

Effectiveness of online HIV treatment services in the context of the COVID-19 pandemic

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Abstract

Background: The COVID-19 pandemic has created challenges with respect to HIV care services. Remote online services might provide an effective method for health service delivery to people living with HIV (PLHIV). Few studies have focused on the efficacy of telemedical services for PLHIV and the effect of antiretroviral treatment via online services in China.

Methods: We developed a platform called the “No. 8 Health” for online antiretroviral drug collection and delivery services in Beijing from January 21 to June 30, 2022. We evaluated the online treatment service according to viral load suppression rates and compared differences in social characteristics between PLHIV who received antiretroviral drugs through online or offline treatment services.

Results: By June 2022, 9528 PLHIV had received outpatient treatment services, among which 44.6% (4031/9528) used the online treatment and drug delivery services for a total of 5590 person-times. The satisfaction rate was 100%. Rates of viral load suppression among PLHIV who initiated antiretroviral therapy (ART) in 2020 and 2021 were 96.4% and 93.1%, respectively. Results showed that the viral load suppression rate was 97.9%. Regarding HIV rapid self-testing, 4513 men who have sex with men used the online HIV rapid testing service. The number of users was approximately the same as in 2021, but both were slightly lower than those in 2020.

Conclusion: This study was the first to evaluate the effect of online drug collection and delivery services and virologic outcomes among PLHIV in China. The online service helped with maintenance of ART services, but the COVID-19 pandemic still had some impacts on viral load suppression.

KEYWORDS

HIV, online service, efficacy

Abbreviations: ART, antiretroviral therapy; ARV, antiretroviral; COVID-19, coronavirus disease 2019; INSTI, integrase strand transfer inhibitors; MSM, men who have sex with men; NNRTI, non-nucleoside reverse transcriptase inhibitors; PI, protease inhibitors; PLHIV, people living with HIV.

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1 | INTRODUCTION

Amidst the global HIV epidemic, the world was suddenly confronted with a new, serious, and multifaceted health crisis with emergence of the COVID-19 pandemic during which the number of people living with HIV (PLHIV) currently in treatment globally declined from January to June 2020 [1–3]. According to World Health Organization (WHO) survey in July 2020, 73 countries experienced severe stock shortages of antiretroviral (antiretroviral therapy [ARV]) drugs owing to the COVID-19 pandemic, and 24 countries reported severe stock shortages or supply disruptions. Supportive services in many HIV clinics have been temporarily suspended [4]. The interruption in HIV services may subsequently stagnate global progress toward meeting the Joint United Nations Program on HIV/AIDS 95-95-95 goals and may increase HIV-related deaths and HIV transmission [2]. Xu et al. [5] showed that health services at HIV clinics were provided as usual in only 6 of 19 countries in central and eastern Europe during March 2020, and doctors in 11 countries were treating patients with simultaneous HIV and COVID-19 infection. One study on 317 PLHIV mainly from Belgium and Brazil reported that 17.7% had difficulties obtaining ARV therapy medications because of COVID-19-related measures [6]. A study that was focused on young sexual minority men (YSMM) aged 17–24 years, a group at high risk of HIV infection, showed that 41 of 133 YSMM described negative effects of the COVID-19 pandemic on HIV testing and prevention services, such as limited and disrupted access to HIV testing, HIV pre-exposure prophylaxis, and HIV postexposure prophylaxis [7].

Most offline ART services have been interrupted by the pandemic, with the increased risk of COVID-19 infection when attending clinical appointments. Considering this situation, remote online services might provide an effective method for health service delivery among PLHIV. In the United States, some medical centers in Seattle and Chicago have collaborated with community organizations that offer remote visits for PLHIV to complete the treatment process. In Spain, community organizations obtain medicines on behalf of patients and distribute them to patients to maintain uninterrupted treatment. However, there are limited studies on how to promote telemedical services for PLHIV and the effect of ART via online medical treatment services in China.

Beijing Ditan Hospital was the first designated medical institution to provide ART in China. In total, 38% of PLHIV in Beijing have received ART at the hospital. Ditan Hospital is the only designated medical facility for treating patients with COVID-19 in Beijing.

