of Google Maps (low/high estimates). We also determined patient preferences regarding telemedicine for ID care.

Results. Seventy-five patients completed the study. The round-trip mean travel distance was 227.2 ± 142.6 miles, mean travel time was 3.6 ± 2.0 hours to 4.5 ± 2.3 hours (low and high estimates from Google Maps), travel costs were $131.34 ± $82.27, and mean carbon dioxide emissions were 91.79 ± 57.60 kg. Fifty-eight patients (77.3%) said they would be willing to have a telemedicine visit in the future, and 30 (40.5%) said they would rather have had their visit the day the survey was completed as a telemedicine visit.

Conclusions. Telemedicine has the potential to significantly reduce patient costs, both monetary and time-related, and offers substantial environmental benefits, while being an acceptable method of care delivery to most patients at a general ID clinic.

Keywords. infectious diseases consultation; social capital expenditure; telemedicine; telemedicine cost; telemedicine environmental impact.

Telemedicine consultation for infectious diseases (ID) is an understudied area [1]. Patients are satisfied with telemedicine ID services [2–10], but few studies have evaluated clinical outcomes [1]. Telemedicine can expand ID expertise to underserved areas, as has been demonstrated within the Veterans Affairs (VA) system for outpatients. Rural veterans with HIV are less likely to use specialty care, such as ID clinics, than their urban counterparts [11]. Among outpatients, veterans with HIV or hepatitis C virus infection are more likely to complete therapy and/or go to appointments if the appointments are via telemedicine (vs in-person) [7].

In addition, few studies have addressed the time-related, monetary, social, and societal costs incurred by patients attending general ID clinics. As a tertiary care referral hospital in an underserved state, Barnes-Jewish Hospital and Washington University in St. Louis School of Medicine (WUSM) have patients traveling significant distances, which can be costly and time-consuming for patients and their families. This is particularly relevant to general ID populations at our facility, as they tend to be more remote than patients with HIV. As such, we surveyed general ID patients to determine their costs of coming to clinic, eliciting their perspectives on the use of telemedicine for care. Factors studied included costs and time for patients and family, distance traveled, available medical services nearer their home, and patients' preferences, questions, and concerns regarding telemedicine.

METHODS

Survey Development

Our survey was developed to capture the time-related, monetary, social, and societal costs associated with travel to the clinic. The survey was piloted for language clarity by physicians and those with expertise in survey development/quantitative methods. The full 20-question instrument can be found in Supplementary Data.

Patient Recruitment

Patients were recruited from the general ID clinic at WUSM from June 2019 to February 2020. For feasibility, we aimed to

Received 29 September 2021; editorial decision 22 December 2021; accepted 28 December 2021; published online 22 January 2022.

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Open Forum Infectious Diseases®2022

https://doi.org/10.1093/ofid/ofab661

enroll 75 patients. This survey was approved by the WUSM Institutional Review Board. For eligibility, patients had to be ≥18 years of age, able to consent, live ≥25 miles from clinic, and be staying at their home address at the time of their clinic visit (eg, patients at a nursing home or rehabilitation facility were ineligible).

Patient Consent

This survey was approved by the WUSM Institutional Review Board, wherein completion of the survey implied patient consent.

Travel Distance and Time, Transportation Costs, and Energy Savings

Patients were asked to provide their home address and distance to their nearest hospital. We used home addresses and the directions function of Google Maps (Google, Inc., Mountain View, CA, USA) to calculate their 1-way distance and travel time to the clinic, doubling the values for round-trip travel. We recorded miles to 1 decimal, using the fastest route identified, specifying a standard clinic arrival time of 8:00 a.m. We recorded low and high estimates of travel time. In instances where the exact address could not be found on Google Maps (n = 2) or a PO Box was provided (n = 3), we used hometown as an approximation of home address.

