OPEN ACCESS

Can we screen less frequently for STI among PrEP users? Assessing the effect of biannual STI screening on timing of diagnosis and transmission risk in the AMPrEP Study

Vita W. Jongen ,[1] Hanne M.L. Zimmermann,[1,2] Marit Goedhart,[1] Johannes A. Bogaards,[3] Udi Davidovich,[1,4] Liza Coyer,[1,5] Henry J.C. de Vries,[1,6] Maria Prins,[1,5] Elske Hoornenborg,[1] Maarten F. Schim van der Loeff ,[1,5] on behalf of the Amsterdam PrEP Project team in the HIV Transmission Elimination Amsterdam (H-TEAM) Initiative

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/sextrans-2022-055439).

For numbered affiliations see end of article.

Correspondence to
Dr Vita W. Jongen, Infectious Diseases, Public Health Service of Amsterdam, 1018 WT Amsterdam, The Netherlands; vjongen@ggd.amsterdam.nl

VWJ and HM.Z are joint first authors.

Received 31 January 2022
Accepted 15 April 2022
Published Online First 18 May 2022

To cite: Jongen VW, Zimmermann HM.L, Goedhart M, *et al*. *Sex Transm Infect* 2023;**99**:149–155.

ABSTRACT

Background In many countries, HIV pre-exposure prophylaxis (PrEP) users are screened quarterly for STIs. We assessed the consequences of less frequent STI testing. We also assessed determinants of asymptomatic STI and potential for onward transmission.

Methods Using data from the AMPrEP study, we assessed the proportion of syphilis, and genital, anal, and pharyngeal chlamydia and gonorrhoea diagnoses which would have been delayed with biannual versus quarterly screening. We assessed the potential for onward transmission by examining reported condomless anal sex (CAS) in periods after to-be-omitted visits when screening biannually. We assessed determinants of incident asymptomatic STIs using Poisson regression and calculated individual risk scores on the basis of the coefficients from this model.

Results We included 366 participants. Median follow-up was 47 months (IQR 43–50). 1,183STIs were diagnosed, of which 932(79%) asymptomatic. With biannual screening, 483 asymptomatic STIs (52%) diagnoses would have been delayed at 364 study visits. Of these visits, 129 (35%), 240 (66%) and 265 (73%) were followed by periods of CAS with steady, known casual or unknown casual partners, respectively. Older participants had a lower risk of asymptomatic STI (incidence rate ratio (IRR) 0.86/10-year increase, 95% CI 0.80 to 0.92), while CAS with known (IRR 1.36, 95% CI 1.10 to 1.68) and unknown (IRR 1.86, 95% CI 1.48 to 2.34) casual partners and chemsex (IRR 1.51, 95% CI 1.28 to 1.78) increased the risk. The individual risk scores had limited predictive value (sensitivity=0.70 (95% CI 0.66 to 0.74), specificity=0.50 (95% CI 0.48 to 0.51)).

Conclusion Reducing the STI screening frequency to biannually among PrEP users will likely result in delayed diagnoses, potentially driving onward transmission. Although determinants for asymptomatic STIs were identified, predictive power was low.

KEY MESSAGES

⇒ HIV pre-exposure prophylaxis (PrEP) users are screened quarterly for STIs. We assessed the consequences of less frequent STI testing.
⇒ Reducing the STI screening frequency to biannually among PrEP users will likely result in delayed diagnoses, potentially driving onward transmission.
⇒ A targeted STI screening approach may help guide screening and reduce screening frequency and treatment, thereby reducing antibiotic intake.

INTRODUCTION

Pre-exposure prophylaxis (PrEP) is highly effective against HIV acquisition,[1 2] but does not protect against other STIs. Since the introduction of PrEP, concerns have been raised that PrEP users may be at increased risk of STIs due to engagement in more condomless sex.[3] Indeed, the number of condomless anal sex acts since PrEP initiation seems to be increasing among men who have sex with men (MSM)[4–6] and STI incidence is high.[4 6–9]

Considering the high STI incidence among PrEP users, PrEP guidelines (including the Dutch PrEP guidelines[10]) advise to screen PrEP users for STIs every 3–6 months.[11 12] However, the optimal screening frequency for syphilis, chlamydia and gonorrhoea is under debate as (1) screening for chlamydia and gonorrhoea is costly, (2) serious sequelae in men are rare, also for syphilis when testing is done within 6 months, and (3) frequent antibiotic use may lead to antimicrobial resistance (AMR). A Dutch modelling study suggested that quarterly compared with biannual screening for chlamydia and gonorrhoea is not cost-effective under prevailing health economic criteria.[13] However, an empirical study showed that screening biannually could lead to delayed diagnosis and treatment of a substantial proportion of asymptomatic STIs, possibly leading to more transmission.[14] We previously showed that the incidence of chlamydia and gonorrhoea was higher during daily than event-driven PrEP use,[6 15] probably due to fewer condomless sex acts among event-driven PrEP users,[4 6] while the incidence of syphilis was similar. Further determination of a profile for PrEP users at high

risk of STIs or a risk prediction score may provide opportunities for targeted STI screening.

To optimise the STI screening frequency of PrEP programmes, more data are needed on the effect of biannual versus quarterly screening. We therefore aimed to assess the proportion of PrEP users with STIs for whom diagnosis would be delayed if screening were conducted biannually instead of quarterly. As syphilis screening is relatively inexpensive and blood is routinely drawn every 3 months for HIV screening, we also assessed the proportion of delayed diagnoses for chlamydia and gonorrhoea separately to estimate the consequences if screening for these STIs only was delayed. In addition, we assessed the potential for onward transmission by examining reported condomless anal sex in periods after to-be-omitted visits when screening biannually and determinants of asymptomatic STIs.

METHODS

Study design and participants

The Amsterdam PrEP (AMPrEP) study was a demonstration project that assessed the uptake and feasibility of daily and event-driven PrEP among MSM and transgender persons in Amsterdam, the Netherlands.[16] In brief, participants were enrolled between 3 August 2015 and 31 May 2016. HIV-negative MSM and transgender persons were eligible for inclusion if they were ≥18 years old and reported any of the following in the preceding 6 months: condomless anal sex with casual partners, ≥1 diagnosed bacterial STI, post-exposure prophylaxis use, or sex with a partner living with HIV with a detectable or unknown viral load. Follow-up for the AMPrEP study ended December 2020. For this analysis, we used data until 29 February 2020, as PrEP care and routine STI testing at the Center for Sexual Health of the Public Health Service of Amsterdam were scaled down from March 2020 onwards due to the SARS-CoV-2 pandemic.

The AMPrEP study was registered with the Netherlands Trial Registry (NL5302).

Procedures

At the baseline visit, participants were offered a choice between daily and event-driven PrEP and they could switch PrEP regimens at each 3-monthly study visit. PrEP was provided free of charge.

