

Final technical report

Phase A of the National Syphilis Action Plan: Modelling evidence and research on acceptability of interventions for controlling syphilis in Australia

2009



National Centre in HIV Epidemiology
and Clinical Research



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THE UNIVERSITY OF NEW SOUTH WALES

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Executive summary and recommendations

Recommendations from Phase A of the National Syphilis Action Plan

In September 2008, the Blood Borne Virus and STIs Subcommittee (BBVSS) of the Australian Population Health Development Principal Committee committed to the development of a National Syphilis Action Plan (NSAP) as a priority area for action. Phase A of the plan involved determining the variables and targets to underpin the shared goal of reducing the incidence of syphilis among gay men. Detailed mathematical modelling research was carried out to investigate the expected epidemiological impact of a large number of potential interventions and this was complemented by social research on the acceptability of interventions among gay men as ascertained in focus group sessions. A technical workshop was held on 25 June, 2009 to review the background modelling and social research and summaries of international and local responses to syphilis epidemics carried out thus far, and to establish recommendations for the NSAP. The recommendations from Phase A of the NSAP are as follows.

Priority 1

Gay men are encouraged to test for syphilis as it pertains to their level of risk: The more sexually active the individual gay man then the more often he should be tested. For sexually-active gay men in general, testing for syphilis should be linked to other routine testing. ***Ongoing screening for syphilis should be routine with HIV management and testing*** (as opt-out strategies): Sexually-active HIV-infected men should be tested for syphilis during routine check-up, usually every 3 months; Screening for syphilis should also be conducted alongside every HIV test for sexually-active gay men not previously diagnosed with HIV. In addition, as a minimum, ***men who have more than 20 partners per 6 months should be tested for syphilis at least twice per year***. Testing sexually active gay men who have never previously been tested is also important.

These interventions must be on-going and will likely require increased clinical capacity. Implementation should also consider improving access to testing through different types of tests and sites, and extending operating hours.



Priority 2

Easier ways for notifying sexual partners discreetly should be created. The goal is to quantifiably observe an **increase in the rate of partner notification**. To decrease stigma, **increased education about syphilis** is required. Mechanisms for partner notification should consider patient-led, clinician-led, and centralised notification models that use a variety of means and technologies.

Priority 3

There is general agreement that the proposed syphilis chemoprophylaxis ('syphilaxis') trial should proceed as soon as is practical. It is recommended that **possible Australian funding sources for the trial** be investigated.

Supporting priorities

1. Promoting condom use to maintain current high usage levels remains critical. Condom use and number of sexual partners are also important concepts in education for gay men in assessing their level of risk and relative need for, and frequency of, testing.

2. Consideration should be given to **locating highly sexually active gay men**, who have greater than 20 partners per 6 months, for the purposes of targeting interventions. Care should be taken for protecting the confidentiality of the venues and men involved.

Non-priorities

The participants at the technical workshop also considered the expected effectiveness and acceptability of other possible interventions, including reductions in the number of sexual partners and mass treatment. Based on the evidence provided it was determined that interventions associated with these approaches should not be priorities of the NSAP.

The priorities recommended in this report are consistent with the priority action areas from the last National Sexually Transmissible Infections Strategy (2005-2008) and will inform part of the next National STI strategy.



Model simulations based on priority recommendations

The expected impact of interventions based on the recommendations in Priorities 1 and 2 on annual syphilis diagnoses are shown in Figure 1. The implementation of interventions based on the recommendations is forecasted to rapidly reduce the number of syphilis diagnoses after an initial spike (due to the increase in testing).

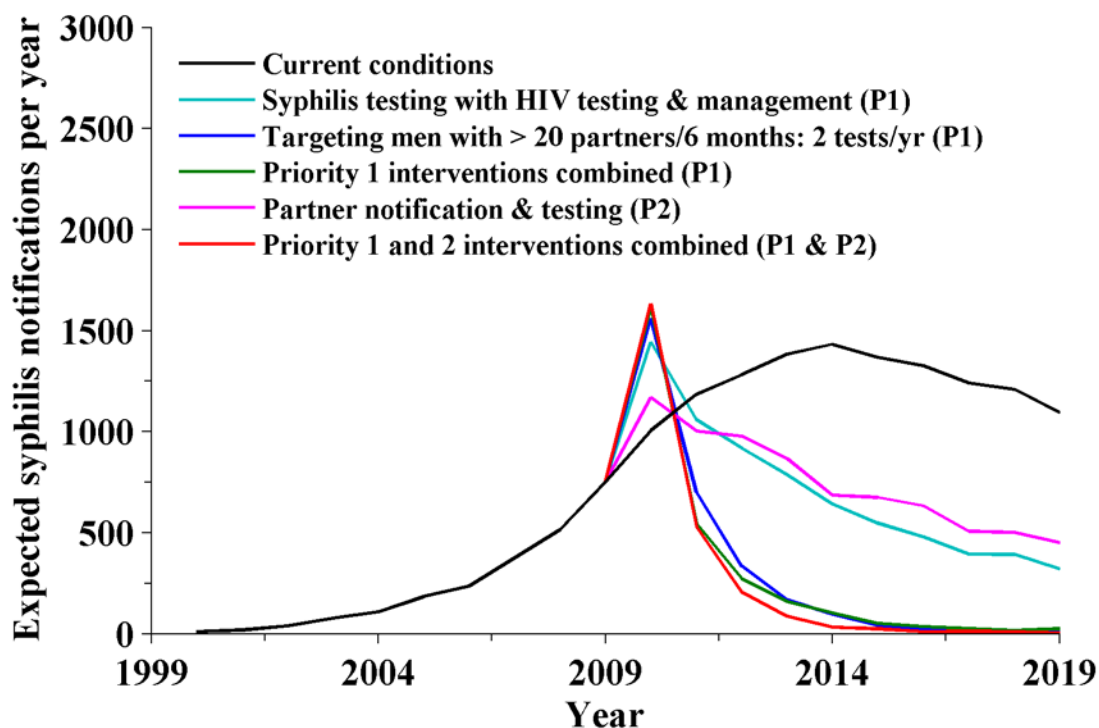


Figure Caption: Simulations showing the expected syphilis notifications associated with implementation of interventions listed in Priorities 1 and 2. For each intervention the percentage of men who never get tested is reduced from 15% to 10% (Priority 1) and rates of condom use are maintained (Secondary Priority 1). The light blue curve shows the expected impact of incorporating syphilis testing with HIV testing and management if 90% of diagnosed HIV-infected men are tested 4 times per year and if all HIV tests of men not previously diagnosed with HIV are accompanied with a syphilis test (Priority 1). The dark blue curve shows the expected impact of testing 90% of men who have greater than 20 partners per six months (Priority 1). The expected overall impact of all the interventions in Priority 1 is shown in green. The pink curve shows the expected impact if partner notification (Priority 2, such that 75% of regular partners and 10% of casual partners are notified and receive a syphilis test). The red curve shows the expected impact of effective implementation of both Priorities 1 and 2.

Glossary

Mathematical modelling: the use of mathematics to:

- Describe real-world phenomena
- Investigate important questions about the observed world
- Test ideas
- Make predictions about the real world

Mathematical models can take many forms, including but not limited to dynamical systems, statistical models, differential equations, or game theoretic models. These and other types of models can overlap, with a given model involving a variety of abstract structures. The form of model used in this project is individual/agent-based.

Individual-based model: a type of mathematical model which focuses on individual ‘agents’/people rather than population level dynamics. This type of model allows for finer detail at the individual level, with the possibility of being able to track the progress of an individual throughout every stage of the model.

Intervention: a strategy designed to reverse the current increasing trend in an epidemic.

Simulation: a simulation is one complete run from start to finish of the model.

Stochastic variation: this is the effect of randomness, which causes differing results using the same initial parameters. Stochastic variations in the results are considered in the current modelling work.

Baseline: this is the reference case to which we compare intervention results. For our baseline case we assume no change or intervention has taken place, this allows us to easily compare the success of each intervention.

Efficiency: a measure of performance for interventions. We compare the difference in the cumulative number of infections between the baseline case and the intervention case. We also look at the total number of tests or treatments performed, and determine the number of tests/treatments performed to prevent one infection.



Cofactor for transmission: this is the multiplicative increase in the transmission probability of an infection due to the presence of another infection.

Calibration: the process of matching the model outputs to real world data. The current model was calibrated to match the syphilis and HIV epidemics among gay men in Victoria.

Prevalence: the prevalence of a disease in a statistical population is defined as the total number cases of the disease in the population at a given time, or the total number of cases in the population, divided by the number of individuals in the population. It is used as an estimate of how common a condition is within a population over a certain period of time to help understand the probability of certain diagnoses. Prevalence should not be confused with incidence. Incidence conveys information about the risk of contracting the disease, whereas prevalence indicates how widespread the disease is.

Notifications/diagnoses: a diagnosis (plural, *diagnoses*) is the process of identifying a medical condition or disease by its signs, symptoms, and from the results of various diagnostic procedures, such as swabs sample collection and analysis. The positive diagnoses of some STIs by a doctor must be reported to the relevant jurisdiction; this is known as a notifiable disease.

Incidence: a measure of the risk of developing some new condition within a specified period of time. Although sometimes loosely expressed as the number of new cases during some time period, it is better expressed as a proportion or a rate with a denominator.

Screening: Screening is the process of using tests on a large scale to identify the presence of disease in apparently healthy people. Screening tests do not usually establish a diagnosis, but rather the presence or absence of an identified risk-factor, and thus require individual follow-up and treatment. Screening can also be used to identify high exposure to risk factors.

Contact tracing: involves finding and informing the sexual contacts of a person who has been diagnosed with an STI so they can be referred to counselling, testing and, if necessary, treatment. Contact tracing is an important strategy in the control of



sexually transmitted infections because it encourages individuals who may be unaware they have been exposed to an infection to be tested and treated.

Partner notification: this is where the partner of a person who is diagnosed with an STI is notified by their partner and encouraged to seek testing.

Mass treatment: a type of intervention which involves a large amount of treatment being distributed throughout the population, regardless of whether an individual is infected or not.

Chemoprophylaxis: a type of intervention involving the use of drugs to prevent disease and infection.

Serosorting: the practice of choosing sexual partners thought to be of concordant HIV serostatus.

Treponema pallidum: is a long, thin, tightly coiled bacterium. Both the corkscrew shape and the mobility of the organism play important roles in its invasion and dissemination. The body mounts an immune response against invading treponemes, both humoral and cell-mediated immune responses, and many of the unique clinical features of syphilis are due to the immune response.

Bacteria are able to establish latency in lymphatic and splenic tissue and during this period of latency, which may last for many years in untreated patients, the infected person will be resistant to reinfection from a new challenge with *T. pallidum*.

Chancere: the painless ulcer of primary syphilis.

Primary syphilis: (the chancre) is a self-limiting condition, with ulceration healing within a few weeks in untreated patients.

Secondary syphilis: is also self-limiting with clinical manifestations resolving over several weeks, although, in at least 25% of untreated people, relapses of secondary syphilis continue to occur over the first two years after infection.

Tertiary syphilis: cardiovascular and neurosyphilis occur at a variable period of time after infection, from as short as one year through to forty years later. Historical studies done on untreated patients indicate that only about 30% of those with syphilis develop these late manifestations of disease. In the other 70% immune



responses manage to control the infection. Co-infection with HIV may alter the natural history of syphilis.



Introduction and background

Over the last decade syphilis has re-emerged in numerous industrialized countries including Australia [1-5], particularly among gay men [6-9]. Infectious syphilis diagnoses in Australian men have increased from approximately 1 per 100,000 in the year 2000 to 10-15 per 100,000 in 2008; with increasing trends in diagnoses of infectious syphilis occurring in each Australian state and territory. Among gay and other homosexually active men, rates of sexually transmissible infections (STIs), and particularly syphilis have increased significantly in all major Australian cities since the late 1990s, with at least half the cases being among HIV-positive gay men. These epidemics are concerning since syphilis infections are accompanied by significant health burdens as untreated cases may progress to tertiary syphilis [10, 11], and the presence of syphilis lesions facilitate HIV transmission [12]. This concern is highlighted by the increase in HIV incidence seen in gay men over the last 10 years coinciding with the rise in syphilis [13-15]. It is not surprising that both infections often co-exist because both HIV and syphilis are transmitted sexually. However, oral sex is relatively safe with respect to HIV transmission but it is an efficient transmission mode for syphilis. Hence, designing effective interventions to reduce the incidence of syphilis is currently important for many public health systems.

Health promotion activities across the country have had little impact on this resurgence in infections within this population, and rates continue to rise. It has been suggested that a consistent national approach to curbing rates of syphilis should be adopted. In response to the syphilis epidemic in Australia, in September 2008 the Blood Borne Virus and STIs Subcommittee (BBVSS) of the Australian Population Health Development Principal Committee committed to the development of a National Syphilis Action Plan (NSAP) as a priority area for action. The aim of the NSAP is to:

- develop a nationally consistent approach to reducing the incidence of syphilis, particularly amongst gay men, while allowing jurisdictions to develop tailored approaches specific to their individual needs;
- consider current gaps in policy and program development and implementation, including in the research base; and



- describe a coordinated strategy in relation to reducing the incidence of syphilis.

There is substantial evidence of a particular association between syphilis and gay men who participate in highly sexually active subcultures. But there is no evidence – nationally or internationally - of a sustained decline in diagnoses resulting from syphilis control measures undertaken in metropolitan communities of gay men in the last decade. There is also minimal information about gay men’s beliefs with respect to syphilis or about their attitudes toward the range of syphilis control measures. Therefore, phase A of the NSAP is the ascertainment of variables and targets that are likely to be the most effective in mitigating syphilis epidemics among Australian gay men.

Evidence for informing targets for effective control of syphilis in Australia is based on detailed mathematical modelling research. This research investigated the expected epidemiological impact of a large number of potential interventions. This is considered in the context of the acceptability of these interventions as indicated by focus group research among gay men and reviews of international and local responses to syphilis epidemics. Suggested approaches were assessed by measuring levels of men’s knowledge around syphilis and assessing their willingness to respond to health promotion efforts, including specific targeted interventions, to encourage behaviour changes that would help reduce syphilis transmission in this population. We refer to the review paper by Murphy and Holt for an overview of recent international responses to syphilis [16].



Overview of mathematical modelling

Mathematical models can provide useful insights into the complex dynamics of disease transmission [17]. Mathematical modelling has been applied to syphilis epidemics in recent decades [18-20]. The model of Garnett et al. [20] incorporated syphilis natural history and demonstrated the importance of treating infected people in the early stages of infection. Modelling also suggests that high activity groups should be targeted [21] and widespread treatment should continue beyond the control of an outbreak if the control is to be sustained [22]. The research presented in this study advances prior models by developing a detailed and realistic individual-based computer simulation model to forecast the potential impact of various interventions, informed by biological, clinical, and sexual behaviour data of a population of gay men in Australia. There is evidence that a disproportionate number (50-55%) of syphilis diagnoses are in HIV-positive men [23, 24]. Therefore, in order to accurately reflect the syphilis epidemic and the subgroups most at risk we also incorporated HIV transmission into the mathematical model. Thus, the model described both the syphilis and HIV epidemics in Australian gay men, with possible mono or co-infection of syphilis and HIV. But the model's primary purpose is for the accurate description and investigation of syphilis epidemics.

We developed an individual-based transmission model that simulates a population of sexually active gay men, tracks the formation and breakup of sexual partnerships, and records the transmission of syphilis and HIV. The main characteristics and assumptions of the model are listed below in the 'Mathematical modelling assumptions' section with a detailed description of the model presented in Appendix 1. The parameters of the model (appropriate for the context of Victoria, Australia) are listed in Table 1.

Mathematical Modelling Assumptions

- The simulation model tracks every individual and sexual partnership in a population of gay men over time.



- Model variables describing the infection and disease status of syphilis and HIV, disease progression, level of sexual activity, partnership availability, and current sexual partners of each individual are updated daily.

Demographic parameters

- The model population consists of 30,000 sexually active gay men (the estimated size of this population in Victoria [25]).
- As individuals leave the population, new individuals enter the population keeping the population size constant.
- Individuals (unless they die from HIV-related causes) leave the population between 65 and 85 years of age.
- Individuals enter the population uniformly aged between 15 and 25 years of age.
- Each individual in the population has their sexual and baseline testing-related behaviour fixed during the course of a simulation (unless there is a specific intervention).

Sexual Behaviour

- The model simulates a dynamic sexual partnership network that is updated daily.
- Each person's sexual activity is determined by the average number of sexual partnerships they have per six months, as informed by Australian sexual behaviour data [26-30] (e.g. the gay periodic surveys [29] and the Three or More Study [30]).
- Individuals are classified as 'low-activity' if they have less than 5 partnerships per six months, otherwise they are classified as 'high activity'.
- Gay men can participate in casual partnerships (lasting up to one day), form long-term (regular) partnerships, and/or engage in group sex.
- A proportion of men who are HIV-positive who always disclose their HIV serostatus only have partners with other HIV-positive men (i.e. they serosort for partners). The disclosure of serostatus amongst partners is based on that reported in behavioural surveys conducted in each state [29, 31-33].
- Group size, the frequency, and the number of sexual encounters within a group sex event are determined probabilistically.



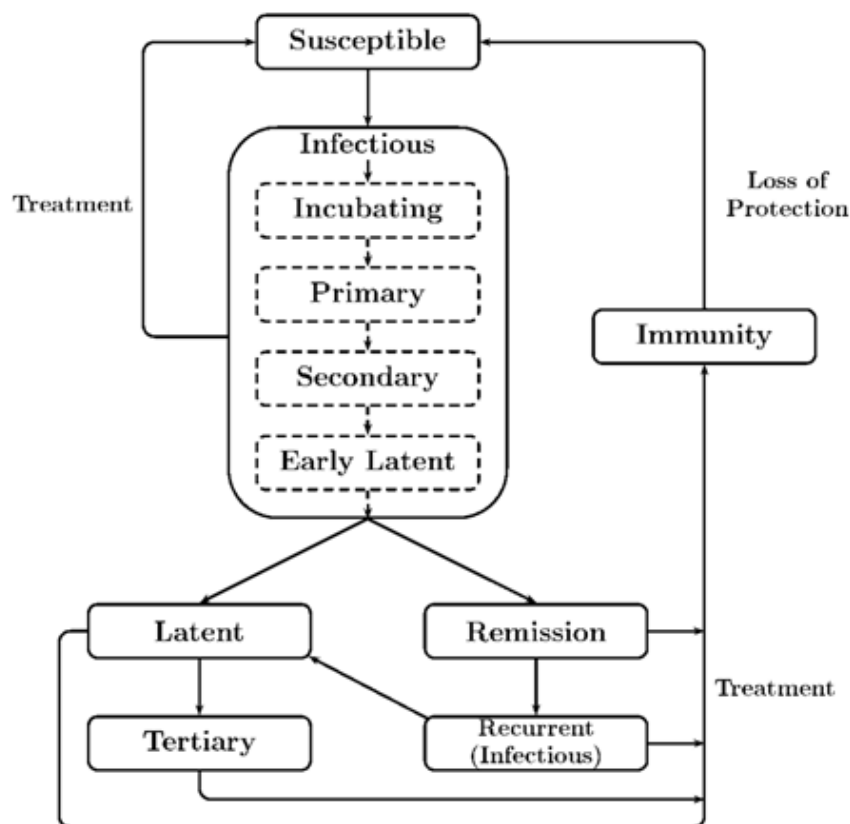
- The overall probability of an individual being in a regular partnership at any one time is 50%, consistent with behavioural data [34].
- When someone is in a regular partnership they are still available to form a casual partnership.
- Sexual behaviour (condom use and frequency of sexual acts) within a partnership is simulated according to probabilistically-inferred rates dependent on partnership type based on available behavioural data [32, 34].
- Within casual and group sex partnerships there is a probability of once off anal and oral sex during the partnership.
- We assume there is no condom usage during oral sex.
- Condom use during anal sex depends on the HIV serostatus of each partner and the probability of disclosure within the partnership.