To estimate fuel usage, round-trip travel distance (miles) was divided by the Environmental Protection Agency (EPA)–reported fuel economy of the average gasoline vehicle (22.0 miles per gallon) [12]. Fuel cost was calculated by multiplying fuel volume by the average fuel cost in the St. Louis, MO–IL region for the month of the patient's visit, based on US Bureau of Labor Statistics data; these rates, in price per gallon, were $2.507, $2.634, $2.499, $2.408, $2.358, $2.255, $2.237, $2.242, and $2.136 for each respective month from June 2019 to February 2020 [13]. For a more comprehensive estimate of transportation costs, round-trip distance was multiplied by the standard Internal Revenue Service (IRS) mileage rates for business; the business rate was used to account for all fixed and variable costs of operating an automobile. For clinic visits that occurred in 2019, the rate was $0.58 per mile; for 2020, the rate was $0.575 per mile [14]. Carbon dioxide (CO_2) emissions were calculated by multiplying round-trip travel distance (miles) by 0.404 (kg CO_2 per mile), based on average passenger vehicle emissions from the EPA [12].

Patients self-reported their parking and transportation costs via preselected ranges. To estimate median and average patient-reported costs, for minimum estimates, we assigned the minimum value for each cost range; for maximum estimates, we assigned the maximum value for each cost range. We then calculated the median (interquartile range [IQR]) and mean (SD) for each minimum and maximum cost estimate separately.

Rural–Urban Definitions

Patient rurality was established with Rural-Urban Commuting Area (RUCA) codes [15]. First, state-county-tract Federal Information Processing Series (FIPS) codes were assigned based on home address, using the geocoding/mapping function of the Federal Financial Institutions Examination Council [16]. FIPS codes were used to assign primary and secondary 2010 RUCA codes [15]. Primary and secondary RUCAs were aggregated according to the University of Washington's Rural Health Research Center's suggested Categorization A, with 4 categories consisting of urban focused, large rural city/town (micropolitan) focused, small rural town focused, and isolated small rural town focused [17]. RUCA code definitions are available from the University of Washington [18].

Analysis

Statistical analyses were conducted using Stata (version 14.2; StataCorp, College Station, TX, USA). P values ≤.05 were considered statistically significant. For bivariate statistics, probability values were obtained with a Fisher's exact test for categorical variables and a 2-sample t test for continuous variables or 1-way analysis of variance (when >2 groups). Ordered logistic, ordered probit, and multinomial logit models were used for our ordered categorical outcome, telemedicine willingness. Due to the small sample size, we collapsed response categories as follows: *strongly agree/agree* and *disagree/strongly disagree*. We examined the association of telemedicine willingness with patient cost variables (travel distance and whether the patient missed work) while adjusting for demographic variables (patient's age and gender). Both age [19] and gender [20] have been reported as factors associated with telemedicine preference. To discern which model was more appropriate, the ordinality of the outcome variable (telemedicine willingness) was checked using correlations between the model-predicted probabilities of the multinomial logit model and the ordered logit model. Correlation between probabilities for the category *strongly agree/agree* was high (r = 0.822), while *neutral/neither agree nor disagree* was low (r = 0.283) and *disagree/strongly disagree* was moderate (r = 0.672). Given these differences, the multinomial model is preferred and is presented here.

Interpretive analyses were conducted on open-ended responses using NVivo (version 12; QSR International, Melbourne, Australia). One study team member (E.C.E.) trained in qualitative analysis reviewed responses and developed a set of open and focused codes [21]. An eclectic combination of descriptive, in vivo, process, concept, and evaluation coding techniques was applied [22]. Responses were coded separately for each question and for each visit preference (telemedicine vs in-person visit). Codes were aggregated within categories. The process of analyzing the data was iterative; all responses were reviewed multiple times, and codes and categorizations were refined. Once the codebook was finalized, all responses and coding were reviewed again to ensure consistency and completeness, and exemplary quotes were selected.

