Title: 100 years of Sexually Transmitted Infections in the United Kingdom: A review of national surveillance data

Hamish Mohammed[1]*, Paula Blomquist[1], Dana Ogaz[1], Stephen Duffell[1], Martina Furegato[1], Marta Checchi[1], Neil Irvine[2], Lesley Wallace[3], Daniel Thomas[4], Anthony Nardone[1], Kevin Dunbar[1] and Gwenda Hughes[1]

1 - Public Health England, London, United Kingdom
2 - Public Health Agency, Belfast, United Kingdom
3 - Heath Protection Scotland, Glasgow, United Kingdom
4 - Public Health Wales, Cardiff, United Kingdom

* Corresponding author:
Hamish Mohammed, PhD, MPH
Principal STI Prevention & Surveillance Scientist, Department of HIV and STIs
National Infection Service
Public Health England
61 Colindale Avenue
London, UK
NW9 5EQ
hamish.mohammed@phe.gov.uk
Tel: 020 8327 6403

Key words: sexual health, surveillance, gay men, ethnicity, adolescent

Word count: 2,999

ABSTRACT

Objectives: The 1916 Royal Commission on Venereal Diseases was established in response to epidemics of syphilis and gonorrhoea in the UK. In the 100 years since the Venereal Diseases Act (1917), the UK has experienced substantial scientific, economic and demographic changes. We describe historical and recent trends in sexually transmitted infections (STIs) in the UK.

Methods: We analysed surveillance data derived from STI clinics' statistical returns from 1917-2016.

Results: Since 1918, gonorrhoea and syphilis diagnoses have fluctuated, reflecting social, economic and technological trends. Following spikes after World Wars I and II, rates declined before re-emerging during the 1960s. At that time, syphilis was more common in men, suggestive of transmission within the men who have sex with men (MSM) population. Behaviour change following the emergence of HIV/AIDS in the 1980s is thought to have facilitated a precipitous decline in diagnoses of both STIs in the mid-1980s. Since the early 2000s, gonorrhoea and syphilis have re-emerged as major public health concerns, due to increased transmission among MSM and the spread of antimicrobial resistant gonorrhoea. Chlamydia and genital warts are now the most commonly diagnosed STIs in the UK and have been the focus of public health interventions, including the national human papillomavirus vaccination programme, which has led to substantial declines in genital warts in young people, and the National Chlamydia Screening Programme in England. Since the 1980s, MSM, black ethnic minorities and young people have experienced the highest STI rates.

Conclusion: Although diagnoses have fluctuated over the last century, STIs continue to be an important public health concern, often affecting more marginalised groups in society. Prevention must remain a public health priority and, as we enter a new era of sexual healthcare provision including online services, priority must be placed on maintaining prompt access for those at greatest risk of STIs.

Word count: 300 (limit: 300)

KEY POINTS

- Sexually transmitted infections (STIs) are a major public health concern and disproportionately affect men who have sex with men (MSM), black ethnic minorities and young people
- Gonorrhoea and syphilis diagnoses have fluctuated considerably over the last century but have recently re-emerged especially among MSM, in part associated with HIV seroadaptive behaviours
- STI interventions including the promotion of risk reduction, increased and improved testing, and vaccination have led to improvements in sexual health
- As originally envisaged in 1917, there is a need to maintain free, confidential, open access sexual health services for those in need

INTRODUCTION

The Royal Commission on Venereal Diseases of 1916 was established in response to widespread epidemics of syphilis and gonorrhoea in the UK. [1] At that time, syphilis was considered to be a leading cause of death, stillbirths, infant mortality and blindness, and gonorrhoea was a leading cause of infertility in women. [2] The subsequent passage of the Venereal Diseases Act of 1917 facilitated the provision of free, confidential, open-access sexually transmitted infection (STI) clinics in an attempt to prevent and control these infections. [1 3] While their epidemiology has changed remarkably over the last century, STIs continue to negatively impact the health and wellbeing of the population. [4]

For this reflective overview, we review and discuss STI surveillance data derived from mandatory statistical returns from STI clinics over the 100 years since the passage of the Venereal Diseases Act (1917). Data were primarily derived from aggregated statistical returns from STI clinics, but in more recent years were also derived from disaggregated electronic data from STI clinics and laboratories. [5] Data on gonorrhoea and syphilis were available from 1918 and 1922, respectively. Data on causes of morbidity were collected prior to this, however STI-related morbidity was understood to be severely underreported: "Syphilis had been, and remained, the despair of the statistician… Even in death a stigma was associated with it". [2]

The aggregated returns from STI clinics contain limited demographic data, but provide key insights into historical STI trends. Gender data have been available for syphilis and gonorrhoea since 1925, and high male:female (M:F) ratios have been used to infer trends among gay, bisexual and other men who have sex with men (MSM). In the last 10 years, the availability of disaggregated data in some UK countries has enabled more in-depth exploration of the population sub-groups affected. The results of descriptive analyses are reported, with a focus on primary, secondary or early latent syphilis (hereafter: 'syphilis'), gonorrhoea, chlamydia and first episode genital warts (hereafter: 'genital warts'), and first episode genital herpes (hereafter: 'genital herpes').

