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Evaluation of recorded video-observed therapy for anti-tuberculosis treatment

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SUMMARY

BACKGROUND: Asynchronous video directly observed therapy (VDOT) may reduce tuberculosis (TB) program costs and the burden on patients. We compared VDOT performance across three cities in the United States, each of which have TB incidence rates above the national average.

METHODS: Patients aged ≥18 years who are currently receiving directly observed anti-TB treatment were invited to use VDOT for monitoring treatment. Pre- and post-treatment interviews and medical records were used to assess site differences in treatment adherence and patient characteristics and perceptions.

RESULTS: Participants were enrolled in New York City, NY ($n = 48$), San Diego, CA ($n = 52$) and San Francisco, CA, USA ($n = 49$). Overall, the mean age was 41 years (range 18–87); 59% were male; most were Asian (45%) or Hispanic/Latino (30%); and 77% were foreign-born. The median fraction of expected doses observed (FEDO) was 88% (IQR 76–96). At follow-up, 97% thought VDOT was "very or somewhat easy to use" and 95% would recommend VDOT to other TB patients. Age, race/ethnicity, annual income, and country of birth differed by city ($P < 0.05$), but FEDO and VDOT perceptions did not.

CONCLUSIONS: TB programs in three large US cities observed a high FEDO using VDOT while minimizing staff time and travel. Similar findings across sites support VDOT adoption by other large, urban TB programs.

KEY WORDS: mHealth; monitoring; adherence

THE US STATES OF CALIFORNIA, Texas, New York, and Florida account for over 50% of the tuberculosis (TB) cases in the United States, where foreign-born persons and racial/ethnic minorities continue to bare a disproportionate burden of disease, with the highest incidence among Asians and Hispanics.[1] Most TB is curable with anti-TB drugs; however, poor adherence to protracted multi-drug treatment regimens can lead to ongoing transmission, mortality, and development of drug resistance. Directly observed therapy (DOT), which enlists healthcare workers or trusted designees to watch patients take each medication dose[2,3] is thus endorsed as standard practice to support medication adherence, prevent drug resistance and ensure a cure.[4–6]

While effective in supporting treatment adherence, DOT is costly, labor-intensive and sometimes not possible.[7,8] Asynchronous (recorded) video directly observed therapy (VDOT) was developed to address barriers to DOT. Asynchronous VDOT applications allow patients to record themselves swallowing each treatment dose and automatically send date/time-stamped videos for review by a healthcare worker through an internet-based provider dashboard. Asynchronous VDOT differs from video-conferencing where providers watch patients ingest medications in real-time (also known as synchronous VDOT),[9] because dosing is not restricted to traditional business hours, medication can be taken in any location, and a network connection is not required at the time patients record each date/time-stamped video. Providers using asynchronous VDOT can watch patient videos during business hours regardless of when the videos are received.

A study conducted in San Diego, CA, USA, and Tijuana, Baja California, Mexico, where TB incidence rates are among the highest in both bordering

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countries,[10] found that asynchronous VDOT was feasible and widely acceptable to patients and providers in these high- and low-resource settings, respectively.[11] Furthermore, respectively 95% and 96% of expected doses were observed on-schedule via VDOT in San Diego and Tijuana, and 92% of participants overall preferred VDOT over DOT. A subsequent study involving five California health districts obtained similar findings from both urban and rural counties.[7] VDOT scale-up requires evidence that it performs similarly well across health departments implementing the intervention. The current study evaluated VDOT implementation in three major metropolitan US cities with above-national average TB incidence rates. This allowed us to determine whether site affected VDOT outcomes.

Study population and methods

Study design and setting

This was a pragmatic single-arm intervention study conducted through the San Diego County, San Francisco City, and New York City Health Departments between August 2013 and July 2014. Patients with newly diagnosed pulmonary or extrapulmonary TB were sequentially invited by TB program staff to switch from DOT to VDOT for the duration of their TB treatment provided at least 2 months of treatment remained.