Participants were tested every 3 months for chlamydia, gonorrhoea and syphilis[6] at scheduled study visits. Additional STI testing in-between the 3-monthly scheduled visits was available for those with STI-related symptoms or for people who were notified for an STI by a sexual partner. All STI testing was done free of charge. Serology testing for syphilis was done using the LIAISON Treponema Screen assay for primary infections (DiaSorin, Saluggia, Italy), and VDRL (RPR-Nosticon II; bioMérieux) for reinfections. Urine, anal and pharyngeal swabs were tested for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* using nucleic amplification testing (Aptima Combo 2 assay; Hologic, San Diego, California, USA). If an STI was detected, immediate, free-of-charge treatment was offered.

At baseline and quarterly scheduled study visits, participants completed a questionnaire on sexual behaviour.[16] The Alcohol Use Disorder Identification Test,[17] Drug Use Disorder Identification Test,[18] Mental Health Inventory screening test,[19] Sexual Compulsivity Scale,[20] and a questionnaire on substance use was completed at baseline and yearly thereafter. Questions on substance use related to use in general and in sexual settings. Chemsex was defined as the use of gamma-hydroxybutyrate/gamma-butyrolactone, mephedrone or crystallised methamphetamine around the time of sex.[21]

Statistical analysis

The baseline visit was defined as the date of PrEP initiation. Follow-up started at baseline and continued until PrEP discontinuation, loss to follow-up, HIV seroconversion or 29 February 2020, whichever came first. After PrEP discontinuation, participants were allowed to re-enter the study if they were still HIV negative; follow-up then continued from date of re-entry.

We described baseline demographics using count data and proportions for categorical variables and median and IQR for continuous variables. To estimate the number of asymptomatic syphilis (primary, secondary or early latent), chlamydia or gonorrhoea infections with a delayed diagnosis if testing had been done biannually, we subtracted the sum of asymptomatic bacterial STIs diagnosed at biannual scheduled study visits (ie, month 6, 12, 18, etc) from the sum of asymptomatic STIs diagnosed during all scheduled study visits (ie, at month 3, 6, 9, 12, etc). In addition, we estimated the number of STIs with a delayed diagnosis as a proportion of the total number of STIs diagnosed at scheduled and additional visits, to give an indication of the number of STI diagnoses delayed if screening was done biannually or based on symptoms. An STI was defined as asymptomatic if no symptoms were reported during triage and if the participant was not notified for possible exposure to an STI by a sexual contact. If a participant reported any STI-related symptom or was notified of possible exposure, the STI was defined as symptomatic, regardless whether the reported symptoms were due to the diagnosed STI (hereafter, symptomatic STI). We assessed the number of condomless anal sex acts in the 3-month period after scheduled study visits that would have been delayed with biannual testing to obtain a proxy for transmission potential of undiagnosed and untreated STIs to sexual partners if testing would have been done biannually.

We estimated incidence rates of symptomatic and asymptomatic syphilis, chlamydia and gonorrhoea per 100 person-years by dividing the number of incident infections by the person-years of observation. Multiple incident infections at the same time point were counted as one. STI incidence rates were estimated including and excluding the additional STI visits in-between study visits. Repeated incident infections were included and all follow-up time was considered as time at risk.

We assessed incidence rate ratios (IRRs) and 95% CIs of determinants of any asymptomatic STI using a Poisson regression model, using the number of incident asymptomatic infections as the outcome. Determinants with $p<0.2$ from a Wald $\chi 2$ test in univariable analysis were included in an initial multivariable model. Years since PrEP initiation wasforced into the multivariable model to account for a possible increase in STI risk over time due to a lesser perceived need for condoms. Backwards variable selection was performed to obtain the final multivariable model; variables that did not significantly improve the model ($p>0.05$) based on the likelihood-ratio test were removed from the multivariable model. Determinants for any asymptomatic chlamydia or gonorrhoea were assessed in a similar matter. We calculated individual risk scores on the basis of the coefficients from the multivariable Poisson models (using categorical variables for age groups <35, 35–44 and ≥45 years instead of the continuous variable). We estimated the cut-off point of these prediction scores to predict the occurrence of asymptomatic STIs using the Youden index. We assessed the accuracy of the prediction scores

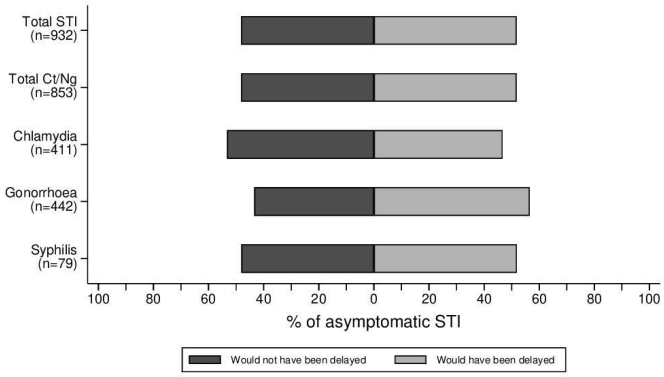

Figure 1 Proportion of bacterial STI diagnoses that would have been delayed and that would not have been delayed if screening was done biannually rather than quarterly. Ct, *Chlamydia trachomatis*; Ng, *Neisseria gonorrhoeae*.

using sensitivity and specificity for the optimal cut-off point, and the area under the curve (AUC).

All analyses were carried out using Stata (V.15.1, StataCorp, College Station, Texas, USA).

RESULTS

Between August 2015 and May 2016, 376 participants were included in the AMPrEP study. Of these, 9 (2.7%) did not have follow-up data and 1 was diagnosed with HIV at an additional STI visit shortly after enrolment; thus 10 participants were excluded from these analyses. Of the 366 included participants, 268 (73%) chose the daily PrEP regimen at baseline, 364 (99%) were male and median age was 40 years (IQR 32–48) (online supplemental table 1). The majority (n=350, 96%) reported condomless anal sex with casual partners in the 6 months before baseline and 154 (43%) indicated chemsex in the 3 months before baseline. At baseline, 5 participants (1%) had a prevalent syphilis infection, 35 (10%) chlamydia and 35 (10%) gonorrhoea.

Scheduled study visits

Median follow-up time was 47 months (IQR 43–50), during which participants attended a total of 4974 scheduled study visits. Median time between scheduled study visits was 3.0 (IQR 2.8–3.1) months. A total of 1183 bacterial STIs were diagnosed at these study visits, of which 932 (79%) were asymptomatic. Diagnosis of 483 of 932 asymptomatic STIs (52%) would have been delayed at 364 scheduled study visits if screening had been done biannually rather than quarterly (figure 1). For the various STIs, we found that 411 asymptomatic chlamydia (293 anal, 83 urethral, 35 pharyngeal), 442 asymptomatic gonorrhoea (227 anal, 34 urethral, 181 pharyngeal), and 79 asymptomatic syphilis diagnoses were made at any scheduled study visit, of which 192 (47%), 250 (57%) and 41 (52%) would have been delayed if screening had been done biannually. Twenty-eight asymptomatic anal lymphogranuloma venereum infections were diagnosed, of which 13 (46%) would have been delayed with biannual screening. Of the 364 scheduled study visits during which diagnosis of an asymptomatic STI would have been delayed when screening biannually, 129 (35%), 240 (66%) and 265 (73%) were followed by periods during which the participant reported condomless anal sex with a steady, known casual or unknown casual partner, respectively. In total, 193 (53%) of 366 participants could have transmitted one or more undetected and untreated asymptomatic STI during follow-up to a sex partner.

