Title: The Delivery of Primary Prevention Interventions in Sexual Health Services

Summary text for the Table of Contents: Prevention of Sexually Transmitted Infections (STIs) is central to achieving good sexual health and to reducing the cost burden of treatment and management on healthcare services. Specialist sexual health services (SHS) are ideally placed to deliver primary prevention interventions for STIs however quantifying their impact remains a challenge. This review summarises the role of specialist SHS in the delivery of primary prevention and considers the barriers and opportunities presented by emerging technologies for STI prevention and changing SHS delivery models.

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Word count: 2933

Tables: 2 (two)

Abstract

Sexually transmitted infections (STIs) affect hundreds of millions of people globally. The resulting impact on quality of life and the economy for health systems is huge. Specialist sexual health services play a key role in the provision of primary prevention interventions targeted against STIs. Established interventions include education and awareness building, condom promotion, and the provision of vaccines. Nascent interventions such as the use of antibiotics as pre- and post-exposure prophylaxis are not currently recommended but have already been adopted by some key population groups. The shift to delivering sexual health services through digital health technologies may help to reduce barriers to access for some individuals but creates challenged for the delivery of primary prevention and may inadvertently increase health inequities. Intervention development will need to consider carefully these shifting models of service delivery so that existing primary prevention options are not side-lined and that new interventions reach those who can benefit most.

Keywords: Prevention, STIs, Health Services, Health Promotion, Vaccines, HPV, Hepatitis

Introduction:

Sexually transmitted infections (STIs) are a major public health concern. In 2020, the World Health Organization estimated that more than 374 million new infections occurred with either *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Treponema pallidum* or *Trichomonas vaginalis.*(1) Many hundreds of millions more individuals are living with genital herpes simplex virus, human papilloma virus (HPV) and chronic hepatitis B infection.(1) STIs are also often associated with shame, social stigma and intolerance, all of which can dramatically impact an individual's wellbeing and quality of life.(2)

Undiagnosed or untreated STIs can lead to life-changing complications, including pelvic inflammatory disease (PID); tubal factor infertility (TFI); ectopic pregnancy; cervical cancer; perinatal, congenital or disseminated infections; cardiovascular and neurological complications; and increased susceptibility to HIV.(3) The resulting impacts on morbidity, mortality and costs on the healthcare system are enormous.(4-6) Prevention and treatment of STIs can be significantly less costly than treating the sequelae of infections. For example, in the UK, initial treatment of syphilis is estimated to be less than 300 times the management costs for permanent disability caused by neurosyphilis (£77 vs. £25,776).(7)

Although achieving good sexual health '*is not merely the absence of disease*', efforts to prevent the acquisition of infections form a key part of activities undertaken by sexual and public health professionals.(8) Broadly, these activities operate at each of the three levels of prevention in public health: primary, secondary and tertiary (table 1). Primary prevention methods aim to prevent the acquisition of an infection and include activities such as the use of safer sex practices to reduce exposure (e.g. condoms), education on sexual and

reproductive health and relationships (e.g. school-based education and public campaigns), the use of chemoprophylaxis (e.g. pre- and post-exposure prophylaxis for HIV, chlamydia and syphilis) and vaccination (e.g. for HPV, hepatitis A and B viruses). Secondary prevention aims to treat the infection to prevent health harms and transmission. Examples include STI testing, treatment, and partner notification and management. Tertiary prevention for STIs aims to reduce any long-term effects of chronic infections, for example, management of genital herpes and HIV.(9)

Whilst a combination prevention approach should be taken, drawing on interventions across primary, secondary and tertiary prevention options, this review focusses on evidence to support the delivery of primary prevention interventions for STIs delivered within specialist sexual health services (SHS) and considers implications for delivery of these within future and emerging models of SHS delivery. The exact structure of these services will vary between countries and health systems; however, the primary focus of these services should be the delivery of sexual healthcare and have healthcare professionals trained in sexual health. Although primary prevention for STIs can, and should, be delivered in a variety of settings, there are several features which make SHS particularly well suited. Healthcare professionals within these settings specialise in sexual health, a key part of which is having structured, culturally competent discussions about sex, risk and prevention that may be more challenging in other settings or for other health professionals.(10) This is important as concerns about being able to take sexual histories and being asked sensitive questions can act as a barrier to the delivery of good care. In many areas, there have been large changes in how these services are delivered over the last decade for example, with the availability of technologies to allow for remote self-sampling. More recently, the SARS-CoV-2 pandemic

has led to rapid and sustained changes in service delivery with a shift to more remote consultations and management.(11) We consider how these changes may impact the delivery of primary prevention and implications of this.

Education, awareness and health promotion

Health promotion is "*the process of enabling people to increase control over, and to improve, their health*" and encompasses interventions aimed at changing individual behaviours and reducing risk.(12) Accessible and high-quality information that empowers people to manage their own sexual health needs is essential to prevent acquisition and transmission of STIs.

While some health promotion activities are universal in scope, others need to be tailored for key populations and marginalised groups disproportionately affected by STIs. Examples of these key population groups may include gay, bisexual, and other men who have sex with men (MSM), trans and gender diverse people, and sex workers. Understanding the differences in knowledge and awareness of STIs in these population groups as well as behaviours, attitudes and other factors that influence their risk of acquiring STIs are essential for developing effective health promotion interventions.