Syphilis Disease Progression

- The assumed natural history of disease progression of a syphilis-infected individual is shown in Figure 1.
- Individuals are designated to be infectious if they are in the exposed, primary, secondary, early latent or recurrent infectious stages of syphilis with the transmission probability per sexual act depending on the infection stage (see Table 1).
- Infected individuals are given a duration for their incubating, primary, secondary, and early latent stages. These time periods are randomly assigned uniformly at the time of infection.
- When individuals progress to tertiary syphilis they remain there unless they receive treatment.
- Individuals who are treated in the early infectious stages are assumed to become susceptible to re-infection.
- Men treated in the later stages of syphilis are immune to re-infection for an average duration of 5 years [20, 30].



Figure 1: Schematic diagram of the stages and disease progression of syphilis included in the model. Infectious syphilis includes the incubating, primary, secondary, early latent and recurrent stages.



Syphilis Testing and Treatment

- Individuals are tested for syphilis on a random day with a probability per day that depends on the sexual behaviour, the HIV status of each individual, and the intervention simulated. This is done in such a way to quantitatively match the current testing practices or those of effective implementation of interventions while also representing the diversity in the population.
- Each of the sub-populations has a different background rate of testing in the absence of specific interventions. Prior to the introduction of interventions 55-70% of the population is tested for syphilis at least once every year [34] depending on their sexual activity and HIV status (see Table 1). We also include a proportion of the population who never get tested for syphilis [30, 35].
- We assume that there is a proportion of gay men who never test for syphilis or HIV.



- For the purposes of testing and the targeting of interventions four sub-populations (not mutually exclusive) of gay men are considered; these are high-activity gay men, gay men who engage in group sex, diagnosed HIV-positive gay men, and the low-activity gay population.

HIV Progression, testing, and treatment

- HIV-infected individuals are in one of four stages: primary, asymptomatic/chronic, AIDS, or on antiretroviral therapy (ART).
- The untreated HIV-infected population in our model progresses through three stages of disease: from primary infection to chronic infection and eventually to AIDS.
- When men become HIV-infected they enter the primary stage of infection.
- HIV-infected individuals are given a fixed duration for their primary and asymptomatic stages and their life expectancy when they have AIDS. These time periods are randomly assigned uniformly at the time of infection with HIV progression stopped upon initiation of ART.
- Individuals who have not been diagnosed with HIV are tested for HIV probabilistically based on population HIV testing rates [34, 36].
- On any given day there is a probability that an HIV-infected person will begin effective ART. This treatment probability depends on the stage of infection.
- We assume that men on treatment remain on effective treatment until they age out of the population.

Syphilis and HIV Transmission

- The transmission of syphilis and/or HIV within a partnership depends on the frequency of anal and oral intercourse within a partnership and whether a condom has been effectively used.
- Individuals are designated to have infectious syphilis if they are in the incubating, primary, secondary, early latent or recurrent infectious stages of syphilis.
- The probability of syphilis transmission to a susceptible partner depends on the stage of syphilis, the sexual behaviour within the partnership, and the HIV status of each partner.



- The infectiousness of a syphilis-infected individual is constant while they are in each disease stage. Primary and secondary stages are more infectious than the early latent stage.
- Anal sex is more likely than oral sex to transmit syphilis.
- HIV-infected men are assumed to be more susceptible to syphilis infection.
- The probability of HIV transmission to a susceptible partner depends on the stage of HIV progression and the sexual behaviour within the partnership.
- Each stage of infection was associated with a different viral load which differentially determined the probability of transmission to a susceptible person [37] during an act of penile-anal intercourse.
- We assume that HIV is only transmitted through anal sex.
- If one partner is infected with syphilis then the probability of HIV transmission is increased.
- The effectiveness of a condom in preventing the transmission of syphilis or HIV from an infected person to a susceptible partner during anal sex is assumed to be 90-95%.
- People in late latent and tertiary syphilis are assumed to be no longer infectious.
- The presence of syphilis in a partnership is assumed to increase the probability of HIV transmission by a factor of 1-5 [38-44].
- A HIV-infected individual is assumed to be more susceptible to syphilis. The probability of syphilis transmission to a HIV-positive person is increased by 1.5-2.5-fold.



Baseline Model Parameters and Calibration

Table 1: Model parameters and values for calibration (baseline scenario)

Parameter	Value	
Demographic and Epidemiologic Parameters		
Population size	30,000 [25]	
Age of entering population	15-25 years	
Age of leaving the population	65-85 years	
Distribution of Number of Sexual Partners		
Distribution of the number of casual partners of gay men per 6 months (proportion of men in each category) [31]	1-1.5	26%
	2-5	21%
	6-10	16%
	11-50	30%
	51-60	7%
Number of casual partners per 6 months for 'low activity' gay men	1-5	
Proportion of men who engage in group sex	17% [34]	
Syphilis Biological Parameters		
Overall duration of infectious syphilis	1-2 years	
Duration of incubation period	3-4 weeks [45]	
Duration of syphilis primary stage	45-60 days [46]	
Duration of syphilis secondary stage	100-140 days [11]	
Transmission probability per act in incubating, primary and secondary stages [11, 20, 22, 46-52]	Penile-anal	1.4%
	Penile-oral	1%
Transmission probability per act in early latent stage [11, 20, 22, 46-52]	Penile-anal	0.7%
	Penile-oral	0.5%
Per act multiplicative increase in transmission probability of syphilis to HIV infected men	1.5-2.5	
Percentage of syphilis cases that recur after infectious syphilis	25% [53]	
Average duration of remission	6 months [11]	
Average duration of relapse	90 days [11]	



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Average duration of latency before establishing tertiary disease		15 years [11]
Average duration of protective immunity post-treatment of late infection		5 years [20, 30]
HIV Biological Parameters		
Duration of Primary HIV stage		70-110 days [54-56]
Duration of Chronic HIV stage		3000-5000 days [57-62]
Length of time with AIDS before death		100-365 days [63-66]
HIV transmission probability per act in primary stage		1.5-3% [37, 67, 68]
HIV transmission probability per act in chronic stage		0.15-0.25% [69-74]
HIV transmission probability per act in AIDS stage		1.5-3% [37, 67, 68]
HIV transmission probability per act for men on ART		0.0015-0.005% [37, 67, 68, 75]
Per act multiplicative increase in transmission probability of HIV due to a syphilis infection in either partner		1-5 [38-44]
Sexual Behaviour Parameters		
Percentage of gay men in a regular sexual partnership		50% [34]
Average duration of regular partnerships		4 years [30]
Average number of acts with regular partner per week	penile-oral	2 *
	penile-anal	2 *
Average number of acts per casual partner/encounter	penile-oral	1 [34]
	penile-anal	0.7 [34]
Proportion of partnerships in which HIV serostatus is disclosed	Casual/Group	35% [30, 34]
	Regular	85% [24, 31, 33]
Proportion of sexual acts in which condoms are used for partnerships that are (the HIV discordant value decreased from 80% to 69% from 1999 to 2009 [34])	HIV discordant	80-69%
	HIV concordant	10%
	HIV status not disclosed	40%
Proportion of HIV-infected men who disclose their infection status that serosort for other HIV infected partners		10% *
Group sex parameters		
Average number of group sex events per year for men who engage in group sex		3.5 [30]



Average number of men in each group sex event		Median 4.4 [30, 76]
Average number of sexual partners in group sex event per person		Min: 1, Max: 10
Clinical Parameters		
Efficacy of condoms in protecting against syphilis transmission	penile-anal	90% [77]
	penile-oral	90% *
Percentage of gay men who test for syphilis each year in the absence of a specific intervention (frequency one test per year except for gay men on ART who test on average two times per year)	Highly active	55% [34]
	Engage in group sex	65% [34]
	On ART	70% [34]
	Everyone else	55% [34]
Percentage of the gay population that never test for syphilis		15% [30]
Sensitivity of syphilis test for detecting current infection		95% [78, 79]
Proportion of HIV infected men in primary stage who go onto treatment each year		11% *
Proportion of HIV infected men in chronic stage who go onto treatment each year		11% *
Proportion of men with AIDS who go onto treatment each year		95% *
Percentage of high sexual activity men that get tested for HIV at least once per year		50% *
Percentage of men who engage in group sex that get tested for HIV at least once per year		75% *
The HIV testing rate for low sexual activity men was calibrated so that HIV prevalence was 10% in the population and notifications matched surveillance data		
* Assumption based on discussions with expert stakeholders		

Model implementation and calibration

The model was implemented using Matlab[®] with each simulation tracking the dynamic sexual network, syphilis and HIV transmission, and disease progression of syphilis-infected and HIV-infected individuals. The model was specifically calibrated to match the estimated infectious syphilis notifications and HIV diagnoses among gay men in Victoria, Australia. The median trajectory of 52 model simulations, using realistic parameter values (see Table 1), accurately reflected surveillance data for Victoria (Figure 2). The 5 simulations (Figure 2) that best fit the epidemic data were selected (using a Pearson chi-squared test) to forecast epidemic trajectories over the



next 10 years under various interventions. Although the model used Australian behavioural data and was calibrated to reflect the epidemic in the state of Victoria, the relative impact of each intervention should be generally applicable to other jurisdictions.

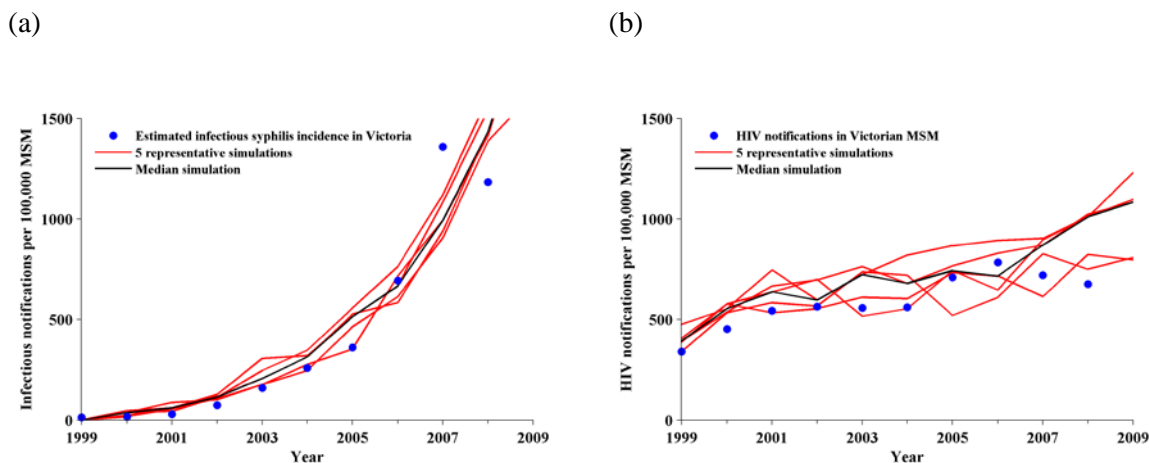


Figure 2: (a) The number of infectious syphilis notifications in Victoria (blue discs, data) compared with 5 model-based simulations (red). (b) The number of HIV notifications in Victoria (blue discs, data) compared with the same 5 model-based simulations (red) in (a). The median of these 5 simulations is shown in black.

Overview of acceptability studies

This component of the report incorporates work being undertaken for a broader study of beliefs about sexual health among gay men, Pleasure and Sexual Health (PASH). PASH is a collaboration between the National Centre in HIV Epidemiology and Clinical Research at the University of New South Wales, and the Australian Research Centre in Sex Health and Society at La Trobe University.

For this project, we used a mixed-method approach, incorporating both qualitative and quantitative data collection and analysis, and involving key informant interviews, focus groups, and survey questionnaires.

The results from these studies are based on data collected to date. This work has been completed within a particularly short time-frame and further data collection is planned. Also, the findings contained herein are mainly descriptive and further analysis, enabling greater contextualisation of these preliminary findings, may

provide greater understanding of the issues than is possible from these early analyses.

Key Informant Interviews

We sought advice from medical practitioners and health promotion providers, as key informants, regarding the sorts of interventions that may be effective. We conducted both formal and informal interviews with these key informants to understand what interventions could practically applied, how they would best be implemented, and what impact they believed they may have. We also recorded multidisciplinary workshop discussions at a national meeting facilitated by the Australian Federation of AIDS Organisations. These discussions explored the interventions, their feasibility, and how they could best be implemented.

Focus Groups

We conducted focus groups to ask men about their attitudes toward and understandings of syphilis and what interventions to promote behaviour change for the purpose of reducing the risk of syphilis transmission they felt might be acceptable. Men were recruited for these focus groups through multiple methods, including snowballing through established online and offline networks and on-site recruitment at gay community events. Most of the men recruited to these focus groups were gay-identified although one man was living in a heterosexual relationship. We held five focus groups – three in Sydney (one group for HIV-positive men, and two mixed groups of HIV-negative and HIV-positive men) and two mixed groups in Melbourne. In these groups we asked men to discuss how they perceive STIs in general in their lives and how syphilis fits in with this. We then asked the men about their knowledge of syphilis and what they would be prepared to do to avoid it, based on the suggested range of interventions identified by the key informants.

Online Survey

We included a series of questions to measure gay men's attitudes toward and knowledge of syphilis within the already established PASH (Pleasure and Sexual Health) study. Depending on the findings from this initial exploration of the issues, we will consider conducting a smaller, more focussed survey specifically addressing syphilis. Men recruited into the PASH survey have been mostly gay-identified,



although about one in eight are bisexual. Over 2000 men from all states and territories had completed the survey at the time of writing.

In Depth Interviews

Where relevant, we have also specifically included questions that deal with the topic of syphilis within in-depth interviews conducted as part of the HIV Seroconversion Study as well as the PASH Study. Excerpts from these interviews also contributed to the findings in this report. Men were interviewed in five states.

Ethics approval was obtained from the University of New South Wales. This took the form of an amendment to PASH; HREC 07207.

Interventions Considered

In this section the types of interventions that we considered are listed. For each type of intervention a table shows the actual intervention strategies simulated with the mathematical model. These intervention strategies were formulated based on our key informant discussions.

To compare different interventions, the median prevalence and syphilis diagnoses (taken as the number of treatments) per year were recorded for each model simulation. The number of tests carried out and the number of infections averted (compared to the baseline case) was also recorded to measure the efficiency of each intervention scenario.

Behaviour change interventions

These interventions involve changes in sexual behaviour with background testing continuing at current levels.

	Intervention	Target	Coverage	Duration
1	Increased condom use	Discordant and undisclosed partnerships	80%	1 month
2				3 months
3				Indefinitely
4			100%	1 month
5				3 months
6				Indefinitely
7	Decrease number of partners	All casual partners	25%	1 month
8				3 months
9				Indefinitely

10			50%	1 month
11				3 months
12				Indefinitely
13	Increased condom use in discordant and undisclosed partnerships 90% and decreased number of partners by 50% for 3 months.			

Syphilis testing interventions

These interventions involve increasing the level of syphilis testing and treatment for those diagnosed with syphilis.

	Intervention	Target/coverage	Frequency
1	Increasing testing coverage	85% across all groups of MSM	At least once per year
2		100% across all groups of MSM	At least once per year
3	Increase testing frequency	Same testing coverage as currently but increased frequency	2 times per year ⁶ p.y. (Diagnosed HIV+ men)
4		Same testing coverage as currently but increased frequency	4 times per year ⁶ p.y. (Diagnosed HIV+ men)
5		Target just diagnosed HIV+ men	6 times per year
6		Target men who regularly (each year) have group sex	2 times per year
7		Target men who regularly (each year) have group sex	4 times per year
8		Target men with >10 partners per 6 months	2 times per year
9		Target men with >20 partners per 6 months	2 times per year
10		Target men with >50 partners per 6 months	2 times per year
11		Target men with >10 partners per 6 months	4 times per year
12		Target men with >20 partners per 6 months	4 times per year
13		Target men with >50 partners per 6 months	4 times per year
14	Synchronized/blitz testing	Testing men (same coverage) in one month period	Once per year
15		Testing men (same coverage) in one month period	Twice per year
16	Contact tracing	50% of regular partners & 5% casual partners in previous month	Within 1 week of diagnosed index case
17		75% of regular partners & 5% casual partners in previous month	Within 1 week of diagnosed index case
18		75% of regular partners & 10% casual partners in previous month	Within 1 week of diagnosed index case
19		100% of all partners (theoretical maximum)	Within 1 week of diagnosed index case
20	Following up previously infected men	25% return	Every 3 months
21			Every 6 months
22			Every 12 months
23		50% return	Every 3 months



24			Every 6 months
25			Every 12 months
26		75% return	Every 3 months
27			Every 6 months
28			Every 12 months

Pre-exposure Prophylaxis

These interventions involve a proportion of gay men taking pre-exposure prophylaxis to prevent the acquisition of syphilis.

	Target/coverage	Duration	Efficacy
1	50% men with >10 partners per year	6 months	70%
2	50% men with >20 partners per year	6 months	70%
3	50% men with >50 partners per year	6 months	70%
4	50% men with >10 partners per year	12 months	70%
5	50% men with >20 partners per year	12 months	70%
6	50% men with >50 partners per year	12 months	70%

Mass treatment

These interventions involve a proportion of all gay men taking treatment regardless of whether they are infected or not.

	Target/coverage	Frequency
1	30% men with >10 partners per year, 15% others	Once only
2	50% men with >10 partners per year, 25% others	Once only
3	70% men with >10 partners per year, 35% others	Once only
4	30% men with >10 partners per year, 15% others	Once per year
5	50% men with >10 partners per year, 25% others	Once per year
6	70% men with >10 partners per year, 35% others	Once per year
7	30% men with >10 partners per year, 15% others	Twice per year
8	50% men with >10 partners per year, 25% others	Twice per year
9	70% men with >10 partners per year, 35% others	Twice per year



Results

In this section mathematical results showing the predicted impact of the interventions listed above and the acceptability of these interventions within the gay community are presented.

