

# Sexually transmissible infection control programs for men who have sex with men – what will they look like in 2020?

Oliver N. Refugio<sup>A,D</sup>, Chelsea Roberts<sup>A</sup>, Richard West<sup>B</sup> and Jeffrey D. Klausner<sup>A,C</sup>

<sup>A</sup>David Geffen School of Medicine, University of California, Los Angeles, 10833 Le Conte Avenue, Los Angeles, CA 90095, USA.

<sup>B</sup>Directorate of Sexual Health and HIV, Chelsea and Westminster NHS Foundation Trust, 369 Fulham Road, London, SW10 9NH, UK.

<sup>C</sup>Fielding School of Public Health, University of California, Los Angeles, 540 Charles E Young Drive, Los Angeles, CA 90024, USA.

<sup>D</sup>Corresponding author. Email: [orefugio@mednet.ucla.edu](mailto:orefugio@mednet.ucla.edu)

**Abstract.** The resurgence of sexually transmissible infections among men who have sex with men is a concern for sexual health. Traditional strategies have relied on the promotion of condom use, regular testing, treatment, and partner management. Future sexually transmissible infection control programs must combine current prevention methods with novel approaches that target the providers, patients, and mechanisms of health care delivery.

Received 11 March 2016, accepted 2 May 2016, published online 22 July 2016

## Current state of sexually transmissible infection control in men who have sex with men

The onset of the HIV epidemic in the 1980s renewed public health efforts to control sexually transmissible infections (STIs) due to the well-established synergistic relationship between HIV infection and other STIs.<sup>1</sup> After a dramatic and steady decline through the middle of the 1990s, STIs resurged among men who have sex with men (MSM) and became hyperendemic.<sup>2–4</sup> Recent trends suggest that with the advent of pre-exposure prophylaxis (PrEP), increases in STIs among MSM may be accelerating further.<sup>5–7</sup> It is evident that current strategies need to be expanded upon, improved and combined with novel approaches. A closer examination of current barriers to STI control, as well as the anticipation of new challenges that may arise, can give us a glimpse ahead as to what STI control may look like in 2020.

## Traditional STI control methods

The traditional approach to STI prevention and control has relied on promoting condom use, regular testing and treatment, and partner management.<sup>8</sup> Condoms are known to reduce the risk of HIV infection and bacterial STI transmission.<sup>9</sup> There was a massive increase in condom use in the 1980s due to the onset of the HIV epidemic, but currently, in some settings, consistent condom use may be declining.<sup>10</sup> Reasons for not using condoms include preferences for intimacy, low perceived risk or consequences of infection, use of seroadaptive behaviours, and the use of HIV PrEP.<sup>11,12</sup>

Because most STIs are asymptomatic, regular screening and treatment is a critical component for reducing the reservoir of infection and the forward transmission of infection.<sup>13</sup>

Regular STI testing of high-risk MSM is recommended by international guidelines, but adherence by both providers and the population is highly variable.<sup>14,15</sup> Furthermore, pharyngeal and rectal testing is often not performed, despite evidence that *Neisseria gonorrhoeae* (NG) and *Chlamydia trachomatis* (CT) infections are more frequently extragenital. Pharyngeal NG, rectal NG, and rectal CT infections are more often detected than urethral NG and CT infections in MSM.<sup>16,17</sup> Additionally, there are inconsistencies in the availability of the best NG and CT detection modalities.<sup>18</sup> Nucleic acid amplification tests (NAATs) provide highly sensitive and specific detection of NG and CT in all three susceptible anatomic sites.<sup>19</sup> Nevertheless, no manufacturer currently has a USA Food and Drug Administration approved product for pharyngeal or rectal specimen testing, despite its superiority to culture and recommended use by international guidelines.<sup>6,19–21</sup> Currently in the USA, only laboratories that comply with the Clinical Laboratory Improvement Act and conduct a verification study may use NAATs for non-urethral testing.<sup>22</sup>

Early detection of infection and appropriate medical therapy precludes further transmission of STIs (i.e. treatment as prevention).<sup>8</sup> In some cases, treatment soon after exposure may be warranted even before infection is detected or becomes symptomatic, a strategy known as post-exposure prophylaxis (PEP). PEP has been effective in the prevention of syphilis.<sup>23</sup> However, an individual will only seek PEP if they are aware of their exposure to infection. Thus, STI control with PEP is only effective if an infected individual discloses their infection status to their sex partners.

Strategies are needed to increase partner notification and the use of expedited partner therapy for MSM. While not recommended in the USA Centers for Disease Control

guidelines, many jurisdictions and global programs routinely offer extra medication(s) or additional prescriptions to expedite partner therapy.<sup>6,24</sup> The benefit of treating partners for exposure to bacterial STIs outweighs the risk of missing other undiagnosed conditions. Partner therapy is a critical component of STI control.<sup>8</sup> Although the future of STI control will likely employ those established methods, the persistent high rates of infection in MSM will require novel approaches in conjunction with existing strategies.

