CSIRO PUBLISHING
Sexual Health, 2017, **14**, 18–27
http://dx.doi.org/10.1071/SH16104

Review

As through a glass, darkly: the future of sexually transmissible infections among gay, bisexual and other men who have sex with men

Mark Richard Stenger[A,F], *Stefan Baral*[B], *Shauna Stahlman*[B], *Dan Wohlfeiler*[C], *Jerusha E. Barton*[D] *and Thomas Peterman*[E]

[A]US Centers for Disease Control and Prevention – Division of STD Prevention, Mail Stop E-63 1600 Clifton Road NE, Atlanta, GA 30333, USA.
[B]Johns Hopkins Bloomberg School of Public Health, Center for Public Health and Human Rights, Department of Epidemiology, 615 N. Wolfe Street, Baltimore, MD 21205, USA.
[C]University of California San Francisco, San Francisco, CA 94143, USA.
[D]US Centers For Disease Control and Prevention – Division of STD Prevention (ORISE Fellow), Mailstop E-63, Atlanta, GA 30333, USA.
[E]Centers for Disease Control and Prevention – Division of STD Prevention, Mailstop E-02 CDC, Atlanta, GA 30333, USA.
[F]Corresponding author. Email: mstenger@cdc.gov

Abstract. The trajectory of sexually transmissible infection (STI) incidence among gay and other men who have sex with men (MSM) suggests that incidence will likely remain high in the near future. STIs were hyperendemic globally among MSM in the decades preceding the HIV epidemic. Significant changes among MSM as a response to the HIV epidemic, caused STI incidence to decline, reaching historical nadirs in the mid-1990s. With the advent of antiretroviral treatment (ART), HIV-related mortality and morbidity declined significantly in that decade. Concurrently, STI incidence resurged among MSM and increased in scope and geographic magnitude. By 2000, bacterial STIs were universally resurgent among MSM, reaching or exceeding pre-HIV levels. While the evidence base necessary for assessing the burden STIs among MSM, both across time and across regions, continues to be lacking, recent progress has been made in this respect. Current epidemiology indicates a continuing and increasing trajectory of STI incidence among MSM. Yet increased reported case incidence of gonorrhoea is likely confounded by additional screening and identification of an existing burden of infection. Conversely, more MSM may be diagnosed and treated in the context of HIV care or as part of routine management of pre-exposure prophylaxis (PrEP), potentially reducing transmission. Optimistically, uptake of human papillomavirus (HPV) vaccination may lead to a near-elimination of genital warts and reductions in HPV-related cancers. Moreover, structural changes are occurring with respect to sexual minorities in social and civic life that may offer new opportunities, as well as exacerbate existing challenges, for STI prevention among MSM.

Received 1 June 2016, accepted 28 June 2016, published online 2 September 2016

Introduction

In the context of the HIV pandemic, behavioural risk information is generally available in most regions of the world. Even countries with only modest surveillance capacity are able to assess the proportion of HIV cases among men who have sex with men (MSM) by modelling modes of transmission with the assistance of international partners. This is perhaps owing to the relatively recent emergence of HIV and an appropriately robust international public health surveillance effort. In stark contrast, there continues to be a paucity of MSM-specific risk information available globally for persons diagnosed with other bacterial and viral sexually transmissible infections (STIs). In many regions of the world, STI surveillance is further challenged by largely syndromic case identification and treatment. The relative scarcity of even minimal case-based evidence for STIs among MSM is often aggravated by severely constrained resources for all disease surveillance in general. In light of these challenges, the broader landscape of STIs among MSM globally remains largely unmapped. The few clearly marked paths available for traversing this ground generally exist in high-income settings, limiting the breadth of global coverage with respect to STIs among MSM.

Even in countries and regions with advanced public health systems and relatively well-resourced disease surveillance

infrastructures, homophobia and stigma often remain barriers to better ascertainment of the burden of STIs among MSM. Nevertheless, there are useful mileposts available to chart the course of STI incidence among MSM into the next decade. Despite limitations, evidence does exist from past decades, and there is more robust information available on current trends that potentially signal opportunities for the public health community to bend the trajectory of incidence in more favourable directions. This will inform speculation on how STI incidence among MSM might change as we approach the end of the current decade.

It is tempting to quip dismissively that hindsight is always 20/20; yet the past, in this case, is revealing in guiding thinking about future trends. It is also essential to keep in mind that STIs are not a monolithic, singular phenomenon; future incidence will likely follow multiple trajectories across different regions and in different subpopulations of MSM. Moreover, STIs among MSM have potentially quite divergent consequences and outcomes with respect to individual and population health status than is generally the case for heterosexual men and women. This perspective on the impact of STIs is a key point to consider as we look towards the next decade and beyond, keeping in mind that within a framework of sexual health for MSM, attitudes towards asymptomatic STIs with little or no long-term health consequences may be evolving and a new paradigm potentially emerging to guide interventions that focuses specifically on infections which have immediate or long-term individual health consequences.

The sage advice usually given to new drivers, to look all ways before turning onto a busy motorway, is a useful metaphor. There is a lot of other traffic on this particular motorway, especially given the considerable biological diversity of STIs and the rapidly evolving sexual and social ecology of MSM. HIV is explored at much greater length elsewhere in this supplement; the focus here will be limited to select STIs other than HIV. Yet, the intersection of the HIV pandemic and other STIs clearly adds a layer of complexity to the roadmap and plays an integral role in the discussion. With respect to the social ecology of MSM, distinctions between the cultural and social constructs of gender identity – only recently recognised as factors of particular relevance to STIs – are nuances beyond the scope of the current discussion. Focusing attention on those STIs providing the most visible bacterial signposts, including *Treponema pallidum* and *Neisseria gonorrhoeae* also provides the most robust evidence to suggest a possible outline for the trajectory of these and other STIs among MSM looking towards the year 2020.

STIs among MSM before HIV

As early as the mid-1960s, there was widespread speculation in higher-income countries that syphilis and gonorrhoea were highly prevalent among 'homosexuals'.[1–17] In one clinic in London, 62% of syphilis cases and 14.8% of gonorrhoea cases among men in 1965 were attributable to same-sex sexual behaviour. Similarly, among patients diagnosed with STIs in a metropolitan Toronto clinic, 62% of males with syphilis and 22.4% of males with gonorrhoea acknowledged same-sex sexual behaviour. In the US, there was also evidence that homosexual patients named two- to five-fold more partners than heterosexuals during case investigations, leading to the conclusion that transmission was likely ongoing and suggesting a largely undiagnosed and potentially increasing burden of disease in this group.[7,14,15] Similarly, overall increases in gonorrhoea were noted in Europe and New Zealand in the 1960s, and difficulties controlling syphilis and gonorrhoea in the UK in that decade were, in part, attributed to ecological factors that included an observed increase in 'prostitution and homosexuality'.[5,16,17] This type of characterisation is typical of the literature of the period, with MSM often aggregated into atypical and sometimes derogatory groupings not explicitly separable from heterosexuals.

Though the proportion of all cases in the broader population attributable to MSM was not explicitly measured during the 1960s, the overall incidence of syphilis and gonorrhoea increased across the decade. For example, rates of primary and secondary syphilis increased from near zero in 1960 to between 150 and 300 cases per 100 000 in Oslo, Copenhagen and Stockholm.[16] Evidence for increasing or decreasing trends among MSM was largely anecdotal, or based on small clinical cohorts and specific patient populations, yet these studies do suggest STIs were endemic in MSM in many urban centres. Moreover, these men were increasingly being recognised as a behavioural group specifically in need of additional STI services.