Among MSM, poorer knowledge of STIs has been shown to be associated with higher risk behaviours. Although some MSM are well informed, there remains widespread lack of knowledge around prevention, modes of STI transmission and treatment options, especially among HIV-negative men or those with unknown HIV status compared with HIV-positive men.(13-18) Specialist SHS play an important role in providing health promotion and advice

and are widely perceived as acceptable and preferable as a source of information compared to other settings among MSM and young people.(19) Barriers exist to accessing specialist SHS including concerns over confidentiality and being identified within their communities among men of Black and Asian ethnicities in the UK [Datta 2018] although variation exists with people from a Black Caribbean background more likely than those in other ethnic groups to access UK sexual health clinics.(20, 21)

Community involvement in the design, delivery and evaluation of sexual health promotion and interventions is also recognised as an important factor among both MSM and Black Caribbean groups.(22, 23) To help stimulate behaviour change, health promotion activities and interventions should therefore be co-developed with key populations to ensure they are culturally relevant, tailored to groups that are at higher risk of acquiring STIs and reflect different groups preferences for their content, format and delivery.

In the UK, the main source of information about sex for the majority of young people is through lessons at school, with a lower reporting of STI diagnoses and unplanned pregnancy among young people who gain information through Sexual and Reproductive Health Education in school compared to those gaining information mainly through other sources.(24, 25) Although only the minority (0.9%) of young people cite doctors, nurses and clinics as their main source of information, it is a highly trusted and preferred setting for information about condoms and contraception.(24, 26) Whilst the provision of factsheets and clear, accurate written information about STIs and their prevention is recommended within STI management guidelines, the evidence to support the effectiveness of such an approach in prevention of reinfection is lacking.(27) (28)

The use of digital media for sexual health promotion has significant potential given the reach and popularity of the internet and mobile phones.(29) A recent systematic review of digital media interventions (i.e. social media, web pages, text messages) for sexual health among young people found evidence that these interventions are effective in increasing knowledge around the prevention of STIs and HIV, however this increase in knowledge does not guarantee improved health outcomes.(30, 31) Among MSM, the delivery of sexual health information and promotion through social media is viewed as acceptable and feasible, but to be effective it should be engaging, positive in tone and delivered by trusted healthcare organisations.(32) More targeted in-person or digital brief interventions that address key risk behaviours, for example drug and alcohol use, have also been widely used in SHS but, whilst feasible, have shown mixed results.(33-36)

Digital interventions have the potential to provide a cost-effective way to deliver sexual health promotion, particularly promotion that appeals to young people and could be delivered from SHS, but significant barriers exist to this approach. These include shared computer space (privacy concerns) or filtering software on phones or other devices.(29) Moreover, the scale of digital exclusion needs to be considered to ensure the equitable delivery of digital or online health promotion messages.

Condoms

Consistent and correct use of condoms can significantly reduce the risk of acquiring STIs, including HIV.(37-40) An international systematic review looking at the effectiveness of global condom promotion programmes, including interventions relating to social marketing,

promotion of condom brands and HIV/STI prevention programmes that specifically promoted condom use, confirms that condoms remain a crucial intervention for the prevention of STI transmission.(41) Interventions that teach and encourage correct and consistent condom use, along with communication and negotiation skills, are particularly effective in reducing STI transmission.(42) The use of female (internal) and male (external) condoms (when women are given the option to make a choice of one or both at each sexual act) is more effective than use of male condoms only in preventing chlamydia and gonorrhoea, and is potentially more effective in preventing trichomoniasis and other STIs.(43) Therefore, access to condoms of all types is an essential component of SHS delivery.

Young people experience the highest diagnosis rates of the most common STIs and studies have shown rising trends in diversity of sexual practices.(44-48) Despite changes in behavioural patterns, the use and perception of condoms varies among young people with unintended conception viewed as a greater concern than contracting a STI.(26) Young people also report major barriers to accessing SHS, including long waiting times, stigma and embarrassment, lack of clarity on which services are available, and an insufficient number of specialised SHS.(26) Many of these access challenges for young people have been compounded by the COVID-19 pandemic.(49) These changing patterns of behaviour and barriers to access raise new challenges for health promotion and the provision of condoms through SHS.

Motivational interviewing has been found to be effective at increasing the frequency of condom use during anal or oral sex among MSM living with HIV in the three months

following the motivational interviewing intervention.(50) However, this intervention was delivered within an academic centre providing HIV outpatient care and there is a lack of evidence that motivational interviewing reduces the likelihood of unprotected anal intercourse with casual partners among young MSM. There is some evidence to suggest that lay health advisor delivered interventions could be effective at reducing STI acquisition and improving condom use among young heterosexual African American men.(51, 52)

Biomedical prevention

Vaccination

Safe and effective vaccines exist for several STIs and can be delivered to individuals attending SHS, although vaccine coverage varies between and within programmes and populations. Within current delivery models, these require administration within the clinic, or by healthcare workers in outreach settings (table 2). Therefore, the shift to remote and digital delivery of SHS may present a challenge to ongoing vaccination efforts.

Hepatitis A and B Virus

Hepatitis A virus (HAV) causes an acute infection of the liver and is primarily transmitted faecal-orally via ingestion of contaminated food or water or by direct contact with an infectious individual.(53) There are 1.4 million new cases annually reported globally accounting for approximately 7,000 deaths.(54) In a number of countries, selective vaccination is recommended for individuals travelling to endemic countries and other key risk groups, including MSM (table 2). Outbreaks of HAV in MSM do occur, most recently in England in 2017, partly attributable to variable implementation of vaccination in SHS.(55)

Hepatitis B virus (HBV) also causes an acute or chronic infection of the liver, and is transmitted through sex, blood to blood contact and perinatally. If persistent infection develops, it can lead to cirrhosis and liver cancer.(53) There are approximately 250 million people living with chronic HBV infection and almost 900,000 people die from complications of infection annually.(56) Infant vaccination programmes have been introduced in most countries, but selective immunisation for certain key populations at risk through sexual exposure or blood, for example MSM, sex workers, prisoners and people who inject drugs, is also recommended in guidelines (table 2).(57)