### Novel approaches to STI prevention in MSM

PrEP is one of the most recent HIV prevention strategies that target individuals who are at substantial risk for infection. In 2012, the USA Food and Drug Administration approved Truvada® (Gilead Sciences, Inc., Foster City, CA, USA) in combination with safer sex practices for use as HIV PrEP in adults following reports of its safety and effectiveness in phase III clinical trials.<sup>25,26</sup> Truvada® (FTC–TDF) is a fixed-dose combination of two antiviral agents: emtricitabine (FTC) and tenofovir disoproxil fumarate (TDF) labelled for once daily oral dosing. Studies have found that adherence to this daily regimen is correlated with its effectiveness in preventing HIV infection, which has been mathematically modelled to be as high as 99% in MSM, with daily oral dosing as prescribed.<sup>27,28</sup> Thus, there has been a push to implement multifaceted approaches to promote and maximise daily adherence to FTC–TDF for PrEP. ‘On demand’ PrEP – taking FTC–TDF before and after sexual activity – has also been investigated as an alternative to daily dosing. Adverse effects caused by FTC–TDF observed in the placebo-controlled pre-exposure prophylaxis initiative (iPrEx) and USA MSM safety trials included nausea, unintentional weight loss, and reduced bone mineral density (~1.5% at 1 year without an increase in fracture risk).<sup>25,26,29</sup> Despite those documented side effects, a recent narrative review concluded that short- and medium-term use of FTC–TDF for PrEP has a safety profile comparable to aspirin.<sup>30</sup>

Similar to PrEP for HIV infection, prophylaxis against bacterial STIs has recently shown some promise. Bolan *et al.* reported decreased incidence of NG, CT or syphilis infections as a result of daily doxycycline prophylaxis among 30 high-risk MSM in a randomised, controlled pilot study.<sup>31</sup> Larger randomised control trials should be conducted to confirm the effectiveness of STI PrEP against those bacterial infections. Daily chemoprophylaxis to reduce syphilis incidence was reported to be acceptable among MSM.<sup>32</sup> Additionally, mathematical models have shown that syphilis chemoprophylaxis may have a substantial impact on the epidemic.<sup>33</sup> Daily doxycycline may only be appropriate for a subset of MSM for whom the benefits outweigh the possible risks. Although doxycycline is prescribed long term for conditions ranging from acne to malaria, while generally safe, its prolonged use has been rarely associated with irritable bowel syndrome, abnormal weight gain and photosensitivity.<sup>34–36</sup> Currently, a few laboratories are researching vaccines to prevent bacterial STIs. While no vaccine is imminent, continued research may generate a product for further evaluation.

### Existing and anticipated challenges of the STI epidemic in MSM

Although FTC–TDF for PrEP appears to be a promising agent to prevent HIV transmission, one of the main concerns regarding its implementation is risk compensation with subsequent increased rates of other STIs. Due to the reduced risk of HIV acquisition in users of FTC–TDF for PrEP, it is plausible that MSM on PrEP might reduce their condom use during anal sex and increase their number of sex partners. A similar phenomenon occurred after the introduction of highly active antiretroviral therapy (HAART). People living with HIV who were being treated with HAART were more likely to perceive less severe consequences of HIV infection and were at an increased risk of acquiring a STI.<sup>37,38</sup> The evidence on how PrEP may influence risk behaviour is still emerging. Earlier clinical trials and more recent observational studies of PrEP users reported high STI incidence among participants.<sup>39–42</sup> Those findings suggest that PrEP is reaching the intended high-risk MSM population. However, it is difficult to extrapolate whether those elevated STI rates were a result of risk compensation following PrEP initiation or from increased detection due to more frequent screening. In an investigation by Volk *et al.*, 41% of participants admitted to a decrease in condom use 6 months after starting FTC–TDF for PrEP.<sup>42</sup> In practice, STI screening of MSM should be performed quarterly, as suggested by international guidelines.<sup>43–45</sup> If quarterly screening of PrEP users becomes routine, then MSM on PrEP may actually receive more frequent and consistent STI testing and treatment compared with MSM with similar risk profiles who are not on PrEP, thereby leading to reduction in STIs among PrEP users.

Implementation of chemoprophylaxis against HIV infection and bacterial STIs also elicits concern over the development of drug-resistant microbial species. Acquisition of drug-resistant HIV strains in initiators of FTC–TDF for PrEP has been documented in clinical trials.<sup>46,47</sup> Among participants in the FTC–TDF for PrEP treatment arm who seroconverted during the Partner’s PrEP study, there were seven cases of detectable FTC–TDF-related mutations.<sup>47</sup> Three of those seven seroconversions were unrecognised at baseline and did not have detectable FTC–TDF-related mutations at that time, which suggests that these mutations were likely caused by treatment rather than acquisition of an already mutated strain. However, these FTC–TDF-related mutations were no longer detectable 6 months after PrEP cessation. The clinical significance of that rapid decay in drug-resistance on the initiation of antiretroviral therapy for these patients should be further investigated. The possibility of drug resistance is also a deterrent for implementing PrEP against bacterial STIs due to the concern that the use of antimicrobials might select for drug-resistant species.<sup>48</sup>

Advancements in technology have also created a set of new issues with regard to STI control. The different ways MSM find sex partners have evolved since the early HIV/AIDS epidemic. While bars and bathhouses still exist, the Internet and, more recently, mobile phones serve as modern methods of meeting partners for sexual encounters, especially for younger MSM.<sup>49,50</sup> By the late 1990s and early 2000s, seeking sex

partners via the Internet was made possible by online chat rooms and websites such as AOL, Adam4Adam, Manhunt and Craigslist.<sup>51,52</sup> Such websites may facilitate negotiating condomless anal intercourse with seroadaptive behaviours. A meta-analysis of studies on Internet-based partner selection conducted between 2002 and 2009 found that condomless anal sex was 75% more likely to be reported among MSM who found their sex partners on the Internet compared with those who met offline.<sup>53</sup>