We used this review of surveillance data to compare and contrast the historical and current epidemiology of STIs, explore the factors contributing to the high diagnosis rates of STIs among select population subgroups in recent years, then discuss implications for the future provision of STI services.

TRENDS IN GONORRHOEA AND SYPHILIS FROM 1918 TO THE EARLY 2000s

As previously described, [5] diagnoses of gonorrhoea and syphilis have fluctuated since 1918, reflecting social, economic and technological trends. Briefly, after the return of the armed forces to the UK at the end of World War I in 1918, diagnoses of syphilis and gonorrhoea both exceeded 35,000 annually (figures 1a and 1b and appendix tables 1 and 2). This was followed by a slow decline in cases for two decades, after which the number of diagnoses of both infections increased sharply in the mid-1940s at the end of World War II. Subsequently, there was a rapid decline in both infections, facilitated by the mass production of penicillin, until the number of diagnoses of both STIs reached a nadir the decade later. However, following the period of sexual liberation of the 1960s,[6] diagnoses of both infections increased, with gonorrhoea returning to levels unseen since the late 1940s. In the case of syphilis, far more cases were reported in men (figure 1c), suggesting that sex between men became the predominant route of transmission. During the 1980s, there was another precipitous decrease in cases, thought to be due to behaviour change in response to the emergence of HIV/AIDS in the 1980s, the related public health campaigns, and the high case-fatality rate of HIV/AIDS at that time. While diagnoses of both STIs remained very low during the 1990s, there has been a re-emergence of both gonorrhoea and syphilis in MSM since 2000. [5]

In the following sections, we describe more recent trends in STIs in the UK then explore inequalities in STI distribution by population subgroups.

RECENT STI TRENDS IN THE UK

Currently, STI surveillance data from all UK countries are available for chlamydia, gonorrhoea and syphilis. In 2016, there was a combined total of 276,134 diagnoses of these STIs, with the most commonly reported (83.1%) being chlamydia; the majority of diagnoses of gonorrhoea (74.7%) and syphilis (94.4%) were in men, while more chlamydia diagnoses (57.2%) were in women. [7] Between 2012 and 2016, there were increases in the numbers of gonorrhoea (33.5%) and syphilis (93.3%), whereas chlamydia diagnoses decreased by 5.0%. The majority (88.6%) of the overall total of these three STI diagnoses were made in English STI clinics, which heavily influences the UK-wide trends; slightly different trends were observed in the other countries of the UK. [8-10]

ADOLESCENTS AND YOUNG ADULTS

Teenagers and young adults experience the highest diagnosis rates of chlamydia and gonorrhoea (figure 2 and appendix figure 1); this has been recognised at least since the 1980s, when roughly one third and one eighth of chlamydia and gonorrhoea diagnoses, respectively, were in those under 20 years. [11] In the 1990s, 16 to 19 year-old women had the highest diagnosis rates of gonorrhoea, chlamydia and genital warts, and the second highest rate (after 20 to 24 year old women) of genital herpes. [12] Currently, among 15 to 24 year olds, men are three and women are 11 times more likely to be diagnosed with chlamydia, gonorrhoea, or syphilis than their counterparts aged 25 to 64 years (figure 2). The age disparity in STI rates is likely due to higher partner turnover in young people. Compared to older people, those aged 16 to 24 are most likely to report a new sex partner or two or more sex partners of the opposite sex in the previous year. [13]

There is a marked disproportionality in diagnosis rates by gender in those aged 15 to 19 years and women are now 2.8 times more likely to be diagnosed with chlamydia, gonorrhoea or syphilis than men in this age group (figure 2).[11] To some extent the disparity will reflect improved access to STI testing among younger women in a range of clinical settings, including through the National Chlamydia Screening Programme (NCSP) in England,[4] but it may also be due to disassortative sexual mixing patterns between young women and older male partners[14] [15] or greater biological susceptibility to STIs among younger women. [16]