Eligibility and recruitment

Eligible patients were aged ≥18 years who were prescribed TB treatment using DOT. Patients who planned to move out of the health district before completing treatment or who had physical or cognitive conditions that prevented performance of VDOT procedures were excluded. Patients with suspected TB were included if they were prescribed anti-TB treatment while awaiting confirmatory test results, which could take up to 2 months. If TB was not confirmed by the tests, treatment was terminated, and adherence was measured for the period of time those patients used VDOT. Patients with drug-resistant TB receiving all oral medications were eligible, as their monitoring procedures did not differ. All participants received DOT at the start of anti-TB treatment and switched to VDOT after 2 weeks or after their providers determined that they were tolerating their medications (whichever was longer). Of the 161 participants who consented, 2 were withdrawn due to technical problems that prevented use of VDOT, 5 ended treatment before starting VDOT, 4 decided not to participate, and 1 was lost before starting treatment.

Ethical considerations

Ethical clearance was obtained from the Institutional Review Boards of the University of California San Diego, University of California San Francisco, and New York City Department of Health and Mental Hygiene, as well as the San Diego County Health and Human Services Agency Research Committee, San Diego, CA, USA. All participants provided written informed consent.

Data collection

Participants underwent brief (15–20 min) interviews by phone at the start and end of VDOT use. Baseline interviews assessed participant sociodemographics, TB treatment history, TB risk factors (e.g., alcohol and illicit drug use, smoking status, homelessness and history of incarceration), and concerns about privacy (variables listed in Table 1). Follow-up interviews assessed participant VDOT experiences, including the number of training days required to learn the VDOT procedures, problems recording videos, confidentiality and satisfaction with their overall TB care and use of VDOT (variables listed in Table 2). To minimize socially desirable responding, all interviews were conducted by research assistants who were not involved in patient care. Participants received US$10 for completing each interview but were not remunerated for recording videos.

VDOT procedures

A detailed description of the VDOT system is described elsewhere,[12] but in essence, participants used smartphones to record themselves taking each medication dose and TB program staff watched them via a secure website. At enrolment, 69% of participants possessed smartphones; however, the study loaned smartphones for participants to use, which ensured that the application functioned similarly for all participants and cellular service was maintained. Participants could use smartphones for TB care purposes, such as communicating with their provider by phone, text or email and searching the Internet for TB information; however, only the volume of data usage was monitored.

Prior to study enrolment, TB program staff received training on study procedures, enrolment, consenting, data entry and participant training on the use of VDOT. TB program staff trained participants to perform VDOT procedures during routine DOT visits until the participant demonstrated competency (median, 1 day). Participant treatment regimens and routine monthly clinic visits were not altered by the study. Given the pilot nature of the study, participants were instructed to call or visit their healthcare provider to report symptoms before ingesting a medication dose, rather than attempting to convey such information through VDOT videos. If medication side effects were mentioned during videos, it was documented, and program staff contacted participants per local protocol.