Geosocial networking apps are the latest platforms for partner seeking. The apps that cater to MSM, such as Grindr, Jack'd, Scruff and Krave, connect men to each other based on geographical proximity. As with the advent of Internet-partner seeking in the past decade, there is a concern that facilitating partner meeting through those apps will increase the contact rate and STIs among MSM.<sup>54</sup> A cross-sectional study in Los Angeles found higher odds of gonococcal and chlamydial infection in MSM who used geosocial networking apps for meeting sex partners compared to MSM who met partners through in-person methods only.<sup>55</sup>

Concerns regarding how online avenues might affect implementation of infection control were legitimised by a syphilis outbreak in 1999, where a cluster of syphilis cases in San Francisco was associated with meeting partners in an Internet chat room.<sup>56</sup> Public health efforts to conduct partner notification were hindered by the anonymity and privacy provided by the online chat room. Partner notification is an important component of STI control; however, it is reliant on the willingness of the infected party to disclose to their partners their exposure to infection. That process is now facilitated by free services such as inSPOT and Let Them Know, which provide anonymous partner notification via email or text message with linkage to information about testing and treatment.<sup>57,58</sup> There is a need for service providers to integrate with these services and for a system to allow a networked electronic partner notification system. Such integration could enable healthcare providers to verify testing and treatment of contacts.

Although online partner-seeking websites or apps may be contributing to larger sexual networks and higher contact rates, they have the potential to serve as a medium to reach out to high-risk MSM in terms of STI education, prevention, screening and treatment.<sup>59,60</sup> The San Francisco Department of Public Health successfully used online advertising for free syphilis testing at non-clinic sites.<sup>61</sup> Similarly, Grindr and other social media have been successfully used to advertise syphilis testing among MSM in Darwin, Australia and home-based self-collection HIV testing in England.<sup>62,63</sup>

Internet-capable devices such as smartphones and tablets have revolutionised communication and the dissemination of information. One service that utilises those technologies is Healthvana ([www.healthvana.com](http://www.healthvana.com)), a self-described patient engagement platform, which is in use at clinics serving MSM in several large cities including Los Angeles, Fort Lauderdale and Chicago. It helps users along the entire STI screening and treatment continuum. With that service, patients can locate nearby STI testing facilities and view valuable information about each site, such as whether the clinic has a lesbian, gay,

bisexual and transgender (LGBT) focus. At Healthvana-certified facilities, users can complete pre-visit registration and check in for an appointment from their tablet or smartphone. Through those devices, users also receive their test results, educational information and instructions about the next steps should they test positive. Healthvana allows providers to follow and monitor their patients virtually along the process. All of those features make STI testing and treatment more efficient for both patients and their providers.

### **Delivery of sexual health services for MSM**

Accessibility of sexual health services varies considerably for MSM, who may encounter particular barriers to receiving care. Deterrents may be structural in nature, such as lack of services within a reasonable distance, long waiting times for appointments or test results and shortage of providers who are culturally sensitive to the specific needs of MSM.<sup>14,64</sup> Social stigmatisation of disclosing sexual behaviours, visiting facilities designated for sexual health services, and fear of testing positive for infection may prevent MSM from receiving appropriate care.<sup>64,65</sup> Also, cost undoubtedly limits care for certain groups of MSM.<sup>14</sup> Despite those barriers, there are a variety of clinic-based and decentralised services available to MSM, which are in need of expansion.

Primary care is generally desirable for the continuity of health care. As patients may not readily disclose their sexual behaviours, providers must initiate the conversation by asking questions pertaining to sexual history in a culturally sensitive and non-judgmental manner.<sup>66</sup> In a study investigating same-sex attraction disclosure to healthcare providers, only 39% of MSM discussed their history of sexual activity with men.<sup>67</sup> That issue could be remedied by including a question on pre-visit documents that allows patients to identify the gender of their sex partners before their provider encounter. However, knowledge of a patient's sexual behaviours is futile if the physician is unfamiliar with the special health needs of MSM.

It may not be feasible or convenient for high-risk MSM, who are advised to receive STI screening more frequently than annually, to visit their primary care provider each time they need to be tested. Clinics designated specifically for sexual health services might be a more appropriate choice. However, MSM may delay or forego testing at those sites due to a variety of reasons, including the stigma of visiting STI clinics, excessive waiting times and lack of walk-in services. Sexual health clinics may need to be redesigned to address those barriers.

One example of an innovative clinic is the Dean Street Express, a National Health Services facility in London that offers free and confidential STI testing by appointment or walk-in visits. Its streamlined process takes an estimated hour; beginning with a computerised self-check in, followed by self-collection of specimens and finally, a rapid HIV test alongside a counsellor. Results of the other STI tests are sent via text message within 6 h. The quick turnaround time is made possible by rapid on-site diagnostics that most clinics do not possess. Reported time from diagnosis to treatment was shorter for Dean Street Express patients compared with ones who tested at a clinic whose samples were analysed offsite.<sup>68</sup> Receiving

treatment more rapidly allows less opportunity to transmit infection.<sup>69</sup> The Dean Street Express was also purposely designed to bear little resemblance to a typical clinic, in hopes of mitigating the stigma of attending a sexual healthcare facility. It may serve as a paradigm for future STI services that would be associated with reduced stigma and increased utilisation. Perhaps in the future, clinics will be created to enable self-testing and self-treatment for documented infections without the need for a provider evaluation.