Men's Knowledge of and Attitudes to Syphilis

Levels of knowledge about syphilis among the men were low in terms of symptoms, transmissibility, treatment and impact. Even men who had previously been infected with syphilis were unclear.

There was considerable confusion around symptoms of syphilis among men in the focus groups. A man from the HIV-positive group held in Sydney who reported having had syphilis described being aware of symptoms, such as a rash, that he believed was just a heat rash and waited several months before visiting his doctor who immediately recognised it as syphilis. Another noticed a sore at the base of his penis which he believed to be an ingrown hair, and only after some time did he seek medical advice and tested positive for syphilis.

In the online survey, some clear examples of misinformation about the natural history of syphilis were provided, such as the following. It should be noted that the response relayed verbatim, including contractions and non-capitalisation common to internet communication. *Sic* has not been used in the interest of readability:

And as for getting syphilis my attitude is that i would rather contract it so i can be treated because as far as im aware once your treated its rare for u to be able to get symptoms again and i dont believe u can pass it on once been treated. (Survey respondent)

Both online and in focus groups, STIs were seen mostly as an inconvenience which medical science could easily correct:

I just think it's inconvenient. I mean it's as simple as that. Anything that makes you feel, you know, unhealthy and, you know, have a doctor's visit, and have to take any kind of antibiotics. To me it's just something that's inconvenient and I would just want to avoid. I don't know if there's a scale to it. Because



like you said, even, I mean, you know, even the crabs would be an inconvenience. (Focus group 1, Sydney)

What's this obsession with syphilis? It's more easily curable than the common cold – just one jab! (Survey respondent)

In the survey data, when asked how they would react to a syphilis infection, the most common response was that it would be 'a hassle' with 40.7% indicating that this would 'very much' be the case for them. Among men who reported having recently engaged in unprotected anal intercourse with a casual partner, only a small proportion – less than one in six – indicated that they had been at all concerned about the possibility of getting a syphilis infection.

However, the men were clear that they did little to protect themselves from STIs in general. STIs were seen as an “occupational hazard”, “part of being gay and playing in the gay scene” and sometimes men would just “hope for the best”:

Certainly I wouldn't want to give anyone HIV so that sort of prevents some STI transmission. But there is sexual activity that you do without like protection. Like I wouldn't engage in oral sex with condoms and certainly there is a risk of herpes and that type of infection. So yeah, it's just luck of the draw. (Focus group 1, Sydney)

So that's why I liken it to Russian Roulette, because you just don't, you, you can protect against some things but you can't protect against everything in every situation. (Focus group 1, Sydney)

I think it's that Russian roulette type attitude. “Yeah, it can be cured so let's go, let's have our fun, that kind of attitude. And I'll take the risk because there is a cure for it.” (Focus group 4, Melbourne)

Shit happens: it's out there and increasing. (Survey respondent)

In terms of the seriousness, there was a consensus among the men that, as a treatable condition, syphilis was not perceived as a great threat, although it was seen as more serious than Chlamydia – but less serious than chronic conditions such as HIV or herpes:

Hey, it's not HIV, we have curative treatments for it. So it's not that big a deal really. (Survey respondent)

There was little knowledge of the various stages of the illness, or that once symptoms disappear, the infection remains and progresses.

There were, however, high levels of stigma particularly as HIV is no longer perceived as uniformly fatal meant that for one group, syphilis was seen as a more stigmatised condition:

I'd feel really filthy. (Interview participant, Sydney, 65 years old)

Because there's a new social stigma about it and you don't talk about ... and it's, and it's regarded as unclean. (Focus group 1, Sydney)

Because people's attitude to say HIV, they say, "Oh well, you know, times are different now. People don't die," and so we're, our, our so-called fear, our fears and anxiousness about HIV were allayed with the "oh yes, it's easily treated" okay so then that changes the attitude towards, towards syphilis because that puts that into the new, new realm of that, that hidden, you know, the hidden monster or the hidden Grim Reaper. (Focus group 1, Sydney)

In the survey data, when asked how they would react to a syphilis infection, nearly a quarter (22.6%) agreed 'very much' that they would 'feel dirty' and a further 30.8% indicated they agreed somewhat with this. Similar proportions (21.5% and 25.1% respectively) indicated they would 'feel guilty'.

Behaviour Change

Modelling results

Changes in condom usage and partner numbers were investigated using the mathematical model for time periods of 1 month, 3 months, and indefinitely. In all figures the median results for the 5 baseline simulations in Figure 2 are shown in black.

The impact of changes in condom usage on the monthly syphilis incidence is shown in Figure 3. As expected increasing condom use results in a reduction in incidence; however, when condom use returns to its previous level the incidence rapidly returns

to the baseline level. A continual reduction in syphilis incidence is only sustained if the increase in condom use is maintained indefinitely.

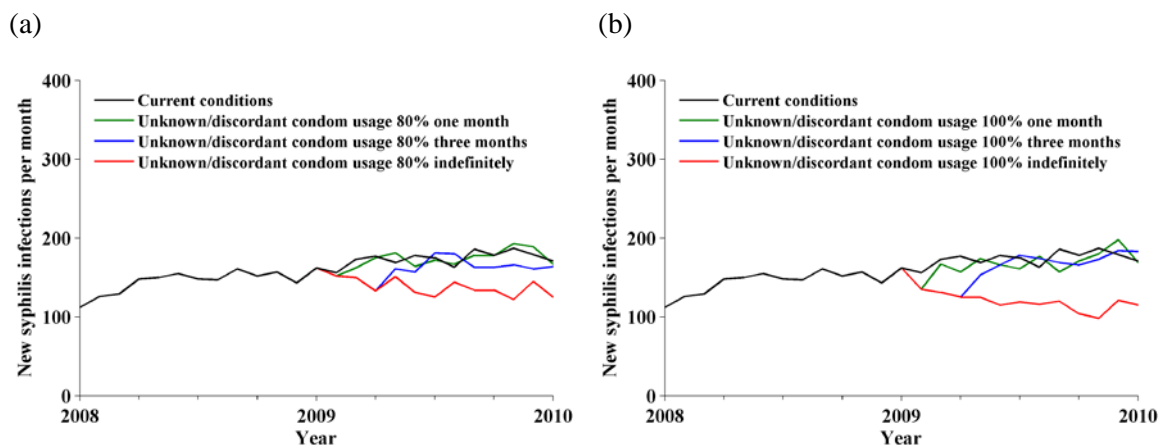


Figure 3: Median change in monthly syphilis incidence due to increases in condom usage over a 1 month, 3 month, and indefinite period. Condom use in HIV serodiscordant and undisclosed partnerships increased to (a) 80% and (b) 100%.

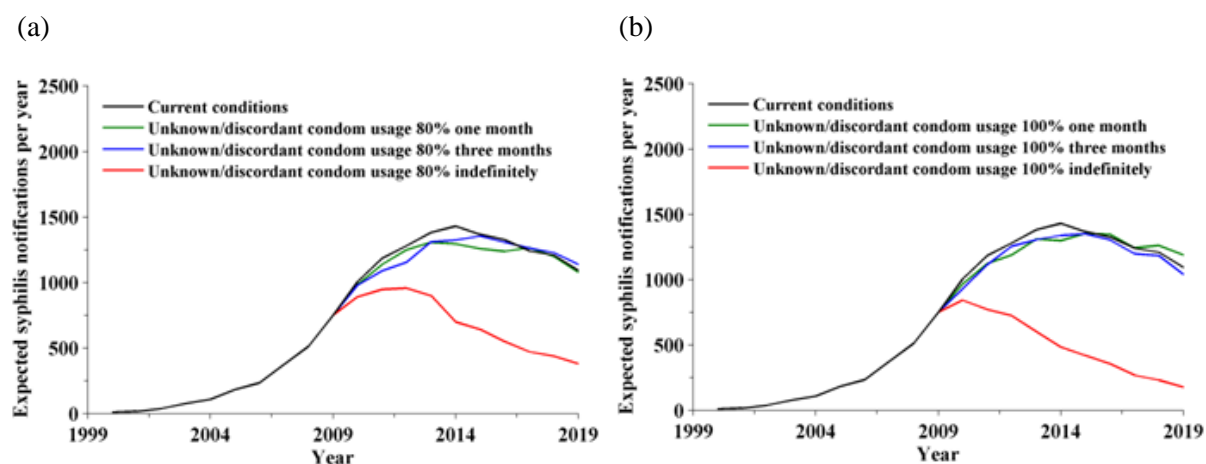


Figure 4: Median change in annual syphilis notifications due to changes in condom usage over a 1 month, 3 month, and indefinite period. Condom use in HIV serodiscordant and undisclosed partnerships increased to (a) 80% and (b) 100%.

This is reflected in the expected trends in the number of notifications and prevalence over the next 10 years (Figs. 4 and 5). The modelling results show that increasing condom use has minimal impact on notifications and prevalence unless it is maintained over the long term. Note that Figures 4 and 5 both show similar trends and thus for the remainder of the report we only present prevalence results unless a particular characteristic of notifications requires emphasis.



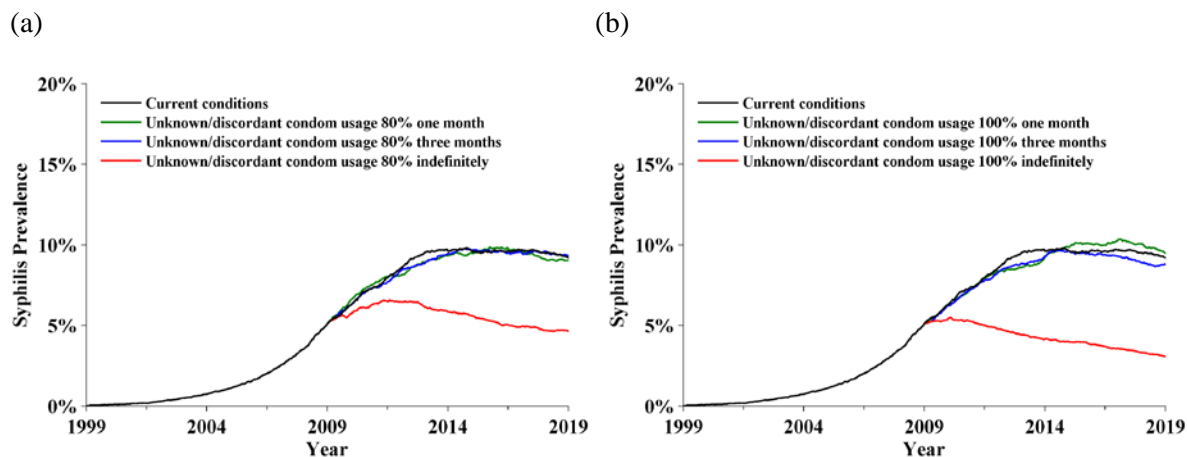


Figure 5: Median change in syphilis prevalence due to increases in condom usage over a 1 month, 3 month, and indefinite period. Condom use in HIV serodiscordant and undisclosed partnerships increased to (a) 80% and (b) 100%.

Decreasing partner numbers has a similar impact on the syphilis epidemic as increasing condom use with no change in notifications and prevalence from baseline levels unless a reduction in partner numbers is maintained over the long term (Fig. 6).

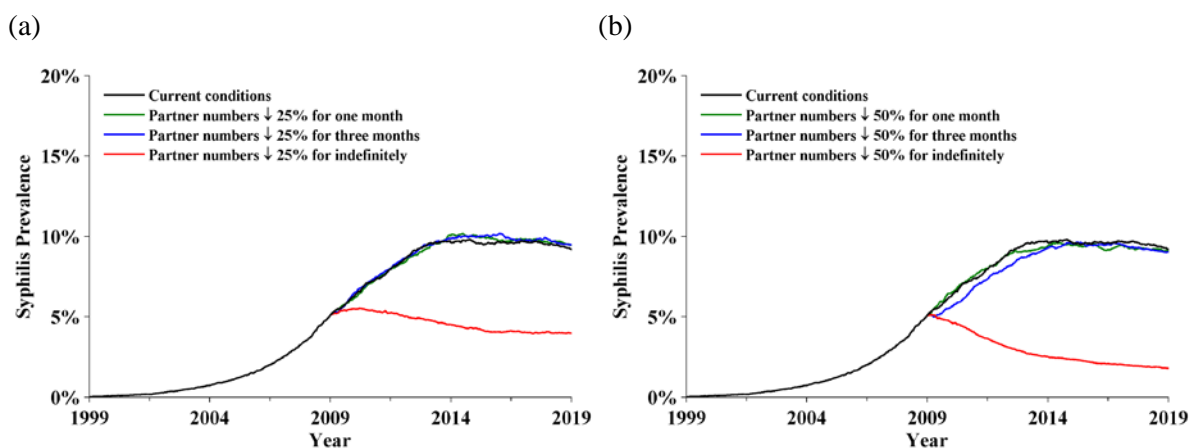


Figure 6: Median change in syphilis prevalence due to decreases in partner numbers over a 1 month, 3 month, and indefinite period. Condom use in HIV serodiscordant and undisclosed partnerships increased to (a) 80% and (b) 100%.

The combined behaviour change intervention, where condom usage in discordant and undisclosed partners increased to 90% and the number of partners decreased by 50% for 3 months had a similar impact on the syphilis epidemic as the other behaviour change interventions. The results in Figures 3-6 show that if behaviour change is temporary then it will have little long term impact on the syphilis epidemic.



Acceptability

In terms of existing risk reduction strategies – what they did *now* to avoid STIs, including syphilis – men in the focus groups mostly talked about looking for visible symptoms of STIs on their sexual partners, acknowledging that this was only possible in certain contexts, and relying on ‘safe sex’ practices; there was little understanding that STIs can be asymptomatic:

And certainly I don't focus on, you know, when you, when you're engaging in sexual activity you don't focus on whether or not you're going to contract an STI. And certainly that's not your intent. But I don't think when you're in the heat of the moment that you go out of your way to, well I don't go out of my way to actively prevent the transmission of an STI. (Focus group 1, Sydney)

Well the, our educated thinking is, of course, we will practice safe sex but it doesn't happen all the time. (Focus group 1, Sydney)

Although there have been some calls to encourage men to reduce their numbers of sexual partners, thus reducing their chance of exposure to syphilis, even many of the key informants believed that this approach was likely to be unrealistic and difficult to implement.

Some men did indicate that this was a risk reduction strategy they employed:

I guess the only way that I can say that I that I try to minimise the risk is by fewer partners. Knowing, kind of knowing a partner and having that type of relationship where you feel, you never know if somebody's really going to be truthful about it. But I think that if you're having sex with somebody that you do know as opposed to someone you met at a bar two hours ago, that there's a higher chance that there will be some disclosure there. (Focus group 1, Sydney)

In a funny way I have because I am probably more scared of syphilis. I'm obviously not scared of HIV anymore [as I am HIV-positive]. [...] And I have a regular, a semi-regular let's say poz partner. Who knows how long that'll last for? And I actually feel good about that because I feel like I'm reducing my

chances, even though, as I said, he could be having it off with [a number of other men who I am unaware of]. (Focus group 4, Melbourne)

These men were also expounding the idea of moving from strictly casual sex to ‘fuckbuddies’ with whom they have ongoing relationships, who they hope are also reducing their number of partners, and who feel comfortable discussing any possible infection risks they may have encountered.

Four other themes emerged in the rest of the discussion which illustrated an interwoven network of mitigating factors, potentially precluding the uptake of this intervention. The themes were: Going against male instincts; difficulty in quantifying how much to reduce their partner numbers and operationalising when not to have sex; an unfair imposition on single men; and the belief that as syphilis is treatable, it is not of sufficient concern to warrant behaviour change. Firstly, the idea that sex is an irrepressible male drive:

Because part of the nature of the gay beast is that it is perpetually out there looking for another partner. (Focus group 1, Sydney)

A man will be a man type of thing. I think it's great, you know. We all want as much as we can, you know, can chew. (Focus group 1, Sydney)

I keep thinking of reducing my number of sexual partners but I have no self-control whatsoever so it doesn't work. I'll probably try other means of protection. (Focus group 4, Melbourne)

The numbers of partners who men had varied, and so there was no agreement on what an acceptable number of partners per month might be, or how many they should be reducing by. Similarly, sex was positioned as opportunistic, to be grabbed when it presented, and unable to be scheduled:

Because you can only quantify it in hindsight. (Focus group 3, Melbourne)

I think that, that ... the only problem with that is no-one actually goes, "I'm going to have 50 roots this month." Even my most organised friends with the biggest black books aren't kind of booking out their time like that. Like they're, it's, it's ... it's a little bit more ad hoc. (Focus group 3, Melbourne)

Invariably when you're not looking for it, it turns up. And I can't imagine going out thinking, going to a bar and just thinking, "Okay, tonight I'm not picking up." And you know, the next time going, "Well now I am ..." You know, it's like, *I'm not gonna sort of like ... Because the night I say I'm not gonna pick up I possibly wouldn't have picked up anyway.* (Focus group 2, Sydney)

So if you're told you can only have this many partners per week, per month, per day, per year, it's like, "Shit, I've reached my quota. I can't have any more partners." (Focus group 2, Sydney)

The burden of this intervention was seen as disproportionately applying to single men. Those with partners did not have to reduce the amount of sex they had, only the number of men they had it with:

Yeah, well not everyone that's having sexual activity is in a partnered relationship. (Focus group 1, Sydney)

I find that I couldn't reduce my number of partners because it's great when you're in a relationship, because you've always got it, kind of thing – always there. And being male one has this dominant need for, to express myself sexually. And I would agree with you on that: I couldn't look at reducing the number of partners, certainly not while I'm on my own at this stage. (Focus group 4, Melbourne)

The success of treating syphilis over the past 60 years had proved to be a 'double-edged sword', as noted in the following quote. With syphilis seen as a treatable condition, there is little incentive for this man to reduce his number of sexual partners:

I would never do it. I wouldn't reduce my partners. I'm happy to have sex with 20 in a night, if I could. If I was Superman! [...] When I go and have sex with a lot of people the big thing that is in my mind is always HIV because it's incurable. [...] No, I would only reduce my sexual partners if there was no way of curing syphilis. (Focus group 4, Melbourne)

Despite being presented with information about how less partners could equate to less infection risk, this intervention produced the shortest discussions, and was the

one most likely to induce a hostile response from focus group participants, as this exchange shows:

Participant 1: *It's just so unbelievably not working that, in my view, that it's not even, we can't even discuss it. I don't know why it was on the paper.*

Participant 2: *Why is it there?*

Facilitator 1: *The reason it's on the paper is because if people did it, it would work. The less sex you have the less chance you have [of getting infected].*

Facilitator 2: *But you know, [deleted sexual health centre] experts seem to think that if men were to reduce the number of sexual partners by say 50 percent you would reduce your chance of picking up syphilis by about 75 percent.*

Participant 3: *Totally disagree. Totally.* (Focus group 2, Sydney)

In the survey, when asked whether they would be prepared to reduce their partner number in order to reduce their chances of a syphilis infection only a quarter (27.5%) indicated they would be 'very likely' to implement this approach (Chart 1).