RESULTS

Of 75 patients enrolled, 53.3% were male, and the average age was 54.7 years (Table 1). Most patients traveled to clinic via their own vehicle (n = 55, 73.3%), while 21.3% (n = 16) utilized a friend/family member's vehicle. Whether traveling via their own vehicle or that of friend/family, patients often relied on someone else to drive (n = 41, 54.7%). Half of patients reported traveling >100 miles for their visit, with an average patient-reported travel time of 2 hours. For most patients, this was not their first visit; 55 (75.3%) had, on a different day, previously had an ID visit at either our ID clinic or elsewhere on campus (including prior hospitalization). Nearly all (n = 72, 96.0%) reported that the hospital nearest to their home was reachable within a 1-hour drive. Participants were observed to be split relatively evenly from urban focused vs rural areas.

Overall, most patients (n = 58, 77.3%) were willing to complete a future visit by telemedicine, but for today's visit, the majority (n = 44, 59.5%) preferred in-person. Among those who preferred an in-person appointment today, nearly 64% would be willing to complete a future visit by telemedicine. Only mode of transportation showed a statistically significant relationship with telemedicine preference for today's visit, but it was not significantly associated with telemedicine willingness for a future visit (Table 1). Both travel distance and patient-reported travel time were significantly associated with willingness for a future visit via telemedicine; those who were less inclined toward telemedicine had a significantly lower average travel time (Table 1).

Patients reported a variety of costs associated with their visit (Table 2). Most (n = 59, 79.7%) reported no cost for parking, although the maximum was >\$100. Self-reported transportation costs were varied, ranging from \$0 to >\$100. Nine patients (12.0%) had an overnight stay away from home, 8 (10.7%) in a hotel, and 1 (1.3%) with a friend/family member. Hotel costs (among those who stayed in a hotel) averaged \$162.63, while the maximum reported was \$500 (4 nights). The combined total median self-reported costs of parking, transportation, and lodging (IQR) was between \$2 (\$1–\$39) and \$36 (\$24–\$75). Fourteen patients (18.7%) reported missing work for their visit. Sixteen patients (21.3%) rearranged their work schedule for the appointment, used sick days, or scheduled their clinic visit on a day off from work. Nearly 40% (n = 29) of patients reported that family/friends missed work to help them attend their visit.

Using the directions function of Google Maps, we explored potential round-trip cost savings; average round-trip distance, travel time, fuel costs, and IRS mileage rates were substantial (Table 3). Had the trip occurred by telemedicine, rather than in-person, an average (SD) of 91.79 (57.60) kg of CO_2 emissions per person could have been saved.

Differences in predicted probabilities of telemedicine willingness for selected characteristics based on estimated coefficients of the multinomial logit model, calculated as average marginal effects, are presented in Table 4. A typical study participant had a probability of .773 of responding *strongly agree/agree*, a probability of .133 for *neutral/neither agree nor disagree*, and a probability of .093 for *disagree/strongly disagree*. Other things being equal, every SD unit increase in 1-way travel distance, roughly 71 miles, decreased the probability of responding *disagree/strongly disagree* by .08 (P = .003). This was offset by an increase in the probability of responding *neutral/neither agree nor disagree* by .06 (P = .159) and an increase in responding *strongly agree/agree* by .02 (P = .68). On average, for people similar on other characteristics, missing work decreased the probability of responding (to telemedicine willingness) *disagree/strongly disagree* by .11 (P = .003) and *neutral/neither agree nor disagree* by .07 (P = .451) compared with someone not missing work. This was offset by an increase in responding *strongly agree/agree* by .175 (P = .062). There were no statistically significant effects by gender or age.

Qualitative Responses

Patients were asked 3 open-ended questions (Table 5). The first question addressed the patient's reasoning behind their preferences. Among those who preferred in-person visits, 6 themes emerged: interpersonal (building relationships, communications, preference for face-to-face, need for reassurance), concerns regarding physical exam (need for hands-on), type of visit or stage of treatment (first visit vs follow-up), severity of illness, technology (internet access, comfort with computers), and dual scheduling of other services (eg, flu shots, other appointments, diagnostic services). Among those who preferred a visit via telemedicine, 2 themes were reinforced from a different perspective: interpersonal (existing relationship with physician, needing another person to take off work to drive them—both increased willingness for a telemedicine visit) and type of visit or stage of treatment (follow-up). Additional themes included recent travel for other appointments, savings (time, distance, expense, and safety), and convenience.