MSM-focused community-based STI screening and treatment serve as an alternative source of testing for those who experience barriers to receiving care at clinic-based facilities.<sup>18,70–72</sup> Such programs are more likely to provide culturally competent services and be located in areas where many MSM reside or congregate, such as LGBT centres, Pride events and gay nightclubs. Unfortunately, those community-based services are likely limited to MSM who live in urban areas or cities with prominent communities of MSM.

The final frontier of STI screening that seems to be the most convenient and mitigates structural and stigmatising obstacles to clinical care is home-based specimen self-collection or testing. A systematic review of randomised control trials investigating home-based versus clinic-based specimen collection for gonococcal and chlamydial detection found no difference in completing testing, diagnosis and treatment between the two methods.<sup>73</sup> Detection rates for pharyngeal and rectal NG or CT were equal or better with self-collection compared with provider-collection in a study on the reliability of self-testing in MSM.<sup>74</sup> Home-based self-collection of specimens may be comparable to clinic-based testing and is being evaluated by the 'I Want the Kit' (IWTk) program. IWTk ([www.iwantthekit.org](http://www.iwantthekit.org)) is a public Internet-based service that provides STI education along with free testing for NG, CT and *Trichomonas vaginalis* for residents of Maryland, Washington D.C. and Alaska. Participants are mailed a kit containing supplies and directions for penile and rectal specimen self-collection, which are returned for testing. Results are provided online, and participants who test positive receive a clinic referral for treatment. Male IWTk users were found to have risk factors for STIs, high prevalence of infection and preferred home-based self-collection over attending a clinic.<sup>75</sup> myLAB Box ([www.mylabbox.com](http://www.mylabbox.com), myLAB Box, Inc., Los Angeles, CA, USA) is a for-profit commercial entity that offers home-based self-collection STI screening for the same infections as IWTk, as well as for HIV and hepatitis C. That service currently does not offer testing of specimens collected from extragenital sites. Postal and self-collection STI testing services may considerably reduce the burden on publicly funded resources. Another inventive mode of STI testing found to be acceptable by MSM is test kit dispensing through electronic vending machines placed at locations frequented by MSM.<sup>76</sup> All of those strategies may be needed to increase availability and frequency of testing and treatment, which are critical for STI control.

### The future of STI control programs for MSM

The persistently high rates of STIs in MSM suggest that the existing methods of prevention are inadequate, incomplete or

inefficient. Furthermore, it is likely that there are new or re-emerging facilitators of transmission that are contributing to the recent rise in STI incidence. Future STI control must combine current prevention strategies with novel approaches that target the providers, patients and mechanisms of healthcare delivery (Box 1). Although directories of 'LGBT friendly' providers exist, this describes little about their qualifications to care for their patients. Perhaps in the future, physicians will be certified in LGBT health and form networks that facilitate care for MSM. Ideally, FTC–TDF for HIV PrEP will be scaled up in the upcoming years, with PrEP against bacterial STIs for high-risk MSM following suit. PrEP along with the development of vaccines against NG, CT and syphilis will reduce infection rates.

By 2020, the expansion of technology-driven services will allow patients to take more ownership over their health. The future of STI testing and treatment will rely less on providers and more on diagnostics that are quick, accurate and convenient, combined with electronic results notification, disclosure to partners and management. Counselling and treatment will also be timely and amenable for patients so that they may not need to leave their homes. Telehealth will play a role in providing patients with sexual health education and information on therapies. Positive test results would initiate automated physician orders to the pharmacy or even home delivery of medications, which will shorten the time between diagnosis and treatment and reduce the number of those who are untreated. Partner notification and treatment will also incorporate those rapid and convenient methods.

All of those mechanisms will not only streamline the testing and treatment process, but also will eliminate many of the barriers that MSM encounter along the way. It is uncertain what STI control will look like in 2020, but there are many exciting possibilities to be explored. Yet, it is apparent that the methods of STI prevention and management must continue to evolve to accommodate the advances in society, medicine and technology.

#### Box 1. Innovative strategies to enhance sexually transmissible infection control in men who have sex with men

##### Testing:

- Clinic-based testing without provider encounter
- Community-based testing
- Home-based specimen self-collection
- Home-based testing

##### Treatment:

- Electronic prescription for treatment

##### Partner management:

- Electronic partner notification
- Electronic partner prescription for treatment



## Conflicts of interest

None declared.

## Acknowledgements

Jeffrey D. Klausner is supported by the Center for HIV Identification, Prevention, and Treatment Services (CHIPTS) through NIH grant no. P30MH058107 and the UCLA Center for AIDS Research (CFAR). NIH/NIAID AI028697.