Treatment adherence was documented by TB

Table 1 Participant baseline characteristics by city, 2013–2014

Variable	Total ($n = 149$) *n* (%)	San Diego, CA ($n = 52$) *n* (%)	San Francisco, CA ($n = 49$) *n* (%)	New York City, NY ($n = 48$) *n* (%)	*P* value*
Age, years					
Mean [SD]	40.9 [16.0]	39.6 [16.3]	47.4 [15.7]	35.6 [14.0]	<0.001
Median [IQR]	39 [28–50]	35.5 [29–47]	48 [32–59]	34 [23–46]	
Range	18–87	18–87	25–80	18–72	
Education					0.252
≤Primary	20 (13.4)	4 (7.7)	7 (14.3)	9 (18.8)	
High school	65 (43.6)	23 (44.2)	20 (40.8)	22 (45.8)	
Some college/technical school	28 (18.8)	11 (21.2)	7 (14.3)	10 (20.8)	
≥Graduate	32 (21.5)	13 (25.0)	14 (28.6)	5 (10.4)	
Missing	4 (2.7)	1 (1.9)	1 (2.0)	2 (4.2)	
Sex					0.728
Male	88 (59.1)	33 (63.5)	28 (57.1)	27 (56.2)	
Female	61 (40.9)	19 (36.5)	21 (42.9)	21 (43.8)	
Race/ethnicity					<0.001
Asian	67 (45.0)	23 (44.2)	33 (67.3)	11 (22.9)	
Black/African-American	20 (13.4)	1 (1.9)	—	19 (39.6)	
American Indian/Alaskan Native	—	—	—	—	
Pacific Islander/Native Hawaiian	1 (0.7)	—	—	1 (2.1)	
Caucasian/White	10 (6.7)	5 (9.6)	4 (8.2)	1 (2.1)	
Hispanic/Latino	44 (29.5)	21 (40.4)	9 (18.4)	14 (29.2)	
Other/mixed race	7 (4.7)	2 (3.8)	3 (6.1)	2 (4.2)	
Country of birth					
USA	34 (22.8)	12 (23.1)	6 (12.2)	16 (33.3)	0.002
Mexico	19 (12.8)	13 (25.0)	4 (8.2)	2 (4.2)	
Other†	96 (64.4)	27 (51.9)	39 (79.6)	30 (62.5)	
Annual income, US dollar					
<10 000	68 (45.6)	21 (40.4)	20 (40.8)	27 (56.2)	0.020
10 000–30 000	44 (29.5)	12 (23.1)	17 (34.7)	15 (31.2)	
30 000–50 000	11 (7.4)	8 (15.4)	2 (4.1)	1 (2.1)	
>50 000	16 (10.7)	8 (15.4)	7 (14.3)	1 (2.1)	
Missing	10 (6.7)	3 (5.8)	3 (6.1)	4 (8.3)	
Had health insurance at baseline					
Yes	118 (79.2)	40 (76.9)	42 (85.7)	36 (75.0)	0.441
No	30 (20.1)	12 (23.1)	7 (14.3)	11 (22.9)	
Missing	1 (0.7)	0 (0)	0 (0)	1 (2.1)	
Owned a cell phone at baseline					
Yes	136 (91.3)	46 (88.5)	46 (93.9)	44 (91.7)	0.672
No	13 (8.7)	6 11.5)	3 (6.1)	4 (8.3)	
Owned a smartphone at baseline					
Yes	103 (69.1)	38 (73.1)	31 (63.3)	34 (70.8)	0.555
No	46 (30.9)	14 (26.9)	18 (36.7)	14 (29.2)	
Reported physical conditions that could make it hard to use a cell phone at baseline					
Yes	6 (4.0)	1 (1.9)	3 (6.1)	2 (4.2)	
No	141 (94.6)	50 (96.2)	46 (93.9)	45 (93.8)	0.606
Missing	2 (1.3)	1 (1.9)	0 (0)	1 (2.1)	

* Based on Fisher's exact test for categorical variables excluding the missing category and Kruskal-Wallis test for continuous variables.
† "Other" countries were predominately in Asia.
SD = standard deviation; IQR = interquartile range.

program staff using the VDOT website. For each day that a medication dose was prescribed, program staff documented whether a video had been received and, if so, whether they observed all, some or no pills swallowed. If videos were missing or ingestion was not observed, participants were contacted to determine the reason and provided adherence support as needed. Doses reported by participants as taken, but not recorded (e.g., phone not charged; patient forgot to make video) were documented as self-administered and counted as unobserved. For this analysis, self-administered doses were not considered as taken.

Data analysis

Treatment observation data were used to calculate the fraction of expected doses observed (FEDO), the number of doses observed via VDOT divided by the total number of doses expected during the study period. Descriptive statistics (mean, standard deviation, range, frequency and percentage) were used to summarize the FEDO, sociodemographic characteristics, TB history, TB risk factors, and VDOT perception variables across study sites. Site differences in these variables were assessed using χ^2, Kruskal-Wallis and Fisher's exact tests. Analyses were