The second item solicited questions patients have about telemedicine. Among those who preferred in-person visits, 5 themes were identified: general ("What it involves"), types of visits ("Will this take the place of consultation visits?"), efficacy ("How can a doctor truly evaluate your condition?"), technology ("How technologically familiar do you have to be to do this?"), and statements of strong feelings ("NONE! Don't like it and I won't use it!"). Those who preferred a telemedicine appointment did not report any questions.

The final question asked participants to describe their concerns regarding telemedicine. Among those who preferred in-person, the following themes emerged: efficacy and accuracy ("Might miss a problem"), privacy, technology ("Internet connection"), logistics ("Will they be less likely to follow up?"; ie, will telemedicine result in the patient not receiving adequate

Table 1. Characteristics of 75 Study Participants, by Telemedicine Preference for Today's Visit and Willingness for Future Visits

		What Would Have Been Your Preference for Today's Visit?[a]			I Would Be Willing to Complete a Visit With a Doctor by Telemedicine (Video Conferencing)			
	All Participants	Telemedicine (n = 30)	In-person (n = 44)	P[b]	Strongly Agree/Agree (n = 58)	Neutral/Neither Agree nor Disagree (n = 10)	Disagree/ Strongly Disagree (n = 7)	P[c]
Age, y	54.7 ± 17.2	54.4 ± 17.8	54.8 ± 17.2	.909	53.7 ± 18.1	57.6 ± 12.5	58.3 ± 16.0	.687
Sex								
Male	40 (53.3)	16 (53.3)	23 (52.3)	1.000	28 (48.3)	7 (70.0)	5 (71.4)	.307
Mode of transportation to clinic								
Patient's vehicle				.038				.308
Patient drove	25 (33.3)	19 (63.3)	35 (79.6)		39 (67.2)	10 (100.0)	6 (85.7)	
Someone else drove	29 (38.7)							
Took turns driving	1 (1.3)							
Friend or family member's vehicle								
Patient drove	2 (2.7)	7 (23.3)	9 (20.5)		15 (25.9)	0 (0.0)	1 (14.3)	
Someone else drove	12 (16.0)							
Took turns driving	2 (2.7)							
Medical transportation	1 (1.3)	4 (13.3)	0 (0)		4 (6.9)	0 (0.0)	0 (0.0)	
Transport service (eg, taxicab, Uber, Lyft, etc.)	1 (1.3)							
Combination of public transportation and transport service (eg, taxicab, Uber, Lyft, etc.)	1 (1.3)							
Other	1 (1.3)							
Visit history with clinic or hospital								
First visit with this infectious disease clinic	19 (25.3)	6 (20.0)	13 (29.6)	.543	14 (24.1)	3 (30.0)	2 (28.6)	.785
Prior visit with infectious disease physician from Washington University/Barnes Jewish Hospital	23 (30.7)	9 (30.0)	14 (31.8)		20 (34.5)	2 (20.0)	1 (14.3)	
Prior visit with this infectious diseases clinic	33 (44.0)	15 (50)	17 (38.6)		24 (41.4)	5 (50.0)	4 (57.1)	
	All Participants	Telemedicine (n = 30)	In-person (n = 44)	P[b]	Strongly Agree/Agree (n = 58)	Neutral/Neither Agree nor Disagree (n = 10)	Disagree/ Strongly Disagree (n = 7)	P[c]
Travel distance for appointment								
25–50 miles	15 (20.0)	4 (13.3)	11 (25.0)	.489	9 (15.5)	2 (20.0)	4 (57.1)	.024
51–75 miles	10 (13.3)	3 (10.0)	7 (15.9)		8 (13.8)	0 (0.0)	2 (28.6)	
76–100 miles	12 (16.0)	6 (20.0)	6 (13.6)		9 (15.5)	2 (20.0)	1 (14.3)	
>100 miles	38 (50.7)	17 (56.7)	20 (45.5)		32 (55.2)	6 (60.0)	0 (0.0)	
Patient-reported travel time, h	2.0 ± 1.1	2.12 ± 1.07	1.93 ± 1.14	.465	2.11 ± 1.07	2.11 ± 1.32	1.00 ± 0.47	.037
Driving time to hospital closest to home								
<30 min	61 (81.3)	25 (83.3)	35 (79.6)	.564	50 (86.2)	6 (60.0)	5 (71.4)	.093
30–60 min	11 (14.7)	3 (10.0)	8 (18.2)		6 (10.3)	4 (40.0)	1 (14.3)	
1–2 h	1 (1.3)	1 (3.3)	0 (0.0)		1 (1.7)	0 (0.0)	0 (0.0)	
2–3 h	2 (2.7)	1 (3.3)	1 (2.3)		1 (1.7)	0 (0.0)	1 (14.3)	
Rural-Urban Commuting Areas (RUCAs)								
Urban focused	39 (52)	14 (46.7)	25 (56.8)	.734	30 (51.7)	4 (40.0)	5 (71.4)	.880
Large rural city/town (micropolitan) focused	14 (18.7)	5 (16.7)	8 (18.2)		10 (17.2)	3 (30.0)	1 (14.3)	
Small rural town focused	18 (24.0)	9 (30.0)	9 (20.5)		14 (24.1)	3 (30.0)	1 (14.3)	
Isolated small rural town focused	4 (5.3)	2 (6.7)	2 (4.6)		4 (6.9)	0 (0.0)	0 (0.0)	