Owing to the COVID-19 epidemic, lockdown measures were implemented in January 2022 in the residential areas of some PLHIV. Ditan Hospital ceased all medical services from February 3, 2022, to July 29, 2022, to focus on the treatment of patients with COVID-19. The diagnosis and treatment of PLHIV were carried out simultaneously online and in the branch of Ditan Hospital. The aim of this study was to describe online HIV treatment services at Ditan Hospital during the COVID-19 epidemic and to evaluate the effect of these services, especially on HIV viral load.

2 | METHODS

2.1 | Online service implementation

We developed a comprehensive online management platform called “No. 8 Health” for the treatment and care of PLHIV. The platform included drug delivery management, follow-up management, and patient information management, including ART drug regimens and clinical or laboratory test results (routine blood tests, liver and kidney function, CD4+ T cells, viral load) in the previous 3 months.

We also applied for an official account on the WeChat Official Platform to implement an online drug collection and delivery service, in cooperation with community organizations. The function of the official account was discussed by hospital case managers and clinicians. Patients obtained an official account through the exclusive WeChat public account of Ditan Hospital. The online service platform comprised three main modules: “Instructions for medical treatment,” “Drug delivery service,” and “High-risk rapid self-test.”

The “Drug delivery service” module was specially designed for online drug delivery. PLHIV whose medication and treatment information were included in the patient’s records at Ditan Hospital could enter the “Drug Delivery Service” module and provide their treatment information (medication number, medication regimen, medical visit method) and address, and then submit the form. The staff would contact the patient in 1–2 working days and confirm the information. Medications would then be mailed to the designated address by a professional express delivery company. Patients with privacy concerns could mosaic details of the items to be sent.

The “High-risk rapid self-test” module was specially designed for HIV rapid testing among high-risk individuals. HIV rapid testing is recommended by the WHO as part of routine HIV testing services, which offered the potential to help maintain HIV testing rates during the

COVID-19 pandemic [8]. Before the pandemic, hospital outpatient work involved providing face-to-face counseling and testing services for people with high-risk sexual behaviors. This work was also transferred to online services. People could enter this module to apply for mailing service for rapid test reagents.

To maintain medication adherence and support mental health among PLHIV during the COVID-19 epidemic, medical staff, community organizations, and peer educators released timely hospital notifications via the WeChat public platform and WeChat groups. The hospital outpatient service telephone line was also continuously maintained.

For people who did not have mobile phones, patients with disabilities, and other patients who required offline diagnosis and treatment, we provided transportation support, laboratory testing support, and referrals to medical institutions.

2.2 | Effectiveness of online treatment service evaluation

We provided comprehensive online diagnosis and treatment services for HIV-positive patients or individuals at high risk of HIV infection during the COVID-19 pandemic. Assessment of the effectiveness of these online services covers both groups. Evaluation of the effectiveness of online HIV treatment services included patient satisfaction with online services, viral load suppression for different ART initiation periods among online service groups, and the completion rate of high-risk rapid self-testing.

2.3 | Evaluation of acceptance and satisfaction

We conducted a telephone interview among all PLHIV who used the online diagnosis and treatment services. The interview was conducted by professional case managers or nurses after training. The interview mainly included the following questions. (1) How do you feel about online therapy services? (2) What are your primary needs for online therapy services? (3) What are your recommendations for current online health services?

2.4 | Virologic evaluation

Online drug collection and delivery services started on January 21, 2022. We, therefore, divided patients who used the online drug service into three categories: not

used (0 times), used one time, and used more than one time from January 21 to June 30, 2022. Virologic response was considered the primary outcome in evaluating the efficacy of ART. Viral suppression was defined as a viral load of less than 50 copies/mL among PLHIV who were treated for more than 6 months. Recovery of CD4+ T cells, loss to follow-up, and rapid testing services were secondary outcomes used to comprehensively evaluate the effectiveness of online diagnosis and treatment services.

3 | RESULTS

3.1 | Demographic characteristics

As of June 30, 2022, there were 9528 patients in the treatment database; 9048 patients (94.96%) were men, the median age was 30.26 (25.97, 37.50) years, and 67.56% of patients were treated with non-nucleoside reverse transcriptase inhibitors (NNRTI)-based ART. A total of 8724 patients who had been treated for more than 6 months and had one or more viral load records in addition to baseline data were analyzed. Characteristics of PLHIV according to different online drug collection/delivery services are shown in Table 1.