Table 2 Treatment adherence and participant experience using VDOT by city

Variable	Total ($n = 149$) *n* (%)	San Diego, CA ($n = 52$) *n* (%)	San Francisco, CA ($n = 49$) *n* (%)	New York City, NY ($n = 48$) *n* (%)	*P* value*
FEDO,† median [IQR]	88 [33–100]	88 [33–100]	93 [39–99]	85 [44–100]	0.099
Duration of VDOT use, months					
Mean [SD]	5.4 [3.1]	5.5 [3.1]	5.8 [3.4]	5.1 [2.9]	0.685
Median [IQR]	5.4 [0.3–18.1]	5.4 [0.3–14]	5.6 [1–18.1]	5.0 [0.3–14]	
Total completed follow-up interview, *n*	121	43	47	31	
Confidentiality and privacy					
Were you concerned someone would see you using the VDOT cell phone?					
Yes	49 (40.5)	14 (32.6)	21 (44.7)	14 (45.2)	0.422
No	72 (59.5)	29 (67.4)	26 (55.3)	17 (54.8)	
Did you ever fail to record a video because you were worried someone might see you taking your medicine?					
Yes	12 (9.9)	4 (9.3)	5 (10.6)	3 (9.7)	1.000
No	109 (90.1)	39 (90.7)	42 (89.4)	28 (90.3)	
Did you share your experience using VDOT with family members?					
Yes	89 (73.6)	35 (81.4)	31 (66.0)	23 (74.2)	0.241
No	32 (26.4)	8 (18.6)	16 (34.0)	8 (25.8)	
Did you share your experience using VDOT with friends, neighbors, schoolmates, workmates?					
Yes	41 (33.9)	15 (34.9)	17 (36.2)	9 (29.0)	0.833
No	80 (66.1)	28 (65.1)	20 (63.8)	22 (71.0)	
Did you find VDOT more or less confidential than in-person DOT?					
More	75 (62.0)	25 (58.1)	33 (70.2)	17 (54.8)	0.519
Less	5 (4.1)	2 (4.7)	1 (2.1)	2 (6.5)	
Same	40 (33.1)	16 (37.2)	12 (25.5)	12 (38.7)	
Missing	1 (0.8)	0 (0)	1 (2.1)	0 (0)	
Satisfaction with VDOT					
If you had to re-do your TB treatment, would you choose VDOT or in-person DOT?					
VDOT	112 (92.6)	41 (95.3)	45 (95.7)	26 (83.9)	0.172
In-person DOT	2 (1.6)	0 (0)	0 (0)	2 (6.4)	
No preference	7 (5.8)	2 (4.7)	2 (4.3)	3 (9.7)	
Would you recommend VDOT to other TB patients?					
Yes	114 (94.2)	40 (93.0)	45 (95.8)	29 (93.5)	0.573
No	6 (5.0)	3 (7.0)	1 (2.1)	2 (6.5)	
Missing	1 (0.8)	0 (0)	1 (2.1)	0 (0)	
Overall, how easy/difficult did you find the VDOT process?					
Very easy	95 (78.5)	32 (74.4)	38 (80.9)	25 (80.6)	0.074
Somewhat easy	22 (18.2)	11 (25.6)	5 (10.6)	6 (19.4)	
Somewhat difficult	4 (3.3)	0 (0)	4 (8.5)	0 (0)	

* Based on Fisher's exact test for categorical variables excluding the missing category and Kruskal-Wallis test for continuous variables.
† Number of complete doses observed using VDOT divided by the number of doses expected.
VDOT = video directly observed therapy; FEDO = fraction of expected doses observed; IQR = interquartile range; SD = standard deviation; TB = tuberculosis.

conducted using *R* statistical software (R Computing, Vienna, Austria).[13]

RESULTS

Sociodemographics

Overall, 149 patients (52 in San Diego, 49 in San Francisco, and 48 in New York City) participated in the study and completed the baseline interview; 121 completed the follow-up interview. Seven participants returned to DOT after study enrolment due to non-adherence ($n = 5$), lost smartphone ($n = 1$) or technical problems caused by poor cellular reception ($n = 1$). In New York City, one participant was lost despite several contact attempts by clinic staff. The mean age of participants was 41 years (range 18–87); 59% were male; 45% were Asian and 30% were Hispanic/Latino; and 23% were born in the United States, 13% in Mexico and 64% in other countries (Table 1). All participants were diagnosed with pulmonary TB and one participant had multidrug-resistant TB (MDR-TB).

Other than history of cigarette smoking (43.6%), self-reported potential TB risk factors were infrequent: homelessness in past 6 months (1.3%), marijuana use (8.1%), non-injection drug use in past 6 months (2.7%), and injection drug use (1.3%). The prevalence of TB risk factors did not differ across sites (data not shown). All other factors measured were similar across cities except age, race/ethnicity, annual income, and country of birth ($P < 0.05$).

Overall, the median FEDO was 88% (interquartile range [IQR] 76–96), which did not differ by city (Table 2). Only six (4%) participants had FEDO <50%. The median duration of VDOT use until treatment completion was 5.4 months (IQR 3.2–7.1). Overall, 26% of participants reported that they did not share their VDOT experience with family members, and 66% did not share with friends, neighbours, schoolmates, or workmates. While 40% said they had concerns about others seeing them recording VDOT videos, only 10% failed to record at least one dose because they did not want others to see; 63% felt that VDOT was more confidential than

DOT, 97% thought VDOT was "very or somewhat easy to perform", only 2% would choose DOT over VDOT if they had to repeat treatment, and 95% would recommend VDOT for other TB patients. These responses also did not differ by city.