Chlamydia is the most commonly diagnosed STI in the UK, and the highest diagnosis rates are reported in those under the age of 25 years. [4] Testing was only readily available since the mid-1990s, and since then widespread testing, which in England was facilitated by the NCSP, led to a rapid increase in chlamydia diagnoses. [17] The NCSP offers opportunistic screening of sexually active young people aged 15 to 24 years with the aim of increasing the detection of chlamydia and reducing the prevalence of associated sequelae. Chlamydia screening programmes have not been implemented in other countries of the UK. [18] However, widespread chlamydia testing in Scotland was driven by changes implemented following the publication of the Scottish Intercollegiate Guideline Network guidance in 2000; this recommended urine sampling and the use of sensitive, specific nucleic acid amplification tests. [19]

Historically, young women have also experienced much higher rates of genital warts than older women, [12] but recent years have seen marked declines in the younger age groups (appendix figure 2), likely associated with the introduction of the UK schools-based human papillomavirus vaccine (HPV) programme in 2008. [20] In England in 2016, the diagnosis rate of genital warts in 15 to 17 year old girls, most of whom would have been offered the

quadrivalent vaccine when aged 12 to 13 years, was 121.5 per 100,000 population, a 72% decrease relative to 2009. There has been a 62% decrease in the diagnosis rate of genital warts in 15 to 17 year old boys over the same time period, providing evidence of herd protection from the high coverage female HPV vaccination programme. [4] Similar reductions have not been seen in older age-groups. This school-aged vaccination programme offers no protection to MSM so a targeted HPV vaccination programme for MSM will be introduced in England in April 2018 following an initial pilot that ran from 2016.. [21] HPV vaccination has been offered opportunistically to MSM in Northern Ireland since October 2016 and Scotland since July 2017. HPV vaccination of MSM will provide direct protection against HPV infection with the aim of reducing the incidence of genital warts and HPV-related cancers.

GAY, BISEXUAL AND OTHER MEN WHO HAVE SEX WITH MEN

In the last decade, MSM have continued to be disproportionately affected by STIs including HIV, as well as blood-borne infections, such as hepatitis B and C, and sexually transmissible enteric infections, such as *Shigella flexneri*. [5 22-28] While only 11% of all attendances at English STI clinics in 2016 were by MSM, 53% of all gonorrhoea and syphilis diagnoses were made in this group. The number of diagnoses of these bacterial STIs in MSM in England has risen three- to five-fold over the last decade (figure 3). In 2016, the total number of syphilis diagnoses at STI clinics in England increased to 5,920, the largest number reported since 1949; the majority (81%) were in MSM. Similarly, in Scotland, syphilis diagnoses have doubled since 2014 to 356 in 2016, the largest number recorded since 1951; the majority (83%) were made in MSM. [29]

Several factors likely explain these increases. Studies suggest that increased frequency of condomless anal intercourse (CAI), sometimes associated with HIV sero-adaptive behaviours, group sex facilitated by geosocial networking applications and ‘chemsex’, may play a role. [30 31] The seven-fold rise in gonorrhoea diagnoses among MSM in England between 2007 and 2015, which has been mirrored in Wales and Northern Ireland, [9 10] and to a similar extent in Scotland based on male rectal diagnoses[8] may also be partly explained by increased detection following the change in the national gonorrhoea testing guideline to include asymptomatic screening at extra-genital sites in MSM using highly sensitive nucleic acid amplification tests. [32-36] In England, after years of successive increases since 2008, the number of gonorrhoea diagnoses in MSM decreased 22% to 17,584 between 2015 and 2016. This decline coincided with reductions in HIV diagnoses which have been associated

with improved HIV testing uptake at STI clinics, including repeat testing; prompt initiation of anti-retroviral treatment following diagnosis and irrespective of immune status to prevent onward transmission ('treatment as prevention'); and private access of HIV pre-exposure prophylaxis. [37] [38] Increased STI testing uptake at STI clinics occurred in parallel, and may have helped facilitate prompt identification and treatment of asymptomatic infection, reducing the likelihood of secondary transmission. More targeted, quarterly syphilis testing, especially in HIV-positive MSM, may be required to effect a reduction in syphilis incidence [39] [40].

