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THE COST OF SMS REMINDER TO IMPROVE ARV ADHERENCE AMONG KEY POPULATIONS

Analisis Biaya SMS Reminder untuk Meningkatkan Kepatuhan ARV Populasi Kunci

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Abstract

Background: HATI is an implementation trial aimed at improving HIV care and treatment, including through SMS reminders..
Aims: This study aimed to estimate the cost and analyze the outcomes of providing SMS Reminders within the HATI program in different settings.
Methods: Data were analyzed using a micro-costing approach from providers' and health systems' perspectives. Subjects were divided into intervention and control groups for outcome analysis, with adherence as the outcome indicator.
Results: From a provider's perspective, the highest cost was incurred in primary health care (PHC) clinics, while the lowest was in hospital clinics, most likely due to a much higher volume of SMS sent from hospitals. Costs from the health system perspective were more than two times higher than those from the provider perspective, as they included costs borne by HATI management and intervention setup. In one year, the number of patients with >95% adherent visits was higher in the intervention group than the control group, although visits decreased over time in both groups. The highest number of patients with >95% adherent visits was found in PHC clinics, while the lowest was in hospital clinics.
Conclusion: SMS reminders can be expensive initially due to setup and program costs. However, they become cheaper once they are embedded into the existing system. Further studies are necessary to determine better site options for scaling up SMS reminder intervention and to study the declining adherence rate in all clinics.

Keywords: Adherence, cost analysis, HIV, Indonesia, SMS reminder

Abstrak

Latar Belakang: *Program HATI adalah sebuah program uji coba yang bertujuan meningkatkan pelayanan dan pengobatan HIV yang mencakup SMS reminder sebagai salah satu programnya.*
Tujuan: *Untuk mengestimasi biaya dan menganalisis luaran pelaksanaan SMS reminder pada program HATI di berbagai situasi.*
Metode: *Data dianalisis menggunakan micro-costing dengan pendekatan penyedia layanan dan sistem kesehatan. Penelitian ini membagi pasien menjadi kelompok intervensi dan kontrol dengan kepatuhan sebagai indikator.*
Hasil: *Dari perspektif penyedia layanan, biaya setiap SMS terkirim tertinggi ditemui di level puskesmas dan terendah di level rumah sakit, karena jumlah SMS terkirim di rumah sakit lebih banyak. Biaya pada perspektif sistem kesehatan dua kali lipat lebih besar dibandingkan perspektif penyedia layanan, karena perspektif sistem kesehatan mencakup biaya pembentukan program HATI. Dalam setahun, jumlah pasien dengan tingkat kepatuhan >95% lebih tinggi pada kelompok intervensi dibanding kelompok kontrol, meskipun terjadi penurunan jumlah kepatuhan >95% seiring waktu pada keduanya. Jumlah kunjungan kepatuhan>95% tertinggi terdapat di Puskesmas, dan terendah di klinik rumah sakit.*
Kesimpulan: *Intervensi SMS reminder lebih mahal saat awal pelaksanaan karena biaya pembentukan program, namun akan lebih murah setelah program berjalan. Penelitian lebih lanjut diperlukan untuk menentukan pilihan lokasi yang lebih baik untuk meningkatkan intervensi SMS reminder dan meneliti tren penurunan tingkat kepatuhan secara keseluruhan sejalan dengan waktu.*

Kata kunci: *analisis biaya, HIV/AIDS, Indonesia, kepatuhan, SMS reminder*

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Introduction

Based on the World Health Organization (WHO) Campaign, the 90-90-90 targets need to be achieved to end the AIDS epidemic in 2030. The targets correspond to 90% of people living with HIV (PLHIV) should know their HIV status, 90% of PLHIV who know their HIV status are undergoing antiretroviral treatment (ARV), and 90% of those who are taking ART have suppressed viral loads (World Health Organization, 2016). In Indonesia, the number of PLHIV has increased from 620,000 people in 2015 to 640,000 in 2018 (UNAIDS, 2019). Only around half of PLHIV are aware of their HIV status with only 17% of them taking ARV medication (UNAIDS, 2019), which potentially affect the achievement of the third target of PLHIV having suppressed viral loads (World Health Organization, 2016). Currently, Indonesia is still experiencing poor retention, with the loss to follow-up rate can be as high as 24% among key populations (Januraga *et al.*, 2018; Rahmalia *et al.*, 2019). This calls for a reform in current interventions to improve the adherence to ARV.