DISCUSSION

This study found that VDOT was feasible and acceptable for monitoring medication ingestion among TB patients, and that the results were similar in three major TB programs in the United States. Although patients differed across cities by age, race/ethnicity, income, and country of birth, their treatment adherence and satisfaction with VDOT were high and did not differ by city.

TB-related stigma can adversely affect treatment adherence. For example, poor adherence could result when patients resist making frequent visits to a TB clinic or receive healthcare worker visits at their home, school or workplace due to concerns over privacy.[14,15] These studies reported concerns from participants about being questioned by community members about DOT worker visits to their homes. The importance of confidentiality in the present cohort is highlighted by the fact that 40% of participants reported having concerns about others seeing them recording videos. Nevertheless, only 10% reported ever actually failing to record at least one dose because they did not want others to see. This suggests that VDOT allowed participants greater autonomy to choose when and where they took their medications, thereby improving confidentiality.

Advantages of asynchronous VDOT over DOT include greater flexibility in the time and location of medication dosing, as well as savings in resources such as travel time, mileage and workload. For example, resources saved using VDOT have been shown to enable DOT workers to double their caseloads.[9] In the current study, the San Francisco TB program director reported that VDOT allowed their clinic to achieve universal DOT by moving patients who could not use DOT to VDOT without adding program staff. Other TB program staff in the current study similarly reported that VDOT allowed them to view several participants' videos in one sitting at convenient times during work hours, which saved time by eliminating travel and scheduling patient visits.

Limiting VDOT to specific patients was a consideration in this study. For example, advanced age has been suggested to be a barrier to using digital adherence technologies.[16,17] However, all sites included elderly patients, some who had never previously used a smartphone, but after training felt comfortable with the technology and successfully completed treatment using VDOT. Poor adherence to DOT was also proposed as a restriction to VDOT. The San Francisco TB program staff reported that excluding patients from VDOT if they were non-adherent to community-based DOT was not necessary after they observed that adherence improved substantially on switching non-adherent patients to VDOT. This included one patient under consideration for legal action if adherence did not improve. While patient selection for this pilot could explain some of the high adherence observed, program staff were self-motivated to enrol all patients because VDOT was perceived to be beneficial for both staff and patients. Although data were not systematically collected on patients who refused or were not offered VDOT, program staff reported that this occurred infrequently.

It is also important to acknowledge that VDOT does not guarantee high adherence. Because it was unknown at the start of this study whether VDOT would be an effective alternative to DOT or who it might benefit, TB program staff or participants could elect at any time to switch from VDOT back to DOT. Overall, only seven (5.4%) participants returned to DOT before completing treatment (five due to non-adherence) and they did not appear to cluster by sociodemographic factors. Previous research on latent TB infection treatment showed no association between patients' demographic characteristics and adherence,[18] and an independent study of VDOT for active TB found that patient baseline characteristics were not predictive of adherence.[12] These results suggest that VDOT could potentially be offered to all patients after an initial period of DOT (2 weeks in this study), provided that protocols exist for guiding decisions around discontinuation of VDOT.

Limitations

Some important limitations should be considered. First, risk factors (e.g., substance use; homelessness) might have been under-reported if participants were embarrassed to disclose them. Second, 3.7% of the videos were received but not viewable (due to a programming error that was corrected midway through the study). Although TB program staff could document when these videos were recorded, the doses were counted as self-administered because pill ingestion was not observed. Hence, the computed FEDO in this study (88%) may have been an underestimation of the true adherence. If the corrupted videos were counted as taken doses, the median FEDO would increase to 93%. This technical problem could have also influenced some participants' satisfaction with using VDOT because program staff spent extra time with them to determine the cause of the corrupted videos and whether doses were actually taken. Third, this study lacked a comparison group and we are therefore unable to assess whether FEDO would have differed for a comparable group of patients monitored using only DOT. Fourth, refusal to participate

could have resulted in a selected sample. While not systematically collected, program staff reported that refusals were rare. Fifth, patients potentially adhered because they were being observed;[19] however, this principal is the motivation behind DOT. Randomized controlled trials are needed to assess this affect. Finally, these results may not be applicable to smaller health departments in the United States, or to low-income, high-burden countries.