The early1970s was a time of phenomenal social change with marginally increasing cultural acceptance for MSM in many urban settings across the world. Less prescriptive attitudes towards same-sex sexual partnerships were becoming more widespread and represented the vanguard of popular urban culture, with at least somewhat broader social acceptance. By 1973, the American Psychiatric Association had removed homosexuality as a psychiatric disorder from its diagnostic literature.[18] Openly gay-identified communities emerged and flourished in many metropolitan areas in the US and in Europe. The South Australia and Australian Capital Territory legislatures repealed outdated sodomy laws in the middle of that same decade,[19] reflecting similar social trends in the southern hemisphere. Concurrently, in many urban centres around the world, a consensus on the part of clinicians and the public health community was gradually emerging that recognised STIs among MSM as an increasingly important public health issue.[20–22]

STI incidence among MSM was also becoming more commonly measured, as an increasing number and variety of clinical settings sought to adopt non-judgmental attitudes in deliberate efforts to better serve MSM communities. This encouraged disclosure on the part of patients and facilitated better capture of this information in clinical records. In places as diverse as Cincinnati, Denver, Toronto, San Diego, San Francisco, New York, London, Copenhagen, Melbourne, Oslo and elsewhere, it was clear that a substantial majority of the early syphilis cases diagnosed among men in many primary genitourinary medicine (GUM) and STD clinics were attributable to same-sex practices.[2,7–9,11–13,16,21] For example, at a large GUM clinic in London, 84.5% of early syphilis cases diagnosed in 1971 were among MSM.[21] Throughout the decade, there was a growing body of evidence suggesting that gonorrhoea and syphilis were common among MSM in multiple countries.

Yet the burden of STIs among MSM in comparison to heterosexuals at the population level was only measured by crude indicators like male-to-female case ratios, supplemented in limited clinical settings by eliciting MSM exposure from male patients. Due to the mostly anecdotal nature of the evidence, rate ratios and other measures of unequal incidence remained unavailable to the public health community because of a lack of denominator data for MSM and complete information on gender of sex partners. Nevertheless, it seems clear that STIs were increasing and prevalent at high levels wherever there were sizable communities of MSM. In settings where comparative studies with heterosexuals were undertaken, the likelihood of MSM presenting with gonorrhoea, syphilis and other STIs was found to be significantly higher than among age- and race-matched heterosexual men.[12] In one large STD clinic in the US (Denver, Colorado), an analysis of over 17 500 initial clinic visits among men presenting for care found that 30.3% of MSM had gonorrhoea compared with 19.8% of heterosexuals, and that MSM were statistically more likely to be diagnosed with early syphilis as well (1.08% of MSM vs 0.38% in heterosexual men).[12]

By the close of the 1970s, all signposts pointed towards markedly high incidence and prevalence of STIs among MSM, especially in urban centres. Absolute numbers of MSM cases appeared to be increasing, but there are few data available to conclusively demonstrate population-level trends given the lack of denominators or standardisation in capturing gender of sex partners for surveillance purposes. With increasing ascertainment of same-sex behaviour, these reports are limited and potentially biased. But perhaps equally telling, the literature from this time documents sporadic incidence of *Lymphogranuloma venereum* (LGV), high prevalence of herpes simplex virus (HSV), high prevalence of the viral hepatidities and numerous outbreaks of enteric pathogens not ordinarily associated with sexual transmission among clinical cohorts of MSM.[9,20–22] Despite limitations, it seems reasonable to consider that STIs were hyperendemic among MSM by the close of the 1970s. This is especially true for syphilis and gonorrhoea, which provide a reasonable baseline for comparative purposes in subsequent decades.

By 1980, the growing consensus in the public health community that MSM were at significantly increased risk of contracting STIs and related health issues also led to calls for an increasing focus on MSM in publicly funded STI clinical facilities.[22] In large US, European and Australian cities, a significant and growing proportion of the patient populations in many speciality GUM or STI clinics comprised self-identified MSM, as these clinics purposely tailored both services and settings to better serve this community. HIV emerged and spread with frightening rapidity in just such concentrated MSM neighbourhoods with existing high incidence and prevalence of multiple STIs.

Impact of HIV and AIDS anxiety on STIs

By the time the World Health Organization began limited international surveillance for AIDS in October of 1983,[23] the HIV pandemic was likely having a significant and increasingly dramatic impact on the sexual networks and practices of MSM. Population-based rates of gonorrhoea and syphilis fell throughout the latter half of the decade in many countries. Of particular note, the male-to-female case ratio – often a benchmark indicator for STI incidence among MSM – was falling incrementally towards parity in some locations.[24–26] These changes in STI incidence patterns were, at the time, attributed to multiple, sometimes related and inseparable factors. Yet chief among these, behavioural changes in response to the HIV pandemic and catastrophic mortality in MSM communities were thought to have had a significant impact on the transmission of bacterial STIs in some settings.[27]

In the US alone, over 122 000 people had died of HIV-related causes by 1990, an overwhelming proportion of whom were MSM living in metropolitan areas.[28] These men were integral to existing sexual networks in MSM communities, contributing to the size and density of sexual networks and likely occupying central positions in these same networks. Loss of network cohesion, and a generalised decrease in the number of network participants as a result of HIV mortality, likely contributed to decreasing STI transmission in many MSM communities.[29] Individual-level behavioural changes were also observed in response to anxiety generated by HIV-related morbidity and mortality, including reporting fewer overall sex partners, slower partner exchange rates, increased use of condoms and intensified public health behavioural interventions.[30,31]

The loss of such a large number of sexually active MSM due to the impact of continuing HIV morbidity on the sexual behaviour of those living with HIV disease and widespread behaviour change among those not infected, likely created conditions conducive to rapid and substantial decreases in the incidence of other STIs. Reported gonorrhoea incidence among all populations fell dramatically across the decade of the 1980s. In the US, overall gonorrhoea rates decreased from 445 per 100 000 in 1980 to 278 per 100 000 in 1990. Much of this decline was among men, as demonstrated by the male-to-female case ratio, which declined steadily throughout the decade in both the US and Europe, reaching a low of 1.04 male to females cases in the US by 1996.[24,32–36] Primary and secondary (P&S) syphilis, considered in retrospect to have been a good proxy for HIV incidence,[37] saw similar declines, falling from 14.1/100 000 in 1983 to reach a historic low of 2.1 per 100 000 in the US in 2001. This decline, in both men and women, was sufficiently precipitous by 1998 to encourage the public health community in the US to consider the possibility of completely eliminating indigenous syphilis transmission.[38] However, evidence also existed at the time to indicate that the remaining burden of P&S syphilis was likely concentrated among MSM, as the overall male-to-female case ratio of 1.5 to 1 in 1998 and male-to-female ratios of 38 : 1 and 25 : 1 in Seattle and San Francisco, respectively, that same year suggests.[38]