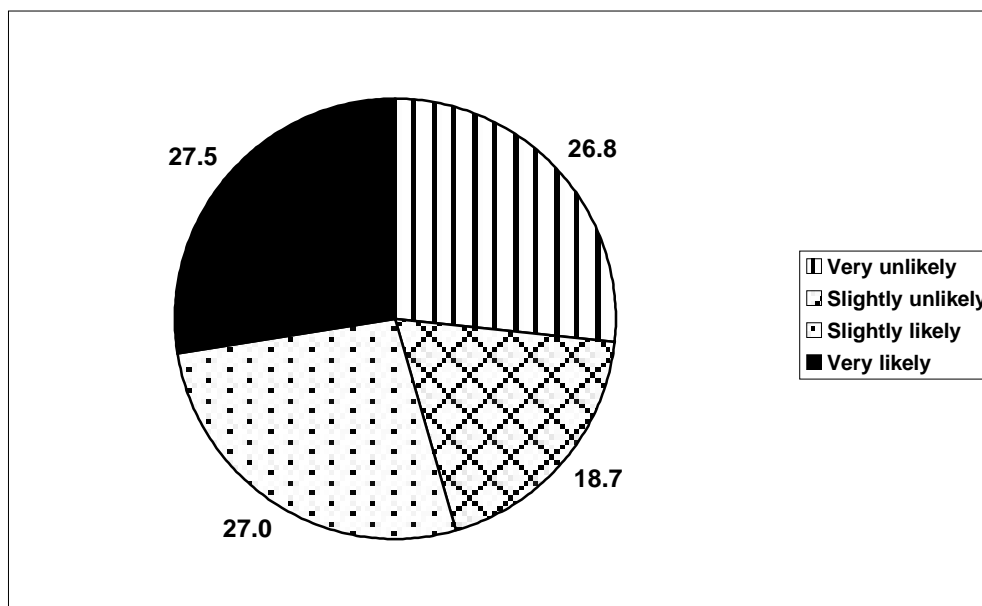


Chart 1: Acceptability of partner reduction: How likely was it that participants would reduce their number of sexual partners to reduce their personal chances of infection (%).

However, when asked if they would be willing to do so if they were told that it would help reduce infections in the gay community as a whole, well over a third (39.5%) indicated they would be 'very likely' to do so (Chart 2). This was a 43% increase in likelihood to make this behavioural change when it was for the benefit of the community.

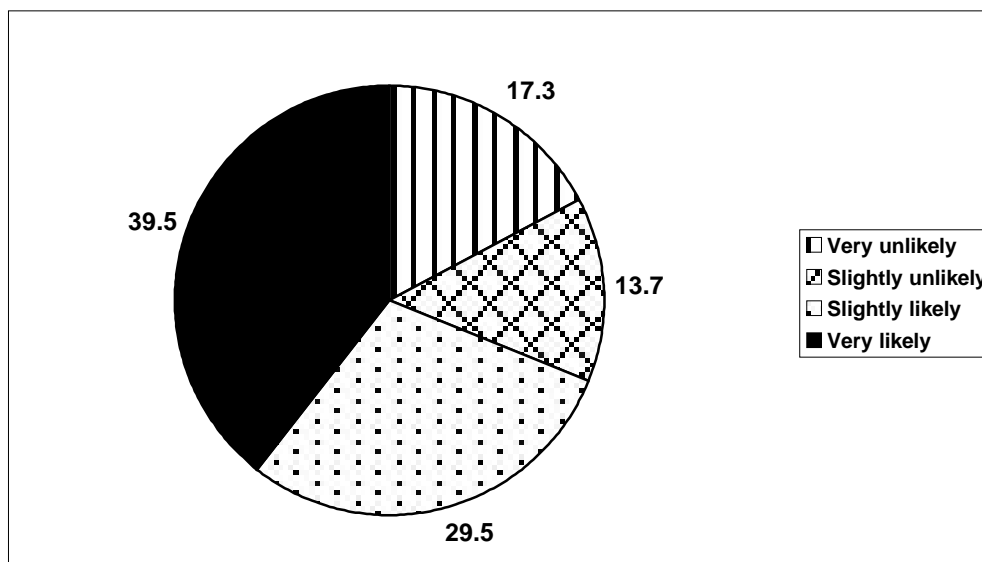


Chart 2: Acceptability of partner reduction: How likely was it that participants would reduce their number of sexual partners to help reduce rates of infection in the gay community (%).

When restricted to men at highest risk of infection with syphilis, such as men who engage in group sex, these proportions were significantly lower: 17.2% indicated being 'very likely' to reduce partner number to avoid infection themselves, while 30.2% were 'very likely' to do so to help reduce infections in the community. Nonetheless, although the absolute proportions were low, this represented a 76% increase in likelihood to make this behavioural change when it was for the benefit of the community.

It has been suggested that a return to more consistent condom use, at least for a determined period, would provide another means of reducing syphilis infection rates. However, this idea was also largely seen by focus group participants as untenable, although mostly they projected how they expected other men to react:

And I think that there's, you know, if they're gonna do it, they're gonna do it. You know, you can't stop them. So I think it's a bit, definitely unrealistic. They

want that. They want that, the risk that they're playing with the fire, you know. So they're gonna do it. So I don't reckon it's sort of, you know, that's how they want it. I think they want to be naughty. They want to muck around and, yeah, muck around with their lives. I think it's just like, you've just gotta let them go. (Focus group 1, Sydney)

In an example of reverse-stigma, one HIV-positive man feared embarrassment if he suggested introducing condoms to his HIV-positive fuckbuddy:

I could have a discussion with him, but I think, I think he'd be, he'd laugh in my face. (Focus group 4, Melbourne)

Similarly, this HIV-negative man said he frequently saw other men engaging in unprotected anal intercourse:

I don't talk to people who have unprotected sex about syphilis or other things. I hope they have made the decision before they get into it. But I try not to be righteous about unprotected sex as well. (Focus group 4, Melbourne)

In the survey, when asked whether they would be prepared to use condoms with *all* their casual partners in order to reduce their chances of a syphilis infection two thirds (67.2%) indicated they would be 'very likely' to implement this approach (Chart 3).

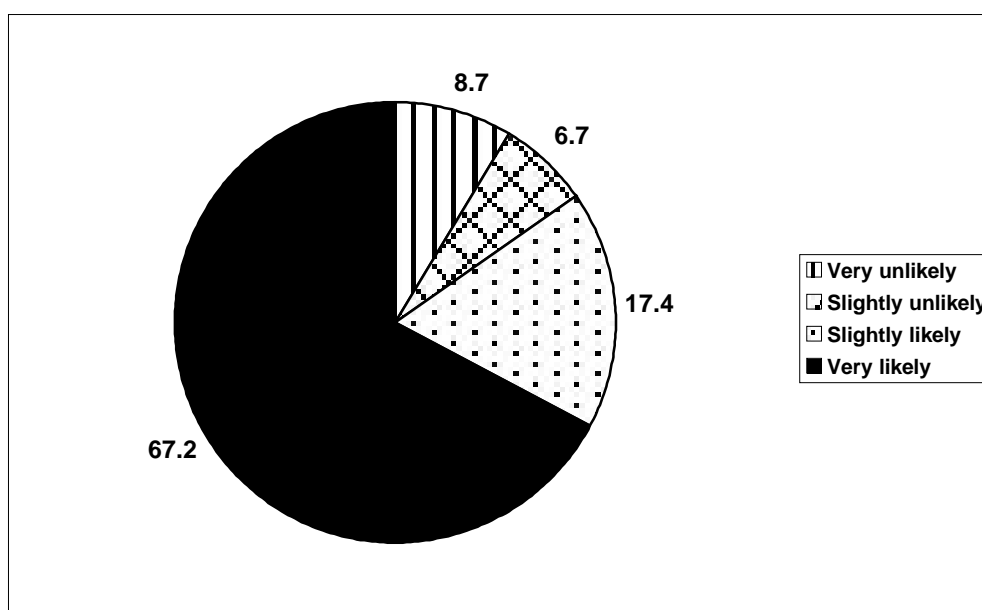


Chart 3: Acceptability of consistent condom use: How likely was it that participants would use condoms with all casual partners to reduce their personal chances of infection (%).

When asked if they would be willing to do so if they were told that it would help reduce infections in the gay community as a whole, nearly three quarters (73.9%) indicated they would be 'very likely' to do so (Chart 4). However, this was only a 10% increase in likelihood to make this behavioural change when it was for the benefit of the community and it is likely that the majority of the men endorsing this proposal were men who were already using condoms consistently or had relatively few sex partners anyway.

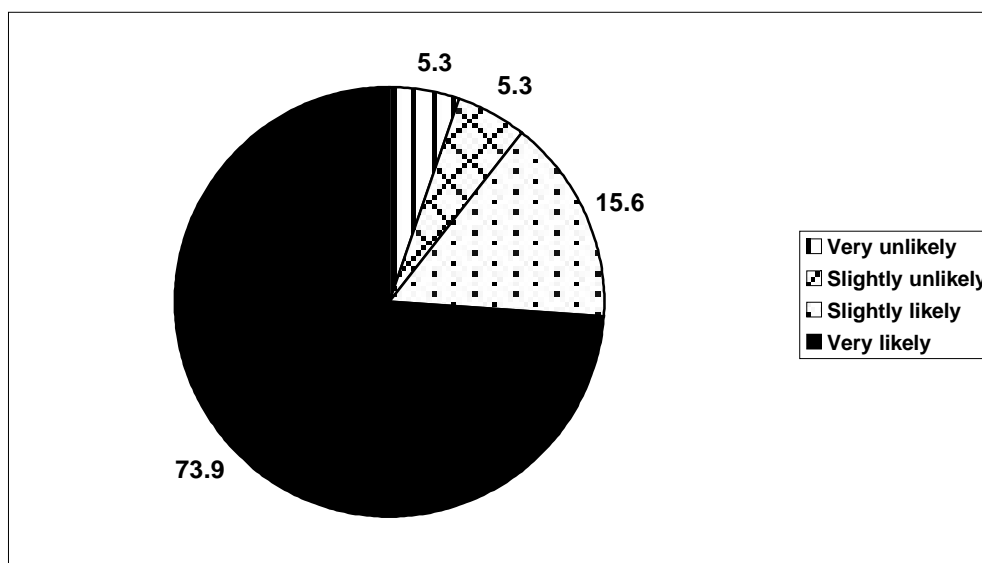


Chart 4: Acceptability of consistent condom use: How likely was it that participants would use condoms with all casual partners to help reduce rates of infection in the gay community (%).

When restricted to men who engage in group sex, these proportions were: 61.0% indicated being 'very likely' to use condoms with all their casual partners to avoid infection themselves, while 67.2% were 'very likely' to do so to help reduce infections in the community, representing just a 10% increase in likelihood for the benefit of the community. However, among men who reported currently engaging in unprotected anal intercourse with casual partners, only 36.6% indicated being 'very likely' to always use condoms with these partners to avoid infection themselves, while 51.5% were 'very likely' to do so to help reduce infections in the community; A 41% increase in likelihood to make this behavioural change when it was for the benefit of the community, although still restricted to only about half the men at highest risk.

Conclusions

Recently the Health Protection Agency in the United Kingdom recommended that behaviour modification should be a key component of control strategies aimed at syphilis [80]. However, the results of the mathematical modelling show that behaviour modification will only be effective if changes in behaviour are maintained over the long term. While information can be presented to men on the benefits of increased condom use (particularly while appealing to their sense of community responsibility) the acceptability studies show that a campaign of this sort may only appeal to the 'worried well' and alienate those most at risk. The potential hostility to the idea of partner reduction may be particularly counter-productive as it impinges on gay men's strongly protected sexual rights and is operationally fraught with difficulties. The potential for message bearers to be tagged as 'sex police' could have a bleed-through effect on other sexual health messages.

The results from the modelling and acceptability studies imply that behaviour change interventions, beyond maintaining current condom use levels, should not be a priority of the NSAP. Efforts should be concentrated on strategies that will be both effective, and will also have greater traction in the community.

Chemoprophylaxis

Modelling results

The impact of this type of intervention was investigated by varying the proportion of the population taking chemoprophylaxis for a time period of 6 months, 12 months, and indefinitely. Men taking chemoprophylaxis are assumed to have a 70% decrease in the risk of acquiring syphilis. In Figure 7 we present the expected epidemiological impact of targeting 50% of men with more than 10, 20, or 50 partners per 6 months with chemoprophylaxis for a period of 1 month, 3 months, or indefinitely. These results suggest that short or medium term interventions are expected to have a moderate impact and a large epidemiological impact can only be expected if chemoprophylaxis is used in an on-going manner.

(a)

(b)



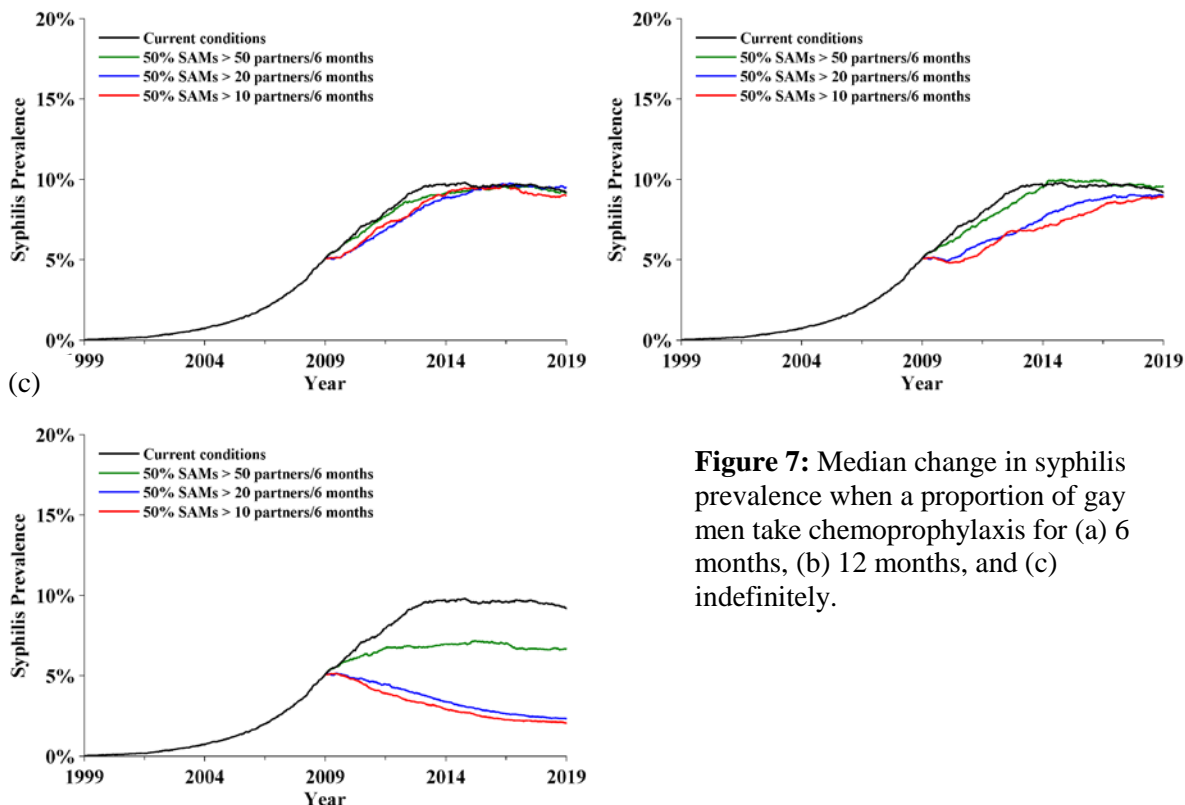


Figure 7: Median change in syphilis prevalence when a proportion of gay men take chemoprophylaxis for (a) 6 months, (b) 12 months, and (c) indefinitely.

Acceptability

Men were very enthusiastic about the idea of Doxycycline being made available to at-risk men to use prophylactically, in an attempt to reduce syphilis infections:

I think that whatever the disease that you, that you came up with, you created the pill to prevent people from getting it ... I think everyone would sign up for it. (Focus group 3, Melbourne)

Sexually active and sexually adventurous men could, could choose to take the pill, trying to bring the rates down, I think that you, you might get the community responding in a big way to that. (Focus group 3, Melbourne)

This intervention was not without cautions. The following two HIV-negative men expressed hesitancy about taking any medication prophylactically:

I take six different tablets in the morning, one of them happens to be an antibiotic for something completely unrelated, but that can only be taken after food, and I've got an anti-inflammatory for something else, then I'm taking a whole lot of herbal medications. Now you want to add something like this that

I have to take on a daily basis. Are you gonna end up with like 20 lined up tablets and I'm not even someone who's falling apart at 80 years old. I don't know if I could do that. (Focus group 4, Melbourne)

I would not take it. I would not do it. I would have to get sick first. I would have to know I've got something before I started taking medicine. I would not take a preventative thing until I needed it. (Focus group 4, Melbourne)

However, for some HIV-positive men, the benefits of avoiding syphilis meant a small, easily manageable modification to their existing regimen of daily medication:

I would definitely do it. I take 22 tablets a day. No drama. (Focus group 4, Melbourne)

Personally, I'm taking a number of pills a day. One more pill which would help me not have to stress over that fact, I would find that beneficial. (Focus group 2, Sydney)

The safety of doxycycline would need to be assured in order to make it acceptable:

Would it be a good idea to take an antibiotic every day? Wouldn't it make your immune system really weak? (Focus group 3, Melbourne)

Other considerations included how long men would be prepared to take a prophylactic treatment:

A week's a push.

Definitely. A week. You start talking "weeks" and they'd say, "Oops, missed a day." I think everyone knows that they're gonna do that. (Focus group 1, Sydney)

As such, ongoing campaigns were considered to be less attractive, but men did suggest targeting campaigns around major events as a form of PREP for syphilis. This would provide both an opportunity to dovetail in with publicity around the parties, and protection when the community was most at risk:

So pitch it to say start August, late August/September, because [the annual gay community] Sleaze [Ball] is early mid-October. So you've either done

your pills or you're off your pills. [...] Then target it again the second of February, first weekend of March [for Mardi Gras].

I agree. I think that there's, there's peak seasons for promiscuity. (Focus group 3, Melbourne).

Accessibility and cost were seen as the biggest stumbling blocks to uptake – men would prefer not to have to visit their doctor or pay for a script in order to obtain the medication. When they understood that this is a prescription only medication, that was a barrier to them taking it up:

Participant 1: *Put a basket of them on every bar on Oxford Street. Yeah, I'm like, that's what we do now. Condoms are there.*

[...]