Human papillomavirus

Human papillomavirus (HPV) is one of the most commonly transmitted STIs and worldwide, about 5% of all cancers are linked to the virus, mostly to subtypes HPV16 and 18, including cervical, penile, anal and genital cancers and some cancers of the head and neck.(58) Other subtypes of HPV, such as 6 and 11, cause external genital warts which can place a significant impact on personal wellbeing as well as an economic burden on health systems.(59)

Since the introduction of the HPV vaccine, there have been significant reductions in HPV infections, cervical intraepithelial neoplasia 2+ and anogenital warts diagnoses seen globally and, in England, the HPV immunisation programme has almost eliminated cervical cancer in women born since 1 Sept, 1995.(60, 61) In some countries where universal vaccination of school-aged children was not initially adopted, catch up vaccination of key population groups in SHS has been introduced. For example, in England, the HPV vaccination programme has had a phased expansion based on modelling direct and indirect benefits to include MSM up to 45 years of age attending SHS (since 2018) and boys via a gender-neutral

school-based adolescent immunisation programme in school year 8 i.e. aged 12 and 13 years (since 2019).(62, 63) By the end of December 2019, 93% of specialist SHS in England reported HPV opportunistic vaccination activity for MSM.(64)

Barriers to HPV vaccination are varied and can range from lack of knowledge of HPV, HPV related diseases, HPV or vaccine stigma and vaccine beliefs to delivery-specific concerns, such as long intervals between dose and the inconvenience of multiple doses.(65, 66) Offering the vaccine when testing for STIs or within SHS, support from the healthcare provider and increasing public awareness of HPV and the health benefits of vaccination to MSM may overcome some of these barriers to facilitate vaccine uptake.(65, 66)

Gonorrhoea and chlamydia

Whilst there are currently no licensed vaccines for most STIs, such as herpes simplex, chlamydia, gonorrhoea, and syphilis, or Sexually Transmissible Enteric Pathogens (STEIs) such as *Shigella*, several are in development.(67-69) Efforts to develop vaccines against *Neisseria gonorrhoeae* have become increasingly critical given the rising threat of gonococcal AMR.(70) Analyses of surveillance data collected in New Zealand showed that individuals who had received Meningitis B vaccine were at lower risk of subsequently acquiring gonorrhoea and clinical trials are currently underway to evaluate the efficacy of the four-component meningococcal B vaccine (Bexsero) in preventing gonorrhoea in gay and bisexual men.(71, 72) An additional anticipated benefit to reducing diagnoses of gonorrhoea would be to slow the development of antimicrobial resistance. However, vaccine hesitancy could be an issue if the stigma associated with STIs extended to STI vaccines.

The complex life cycle of chlamydia has made vaccine development challenging. A recent first-in-human clinical phase 1 trial showed a vaccine candidate and adjuvant were immunogenic, safe and well tolerated with further efficacy studies underway.(73)

Doxycycline prophylaxis for chlamydia and syphilis

Doxycycline as pre- and post-exposure prophylaxis for syphilis and chlamydia has been shown to reduce the risk of acquiring chlamydia and syphilis in a very small number of published studies.(74, 75) There are several ongoing international studies to further explore the efficacy and potential harms of doxycycline prophylaxis, particularly in relation to AMR.(76, 77) Significant uncertainties currently exist about the efficacy, safety, harms and

most appropriate target populations for doxycycline prophylaxis. So, whilst the delivery of antibiotic prophylaxis could feasibly be delivered through SHS, it is not currently recommended in any guidelines internationally. Despite this, there is evidence that some MSM at higher risk of STIs (e.g. MSM on HIV-PrEP) are self-sourcing antibiotics to use as STI prophylaxis and healthcare providers should be aware of the issues.(78-83)

The future of primary prevention in SHS

Whilst there are many strengths to the approach of delivering primary prevention in SHS, there are also several potential weaknesses and emerging challenges. SHS are limited in their physical and financial capacity to deliver care to those at risk of STIs. Key populations still experience significant barriers to accessing services and continue to be disproportionately affected by STIs. The COVID-19 pandemic has accelerated the move to online provision of SHS. Although this may facilitate access for some groups, it may also present a significant barrier to access for others [cross reference article in this issue by Matt Golden and Claudia Estcourt]. Online delivery may provide savings due to factors such as reduced staffing costs, but there is limited existing evidence to support the cost effectiveness of online service models. Those who are already disproportionately affected by STIs are also those who may struggle most to use digital healthcare, thereby cementing and worsening health inequalities.(84) In terms of the delivery of the primary prevention interventions outlined above, there are obvious challenges in delivering many of these through virtual consultations. Online models of PrEP delivery may offer an example of how biomedical STI prevention could be delivered in the future, but vaccination currently requires face to face delivery. However, self-administered intradermal and intramuscular influenza vaccination has been shown to be acceptable and feasible among healthcare

workers so could be explored for other vaccines and for lay users, although logistical issues particularly around cold-chain management could be an issue.(85) Self-administration of heparin and long-acting contraception are other examples that could be drawn upon.

Conclusion

SHS are ideally placed to provide a variety of primary prevention interventions to a range of key population groups. Evidence to support their delivery in these settings predominantly comes from observational data to show it is feasible and acceptable but quantifying the economic and disease impacts remains challenging. Interventions to improve uptake and delivery of primary prevention should be co-produced with input from the population groups for whom these interventions are targeted. Whilst the shift to delivering online services may help to create opportunities for some service users, digital exclusion could contribute to worsening health outcomes. Therefore, robust evaluation should underpin any intervention development and delivery to improve our understanding of what works for whom, why and in what context. This is important to allow services in other settings to adopt and adapt interventions to best suit their own context.