Adherence is one of the indicators to measure the success and effectiveness of ARV (Pop-Eleches *et al.*, 2011; Rodrigues *et al.*, 2012; Maduka and Tobin-west, 2013; Bezabhe *et al.*, 2014; Azia, Mukumbang and Wyk, 2016). An adherence rate of less than 95% is considered poor, reflecting a regimen failure. However, the role of adherence rate in ensuring the success of ARV is influenced, among others, by social issues such as disclosure, adherence support, stigma, and discrimination (Wasti *et al.*, 2012; Azia, Mukumbang and Wyk, 2016; Chirambo *et al.*, 2019; Nurfalah, Yona and Waluyo, 2019). For instance, PLHIV who disclose their status and have support from their partner/spouse or family have a higher chance of better adherence (Bezabhe *et al.*, 2014; Siregar, Pitriyan and Wisaksana, 2016; Gugsa *et al.*, 2017). One of the supports to ensure adherence is mobile phone text (World Health Organization, 2016), such as SMS Reminder, as a form of a short and simple communication (Da Costa *et al.*, 2012; Ware *et al.*, 2016). SMS reminder has a lower possibility of hindrance as it can be sent virtually everywhere (Kaplan, 2006). This intervention has low cost (Da Costa *et al.*, 2012; Davey *et al.*, 2013), with a much lower cost than follow up calls (Lester *et al.*, 2010).

SMS intervention has been proven to be cost effective in improving the HIV treatment outcome (Patel *et al.*, 2017). Studies have also shown that reminders in the form of mobile text may improve adherence to treatment and self-reported adherence, eventually leading to lower viral load and better CD4 cell count (Lester *et al.*, 2010; Dowshen *et al.*, 2012; Kinyua *et al.*, 2013; Lewis *et al.*, 2013). In a limited resource and work hour settings, SMS reminder is considered to be more effective compared to follow up calls as well as follow up calls combined with mobile text, as one server can reach a large population in fewer working hours (Pop-Eleches *et al.*, 2011; Da Costa *et al.*, 2012; Bigna *et al.*, 2014; Desouza *et al.*, 2014; Linnemayr *et al.*, 2017).

HIV *Awal* (Early) Testing and Treatment Indonesia (HATI) is an implementation trial aimed to improve the HIV care and treatment in Indonesia (Januraga *et al.*, 2018). The evaluation of the program shows that the PLHIV in Indonesia needs support to ensure adherence to ARV, and SMS Reminder is preferred as one of the interventions (Januraga *et al.*, 2018). However, the cost of providing SMS reminder has not been analyzed and, thus, determining the required budget to scale up the intervention is currently difficult. In fact, the cost of providing SMS reminder is rarely studied (Patel *et al.*, 2017; Amankwaa *et al.*, 2018), with only few studies presented the cost per SMS sent as per existing market price (Da Costa *et al.*, 2012; Mbuagbaw *et al.*, 2012).

This paper presents an economic analysis of providing SMS Reminder within the HATI program across various settings in several cities of Indonesia that are supported by the HATI program. Specifically, this study aimed to, first, estimate the cost of providing SMS reminder across settings within the HATI program, second, compare outcomes

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between the group receiving SMS reminder and the control group. The third objective of this study was to explore the costs and outcome of SMS reminder in various settings. To our knowledge, this study is the first to perform cost and outcome analysis for SMS reminder in the Indonesian settings, and provide the necessary inputs for advocacy and policy making in relation to developing policies to improve adherence to ART.