Participant 2: *Is it prescription though now?*

Facilitator: *At this stage, yeah.*

Participant 1: *So you'd have to see a doctor?*

Facilitator: *For a script, yeah. So what would it take to get people to go to a doctor and get a prescription? Or is it only going work if can go to your pharmacy and they can give it to you?*

Participant 3: *It's a, it's a big call. (Focus group 1, Sydney)*

I don't think [anyone will pay] because everyone doesn't believe they'd get syphilis. So if that's the case ... I mean I don't think I should have to bloody pay for it. You know, that's the attitude. So it's, it's ... as soon as costs come to this, you're going to, you're going to not, you're going to fall in some part of this focus. (Focus group 2, Sydney)

In the survey, when asked whether they would be prepared to take pills every day for a period of time in order to reduce their chances of a syphilis infection about a quarter (26.3%) indicated they would be 'very likely' to implement this approach (Chart 5). When restricted to men at higher risk, these proportions were similar to those for the entire sample.

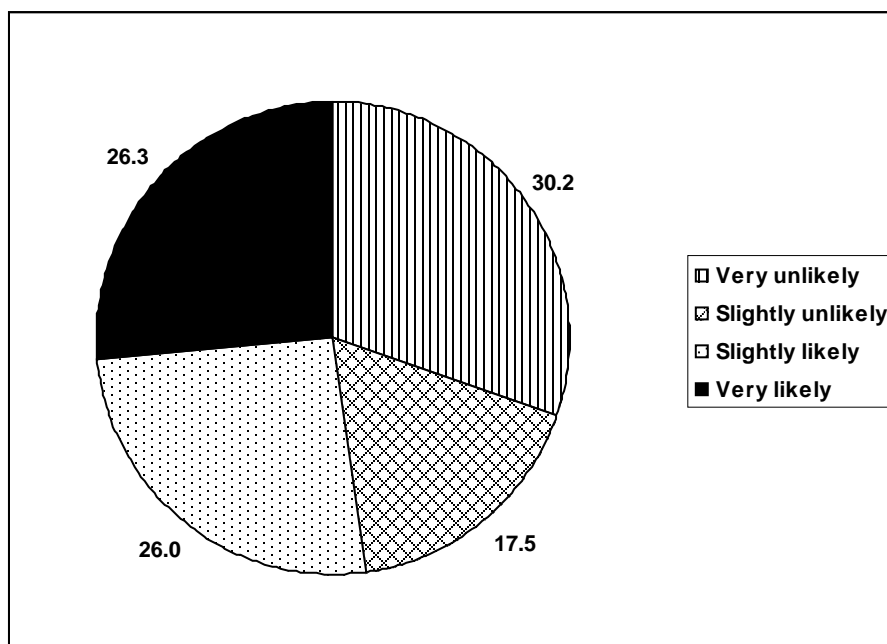


Chart 5: Acceptability of syphilaxis: How likely was it that participants would take pills every day to reduce their personal chances of infection (%).

However, when asked if they would be willing to do so if they were told that it would help reduce infections in the gay community as a whole, nearly half (48.6%) indicated they would be 'very likely' to do so (Chart 6). This was an 85% increase in likelihood to make this behavioural change when it was for the benefit of the community. When restricted to men at higher risk, these proportions were similar to those for the entire sample, so men at high risk were as likely to accept these strategies as were other gay men.

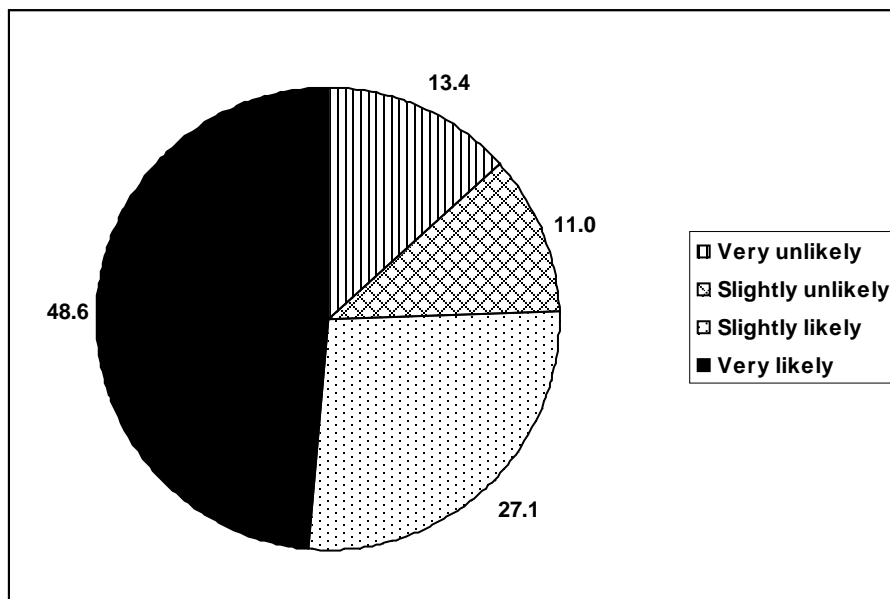


Chart 5: Acceptability of syphilaxis: How likely was it that participants would take pills every day to help reduce rates of infection in the gay community (%)

Conclusion

The appeal of prophylactic treatment of the syphilis outbreak was wide, although the current status of doxycycline as a prescription-only medicine and its implications for accessibility would need to be considered for it to have any realistic chances of widespread uptake. The proposed trial of doxycycline will provide empirical evidence as to its efficacy. If logistical considerations such as access, cost and safety concerns can be alleviated, this intervention appears to be relatively acceptable to sexually active gay men.

Targeting Screening and Treatment

Modelling results

Increasing the coverage of testing can have a large impact on syphilis epidemics (Figure 8), although initially a large increase in notifications could be seen (Fig. 8b) since increases in testing will result in diagnoses that would not have occurred otherwise. Including men who never test for syphilis and HIV could have a large impact on syphilis prevalence.



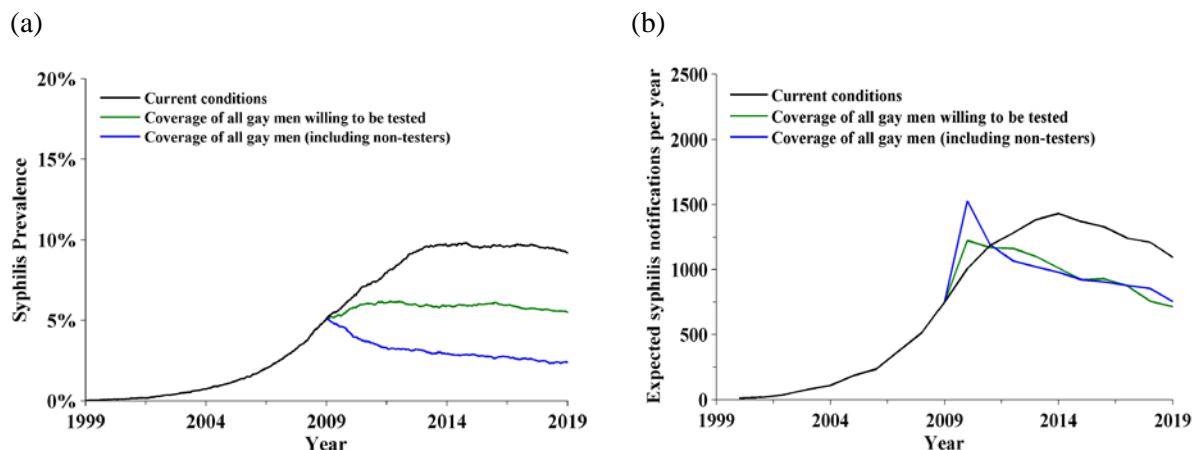


Figure 8: Median change in (a) syphilis prevalence and (b) syphilis diagnoses due to increases in testing coverage assuming baseline testing frequency.

Increases in testing frequency can have a large impact on syphilis epidemics (Figure 9), potentially eliminating infectious syphilis notifications within 10 years (Fig. 9b). Despite the large decrease in notifications, Figure 9a shows that prevalence will only fall to a lower but steady level. This is due to infections in men who never get tested. Syphilis infections in these men will progress to late syphilis potentially resulting in serious morbidity due to tertiary syphilis. With the coverage results in Figure 8 this highlights the importance of encouraging gay men normally resistant to testing to be tested for syphilis.

Increasing the testing frequency for syphilis within particular sub-populations could also have a large impact on the epidemic. In particular, increasing the frequency that diagnosed HIV-infected men are tested for syphilis could limit the increase in syphilis prevalence even though they make up less than 10% of the population. This is due to high prevalence of syphilis in HIV-positive men. Also increasing the frequency of testing a large proportion of highly sexually active men has almost the same impact on the syphilis epidemic as increasing the testing frequency for the whole population (Figure 10).

Concentrating all the testing that normally occurs during a year into an annual or biannual 'blitz' period has no additional effect on syphilis epidemics than baseline or twice annual testing, respectively (Fig. 11).

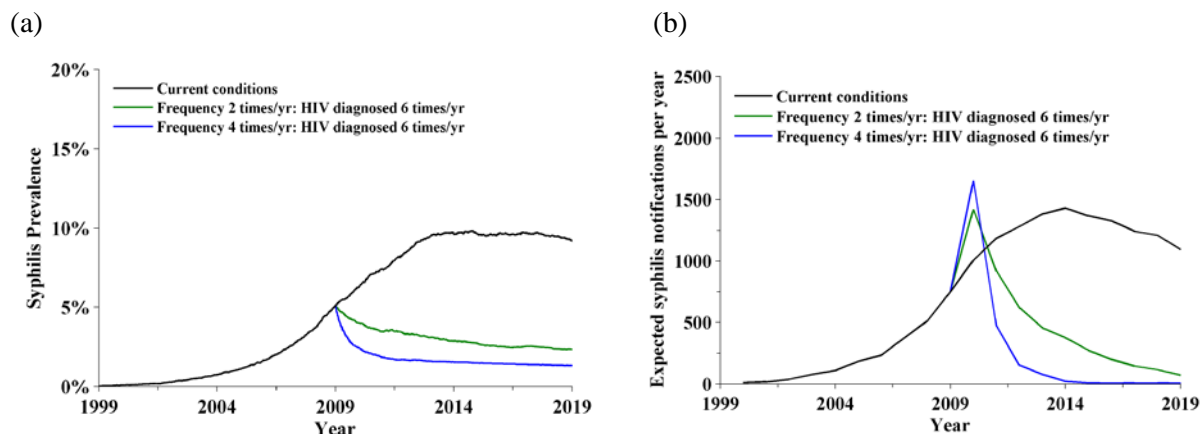


Figure 9: Median change in (a) syphilis prevalence and (b) syphilis diagnoses due to increases in testing frequency assuming baseline coverage levels.

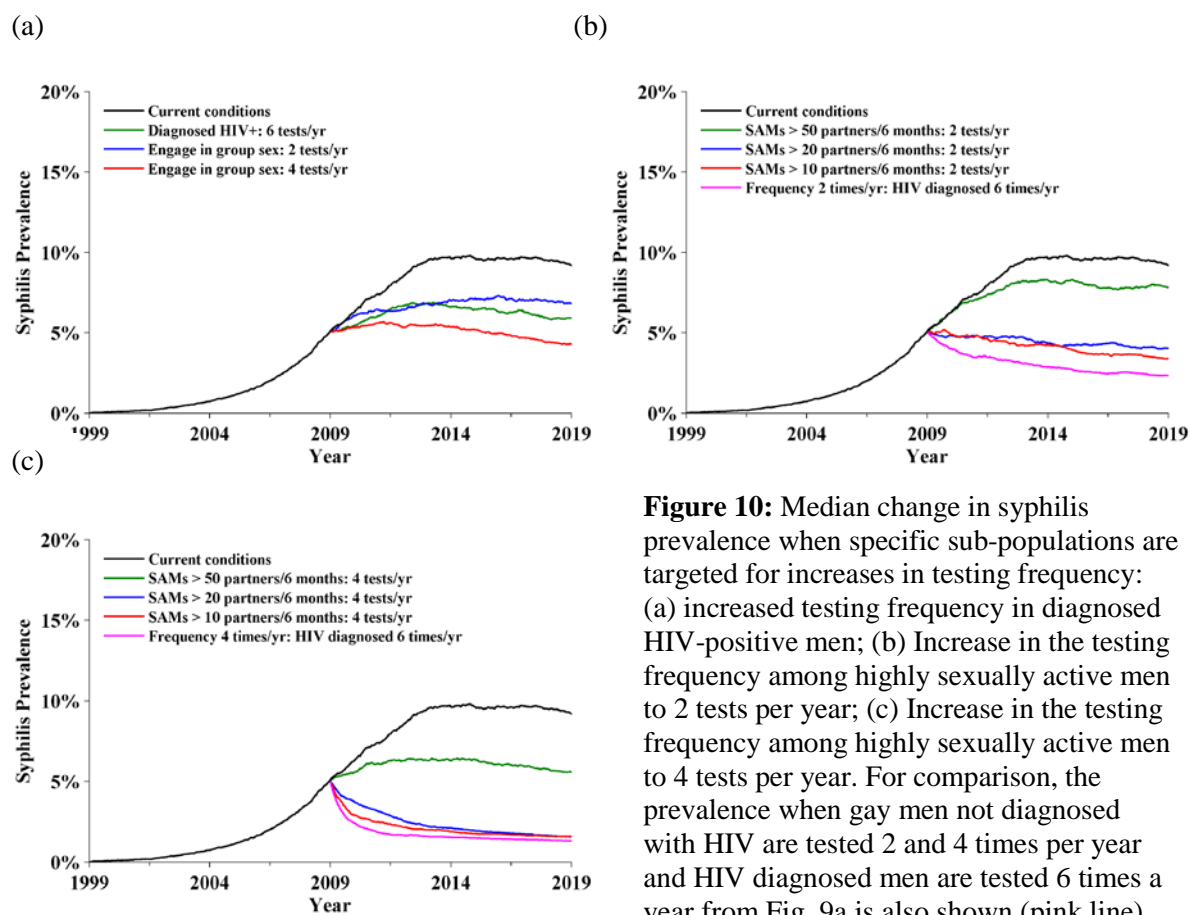


Figure 10: Median change in syphilis prevalence when specific sub-populations are targeted for increases in testing frequency: (a) increased testing frequency in diagnosed HIV-positive men; (b) Increase in the testing frequency among highly sexually active men to 2 tests per year; (c) Increase in the testing frequency among highly sexually active men to 4 tests per year. For comparison, the prevalence when gay men not diagnosed with HIV are tested 2 and 4 times per year and HIV diagnosed men are tested 6 times a year from Fig. 9a is also shown (pink line).

It is important to note that for all testing interventions there will be an initial large spike in syphilis notifications after their introduction as many more infections will be diagnosed due to the increased testing. This means it will take at least two years before the true impact of these interventions will be detected by the surveillance system.



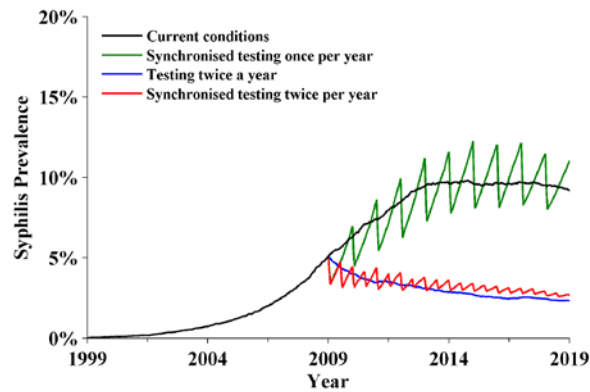


Figure 11: Median change in syphilis prevalence due to the introduction of synchronized ‘blitz’ testing annually (green line) and twice yearly (red line). For comparison the prevalence for testing gay men not diagnosed with HIV twice a year and HIV diagnosed men 6 times a year from Fig. 9a is shown (blue line).

Efficiency of testing interventions

Each of the different testing-based interventions require different numbers of tests to be carried out and would result in different expected epidemiological impacts. Therefore, we estimated the efficiency of each intervention by calculating a measure of the number of tests required per infection averted. The number of extra tests carried out due to the intervention (compared to current ‘baseline’ conditions) divided by the number of infections averted (relative to baseline) was calculated for each intervention and presented in the Table below.

Intervention	Infections averted (10 years)	Total tests (10 years)	Tests per infection averted
All men previously tested / willing to be tested (85%, at least once per year)	6524	83004	13
100% coverage for all	9194	123080	13
Testing all men previously tested 2 times per year	16466	239369	15
Testing all men previously tested 2 times per year and diagnosed HIV+ men 6 times per year	20506	548767	27
Diagnosed HIV-infected men: 6 tests/yr	6678	84535	13

Men with > 10 partners/6 months: 2 tests/yr	12865	83929	7
Men with > 20 partners/6 months: 2 tests/yr	12254	45329	4
Men with > 50 partners/6 months: 2 tests/yr	3003	8539	3
Men with > 10 partners/6 months: 4 tests/yr	19697	254356	13
Men with > 20 partners/6 months: 4 tests/yr	18993	133374	7
Men with > 50 partners/6 months: 4 tests/yr	8459	26387	3

Acceptability

One of the main issues around STI testing appears to be the amount of time currently involved in being tested. In the survey, when asked what are the current impediments to being tested for STIs, the most common problem raised was finding the time to do it: 62.6% indicated this was a problem, including 22.7% who said this was often the case. Also, 42.8% indicated that getting an appointment to see a doctor was an impediment.

We asked men in the focus groups if they believed the community would mobilise around a period of synchronised testing for syphilis, which would see as many gay men as possible testing for syphilis in one short time period, resulting in unidentified cases being identified and treated.

There were mixed feelings among the men about this approach. Many believed it was not viable to have sufficient numbers of men participate.

Call me terribly cynical – but I don't think there is any community adherence that would support that. (Focus group 2, Sydney)

I think that really the only people you could even contemplate depending, or placing that strategy to and having any sort of uptake from is, are people who, who are actually in treatment regimes already. Whether it's HIV or anything else. Because, quite frankly, I don't think anybody else will give a damn. (Focus group 2, Sydney)

Others suggested that, with sufficient planning and proper implementation, men could be encouraged to participate:

Yeah, but I think the most important part of this campaign is the initial stage. Whoever is going to participate in the campaign would, must understand why they are taking part in this campaign... this is important. It's for our sake.
(Focus group 2, Sydney)

Mass synchronised testing for syphilis was not well received, with men being quite cynical about whether enough men would participate. Campaigns such as 'Rug up for winter' and 'Join me for October testing month' were cited as examples which had not caught the public imagination.

Another approach to increase testing practices is to use social marketing to encourage men at high risk to undertake more regular testing for syphilis. Men's current attitudes to testing ranged from the 'worried well' – one who tested frequently despite having few if any risk factors – to one who tested irregularly despite engaging in more high risk practices:

Personally, I think I'm really paranoid about STDs because I think much before I started having sex, I'd read about AIDS and I'd read stories about it. So I was fairly scared of it when I came out. I, I get checked every three months and so far I've not had anything, so ... yeah, so it's been good so far. But I'm really worried about it all the time. (Focus group 4 Melbourne)

Well I'm not very paranoid about STIs: I'm quite happy to play, continue playing. But I think it's really good that it's, you know, I don't get checked every three months. I might go maybe two years without being checked. It might be four months. If I'm sick I'll get checked. And if I have some kind of scare where I think I might have got something, [Yep] then I'll just get checked. [Okay] So I'm not a regular, regular like that. (Focus group 4 Melbourne).