Study visits including additional STI screening visits

The participants attended 776 additional STI screening visits (ie, additional to the scheduled study visits), so that a total of 5750 visits with STI screening were recorded. Median time between these visits was 2.9 (IQR 2.5–3.0) months. A total of 1624 bacterial STIs were diagnosed at the scheduled and additional study visits. If screening had been done biannually or based on symptoms, diagnosis of 483 STIs (30%) would have been delayed (online supplemental table 2). Overall, the incidence rate of asymptomatic STIs was higher than the incidence rate of symptomatic STI (table 1). More incident symptomatic STIs were diagnosed when including the additional STI visits (incidence rate of any symptomatic STI 29.0 per 100 person-years, 95% CI 26.2 to 32.0) than during the scheduled study visits only (incidence rate 12.4, 95% CI 10.7 to 14.5). In contrast, the incidence rate of any asymptomatic STI was similar when including (incidence rate 57.3, 95% CI 53.3 to 61.5) or excluding (incidence rate 53.2, 95% CI 49.4 to 57.3) the additional STI visits. Similar patterns were seen for chlamydia, gonorrhoea and syphilis (figure 2).

Determinants of asymptomatic STIs

In multivariable analysis, older PrEP users had a decreased risk of any incident asymptomatic chlamydia, gonorrhoea or syphilis infection (IRR 0.86 per 10-year increase in age, 95% CI 0.80 to 0.92) (table 2). Condomless anal sex with known (IRR 1.36,

Table 1 Incidence rate (IR) of symptomatic and asymptomatic chlamydia, gonorrhoea and syphilis among PrEP users, AMPrEP cohort study, August 2015–February 2020, Amsterdam, the Netherlands

	Scheduled study visits only (n=366 persons, n=4974 visits)						Including additional STI visits (n=366 persons, n=5750 visits)					
	Symptomatic			Asymptomatic			Symptomatic			Asymptomatic		
	Events	PY	IR (95% CI)*	Events	PY	IR (95% CI)*	Events	PY	IR (95% CI)*	Events	PY	IR (95% CI)*
Any chlamydia	72	1303	5.5 (4.4 to 7.0)	355	1303	27.3 (24.6 to 30.2)	162	1308	12.4 (10.6 to 14.4)	386†	1308	29.5 (26.7 to 32.6)
Any gonorrhoea	104	1303	8.0 (6.6 to 9.7)	354	1303	27.2 (24.5 to 30.2)	240	1308	18.3 (16.2 to 20.8)	388†	1308	29.7 (26.9 to 32.8)
Syphilis	26	1303	2.0 (1.4 to 2.9)	79	1303	6.1 (4.9 to 7.6)	62	1308	4.7 (3.7 to 6.1)	84†	1308	6.4 (5.2 to 8.0)
Any chlamydia or gonorrhoea‡	146	1303	11.2 (9.5 to 13.2)	636	1303	48.8 (45.2 to 52.8)	337	1308	25.8 (23.2 to 28.7)	690†	1308	52.7 (49.0 to 56.8)
Any chlamydia, gonorrhoea or syphilis‡	162	1303	12.4 (10.7 to 14.5)	693	1303	53.2 (49.4 to 57.3)	379	1308	29.0 (26.2 to 32.0)	749†	1308	57.3 (53.3 to 61.5)

*Per 100 PY.
†Additional asymptomatic STIs were found during the additional in-between STI visits. We defined an infection as asymptomatic if no symptoms were reported during triage and if the participant was not notified for possible exposure to an STI by a sexual partner. To assess symptoms, we used the data completed by the study physician or nurse during triage. It is possible that participants indicated they had symptoms or were notified to make an appointment, but then did not disclose any symptoms or notification during triage and were thus classified as asymptomatic.
‡The diagnosis of multiple STIs at a (study or extra) visit was counted as one incident event.
AMPrEP, Amsterdam PrEP demonstration project; PrEP, pre-exposure prophylaxis; PY, person-years.

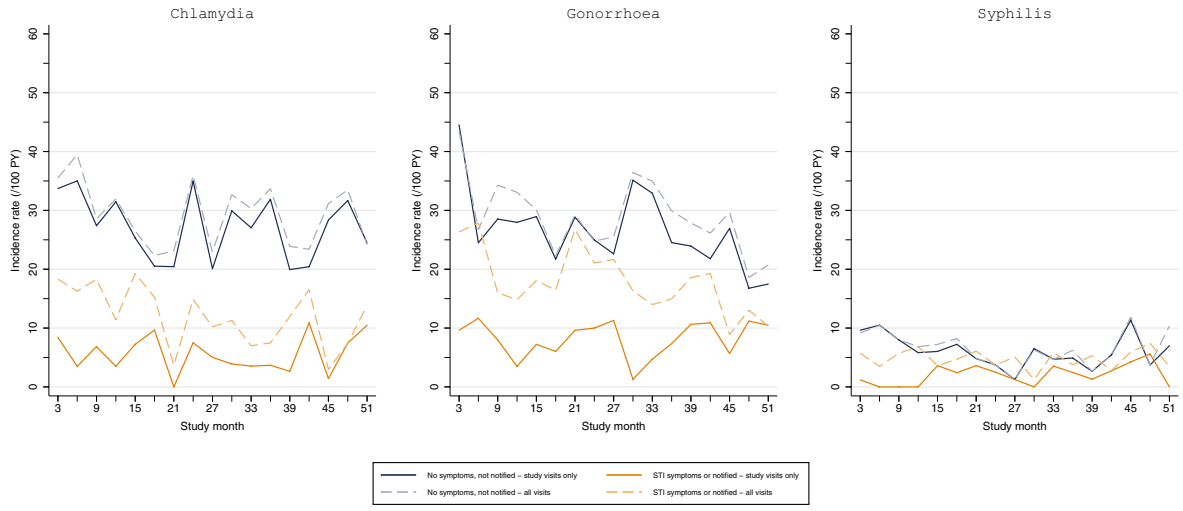

Figure 2 Incidence rate per 100 person-years (PY) of chlamydia, gonorrhoea and syphilis among PrEP users at all visits and at scheduled study visits only, AMPrEP cohort study, August 2015–February 2020, Amsterdam, the Netherlands. The week 54 visit was excluded due to the small number of participants who attended this visit. AMPrEP, Amsterdam PrEP demonstration project; PrEP, pre-exposure prophylaxis.