The distribution showed that female patients tended to choose offline treatment whereas PLHIV younger than 30 years had a higher percentage of using online drug services than those older than 40 years. A higher proportion of PLHIV taking NNRTI-based ARV regimens among those who used online drug collection/delivery services. PLHIV who had received ART for more than 5 years tended to use offline treatment services.

3.2 | Implementation of online services

We published 39 articles on the WeChat official account from January 21, 2022 to the end of June 2022, which was 2.3 times more frequently than the rate in the same months previously. These articles had a total of 70,753 views, which was 3.76 times greater than before the COVID-19 epidemic. Furthermore, 14 online meetings or lectures were held, which were viewed by 14,000 people.

Of the total 9528 PLHIV who received outpatient treatment services, 44.6% (4031/9528) used the online treatment and drug delivery services, with a total of 5590 person-times. Additionally, 88% (4930/5590) of PLHIV took nationally free routine ARV drugs, and 12% (660/5590) had medical insurance. The geographic distribution of mailings covered 30 provinces and autonomous regions of China, and approximately 55% of mailing

TABLE 1 Characteristics of PLHIV receiving ART.

Variables	Online drug delivery [number of patients (%)]			Total [number of patients (%)]	p
	Not used	One time	More than one time		
Gender					
Male	4777 (93.81)	2407 (96.43)	1094 (96.30)	8278 (94.89)	<0.001
Female	315 (6.19)	89 (3.57)	42 (3.70)	446 (5.11)	
Age at ART initiation (years old)					
<18	21 (0.41)	21 (0.84)	6 (0.53)	48 (0.55)	<0.001
~29	2199 (43.19)	1372 (54.97)	647 (56.95)	4218 (48.35)	
~39	1636 (32.13)	743 (29.77)	353 (31.07)	2732 (31.32)	
~49	744 (14.61)	255 (10.22)	96 (8.45)	1095 (12.55)	
≥50	492 (9.66)	105 (4.21)	34 (2.99)	631 (7.23)	
Year of ART initiation					
Before 2019	4572 (89.79)	2245 (89.94)	1026 (90.32)	7843 (89.9)	0.934
2020	345 (6.78)	160 (6.41)	73 (6.43)	578 (6.63)	
2021	175 (3.44)	91 (3.65)	37 (3.26)	303 (3.47)	
ARV drugs regimens					
NNRTI-based	3085 (60.59)	1899 (76.08)	904 (79.58)	5888 (67.49)	<0.001
PI-based	446 (8.76)	222 (8.89)	110 (9.68)	778 (8.92)	
INSTI-based	1557 (30.58)	372 (14.90)	120 (10.56)	2049 (23.49)	
ART period (years)					
<1	224 (4.40)	103 (4.13)	50 (4.40)	377 (4.32)	<0.001
~2	423 (8.31)	271 (10.86)	131 (11.53)	825 (9.46)	
~5	1679 (32.97)	1011 (40.50)	477 (41.99)	3167 (36.30)	
~10	2235 (43.89)	1009 (40.42)	448 (39.44)	3692 (42.32)	
≥10	531 (10.43)	102 (4.09)	30 (2.64)	663 (7.60)	
Total	5092 (58.37)	2496 (28.61)	1136 (13.02)	8724	

Abbreviations: ART, antiretroviral therapy; ARV, antiretroviral; INSTI, integrase strand transfer inhibitors; NNRTI, non-nucleoside reverse transcriptase inhibitors; PI, protease inhibitors; PLHIV, people living with HIV.

addresses were in Beijing. By the end of June 2022, a total of 500 patients were lost to follow-up, with a loss rate of 5.25%. Additionally, 689 newly diagnosed individuals who had to be closely monitored for side effects of ARV drugs in the early stages of ART used offline medical treatment. Owing to the impact of epidemic control measures, only 2820 patients (approximately 30%) had completed routine viral load and CD4 testing for 2022 by June 30.