Resurgence of STIs in 1995–2010

There were decreasing trends in STIs diagnosed among MSM emerging globally through the early 1990s. Yet by the middle of that decade, there were indications that these promising trends might be short-lived. Increased sexual risk-taking and increased STIs were being observed among MSM in urban centres in the US, Europe, the UK and Australia.[39–55] This apparent

resurgence of STIs gained traction and became more widespread into the first decade of the new millennium. Potentially even more troubling, increases in the incidence of bacterial STIs among HIV-positive MSM were being observed in many regions.[56–59] With the synergistic relationship between HIV and other STIs well established, additional focus was directed towards determining the HIV status of MSM being diagnosed with syphilis and gonorrhoea.[57,58] The burden of STIs, especially syphilis, among HIV-positive MSM was found to be quite high in major urban centres globally, most likely attributable to dramatic reductions in HIV-related morbidity as prophylaxis for opportunistic infections and antiretroviral therapy (ART) gradually became more widely used in the late 1990s and early 2000s.[28]

The emerging belief in the early 2000s that ART might reduce the risk of HIV transmission, shared among both public health officials and MSM communities, was soon reinforced by treatment-as-prevention messages leveraging the demonstrable population-level impact of viral suppression on HIV transmission.[60–62] A highly visible decrease in HIV/AIDS-associated morbidity among those infected, emerging optimism with respect to HIV transmission, and an overall prevention fatigue among MSM, appeared to be leading to increased sexual risk-taking as evidenced by greater numbers of MSM being diagnosed with STIs.[63–69] With syphilis and gonorrhoea incidence among MSM increasing, it is not surprising that beginning in 2000 modest increases in newly reported HIV infections among MSM were also observed in the US, Western Europe and Australia.[70]

The inescapable conclusion from the available evidence was that, along with ecological and social changes, individual protective behaviours adopted in response to the HIV pandemic appeared to be on the wane. STI incidence, especially syphilis, was rebounding towards pre-HIV levels in many regions simultaneously. In 2010, the P&S syphilis rate among men in the US had reached 7.9 per 100 000, with at least 68% of cases attributed to MSM. Similarly, reported rates of P&S syphilis among males in Australia reached 8.9 per 100 000.[71–74] While some of the increase across the 2000s was likely the result of greater awareness on the part of MSM and their healthcare providers of the importance of screening for and treating STIs that resulted in the identification of previously undiagnosed or asymptomatic infections, there were also social and demographic changes in the broader society and within MSM communities that mitigated against sustaining decreases in STI incidence noted in the 1980s and 1990s.

Tremendous reductions in AIDS mortality also meant that the size of sexually active MSM populations was rebounding. Additionally, as HIV prevention efforts reached a level of maturity and professionalism in many higher-income countries, the level of community activism and direct involvement with prevention efforts may have begun to wane.[69] In the early 2000s, a new cohort of sexually active MSM was coming of age into a very different social as well as HIV prevention milieu than their immediate predecessors. With a high baseline prevalence of STIs newly re-established among MSM, age-bridging and consistently high rates of partner exchange between older and younger cohorts set the stage for more generalised STI epidemics among MSM. STIs, including HIV, were clearly spreading across generational cohorts of MSM towards the end of the first decade of the 2000s.[70,73,74]

Moreover, emergence of a host of non-venue-based channels and modes for locating potential sex partners through Internet and smart-phone applications was clearly having an impact on sexual networks. Most of these technologies facilitate real-time, on-demand identification of potential partners in convenient geographic proximity.[75–82] These likely increased the density of anonymous sexual contacts beyond the reach of traditional disease management activities, such as partner and provider referral, where those were available. Moreover, increases of syphilis, a primary focus of traditional public health activities, among MSM were occurring in an era of declining resources for STI control in general. In many areas of the US and Europe, investments in public health disease control activities were either beginning to decrease, were increasingly insufficient for the rising burden of disease, or perceived to be under threat as a result of the downturn in economic activity.[83,84] By 2010, conditions were seemingly ripe for rapid and sustained increases in STIs among MSM in the US, Europe and elsewhere.

Current epidemiology of STIs in MSM for 2011–2016

There appears to be universally resurgent epidemics of syphilis, gonorrhoea and, where data exists, chlamydial infection among MSM across higher-income settings.[85–102] Incidence of syphilis among MSM is surging dramatically in many regions globally and likely represents only the most visible burden of STI among MSM. Rate of reported P&S syphilis cases among men recently exceeded 10 cases per 100 000 in Australia, Canada and the US, and significant increases in the number of MSM cases were reported in multiple European Union (EU) countries.[100–102] A recent estimate of the incidence of P&S syphilis specifically among MSM in the US indicated the overall rate to be 154 per 100 000 and 353 per 100 000 among African American/Black MSM.[103] Gonorrhoea and chlamydial infections are also increasing significantly in numerous settings.[85,87,90,98] Though the data are less universally available to fully characterise gonorrhoea and chlamydia incidence among MSM, it is informative to note that guidelines for screening MSM for gonorrhoea and chlamydial infection at non-genital anatomic sites have been recently issued in numerous countries.[104-107]

Anecdotal evidence and facility-based research indicates that screening in non-genital anatomic sites is becoming, appropriately, more wide-spread in clinical settings serving significant populations of MSM. This increase in screening is likely identifying a previously undiagnosed burden of anorectal and pharyngeal infections.[66,108–114] In light of this fact, it is not clear whether the increases of these two STIs noted in clinical cohorts and in various sentinel surveillance projects reflect a true increase in incidence, an artefact of enhanced screening or, more plausibly, some combination of both. The incontrovertible evidence documenting accelerating incidence of syphilis among MSM would suggest that at least some proportion of the observed volume of new gonorrhoea and chlamydial infections may represent a trend towards increasing incidence as well.

With respect to gonorrhoea incidence in particular, there is evidence from the US that MSM are particularly vulnerable

to the emergence of antimicrobial resistant strains of *N. gonorrhoeae*.[115,116] This is potentially quite troubling when considering evidence for increasing incidence of gonorrhoea in MSM globally. Current recommendations for first-line therapy include parenteral treatment with Ceftriaxone and Azithromycin, effectively limiting the settings in which all persons with gonorrhoea must present for appropriate treatment.[104–106] There have been documented treatment failures observed using widely available oral cephalosporins,[116] and it is becoming clear that expedited options for partner treatment, a key disease control measure available in some countries, are quickly narrowing. The implications for persistent and/or difficult-to-treat gonorrhoea infections, often across multiple anatomic sites, among MSM are not fully understood but may well represent an unacceptable future burden in terms of quality of life, as well as diagnostic and treatment costs.

Against this rather pessimistic backdrop there are, however, promising trends with respect to at least one viral STI. The incidence of genital warts caused by human papillomavirus (HPV), appears to be changing in response to HPV vaccination efforts. While the data are most striking for young women, given the initial targeting of vaccination efforts to girls, in countries where vaccine uptake is robust in both girls and boys, the burden of genital warts in the general population appears to have fallen to levels that could reasonably be characterised as presaging eradication of the associated HPV types.[117–120] While more work is clearly needed to understand the burden and distribution of HPV types associated with genital warts, anorectal, penile and other cancers of the head, neck and throat in MSM, current evidence suggests that vaccination efforts can be highly successful at the population level, and would plausibly have a similar impact in reducing incidence of disease among MSM.