Method

Study settings and population

This study was conducted in four cities in Indonesia within the scope of HATI program, namely Bandung, Jakarta, Denpasar, and Yogyakarta. These areas have a relatively high number of key-populations (i.e. populations with people with a high risk to be infected by HIV) (Januraga *et al.*, 2018; Ministry of Health of the Republic of Indonesia, 2019). Each city has a coordinating unit which collaborated with the local health care facilities and partner universities (Januraga *et al.*, 2018), with satellite clinics in hospital's HIV/AIDS care units, PHCs, and HIV clinics. Patients in the HATI program were divided into two phases. Phase 1 consisted of patients registering to the program between September 2015 and December 2018, while phase 2 consisted of patients registering between January and December 2019.

The SMS reminder aims to increase the adherence rate of the key populations taking ART, i.e. man having sex with man (MSM), female sex worker (FSW), transgender (TG), and people who inject drugs (PWID). The key population/s recruited in respective cities differed. Jakarta only recruited PWID; Denpasar and Yogyakarta recruited MSM, FSW, and TG; and Bandung recruited all types of key population. Participants who were eligible to be included in the SMS reminder group were HATI program's patients who collected ARV in the corresponding clinics that provided SMS Reminder. In addition, patients must own a mobile phone and agreed to join the SMS reminder intervention. HATI program's patients who declined to join SMS reminder program and did not have a mobile phone were excluded from the intervention.

Data collection and cost estimation

Data collected were the costs of SMS reminders, which were divided into capital and recurrent costs. Capital cost is capital assets used over time where, for this study, the value was annualized using a discount rate of 3% (Drummond *et al.*, 2015). Capital cost consists of training and workshop, building, and equipment required by the intervention (e.g. rooms and computer tablets to send SMS reminders). Data on the building and equipment costs were obtained through interviews, HATI program data, and assumptions.

Recurrent cost consists of yearly supplies, personnel salary, and incentive per SMS sent (for SMS operator in respective clinics). Yearly supplies include domain fee, top-up credit, and form printing cost. The salary was allocated for staff involved in health care and HATI management in each city. The salary data were obtained through interviews, clinical records, HATI data, national standards, and assumptions.

All costs were collected in Rupiah and converted to US$ using the 2019 exchange rate (Rp 14,236.94/US$) (Bank Indonesia, 2020). All resources used jointly between interventions under HATI program were assumed to have proportional share of use, in line with the number of existing interventions. Data were analyzed using the micro-costing approach, whenever possible, and Microsoft Excel was used for calculation. We used provider and health system perspectives in the analysis. The provider perspective calculated specific costs borne by respective health care facilities. Health system perspective calculated the costs incurred by interventions stemming from provider perspective, HATI program management, and other sources of funding (Afriandi *et al.*, 2010; Drummond *et al.*, 2015).

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Outcome analysis

In the outcome analysis, patients were divided into two groups: intervention group/joining SMS reminder intervention (324 patients) and control group/not joining the intervention (430 patients). We treated adherence as the outcome indicator based on HATI program database. Adherence rate data of HATI program's patients were collected within a year after joining SMS reminder of HATI program (2019), and these data were compared to those of patients within the HATI program who did not join the SMS reminder intervention (Lester *et al.*, 2010; Hardy *et al.*, 2011; Dowshen *et al.*, 2012; Huang *et al.*, 2013; Garofalo *et al.*, 2016; Abdulrahman *et al.*, 2017). The adherence rate data was defined as the self-reported ARV drug consumption, and were divided into two groups: >95% (adherent) and ≤95% (non-adherent). Adherence was reflected by the amount of ARV drugs consumed in time of visit. Thus, patients who came to a HATI program partner clinic to collect their ARV drugs and had consumed all previously collected ARV drugs were considered to be adherent or >95% adherent (Unge *et al.*, 2010; Maduka and Tobin-west, 2013; Bezabhe *et al.*, 2016; Semvua *et al.*, 2017).

In this study, we observed the adherence rate as the number of patients with >95% adherent visits for both intervention and control groups (ideally, there should be six >95% adherent visits in a six-month period). The adherence rate of the two groups were then compared and the mean difference test was performed to identify whether there was a significant difference in terms of the average number of >95% adherent visits between the two groups within the period of six and twelve months. Additionally, the reasons underlining patients' decision to not joining the intervention were also explored.