One group discussed having clinics send text reminders out, in particular to highly sexually active men:

But I think it will work. I mean just like dental treatment; every six months I get a text message from my dentist who says, you know, "It's time for you to do the check-up." (Focus group 2, Sydney)

This man showed a preparedness to increase his annual testing, particularly if a wider range of testing facilities was available:

I get tested every six months without fail. I would be prepared to bring that down to every three months if that made it easier. I think there needs to be something more than just going to your doctor for it. (Focus group 4 Melbourne)

While some men were testing more frequently than every six months, more than this was often seen as excessive, particularly in the face of negative tests:

I meant if by, as I've been doing, checking every six months kind of feel it's, it's enough ... always comes back negative and in the meantime, of course, if I felt that I have some sort of symptom I would go back immediately and not wait for the six months. But every three months is a lot. (Focus group 3, Melbourne)

Among the HIV-positive men, there was a belief that they were being screened regularly for syphilis as part of their regular three monthly visits to their doctor. However, it was unclear whether this was just an assumption that they were being tested for syphilis, or whether it was explicit that this was happening as in this interaction:

Participant 1: *I just made it everything. I just found it like if you're gonna get tested, do the whole lot. And I say to my doctor, "Test me for everything." I hold my arm out, you know, and I expect it... So you test me for everything. You know –*

Participant 2: *But that doesn't all come out of the, out of the bloods, out of the serology. You also, there's also the other ones. You have to ... they take a throat swab and also a urine sample as well.*

Participant 1: *Why didn't my doctor tell me that? When I say, "Test me for everything," why didn't you (he) tell me? Well everything; open your mouth.*

You know, bend over, whatever. When I say everything and you take my blood, now I'm thinking that's everything. (Focus group 1, Sydney)

Many HIV-positive men who were on HAART medication see their doctors every three months, and some of these are also at least assuming that they are being tested for other STIs. This could lead to a false sense of security, which is at odds with the statistical over-representation of syphilis in the HIV-positive community:

I mean, can I just say ... And I'm sure I'm talking for [deleted partner's name] on this as well. From our acquaintances and our group of friends, which include positive and non-positive, negative, people, we actually find that amongst our friends who are poz, we seem to actually get less STIs than the people who are neg. (Focus group 2, Sydney).

In the survey, when asked whether they believed they were currently being tested for syphilis when they received their regular viral load and CD4 tests, 86.4% of HIV-positive men indicated that they believed this to be the case.

A related theme to STI testing, HIV testing, did uncover two interesting themes. Once men have an HIV-positive diagnosis, some will forgo condoms, as they see them as unnecessary if they are serosorting. While HIV risk is negated in this context, there is still a significant potential for other STIs which some men acknowledged:

I mean I have, I have some fuck-buddies which are, we do bareback. But because we're positive amongst ourselves ... So in that kind of situation you don't have unprotected sex either. So, so the chance of getting STIs might increase as well. (Focus group 2 Sydney)

I'm a poz guy and I do find that has increased my exposure to STIs, and because most of the pos guys I meet, and obviously we disclose to each other, expect you not to use condoms. So when you say how you protect yourself, from my point of view the only way I can protect myself is to get checked every three months. (Focus group 4, Melbourne)

Men did respond well to the idea of rapid testing for syphilis. Waiting times for doctors' appointments, paying for consultations with a doctor, and the waiting period



for test results were seen as barriers to testing. The idea of have testing facilities available in community spaces, which were easy to administer, and have tests results quickly delivered, made the idea of testing more appealing:

I mean I have had [an HIV test at a sex on premises venue] before. [...] But then all those things – I'll have to come back in two weeks later to get the result. So it's like, "Oh well, that's another time I'll have to come by." So if I was to get a result right there and then [...] But then if it was for syphilis as well then yeah, I'd be, I'd be ... if it, if it was convenient I'd do it, yeah! (Focus group 4, Melbourne)

There was added enthusiasm if the rapid test could be obtained independent from a doctor:

Yeah, that's pretty cool. I mean take-home pregnancy test or the take-home syphilis test. Not too bad. (Focus group 3, Melbourne)

So can we buy that at a chemist? (Focus group 4, Melbourne)

Can't, can't you do like a two-dollar slot machine in the men's toilets? Like, you know, can you imagine that? Like seriously, like imagine if you can get that swab: pink, you're good; blue, go see your doctor. (Focus group 1, Sydney)

The idea did raise some privacy and confidentiality concerns regarding where the tests would be conducted and how results would be provided.

Although not directly applicable, HIV-negative men were asked in the survey what would make it easier for them to be tested more often for HIV; it is very likely that the same issues would apply equally to testing for syphilis. Three quarters (79.9%) indicated that if they could receive their results in a few minutes they would get tested more often, and almost as many (74.5%) indicated that if they could test themselves at home they would be more likely to do so. However, only 21.1% indicated that having testing facilities in gay commercial venues would make them more likely to get tested.

Following a synchronised testing period, it has been suggested that, to be effective, a period of consistent condom use should continue for a determined period. However, this idea was also largely seen by participants as untenable.

No way! No bloke is going to do that. No regular male. No, not even how healthy or how sexually active, they will not take that responsibility and come back every three months. (Focus group 3, Melbourne)

Conclusions

Mathematical modelling shows that increasing the frequency of testing, particularly in those who are highly sexually active, is likely to be the most effective intervention with the potential to completely mitigate the epidemic within 10 years. In particular, HIV-positive men, who are disproportionately over-represented in syphilis diagnoses and are visiting the clinic regularly as part of their regular medical check-up, should be targeted. Additionally encouraging men who normally do not get tested for syphilis to get tested will be highly beneficial in terms of its impact on syphilis prevalence and the prevention of future health complications due to tertiary syphilis.

In terms of acceptability mass synchronised testing for syphilis was not well received. On the whole, though, increasing the number of tests men received each year elicited a more enthusiastic response. Syphilis testing was presumed to already occur for HIV-positive men as part of their ongoing health monitoring, and as such was not seen as any further inconvenience; men were prepared to commit to increased testing if it could be made more easily accessible and less reliant on doctors (with associated costs and time considerations); and lastly, the possibility of a take-home rapid test was very popular.

Overall, increasing the frequency of syphilis testing in highly active gay men should be a priority of the NSAP as it is likely to be both effective in mitigating the epidemic and acceptable to the gay community. In addition, ongoing screening for syphilis should be routine with HIV management and testing (as opt-out strategies) with sexually-active HIV-infected men tested for syphilis during routine check-up.

Mass Treatment

Modelling Results

Mass treatment involves giving treatment to a large proportion of gay men whether they are infected with syphilis or not. A once-off rollout of mass treatment could result in a sudden and sharp decrease in syphilis prevalence; however, if it does not remove the vast majority of infections in the population then the syphilis epidemic could rebound and is unlikely to be an effective control strategy (Figure 12).

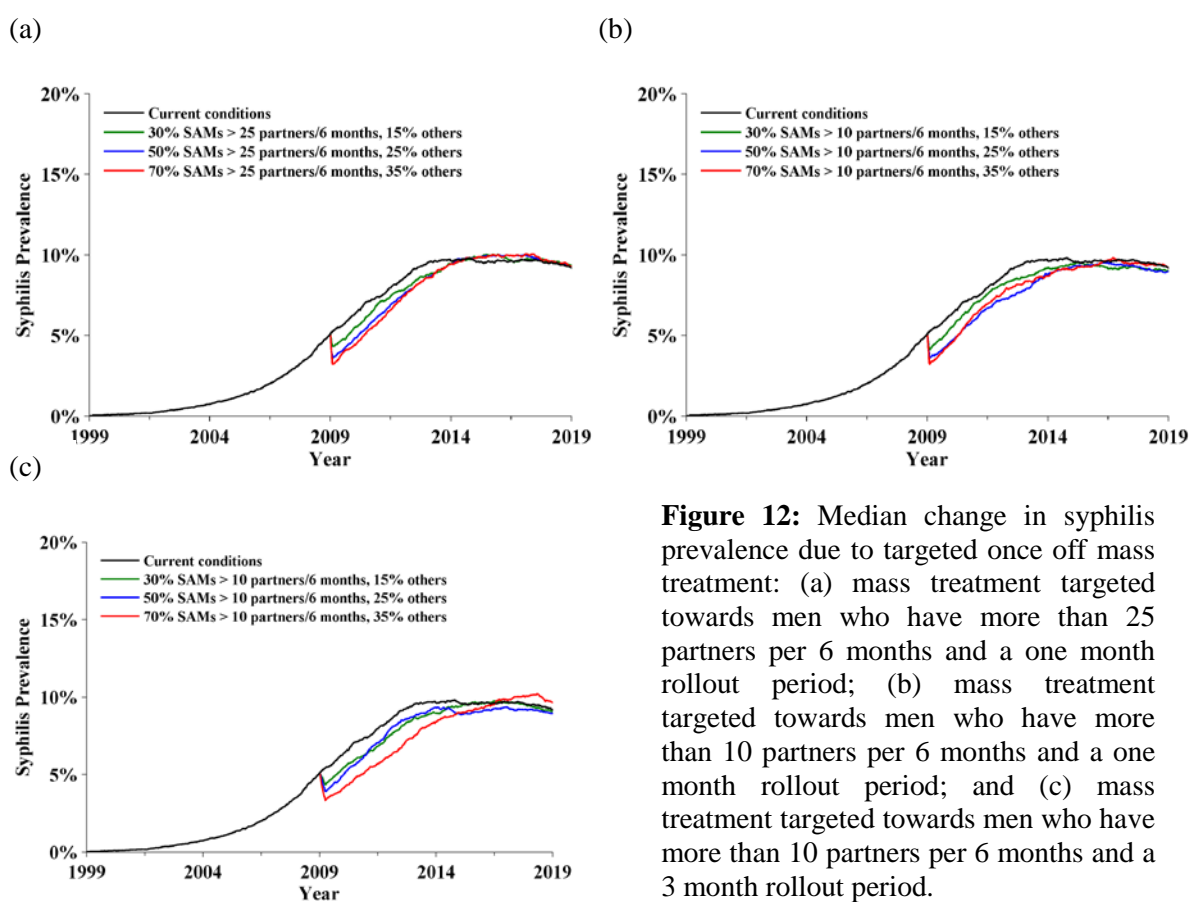


Figure 12: Median change in syphilis prevalence due to targeted once off mass treatment: (a) mass treatment targeted towards men who have more than 25 partners per 6 months and a one month rollout period; (b) mass treatment targeted towards men who have more than 10 partners per 6 months and a one month rollout period; and (c) mass treatment targeted towards men who have more than 10 partners per 6 months and a 3 month rollout period.

Rolling out mass treatment annually or biannually can have a large impact on syphilis epidemics (Figures 13 and 14). This impact is similar to having short annual or biannual blitz testing periods each year in addition to baseline testing; however, mass treatment is likely to capture men who are unwilling to be tested for syphilis resulting in a larger decrease in prevalence (Fig. 14 vs. Fig. 10).



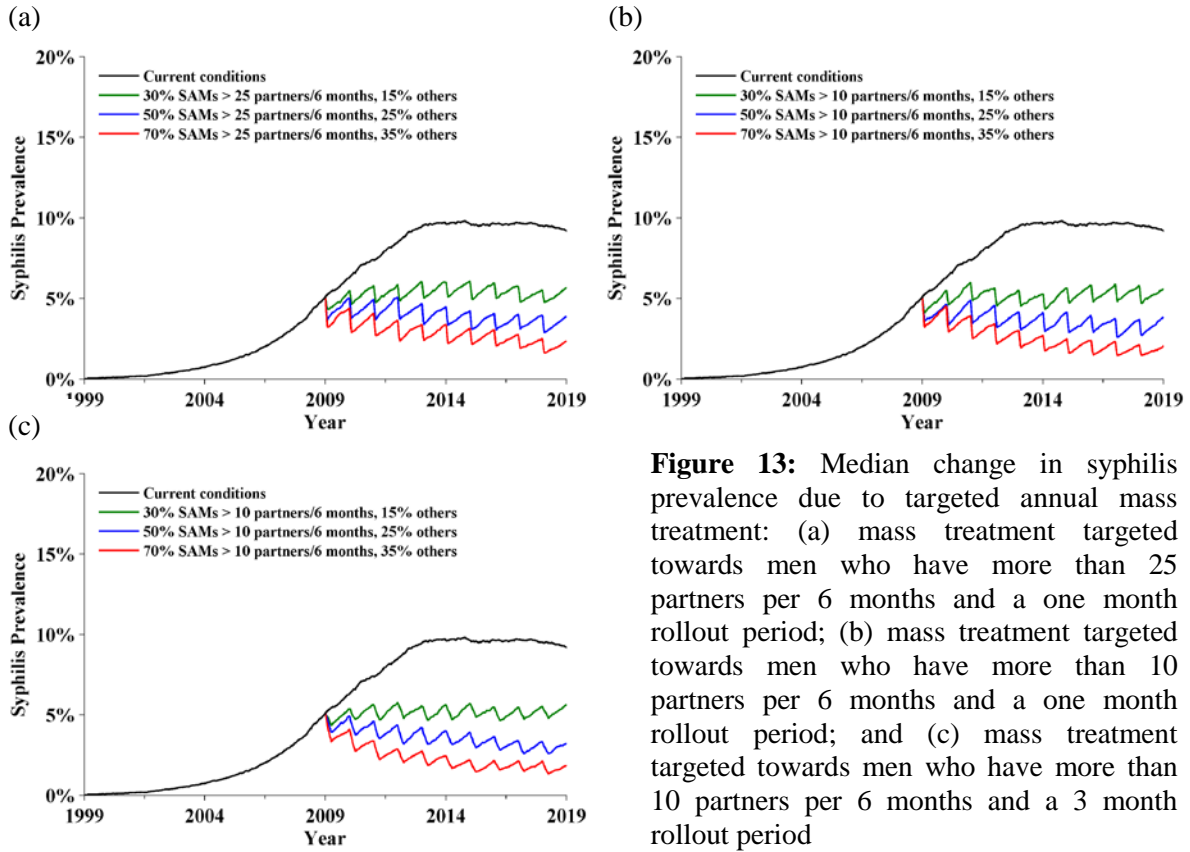


Figure 13: Median change in syphilis prevalence due to targeted annual mass treatment: (a) mass treatment targeted towards men who have more than 25 partners per 6 months and a one month rollout period; (b) mass treatment targeted towards men who have more than 10 partners per 6 months and a one month rollout period; and (c) mass treatment targeted towards men who have more than 10 partners per 6 months and a 3 month rollout period

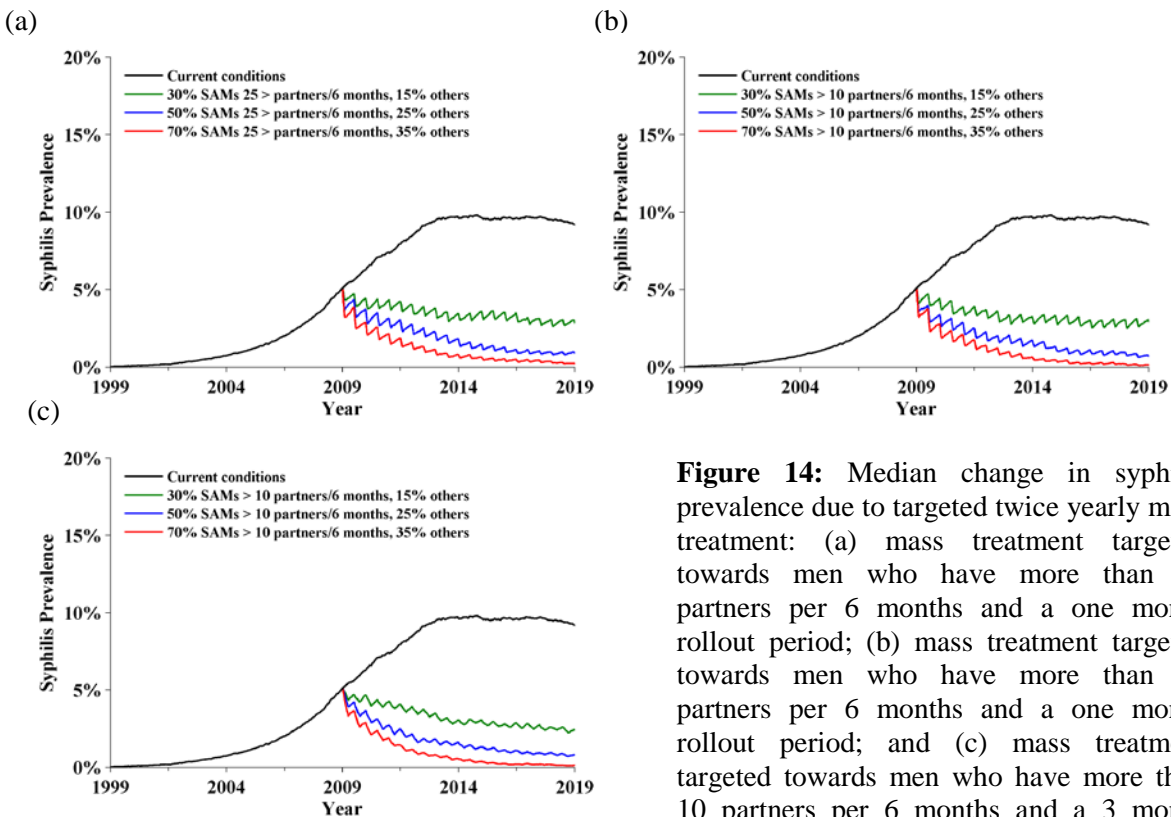


Figure 14: Median change in syphilis prevalence due to targeted twice yearly mass treatment: (a) mass treatment targeted towards men who have more than 25 partners per 6 months and a one month rollout period; (b) mass treatment targeted towards men who have more than 10 partners per 6 months and a one month rollout period; and (c) mass treatment targeted towards men who have more than 10 partners per 6 months and a 3 month rollout period.



Efficiency of mass treatment

The efficiency of mass treatment is similar to the corresponding testing interventions. For each mass treatment intervention a similar number of treatments are required to avert one infection (see Table below).

Intervention	Infections averted (10 years)	Estimated treatments (10 years)	Treatments per infection averted
70% of men with > 10 partners per 6 months, 25% others: Once/yr, 1 month rollout	13026	141754	11
70% of men with > 10 partners per 6 months, 35% others: Twice/yr, 1 month rollout	18508	283507	15
70% of men with > 25 partners per 6 months, 35% others: Once/yr, 1 month rollout	11825	130011	11
70% of men with > 25 partners per 6 months, 35% others: Twice/yr, 1 month rollout	17822	260022	15
70% of men with > 10 partners per 6 months, 35% others: Once/yr, 3 month rollout	13656	141754	10
70% of men with > 10 partners per 6 months, 35% others: Twice/yr, 3 month rollout	18194	283507	16

Acceptability

Issues around mass treatment were discussed at the same time as the concept of chemoprophylaxis. In general, men's responses to these two proposals were similar. Particular concerns about mass synchronised testing also applied to mass treatment: Many men expressed reservations about the likely effectiveness of this approach and expected that many would be unwilling or unable to commit to this activity.