3.3 | Evaluation of online services

Among patients who used the online diagnosis and treatment service, the satisfaction rate was 100%. Among

the 4930 deliveries of national routine free ARV drugs, a total of 1691 remarks were received from patients expressing their appreciation for the online service. In total, 184 (10.89%) noted that they had to anonymize their personal, packaging, or drug information when drugs were sent.

We summarized the results for viral suppression in different years of ART initiation in Table 2. The viral load suppression rates of PLHIV who initiated ART in 2020–2021 were 96.4% and 93.1%, respectively, a relatively high level. Immunologic recovery was divided into a low level (CD4+ T cells <750/mm³) and high level (CD4+ T cells ≥750/mm³) according to absolute counts of CD4 cells. The last CD4 test results showed that 87.33% of patients had a high level of immunologic

TABLE 2 Viral suppression at different years of initiation.

Year of ART initiation	Latest viral loads (copies/mL)		Total	%
	<50	≥50		
Before 2010	460	9	469	98.08
2011	304	2	306	99.35
2012	399	13	412	96.84
2013	587	15	602	97.51
2014	785	12	797	98.49
2015	1003	12	1015	98.82
2016	1066	22	1088	97.98
2017	1052	18	1070	98.32
2018	1064	11	1075	98.98
2019	986	23	1009	97.72
2020	557	21	578	96.37
2021	282	21	303	93.07
Total	8545	179	8724	97.95

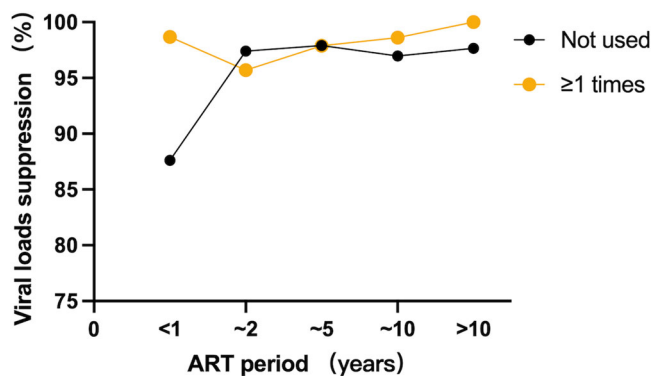
Abbreviation: ART, antiretroviral therapy.

recovery. However, owing to the impact of epidemic control measures, only 2820 patients (approximately 30%) had completed routine viral load and CD4 testing for 2022 by June 30.

The results of viral load suppression showed that the viral load suppression rate was 97.9%; viral load suppression was significantly different in different ART periods and with different ARV drug regimen (Table 2). Among PLHIV who had received ART for less than 1 year, viral suppression rates were significantly lower for those who did not use online drug collection and delivery than for those who ever used the online service. However, the rate of viral load suppression was similar for PLHIV who received ART for more than 1 year in the different groups, which remained at a relatively high level (Figure 1).

3.4 | HIV rapid testing services

HIV self-testing was recording using the same official WeChat account. When information was uploaded, two kinds of self-test materials and corresponding instructions for the self-test procedure were provided, as well as consultation by telephone for special situations (such as results interpretation or incorrect test performance). HIV rapid testing services were transferred to the online mailing service (more than 90%), which helped with determining HIV infection status among high-risk

**FIGURE 1** Viral load suppression during different ART periods among different online service groups. ART, antiretroviral therapy.**TABLE 3** Online HIV rapid testing.

Variables	Year					
	2017	2018	2019	2020	2021	2022 (End on 31st May)
MSM HIV testing	1932	4468	6057	5133	4326	4513
HIV-positive	115	192	239	135	167	57

Abbreviation: MSM, men who have sex with men.

groups in a timely manner. We distributed publicity on websites or apps that are commonly used by men who have sex with men (MSM), such as Weibo, Baidu Tieba, and Blued. Furthermore, a high-risk MSM WeChat group and bar activity group were established, and a total of 20 national promotion volunteers promoted these online. There were 4513 MSM who used the online HIV rapid testing service; the number of users was approximately the same as in 2021, but both were slightly lower than the number in 2020 (Table 3).

4 | DISCUSSION

To our knowledge, this study was the first to describe an online HIV treatment service and evaluate the efficacy of virologic outcomes among PLHIV in China during the COVID-19 epidemic.