Table 1 Socio-demographic characteristics

Variables		Control (n=430)	Intervention (n=324)	Sig
Age, mean years		29.8 (8.5)	28.4 (7.1)	0.03
Gender	Male	384 (89)	276 (85)	0.03
	Female	38 (9)	46 (14)	
	Transgender	8 (2)	2 (1)	
Type of cities	Denpasar	62 (14)	106 (33)	0.00
	Bandung	148 (34)	153 (47)	
	Yogyakarta	214 (50)	61 (19)	
	Jakarta	6 (1)	4 (1)	
Education	Primary School	21 (5)	26 (8)	0.32
	Junior High School	43 (10)	34 (11)	
	Senior High School	241 (56)	169 (52)	
	University	125 (29)	94 (29)	
Occupation	Unemployed	113 (26)	78 (24)	0.51
	Employed	317 (74)	245 (76)	
Marital Status	Never Married	352 (82)	262 (81)	0.17
	Divorced/widowed	34 (8)	38 (12)	
	Currently Married	43 (10)	22 (7)	
	Living with partner	1 (0)	1 (0)	
Type of clinics	Hospital	122 (28)	167 (51)	0.00
	PHC	179 (42)	56 (17)	
	HIV Clinic	129 (30)	101 (31)	

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Table 2 Yearly cost of SMS reminder (in US$, using 2019 exchange rate)

Type of Cost	Jakarta	Denpasar		Yogyakarta		Bandung		
	PHC	HIV Clinic	PHC	Hospital	PHC	Hospital	PHC	HIV Clinic
Provider Perspective								
RECURRENT COSTS								
Personnel	1.83	18.44	11.88	21.51	7.36	33.58	1.78	1.08
Supplies	11.39	212.21	73.47	79.34	85.80	670.52	14.94	17.07
Incentive for SMS operator	23.53	241.98	84.29	140.13	116.25	583.34	21.07	33.36
Sub-total	*36.75*	*472.63*	*169.64*	*240.98*	*209.40*	*1,287.44*	*37.79*	*51.52*
CAPITAL COSTS								
Training & workshop	1.98	11.60	-	0.99	1.98	2.97	0.99	0.99
Building/ space	9.83	1.18	4.14	57.87	114.33	8.18	0.21	0.00
Equipment	4.80	39.21	132.10	21.25	58.40	189.27	56.83	94.12
Sub-total	*16.61*	*51.99*	*136.24*	*80.11*	*174.71*	*200.43*	*58.02*	*95.12*
TOTAL COSTS	53.36	524.62	305.88	321.09	384.11	1,487.86	95.81	146.64
Unit cost/Patient per year	10.67	5.64	15.29	12.84	12	10.19	13.69	18.33
Unit cost/SMS sent	0.94	1.04	1.53	0.94	1.44	0.96	2.08	1.83
Total Patients	5	93	20	29	32	146	7	8
Total SMS Sent	57	503	200	341	267	1553	46	80
Average SMS Sent	11	5	10	12	8	11	7	10
Health System Perspective								
RECURRENT COSTS								
Personnel	217.88	2,149.78	454.85	1,153.70	1,456.55	3,983.21	191.14	217.50
Supplies	11.39	212.21	73.47	79.34	85.80	670.52	14.94	17.07
Incentive for SMS operator	23.53	241.98	84.29	140.13	116.25	583.34	21.07	33.36
Sub-total	252.81	2,603.97	612.61	1,373.16	1,658.60	5,237.07	227.15	267.94
CAPITAL COSTS								
Training & workshop	1.98	11.60	-	0.99	1.98	2.97	0.99	0.99
Building/ space	35.32	84.03	18.40	57.87	183.17	447.54	21.27	24.08
Equipment	9.53	68.21	168.27	21.25	71.16	286.00	61.46	99.42
Sub-total	46.83	163.83	199.99	80.11	256.31	736.51	83.73	124.49
TOTAL COSTS	299.64	2,767.81	799.27	1,453.27	1,914.90	5,973.58	310.88	392.43
Unit cost/patient per year	59.93	29.76	39.97	58.13	59.84	40.91	44.41	49.05
Unit cost/SMS	5.26	5.50	4.00	4.26	7.17	3.85	6.76	4.91