Conclusion

For mass treatment to be effective a large proportion of the gay community would need to receive mass treatment over a short time frame regularly. As with mass testing, participants of the focus groups felt that the logistics of mass treatment



would interfere with effectiveness and there were considerable concerns regarding personal cost and accessibility. These results from the modelling and acceptability studies imply that mass treatment should not be a priority of the NSAP.

Partner Notification and Follow-up

Modelling results

Notifying and testing partners of infected men could have a large impact on the epidemic (Fig. 15). However, partner notification is likely to be less effective than increasing the frequency of testing in larger proportions of the population. Plausible scenarios for the number of sexual partners notified and tested results in prevalence flattening out to a steady level. It is only in the unrealistic scenario of 100% of sexual partners being traced and treated that results in an immediate decline in syphilis prevalence.

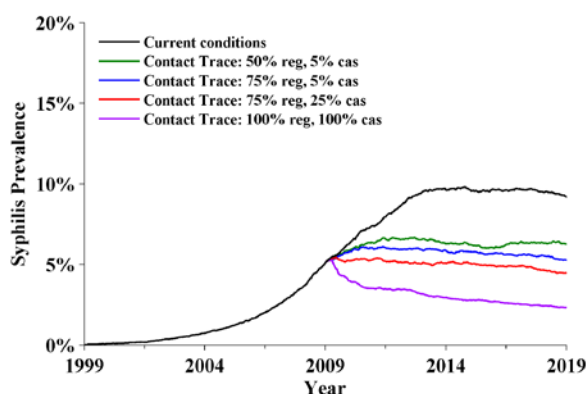


Figure 15: Median change in syphilis prevalence when a proportion of regular partners within the previous 6 months and casual partners within previous month of infected men are also tested.

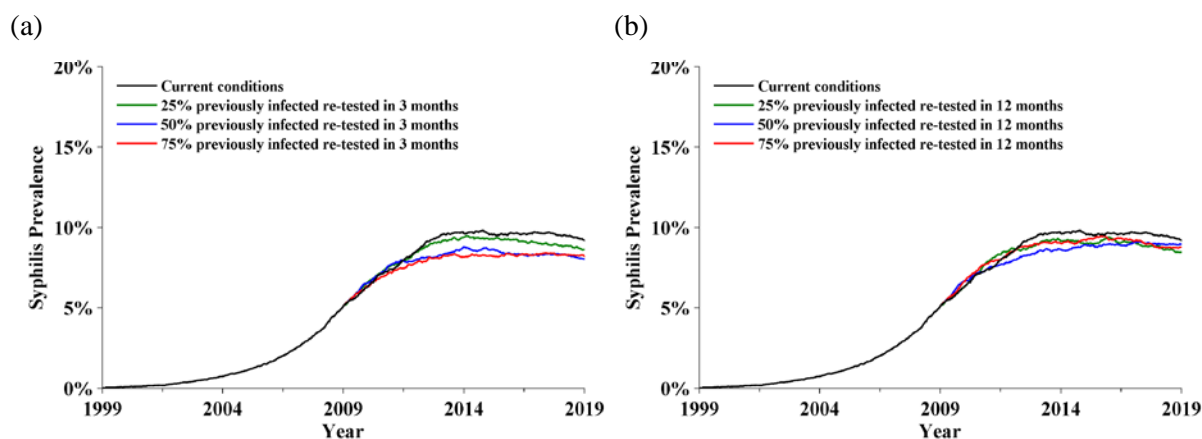


Figure 16: Median change in syphilis prevalence due to re-testing a proportion of previously infected men in (a) 3 months and (b) 12 months.

Re-testing (following-up) men who have previously been infected with syphilis within a short period of time has a limited impact on the epidemic (Figure 16). However, as with contact tracing this approach is highly efficient (see Table below).

Efficiency of partner notification and follow-up

Intervention	Infections averted (10 years)	Total tests (10 years)	Tests per infection averted
Contact tracing 50% regular, 5% casual	6777	4323	0.6
Contact tracing 75% regular, 5% casual	8903	6199	0.7
Contact tracing 75% regular, 25% casual	10588	10281	1
Contact tracing 100% regular, 100% casual	16268	18219	1
Follow up 75% every 3 months	2385	5036	2
Follow up 75% every 6 months	2867	5314	2

For contact tracing it is possible for an infection to be averted with less than one test; this is because testing and treating partners of infected men soon after diagnosis prevents those partners from infecting other men.

Acceptability of Partner Notification

Some jurisdictions have implemented systems to facilitate those who test positive for syphilis in notifying their recent sexual partners. In our study, reactions to the concept of partner notification were wildly divergent, with responses ranging from ‘It’s his problem if he catches something’ to ‘It would be an awkward conversation, but of course I would do it’. Men largely expressed a desire to be able to pass that information on, but did not necessarily expect this to be reciprocated.

Mostly, men felt comfortable notifying partners if they were diagnosed with a STI, although this depended on the context of the sexual encounter. There was an acknowledgement that many sexual encounters are relatively anonymous, which



makes contact difficult. Where the partners are known, many men felt there was a code of ethics which made it appropriate to tell:

I think one of the issues that, well, that I know my circle of friends and myself might face is that you don't always have an ongoing relationship with the person that you are having sexual activity with. And so from that perspective that makes it quite hard if you are, you know, if you are one of the, if you're a type of person that would want to alert someone of, you know, that you had, have an STI, you've since found out that you have an STI and they should get tested. That opportunity doesn't always arise. If it was, if it was a fuck-buddy I don't think there, there would be an issue in disclosing that information because I think that's the type of relationship that you set up to go ahead with that activity. (Focus group 1, Sydney)

Yeah, I actually wouldn't. I'd just, no, I wouldn't tell. Unless it was a relationship and I was going down that path. But if I knew that I'm not entering, and it's, well it's pretty much you're just going to be a fuck-buddy, whether it's once or more, yeah, I wouldn't, I wouldn't tell. I'd just, no, no. I'd be safe, I'd wear a condom. Yeah. But I wouldn't say anything. I wouldn't feel a need to. (Focus group 1, Sydney)

Interestingly, some men said they did not expect others to disclose to them:

I wish they would tell me. It would be nice if they told me. But I find it safer to go into the expectation that they wouldn't tell me. Or they wouldn't know themselves. (Focus group 1, Sydney)

Nonetheless, in the survey, when asked how they would react to a syphilis infection, most men said they would not want to tell anyone, including nearly a third (29.6%) who indicated this was 'very much' the case. Despite this, among the small number of men who reported having been diagnosed with a STI since their most recent casual sex encounter, the majority had informed one or more of their sexual partners.

There was support among focus group participants for SMS facilities being available to help make partner notification easier:

I normally text people, saying, in a very non-committal way, "I have been diagnosed with," not, "You bastard, you gave me ...". So what I'm trying to differentiate here is, tease out is that there's a statement of fact thing. There's a diagnosis. You better get treated. As opposed to, "Why did you ..." you know, that whole blame thing. (Focus group 2, Sydney).

Some particular concerns were raised about the use of the internet for these purposes. Men who met through the internet were often not considered contactable, in part because of no on-going relationship, and in part because of uncertainty of the 'netiquette' of passing on such information through a dating site, particularly given the potential for abuse or of being harassed by others. Knowledge of sites such as Whytest.org was limited, and as with dating websites, the potential for nuisance messages was mentioned.

Conclusions

Modelling shows that partner notification and testing is likely to be a highly efficient intervention that has a moderate impact on the syphilis epidemic. From the acceptability studies men mostly expressed a desire to be able to pass on information about STIs to their sexual partners, although they did not necessarily expect this to be reciprocated. The variety of sexual contacts, from anonymous encounters, to regular fuckbuddies, adds complexity to the issue. Practicalities of making contact with anonymous partners were apparent. Overall, most men wanted to 'do the right thing' by their sexual partners, and the stronger the relationship with the man in question, the higher the likelihood that they would be notified if he had been put at risk. Given this desire to pass on information about STIs and the efficient impact that partner notification and testing has on the syphilis epidemic attempts to increase the rate of partner notification and testing should be a focus of the NSAP.



Conclusions

The interventions with the greatest impact in mitigating syphilis epidemics are those that involve frequent testing of highly sexually active men, the testing of diagnosed HIV-positive men, and testing men who have recently had a sexual partnership with a diagnosed person. One particularly important aspect highlighted by the modelling is that any intervention has to be continued over the long term for its impact on the epidemic to be sustained; otherwise a syphilis epidemic is likely to re-emerge. Thus the long term acceptability of an intervention to the gay community is a highly important consideration. In general, men were interested in taking action to reduce their chances of syphilis infection and, especially, to reduce infection rates among gay men generally. However, they raised many challenges that would need to be dealt with to make this possible.

When asked to consider making changes to their own sexual behaviour, the absolute and relative levels of support for making such changes was not encouraging. There was considerable resistance to making any changes that would further restrict their sexual behaviour (than they already do to avoid HIV), and the men who were at highest risk were no more inclined to make such changes than were men at relatively low risk. Some men felt that they had already been asked to give up enough of their sexual freedom already, especially if they had been diagnosed HIV-positive and as such had then reclaimed some previously taboo sexual activities. Having less sex or returning to universal condom use were both highly unpopular amongst some men.

On the other hand, interventions that did not involve sacrificing aspects of their sexuality were more readily accepted. Increased testing or mass testing and treatment were viewed fairly favorably, although there was considerable concern about the relative convenience and the possible burden of time and effort such interventions might require. Use of prophylaxis, at least for a clear fixed time period, was viewed very favorably and men seemed to express relatively few reservations about this intervention. Nonetheless, the concepts of mass synchronised testing and treatment were viewed as being potentially more fraught due to the logistical

limitations and likely failure to achieve sufficient coverage and consistency, but increased testing in general was felt to be far less problematic.

The importance of community benefit and altruism as a motivator for action cannot be underestimated – particularly as most men appear not to be all that concerned by the prospect of a syphilis infection for themselves. While syphilis is viewed as an inconvenience and an embarrassment, it does not figure very highly as a particular health risk for most gay men because it can be treated and cured, unlike HIV. Relying on reducing the personal risk alone as a motivator for any action would be insufficient, and would fail to take advantage of the enormous community goodwill among most gay men in this regard. Despite their own cynicism about the concept of ‘gay community’ and that of many commentators, these data speak very strongly to some form of community spirit.

Convenience of implementation of interventions among men needs consideration. Most men do not consider syphilis or other STIs as being particularly important, but they are being asked to devote considerable time, effort, and potentially money to some of these interventions. We should take seriously their desire for simple, quick and convenient testing options. It is useful to remember who these men are: gay men are overwhelmingly in professional occupations and appear to be much like all other professionals where their time is very limited and precious. Whatever interventions are proposed need to be respectful of the contributions being made by gay men, largely, it appears, on behalf of the community, and therefore should be as simple and convenient as possible. Current testing and treatment facilities may be good, but they clearly do not provide sufficient flexibility or convenience to meet the needs of men for their current testing arrangements, so any further expectations would inevitably be viewed as an imposition without some other provisions being made.

Overall, there was general agreement between the conclusions from the modelling and focus group studies with those interventions predicted to have the greatest impact on syphilis epidemics tending to be the ones also likely to be accepted by gay men over the long term.



Overview of the syphilis technical workshop

A syphilis technical workshop was held on 25 June, 2009. Workshop participants crossed jurisdictions and represented numerous organisations within the sector; participants are listed in the acknowledgements of this report. The workshop commenced with an overview of the objectives of the NSAP as well as summaries of international and Australian responses to syphilis epidemics and their outcomes thus far. An overview was then provided of the methods carried out and data sources used to develop the mathematical modelling and focus group research. The rest of the day was broken into five themes of potential types of intervention. For each theme a short presentation was made on the results of the mathematical modelling simulations on the likely epidemiological impact of different intervention strategies if they were to be implemented. A short presentation was also made on the acceptability of the interventions, based on social research from the focus group sessions. Workshop participants were split into three groups and each discussed possible interventions for the theme of interest. Specific and targeted interventions were recommended as goals associated with the theme. Recommendations were reported back to the larger group and discussed. This exercise was repeated for each of four themes (with chemoprophylaxis discussed only in the larger group). The last session of the workshop involved summarising the recommendations from each of the themes. The small groups then ranked each of the recommendations in priority for target goals and reported them to the larger group. The workshop was facilitated by an external person, Mr Tim Leach. An agenda of the workshop is in Appendix 2.



Recommendations from technical workshop

The technical workshop participants were split into three working groups. Each group listed recommendations for each theme of recommendations as shown below.

Recommendations around behaviour change	
Group 1	<ol style="list-style-type: none"> 1. Partner change – <ol style="list-style-type: none"> 1. Provide information for education 2. Don't make it a major focus 3. Don't make it a directive 2. Condom use – keep promoting condom use to maintain current high levels
Group 2	<ol style="list-style-type: none"> 1. Neither condom use nor partner change likely to be a major change variable for future efforts. 2. Condom promotion remains critical in maintaining the 'current conditions', ie, condom use maintained at existing levels. 3. Condom use and partner numbers are both important concepts for gay men to understand in determining their relative need for and frequency of testing
Group 3	<ol style="list-style-type: none"> 1. Social research and mathematical modelling shows the futility of partner reduction. 2. Encourage men who are having on-going <i>high</i> levels of partner change increase testing. 3. Maintain current levels of condom use for HIV-prevention to assist in keeping other infections increasing too fast.



Recommendations around screening and treatment	
Group 1	<ol style="list-style-type: none"> 1. Remove barriers or labs to provide more tests – 3 test rule 2. Comprehensive bundle of tests 3. For HIV+ add full range of tests on routine check up (opt in/out) 4. Improving access to testing – <ul style="list-style-type: none"> Rapid testing Home testing Presumptive tests 5 Promote 6 monthly testing
Group 2	<ol style="list-style-type: none"> 1. Target men with >20 partners per 6 months to test twice per year 2. Make screening routine alongside HIV management (HIV+ men): every 3 months 3. Make screening routine alongside HIV testing (HIV- men) 4. Encourage testing among those never previously tested (need to see significant reductions in the proportion never tested – epidemiologically and morbidity) 5. Interventions must be ongoing
Group 3	<ol style="list-style-type: none"> 1. Increase coverage and frequency of testing, inc. getting doctors to test routinely (opt out). 2. Make getting tested easier: testing outside of clinics/office hours, available at shopfronts, chemists, community centres etc. or pathology collection centres. 3. Rapid testing, preferably one that can be done by the participant but will this only show antibodies or active infections? Do this is in a range of setting. 4. Situation analysis.

Recommendations around mass treatment	
Group 1	<ol style="list-style-type: none"> 1. Look at costing including cost of social marketing campaign for all cases or more information
Group 2	<ol style="list-style-type: none"> 1. Relative to the benefit suggested by the modelling, the intervention is not considered feasible.
Group 3	<ol style="list-style-type: none"> 1. Mass treatment is not justified as prevalence is not high enough for the resources required and logistics involved.



Recommendations around partner notification and follow-up	
Group 1	<ol style="list-style-type: none"> 1. Three prerequisites to help increase partner notification: <ol style="list-style-type: none"> 1. Increase knowledge about syphilis 2. Decrease stigma 3. Provide more support to enable people to notify partners
Group 2	<ol style="list-style-type: none"> 1. Recommend: Contact trace: 90% regular; 25% casual. 2. Focus groups and Periodic Surveys to further explore with gay men whether they could contact their last sexual partner (and then one prior to that, etc), and how. This information then can support development of partner notification models (patient-lead, clinician-lead, centralised, etc).
Group 3	<ol style="list-style-type: none"> 1. De-stigmatise the way diagnoses are discussed by men – make it normative to discuss the possibility of infection especially for the harder players. 2. But also provide ways to pass on this information discretely i.e., web-based services, SMS from clinician/practice nurse. 3. Follow up people with a diagnosis to see if they have trouble with contact tracing.

The workshop indicated the following statements regarding the chemoprophylaxis (syphilaxis) trial that has been designed.

Chemoprophylaxis (syphilaxis) trial
<ul style="list-style-type: none"> • General optimism towards the syphilis chemoprophylaxis trial • We support/endorse the trial design and its implementation • Recommend investigation into possible Australian funding sources



All recommendations of the day were discussed among small groups and the following recommendations were given highest priority.

Group 1

1. General testing goal: promote 6 monthly testing among all gay men, particularly highly sexually active (>20 partners)
2. Improving access to testing (e.g. Rapid or home testing, presumptive treatment)
3. We support/endorse the trial design and its implementation

Group 2

1. For HIV+ add syphilis test on routine checkup (opt out): every 3 months
 1. General testing goal: promote 6 monthly testing among all gay men, particularly highly sexually active (>20 partners)
2. Recommend investigation into possible Australian funding sources
3. Create easier ways of notifying partners discreetly and identify appropriate support

Group 3

1. For HIV+ add syphilis test on routine checkup (opt out): every 3 months
2. We support/endorse the trial design and its implementation
3. Improving access to testing (e.g. Rapid or home testing, presumptive treatment)

It was also decided that a small group of participants would discuss mass treatment further over a teleconference, with possible further investigation into its effectiveness and acceptability with the addition of more specific modelling. All recommendations will be synthesized further and discussed with the technical working group. Final recommendations will be available in the final report.



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Appendix 1: Description of modelling methods

This appendix describes specific details of the individual-based syphilis/HIV transmission and sexual behaviour model. The primary purpose of this model was to investigate syphilis epidemics in gay men and the impact of potential interventions on these epidemics. HIV transmission and infection progression was incorporated to improve the model's accuracy in describing syphilis epidemiology.

The size of the simulated population is constant, with individuals entering the population as others age out or die. The sexual behaviour, HIV status, and clinical behaviour of an individual is fixed. The model tracks every individual and sexual partnership in a population of gay men over time with state variables describing the HIV status, HIV and syphilis disease progression, level of sexual activity, partnership availability, and current sexual partners updated daily. Our model is calibrated using data from surveys of gay sexual behaviour [30, 34] to be representative of the increasing syphilis and HIV incidence and prevalence in the state of Victoria, Australia over the period 1999 to 2008.

Each person's sexual activity is determined by the average number of sexual partnerships they have per year. Individuals are classified as 'low-activity' if they have less than 5 partnerships per 6 months, otherwise they are classified as 'high activity'.

The model simulates a dynamic sexual partnership network that is updated daily. Gay men can participate in casual partnerships (lasting up to one day), form long-term (regular) partnerships, or engage in group sex. Group size, the frequency, and the number of sexual encounters within a group sex event are determined probabilistically. Sexual behaviour (condom use and frequency of sexual acts) within a partnership is also simulated according to probabilistically-inferred rates dependent on partnership type, as defined in the Table.