Data are presented as mean ± SD or No. (%).

[a]n = 74.

[b]Fisher exact test for categorical variables and 2-sample *t* test for continuous variables.

[c]Fisher exact test for categorical variables and 1-way analysis of variance for continuous variables.

follow-up?), and statements of strong feelings ("Not interested"). Those who preferred telemedicine reiterated efficacy themes ("Inability to perform a proper exam") and privacy, while adding an additional concern over specific procedures ("Removing a PICC [peripherally inserted central catheter] line").

DISCUSSION

Among general ID clinic patients, over three-quarters reported willingness to complete a future visit by telemedicine. Travel time and distance were significantly associated with telemedicine willingness; those who were less inclined toward

Table 2. Costs Associated With Traditional Infectious Disease Office Visit

	No. (%) or Mean ± SD
Parking	
$0 (did not pay)	59 (79.7)
<$25	13 (17.6)
$25–$50	0 (0)
$51–$75	1 (1.4)
$76–$100	0 (0)
>$100	1 (1.4)
Transportation costs	
$0 (did not pay)	18 (24.7)
<$25	23 (31.5)
$25–$50	18 (24.7)
$51–$75	9 (12.3)
$76–$100	4 (5.5)
>$100	1 (1.4)
Overnight stay away from home	
Hotel	8 (10.7)
Cost	$162.63 ± $137.95
With family or a friend	1 (1.3)
No. of nights away	
1 night	8 (10.7)
4 nights	1 (1.3)
Missed work for visit	14 (18.7)
Time off work	
Not employed before illness	9 (12)
Not working due to illness (not on FMLA)	9 (12)
On FMLA	8 (10.7)
Rearranged work schedule for appointment	11 (14.7)
Using sick days	2 (2.7)
Other:	36 (48)
Disability	9 (12.2)
Skilled Nursing Facility	1 (1.3)
Unemployed	2 (2.7)
Day off work	3 (4.0)
Retired	17 (22.7)
Family member or friend missed work	29 (39.2)

Abbreviation: FMLA, Family and Medical Leave Act.

telemedicine reported lower average travel time. Patients reported substantial costs related to visits, including money for parking, transportation, and lodging, as well as social costs, including missing work, needing a ride from family/friends, or needing family/friends to miss work. As costs accrue, telemedicine becomes more appealing for many patients. Consider a hypothetical worst-case scenario from our data: A patient with round-trip travel of 666 miles and 11.6 hours, with estimated IRS travel costs of $383, paying >$100 for parking, paying $500 for 4 nights in a hotel, requiring time off work, and needing family/friends to take off work. With constraints such as these, it is no wonder patients have difficulty maintaining follow-up appointments.