BLACK MINORITY ETHNIC POPULATIONS

In 2016, data from England showed that diagnosis rates of chlamydia and gonorrhoea in black Caribbean populations were 4 times those of the general population. Similarly, in Wales in 2015, the gonorrhoea diagnosis rate in black populations was 3 times that of white populations.[9] The ethnic disparity in poor sexual health is even starker in the case of trichomoniasis where, in 2016 in England, the diagnosis rate in black Caribbean women was 14 times that of all women. There is considerable heterogeneity in STI diagnoses among black ethnic minority (BME) groups: black Caribbean and black non-Caribbean/non-African people (hereafter: 'any other black background') have the highest diagnosis rates of many STIs of all ethnic groups, while black Africans have relatively lower rates (figure 4). [41] [42]

Disproportionately higher rates of gonorrhoea in black Caribbean people in urban areas have been recognised since the 1950s and have persisted to the present day. [42-47] Since the mass wave of migration of people from the Caribbean and elsewhere in the British Commonwealth to the UK after the British Nationality Act of 1948, [48] most black Caribbean and other BME people have resided in the most deprived urban areas of England. [42] There is an inextricable link between the socioeconomic context of neighbourhoods and the health outcomes of their residents. [49] Sexual health is no exception, and evidence suggests that socioeconomic deprivation plays a role in ethnic disparities in STI diagnosis rates, although it does not fully explain it. [42] Behavioural factors, which are themselves influenced by socioeconomic environment, likely contribute. The findings of a national probability sample indicate that men of black Caribbean or any other black backgrounds are most likely to report higher numbers of recent sexual partners and concurrent partnerships which, coupled with assortative sexual mixing patterns, may be maintaining endemic levels of gonorrhoea transmission in these communities.[50] Data from England also suggest that BME MSM are more likely to be diagnosed with a bacterial STI and are at greater risk of HIV than white

British MSM, a disparity which may be explained by differences in health-seeking behaviour or sexual mixing patterns. [51 52]

DISCUSSION

Since the introduction of the Venereal Diseases Act (1917) 100 years ago, the complex interplay of historical events, changes in cultural mores, and technological and service developments are clearly reflected in the STI surveillance data presented. [5] More recently, there has been a re-emergence of gonorrhoea and syphilis among MSM, likely associated, at least in part, with increasing CAI as a result of HIV treatment optimism. [30 53 54] The rise in gonorrhoea diagnoses is of particular concern given the propensity of *Neisseria gonorrhoeae* to develop resistance to successive antimicrobials used for treatment. [55 56] However, there have also been notable successes in STI prevention in the last decade: following the implementation of the national HPV vaccination programme in school-aged girls, diagnoses of genital warts have declined markedly in young adults, and future reductions in HPV-related cancers are anticipated. [w1 2]

Accurate and easy to perform diagnostic tests are fundamental for early diagnosis and effective treatment, as well as informing our understanding of the epidemiology of STIs. The key development in the last 100 years was a shift in the method of confirming a bacterial STI diagnosis from one based on symptoms to one of defining asymptomatic people as carriers of a pathogen. For example, in 1917 syphilis diagnosis depended solely upon microscopic identification of the organism but, with advances in immunological techniques, serological assays were used routinely to provide more accurate results by the 1930s. In the 1970s the creation of monoclonal antibodies allowed the production of highly specific methods of testing patients for infections. [w3] The development of nucleic acid testing in the 1990s led to accurate, high volume, low cost tests which are now routinely used in the UK, [w4 5] and are likely to have contributed to the sharp rise in gonorrhoea diagnoses in England after 2010. [w6]

Regular testing for STIs, especially in those individuals at higher risk of infection, has been promoted through both targeted, public facing campaign work and changes in clinical and diagnostic practice. For example, clinical recommendations that MSM should test regularly for HIV (and thus, by extension, STIs) have been reinforced by promoting testing among MSM through campaigns such as National HIV Testing Week in England and the European HIV-Hepatitis Testing Week. National provision of pre-exposure prophylaxis for HIV (PrEP) has been forecasted to reduce STIs in MSM due to the increased STI screening required for

PrEP management. [w7] This has not yet been observed in practice, but the NHS-funded HIV PrEP programme in Scotland and national implementation trials in Wales and England will provide a unique opportunity to assess this on a national scale. [w8-10]

Promoting condoms, early diagnosis, access to effective treatments and effectual partner notification are key components of the prevention and control of STIs by interrupting onward transmission of infection, especially in high risk groups. [38] Access to STI clinics has improved over the last 10 years and, there are now over 4 million attendances at STI clinics annually [w11] and this marked improvement is in part due to the introduction of access targets for STI clinics in England in 2006. [w12] Although in 2011 nearly everyone (99.9%) was offered an appointment within 48 hours, [w13] there has since been a worrying worsening of service access, especially for symptomatic patients and women. [w14] Ensuring prompt access to those in need should remain a priority, especially given significant reorganisations in sexual health service provision and reductions in spend on services. [w15-17]