Recently emergent trends in primary HIV prevention, including post/pre-exposure prophylaxis (PEP/PrEP), are also changing the social and ecological landscape of STIs among MSM.[121–126] Clearly, a conceptual decoupling of HIV and STI prevention is underway among MSM, as well as in the public health community.[127] Though the impact of this decoupling is not yet fully understood, there will inevitably be implications for STI incidence among MSM across the full spectrum of pathogens. As PrEP becomes more widespread and accepted among MSM, there will likely be marked and significant increases in reports of syphilis, gonorrhoea and chlamydial infection cases. It is tempting to make a snap judgment and assume that individual risk behaviours and community-level prevalence and incidence will naturally increase, thus leading to a higher volume of cases reported to public health and more frequent infections diagnosed and treated in MSM patients. But the reasons for increasing reports will be considerably more complex than the simplistic, reductionist explanation of increased risk behaviour would suggest. The standard of care for monitoring PrEP use will likely bring increasing numbers of MSM into an ongoing relationship with providers. As a result, the opportunities for detecting and treating STIs will no doubt increase as well. The population-level benefit of normalising STIs screening, diagnosis and treatment into routine care will take time to be fully realised. Yet it will likely identify and treat a significant number of asymptomatic gonorrhoea and chlamydia infections resulting in initial increases in reported cases. This may also lead to reductions in the duration of infectiousness that may have a mitigating effect on incidence in the long run.

Reprise

To sum up what has admittedly been a facile, high-octane journey through 50 years of evidence for evolving trends in STIs among MSM, a couple of observations seem particularly pertinent. First, the evidence base for global comparative and population-level assessment of STIs in MSM remains woefully inadequate. This limits the ability of the public health community to generalise surveillance findings to encompass the full richness and diversity of MSM communities. Assessments of the burden of disease among MSM in the past, out of necessity, are constrained to non-representative clinical populations or to estimates based on sentinel and enhanced investigations. This scarcity of information has perhaps led to an epidemiological tunnel-vision of sorts, reifying the problem of STIs among MSM and leading to generalising beyond the evidence. Despite limitations in the available evidence, trends in incidence of STIs in MSM over the past generation have indeed risen from the available data, and the narrative is not particularly encouraging. Incidence among MSM was likely quite high in the 1960s and 70s, fell considerably in the beginning of the HIV pandemic through the 1990s, and has rebounded steadily to the present day.

Towards 2020

The future can only be glimpsed through a glass, darkly. Yet given the somewhat grim assessment of current trends in STIs among MSM at present, there is perhaps little reason to be sanguine looking towards 2020. The current ecology of high prevalence, emerging evidence of sustained incidence coupled with well-founded optimism regarding advances in reducing HIV transmission, suggests that ongoing syphilis transmission in MSM will continue globally and will likely increase in magnitude and geographic distribution. Reports of gonorrhoea and chlamydial infections will also inevitably continue to increase for some time to come, though the interpretation of these increases will need to be tempered by findings from expanded research into the type and frequency of sexual health services being accessed by MSM, including those using PrEP and those accessing HIV primary care.

Increases in STIs among MSM will be especially pronounced in urban areas where dense sexual networks, population churn and high prevalence of anonymous partnerships sustain ongoing transmission. These network factors, as well as community intervention preferences, are critical for the public health community to address in the development of a fuller understanding STI incidence. Far more attention needs to be paid to such factors in designing interventions to supplement the currently inadequate inventory of interventions targeted to reducing STIs among MSM.[128,129] More reliable estimates of the proportion of MSM not routinely accessing sexual health services are also needed, along with well-designed and intensive efforts to link these men with appropriate primary care that includes comprehensive STI services.

STIs among MSM will manifest in disconcerting trends for some time to come. There is cause for heightened vigilance for the emergence and spread of novel sexually transmitted pathogens into MSM networks such as hepatitis C, Zika and Ebola viruses, as conditions clearly exist for rapid spread.[130,131] Yet there is also cause for cautious optimism in the longer term. The trajectory of gonorrhoea and chlamydial infection may flatten over time if comprehensive sexual health services become broadly integrated into MSM health care, especially if the paradigm is shifted to focus on STIs with potentially more significant health impacts, such as HPV and syphilis. Better understanding and articulating the risks in MSM-specific health communications may help reduce barriers to more comprehensive STI care. But the greatest impact on the sexual health of MSM may lie in recognising that STI risk is not simply an issue of individual behaviour but is more fully explained in the context of broader social and epidemic factors; considerations of community and global context are critical elements needed in responding to STIs among MSM.

The good news, however, is that the public health evidence base for STIs among MSM has been improving significantly over the past decade. Efforts are underway in many countries to improve ascertainment of gender of sex partners both in routine and enhanced surveillance, to collect sexual orientation and gender identity as structured data in health records for analytic purposes and to develop reliable estimates of the size of sexual minority populations. These efforts will inevitably lead to more valid, broadly representative estimates of the burden of STIs in MSM. Moreover, sweeping social and cultural changes occurring in many countries towards integrating MSM and other sexual and gender minorities into civic and cultural institutions may presage significant changes in STIs as well. The structural impact these changes may have on sexual behaviours and the dynamics of STI transmission is yet to be fully revealed, but these are welcome steps towards reducing widely acknowledged inequities in health outcomes experienced by sexual minorities globally. Pragmatism with respect to the near term, tempered by determination to pursue what must still be achieved, and a steadfast, unwavering zeal to address both the human and informational needs of MSM sexual health should be the signposts guiding the public health community on the road ahead.

Conflicts of interest

No conflicts of interest identified or declared.