Table 3 The number of >95% adherent visits of patients in control (ctrl) and intervention (int) groups

Type of clinics	1 - 6 months, n (s.d)			7 - 12 months, n (s.d)			12 months, n (s.d)		
	Int	Ctrl	p	Int	Ctrl	p	Int	Ctrl	p
Jakarta									
PHC	4.3(2.2)	4.3(1.2)	0.95	4.0(2.7)	3.5(2.8)	0.79	8.3 (4.9)	7.8(3.9)	0.89
Denpasar									
HIV clinic	3.9(2.3)	3.7(2.2)	0.58	2.8(2.4)	2.7(2.4)	0.80	6.7 (4.4)	6.4(4.3)	0.67
PHC	5.0(1.5)	2.6(2.8)	0.13	3.6(2.0)	1.6(2.3)	0.13	8.6 (3.2)	4.2(5.0)	0.12
Yogyakarta									
Hospital	3.4(1.8)	3.4(2.0)	0.97	3.5(2.1)	3.1(2.2)	0.44	7.0 (3.6)	6.6(3.9)	0.67
PHC	4.2(1.8)	3.6(2.2)	0.09*	3.3(2.2)	3.2(2.2)	0.84	7.5 (3.6)	6.8(4.2)	0.34
Bandung									
Hospital	4.4(1.9)	3.5(2.3)	0.00***	3.7(2.2)	3.3(2.3)	0.19	8.1 (3.8)	6.7(4.2)	0.02**
PHC	5.6(0.5)	3.9(2.0)	0.00***	4.6(0.5)	3.2(2.0)	0.01**	10.2(0.8)	7.0(3.7)	0.00***
HIV clinic	4.7(1.7)	2.5(2.0)	0.01**	4.7(1.9)	3.4(2.2)	0.09*	9.3 (3.4)	5.9(3.6)	0.02**

* p < 0.1, ** p < 0.05, *** p < 0.01

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Results and Discussion

Patient characteristics

The mean age of control and intervention groups was 30 and 28 years old, respectively. The majority of patients were male, employed, and not married (Table 1). There were significant differences between the control and intervention groups in terms of age (p = .03), gender (p = .03), city (p = .00), and type of clinic visited (p=.00).

Number of patients and SMS sent per clinic

The highest number of patients receiving SMS reminders was in Bandung since it has three hospitals with ARV that provide services to all types of key populations. Jakarta, on the other hand, had the lowest number of SMS reminders sent. On average, SMS was sent once per week for 12 months to remind patients to adhere to their follow-up visits, totaling to 3,047 SMS sent in a year.

SMS reminders sent per patient vary significantly across different clinic types and regions. In Jakarta, PHC clinics averaged 11 SMS reminders per patient, potentially indicating a focused patient engagement strategy. Denpasar's HIV Clinic had a lower average of five (5) SMS per patient, whereas its PHC clinic sent ten (10) reminders per patient. In Yogyakarta, hospitals averaged twelve (12) SMS reminders per patient, while PHC clinics averaged eight (8). Bandung's hospital reported eleven (11) SMS per patient, with lower averages in its PHC (7) and HIV clinics (10). Overall, hospitals and HIV clinics exhibited higher patient volumes and SMS activity compared to PHC (5-12 per patient), suggesting a variability in the SMS intervention across clinics and regions.

Some patients have asked to stop joining the SMS Reminder given the following reasons: referred to others facilities (6.5%), felt that they do not need the reminder (4.9%), lost to follow up (3.7%), felt disturbed by SMS reminder (2.1%), technical problem (0.3%), or died (1.9%).

Cost of SMS Reminders

Table 2 presents the cost of providing SMS reminder from provider and health system perspectives divided into per patient and per SMS sent by type of clinic. It is understandably more than two times higher than the provider perspective cost estimate as it includes costs borne by the HATI program (e.g. HATI program management and intervention setup costs).