In the current climate of reduced funding, cost saving measures, such as the scale up of online service provision using STI self-sampling kits, are being pursued. [w17] [w18] An objective of a new service model for London residents is to direct patients to online services rather than attending terrestrial STI clinics. [w18] This has the potential to increase access to testing,[w19] but care must be taken to avoid exacerbating sexual health inequality through the digital divide; [w20-22] this is of particular concern for BME people from socioeconomically deprived areas, who experience disproportionate sexual ill-health.[42] It is vital that STI surveillance systems continue to adapt to capture this shift in service provision and thereby enable evaluation of its real-life impact. [w23]

There are promising developments on the horizon. Recently published case-control data from New Zealand provide evidence of a protective effect of group B meningococcal vaccine for gonorrhoea; [w24] [25] if this is corroborated by robust clinical trial data, improved control of gonorrhoea is potentially within reach. Furthermore, the widespread use of geosocial networking applications presents novel opportunities for both sexual health education and promotion. [w26] New developments in STI prevention should supplement more traditional approaches: condom use is a highly effective intervention to control the transmission of STIs, and should continue to be promoted.[w27]

Despite the myriad economic and societal changes over the last century, STIs continue to be associated with stigma, discrimination and socio-economic inequality. The means to prevent and control STIs are readily available, and in the UK the key mechanism for their delivery is

through open access clinics. As we enter a new era of sexual healthcare provision, we must ensure that innovation in interventions and their delivery continue to meet population needs as well as reduce health inequalities.

Acknowledgements: The authors acknowledge the contribution of all sexual health services to the surveillance of STIs since the inception of these surveillance systems. They also thank Ian Simms for his insight on the history of the UK's STI surveillance systems and Peter Kirwan for further editorial input.

Author contributions: HM, PB and GH designed the data analysis plan. HM, PB, DO, SD and MC performed the data analysis. HM wrote the first draft of the paper, which was reviewed and edited by all coauthors.

Competing interests: The authors declare no competing interests.

Funding: No additional funding was received for this analysis.

Ethics statement: As GUMCAD is a routine public health surveillance activity, no specific consent was required from the patients whose data were used in this analysis. In its role providing infectious disease surveillance Public Health England has permission to handle data obtained by GUMCAD under Regulation 3 of the Health Service (Control of Patient Information) Regulations 2002. Public Health Wales, the Public Health Agency and Health Protection Scotland have a statutory function to carry out surveillance of communicable disease.

REFERENCES

1. The Report of the Royal Commission on Venereal Diseases. *British Medical Journal* 1916;1(2879):345-46. doi: 10.1136/bmj.1.2879.345-b
2. Osler W. The campaign against venereal diseases. *Br Med J* 1917;1(2943):694-96. doi: 10.1136/bmj.1.2943.694
3. Simms I, Hughes G. 1917: responding to the challenge posed by venereal disease. Sex Transm Infect. In press. 2017
4. Public Health England. Sexually transmitted infections and chlamydia screening in England, 2016. Health Protection Report. 11(20), Advanced Access report published 6 June 2017. Available at: https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables. Accessed 7th June 2017.
5. Hughes G, Field N. The epidemiology of sexually transmitted infections in the UK: impact of behavior, services and interventions. *Future Microbiology* 2015;10(1):35-51. doi: 10.2217/fmb.14.110
6. Silies E-M. Taking the Pill after the 'sexual revolution': female contraceptive decisions in England and West Germany in the 1970s. *European Review of History: Revue européenne d'histoire* 2015;22(1):41-59. doi: 10.1080/13507486.2014.983431
7. Public Health England. Table 9: Selected STI diagnoses and rates in the UK by gender and age group, 2012 to 2016. Sexually transmitted infections (STIs): annual data tables. Available at: https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables. Accessed 3rd November 2017
8. Health Protection Scotland Weekly Report. Genital chlamydia and gonorrhoea infection in Scotland: laboratory diagnoses 2007 - 2016. Available at: http://www.hps.scot.nhs.uk/ewr/article.aspx. Accessed 3 November, 2017.
9. Public Health Wales. HIV and STI trends in Wales. Data tables, June 2017. Available at: http://www.wales.nhs.uk/sitesplus/888/news/45989. Accessed 3rd November, 2017.
10. Public Health Agency. Sexually Transmitted Infection surveillance in Northern Ireland 2016 - An analysis of data for the calendar year 2015. Available at: http://www.publichealth.hscni.net/directorate-public-health/health-protection/sexually-transmitted-infections. Accessed 3rd November, 2017.
11. Cowan FM, Mindel A. Sexually transmitted diseases in children: adolescents. *Genitourinary Medicine* 1993;69(2):141-47.
12. Nicoll A, Catchpole M, Cliffe S, et al. Sexual health of teenagers in England and Wales: analysis of national data. *BMJ* 1999;318(7194):1321-22. doi: 10.1136/bmj.318.7194.1321