Some studies have reported a loss of access to HIV health care providers or interruption of care during the pandemic [9, 10]. A global app-based survey of MSM showed that 473 PLHIV (18%) surveyed had issues with drug refills or access to ART after the start of the pandemic [11]. A survey among PLHIV and people at risk of HIV in Korea showed that most PLHIV (91.3%) and people at risk of HIV reported never having received

telehealth services [12]. Different countries have conducted policy studies or discussed how to solve the problem of interrupted diagnosis and treatment services for HIV-positive patients caused by the COVID-19 pandemic. Ianka et al. emphasized initiatives for the coordination of care, decentralization of clinical management for primary health care services, establishment of protocols and flows, use of groups and social networks, and tools such as teleconsultation and health surveillance spreadsheets [13].

According to policy changes in China during the COVID-19 pandemic, emergency response plans at different levels should be formulated to ensure an uninterrupted supply of ARV drugs for PLHIV. We restructured the outpatient clinic, released relevant information on the WeChat official account for the first time, counted and prepared the available stock of ART drugs, and then built the online drug collection/delivery platforms and collaborated with community organizations to ensure the uninterrupted provision of AIDS-related services. We provided online drug delivery services for nearly half of PLHIV in the ART clinic, which implies that the timely provision of online delivery services helped them to obtain ART medicines.

Demographic characteristics may have had an impact on whether patients used the online service. PLHIV older than 40 years who had received ART for more than 5 years had a lower rate of using online drug collection/delivery services, suggesting that online ART services might be more appropriate for younger people and PLHIV who have been treated for a short time. People with a longer duration of ART tended to be older, which may explain why a higher proportion of patients with a duration of ART more than 5 years did not participate in online diagnosis and treatment. PLHIV who were taking INSTI-based ARV regimens had a lower rate of online drug collection/delivery service use, which might be because PLHIV receiving INSTI-based regimens tend to be newly diagnosed and treated. These results suggested that online or offline ART services should be tailored to the different characteristics of HIV-positive people.

ART disruptions might result in PLHIV not maintaining viral suppression or immune system function [14]. Our online drug collection and delivery service nearly maintained the virologic suppression rate among PLHIV users during the pandemic. In this study, the rate of viral suppression (viral load <50 copies/mL) for PLHIV who initiated ART in 2021 was 93%, and this was 98.6% (299/303) in those with viral load <1000 copies/mL. One study in Malawi showed that among 607,894 routine viral load samples from 556,281 patients, 94% of them had viral load <1000 copies/mL after the COVID-19 pandemic [15]. The high proportion of

virologic suppression in our study may be attributed to the fact that the online services largely solved the problem of drug discontinuation. However, the sample size of this study was small, and thus follow-up observations are needed. Comparing studies before the pandemic, one national cross-sectional study conducted among PLHIV enrolled in China's National Free Antiretroviral Treatment Program (NFATP) who were on ART on December 31, 2019 showed that of the 704,375 participants in the entire cohort who were on ART for at least 12 months, 82.9% had complete virologic suppression (viral load <50 copies/mL) [16]. In another retrospective study of HIV-positive patients registered with the NFATP from July 2012 to January 2017 who were followed at a tertiary care hospital in Beijing, 90.9% and 98.5% of PLHIV had HIV-1 RNA ≤ 40 copies/mL at 6 and 24 months of treatment, respectively [17]. Our results showed a high level of viral load suppression, although this was lower than that before the COVID-19 epidemic.

Studies outside of China have also explored the effectiveness of Internet diagnosis and treatment in helping people with HIV to maintain access to medical services during the COVID-19 pandemic. A study in Uganda focused on the effect of a mobile phone-based intervention to promote uninterrupted HIV treatment during the pandemic. The study focused on two phases; in Phase 1, Makerere College of Health Sciences (MakCHS) designed an unstructured supplementary service data-based application (app), and patient enrollment in the app was piloted in Phase 2. The feasibility of remote follow-up of patients receiving long-term ART was determined, which showed that 112 patients receiving ART at Mulago Immune Suppression Syndrome clinic in Kampala enrolled in the MakCHS Health app. Up to 89 (80%), patients used the app to access COVID-19 vaccination and other personal needs that required a clinician [18]. Another randomized controlled pilot trial in Korea evaluated the effects of a self-management program using a mobile app (Health Manager) on self-management outcomes among PLHIV in Korea. The intervention group used the mobile app for 4 weeks, and the control group received self-management education materials in a portable document format. The results showed that the app-based self-management program was considered a helpful strategy to improve self-management outcomes among PLHIV and reduce perceived stigma during the pandemic in 33 participants (intervention: $n = 17$ vs. control: $n = 16$) [19].