References

1 Jefferiss FJ. Homosexually-acquired venereal disease. *Br J Vener Dis* 1966; 42: 46–7.
2 Ritchey M. Venereal disease control among homosexuals. *JAMA* 1975; 232: 509–10. doi:10.1001/jama.1975.03250050031012
3 Nicol C. Homosexuality and venereal disease. *Practitioner* 1960; 184: 345–9.
4 Fluker JL. A 10-year study of homosexually transmitted infection. *Br J Vener Dis* 1976; 52: 155–60.
5 Willcox RR. A world-wide view of venereal disease. *Br J Vener Dis* 1972; 48: 163–76.
6 Webster B. Venereal disease control in the United States of America. *Br J Vener Dis* 1970; 46: 406–11.
7 Barrett-Connor E. The epidemiology and control of gonorrhea and syphilis: a reappraisal. *Prev Med* 1974; 3: 102–21. doi:10.1016/0091-7435(74)90067-X
8 Felman YM. Relative incidence of sexually transmitted diseases in New York City social hygiene clinics, 1977–1979. *J Urban Health* 1980; 56: 715–20.
9 Hentzer B, Skinhøj P, Høybye G, Nielsen AO, Kvorning SA, Faber V. Viral hepatitis in a venereal clinic population: relation to certain risk factors. *Scand J Infect Dis* 1980; 12: 245–9. doi:10.3109/inf.1980.12.issue-4.02
10 Henderson RH. Improving sexually transmitted disease health services for gays: a national prospective. *J Sex Transm Dis* 1977; 4: 58–62. doi:10.1097/00007435-197704000-00007
11 Garner MF. An analysis of 340 cases of syphilis diagnosed in the laboratory in six months in 1973. *Med J Aust* 1976; 1: 735–7.
12 Judson FN, Penley KA, Robinson ME, Smith JK. Comparative prevalence rates of sexually transmitted diseases in heterosexual and homosexual men. *Am J Epidemiol* 1980; 112: 836–43.
13 Laing LP. The VD clinic: a survey of 1000 patients. *Can Fam Physician* 1975; 21: 89–94.
14 Gelman AC, Vandow JE, Sobel N. Current status of venereal disease in New York City: a survey of 6,649 physicians in solo practice. *Am J Public Health Nations Health* 1963; 53: 1903–18. doi:10.2105/AJPH.53.12.1903
15 Hooker E. Male homosexual life styles and venereal disease. Proceedings of the World Forum on Syphilis and Treponematoses; 1962 Sep 4; Washington, DC: US Dept of Health, Education and Welfare, Public Health Service, 1964; p. 431–7.
16 Guthe T, Willcox RR. The international incidence of venereal disease. *R Soc Health J* 1971; 91: 122–33. doi:10.1177/146642407109100306
17 Platts WM. Epidemiology of gonorrhoea and syphilis in New Zealand. *Br J Vener Dis* 1979; 55: 138.
18 Spitzer RL. A proposal about homosexuality and the APA nomenclature: homosexuality as an irregular form of sexual behavior and sexual orientation disturbance as a psychiatric disorder. *Am J Psychiatry* 1973; 130: 1214–6.
19 Carbery G. Towards homosexual equality in Australian criminal law: a brief history. Sydney: Australian Lesbian and Gay Archives Inc.; 2010.
20 Quinn TC, Stamm WE, Goodell SE, Mkrtichian E, Benedetti J, Corey L, *et al*. The polymicrobial origin of intestinal infections in homosexual men. *N Engl J Med* 1983; 309: 576–82. doi:10.1056/NEJM198309083091002
21 Fluker JL. A 10-year study of homosexually transmitted infection. *Br J Vener Dis* 1976; 52: 155–60.
22 Handsfield HH. Sexually transmitted diseases in homosexual men. *Am J Public Health* 1981; 71: 989–90. doi:10.2105/AJPH.71.9.989
23 Centers for Disease Control. International notes update: acquired immunodeficiency syndrome–Europe. *MMWR Morb Mortal Wkly Rep* 1985; 34: 583–9.
24 Fox KK, Whittington WL, Levine WC, Moran JS, Zaidi AA, Nakashima AK. Gonorrhea in the United States, 1981-1996: demographic and geographic trends. *Sex Transm Dis* 1998; 25: 386–93. doi:10.1097/00007435-199808000-00011
25 Rolfs RT, Cates W. The perpetual lessons of syphilis. *Archives Dermatology* 1989; 125: 107–9. doi:10.1001/jama.1990.03450110078031
26 Crofts N, Gertig DM, Stevenson E, Thompson SC, Stewart T, Lester R, *et al*. Surveillance for sexually transmissible diseases in Victoria, 1983 to 1992. *Aust J Public Health* 1994; 18: 433–9. doi:10.1111/j.1753-6405.1994.tb00278.x
27 Otten MW, Jr, Zaidi AA, Wroten JE, Witte JJ, Peterman TA. Changes in sexually transmitted disease rates after HIV testing

and posttest counseling, Miami, 1988 to 1989. *Am J Public Health* 1993; 83: 529–33. doi:10.2105/AJPH.83.4.529

28 Holtgrave DR. Causes of the decline in AIDS deaths, United States, 1995–2002: prevention, treatment or both? *Int J STD AIDS* 2005; 16: 777–81. doi:10.1258/095646205774988109

29 Chesson HW, Dee TS, Aral SO. AIDS mortality may have contributed to the decline in syphilis rates in the United States in the 1990s. *Sex Transm Dis* 2003; 30: 419–24. doi:10.1097/00007435-200305000-00008

30 Kelly JA, Murphy DA, Sikkema KJ, McAuliffe TL, Roffman RA, Solomon LJ, Winett RA, Kalichman SC. Community HIV Prevention Research Collaborative Randomised, controlled, community-level HIV-prevention intervention for sexual-risk behaviour among homosexual men in US cities. *Lancet* 1997; 350: 1500–5. doi:10.1016/S0140-6736(97)07439-4

31 Disman C. The San Francisco bathhouse battles of 1984: civil liberties, AIDS risk, and shifts in health policy. *J Homosex* 2003; 44: 71–129. doi:10.1300/J082v44n03_05

32 Rolfs RT, Nakashima AK. Epidemiology of primary and secondary syphilis in the United States, 1981 through 1989. *JAMA* 1990; 264: 1432–7. doi:10.1001/jama.1990.03450110078031

33 De Schryver A, Meheus A. Epidemiology of sexually transmitted diseases: the global picture. *Bull World Health Organ* 1990; 68: 639–54.

34 van Duynhoven YTHP. The epidemiology of *Neisseria gonorrhoeae* in Europe. *Microbes Infect* 1999; 1: 455–64. doi:10.1016/S1286-4579(99)80049-5

35 Centers for Disease Control and Prevention (CDC). Tracking the hidden epidemics: trends in STDs in the United States, 2000. Atlanta, GA: Department of Health and Human Services, Division of STD Prevention; 2000. Available online at: http://www.cdc.gov/std/trends2000/trends2000.pdf [verified 22 February 2016].

36 Uusküla A, Puur A, Toompere K, DeHovitz J. Trends in the epidemiology of bacterial sexually transmitted infections in eastern Europe, 1995–2005. *Sex Transm Infect* 2010; 86: 6–14. doi:10.1136/sti.2009.037044

37 Osbak KK, Rowley JT, Kassebaum NJ, Kenyon CR. The prevalence of syphilis from the early HIV period is correlated with peak HIV prevalence at a country level. *Sex Transm Dis* 2016; 43: 255–7. doi:10.1097/OLQ.0000000000000422

38 Centers for Disease Control and Prevention (CDC) Primary and secondary syphilis–United States, 1999. *MMWR Morb Mortal Wkly Rep* 2001; 50: 113–7.

39 Centers for Disease Control and Prevention (CDC) Increases in unsafe sex and rectal gonorrhea among men who have sex with men – San Francisco, California, 1994–1997. *MMWR Morb Mortal Wkly Rep* 1999; 48: 45–8.

40 Centers for Disease Control and Prevention (CDC) Resurgent bacterial sexually transmitted disease among men who have sex with men–King County, Washington, 1997–1999. *MMWR Morb Mortal Wkly Rep* 1999; 48: 773–7.

41 Siushansian JA, Nguyen M, Archibald CP. HIV and men who have sex with men: where is the Canadian epidemic headed? *Can J Hum Sex* 2000; 9: 219–37.

42 Fennema JS, Cairo I, Coutinho RA. [Substantial increase in gonorrhea and syphilis among clients of Amsterdam Sexually Transmitted Diseases Clinic]. *Ned Tijdschr Geneeskd* 2000; 144: 602–3. [Article originally in Dutch]

43 Golden MR, Marra CM, Holmes KK. Update on syphilis: resurgence of an old problem. *JAMA* 2003; 290: 1510–4. doi:10.1001/jama.290.11.1510

44 Peterman TA, Heffelfinger JD, Swint EB, Groseclose SL. The changing epidemiology of syphilis. *Sex Transm Dis* 2005; 32: S4–10. doi:10.1097/01.olq.0000180455.79024.e9

45 Simms I, Fenton KA, Ashton M, Turner KM, Crawley-Boevey EE, Gorton R, *et al*. The re-emergence of syphilis in the United Kingdom: the new epidemic phases. *Sex Transm Dis* 2005; 32: 220–6. doi:10.1097/01.olq.0000149848.03733.c1

46 Hopkins S, Lyons F, Coleman C, Courtney G, Bergin C, Mulcahy F. Resurgence in infectious syphilis in Ireland: an epidemiological study. *Sex Transm Dis* 2004; 31: 317–21. doi:10.1097/01.OLQ.0000123653.84940.59

47 Savage EJ, Hughes G, Ison C, Lowndes CM. Syphilis and gonorrhoea in men who have sex with men: a European overview. *Euro Surveill* 2008; 14: 429–33.