## References

- Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sex Transm Infect* 1999; 75: 3–17. doi:10.1136/sti.75.1.3
- Solomon MM, Mayer KH. Evolution of the syphilis epidemic among men who have sex with men. *Sex Health* 2015; 12: 96–102. doi:10.1071/SH14173
- Nicoll A, Hamers FF. Are trends in HIV, gonorrhoea, and syphilis worsening in Western Europe? *BMJ* 2002; 324: 1324–7. doi:10.1136/bmj.324.7349.1324
- Fenton KA, Imrie J. Increasing rates of sexually transmitted diseases in homosexual men in Western Europe and the United States: why? *Infect Dis Clin North Am* 2005; 19: 311–31. doi:10.1016/j.idc.2005.04.004
- Centers for Disease Control and Prevention. Sexually transmitted disease surveillance 2014. Atlanta: U.S. Department of Health and Human Services; 2015.
- European Centre for Disease Prevention and Control. Sexually transmitted infections in Europe 2013. Stockholm: ECDC; 2015.
- The Kirby Institute. HIV, viral hepatitis, and sexually transmissible infections in Australia. Annual surveillance report 2015. Sydney: The Kirby Institute, University of New South Wales; 2015.
- Klausner JD. AIDS and sexually transmitted disease prevention and control. In Mayer KH, Pizer HF, editors. *The AIDS pandemic: impact on science and society*, 4th edn. San Diego: Academic Press; 2004. pp. 110–136.
- Silverman BG, Gross TP. Use and effectiveness of condoms during anal intercourse. A review. *Sex Transm Dis* 1997; 24: 11–7. doi:10.1097/00007435-199701000-00004
- Centers for Disease Control and Prevention. HIV infection risk, prevention, and testing behaviors among men who have sex with men – National HIV Behavioral Surveillance, 20 U.S. cities, 2014. HIV Surveillance Special Report 15. Atlanta: Centers for Disease Control and Prevention; 2016.
- Belcher L, Sternberg MR, Wolitski RJ, Halkitis P, Hoff C. Team the SUMS Condom use and perceived risk of HIV transmission among sexually active HIV-positive men who have sex with men *AIDS Ed* 2005; 17: 79–89.
- Ostergren JE, Rosser BRS, Horvath KJ. Reasons for non-use of condoms among men who have sex with men: a comparison of receptive and insertive role in sex and online and offline meeting venue. *Cult Health Sex* 2011; 13: 123–40. doi:10.1080/13691058.2010.520168
- Kent CK, Chaw JK, Wonq W, Liska S, Gibson S, Hubbard G, *et al.* Prevalence of rectal, urethral, and pharyngeal chlamydia and gonorrhea detected in 2 clinical settings among men who have sex with men: San Francisco, California, 2003. *Clin Infect Dis* 2005; 41: 67–74. doi:10.1086/430704
- Barbee LA, Dhanireddy S, Tat SA, Marrazzo JM. Barriers to bacterial sexually transmitted infection testing of HIV-infected men who have sex with men engaged in HIV primary care. *Sex Transm Dis* 2015; 42: 590–4. doi:10.1097/OLQ.0000000000000320
- Blair JM, Fagan JL, Frazier EL, Do A, Bradley H, Valverde EE, *et al.* Behavioral and clinical characteristics of persons receiving medical care for HIV infection - Medical Monitoring Project, United States, 2009. *MMWR Surveill Summ* 2014; 63(Suppl 5): 1–22.
- Marcus JL, Bernstein KT, Kohn RP, Liska S, Philip SS. Infections missed by urethral-only screening for chlamydia or gonorrhea detection among men who have sex with men. *Sex Transm Dis* 2011; 38: 922–4. doi:10.1097/OLQ.0b013e31822a2b2e
- Patton ME, Kidd S, Llata E, Stenger M, Braxton J, Asbel L, *et al.* Extragenital gonorrhea and chlamydia testing and infection among men who have sex with men-STD Surveillance Network, United States, 2010–2012. *Clin Infect Dis* 2014; 58: 1564–70. doi:10.1093/cid/ciu184
- Bernstein KT, Bolan R, Gibson S, Golden M, Gratz B, Guerry S. Clinic-based testing for rectal and pharyngeal *Neisseria gonorrhoeae* and *Chlamydia trachomatis* infections by community-based organizations—five cities, United States, 2007. *MMWR Morb Mortal Wkly Rep* 2009; 58: 716–9.
- Ota KV, Tamari IE, Smieja M, Jamieson F, Jones KE, Towns L, *et al.* Detection of *Neisseria gonorrhoeae* and *Chlamydia trachomatis* in pharyngeal and rectal specimens using the BD Probetec ET system, the Gen-Probe Aptima Combo 2 assay and culture. *Sex Transm Infect* 2009; 85: 182–6. doi:10.1136/sti.2008.034140
- Schachter J, Moncada J, Liska S, Shayevich C, Klausner JD. Nucleic acid amplification tests in the diagnosis of chlamydial and gonococcal infections of the oropharynx and rectum in men who have sex with men. *Sex Transm Dis* 2008; 35: 637–42. doi:10.1097/OLQ.0b013e31817bdd7e
- Templeton DJ, Read P, Varma R, Bourne C. Australian sexually transmissible infection and HIV testing guidelines for asymptomatic men who have sex with men 2014: a review of the evidence. *Sex Health* 2014; 11: 217–29. doi:10.1071/SH14003
- Renault CA, Hall C, Kent CK, Klausner JD. Use of NAATs for STD diagnosis of GC and CT in non-FDA-cleared anatomic specimens. *MLO Med Lab Obs* 2006; 38: 10–2.
- Hook EW, Stephens J, Ennis DM. Azithromycin compared with penicillin G benzathine for treatment of incubating syphilis. *Ann Intern Med* 1999; 131: 434–7. doi:10.7326/0003-4819-131-6-199909210-00007
- World Health Organization. Report of the expert consultation and review of the latest evidence to update guidelines for the management of sexually transmitted infections. Geneva: World Health Organization; 2011.
- Grant RM, Lama JR, Anderson PL, McMahan V, Liu AY, Vargas L, *et al.* Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med* 2010; 363: 2587–99. doi:10.1056/NEJMoa1011205
- Grohskopf LA, Chillag KL, Gvetadze R, Liu AY, Thompson M, Mayer KH, *et al.* Randomized trial of clinical safety of daily oral tenofovir disoproxil fumarate among HIV-uninfected men who have sex with men in the United States. *J Acquir Immune Defic Syndr* 2013; 64: 79–86. doi:10.1097/QAI.0b013e31828ece33
- Anderson PL, Glidden DV, Liu A, Buchbinder S, Lama JR, Guanira JV, *et al.* Emtricitabine-tenofovir exposure and pre-exposure prophylaxis efficacy in men who have sex with men. *Sci Transl Med* 2012; 4: 1–9. doi:10.1126/scitranslmed.3004006
- Grant RM, Anderson PL, McMahan V, Liu A, Amico KR, Mehrotra M, *et al.* Uptake of pre-exposure prophylaxis, sexual practices, and HIV incidence in men and transgender women who have sex with men: a cohort study. *Lancet Infect Dis* 2014; 14: 820–9. doi:10.1016/S1473-3099(14)70847-3
- Mulligan K, Glidden DV, Anderson PL, Liu A, McMahan V, Gonzales P, *et al.* Effects of emtricitabine/tenofovir on bone mineral density in HIV-negative persons in a randomized, double-