COVID-19 pandemic has resulted in certain obstacles to HIV diagnosis and treatment [20, 21], but it has been suggested that use of online treatment services can

maintain good ART effectiveness to some degree, which might offer a suitable alternative during periods when offline diagnosis and treatment services are unavailable or for special situations, such as the COVID-19 epidemic. The current online diagnosis and treatment services were focused on drug delivery, which should be further improved to help solve problems of diagnosis and treatment under similar conditions based on the needs of PLHIV. Face-to-face communication between doctors and patients in offline treatment services may better promote medication adherence; however, to maintain the effectiveness of ART, targeted problems need to be solved according to the needs of PLHIV in offline or combined offline and online treatment services.

We found that the use of online drug collection and delivery in the initial stages of ART may positively impact patients' virologic responses. In the early stage of treatment, drug side effects or other physical discomfort owing to treatment should be closely monitored. Patients who used an online service to obtain medications can maintain communication with medical staff, which may help to ensure their medication compliance, thereby leading to better treatment effects.

For HIV self-testing, an online cross-sectional study conducted among Chinese MSM in 2020 showed that 58.4% (427/731) of participants said that they needed an HIV test, but only 64.9% (277/427) of those needs were met during the pandemic. In 2022, we achieved nearly the same number of HIV tests as in 2021 via online mailing services. Patrick et al. created a mail-out HIV self-test kit, which could be delivered without restrictions to decrease the impact of COVID-19 on HIV testing in their region. Those authors built a model that plotted the risks of sexually transmitted infection/HIV transmission and exposure. The authors tested the model together with expert clinicians and over 400 patient cases and refined the algorithm to ensure that testing services targeted those who were most inequitably burdened by these infections. The study implied that the model could be used to provide HIV self-examination services to the most high-risk groups in the future, especially during a public health emergency similar to COVID-19, and the model also might be used to help optimize medical resources [22].

Our online services solved the problem of patients being unable to see a doctor offline during the epidemic, ensuring that drugs and other medical services for HIV-positive individuals were provided in an uninterrupted manner to ensure treatment adherence. Monitoring and consulting were also provided for patients regarding ARV drugs [23]. The present experience of online services provides an example for other chronic diseases, which

might be a lifesaving method in public health practice, especially during public health emergencies like the COVID-19 pandemic.

5 | LIMITATIONS

Our study had several limitations. We did not collect information on medication adherence, and the study outcome was limited in terms of virologic response to online ART services. Some studies have measured affective symptoms, such as depression and anxiety, as effects of the COVID-19 pandemic on PLHIV. In our study, we focused on objective indicators to evaluate the efficacy of online HIV services during the epidemic. Thus, we reported the results of short-term follow-up regarding viral load. Subjective indicators and long-term follow-up should be explored in future studies.

6 | CONCLUSIONS

During the ongoing COVID-19 pandemic, remote online services might provide an effective way for health service delivery to PLHIV. Our study highlighted that online drug collection and delivery services can be effectively used to meet the ongoing demands of PLHIV. However, offline or combined offline and online treatment services should be conducted to provide the most effective ART services.

AUTHOR CONTRIBUTIONS

Jing Han: Funding acquisition (lead); Resources (lead); Writing—review & editing (lead). **Hanxi Zhang:** Data curation (lead); Methodology (lead); Writing—original draft (lead). **Ye Su:** Investigation (equal); Writing—review & editing (equal). **Fujie Zhang:** Writing—review & editing (equal).

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

This study involves data that is not available to be transparent.

ETHICS STATEMENT

The study was reviewed and approved by the Institutional Ethics Committee at the Beijing Ditan Hospital Capital Medical University in China (Approval number: DTEC-KY2021-022-02).

INFORMED CONSENT

All participants provided oral informed consent.

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