95% CI 1.10 to 1.68) and unknown (IRR 1.86, 95% CI 1.48 to 2.34) casual partners and participating in chemsex (IRR 1.51, 95% CI 1.28 to 1.78) in the 3 months prior to a scheduled study visit increased the risk of any asymptomatic STI. Based on the coefficients of the variables included in the final multivariable model, a risk score was calculated. The theoretical range of the score was 0.16–1.56; the actual range of observed values was 0.16–1.50. Based on the Youden index, the optimal cut-off point to predict the occurrence of asymptomatic STIs was 0.51, for which the sensitivity and specificity were 0.70 (95% CI 0.66 to 0.74) and 0.50 (95% CI 0.48 to 0.51), respectively; the AUC was 0.60. Multivariable determinants of any asymptomatic chlamydia or gonorrhoea were similar (online supplemental table 3). The optimal cut-off point, sensitivity, specificity and AUC were similar.

DISCUSSION

We estimated that diagnosis of over half of asymptomatic STIs would have been delayed if STI screening would have been done biannually instead of quarterly. As condomless anal sex was commonly reported in the 3-month periods after the scheduled study visits at which asymptomatic STIs were detected, there is potential for further STI transmission to sexual partners if STI diagnosis would have been delayed with biannual screening.

The high overall incidence of STIs has been reported extensively in PrEP research,[4 7–9] including during the first 2 years of follow-up of AMPrEP,[6] and is likely linked to the high number of condomless anal sex acts among PrEP users.[5] While incidence of STI is high, it is unclear what the optimal STI screening frequency among PrEP users is. This debate usually focuses on screening costs and the impact of screening on STI prevalence, serious sequelae and high frequency of antibiotic use. Reducing the frequency of bacterial STI screening would reduce costs, avoid treatment of self-limiting infections and reduce overall antibiotic consumption. Infections that would become symptomatic would presumably lead to additional STI visits in-between scheduled study visits with testing and treatment, which would avoid sequelae.

Modelling studies have suggested that more frequent screening could reduce chlamydia, gonorrhoea[22] and syphilis incidence,[23 24] but empirical studies assessing the effect of opportunistic testing for chlamydia and gonorrhoea have not demonstrated a decrease.[25 26] Similar to a previous study,[14] we showed that reducing screening frequency to biannually would result in delayed diagnosis of over half of asymptomatic STIs, and 32% of all diagnosed STIs, which provides a window for ongoing transmission, since the majority of individuals engaged in condomless anal sex acts during the time following the to-be-omitted study visits. On the other hand, participants might refrain from condomless sex without the reassurance of a negative test result. The contribution of delayed diagnosis of asymptomatic infections to onward transmission warrants further attention.

While there is a potential for serious sequelae of syphilis if left untreated, the likelihood of these sequelae within a time frame of 6 months is low. However, as per current guidelines, PrEP users will have to be screened for HIV every 3 months and testing for syphilis is relatively inexpensive, quarterly screening for syphilis could still be considered. Similarly, the risk of serious sequelae after chlamydia and gonorrhoea is low in men. In addition, gonorrhoea and chlamydia infections have been found to clear spontaneously[27–29] and thus treating all asymptomatic gonorrhoea and chlamydia with antibiotics may not be necessary and contribute to AMR. A recent study showed that macrolide consumption among PrEP users was high (9.46 daily doses per 1000 inhabitants per day),[30] but that macrolide consumption was almost 75% lower when STI screening changed from quarterly to biannually.[31] Thus, reducing the STI screening frequency may at least be an effective way of reducing macrolide consumption. As we found a relatively high incidence rate of symptomatic infections, especially when including additional STI visits, this could imply that symptomatic STIs are likely to be diagnosed and treated regardless of planned screening frequency. Reducing the screening frequency of gonorrhoea and chlamydia to biannually and encouraging STI testing when needed could reduce the frequency of treatment with antibiotics.

With regard to the high proportion of infections for which treatment would have been delayed with biannual screening, we examined the feasibility of another approach: screening based on personalised risk profiles. We showed that participants who were older and engaged less in risky sexual practices (eg, chemsex or

Table 2 Determinants of any incident asymptomatic chlamydia, gonorrhoea or syphilis among PrEP users, AMPrEP cohort study, August 2015–February 2020, Amsterdam, the Netherlands

			Univariable Poisson model			Multivariable Poisson model		
	# events	Person-years	IRR	95% CI	P value	aIRR	95% CI	P value
Years since PrEP initiation								
1	199	359	Ref		0.763	Ref		
2	169	338	0.90	0.73 to 1.11		0.94	0.76 to 1.15	0.532
3	171	320	0.97	0.79 to 1.19		1.08	0.87 to 1.33	0.491
4	132	259	0.92	0.74 to 1.15		1.09	0.84 to 1.41	0.517
Age, per 10-year increase*			0.87	0.81 to 0.93	<0.001	0.86	0.80 to 0.92	<0.001
Age*								
<35 years	191	308	Ref		<0.001			
35–44 years	246	413	0.96	0.79 to 1.16				
≥45 years	256	582	0.71	0.59 to 0.86				
Self-declared ethnicity†								
White	595	1117	Ref		0.932			
Non-white	98	186	0.99	0.80 to 1.23				
Highest education level†								
No college/university	129	286	Ref		0.029			
College/university	564	1016	1.23	1.02 to 1.49				
Employment†								
Unemployed	142	279	Ref		0.507			
Employed	544	1006	1.06	0.88 to 1.28				
Sexual preference†								
Exclusively homosexual	564	1029	Ref		0.165			
Not exclusively homosexual	129	269	0.87	0.72 to 1.06				
CAS with a steady partner*								
No	413	748	Ref		0.360			
Yes	259	504	0.93	0.80 to 1.09				
CAS with a known casual partner*								
No	125	347	Ref		<0.001	Ref		0.004
Yes	547	906	1.67	1.38 to 2.03		1.36	1.10 to 1.68	
CAS with an unknown casual partner*								
No	105	331	Ref		<0.001	Ref		<0.001
Yes	567	922	1.94	1.57 to 2.39		1.86	1.48 to 2.34	
Chemsex*‡								
No	283	690	Ref		<0.001	Ref		<0.001
Yes	339	477	1.73	1.48 to 2.03		1.51	1.28 to 1.78	
Alcohol Use Disorder Identification Test*§								
Score <8	493	884	Ref		0.049			
Score ≥8	129	280	0.83	0.68 to 1.00				
Drug Use Disorder Identification Test*§								
Score <8	395	802	Ref		0.004			
Score ≥8	227	362	1.28	1.08 to 1.50				
MHI-5*¶								
Score ≥60	504	939	Ref		0.842			
Score <60	117	222	0.98	0.80 to 1.20				
Sexual Compulsivity Scale score***								
Score <24	535	1021	Ref		0.180			
Score ≥24	86	140	1.17	0.93 to 1.47				

*Time updated.
†As reported at baseline.
‡Defined as any gamma-hydroxybutyrate/gamma-butyrolactone, crystallised methamphetamine or mephedrone use during sex.
§A score of 8 or higher indicates possible presence of alcohol or drug use disorder.
¶A score lower than 60 indicates possible mood or depressive mood disorder.
**A score or 24 or higher indicates a greater impact of sexual thoughts on daily functioning and an inability to control sexual thoughts or behaviour.
aIRR, adjusted incidence rate ratio; AMPrEP, Amsterdam PrEP demonstration project; CAS, condomless anal sex; IRR, incidence rate ratio; MHI-5, Mental Health Inventory screening test; PrEP, pre-exposure prophylaxis.

condomless anal sex with unknown casual partners) were at lower risk of asymptomatic STIs. However, the predictive value of the individual risk scores to distinguish participants at low risk of asymptomatic infections was low. In addition, these determinants are known risk factors for STIs among PrEP users[8] and are not specific for asymptomatic infections. To optimise PrEP programmes, it needs to be further evaluated whether a targeted quarterly screening approach is possible and (cost-)effective.