- blind, placebo-controlled trial. *Clin Infect Dis* 2015; 61: 572–80. doi:10.1093/cid/civ324
- 30 Kojima N, Klausner JD. Is emtricitabine-tenofovir disoproxil fumarate pre-exposure prophylaxis for the prevention of HIV infection safer than aspirin? *Open Forum Infect Dis* 2016; 3: 1–5. doi:10.1093/ofid/ofv221
  - 31 Bolan RK, Beymer MR, Weiss RE, Flynn RP, Leibowitz AA, Klausner JD. Doxycycline prophylaxis to reduce incident syphilis among HIV-infected men who have sex with men who continue to engage in high-risk sex. *Sex Transm Dis* 2015; 42: 98–103. doi:10.1097/OLQ.0000000000000216
  - 32 Wilson DP, Prestage GP, Gray RT, Hoare A, McCann P, Down I, *et al.* Chemoprophylaxis is likely to be acceptable and could mitigate syphilis epidemics among populations of gay men. *Sex Transm Dis* 2011; 38: 573–9. doi:10.1097/OLQ.0b013e31820e64fd
  - 33 Boyd MA, Donovan B, Prestage G, Chen M, Petoumenos K, Gray R, *et al.* Is it time to rethink syphilis control? *Clin Infect Dis* 2015; 60: 325–6. doi:10.1093/cid/ciu813
  - 34 Lee TW, Russell L, Deng M, Gibson PR. Association of doxycycline use with the development of gastroenteritis, irritable bowel syndrome and inflammatory bowel disease in Australians deployed abroad. *Intern Med J* 2013; 43: 919–26. doi:10.1111/imj.12179
  - 35 Angelakis E, Million M, Kankoe S, Lagier JC, Armougom F, Giorgi R, *et al.* Abnormal weight gain and gut microbiota modifications are side effects of long-term doxycycline and hydroxychloroquine treatment. *Antimicrob Agents Chemother* 2014; 58: 3342–7. doi:10.1128/AAC.02437-14
  - 36 Sloan B, Scheinfeld N. The use and safety of doxycycline hyclate and other second-generation tetracyclines. *Expert Opin Drug Saf* 2008; 7: 571–7. doi:10.1517/14740338.7.5.571
  - 37 Scheer S, Chu PL, Klausner JD, Katz MH, Schwarcz SK. Effect of highly active antiretroviral therapy on diagnoses of sexually transmitted diseases in people with AIDS. *Lancet* 2001; 357: 432–5. doi:10.1016/S0140-6736(00)04007-1
  - 38 van der Snoek EM, de Wit JBF, Mulder PGH, van der Meijden WI. Incidence of sexually transmitted diseases and HIV infection related to perceived HIV/AIDS threat since highly active antiretroviral therapy availability in men who have sex with men. *Sex Transm Dis* 2005; 32: 170–5. doi:10.1097/01.olq.0000149786.09706.66
  - 39 Liu AY, Vittinghoff E, Chillag KL, Mayer KH, Thompson M, Grohskopf L, *et al.* Sexual risk behavior among HIV-uninfected men who have sex with men participating in a tenofovir preexposure prophylaxis randomized trial in the United States. *J Acquir Immune Defic Syndr* 2013; 64: 87–94. doi:10.1097/QAI.0b013e31828f097a
  - 40 McCormack S, Dunn DT, Desai M, Dolling DI, Gafos M, Gilson R, *et al.* Pre-exposure prophylaxis to prevent the acquisition of HIV-1 infection (PROUD): effectiveness results from the pilot phase of a pragmatic open-label randomised trial. *Lancet* 2016; 387: 53–60. doi:10.1016/S0140-6736(15)00056-2
  - 41 Liu AY, Cohen SE, Vittinghoff E, Anderson PL, Doblecki-Lewis S, Bacon O, *et al.* Preexposure prophylaxis for HIV infection integrated with municipal- and community-based sexual health services. *JAMA Intern Med* 2016; 176: 75–84. doi:10.1001/jamainternmed.2015.4683
  - 42 Volk JE, Marcus JL, Phengrasamy T, Blechinger D, Nguyen DP, Follansbee S, *et al.* No new HIV infections with increasing use of HIV preexposure prophylaxis in a clinical practice setting. *Clin Infect Dis* 2015; 61: 1601–3. doi:10.1093/cid/civ778
  - 43 British Association for Sexual Health and HIV (BASHH). Recommendations for testing for sexually transmitted infections in men who have sex with men. 2014. Available online at: [http://www.bashh.org/documents/BASHH\\_Recommendations\\_for\\_testing\\_for\\_STIs\\_in\\_MSM\\_FINAL.pdf](http://www.bashh.org/documents/BASHH_Recommendations_for_testing_for_STIs_in_MSM_FINAL.pdf) [verified 10 February 2016].