13. Mercer CH, Tanton C, Prah P, et al. Changes in sexual attitudes and lifestyles in Britain through the life course and over time: findings from the National Surveys of Sexual Attitudes and Lifestyles (Natsal). *The Lancet* 2013;382(9907):1781-94.
14. Ford K, Sohn W, Lepkowski J. Characteristics of Adolescents' Sexual Partners and Their Association with Use of Condoms and Other Contraceptive Methods. *Family Planning Perspectives* 2001;33(3):100-32. doi: 10.2307/2673765
15. Kraut-Becher JR, Aral SO. Patterns of age mixing and sexually transmitted infections. *International Journal of STD & AIDS* 2006;17(6):378-83. doi: doi:10.1258/095646206777323481
16. McCree DH, Rompalo AM. Biological and Behavioral Risk Factors Associated with STDs/HIV in Women: Implications for Behavioral Interventions. In: Aral SO, Douglas JM, eds. Behavioral Interventions for Prevention and Control of Sexually Transmitted Diseases. Boston, MA: Springer US 2007:310-24.
17. Chandra N, Soldan K, Dangerfield C, et al. Filling in the gaps: estimating numbers of chlamydia tests and diagnoses by age group and sex before and during the implementation of the English National Screening Programme, 2000 to 2012. Euro Surveill. 2017;22(5):pii=30453. DOI: http://dx.doi.org/10.2807/1560-7917.ES.2017.22.5.30453. Accessed 18th August, 2017.
18. Hughes G, Lowndes CM. Epidemiology of sexually transmitted infections: UK. *Medicine* 2014;42(6):281-86. doi: http://dx.doi.org/10.1016/j.mpmed.2014.03.002
19. Scottish Intercollegiate Guidelines Network. Management of genital Chlamydia trachomatis infection. SIGN 109. March 2009. Available at: http://www.sign.ac.uk/sign-109-management-of-genital-chlamydia-trachomatis-infection.html. Accessed 17th November, 2017.
20. Howell-Jones R, Soldan K, Wetten S, et al. Declining Genital Warts in Young Women in England Associated With HPV 16/18 Vaccination: An Ecological Study. *Journal of Infectious Diseases* 2013;208(9):1397-403. doi: 10.1093/infdis/jit361
21. Department of Health and Social Care. HPV vaccination programme for men who have sex with men. Available at: https://www.gov.uk/government/news/hpv-vaccination-programme-for-men-who-have-sex-with-men. Accessed 16th February, 2018.
22. Gilbart VL, Simms I, Jenkins C, et al. Sex, drugs and smart phone applications: findings from semistructured interviews with men who have sex with men diagnosed with *Shigella flexneri* 3a in England and Wales. *Sexually Transmitted Infections* 2015 doi: 10.1136/sextrans-2015-052014
23. Public Health England. Shigella infections not known to be associated with travel in England: laboratory reports 2004 to 2016. *Health Protection Report* 2016;10 (22)

24. Simms I, Field N, Jenkins C, et al. Intensified Shigellosis epidemic associated with sexual transmission in men who have sex with men - *Shigella flexneri* and *S. sonnei* in England, 2004 to end of February 2015. Euro Surveill. 2015;20(15):pii=21097. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=21097. Accessed 4th June 2015. 2015
25. Beebeejaun K, Degala S, Balogun K, et al. Outbreak of hepatitis A associated with men who have sex with men (MSM), England, July 2016 to January 2017. Euro Surveill. 2017;22(5):pii=30454. DOI: http://dx.doi.org/10.2807/1560-7917.ES.2017.22.5.30454. Accessed 5th May, 2017.
26. Public Health England. Hepatitis A outbreak (England) investigation (2016-2017). Available at: https://www.gov.uk/government/publications/hepatitis-a-outbreak-england-investigation-2016-2017. Accessed 4th July 2017.
27. Simms I, Gilbart VL, Byrne L, et al. Identification of verocytotoxin-producing Escherichia coli O117:H7 in men who have sex with men, England, November 2013 to August 2014. Euro Surveill. 2014;19(43):pii=20946. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20946. Accessed 20 August 2015.
28. Shankar AG, Mandal S, Ijaz S. An outbreak of hepatitis B in men who have sex with men but identify as heterosexual. *Sexually Transmitted Infections* 2016 doi: 10.1136/sextrans-2015-052490
29. Health Protection Scotland. Syphilis in Scotland 2016: update. HPS Weekly Report 2017; 51 (33): 278-287. Available at: http://www.hps.scot.nhs.uk/bbvsti/wrdetail.aspx?id=75392&wrtype=6. Accessed 17 November, 2017.
30. Aghaizu A, Wayal S, Nardone A, et al. Sexual behaviours, HIV testing, and the proportion of men at risk of transmitting and acquiring HIV in London, UK, 2000–13: a serial cross-sectional study. *The Lancet HIV* 2016;3(9):e431-e40. doi: http://dx.doi.org/10.1016/S2352-3018(16)30037-6
31. Daskalopoulou M, Rodger AJ, Phillips AN, et al. Condomless sex in HIV-diagnosed men who have sex with men in the UK: prevalence, correlates, and implications for HIV transmission. *Sexually Transmitted Infections* 2017 doi: 10.1136/sextrans-2016-053029
32. Ison C. GC NAATs: is the time right? *Sexually Transmitted Infections* 2006;82(6):515. doi: 10.1136/sti.2006.022731