Our study is one of the first to evaluate quarterly versus biannual STI screening using longitudinal data of over 4.5 years, in which we were able to differentiate between asymptomatic and symptomatic STIs. Our approach was also subject to some

limitations. First, the participants of AMPrEP were early PrEP adopters, were predominantly white and highly educated, and were at high risk of HIV before they entered the study.[16] Therefore, they may not be representative of the current PrEP-using population. Other PrEP users in the Netherlands may have, on average, lower rates of STIs and thus a lower number of asymptomatic diagnoses that would be missed with less frequent screening. Second, it was assumed that asymptomatic infections remained asymptomatic and thus untreated until the next scheduled study visit, while in theory asymptomatic STIs could become pre-symptomatic and symptomatic over time. In addition, we did not account for spontaneous clearance of gonorrhoea and chlamydia.[27–29] These assumptions may have caused an overestimation of the proportion of infections that would have had delayed treatment. Lastly, we assumed that participants would not change their sexual behaviour if STI screening would have been done biannually.

In conclusion, reducing the screening frequency of STIs from quarterly to biannually among PrEP users may result in many delayed diagnoses of asymptomatic infections, potentially driving onward transmission. Whether this would pose a serious public health threat as far as chlamydia and gonorrhoea are concerned needs further evaluation. Although a risk-based STI screening approach to guide STI testing has potential to mitigate this effect, more research is warranted to evaluate the potential and (cost-)effectiveness of targeted testing in various PrEP-using populations.

Author affiliations
[1]Department of Infectious Diseases, Public Health Service of Amsterdam, Amsterdam, The Netherlands
[2]Department of Work and Social Psychology, Maastricht University, Maastricht, Netherlands
[3]Department of Epidemiology & Data Science, Amsterdam UMC, Vrije Universiteit Amsterdam, location VUmc, Amsterdam, Netherlands
[4]Department of Social Psychology, University of Amsterdam, Amsterdam, Netherlands
[5]Amsterdam UMC, University of Amsterdam, Internal Medicine, Amsterdam Infection and Immunity (AII), Amsterdam, Netherlands
[6]Amsterdam UMC, University of Amsterdam, Department of Dermatology, Amsterdam Infection and Immunity (AII), location Academic Medical Centre, Amsterdam, Netherlands

Handling editor Jason J Ong

Twitter Liza Coyer @LizaCoyer

Acknowledgements We would like to thank all AMPrEP participants, and the members of the advisory board and community engagement group of AMPrEP. Additionally, we thank Roel Achterbergh, Ertan Ersan, Dominique Loomans, Amy Matser, Kees de Jong, Ilya Peters, Princella Felipa, Myra van Leeuwen, Kenneth Yap, Yvonne van Duijnhoven, Adriaan Tempert and all members of the H-TEAM (see Annex 1).

Contributors EH, MP, HdV, UD and MSvdL conceptualised and designed the AMPrEP demonstration project. VWJ, HMLZ, MG, JB and MSvdL contributed to study design of the current study. All authors were involved in data acquisition, data analysis or interpretation of the data. VWJ and HMLZ drafted the manuscript. All authors critically revised the manuscript. MSvdL had full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

Funding The AMPrEP Project received funding as part of the H-TEAM Initiative from ZonMw (grant number 522002003), the National Institute for Public Health and the Environment (grant number not applicable) and GGD research funds (grant number not applicable). The study drugs were provided by Gilead Sciences. The H-TEAM Initiative is being supported by the Aidsfonds Netherlands (grant number 2013169), Stichting Amsterdam Diner Foundation (grant number not applicable), Gilead Sciences Europe (grant number PA-HIV-PREP-16-0024), Gilead Sciences (protocol numbers CO-NL-276-4222, CO-US-276-1712), Janssen Pharmaceuticals (reference number PHNL/JAN/0714/0005b/1912fde), MAC AIDS Fund (grant number not applicable) and ViiV Healthcare (PO numbers 3000268822, 3000747780).

Competing interests The Public Health Service of Amsterdam received the drugs for the Amsterdam PrEP Study from Gilead Sciences based on an unconditional grant. UD received unrestricted research grants and speaker fees from Gilead Sciences, paid to his institute. HdV received grants from Medigene, and advisory board and speaker fees from Gilead Sciences, Medigene, Abbvie, Janssen-Cilag and Willpharma, all paid to his institute. MP received unrestricted research grants and speaker fees from Gilead Sciences, Roche, Abbvie and MSD, all paid to her institute. All other authors declare no competing interest.

Patient consent for publication Not required.

Ethics approval Written informed consent was obtained from all participants. The AMPrEP Study was approved by the ethics board of the Amsterdam University Medical Centers, location Academic Medical Center, the Netherlands (NL49504.018.14).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The AMPrEP data are owned by the Public Health Service of Amsterdam. Original data can be requested by submitting a study proposal to the steering committee of AMPrEP. The proposal format can be obtained from amprep@ggd.amsterdam.nl. Request for further information can also be submitted through the same email address. The AMPrEP steering committee verifies each proposal for compatibility with general objectives, ethical approval, and informed consent forms of the AMPrEP study and potential overlap with ongoing studies. There are no restrictions to obtaining the data and all data requests will be processed in a similar way.

ORCID iDs
Vita W. Jongen http://orcid.org/0000-0001-9538-1501
Maarten F. Schim van der Loeff http://orcid.org/0000-0002-4903-7002