CONCLUSION

VDOT allowed TB programs in three large US cities to observe a high proportion of expected medication doses without the patient or provider having to travel. Despite some patient differences in sociodemographic and TB risk factors across cities, no differences were observed in treatment adherence, perceptions of VDOT use or satisfaction with the TB treatment process. This suggests that scale-up of VDOT to other health departments is feasible. Future studies that include a DOT comparison group are needed to determine whether the low observation rates in some participants was attributable to the method of observation. The cost-effectiveness of VDOT and acceptability of VDOT in both low- and high-income TB programs should also be assessed.

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RÉSUMÉ

CONTEXTE : Le traitement sous observation directe par vidéo asynchrone (VDOT) pourrait réduire les coûts du programme tuberculose (TB) et le fardeau pour les patients. Nous avons comparé la performance du VDOT dans trois grandes villes des Etats-Unis ayant des taux d'incidence de TB supérieurs à la moyenne nationale.

MÉTHODE : Des patients âgés de ≥18 ans et sous traitement anti-TB sous observation directe ont été invités à utiliser le VDOT pour le suivi de leur traitement. Les entretiens avant et après le traitement et les dossiers médicaux ont permis d'évaluer les différences en fonction des sites en termes d'adhérence au traitement ainsi que de caractéristiques et de perceptions des patients.

RÉSULTATS : Les participants ont été enrôlés à New York ($n = 48$), San Diego ($n = 52$) et San Francisco ($n = 49$). L'âge moyen a été de 41 ans (fourchette 18–87) ; 59% étaient des hommes ; beaucoup étaient asiatiques (45%) ou hispaniques/latino (30%) ; et 77% étaient nés à l'étranger. La fraction médiane des doses observées attendues (FEDO) a été de 88% (IQR 76–96). Lors du suivi, 97% ont estimé que le VDOT a été « très ou assez facile à utiliser » et 95% le recommanderaient à d'autres patients TB. L'âge, la race/ethnicité, le revenu annuel et le pays de naissance ont différé d'une ville à l'autre ($P < 0,05$), mais les perceptions relatives à FEDO et VDOT n'ont pas été différentes.

CONCLUSION : Les programmes TB dans trois grandes villes ont observé un FEDO élevé recourant au VDOT tout en minimisant le temps de travail et les déplacements du personnel. Des résultats similaires dans différents sites soutiennent l'adoption du VDOT par d'autres vastes programmes TB urbains.

RESUMEN

MARCO DE REFERENCIA: El tratamiento bajo observación directa mediante videos asincrónicos (VDOT) puede disminuir los costos del programa contra la tuberculosis (TB) y aligerar la carga para los pacientes. Se comparó el rendimiento del VDOT en tres ciudades grandes de los Estados Unidos con tasas de incidencia de TB superiores al promedio nacional.

MÉTODO: Se propuso a pacientes de ≥18 años de edad que recibían el tratamiento antituberculoso directamente observado la utilización del VDOT en la supervisión. Mediante entrevistas previas al tratamiento y posteriores al mismo y el análisis de las historias clínicas se evaluaron las diferencias de cumplimiento terapéutico, características de los pacientes y sus percepciones en los diferentes centros.

RESULTADOS: Se incluyeron pacientes de Nueva York ($n = 48$), San Diego ($n = 52$) y San Francisco ($n = 49$). En general, la edad promedio fue 41 años (intervalo 18–87); 59% era de sexo masculino; la mayoría era de ascendencia asiática (45%) o hispanoamericana (30%); y 77% había nacido en el extranjero. La mediana de la fracción de las dosis previstas observadas (FEDO) fue 88% (IQR 76–96). Durante el seguimiento, 97% consideró que el VDOT era de "utilización fácil o muy fácil" y 95% recomendaría el VDOT a otros pacientes con TB. En las diferentes ciudades se observaron diferencias de edad, etnia, ingreso anual y país de nacimiento ($P < 0,05$), pero la FEDO y la percepción del VDOT no variaron.

CONCLUSIÓN: Los programas contra la TB en tres ciudades grandes lograron una FEDO alta al utilizar el VDOT y además, redujeron al mínimo el tiempo y los desplazamientos del personal. Los resultados equivalentes logrados por los diferentes centros respaldan la adopción del VDOT en otros programas urbanos extensos contra la TB.