48 Marcus U, Bremer V, Hamouda O. Syphilis surveillance and trends of the syphilis epidemic in Germany since the mid-90s. *Euro Comm Dis Bull* 2004; 9: 11–4.

49 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

50 Wohlfeiler D, Potterat JJ. Using gay men's sexual networks to reduce sexually transmitted disease (STD)/human immunodeficiency virus (HIV) transmission. *Sex Transm Dis* 2005; 32: S48–52. doi:10.1097/01.olq.0000175394.81945.68

51 Fox KK, Del Rio C, Holmes KK, Hook EW 3rd, Judson FN, Knapp JS, Procop GW, Wang SA, Whittington WL, Levine WC. Gonorrhea in the HIV era: a reversal in trends among men who have sex with men. *Am J Public Health* 2001; 91: 959–64. doi:10.2105/AJPH.91.6.959

52 Stolte IG, Dukers NH, de Wit JB, Fennema JS, Coutinho RA. Increase in sexually transmitted infections among homosexual men in Amsterdam in relation to HAART. *Sex Transm Infect* 2001; 77: 184–6. doi:10.1136/sti.77.3.184

53 Jin F, Prestage GP, Mao L, Kippax SC, Pell CM, Donovan B, Cunningham PH, Templeton DJ, Kaldor JM, Grulich AE. Incidence and risk factors for urethral and anal gonorrhoea and chlamydia in a cohort of HIV-negative homosexual men: the Health in Men Study. *Sex Transm Infect* 2007; 83: 113–9. doi:10.1136/sti.2006.021915

54 Stolte IG, Coutinho RA. Risk behaviour and sexually transmitted diseases are on the rise in gay men, but what is happening with HIV? *Curr Opin Infect Dis* 2002; 15: 37–41. doi:10.1097/00001432-200202000-00007

55 Nicoll A, Hamers FF. Are trends in HIV, gonorrhoea, and syphilis worsening in western Europe? *BMJ* 2002; 324: 1324. doi:10.1136/bmj.324.7349.1324

56 Blocker ME, Levine WC, Louis ME. HIV prevalence in patients with syphilis, United States. *Sex Transm Dis* 2000; 27: 53–9. doi:10.1097/00007435-200001000-00011

57 Wasserheit JN. Epidemiological synergy: interrelationships between human immunodeficiency virus infection and other sexually transmitted diseases. *Sex Transm Dis* 1992; 19: 61–77. doi:10.1097/00007435-199219020-00001

58 Cohen MS. Sexually transmitted diseases enhance HIV transmission: no longer a hypothesis. *Lancet* 1998; 351: S5–7. doi:10.1016/S0140-6736(98)90002-2

59 Dougan S, Evans BG, Elford J. Sexually transmitted infections in Western Europe among HIV-positive men who have sex with men. *Sex Transm Dis* 2007; 34: 783–90.

60 Ostrow DE, Fox KJ, Chmiel JS, Silvestre A, Visscher BR, Vanable PA, Jacobson LP, Strathdee SA. Attitudes towards highly active antiretroviral therapy are associated with sexual risk taking among HIV-infected and uninfected homosexual men. *AIDS* 2002; 16: 775–80. doi:10.1097/00002030-200203290-00013

61 Stolte IG, De Wit JB, Van Eeden A, Coutinho RA, Dukers NH. Perceived viral load, but not actual HIV-1-RNA load, is associated

with sexual risk behaviour among HIV-infected homosexual men. *AIDS* 2004; 18: 1943–9. doi:10.1097/00002030-200409240-00010
62 Cohen MS, McCauley M, Gamble TR. HIV treatment as prevention and HPTN 052. *Curr Opin HIV AIDS* 2012; 7: 99–105. doi:10.1097/COH.0b013e32834f5cf2
63 Elford J, Bolding G, Davis M, Sherr L, Hart G. Trends in sexual behaviour among London homosexual men 1998–2003: implications for HIV prevention and sexual health promotion. *Sex Transm Infect* 2004; 80: 451–4. doi:10.1136/sti.2004.010785
64 Berglund T, Asikainen T, Grützmeier S, Rudén AK, Wretlind B, Sandström E. The epidemiology of gonorrhea among men who have sex with men in Stockholm, Sweden, 1990–2004. *Sex Transm Dis* 2007; 34: 174–9. doi:10.1097/01.olq.0000230442.13532.c7
65 Sasse A, Defraye A, Ducoffre G. Recent syphilis trends in Belgium and enhancement of STI surveillance systems. *Euro Comm Dis Bull* 2004; 9: 6–8.
66 Kent CK, Chaw JK, Wong W, Liska S, Gibson S, Hubbard G, Klausner JD. 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
67 Mayer KH. Sexually transmitted diseases in men who have sex with men. *Clin Infect Dis* 2011; 53(Suppl 3): S79–83. doi:10.1093/cid/cir696
68 Stenger MR, Courogen MT, Carr JB. Trends in *Neisseria gonorrhoeae* incidence among HIV-negative and HIV-positive men in Washington State, 1996–2007. *Public Health Rep* 2009; 124: 18–23.
69 Wohlfeiler D. From community to clients: the professionalisation of HIV prevention among gay men and its implications for intervention selection. *Sex Transm Infect* 2002; 78(Suppl 1): i176–82. doi:10.1136/sti.78.suppl_1.i176
70 Sullivan PS, Hamouda O, Delpech V, Geduld JE, Prejean J, Semaille C, Kaldor J, Folch C, de Coul EO, Marcus U, Hughes G. Reemergence of the HIV epidemic among men who have sex with men in North America, Western Europe, and Australia, 1996–2005. *Ann Epidemiol* 2009; 19: 423–31. doi:10.1016/j.annepidem.2009.03.004
71 Centers for Disease Control and Prevention (CDC). Sexually transmitted disease surveillance 2010. Atlanta: US Department of Health and Human Services; 2011.
72 NNDSS Annual Report Writing Group. Australia's notifiable disease status, 2010: annual report of the National Notifiable Diseases Surveillance System. *Commun Dis Intell* 2012; 36: 1–69.
73 Agwu A, Ellen J. Rising rates of HIV infection among young US men who have sex with men. *Pediatr Infect Dis J* 2009; 28: 633–4. doi:10.1097/INF.0b013e3181afcd22
74 Jennings JM, Ellen JM, Deeds BG, Harris DR, Muenz LR, Barnes W, Lee S, Auerswald CL. Adolescent Trials Network for HIV/AIDS Interventions Youth living with HIV and partner-specific risk for the secondary transmission of HIV. *Sex Transm Dis* 2009; 36: 439–44. doi:10.1097/OLQ.0b013e3181ad516c
75 Benotsch EG, Kalichman S, Cage M. Men who have met sex partners via the Internet: prevalence, predictors, and implications for HIV prevention. *Arch Sex Behav* 2002; 31: 177–83. doi:10.1023/A:1014739203657
76 Centers for Disease Control and Prevention (CDC). Internet use and early syphilis infection among men who have sex with men–San Francisco, California, 1999–2003. *MMWR Morb Mortal Wkly Rep* 2003; 52: 1229–32.
77 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
78 Berry M, Raymond HF, Kellogg T, McFarland W. The Internet, HIV serosorting and transmission risk among men who have sex with men, San Francisco. *AIDS* 2008; 22: 787–9. doi:10.1097/QAD.0b013e3282f55559
79 Jenness SM, Neaigus A, Hagan H, Wendel T, Gelpi-Acosta C, Murrill CS. Reconsidering the internet as an HIV/STD risk for men who have sex with men. *AIDS Behav* 2010; 14: 1353–61. doi:10.1007/s10461-010-9769-x
80 Rice E, Holloway I, Winetrobe H, Rhoades H, Barman-Adhikari A, Gibbs J, Carranza A, Dent D, Dunlap S. Sex risk among young men who have sex with men who use Grindr, a smartphone geosocial networking application. *J AIDS Clinic Res* 2012; S4: 1–8.
81 Beymer MR, Weiss RE, Bolan RK, Rudy ET, Bourque LB, Rodriguez JP, Morisky DE. 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
82 Rechel B, Suhrcke M, Tsolova S, Suk JE, Desai M, McKee M, Stuckler D, Abubakar I, Hunter P, Senek M, Semenza JC. Economic crisis and communicable disease control in Europe: a scoping study among national experts. *Health Policy* 2011; 103: 168–75. doi:10.1016/j.healthpol.2011.06.013
83 Golden MR, Hogben M, Handsfield HH, St Lawrence JS, Potterat JJ, Holmes KK. Partner notification for HIV and STD in the United States: low coverage for gonorrhea, chlamydial infection, and HIV. *Sex Transm Dis* 2003; 30: 490–6. doi:10.1097/00007435-200306000-00004
84 Gebbie KM, Turnock BJ. The public health workforce, 2006: new challenges. *Health Aff* 2006; 25: 923–33. doi:10.1377/hlthaff.25.4.923
85 Martí-Pastor M, de Olalla PG, Barberá MJ, Manzardo C, Ocaña I, Knobel H, *et al*. Epidemiology of infections by HIV, syphilis, gonorrhea and lymphogranuloma venereum in Barcelona City: a population-based incidence study. *BMC Public Health* 2015; 15: 1015. doi:10.1186/s12889-015-2344-7
86 Read P, Fairley CK, Chow EP. Increasing trends of syphilis among men who have sex with men in high income countries. *Sex Health* 2015; 12: 155–63. doi:10.1071/SH14153
87 Chow EP, Tomnay J, Fehler G, Whiley D, Read TR, Denham I, Bradshaw CS, Chen MY, Fairley CK. Substantial increases in chlamydia and gonorrhea positivity unexplained by changes in individual-level sexual behaviors among men who have sex with men in an Australian sexual health service from 2007 to 2013. *Sex Transm Dis* 2015; 42: 81–7. doi:10.1097/OLQ.0000000000000232
88 Wilton J. The (re)emergence of STIs among MSM: why does it matter and what can be done? Community AIDS Treatment Information Exchange (CATIE): Prevention in Focus. Fall 2015. Available online at: http://www.catie.ca/en/pif/fall-2015/reemergence-stis-among-msm-why-does-it-matter-and-what-can-be-done [verified 22 February 2016].
89 Ling DI, Janjua NZ, Wong S, Krajden M, Hoang L, Morshed M, *et al*. Sexually transmitted infection trends among gay or bisexual men from a clinic-based sentinel surveillance system in British Columbia, Canada. *Sex Transm Dis* 2015; 42: 153–9. doi:10.1097/OLQ.0000000000000250
90 Mohammed H, Mitchell H, Sile B, Duffell S, Nardone A, Hughes G. Increase in sexually transmitted infections among men who have sex with men, England, 2014. *Emerg Infect Dis* 2016. 22: doi:10.3201/eid2201.151331
91 Scott HM, Klausner JD. Sexually transmitted infections and pre-exposure prophylaxis: challenges and opportunities among men