REFERENCES

1 Fonner VA, Dalglish SL, Kennedy CE, *et al*. Effectiveness and safety of oral HIV preexposure prophylaxis for all populations. *AIDS* 2016;30:1973–83.
2 Molina J-M, Capitant C, Spire B, *et al*. On-Demand preexposure prophylaxis in men at high risk for HIV-1 infection. *N Engl J Med* 2015;373:2237–46.
3 Blumenthal J, Haubrich RH. Will risk compensation accompany pre-exposure prophylaxis for HIV? *Virtual Mentor* 2014;16:909–15.
4 Vuylsteke B, Reyniers T, De Baetselier I, *et al*. Daily and event-driven pre-exposure prophylaxis for men who have sex with men in Belgium: results of a prospective cohort measuring adherence, sexual behaviour and STI incidence. *J Int AIDS Soc* 2019;22:e25407.
5 Traeger MW, Schroeder SE, Wright EJ, *et al*. Effects of pre-exposure prophylaxis for the prevention of human immunodeficiency virus infection on sexual risk behavior in men who have sex with men: a systematic review and meta-analysis. *Clin Infect Dis* 2018;67:676–86.
6 Hoornenborg E, Coyer L, Achterbergh RCA, *et al*. Sexual behaviour and incidence of HIV and sexually transmitted infections among men who have sex with men using daily and event-driven pre-exposure prophylaxis in AMPrEP: 2 year results from a demonstration study. *Lancet HIV* 2019;6:e447–55.
7 Zablotska IB, Vaccher SJ, Bloch M, *et al*. High adherence to HIV pre-exposure prophylaxis and NO HIV seroconversions despite high levels of risk behaviour and STIs: the Australian demonstration study prelude. *AIDS Behav* 2019;23:1780–9.
8 Traeger MW, Cornelisse VJ, Asselin J, *et al*. Association of HIV preexposure prophylaxis with incidence of sexually transmitted infections among individuals at high risk of HIV infection. *JAMA* 2019;321:1380–90.
9 Werner RN, Gaskins M, Nast A, *et al*. Incidence of sexually transmitted infections in men who have sex with men and who are at substantial risk of HIV infection - A meta-analysis of data from trials and observational studies of HIV pre-exposure prophylaxis. *PLoS One* 2018;13:e0208107.
10 Nederlandse Vereniging van HIV Behandelaren (NVHB). HIV preexpositie profylaxe (PreP) richtlijn Nederland, gereviseerde versie 2. Nederlandse vereniging van HIV behandelaren (NVHB), 2019. Available: https://nvhb.nl/wp-content/uploads/2019/04/PrEP-richtlijn-Nederland-versie-2-dd-15-april-2019.pdf [Accessed 15 Apr 2020].

11 Centers for Disease Control and Prevention. Us public health service: preexposure prophylaxis for the prevention of HIV infection in the United States—2017 update: a clinical practice guideline., 2018. Available: https://www.cdc.gov/hiv/pdf/risk/prep/cdc-hiv-prep-guidelines-2017.pdf
12 Brady M, Rodger A, Asboe D. BHIVA/BASHH guidelines on the use of HIV pre-exposure prophylaxis (PreP). Available: https://www.bhiva.org/PrEP-guidelines2018
13 van Wifferen F, Hoornenborg E, Schim van der Loeff MF, *et al*. Cost-effectiveness of two screening strategies for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* as part of the PrEP programme in the Netherlands: a modelling study. *Sex Transm Infect* 2021;97:607–12.
14 Tang EC, Vittinghoff E, Philip SS, *et al*. Quarterly screening optimizes detection of sexually transmitted infections when prescribing HIV preexposure prophylaxis. *AIDS* 2020;34:1181–6.
15 Jongen VW, Reyniers T, Ypma ZM, *et al*. Choosing event-driven and daily HIV pre-exposure prophylaxis - data from two European PrEP demonstration projects among men who have sex with men. *J Int AIDS Soc* 2021;24:e25768.
16 Hoornenborg E, Achterbergh RC, van der Loeff MFS, *et al*. Men who have sex with men more often chose daily than event-driven use of pre-exposure prophylaxis: baseline analysis of a demonstration study in Amsterdam. *J Int AIDS Soc* 2018;21:e25105.
17 Babor TF, Higgins-Biddle JC, Saunders JB, *et al*. *The alcohol use disorders identification test: guideline for use in primary care*. Geneva: World Health Organization, 2001.
18 Berman AH, Bergman H, Palmstierna T, *et al*. Evaluation of the drug use disorders identification test (DUDIT) in criminal justice and detoxification settings and in a Swedish population sample. *Eur Addict Res* 2005;11:22–31.
19 Kelly MJ, Dunstan FD, Lloyd K, *et al*. Evaluating cutpoints for the MHI-5 and MCS using the GHQ-12: a comparison of five different methods. *BMC Psychiatry* 2008;8:10.
20 Kalichman SC, Johnson JR, Adair V, *et al*. Sexual sensation seeking: scale development and predicting AIDS-risk behavior among homosexually active men. *J Pers Assess* 1994;62:385–97.
21 Bourne A, Reid D, Hickson F, *et al*. Illicit drug use in sexual settings ('chemsex') and HIV/STI transmission risk behaviour among gay men in South London: findings from a qualitative study. *Sex Transm Infect* 2015;91:564–8.
22 Jenness SM, Weiss KM, Goodreau SM, *et al*. Incidence of gonorrhea and Chlamydia following human immunodeficiency virus preexposure prophylaxis among men who have sex with men: a modeling study. *Clin Infect Dis* 2017;65:712–8.
23 Tuite AR, Fisman DN, Mishra S. Screen more or screen more often? using mathematical models to inform syphilis control strategies. *BMC Public Health* 2013;13:606.
24 Gray RT, Hoare A, Prestage GP, *et al*. Frequent testing of highly sexually active gay men is required to control syphilis. *Sex Transm Dis* 2010;37:298–305.
25 Hocking JS, Temple-Smith M, Guy R, *et al*. Population effectiveness of opportunistic Chlamydia testing in primary care in Australia: a cluster-randomised controlled trial. *Lancet* 2018;392:1413–22.
26 Tsoumanis A, Hens N, Kenyon CR. Is screening for Chlamydia and gonorrhea in men who have sex with men associated with reduction of the prevalence of these infections? A systematic review of observational studies. *Sex Transm Dis* 2018;45:615–22.
27 van Liere GAFS, Hoebe CJPA, Dirks JA, *et al*. Spontaneous clearance of urogenital, anorectal and oropharyngeal *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in women, MSM and heterosexual men visiting the STI clinic: a prospective cohort study. *Sex Transm Infect* 2019;95:505.
28 Hananta IPY, de Vries HJC, van Dam AP, *et al*. Spontaneous clearance of pharyngeal gonococcal infections: a retrospective study in patients of the sexually transmitted infections clinic; Amsterdam, the Netherlands; 2012 to 2015. *Sex Transm Dis* 2018;45:594–9.
29 Dukers-Muijrers NHTM, Wolffs P, Lucchesi M, *et al*. Oropharyngeal *Chlamydia trachomatis* in women; spontaneous clearance and cure after treatment (FemCure). *Sex Transm Infect* 2021;97:147.
30 Kenyon C. Dual Azithromycin/Ceftriaxone therapy for gonorrhea in PreP cohorts results in levels of macrolide consumption that exceed resistance thresholds by up to 7-Fold. *J Infect Dis* 2021;224:1623–4.
31 Vanbaelen T, Van Dijck C, De Baetselier I, *et al*. Screening for STIs is one of the main drivers of macrolide consumption in PreP users. *Int J STD AIDS* 2021;32:1183–4.

SUPPLEMENT TO:

Can we screen less frequently for STI among PrEP users? Comparing biannual versus quarterly STI screening in the AMPrEP cohort study

Vita W. Jongen, Hanne M.L. Zimmermann, Marit Goedhart, Johannes A. Bogaards, Udi Davidovich, Liza Coyer, Henry J.C. de Vries, Maria Prins, Elske Hoornenborg, Maarten F. Schim van der Loeff, on behalf of the Amsterdam PrEP Project team in the HIV Transmission Elimination Amsterdam (H-TEAM) Initiative.