Conflicts of interest: The authors declare no conflicts of interest

Declaration of funding: This research did not receive any specific funding

Acknowledgements: Katy Sinka and Kate Folkard at the UK Health Security Agency; Adam Winter, Sydney Joyce and Andrea Duncan at the UK Department of Health and Social Care.

Data Availability Statement: Data sharing is not applicable as no new data were generated or analysed during this study.

Table 1: Public health prevention levels for prevention of sexually transmitted infections (STI)

Prevention level	Definition	Example
Primary	Preventing the acquisition of STIs	Education and advice, awareness raising, campaigns, condom promotion and provision, needle and syringe exchange, antibiotic prophylaxis, vaccination
Secondary	Reducing the severity of STIs and decreasing opportunities for transmission	STI testing and treatment, partner notification and management
Tertiary	Improving the quality of life for people with chronic STIs	Antiviral treatment of chronic hepatitis B, Herpes simplex virus, reducing STI related stigma

Table 2: UK, USA, Australian, Canadian and World Health Organisation (WHO) guidelines for vaccination against Human Papillomavirus (HPV), Hepatitis A (HAV) and Hepatitis B (HBV)

Vaccination	Guideline	Recommended population	Year implemented
Human Papillomavirus (HPV)			
	UK Health Security Agency(86)	Girls (12-13 years)	2008
		Boys (12-13 years)	2019
		MSM (≤45 years)	2018
		Immunocompromised[a]	-
	US Centers for Disease Control and Prevention(87)	Girls (11-12 years)	2006
		Boys (11-12 years)	2011
		Immunocompromised (≥9 years and ≤26 years)[a]	-
	Public Health Association Australia(88)	Adolescents (9-18 years)	2009
		MSM (≥9 years)	2018
		Immunocompromised[a] (≥9 years)	-

Public Health Agency of Canada(89)	Girls (≥9 years and ≤26 years)	2007
	Boys (≥9 years and ≤26 years)	2012
	Immunocompromised[a]	-
WHO(90)	Girls (9-14 years)	-
Hepatitis A Virus (HAV)		
UK Health Security Agency(91)	People at high risk of exposure to the virus or complications[b] (≥1 year)	1990s
	Susceptible people exposed to the virus (≥1 year)	
US Centers for Disease Control and Prevention(92)	Infants (≥1 year)	1990s
	People at high risk of exposure to the virus or complications[b] (≥6 months)	
	Susceptible people exposed to the virus (≥1 year)	
Public Health Association Australia(93)	People at high risk of exposure to the virus or complications[b] (≥18 months)	1990s
Public Health Agency of Canada(94)	People at high risk of exposure to the virus or complications[b] (≥6 months)	1990s
	Susceptible people exposed to the virus (≥6 months)	
WHO(95)	Universal vaccination in areas of intermediate endemicity (≥1 year)	-
Hepatitis B Virus (HBV)		

UK Health Security Agency(96)	Infants (≥8 weeks)	1980s
	People at high risk of exposure to the virus or complications[c] (any age)	
	People exposed to the virus (any age)	
US Centers for Disease Control and Prevention(97)	Infants (any age)	1980s
	People at risk of exposure to the virus or complications[c] (any age)	
	People who request the vaccine (any age)	
	Susceptible people exposed to the virus (any age)	
Public Health Association Australia(98)	Infants (any age)	1980s
	People at risk of exposure to the virus or complications[c] (any age)	
	Susceptible people exposed to the virus (any age)	
Public Health Agency of Canada(99)	Infants (any age)	1980s
	People at risk of exposure to the virus or complications (any age)	
	Susceptible people exposed to the virus (any age)	
WHO(100)	Universal vaccination (≤1 year)	-

293 [a]Including eligible gay, bisexual and other men who have sex with men (MSM) with human immunodeficiency virus (HIV) infection and people with other

294 immunodeficiencies, such as hyposplenia

[b]Including people travelling to or going to reside in areas of high or intermediate/medium hepatitis A endemicity, people who inject drugs (PWID), MSM, people with severe liver disease or haemophilia, people at occupational risk (e.g. laboratory workers, staff and residents of some large residential institutions, sewage workers, people who work with primates), previously unvaccinated persons who anticipate close personal contact (e.g. household) with an international adoptee from a country of high or intermediate/medium hepatitis A endemicity, people experiencing homelessness, people with chronic liver disease, people living with HIV, Aboriginal and Torres Strait Islander children living in the Northern Territory, Queensland, South Australia or Western Australia, people with developmental disabilities, incarcerated people

[c]Including PWID, MSM, sex workers, close contacts of cases of hepatitis B (including household members), some foster carers, those receiving regular blood products or transfusions (e.g. people with haemophilia), people on haemodialysis or renal transplantation programmes, people with chronic liver disease or hepatitis C infection, incarcerated people, people in residential accommodation for those with learning difficulties, people travelling to or going to reside in areas of high or intermediate/medium prevalence of hepatitis B endemicity, people at occupational risk (e.g. healthcare workers), people with diabetes (aged 19 through to 59 years), people living with HIV, Aboriginal and Torres Strait Islander people, sex workers