  - 44 Workowski KA, Bolan GA. Sexually transmitted diseases treatment guidelines, 2015. *MMWR Morb Mortal Wkly Rep* 2015; 64(RR3): 13–6.
  - 45 Sexually Transmissible Infections in Gay Men Action Group (STIGMA). Australian sexually transmitted infection & HIV testing guidelines 2014 for asymptomatic men who have sex with men. 2014. Available online at: [http://stipu.nsw.gov.au/wp-content/uploads/STIGMA\\_Testing\\_Guidelines\\_Final\\_v5.pdf](http://stipu.nsw.gov.au/wp-content/uploads/STIGMA_Testing_Guidelines_Final_v5.pdf) [verified 10 February 2016].
  - 46 Liegler T, Abdel-Mohsen M, Bentley LG, Atchison R, Schmidt T, Javier J, *et al.* HIV-1 drug resistance in the iPrEx preexposure prophylaxis trial. *J Infect Dis* 2014; 210: 1217–27. doi:10.1093/infdis/jiu233
  - 47 Weis JF, Baeten JM, McCoy CO, Warth C, Donnell D, Thomas KK, *et al.* Preexposure prophylaxis-selected drug resistance decays rapidly after drug cessation. *AIDS* 2016; 30: 31–5. doi:10.1097/QAD.0000000000000915
  - 48 Golden MR, Handsfield HH. Preexposure prophylaxis to prevent bacterial sexually transmitted infections in men who have sex with men. *Sex Transm Dis* 2015; 42: 104–6. doi:10.1097/OLQ.0000000000000235
  - 49 Bolding G, Davis M, Hart G, Sherr L, Elford J. Where young MSM meet their first sexual partner: the role of the Internet. *AIDS Behav* 2007; 11: 522–6. doi:10.1007/s10461-007-9224-9
  - 50 Jennings JM, Reilly ML, Perin J, Schumacher C, Sharma M, Safi AG, *et al.* Sex partner meeting places over time among newly HIV-diagnosed men who have sex with men in Baltimore, Maryland. *Sex Transm Dis* 2015; 42: 549–53. doi:10.1097/OLQ.0000000000000337
  - 51 McFarlane M, Bull SS, Rietmeijer CA. The Internet as a newly emerging risk environment for sexually transmitted diseases. *JAMA* 2000; 284: 443–6. doi:10.1001/jama.284.4.443
  - 52 Benotsch EG, Kalichman S, Cage M. Men who have met partners via the Internet: prevalence, predictors, and implications for HIV prevention. *Arch Sex Behav* 2002; 31: 177–83. doi:10.1023/A:1014739203657
  - 53 Lewnard JA, Berrang-Ford L. Internet-based partner selection and risk for unprotected anal intercourse in sexual encounters among men who have sex with men: a meta-analysis of observational studies. *Sex Transm Infect* 2014; 90: 290–6. doi:10.1136/sextrans-2013-051332
  - 54 Anderson RM, May RM. Infectious diseases of humans: dynamics and control. Oxford: Oxford University Press; 1991.
  - 55 Beymer MR, Weiss RE, Bolan RK, Rudy ET, Bourque LB, Rodriguez JP, *et al.* Sex on-demand: geosocial networking phone apps and risk of sexually transmitted infections among a cross-sectional sample of men who have sex with men in Los Angeles county. *Sex Transm Infect* 2014; 90: 567–72. doi:10.1136/sextrans-2013-051494
  - 56 Klausner J, Wolf W, Fischer-ponce L, Zolt I, Katz MH. Tracing a syphilis outbreak through cyberspace. *JAMA* 2000; 284: 447–9. doi:10.1001/jama.284.4.447
  - 57 Levine D, Woodruff AJ, Mocello AR, Lebrija J, Klausner JD. inSPOT: the first online STD partner notification system using electronic postcards. *PLoS Med* 2008; 5: e213. doi:10.1371/journal.pmed.0050213
  - 58 Bilardi JE, Fairley CK, Hopkins CA, Hocking JS, Kit Sze J, Chen MY. Let them know: evaluation of an online partner notification service for chlamydia that offers e-mail and SMS messaging. *Sex Transm Dis* 2010; 37: 563–5. doi:10.1097/OLQ.0b013e3181d707f1
  - 59 Sun CJ, Stowers J, Miller C, Bachmann LH, Rhodes SD. Acceptability and feasibility of using established geosocial and sexual networking mobile applications to promote HIV and STD testing among men who have sex with men. *AIDS Behav* 2015; 19: 543–52. doi:10.1007/s10461-014-0942-5