33. Health Protection Agency. Guidance for gonorrhoea testing in England and Wales, February 2010. Available at http://www.bashh.org/documents/2580.pdf. Accessed 4th June 2015
34. Fifer H, Ison CA. Nucleic acid amplification tests for the diagnosis of *Neisseria gonorrhoeae* in low-prevalence settings: a review of the evidence. *Sexually Transmitted Infections* 2014;90(8):577-79. doi: 10.1136/sextrans-2014-051588
35. Savage EJ, Marsh K, Duffell S, et al. Rapid increase in gonorrhoea and syphilis diagnoses in England in 2011. *Eurosurveillance* 2012;17(29):20224. doi: doi:https://doi.org/10.2807/ese.17.29.20224-en
36. Public Health England. Sexually transmitted infections and chlamydia screening in England, 2015. Health Protection Report. 10(22), Advanced Access report published 5 July 2016. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/559145/hpr2216_crrctd3.pdf. Accessed 16th February 2018.
37. Nwokolo N, Whitlock G, McOwan A. Not just PrEP: other reasons for London's HIV decline. *The Lancet HIV*;4(4):e153. doi: 10.1016/S2352-3018(17)30044-9
38. Brown A, Mohammed H, Ogaz D, et al. Fall in new HIV diagnoses among men who have sex with men (MSM) at selected London sexual health clinics since early 2015: testing or treatment or pre-exposure prophylaxis (PrEP)? . Euro Surveill. 2017;22(25):pii=30553. DOI: http://dx.doi.org/10.2807/1560-7917.ES.2017.22.25.30553. Accessed 30 June 2017.
39. Gray RT, Hoare A, Prestage GP, et al. Frequent Testing of Highly Sexually Active Gay Men is Required to Control Syphilis. *Sexually Transmitted Diseases* 2010;37(5):298-305. doi: 10.1097/OLQ.0b013e3181ca3c0a
40. Tuite AR, Fisman DN, Mishra S. Screen more or screen more often? Using mathematical models to inform syphilis control strategies. *BMC Public Health* 2013;13(1):606. doi: 10.1186/1471-2458-13-606
41. Le Polain De Waroux O, Harris RJ, Hughes G, et al. The epidemiology of gonorrhoea in London: a Bayesian spatial modelling approach. *Epidemiology & Infection* 2014;142(01):211-20. doi: doi:10.1017/S0950268813000745
42. Furegato M, Chen Y, Mohammed H, et al. Examining the role of socioeconomic deprivation in ethnic differences in sexually transmitted infection diagnosis rates in England: evidence from surveillance data. *Epidemiology and Infection* 2016:1-10. doi: 10.1017/S0950268816001679
43. Beveridge MM. Source of Infection with Gonorrhoea in Various Ethnic Groups. *British Journal of Venereal Diseases* 1962;38(3):154-56.