References

1. World Health Organization. Sexually transmitted infections Factsheet. https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-(stis). WHO: Geneva, 2021.
2. Hood JE, Friedman AL. Unveiling the hidden epidemic: a review of stigma associated with sexually transmissible infections. Sexual health. 2011;8(2):159-70.
3. World Health Organization. Global Health Sector Strategy on Sexually Transmitted Infections, 2016-2021. WHO: Geneva 2016.
4. World Bank. Sexually Transmitted Infections in Developing Countries. https://webworldbankorg/archive/website01213/WEB/0__CO-54HTM. 2009.
5. Jackson LJ, Auguste P, Low N, Roberts TE. Valuing the health states associated with Chlamydia trachomatis infections and their sequelae: a systematic review of economic evaluations and primary studies. Value Health. 2014;17(1):116-30.
6. Centers for Disease Control and Prevention. Sexually Transmitted Infections Prevalence, Incidence, and Cost Estimates in the United States. https://wwwcdcgov/std/statistics/prevalence-2020-at-a-glancehtm#:~:text=CDC%20estimates%20indicate%20about%2020%20percent%20of%20the,system%20nearly%20%2416%20billion%20in%20healthcare%20costs%20alone. 2021.
7. Public Health England. Sexual and Reproductive Health Return on Investment Tool. 2020.
8. World Health Organization. Defining sexual health. Report of a technical consultation on sexual health 28-31 January 2002, Geneva.
9. European Centre for Disease Prevention and Control. Developing a national strategy for the prevention and control of sexually transmitted infections. Stockholm: ECDC; 2019.
10. Yeung A, Temple-Smith M, Fairley C, Hocking J. Narrative review of the barriers and facilitators to chlamydia testing in general practice. Australian Journal of Primary Health. 2015;21(2):139-47.
11. Public Health England. The impact of the COVID-19 pandemic on prevention, testing, diagnosis and care for sexually transmitted infections, HIV and viral hepatitis in England. Provisional data: January to September 2020.
12. World Health Organization. Health Promotion. https://wwwwhoint/westernpacific/about/how-we-work/programmes/health-promotion.
13. Wayal S, Reid D, Weatherburn P, Blomquist P, Fabiane S, Hughes G, et al. Association between knowledge, risk behaviours, and testing for sexually transmitted infections among men who have sex with men: findings from a large online survey in the United Kingdom. HIV Med. 2019;20(8):523-33.
14. McDaid LM, Li J, Knussen C, Flowers P. Sexually transmitted infection testing and self-reported diagnoses among a community sample of men who have sex with men, in Scotland. Sex Transm Infect. 2013;89(3):223-30.
15. Mimiaga MJ, Goldhammer H, Belanoff C, Tetu AM, Mayer KH. Men who have sex with men: perceptions about sexual risk, HIV and sexually transmitted disease testing, and provider communication. Sex Transm Dis. 2007;34(2):113-9.
16. van der Snoek EM, de Wit JB, Gotz HM, Mulder PG, Neumann MH, van der Meijden WI. Incidence of sexually transmitted diseases and HIV infection in men who have sex with men related to knowledge, perceived susceptibility, and perceived severity of sexually transmitted diseases and HIV infection: Dutch MSM-Cohort Study. Sex Transm Dis. 2006;33(3):193-8.
17. Datta J, Reid D, Hughes G, Mercer CH, Wayal S, Weatherburn P. Awareness of and attitudes to sexually transmissible infections among gay men and other men who have sex with men in England: a qualitative study. Sex Health. 2019;16(1):18-24.

18. The EMIS Network. EMIS 2010: The European Men-Who-Have-Sex-With-Men Internet Survey. Findings from 38 countries. Stockholm, European Centre for Disease Prevention and Control; 2013. .
19. Gan J, Kularadhan V, Chow EPF, Fairley CK, Hocking JS, Kong FYS, et al. What do young people in high-income countries want from STI testing services? A systematic review. Sexually Transmitted Infections. 2021;97(8):574.
20. Datta J, Reid D, Hughes G, Mercer CH, Wayal S, Weatherburn P. Places and people: the perceptions of men who have sex with men concerning STI testing: a qualitative study. Sex Transm Infect. 2018;94(1):46-50.
21. Wayal S, Hughes G, Sonnenberg P, Mohammed H, Copas AJ, Gerressu M, et al. Ethnic variations in sexual behaviours and sexual health markers: findings from the third British National Survey of Sexual Attitudes and Lifestyles (Natsal-3). Lancet Public Health. 2017;2(10):e458-e72.
22. Estupinan M, Mercer CH, Hughes G, Winter A, Mohammed H, Jayes D, et al. Sexually transmitted infections: promoting the sexual health and wellbeing of gay, bisexual and other men who have sex with men. From research to public health practice: an evidence-based resource for commissioners, providers and voluntary sector organisations. 2021.
23. Estupinan M, Mercer CH, Woode Owusu M, Gerressu M, Winter A, Hughes G, et al. Sexually transmitted infections: Promoting the sexual health and wellbeing of people from a Black Caribbean background. From research to public health practice: an evidence-based resource for commissioners, providers and third sector organisations. 2021.
24. Tanton C, Jones KG, Macdowall W, Clifton S, Mitchell KR, Datta J, et al. Patterns and trends in sources of information about sex among young people in Britain: evidence from three National Surveys of Sexual Attitudes and Lifestyles. BMJ Open. 2015;5(3):e007834.
25. Macdowall W, Jones KG, Tanton C, Clifton S, Copas AJ, Mercer CH, et al. Associations between source of information about sex and sexual health outcomes in Britain: findings from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3). BMJ Open. 2015;5(3):e007837.
26. Lewis R, Blake C, McMellon C, Riddell J, Graham C, Mitchell KR. Understanding young people's use and non-use of condoms and contraception: A co-developed, mixed-methods study with 16-24 year olds in Scotland. Final report from CONUNDRUM (CONdom and CONtraception UNDerstandings: Researching Uptake and Motivations). MRC/CSO Social and Public Health Sciences Unit: University of Glasgow. 2021.
27. Clutterbuck DJ, Flowers P, Barber T, Wilson H, Nelson M, Hedge B, et al. UK national guideline on safer sex advice. Int J STD AIDS. 2012;23(6):381-8.
28. Australasian Sexual and Reproductive Health Alliance and Australasian Society for HIV Viral Hepatitis and Sexual Health Medicine. Australian STI management gudelines for use in primary care. https://sti.guidelines.org.au/.
29. Bailey J, Mann S, Wayal S, Hunter R, Free C, Abraham C, et al. Sexual health promotion for young people delivered via digital media: a scoping review. Public Health Research. Southampton (UK)2015.
30. Chavez NR, Shearer LS, Rosenthal SL. Use of digital media technology for primary prevention of STIs/HIV in youth. J Pediatr Adolesc Gynecol. 2014;27(5):244-57.
31. Wadham E, Green C, Debattista J, Somerset S, Sav A. New digital media interventions for sexual health promotion among young people: a systematic review. Sex Health. 2019;16(2):101-23.
32. Kesten JM, Dias K, Burns F, Crook P, Howarth A, Mercer CH, et al. Acceptability and potential impact of delivering sexual health promotion information through social media and dating apps to MSM in England: a qualitative study. BMC Public Health. 2019;19(1):1236.
33. Carey MP, Rich C, Norris AL, Krieger N, Gavarkovs AG, Kaplan C, et al. A Brief Clinic-Based Intervention to Reduce Alcohol Misuse and Sexual Risk Behavior in Young Women: Results from an Exploratory Clinical Trial. Arch Sex Behav. 2020;49(4):1231-50.