Jongen VW, *et al. Sex Transm Infect* 2022;0:1–7. doi: 10.1136/sextrans-2022-055439

Supplementary Table 1: Socio-demographic and sexual behaviour characteristics at baseline of PrEP users (n=366), AMPrEP cohort study, August 2015 to June 2016, Amsterdam, the Netherlands.

	n[1]	*%*[1]
PrEP regimen		
Daily	268	73%
Event-driven	98	27%
Age (years)		
Median (IQR)	40	[32-48]
<35 year	120	33%
35 - 44 year	111	30%
≥45 year	135	37%
Gender identity		
Male	364	99%
Transgender woman	2	1%
Self-declared racial-ethnic background		
White	314	86%
Non-white	52	14%
Residence		
Amsterdam	223	61%
Other	143	39%
Highest education level		
No college/university	86	24%
College/university	280	77%
Employment		
Employed	282	78%
Unemployed	80	22%
Monthly net income		
Low (≤€1700)	96	27%
Middle (€1701 to €2950)	150	43%
High (>€2950)	104	30%
Steady relationship		
No	204	56%
Yes	158	44%
Living situation		
Alone	195	53%
With partner	116	32%
With others	55	15%
Sexual behaviour		
Sexual preference		
Exclusively homosexual	288	79%
Not exclusively homosexual	77	21%
Number of anal sex partners[2], median [IQR]	12	[6-25]
Number of casual partners[2], median [IQR]	12	[5-23]
Number of anal sex acts[2], median [IQR]	22	[11-36]
Number of anal sex acts with a casual partner[2], median [IQR]	15	[8-28]
CAS with casual partner[3]		
No	16	4%
Yes	350	96%
Post-exposure prophylaxis used[3]		

No	339	93%
Yes	27	7%
HIV-positive partner with a detectable viral load[3]		
No	357	98%
Yes	9	2%
Any bacterial STI		
Chlamydia	35/357	10%
Gonorrhoea	35/358	10%
Syphilis	5/357	1%
Drug use and mental health characteristics		
Chemsex[2,4]		
No	207	57%
Yes	154	43%
Alcohol-use disorder (AUDIT)[5]		
Score <8	262	72%
Score ≥8	100	28%
Drug-use disorder (DUDIT)[5]		
Score <8	230	63%
Score ≥8	134	37%
MHI-5[6]		
Score <60	76	21%
Score ≥60	290	79%
Sexual compulsivity score (SCS)[7]		
Score <24	283	78%
Score ≥24	82	22%

Abbreviations: AMPrEP, Amsterdam PrEP demonstration project; CAS, condomless anal sex act; HIV, human immunodeficiency virus; IQR, interquartile range; PrEP, pre-exposure prophylaxis

Data were missing for employment (n=4), income (n=16), steady relationship (n=4), sexual preference (n=1), syphilis diagnosis (n=9), AUDIT (n=1), DUDIT (n=2), SCS (n=1).

1. Unless stated otherwise
2. In the 3 months before baseline
3. In the 6 months before baseline
4. Defined as any gamma-hydroxybutyrate (GHB)/gamma-butyrolactone (GBL), crystalized methamphetamine or mephedrone use during sex
5. A score of eight or higher indicates possible presence of alcohol- or drug-use disorder
6. A score lower than 60 indicates possible mood or depressive mood disorder
7. A score or 24 or higher indicates a greater impact of sexual thoughts on daily functioning and an inability to control sexual thoughts or behaviour

Supplementary Table 2: Proportion of bacterial STI diagnoses that would have been delayed and that would not have been delayed if screening was done biannually or based on symptoms rather than quarterly, AMPrEP cohort study, August 2015 to February 2020, Amsterdam, the Netherlands.

	Total	**Would not have been delayed**		**Would have been delayed**	
		n	%	*n*	%
Chlamydia	630	438	70%	192	30%
Gonorrhoea	848	598	71%	250	29%
Syphilis	146	105	92%	41	28%
Total chlamydia or gonorrhoea	1,478	1036	70%	442	30%
Total chlamydia, gonorrhoea or syphilis	1,624	1,141	70%	483	30%

Abbreviations: AMPrEP, Amsterdam PrEP demonstration project; STI, sexually transmitted infection

Supplementary Table 3. Determinants of any incident asymptomatic chlamydia or gonorrhoea among PrEP users, AMPrEP observational cohort study, August 2015 to February 2020, Amsterdam, the Netherlands.

			Univariable Poisson model			Multivariable Poisson model		
	# events	*Person-years*	*IRR*	*95% CI*	*p-value*	*aIRR*	*95% CI*	*p-value*
Years since PrEP initiation								
1	179	359	REF		0.757	REF		
2	156	338	0.93	(0.75-1.15)		0.97	(0.77-1.20)	0.760
3	162	320	1.02	(0.82-1.26)		1.14	(0.92-1.42)	0.227
4	119	259	0.92	(0.73-1.16)		1.07	(0.82-1.41)	0.608
Age, per 10 year increase[1]			0.86	0.80-0.92	<0.001	0.85	0.79-0.91	<0.001
Age[1]								
<35 year	176	308	REF		<0.001			
35 - 44 year	229	413	0.97	0.80-1.18				
≥45 year	231	582	0.69	0.57-0.85				
Self-declared ethnicity[2]								
White	546	1117	REF		0.941			
Non-white	90	186	0.99	0.79-1.24				
Highest education level[2]								
No college/university	118	286	REF		0.033			
College/university	518	1016	1.24	1.01-1.51				
Employment[2]								
Unemployed	129	279	REF		0.452			
Employed	500	1006	1.08	0.89-1.31				
Sexual preference[2]								
Exclusively homosexual	517	1029	REF		0.204			
Not exclusively homosexual	119	269	0.88	0.72-1.07				
CAS with a steady partner[1]								
No	7.5	748	REF		0.390			

Yes	5.0	504	0.93	0.79-1.10				
CAS with a known casual partner[1]								
No	114	347	REF		<0.001	REF		0.008
Yes	503	906	1.69	1.38-2.07		1.35	1.08-1.68	
CAS with an unknown casual partner[1]								
No	98	331	REF		<0.001	REF		<0.001
Yes	519	922	1.90	1.53-2.36		1.84	1.45-2.34	
Chemsex[1,3]								
No	256	690	REF		<0.001	REF		<0.001
Yes	312	477	1.76	1.50-2.08		1.53	1.28-1.81	
Alcohol use disorder identification test (AUDIT)[1,4]								
Score <8	453	884	REF		0.037	REF		0.050
Score ≥8	116	280	0.81	0.66-0.99		0.81	0.66-1.00	
Drug use disorder identification test (DUDIT)[1,4]								
Score <8	355	802	REF		<0.001			
Score ≥8	214	362	1.34	1.13-1.58				
MHI-5[1,5]								
Score ≥60	459	939	REF		0.983			
Score <60	109	222	1.00	0.81-1.24				
Sexual compulsivity score (SCS)[1,6]								
Score <24	489	1021	REF		0.186			
Score ≥24	79	140	1.18	0.93-1.49				