Outcomes

Table 3 summarizes the number of >95% adherent visits among control and intervention groups from different clinics and cities. In a year, generally higher adherence rate in both groups is found in Bandung. The number of >95% adherent visits is higher in the intervention group compared to the control group, and significance difference between the two groups are mostly found in Bandung clinics within six and twelve months period.

Discussion

To our knowledge, this paper is the first to estimate the comparison of the cost of providing SMS reminder to PLHIV in different cities and clinics in Indonesia. The cost per SMS sent is consistently higher in PHC across clinics, while, on the other hand, the average number of >95% adherent visits per patient is also higher in PHC. Based on the findings of this study, the following observations prevail.

First, our estimates from the provider perspective (Table 2) range from US$0.94 to US$2.08 per SMS sent and US$5.64 to US$18.33 per patient per year. This is comparable to a study in Kenya that shows the cost per patient per year to be US$15 from the provider perspective (Patel *et al.*, 2017). In contrast, the cost estimates using the health system perspective are relatively higher, ranging from US$3.85 to US$7.17 per SMS sent and US$29.76 to US$59.93 per patient per year. In most settings in our study, this is more than two times higher than the estimates from provider perspective. The most notable difference between the provide and health system perspectives estimates is the personnel cost. From the health system perspective, personnel costs stemming from HATI

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program management staff are included in the analysis, thus significantly increases the total and unit costs. As the intervention was newly introduced in these settings, these personnel costs are understandably needed to start and manage the intervention. After the intervention is established and runs independently by respective clinics, the HATI management staff costs can be excluded and the estimate from the provider perspective should be used instead. Our cost analyses from the two perspectives show that SMS reminder can be relatively expensive in the beginning, but the cost should potentially decrease substantially as the intervention is established and embedded into the existing system in the clinics, showing a potential economies of scale (Case, Fair and Oster, 2014).

Second, the outcome analysis in this study has shown that in most settings the patients in intervention groups have more >95% adherent visits than their counterparts. Although we did not perform specific effectiveness or cost-effectiveness analyses, our findings may indicate potential benefits of patients joining the SMS intervention as compared to those who do not. Studies have shown that scheduled mobile phone text-messaging reminders are effective in increasing adherence to ARV (Amankwaa *et al.*, 2018). Furthermore, in light of test and treat approach, SMS reminder is recognized as a cost-effective intervention (Patel *et al.*, 2017). Our outcome analysis has shown potentially similar trends despite the need for further studies. However, it is important to note that, almost in all sites the number of >95% adherent visits within the six- and twelve-months period tend to be decreasing. Such a trend is also found by another study in Uganda and requires further exploration to determine the specific settings in which the SMS reminder will remain beneficial (Linnemayr *et al.*, 2017). Further studies exploring this crucial trend are required as it seems that, in Indonesia, the benefits of SMS reminder in terms of ensuring the adherence rate is also waning overtime. This becomes even more important since another study under HATI program has shown that patients having better adherence show lower viral load, potentially reducing the risk of HIV transmission (Mbuagbaw *et al.*, 2012).

Third, we also showed that the PHC has the highest >95% adherent visits compared to other types of clinic in the same city. However, the lowest cost per SMS sent from the provider perspective is found in hospitals, which is most likely due to the higher number of SMS sent in the hospitals compared to other settings. In fact, the highest cost per SMS sent can be found consistently at PHC, consistent with the relatively lower number of SMS sent in each city compared to the other type of clinics. As such, it seems that although patients joining SMS reminder in the PHC have higher >95% adherent visits, the lowest cost per SMS sent is found at the hospitals where the monthly visit is relatively lower to other types of clinic in the same city. Unfortunately, we currently cannot find other research exploring the most effective type of clinic to provide SMS reminder. Further studies are required to identify the reasons underlying the lower number of SMS sent in PHC and the lower number of >95% adherent visits in hospitals. This aspect is important especially if the SMS reminder is going to be scaled up to more PHCs in different regions.