Table 3. Potential Round-trip Savings if Visit Had Occurred by Telemedicine Rather Than In-person

	Mean ± SD	Range
Potential savings		
Travel distance, miles	227.2 ± 142.6	(51.4–666)
Travel time, low estimate; high estimate, h	3.6 ± 2.0; 4.5 ± 2.3	(1.2–9.6); (1.6–11.6)
Fuel costs	$23.50 ± $14.77	($5.24–$67.87)
Travel costs, IRS mileage rates	$131.34 ± $82.27	($29.56–$382.95)
Reduction in emissions		
Carbon dioxide, kg	91.79 ± 57.60	(20.77–269.06)

Although most patients reported willingness to complete a future visit by telemedicine, over half still preferred in-person for today's visit. This could be the result of knowing the details of today's visit; patients reported a preference for in-person visits to build relationships if it was their first visit or a long time since their last visit, if they had concerns about the physical exam, if they gauged their illness or injury to be severe, or if they had other medical appointments co-scheduled. These contradictory results may also be impacted by choice-supportive bias, whereby people tend to express greater support for decisions they have already made [23]. In this case, we would likely expect a greater proportion of patients to endorse an in-person visit for today, as they are already engaged in an in-person visit. Importantly, over three-quarters of patients reported willingness for telemedicine in a future visit. These findings are consistent with prior research reporting that patients are generally satisfied with telemedicine services [2–10].

In addition to reduced costs for patients, telemedicine could offer substantial savings in greenhouse gas emissions. Given that the estimated amount of CO_2 a mature tree can absorb over the course of a year is 22 kg [24], it would take >4 mature trees a year's time to eliminate the average amount of CO_2 produced during travel by just 1 of our patients. Multiplied across patients, the potential savings are considerable. As of 2018, the United States was the second highest CO_2 emitter (total emissions) and fourth highest per capita [25]. US health care plays no small role; the health care sector contributes significantly to air pollution emissions, including responsibility for 10% of greenhouse gas emissions [26]. In the Institute of Medicine's 2013 Public Health Linkages with Sustainability Workshop Summary, it was recommended that the health sector take the lead in improving global and planetary health by shrinking its own ecological footprint [27]. Telemedicine offers one strategy to begin this process.

We did not observe statistically significant differences in telemedicine preference for today's visit or for future telemedicine willingness by rural vs urban residence—distance appeared to play a stronger role. Rural does not necessarily mean remote; distances from rural areas to urban cores and services may range from only a few to hundreds of miles [28]. However, as rural hospitals close, the distances patients must drive for medical care are likely to increase; between January 2013 and February 2020, 101 rural hospitals closed, resulting in patients

Table 4. Differences in Predicted Probabilities of Telemedicine Willingness by Selected Factors[a]

	Telemedicine Willingness		
Characteristic	Strongly Agree/Agree	Neutral/Neither Agree nor Disagree	Disagree/Strongly Disagree
All[b]	0.773	0.133	0.093
Sex			
Male vs female (reference)	–0.111	0.082	0.028
P value	.242	.288	.644
Age (1 SD = 17.2 y)			
Every 1-SD increase	–0.021	–0.002	0.023
P value	.687	.960	.550
One-way travel distance (1 SD = 71.3 miles)			
Every 1-SD increase	0.020	0.061	–0.081
P value	.680	.159	.003
Patient missed work			
Missed vs did not miss (reference)	0.175	–0.067	–0.109
P value	.062	.451	.003
Pseudo R^2	0.1666		
Model likelihood ratio χ^2 (df, *P* value)	17.21 (8, *P* = .0280)		
No.	75		

[a]Predictions are based on the estimated coefficients of the multinomial logit model; they were calculated as average marginal effects.

[b]Average predicted probabilities of all sample participants.

driving ~20 miles farther for common services (eg, inpatient care) or ~40 additional miles for less common services (eg, alcohol or drug abuse treatment) [29]. Since the COVID-19 pandemic, the number of rural hospitals at immediate risk or high risk of closure has reached >800, comprising 40% of rural hospitals in the United States [30]. If trends continue, patient travel distances may become an even greater burden. While telemedicine can facilitate care for rural patients, whether telemedicine will help or hinder rural hospitals' continued existence remains to be seen.