44. Laird SM. Gonorrhoea in the Manchester Region. *British Journal of Venereal Diseases* 1962;38(4):181-88.
45. Watt L. Gonorrhoea in ManchesterIncidence of Repeated Infections. *British Journal of Venereal Diseases* 1958;34(1):9-13.
46. Low N, Daker-White G, Barlow D, et al. Gonorrhoea in inner London: results of a cross sectional study. *BMJ* 1997;314(7096):1719. doi: 10.1136/bmj.314.7096.1719
47. Low N, Sterne JAC, Barlow D. Inequalities in rates of gonorrhoea and chlamydia between black ethnic groups in south east London: cross sectional study. *Sexually Transmitted Infections* 2001;77(1):15-20. doi: 10.1136/sti.77.1.15
48. British Nationality Act 1948. Available at: http://www.legislation.gov.uk/ukpga/Geo6/11-12/56/introduction. Accessed 18th August, 2017.
49. Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of Epidemiology and Community Health* 2001;55(2):111-22. doi: 10.1136/jech.55.2.111
50. Wayal S, Hughes G, Sonnenberg P, et al. Examining ethnic variations in sexual behaviours and sexual health markers: evidence from a British national probability sample survey. *The Lancet Public Health In press* 2017
51. Mohammed H, Furegato M, Hughes G. P068 Inequalities in sexually transmitted infection risk among black and minority ethnic men who have sex with men in England. *Sexually Transmitted Infections* 2016;92(Suppl 1):A42-A42. doi: 10.1136/sextrans-2016-052718.122
52. Desai S, Nardone A, Hughes G, et al. HIV incidence in an open national cohort of men who have sex with men attending sexually transmitted infection clinics in England. *HIV Medicine* 2017;18(9):615-22. doi: 10.1111/hiv.12498
53. Van de Ven P, Rawstorne P, Nakamura T, et al. HIV treatments optimism is associated with unprotected anal intercourse with regular and with casual partners among Australian gay and homosexually active men. *International Journal of STD & AIDS* 2002;13(3):181-83. doi: doi:10.1258/0956462021924884
54. Fenton KA, Imrie J. Increasing Rates of Sexually Transmitted Diseases in Homosexual Men in Western Europe and the United States: Why? *Infectious Disease Clinics* 2005;19(2):311-31. doi: 10.1016/j.idc.2005.04.004
55. Public Health England. High level azithromycin resistant gonorrhoea in England. Available at: https://www.gov.uk/government/publications/high-level-azithromycin-resistant-gonorrhoea-in-england. Accessed 6th Dec, 2016.
56. Public Health England. Surveillance of antimicrobial resistance in *Neisseria gonorrhoeae* in England and Wales. Key findings from the Gonococcal Resistance to

Antimicrobials Surveillance Programme (GRASP) - Data to June 2017. Available at: https://www.gov.uk/government/publications/gonococcal-resistance-to-antimicrobials-surveillance-programme-grasp-report/. Accessed 3rd November 2017

Figure 1 - a. Number of diagnoses of gonorrhoea, 1918-2016, b. number of diagnoses of primary, secondary and early latent syphilis, 1922-2016 and c. ratio of diagnoses of gonorrhoea and primary, secondary and early latent syphilis in men and women, 1925-2016; sexually transmitted infection clinics, United Kingdom *º†

Figure 1a

Figure 1b

Figure 1c

Different scales are used for the y-axes of each of the above graphs

* Data from Northern Ireland are available starting the year 1991
ºScotland data from 1995 are unavailable
† Data from STI clinics' routine surveillance returns and routine laboratory reporting

Syphilis data is only Scotland 1922-1930; England, Wales and Scotland 1931-1990; and all countries from 1991 onwards (except for 1995, which is missing Scotland data)

Gonorrhoea data is only England and Wales 1918- 1921; England, Wales and Scotland 1922-1990; and all countries 1991 onwards (except for 1995, which is missing Scotland data)

Figure 2. Rates of chlamydia, gonorrhoea or syphilis* diagnoses † by age-group and gender, 2016, United Kingdom

* Primary, secondary and early latent stages

† Data from STI clinics' routine surveillance returns and routine laboratory reporting

Figure 3. Number of new diagnoses of selected sexually transmitted infections (STIs) in men who have sex with men attending STI clinics†, 2007–2016, England

Different scales are used for the y-axes for i. chlamydia and gonorrhoea and ii. genital herpes, genital warts, and syphilis

* First episode; ** Primary, secondary and early latent

† Data from routine specialist and non-specialist sexual health services' returns to the GUMCAD surveillance system

Figure 4. Rates of selected sexually transmitted infection (STI) diagnoses* by ethnic group and STI, 2016, England

* Data from routine specialist and non-specialist sexual health services' returns to the GUMCAD surveillance system

** First episode. ‡ Primary, secondary and early latent

Appendix Figure 1. Rates of selected sexually transmitted infection (STI) diagnoses† by gender and age group‡, 2012–2016, United Kingdom

† Data from STI clinics' routine surveillance returns and routine laboratory reporting**; ‡** Years

* First episode; ** Primary, secondary and early latent

Different scales are used for the y-axes of different STIs

Appendix Figure 2. Rates of first episode genital warts diagnoses† by gender and age group‡, 2012–2016, England

† Data from routine specialist and non-specialist sexual health services' returns to the GUMCAD surveillance system**; ‡** Years

* First episode