Lastly, from the provider perspective, implementing SMS reminder interventions for 640,000 PLHIV in Indonesia would cost between USD 7,219,200 to USD 15,974,400 annually, or between USD 29,568,000 to USD 55,065,600 from health system perspective. Although this amount seems high, the potential benefits far outweigh the costs. Our findings indicate that PLHIV who receive SMS reminders exhibit higher adherence levels. This may positively affects their health outcomes, particularly in terms of their CD4 cell counts (Dowshen *et al.*, 2012; Lewis *et al.*, 2013). In the absence of SMS reminders, lower adherence rates potentially results in poorer CD4 cell count among PLHIV. According to previous studies, if 640,000 PLHIV have CD4 cell counts below 350, the annual cost of ARV treatment would be approximately USD 380,284,800. In contrast, the annual cost of ARV treatment

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for those with CD4 cell counts above 350 is significantly lower, at USD 379,692,800 (Siregar *et al.*, 2015; Vadra *et al.*, 2022). These results suggest that, from the health system perspective, implementing SMS reminders is 7–13 times cheaper compared to ARV treatment costs for those with CD 4 cell count under 350, potentially showing the usefulness of SMS reminders.

This study has a few limitations. First, we did not perform specific costs-effectiveness or effectiveness analysis. As such, we cannot specifically ascertain that the change in outcome within our analysis is due to the SMS reminder alone. HATI program also implements other interventions to improve the ART adherence rate, and each may contribute to the adherence rate. Moreover, the adherence to ART is influenced by other factors like discrimination and stigma, in which different levels of stigma negatively affected the level of adherence (Wasti *et al.*, 2012; Azia, Mukumbang and Wyk, 2016; Chirambo *et al.*, 2019; Nurfalah, Yona and Waluyo, 2019). Our study does not capture these factors in spite of the fact that they could influence the adherence rate of HATI program's patients. Nevertheless, our study provides intuitive findings which may, to some extent, show the benefits (and limitations) of SMS reminder. Further cost effectiveness or effectiveness study should be conducted to provide more accurate estimates on the effectiveness of SMS reminder.

Second, our analysis is limited to the HATI program settings, which mostly concentrate in cities in Java and Bali islands. We did not explore the costs and outcome of SMS reminder in other regions in Indonesia, which may exhibit different costs and outcome. Despite this limitation, our framework can be implemented to these other settings to produce similar analysis and compare the results afterwards.

Conclusion

This study shows that SMS reminder may initially be expensive, but will be cheaper once the intervention has been established and embedded into the existing system of the implementing clinics. As for the cost and outcome analysis, we obtained mixed results. The PHC has the highest adherence rate, but with the highest unit cost per SMS sent. In contrast, the hospital has the lowest adherence rate, albeit with the lowest unit cost per SMS sent. As such, further studies are required to determine better site options to scale up SMS reminder. Furthermore, the overall declining trend of the adherence rate in all clinics should be further studied as it will determine the continuation and effectiveness of the SMS reminder intervention.

Abbreviations

WHO: World Health Organization; HIV: Human Immunodeficiency Virus; AIDS: Acquired Immune Deficiency Syndrome; PLHIV: People Living with HIV; ARV: Antiretroviral Treatment; SMS Reminder: Short Message System Reminder; HATI: HIV Awal (early) Testing and Treatment Indonesia; MSM: Man having Sex with Man; FSW: Female Sex Worker; TG: transgender; PWID: People Who Inject Drugs; PHC: Primary Health Care.

Declarations

Ethics Approval and Consent Participant

We received ethical approval from the ethical committee within the correspondence institution through the ethical clearance number 820/UN6.KEP/EC/2019.

Conflict of Interest

No potential conflict of interest was reported by the author(s).

Availability of Data and Materials

Not applicable.

Authors' Contribution

MNJ provided data analysis, examined data analysis results, and led the writing process. DH collected data and provided data analysis, as well as contributed to the writing. RZ assisted in the study design, analyzed data, and contributed to the

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writing. MH, RW, PPJ, and NS provided data and gave critical intellectual feedback to help revise the manuscript. AYMS examined data analysis and construct the study framework as well as assisted in finalizing the manuscript writing process. All authors have read and approved the final manuscript.

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