who have sex with men in the US. *AIDS Res Ther* 2016; 13: 5. doi:10.1186/s12981-016-0089-8

92 Mohammed H, Hughes G, Fenton KA. Surveillance systems for sexually transmitted infections: a global review. *Curr Opin Infect Dis* 2016; 29: 64–9. doi:10.1097/QCO.0000000000000235

93 Petrosky E, Neblett Fanfair R, Toevs K, DeSilva M, Schafer S, Hedberg K, Braxton J, Walters J, Markowitz L, Hariri S. Early syphilis among men who have sex with men in the US Pacific Northwest, 2008–2013: clinical management and implications for prevention. *AIDS Patient Care STDS* 2016; 30: 134–40.

94 Sugishita Y, Yamagishi T, Arima Y, Hori N, Seki N. Increase in primary and secondary syphilis notifications in men in Tokyo, 2007. *Jpn J Infect Dis* 2016; 69: 154–7. doi:10.7883/yoken.JJID.2015.312

95 Childs T, Simms I, Alexander S, Eastick K, Hughes G, Field N. Rapid increase in lymphogranuloma venereum in men who have sex with men, United Kingdom, 2003 to September 2015. *Euro Surveill* 2015; 20: 30076. doi:10.2807/1560-7917.ES.2015.20.48.30076

96 Kanelleas A, Stefanaki C, Stefanaki I, Bezrondii G, Paparizos V, Arapaki A, Kripouri Z, Antoniou C, Nicolaidou E. Primary syphilis in HIV-negative patients is on the rise in Greece: epidemiological data for the period 2005–2012 from a tertiary referral centre in Athens, Greece. *J Eur Acad Dermatol Venereol* 2015; 29: 981–4. doi:10.1111/jdv.12745

97 Jakopanec I. What you love might kill you. Epidemiology, time trends and risk factors for sexually transmitted infections among men who have sex with men in Norway, 1992–2013. PhD Dissertation. Oslo, Norway: Akademika Publishing; 2015.

98 Stenger M, Bauer H, Torrone E. Denominators matter: trends in *Neisseria gonorrhoeae* incidence among gay, bisexual and other men who have sex with men (GBMSM) in the US – findings from the STD Surveillance Network (SSuN) 2010–2013. *Sex Transm Infect* 2015; 91(Suppl 2): A178–9.

99 Chen G, Cao Y, Yao Y, Li M, Tang W, Li J, Babu GR, Jia Y, Huan X, Xu G, Yang H. Syphilis incidence among men who have sex with men in China: results from a meta-analysis. *Int J STD AIDS* 2016; 1–9. doi:10.1177/0956462416638224

100 Centers for Disease Control and Prevention (CDC). Sexually transmitted disease surveillance 2014. Atlanta: US Department of Health and Human Services; 2015.

101 NNDSS Annual Report Writing Group. Australia's notifiable disease status, 2014: annual report of the National Notifiable Diseases Surveillance System. *Commun Dis Intell* 2016; 40: E80–9.