34. Chander G, Hutton HE, Xu X, Canan CE, Gaver J, Finkelstein J, et al. Computer delivered intervention for alcohol and sexual risk reduction among women attending an urban sexually transmitted infection clinic: A randomized controlled trial. Addict Behav Rep. 2021;14:100367.
35. Crawford MJ, Sanatinia R, Barrett B, Byford S, Dean M, Green J, et al. The clinical and cost-effectiveness of brief advice for excessive alcohol consumption among people attending sexual health clinics: a randomised controlled trial. Sex Transm Infect. 2015;91(1):37-43.
36. Lane J, Proude EM, Conigrave KM, de Boer JP, Haber PS. Nurse-provided screening and brief intervention for risky alcohol consumption by sexual health clinic patients. Sex Transm Infect. 2008;84(7):524-7.
37. Weller S, Davis K. Condom effectiveness in reducing heterosexual HIV transmission. Cochrane Database Syst Rev. 2002(1):CD003255.
38. Crosby RA, Charnigo RA, Weathers C, Caliendo AM, Shrier LA. Condom effectiveness against non-viral sexually transmitted infections: a prospective study using electronic daily diaries. Sex Transm Infect. 2012;88(7):484-9.
39. Holmes KK, Levine R, Weaver M. Effectiveness of condoms in preventing sexually transmitted infections. Bull World Health Organ. 2004;82(6):454-61.
40. Bernabe-Ortiz A, Carcamo CP, Scott JD, Hughes JP, Garcia PJ, Holmes KK. HBV infection in relation to consistent condom use: a population-based study in Peru. PLoS One. 2011;6(9):e24721.
41. Evans WD, Ulasevich A, Hatheway M, Deperthes B. Systematic Review of Peer-Reviewed Literature on Global Condom Promotion Programs. Int J Environ Res Public Health. 2020;17(7).
42. Petrova D, Garcia-Retamero R. Effective Evidence-Based Programs For Preventing Sexually-Transmitted Infections: A Meta-Analysis. Curr HIV Res. 2015;13(5):432-8.
43. Wiyeh AB, Mome RKB, Mahasha PW, Kongnyuy EJ, Wiysonge CS. Effectiveness of the female condom in preventing HIV and sexually transmitted infections: a systematic review and meta-analysis. BMC Public Health. 2020;20(1):319.
44. Mercer CH, Tanton C, Prah P, Erens B, Sonnenberg P, Clifton S, 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). Lancet. 2013;382(9907):1781-94.
45. Lewis R, Tanton C, Mercer CH, Mitchell KR, Palmer M, Macdowall W, et al. Heterosexual Practices Among Young People in Britain: Evidence From Three National Surveys of Sexual Attitudes and Lifestyles. J Adolesc Health. 2017;61(6):694-702.
46. Mosher WD, Chandra A, Jones J. Sexual behavior and selected health measures: men and women 15-44 years of age, United States, 2002. Adv Data. 2005(362):1-55.
47. Chandra A, Mosher WD, Copen C, Sionean C. Sexual behavior, sexual attraction, and sexual identity in the United States: data from the 2006-2008 National Survey of Family Growth. Natl Health Stat Report. 2011(36):1-36.
48. Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance: Adolescents and Young Adults. https://www.cdc.gov/std/statistics/2019/figures/2019-STD-Surveillance-Adolescents-and-Young-Adults.pptx. 2019.
49. Dema E, Gibbs J, Clifton S, Copas AJ, Tanton C, Riddell J, et al. Initial impacts of the COVID-19 pandemic on sexual and reproductive health service use and unmet need in Britain: findings from a quasi-representative survey (Natsal-COVID). Lancet Public Health. 2022;7(1):e36-e47.
50. Brown JL, Vanable PA, Bostwick RA, Carey MP. A Pilot Intervention Trial to Promote Sexual Health and Stress Management Among HIV-Infected Men Who Have Sex with Men. AIDS Behav. 2019;23(1):48-59.
51. Crosby R, DiClemente RJ, Charnigo R, Snow G, Troutman A. A brief, clinic-based, safer sex intervention for heterosexual African American men newly diagnosed with an STD: a randomized controlled trial. Am J Public Health. 2009;99 Suppl 1:S96-103.
52. Crosby RA, Charnigo RJ, Salazar LF, Pasternak R, Terrell IW, Ricks J, et al. Enhancing condom use among Black male youths: a randomized controlled trial. Am J Public Health. 2014;104(11):2219-25.