While physical distances between rural and urban areas may vary, the digital divide remains substantial. In rural areas, 22.3% of households lack access to broadband (at the Federal Communications Commission's standard of 25 megabits per second [Mbps] download and 3 Mbps upload speeds), while this is true for only 1.5% in urban areas [31]. This gap has narrowed in recent years, but to date remains considerable. Similar to other specialties [32, 33], in our study, internet access was an important concern.

As a result of the COVID-19 pandemic and temporary policy changes implemented by Centers for Medicare & Medicaid Services (CMS) [34], telehealth services have dramatically increased [35]. Although telemedicine has the potential to play a crucial role in savings for both patients and the environment, challenges remain. It is unclear whether insurance changes will be made permanent after the pandemic ends. Concerns regarding gaps in access to telemedicine remain, including for patients with limited experience with or access to technology [36]. Permitting the use of audio-only for telemedicine visits will help expand access to those without live-video technology [36]. To expand coverage and incentivize clinicians to provide telemedicine, quality of service and payments across insurers must be comparable to in-person care [36].

Patients' concerns and questions regarding telemedicine must also be addressed. Patients in our study expressed concern that in-person visits might be better for communication/building relationships. Currently, public trust of medical doctors and nurses remains high [37, 38], in contrast to declines in interpersonal trust and trust of public institutions and government [39, 40]. Considering the impact of misinformation and disinformation during the current pandemic [41, 42], it is critical that medical professionals continue to build and maintain strong, trusting relationships with patients. While some may view telehealth as a barrier to relationship building, others see an opportunity; telehealth visits may offer a unique way to invest in relationships by respecting patients' needs in combination with careful communications [43].

A limitation of our study is the sample size. Sample size <100 is considered risky for maximum likelihood estimators [44] and thus requires caution in interpreting results of our multinomial logit model of telemedicine willingness. The timing of our clinic survey, June 2019–February 2020, was just before COVID-19 pandemic-related policy changes leading to dramatic increases in usage of telemedicine. Thus, our study likely captures patient sentiment among those who had not yet experienced a telemedicine visit. Actual CO_2 emissions saved could be significantly higher or lower depending on vehicle fuel efficiency.

Our study focused on marginal costs subsumed by patients in travel to our clinic; future studies should also investigate the marginal costs of a visit by telemedicine. Through our qualitative analysis, we learned that in some cases patients preferred an in-person visit because they had co-scheduled other in-person

Table 5. Themes and Quotes From Open-Ended Questions

1. Why would it have been your preference for the visit type you chose (either telemedicine or in-person)?	
In-person preference	
Interpersonal (building relationships, communications, preference for face-to-face, need for reassurance)	"Best to build relationship and ask questions"
	"I like in person because I like more personal situations"
	"Easier to communicate"
	"You can find out more. Face to face means more than over telephone (or any device)"
	"The face to face was encouraging"
	"Reassurance that everything is right"
Physical exam concerns (need for hands-on)	"Because I want a live 1 on 1 visit when it comes to my health. The doc can't feel any issues over a device"
	"Doctor can examine if needed (and do an ekg)"
Type of visit/stage of treatment	"First visit. Follow up visits could be telemedicine"
	"1st Post hospital visit"
	"Long time since last seen"
	"Because of my recent surgery"
Severity of illness	"My injury is serious and I needed to know they think everything is going well"
	"Because of how sick I was before the surgery and the type of surgery"
Technology	"Too difficult to work a computer"
	"No internet or WiFi access"
Dual scheduling of other services	"Wanting to get flu shot"
	"Already here to see a different doctor"
	"We had scans"
1. Why would it have been your preference for the visit type you chose (either telemedicine or in-person)?	
Telemedicine preference	
Interpersonal (existing relationship with physician, need for a driver)	"Being on the upside of my injury me and my doctors have good understanding of each other and knowing that if there was a thought that something was wrong I'd already had let them know"
	"I have to have someone else take off work to drive us"
Type of visit/stage of treatment	"Today was just a quick checkup"
	"There wasn't a hands on need for me to be seen in clinic today. We just discussed medication"
	"The drive is crazy for a 15 minute appointment"
Recent travel for other appointments	"Distance to drive and I had an appointment at Barnes yesterday but they could not get both appointments on the same day"
Savings (time, distance, expense, safety)	"Telemedicine would save on gas, time, and definitely be safer due to all the construction we drive thru on the way here"
	"Telemedicine is convenient for us due to neither one of us are working because of my medical condition and assistant needed. So no income it hard to just up and go places as often as needed"
	"Travel time and expense"
Convenience	"More convenient"
	"Faster and easier"
	"Much less planning…had to change other standing appts"
	"Less stress due to feeling sick"
2. What questions do you have about telemedicine?	
In-person preference	
General	"What it involves"
Types of visits	"Will this take the place of consultation visits?"
	"Would this be just for general questions and filling prescriptions?"
	"Could it be used intermittently"
Efficacy	"How can a doctor truly evaluate your condition?"
Technology	"How technologically familiar do you have to be to do this"
	"How to use technology"
	"None my daughter will help me"
Strong feelings	"NONE! Don't like it and I won't use it!"
Telemedicine preference	
None (no responses)	.
3. What concerns do you have about telemedicine, if any?	
In-person preference	