102 Totten S, MacLean R, Payne E. Infectious syphilis in Canada: 2003–2012. *Can Commun Dis Rep* 2015; 41: 30–4.

103 Purcell DW, Johnson CH, Lansky A, Prejean J, Stein R, Denning P, Gau Z, Weinstock H, Su J, Crepaz N. Estimating the population size of men who have sex with men in the United States to obtain HIV and syphilis rates. *Open AIDS J* 2012; 6(Suppl 1): 98–107. doi:10.2174/1874613601206010098

104 Bignell C, FitzGerald M. Guideline Development Group UK national guideline for the management of gonorrhoea in adults, 2011. *Int J STD AIDS* 2011; 22: 541–7. doi:10.1258/ijsa.2011.011267

105 Bignell C, Unemo M. 2012 European guideline on the diagnosis and treatment of gonorrhoea in adults. *Int J STD AIDS* 2013; 24: 85–92. doi:10.1177/0956462412472837

106 Workowski K, Bolan G. 2015 sexually transmitted diseases treatment guidelines. *MMWR Recomm Rep* 2015; ; 64: 1–137.

107 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

108 Koedijk FD, Van Bergen JE, Dukers-Muijrers NH, Van Leeuwen AP, Hoebe CJ, Van der Sande MA. The value of testing multiple anatomic sites for gonorrhoea and chlamydia in sexually transmitted infection centres in the Netherlands, 2006–2010. *Int J STD AIDS* 2012; 23: 626–31. doi:10.1258/ijsa.2012.011378

109 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

110 Patton ME, Kidd S, Llata E, Stenger M, Braxton J, Asbel L, Bernstein K, Gratzer B, Jespersen M, Kerani R, Mettenbrink C. 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

111 Templeton DJ, Jin F, McNally LP, Imrie JC, Prestage GP, Donovan B, Cunningham PH, Kaldor JM, Kippax S, Grulich AE. Prevalence, incidence and risk factors for pharyngeal gonorrhoea in a community-based HIV-negative cohort of homosexual men in Sydney, Australia. *Sex Transm Infect* 2010; 86: 90–6. doi:10.1136/sti.2009.036814

112 Pathela P, Klingler EJ, Guerry SL, Bernstein KT, Kerani RP, Llata L, Mark HD, Tabidze I, Rietmeijer CA,. SSuN Working Group Sexually transmitted infection clinics as safety net providers: exploring the role of categorical sexually transmitted infection clinics in an era of health care reform. *Sex Transm Dis* 2015; 42: 286–93. doi:10.1097/OLQ.0000000000000255

113 Anschuetz GL, Paulukonis E, Powers R, Asbel LE. Extragenital screening in men who have sex with men diagnoses more chlamydia and gonorrhea cases than urine testing alone. *Sex Transm Dis* 2016; 43: 299–301. doi:10.1097/OLQ.0000000000000435

114 Kidd S, Workowski KA. Management of gonorrhea in adolescents and adults in the United States. *Clin Infect Dis* 2015; 61(Suppl 8): S785–801. doi:10.1093/cid/civ731

115 Kirkcaldy RD, Zaidi A, Hook EW, Holmes KK, Soge O, del Rio C, Hall G, Papp J, Bolan G, Weinstock HS. *Neisseria gonorrhoeae* antimicrobial resistance among men who have sex with men and men who have sex exclusively with women: the Gonococcal Isolate Surveillance Project, 2005–2010. *Ann Intern Med* 2013; 158: 321–8. doi:10.7326/0003-4819-158-5-201303050-00004

116 Kirkcaldy RD, Hook EW, Soge OO, del Rio C, Kubin G, Zenilman JM, Papp JR. Trends in *Neisseria gonorrhoeae* susceptibility to cephalosporins in the United States, 2006–2014. *JAMA* 2015; 314: 1869–71. doi:10.1001/jama.2015.10347

117 Dunne EF, Nielson CM, Stone KM, Markowitz LE, Giuliano AR. Prevalence of HPV infection among men: a systematic review of the literature. *J Infect Dis* 2006; 194: 1044–57. doi:10.1086/507432

118 Korostil IA, Ali H, Guy RJ, Donovan B, Law MG, Regan DG. Near elimination of genital warts in Australia predicted with extension of human papillomavirus vaccination to males. *Sex Transm Dis* 2013; 40: 833–5. doi:10.1097/OLQ.0000000000000030

119 Brewer NT, Calo WA. HPV transmission in adolescent men who have sex with men. *Lancet Infect Dis* 2015; 15: 8–9. doi:10.1016/S1473-3099(14)71019-9

120 Smith MA, Liu B, McIntyre P, Menzies R, Dey A, Canfell K. Trends in genital warts by socioeconomic status after the introduction of the national HPV vaccination program in Australia: analysis of national hospital data. *BMC Infect Dis* 2016; 16: 52.

121 Grant RM, Lama JR, Anderson PL, McMahan V, Liu AY, Vargas L, Goicochea P, Casapía M, Guanira-Carranza JV, Ramirez-Cardich ME, Montoya-Herrera O. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med* 2010; 363: 2587–99. doi:10.1056/NEJMoa1011205

122 McCormack S, Dunn DT, Desai M, Dolling DI, Gafos M, Gilson R, Sullivan AK, Clarke A, Reeves I, Schembri G, Mackie N. 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

123 Martin JN, Roland ME, Neilands TB, Krone MR, Bamberger JD, Kohn RP, Chesney MA, Franses K, Kahn JO, Coates TJ, Katz MH. Use of postexposure prophylaxis against HIV infection following sexual exposure does not lead to increases in high-risk behavior. *AIDS* 2004; 18: 787–92. doi:10.1097/00002030-200403260-00010

124 Fisher M, Benn P, Evans B, Pozniak A, Jones M, MacLean S, Davidson O, Summerside J, Hawkins DUK. Guideline for the use of post-exposure prophylaxis for HIV following sexual exposure. *Int J STD AIDS* 2006; 17: 81–92. doi:10.1258/095646206775455829

125 Dolezal C, Frasca T, Giguere R, Ibitoye M, Cranston RD, Febo I, Mayer KH, McGowan I, Carballo-Diéguez A. Awareness of post-exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP) is low but interest is high among men engaging in condomless anal sex with men in Boston, Pittsburgh, and San Juan. *AIDS Educ Prev* 2015; 27: 289–97. doi:10.1521/aeap.2015.27.4.289

126 Mitchell H, Furegato M, Hughes G, Field N, Mohammed H, Nardone A. O2 An epidemiological analysis of men who have sex with men (MSM) who are prescribed HIV post-exposure prophylaxis: implications for wider pre-exposure prophylaxis policy. *Sex Transm Infect* 2015; 91: A1. doi:10.1136/sextrans-2015-052126.2

127 Scott HM, Klausner JD. Sexually transmitted infections and pre-exposure prophylaxis: challenges and opportunities among men who have sex with men in the US. *AIDS Res Ther* 2016; 13: 5. doi:10.1186/s12981-016-0089-8

128 Sharma A, Johnson BA, Sullivan PS. Evaluating interventions to promote routine preventive screenings: a comparison of analytical outcomes. *Contemp Clin Trials* 2015; 41: 152–9. doi:10.1016/j.cct.2015.01.014

129 Stahlman S, Plant A, Javanbakht M, Cross J, Montoya JA, Bolan R, Kerndt PR. Acceptable interventions to reduce syphilis transmission among high-risk men who have sex with men in Los Angeles. *Am J Public Health* 2015; 105: e88–94. doi:10.2105/AJPH.2014.302412

130 Christie A, Davies-Wayne GJ, Cordier-Lasalle T, Blackley DJ, Laney AS, Williams DE, Shinde SA, Badio M, Lo T, Mate SE, Ladner JT. Possible sexual transmission of Ebola virus-Liberia, 2015. *MMWR Morb Mortal Wkly Rep* 2015; 64: 479–81.

131 Deckard DT, Chung WM, Brooks JT, *et al*. Male-to-male sexual transmission of Zika virus—Texas, January 2016. *MMWR Morb Mortal Wkly Rep* 2016; 65: 372–4. doi:10.15585/mmwr.mm6514a3