- 60 Holloway IW, Rice E, Gibbs J, Winetrobe H, Dunlap S, Rhoades H. Acceptability of smartphone application-based HIV prevention among young men who have sex with men. *AIDS Behav* 2014; 18: 285–96. doi:[10.1007/s10461-013-0671-1](https://doi.org/10.1007/s10461-013-0671-1)
- 61 Levine DK, Scott KC, Klausner JD. Online syphilis testing—confidential and convenient. *Sex Transm Dis* 2005; 32: 139–41. doi:[10.1097/01.olq.0000149783.67826.4d](https://doi.org/10.1097/01.olq.0000149783.67826.4d)
- 62 Su J-Y, Holt J, Payne R, Gates K, Ewing A, Ryder N. Effectiveness of using Grindr to increase syphilis testing among men who have sex with men in Darwin, Australia. *Aust N Z J Public Health* 2015; 39: 293–4. doi:[10.1111/1753-6405.12342](https://doi.org/10.1111/1753-6405.12342)
- 63 Brady M, Nardone A, Buenaventura E, Qureshi F, Edwardes D, Kelly P, *et al.* Home HIV sampling linked to national HIV testing campaigns: a novel approach to improve HIV diagnosis. *HIV Med* 2014; 15(Suppl 3): 7–8.
- 64 Conway DP, Holt M, Couldwell DL, Smith DE, Davies SC, McNulty A, *et al.* Barriers to HIV testing and characteristics associated with never testing among gay and bisexual men attending sexual health clinics in Sydney. *J Int AIDS Soc* 2015; 1–8.
- 65 de Wit J, Adam P. To test or not to test: psychosocial barriers to HIV testing in high-income countries. *HIV Med* 2008; 9(Suppl 2): 20–2. doi:[10.1111/j.1468-1293.2008.00586.x](https://doi.org/10.1111/j.1468-1293.2008.00586.x)
- 66 Wilkin T. Primary care for men who have sex with men. *N Engl J Med* 2015; 373: 854–62. doi:[10.1056/NEJMcp1401303](https://doi.org/10.1056/NEJMcp1401303)
- 67 Bernstein KT, Liu K-L, Begier EM, Koblin B, Karpati A, Murrill C, *et al.* Same-sex attraction disclosure to health care providers among New York City men who have sex with men. *Arch Intern Med* 2008; 168: 1458–64. doi:[10.1001/archinte.168.13.1458](https://doi.org/10.1001/archinte.168.13.1458)
- 68 Wingrove I, McOwan A, Nwokolo N, Whitlock G. Diagnostics within the clinic to test for gonorrhoea and chlamydia reduces the time to treatment: a service evaluation. *Sex Transm Infect* 2014; 90: 474. doi:[10.1136/sextrans-2014-051580](https://doi.org/10.1136/sextrans-2014-051580)
- 69 Byrne R, Cooper F, Appleby T, Chislett L, Freeman L, Kershaw E, *et al.* Can express treatment reduce onward transmission? *Sex Transm Infect* 2015; 91(Suppl 1): A7. doi:[10.1136/sextrans-2015-052126.19](https://doi.org/10.1136/sextrans-2015-052126.19)
- 70 Bowles KE, Clark HA, Tai E, Sullivan PS, Song B, Tsang J, *et al.* Implementing rapid HIV testing in outreach and community settings: results from an advancing HIV prevention demonstration project conducted in seven U.S. cities. *Public Health Rep* 2008; 123 (Suppl 3): 78–85.
- 71 Meulbroek M, Ditzel E, Saz J, Taboada H, Pérez F, Pérez A, *et al.* BCN Checkpoint, a community-based centre for men who have sex with men in Barcelona, Catalonia, Spain, shows high efficiency in HIV detection and linkage to care. *HIV Med* 2013; 14(Suppl 3): 25–8. doi:[10.1111/hiv.12054](https://doi.org/10.1111/hiv.12054)
- 72 Mayer KH, Ducharme R, Zaller ND, Chan PA, Case P, Abbott D, *et al.* Unprotected sex, underestimated risk, undiagnosed HIV and sexually transmitted diseases among men who have sex with men accessing testing services in a New England bathhouse. *J Acquir Immune Defic Syndr* 2012; 59: 194–8. doi:[10.1097/QAI.0b013e31823bbecf](https://doi.org/10.1097/QAI.0b013e31823bbecf)
- 73 Fajardo-Bernal L, Aponte-Gonzalez J, Vigil P, Angel-Müller E, Rincon C, Gaitán Hernando G, *et al.* Home-based versus clinic-based specimen collection in the management of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections. *Cochrane Database Syst Rev* 2015; 9: 3–62.
- 74 Sexton ME, Baker JJ, Nakagawa K, Li Y, Perkins R, Slack RS, *et al.* How reliable is self-testing for gonorrhea and chlamydia among men who have sex with men? *J Fam Pract* 2013; 62: 70–8.
- 75 Chai SJ, Aumakhan B, Barnes M, Jett-Goheen M, Quinn N, Agreda P, *et al.* Internet-based screening for sexually transmitted infections to reach non-clinic populations in the community: risk factors for infection in men. *Sex Transm Dis* 2010; 37: 756–63. doi:[10.1097/OLQ.0b013e3181e3d771](https://doi.org/10.1097/OLQ.0b013e3181e3d771)
- 76 Young SD, Daniels J, Chiu CJ, Bolan RK, Flynn RP, Kwok J, *et al.* Acceptability of using electronic vending machines to deliver oral rapid HIV self-testing kits: a qualitative study. *PLoS One* 2014; 9: e103790. doi:[10.1371/journal.pone.0103790](https://doi.org/10.1371/journal.pone.0103790)