Population demographics, sexual partnership dynamics, and sexual behaviour

Our model population is made up of 30,000 gay men consistent with the demographics of Victorian gay populations [34]. When the population is initialized in the model individuals are given an age between 15 and 85 years. Individuals leave the population when they reach an age uniformly distributed between 65 and 85 years or if they die. When a male leaves the population they are immediately replaced, keeping the population size constant, by another male with an age uniformly distributed between 15 and 25 years.

The sexual activity of each individual is determined by the number of casual partnerships they have per year. Individuals in the model population may engage in three types of sexual partnerships: regular, casual, and group sex. Regular partnerships are long-term partnerships between two gay men with a duration that is geometrically distributed with a mean of 4 years. Casual partnerships have duration of one day and all men can have a casual relationship concurrently with a regular partnership. Group sex partnerships have the same characteristics as casual partnerships except they occur in a group sex setting.

The distributions of the number of casual partners per year were obtained from the 'Health In Men' (HIM) study [31]. In these studies the number of casual partnerships per year is categorized into 1-2, 3-5, 6-11, 12-50, and > 50 casual partnerships every six months. We set the maximum number of partnerships in six months to be 60 and randomly assigned a category for the number of sexual partnerships based on this distribution. The actual number of casual partnerships for each individual is then randomly determined uniformly from their assigned category. In our model gay men who have less than 5 casual partnerships every 6 months are designated to be 'low activity' with the others labelled to be 'high activity'. For Australian populations approximately 50% of gay men are low activity [31].

Group sex activity is also incorporated in the model. Almost all gay men engage in group sex at least once in their lifetime, with many men engaging in it infrequently or once off [30, 76]. However, in our model the sexual activity of each individual is fixed for the duration of a model simulation. The proportion of HIV-negative gay men who regularly engage in group sex is estimated to be 17% [34]. In our model only high-activity gay men are designated to engage in group sex; thus we randomly assign



34% of HIV-negative high activity men in our model population to engage in group sex so that the overall population proportion agrees with these estimates. However, when a high-activity individual is randomly assigned to be someone who engages in group sex the number of casual partnerships they have per year is decreased by the average number of group sex partnerships for the population (described below). Hence their overall number of casual sexual partnerships includes the average number of group sex partnerships they have per year.

In the model simulations, when someone is available to form a casual partnership (see below) another person is randomly selected from the pool of available people (if any) and the partnership is stored. If neither of the two people in a casual partnership also has a regular partner then the partnership can become regular with probability 0.2. This is calibrated so that the overall probability of an individual being in a regular partnership is 50% to match behavioural data [34]. When someone is in a regular partnership they are still available to form a casual partnership. However, in the model individuals can only have one casual partnership per day unless they are engaging in a group sex session.

From the population of gay men available to engage in group sex, groups of males are formed. The size of these groups g_s is given by a generalized Pareto distribution with probability distribution function

$$f(x) = \left(\frac{1}{\sigma}\right) e^{-(x-\theta)/\sigma}$$

for $x > \theta$ where $\sigma = 1.9$ and $\theta = 3$. These parameters are set so that the average and median group size is 4.4 and 4 respectively, matching available behavioural data [30, 76]. The average number of sexual partnerships p_s formed by each individual in the group is uniformly selected from between 1 and $\min(g_s - 1, 10)$. Within a group, casual partnerships are formed randomly with a probability equal to $\min(1, p_s / (g_s - 1))$. Given the distribution for the group size the average number of group sex partners a gay man who engages in group sex has per year is approximately 10.



After someone engages in group sex there is a gap time where they are not available to engage in group sex according to the model. This gap time for each individual is uniformly distributed between 0 and $730/n_g$ days where n_g is the average number of group sex sessions an individual has per year.

The probability of anal and oral intercourse during a day in a regular partnership are given by $p_a^r = f_a^r/7$ and $p_o^r = f_o^r/7$, respectively where f_a^r and f_o^r are the average number of anal and oral acts per week, respectively. Within casual and group sex partnerships there is a probability of once off anal and oral sex during the partnership. In the model we assume there is no condom usage during oral sex but there is a probability of condoms being used during anal sex which is dependent on the serostatus of each partner and the probability of disclosure (see Table in main text). The effectiveness of a condom in preventing the transmission of syphilis from an infected person to a susceptible partner is denoted by ϵ . If a condom is used during anal intercourse then the infectiousness β of an infected partner is reduced to $(1 - \epsilon)\beta$.

Syphilis and HIV transmission, disease progression, and clinical characteristics

The transmission of syphilis and HIV within a partnership depends on the frequency of anal and oral intercourse within a partnership, whether a condom has been effectively used, and the syphilis/HIV status of each partner. The disease progression of syphilis-infected individuals is shown in Figure 1 of the main text. Individuals are designated to be infectious if they are in the incubating, primary, secondary, early latent or recurrent infectious stages of syphilis with the probability of transmission to a susceptible partner changing depending on the stage of syphilis and the sexual behaviour within the partnership (see Table in main text). It is assumed that the infectiousness of an individual is constant while they are in each disease stage. Syphilis-infected individuals are given a fixed duration for their incubating, primary, secondary, and early latent stages. These time periods are randomly assigned uniformly at the time of infection from the ranges specified in the Table. Individuals progress through the late latent, remission, and recurrent stages of syphilis probabilistically with a probability equal to the inverse of the average



duration in each stage. When individuals progress to tertiary syphilis they remain there unless they receive treatment. Individuals who are treated in the early infectious stages are assumed to become immediately susceptible to re-infection, while those who are treated in the later stages of syphilis are immune to re-infection for an average duration of 5 years.

HIV-positive individuals can be in either the primary stage, chronic stage, have late-stage disease/AIDS, or be on treatment. Infected individuals are given a fixed duration for their primary, chronic, and AIDS stages. These time periods are randomly assigned uniformly at the time of infection from the ranges specified in the Table. The time period for the AIDS stage represents the time until death, which can be prevented by the initiation of treatment. HIV-Infected individuals can go onto treatment in any stage but have a much higher per day probability in the AIDS stage than in the primary or chronic stages (see Table). Once an individual begins treatment it is assumed they remain on treatment for the duration of their time in the model population.

The infectiousness of an HIV-infected male changes depending on the stage of infection they are in. Men in the primary and AIDS stages having a higher probability of transmission to HIV-negative partners while males on ART have a very low but non-zero probability of HIV transmission. The probability of HIV transmission varies uniformly in the ranges given in the Table.

There is strong evidence that both ulcerative and non-ulcerative sexually transmissible infections (STIs) can increase the probability of HIV transmission by augmenting HIV infectiousness and susceptibility; reciprocally, HIV infection can enhance the acquisition of other STIs [38-44]. Syphilis is thought to be one of the most important STIs for facilitating HIV transmission. Several studies (in heterosexuals) estimate the relative risks of HIV infection due to infection with other STIs in the range 2-24, but largely clustering between 2 and 5. Therefore, the transmission of both syphilis and HIV within a partnership is affected by the disease status of each partner. For HIV transmission if either partner is infected with syphilis then the per act probability of HIV transmission from the HIV infected person to the HIV-negative person is increased by the multiplicative factor b_{STI} which is uniformly distributed between 1 and 5. We also assume that HIV infected males are more



susceptible to syphilis infection due their compromised immune system. The baseline per act probability of syphilis transmission from a syphilis infected person to a HIV positive person is increased by the multiplicative factor b_{HIV} which is uniformly distributed between 1.5 and 2.5. We assume there is no increase in syphilis transmission from an infected person to a HIV-negative person.

Syphilis testing and treatment

To model syphilis testing and treatment of gay men, individuals are tested randomly each day with a probability per day that depends on the sexual behaviour and HIV status of each individual. For baseline testing four sub-populations of gay men are considered: these are high activity gay men, gay men who engage in group sex, HIV-positive gay men on ART, and the low activity gay population. These sub-populations are not mutually exclusive: if an individual is HIV-positive and on ART then they will be in one of the sub-populations describing their sexual activity and also in the HIV-positive on ART sub-population.

For each of these sub-populations there is a different value for the testing probability, which is determined by four parameters: the duration of the testing/screening period d_t ; the proportion of the population tested p_c during this period (coverage); the frequency of testing (average number of tests) for each individual f_t during this period; and the gap time between testing periods g_t . Each sub-population has different values of p_c , f_t , d_t , and g_t representing different background testing rates or the targeting of specific testing interventions. The probability of being tested during the testing period is given by $p_t = p_c f_t / d_t$ and zero during the gap time between testing periods.

Surveys of Australian gay men show that there is a proportion p_t^u of gay men who are unwilling to undergo testing for syphilis or HIV. For gay men who are willing to get tested, the probability of syphilis testing per day is rescaled by dividing by $(1 - p_t^u)$ so that the overall probability for the entire sub-population equals p_t . For individuals who are HIV-positive and on ART their probability of being screened for



syphilis per day is given by $p_t = 1 - (1 - p_t^s)(1 - p_t^h)$ where p_t^s is the probability of syphilis testing for the sexual activity sub-population they belong to and p_t^h is the probability of syphilis testing because they are HIV-positive and on ART.

When an infected individual is tested for syphilis there is a probability $(1 - t_s)$ where t_s is the test sensitivity, of a miss diagnosis, where t_s is the test sensitivity. Assuming all positively diagnosed individuals are effectively treated, the probability per day that a gay male infected with syphilis is treated equals $(1 - t_s)p_t$.

Background testing for syphilis: Each of the sub-populations has a different background rate of syphilis testing in the absence of specific interventions. The percentage of gay men in each sub-population who test for syphilis at least once each year is estimated from surveys of gay men [34] and listed in the Table in the main text. These estimates determine the proportion of men p_c tested in each subpopulation. For background testing we set $d_t = 365$ and $g_t = 0$ (i.e. gay men can be tested all year every year with no period of no testing). HIV-positive men are tested more frequently than negative men; thus for background testing we estimate f_t to be 2 for HIV positive gay men on ART while $f_t = 1$ for the rest of the population. These values of p_c, f_t, d_t and g_t for each sub-population remain fixed in our model unless a specific screening intervention is targeted at the men in that subpopulation.

HIV testing

As for syphilis testing the per day probability that a male is tested for HIV depends on their sexual activity with high-activity gay men and gay men who engage in group sex more likely to be tested for HIV. This probability is simply given by the coverage of HIV testing per year for each sexual activity sub-population divided by 365. These probabilities are calibrated to the number of HIV diagnoses per year in Victoria from 1999 to 2008. In our model HIV testing is assumed to be 100% accurate. The same men in the model population that are unwilling to get tested for syphilis are also unwilling to get tested for HIV. Therefore, the probability of HIV testing per day for

those who are willing to get tested is rescaled so that the overall probability for the entire sub-population is correct.

Behaviour change interventions for syphilis

To investigate the impact of changes in sexual behaviour on syphilis epidemics we considered increases in condom usage and decreases in the partnerships for a fixed duration. For these interventions baseline testing for syphilis and HIV continues to be implemented.

Increasing condom usage: To model the effect of increased condom usage we increased the probability of a condom being used during anal sex in partnerships where both partners disclosed their HIV status and where HIV status was unknown. Condom usage for disclosed concordant partnerships and oral sex remained unchanged.

Decreasing number of sexual partners: The impact of a reduction in the number of partners was investigated by decreasing the probability of availability for partnership for each individual (equal to the number of partnerships they have per 6 months divided by 182.5) for the duration considered. After the intervention period was completed the original probability for each person was returned. For this intervention we assumed no change in group sex activity.

Screening interventions for syphilis

To model and compare the impact of particular screening interventions on syphilis epidemics the values of p_c, f_c, d_c and g_c for each sub-population and the implementation of screening are changed. The particular interventions and their implementation investigated with our model are listed and described below. These interventions can be targeted at the whole population of gay men by changing the values of p_c, f_c, d_c and g_c for each sub-population or focused on particular sub-populations by only changing the corresponding values of p_c, f_c, d_c and g_c for that sub-population.

Increasing coverage: To model an increase in the coverage of gay men tested per year the value of p_c is increased from the background value with f_c, d_c and g_c



remaining fixed. The maximum value of p_c is $(1 - p_t^n)$, as p_t^n never test for syphilis. However, the impact of increasing the coverage to 100% of gay men being tested at least once per year can be determined by setting $p_c = 1$ and relabelling all men to be willing to test.

Increase frequency of testing: For these interventions the HIV positive on ART sub-population is expanded to include all diagnosed HIV positive men. To model an increase in testing frequency the value of f_t is increased for each sub-population group while p_c , d_t , and g_t remain at their background values.

Synchronized or 'blitz' testing: Modelling of synchronized testing is implemented by setting d_t to the duration of the synchronized testing or 'blitz' and g_t to the time period between testing blitzes. The value of p_c is changed to the proportion of men tested during a blitz while f_t equals the average number times men are tested in a blitz. For example an intervention that tests 80% of gay men during a one month period twice every year would be implemented by setting $p_c = 0.8$, $f_t = 1$, $d_t = 31$, and $g_t = 151$. In our model we assume that testing only occurs during blitz periods with no screening happening between blitzes.

Follow-up testing: We model 'follow-up' testing where previously treated gay men are encouraged to return for another syphilis test after a certain time period. When a male is treated for syphilis there is a probability that they will return for another test in within a fixed time period. This intervention is implemented by performing background screening on the population. When an individual is treated due to this background screening and decides to return for another test they are not tested again until this follow-up test. If a gay male does not return for a follow-up test they return to being tested at the background rate.

Contact tracing: The implementation of contact tracing in the model is carried out differently to the other interventions described above. When an individual is tested and positively diagnosed for syphilis due to background testing, a proportion of the regular and casual partners they had during a fixed time period before their

diagnosis are contacted and tested within two weeks after the individual's diagnosis with a probability $p_t = 1/14$. To reflect the practical difficulty in tracing casual partnerships, the proportion of casual partners tested, and the preceding time period for which they are traced, is less than that for regular partners.

Pre-exposure prophylaxis interventions

Modelling of pre-exposure prophylaxis was implemented by designating a fixed proportion of highly sexually active men in the population to be taking pre-exposure prophylaxis for a fixed period of time. During this period men labelled to take prophylaxis are assumed to be protected from syphilis with an efficacy of ϵ_p (this takes into account both adherence and effectiveness of drugs); i.e. the per act probability that an adherent person acquires syphilis through anal sex and oral sex is reduced by a factor of $(1 - \epsilon_p)$ for the period of the intervention.

Mass treatment

Mass treatment of gay men was modelled by treating a highly sexually active man during the period of the intervention with a probability $p_t = p_c/d_t$ where p_c is the proportion of men targeted for mass treatment and d_t is the period that mass treatment is rolled out. We assumed that infected men were immediately treated on the day they received mass treatment. For uninfected men we assumed mass treatment had no affect and only provided protection from infection for the day they received treatment; i.e. we assumed mass treatment provided no immunity.

Model initialization and running of simulations

The model population is initialized by randomly assigning the sexual activity, average number of partners, and treatment seeking status for each individual. Initially there are no partnerships in the population but everyone is available to form partnerships. Everyone in the population is susceptible to HIV and there are no syphilis infections present. The model was run for 5 years, to stabilize the partnership dynamics, prior to randomly assigning 10% of individuals to be infectious with HIV. The model was



then run for 45 years to establish a steady state for HIV prevalence and annual diagnoses in the population. At this time 10 individuals were randomly designated to have infectious syphilis establishing a syphilis epidemic in the population. The syphilis transmission and disease progression was then tracked for 10 years (corresponding to the years 1999 to 2009).

As described in the main text, the realistic biological and behavioural parameters used in the model led to simulations that were well-calibrated to match HIV prevalence, the number of HIV diagnoses, and the number of syphilis notifications in Victoria, Australia. Out of 52 simulations, the 5 simulations that best fit the epidemic data (according to a Pearson chi-squared test) were selected to forecast the impact of screening interventions (see main text). The random number seeds generated in Matlab[®] for each of these interventions were stored so that the first 55 years prior to the introduction of an intervention for these simulations was repeated and direct comparisons between interventions could be made.



Appendix 2: Agenda of syphilis technical workshop

9am Morning Session

- Welcome and overview of the day: Geoff Honnor / Tim Leach (5m)
- Overview of the National Syphilis Action Plan: Darryl O'Donnell (5-10m)
- Highlights from the AFAO Forum in May 2009: Philip Keen (5-10m)
- Syphilis epidemiology in Australia: Basil Donovan (15m)
- Global responses (emphasis on those related to responses considered in this forum) and outcomes to MSM epidemics: Martin Holt (15m)
- Local responses and outcomes so far: Andrew Grulich (15m)
- Group discussion/questions focused specifically around local and global responses to date (10m)

10:20 Morning Break

10:45 Late Morning Session

- Overview of modelling methodology and calibration, including data sources used to develop the model: David Wilson/Richard Gray (10m)
- Overview of focus group research: background of what was done, demographics of group, number of participants, location of groups etc: Garrett Prestage (10-15m)
- Is change in behaviour (partner numbers, condom use) likely to be effective and acceptable?
 - Modelling predictions: David Wilson (5m)
 - What behaviour change is acceptable for MSM? Pol McCann (10m)
 - Small group discussions: what specific recommendations should be made in terms of target group, behaviour change target, duration of intervention (20m)
 - Group feedback, synthesize to 1-2 recommendations (15m)
- Is chemoprophylaxis expected to be effective and acceptable?
 - Background about the trial: Basil Donovan (5m)
 - Modelling predictions: Alex Hoare (2-5m)
 - Is it acceptable? Garrett Prestage (5m)
 - Whole group discussion on possible endorsements (5m, Tim Leach facilitating)

12:15 Lunch

1:15 Afternoon Session



- Is increased and targeted screening and treatment expected to be effective and acceptable?
 - Modelling predictions: David Wilson (5-10m)
 - Is it acceptable? Garrett Prestage (10m)
 - What are the current testing rates? Iryna Zablotska (5-10m)
 - Small group discussions: recommendations (30m)
 - Feedback and synthesize to 2-3 recommendations (10-15m)
- Is partner notification and follow-up of previously infected men effective and feasible?
 - Modelling predictions: Richard Gray (5m)
 - Is it acceptable? Garrett Prestage (5m)
 - Small group discussions: recommendations (15m)
 - Feedback and synthesize to 1-2 recommendations (10m)
- Is mass treatment effective and feasible?
 - Modelling predictions: Richard Gray (5m)
 - Is it acceptable? Ian Down (5m)
 - Small group discussions: recommendations (10m)
 - Feedback and synthesize to 1-2 recommendations (10m)

3:30 Afternoon Break

3:45 Late Afternoon Session

- Decide upon final recommendations
 - Summarise all recommendations (5m)
 - Small groups discussions: rank all priorities (20m)
 - Feedback and 'consensus' on top 2-3 recommendations

5:00 Close





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