Table 5. Continued

Efficacy/accuracy	"See previous question. Accuracy" "Might miss a problem" "The newness and not being face to face, can't see whole body during visit" "People lying to the doctor" "Not getting hands on with drs to see you in person if something was wrong"
Privacy	"Privacy"
Technology	"Internet connection"
Logistics	"May be dealing with too many differant people" "Will they be less likely to follow up"
Strong feelings	"Not interested"
Telemedicine preference	
Efficacy	"Inability to perform a proper exam"
Privacy	"Privacy"
Procedures	"Removing a PICC line"

Abbreviation: PICC, peripherally inserted central catheter.

services and procedures (eg, immunizations); future studies should query patients to determine if telemedicine could have truly eliminated the need for travel for the visit under investigation. Our qualitative analysis also revealed that patients preferred an in-person visit when they felt their illness or injury was severe; future research should assess the patient's subjective rating of severity, as well as assess International Classification of Diseases codes for complex or sensitive diseases. Additional cost variables, including insurance cost, co-pays, and charges, as well as insurance status (self-pay vs insured), salary, Family and Medical Leave Act (FMLA), and disability status, should be explored in relation to telemedicine preference. While in this study we observed statistically significant differences in telemedicine willingness by distance traveled but not by rural vs urban residence, additional research is needed to further explore this finding, particularly regarding access. As of 2017, 2499 of 3142 US counties (79.5%) did not have a single ID physician [45]. Future studies should explore the density of ID physicians in the patient's county of residence.

CONCLUSIONS

Telemedicine may prove useful for care delivery to general ID patients, particularly those traveling far distances who would benefit from cost savings. However, we must remain mindful of patients' concerns and potential disparities, including access and familiarity with technology.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Acknowledgments

Financial support. Dr. Burnham reports that this study was made possible by grant number UL1 TR002345, sub-award KL2 TR002346, from the National Institutes of Health (NIH)/National Center for Advancing Translational Sciences (NCATS), components of the NIH, and the NIH Roadmap for Medical Research. Its contents are solely the responsibility of the authors and do not necessarily represent the official view of the NCATS or NIH. He also reports that this publication in whole or in part was supported by The Foundation for Barnes-Jewish Hospital and their generous donors and the Washington University Institute of Clinical and Translational Sciences, which is, in part, supported by the NIH/NCATS (CTSA grant UL1TR002345). Dr. Fritz reports that this work was supported by the Agency for Healthcare Research and Quality (AHRQ; grant number R01-HS024269 to S.A.F.).

Potential conflicts of interest. All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

Patient consent. This survey was approved by the WUSM Institutional Review Board, wherein completion of the survey implied patient consent.

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