53. Martin A, Lemon SM. Hepatitis A virus: From discovery to vaccines. Hepatology. 2006;43(S1):S164-S72.
54. World Health Organization. Hepatitis A Factsheet. https://www.who.int/news-room/fact-sheets/detail/hepatitis-a. 2021.
55. Public Health England. Health Protection Report. Volume 11 Number 17 Published on 12 May 2017.
56. World Health Organization. Global Health Sector Strategy on Viral Hepatitis 2016-2021. Towards Ending Viral Hepatitis 2016.
57. Nguyen MH, Wong G, Gane E, Kao J-H, Dusheiko G. Hepatitis B Virus: Advances in Prevention, Diagnosis, and Therapy. Clin Microbiol Rev. 2020;33(2):e00046-19.
58. de Martel C, Plummer M, Vignat J, Franceschi S. Worldwide burden of cancer attributable to HPV by site, country and HPV type. Int J Cancer. 2017;141(4):664-70.
59. Raymakers AJN, Sadatsafavi M, Marra F, Marra CA. Economic and Humanistic Burden of External Genital Warts. PharmacoEconomics. 2012;30(1):1-16.
60. Drolet M, Benard E, Perez N, Brisson M, Group HPVVIS. Population-level impact and herd effects following the introduction of human papillomavirus vaccination programmes: updated systematic review and meta-analysis. Lancet. 2019;394(10197):497-509.
61. Falcaro M, Castanon A, Ndlela B, Checchi M, Soldan K, Lopez-Bernal J, et al. The effects of the national HPV vaccination programme in England, UK, on cervical cancer and grade 3 cervical intraepithelial neoplasia incidence: a register-based observational study. Lancet. 2021;398(10316):2084-92.
62. Public Health England. HPV vaccination programme for men who have sex with men (MSM). https://www.gov.uk/government/collections/hpv-vaccination-for-men-who-have-sex-with-men-msm-programme. 2018.
63. Public Health England. HPV vaccine to be given to boys in England. https://www.gov.uk/government/news/hpv-vaccine-to-be-given-to-boys-in-england. 2018.
64. Public Health England. Human papillomavirus (HPV) vaccination uptake in gay, bisexual and other men who have sex with men (MSM). National programme: 2019 annual report. Available at: https://www.gov.uk/government/publications/hpv-vaccination-uptake-in-men-who-have-sex-with-men-msm (Accessed: 10/02/2022). 2019.
65. Fontenot HB, Fantasia HC, Vetters R, Zimet GD. Increasing HPV vaccination and eliminating barriers: Recommendations from young men who have sex with men. Vaccine. 2016;34(50):6209-16.
66. Gerend MA, Madkins K, Crosby S, Korpak AK, Phillips GL, 2nd, Bass M, et al. A Qualitative Analysis of Young Sexual Minority Men's Perspectives on Human Papillomavirus Vaccination. LGBT Health. 2019;6(7):350-6.
67. Haese EC, Thai VC, Kahler CM. Vaccine Candidates for the Control and Prevention of the Sexually Transmitted Disease Gonorrhea. Vaccines. 2021;9(7).
68. Gottlieb SL, Deal CD, Giersing B, Rees H, Bolan G, Johnston C, et al. The global roadmap for advancing development of vaccines against sexually transmitted infections: Update and next steps. Vaccine. 2016;34(26):2939-47.
69. Mani S, Wierzba T, Walker RI. Status of vaccine research and development for Shigella. Vaccine. 2016;34(26):2887-94.
70. Gottlieb SL, Jerse AE, Delany-Moretlwe S, Deal C, Giersing BK. Advancing vaccine development for gonorrhoea and the Global STI Vaccine Roadmap. Sex Health. 2019;16(5):426-32.
71. Petousis-Harris H, Paynter J, Morgan J, Saxton P, McArdle B, Goodyear-Smith F, et al. Effectiveness of a group B outer membrane vesicle meningococcal vaccine against gonorrhoea in New Zealand: a retrospective case-control study. Lancet. 2017;390(10102):1603-10.
72. ClinicalTrials.gov. Efficacy Study of 4CMenB (Bexsero) to Prevent Gonorrhoea Infection in Gay and Bisexual Men (GoGOVax). NCT04415424.
73. Abraham S, Juel HB, Bang P, Cheeseman HM, Dohn RB, Cole T, et al. Safety and immunogenicity of the chlamydia vaccine candidate CTH522 adjuvanted with CAF01 liposomes or