Abbreviations: aIRR, adjusted incidence rate ratio; AMPrEP, Amsterdam PrEP demonstration project; CAS, condomless anal sex act; CI, confidence interval; IRR, incidence rate ratio; PrEP, pre-exposure prophylaxis

1. Time-updated
2. As reported at baseline
3. Defined as any gamma-hydroxybutyrate (GHB)/gamma-butyrolactone (GBL), crystalized methamphetamine or mephedrone use during sex
4. A score of eight or higher indicates possible presence of alcohol- or drug-use disorder
5. A score lower than 60 indicates possible mood or depressive mood disorder
6. A score or 24 or higher indicates a greater impact of sexual thoughts on daily functioning and an inability to control sexual thoughts or behaviour

Annex 1: Acknowledgements of the H-TEAM consortium

H-TEAM members are: T. van Benthem[1], D. Bons[2], G.J. de Bree[3;4], P. Brokx[5], U. Davidovich[1;6], F. Deug[7], S.E. Geerlings[4], M. Heidenrijk[3], E. Hoornenborg[1], E. Hoskam[7], M. Prins[1;4], P. Reiss[3;5], A. van Sighem[8], M. van der Valk[4;8], W. Zuilhof[7].

H-TEAM Project Management: N. Schat[3].

H-TEAM additional collaborators:
M. van Agtmael[9], J. Ananworanich[10], D. Van de Beek[11], G.E.L. van den Berk[12], D. Bezemer[8], A. van Bijnen[7], J.P. Bil[1], W.L. Blok[11], S. Bogers[4], M. Bomers[9], A. Boyd[1;8], W. Brokking[13], D. Burger[14], K. Brinkman[12], N. Brinkman[12], M. de Bruin[15], S. Bruisten[1], L. Coyer[1], R. van Crevel[16], M. Dijkstra[1], Y.T. van Duijnhoven[1], A. van Eeden[13], L. Elsenburg[13], M.A.M. van den Elshout[1], E. Ersan[17], P. E.V. Felipa[1], T.B.H. Geijtenbeek[18], J. van Gool[1], A. Goorhuis[4], M. Groot[13], C.A. Hankins[3], A. Heijnen[19;20], M.M.J Hillebregt[8], M. Hommenga[1], J.W. Hovius[4], Y. Janssen[21], K. de Jong[1], V. Jongen[1], N.A. Kootstra[22], R.A. Koup[23], F.P. Kroon[24], T.J.W. van de Laar[25;26], F. Lauw[27], M. M. van Leeuwen[5], K. Lettinga[28], I. Linde[1], D.S.E. Loomans[1], I.M. van der Lubben[1], J.T. van der Meer[4], T. Mouhebati[7], B.J. Mulder[1], J. Mulder[29], F.J. Nellen[4], A. Nijsters[7], H. Nobel[4], E.L.M. Op de Coul[30], E. Peters[9], I.S. Peters[1], T. van der Poll[4], O. Ratmann[31], C. Rokx[32], M.F. Schim van der Loeff[1;33], W.E.M. Schoute[12], J. Schouten[1], J. Veenstra[28], A. Verbon[32], F. Verdult[5], J. de Vocht[9], H.J. de Vries[1;33;34], S. Vrouenraets[28], M. van Vugt[4], W.J. Wiersinga[4], F.W. Wit[4;6], L.R. Woittiez[4], S. Zaheri[8], P. Zantkuijl[7], A. Żakowicz[35], M.C. van Zelm[36], H.M.L. Zimmermann[1].

1 Department of Infectious Diseases, Public Health Service of Amsterdam, Amsterdam, the Netherlands
2 Trans United Europe, Amsterdam, The Netherlands
3 Department of Global Health, Amsterdam UMC – location AMC, and Amsterdam Institute for Global Health and Development, Amsterdam, the Netherlands
4 Department of Internal Medicine, Division of Infectious Diseases, Amsterdam UMC – location AMC, Amsterdam, the Netherlands
5 Dutch Association of PLHIV, Amsterdam, the Netherlands
6 Department of Social Psychology, University of Amsterdam, Amsterdam, the Netherlands
7 Soa Aids Nederland, Amsterdam, the Netherlands
8 Stichting HIV Monitoring, Amsterdam, the Netherlands
9 Department of Internal Medicine, Amsterdam UMC – location VUMC, Amsterdam, the Netherlands
10 US Military HIV Research Program and the Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, United States
11 Center of Infection and Immunity Amsterdam (CINIMA), Department of Neurology, Amsterdam UMC – location AMC, Amsterdam, the Netherlands
12 Department of internal medicine, OLVG – location East, Amsterdam, the Netherlands
13 DC Klinieken, Amsterdam, the Netherlands
14 Department of Pharmacy, Radboud University Nijmegen Medical Center, Nijmegen, the Netherlands
15 Aberdeen Health Psychology Group, Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, United Kingdom
16 Department of Internal Medicine, Radboud University Nijmegen Medical Center, Nijmegen, the Netherlands
17 Department of General Practice, Amsterdam UMC – location AMC, University of Amsterdam, Amsterdam, the Netherlands
18 Laboratory of Experimental Immunology, Amsterdam UMC – location AMC Amsterdam, the Netherlands
19 Sexology Center Amsterdam, Amsterdam, the Netherlands
20 GP practice Heijnen & de Meij, Amsterdam, the Netherlands
21 Primary Care Amsterdam and Almere (Elaa), Amsterdam, the Netherlands
22 Laboratory for Viral Immune Pathogenesis, Amsterdam UMC – location AMC Amsterdam, the Netherlands
23 Immunology Laboratory, Vaccine Research Center, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Rockville, Maryland, USA
24 Department of Infectious Diseases, Leiden University Medical Center, Leiden, the Netherlands
25 Department of Medical Microbiology, OLVG, Amsterdam, the Netherlands
26 Department of Donor Medicine Research, Laboratory of Blood-borne Infections, Sanquin Research, Amsterdam, the Netherlands
27 Department of Internal Medicine, Medical Center Jan van Goyen, Amsterdam, the Netherlands
28 Department of Internal Medicine, OLVG – location West, Amsterdam, the Netherlands
29 Department of Internal Medicine, Slotervaart Hospital (former), Amsterdam, the Netherlands
30 Epidemiology and Surveillance Unit, Center for Infectious Disease Control, National Institute of Public Health and the Environment, the Netherlands
31 School of Public Health, Faculty of Medicine, Imperial College London, London, United Kingdom
32 Department of Internal Medicine and Infectious Diseases, Erasmus Medical Center, Rotterdam, the Netherlands
33 Center for Infection and Immunology, Amsterdam (CINIMA), Amsterdam UMC – location AMC, University of Amsterdam, Amsterdam, the Netherlands
34 Department of Dermatology, Amsterdam UMC – location AMC, University of Amsterdam, Amsterdam, the Netherlands
35 AIDS Healthcare Foundation, Amsterdam, the Netherlands
36 Department of Virology, Erasmus Medical Center, Rotterdam, the Netherlands