aluminium hydroxide: a first-in-human, randomised, double-blind, placebo-controlled, phase 1 trial. Lancet Infect Dis. 2019;19(10):1091-100.
74. Bolan RK, Beymer MR, Weiss RE, Flynn RP, Leibowitz AA, Klausner JD. Doxycycline prophylaxis to reduce incident syphilis among HIV-infected men who have sex with men who continue to engage in high-risk sex: a randomized, controlled pilot study. Sex Transm Dis. 2015;42(2):98-103.
75. Molina JM, Charreau I, Chidiac C, Pialoux G, Cua E, Delaugerre C, et al. Post-exposure prophylaxis with doxycycline to prevent sexually transmitted infections in men who have sex with men: an open-label randomised substudy of the ANRS IPERGAY trial. Lancet Infect Dis. 2018;18(3):308-17.
76. Grant JS, Stafylis C, Celum C, Grennan T, Haire B, Kaldor J, et al. Doxycycline Prophylaxis for Bacterial Sexually Transmitted Infections. Clin Infect Dis. 2020;70(6):1247-53.
77. ClinicalTrials.gov. Doxycycline PEP for Prevention of Sexually Transmitted Infections Among Kenyan Women Using HIV PrEP (dPEP-KE). Identifier: NCT04050540 (Feb 2020 –). [Available from: https://clinicaltrials.gov/ct2/show/NCT04050540]
78. O'Halloran C, Croxford S, Mohammed H, Gill ON, Hughes G, Fifer H, et al. Factors associated with reporting antibiotic use as STI prophylaxis among HIV PrEP users: findings from a cross-sectional online community survey, May-July 2019, UK. Sex Transm Infect. 2021;97(6):429-33.
79. Carveth-Johnson T, Stingone C, Nwokolo N, Whitlock G. Doxycycline use in MSM taking PrEP. Lancet HIV. 2018;5(9):e482.
80. Chow EPF, Fairley CK. Use of doxycycline prophylaxis among gay and bisexual men in Melbourne. Lancet HIV. 2019;6(9):e568-e9.
81. Evers YJ, van Liere G, Dukers-Muijrers N, Hoebe C. Use of doxycycline and other antibiotics to prevent STIs among men who have sex with men visiting sexual health clinics in the Netherlands. Sex Transm Infect. 2020;96(7):550-1.
82. Kohli M, Reid D, Pulford CV, Howarth A, Brown J, Mohammed H, et al. Choice of antibiotics for prophylaxis of bacterial STIs among individuals currently self-sourcing. Sex Transm Infect. 2021.
83. Saunders J, Kohli M, Medland N, Fifer H. Position statement on doxycycline as prophylaxis for sexually transmitted infections 2021 update. https://wwwbashhguidelinesorg/media/1296/position_statement_refresh_2021_v11pdf. 2021.
84. Sumray K, Lloyd KC, Estcourt C, Burns F, Gibbs J. Scoping review of online postal sexually transmitted infection services: access, usage and clinical outcomes. medRxiv. 2021:2021.12.10.21267608.
85. Coleman BL, McNeil SA, Langley JM, Halperin SA, McGeer AJ. Differences in efficiency, satisfaction and adverse events between self-administered intradermal and nurse-administered intramuscular influenza vaccines in hospital workers. Vaccine. 2015;33(48):6635-40.
86. UK Health Security Agency. Greenbook Chapter 18a Human Papillomavirus (HPV). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/828868/Greenbook_chapter_18a.pdf (Accessed: 21/02/22).
87. Centers for Disease Control and Prevention. HPV Vaccination Recommendations. Available at: HPV Vaccination Recommendations | CDC (Accessed: 23/02/22).
88. Australian Government Department of Health. Human papillomavirus (HPV). Available at: https://immunisationhandbook.health.gov.au/vaccine-preventable-diseases/human-papillomavirus-hpv (Accessed: 23/02/22).
89. Government of Canada. Human papillomavirus vaccine: Canadian Immunization Guide. Available at: Human papillomavirus vaccine: Canadian Immunization Guide - Canada.ca (Accessed: 23/02/22).
90. World Health Organization. Guidelines for the prevention and control of cervical cancer. Available at: https://www.who.int/reproductivehealth/topics/cancers/hpv-vaccination/en/ (Accessed: 21/02/22).

556 91. UK Health Security Agency. Greenbook Chapter 17 Hepatitis A. Available at:
557 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file
558 /1053507/Greenbook-chapter-17-7Feb22.pdf (Accessed: 21/02/22).
559 92. Centers for Disease Control and Prevention. Hepatitis A. Available at:
560 https://www.cdc.gov/vaccines/pubs/pinkbook/hepa.html (Accessed: 23/02/22).
561 93. Australian Government Department of Health. Hepatitis A. Available at:
562 https://immunisationhandbook.health.gov.au/vaccine-preventable-diseases/hepatitis-a (Accessed:
563 23/02/22).
564 94. Government of Canada. Hepatitis A vaccine: Canadian Immunization Guide. Available at:
565 Hepatitis A vaccine: Canadian Immunization Guide - Canada.ca (Accessed: 23/02/22).
566 95. World Health Organization. WHO position papers on Hepatitis A. Available at:
567 https://www.who.int/teams/immunization-vaccines-and-biologicals/policies/position-
568 papers/hepatitis-a (Accessed: 21/02/22).
569 96. UK Health Security Agency. Greenbook Chapter 18 Hepatitis B. Available at:
570 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file
571 /1052889/Greenbook-chapter-18-4Feb22.pdf (Accessed: 21/02/22).
572 97. Centers for Disease Control and Prevention. Hepatitis B. Available at:
573 https://www.cdc.gov/vaccines/pubs/pinkbook/hepb.html (Accessed: 23/02/22).
574 98. Australian Government Department of Health. Hepatitis B. Available at:
575 https://immunisationhandbook.health.gov.au/vaccine-preventable-diseases/hepatitis-b (Accessed:
576 23/02/22).
577 99. Government of Canada. Hepatitis B vaccine: Canadian Immunization Guide. Available at:
578 Hepatitis B Vaccine: Canadian Immunization Guide - Canada.ca (Accessed: 23/02/22). .
579 100. World Health Organization. Hepatitis B. Available at: https://www.who.int/news-room/fact-
580 sheets/detail/hepatitis-b (Accessed: 21/02/22).

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