Public Health England

Protecting and improving the nation's health

Sexual and Reproductive Health Return on Investment Tool

Final report

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Contents

Acronyms

CCG	Clinical commissioning groups
CDC	Centers for Disease Control and Prevention
HIV	Human immunodeficiency virus
HMT	Her Majesty's Treasury
MSM	Men who have sex with men
NATSAL	National Survey of Sexual Attitudes and Lifestyles
NICE	National Institute for Health and Care Excellence
ONS	Office for National Statistics
PHE	Public Health England
PID	Pelvic inflammatory disease
PN	Partner notification
QALY	Quality adjusted life year
RAG	Red, amber, green rating
ROI	Return on investment
RR	Relative risk
SRH	Sexual and reproductive health
STI	Sexually transmitted infection
TFI	Tubal factor infertility

Executive summary

Background

This report is designed as a companion guide to users of the Sexual and Reproductive Health Return on Investment Tool published by Public Health England (PHE). The tool allows users to tailor health economics evidence to their local setting to inform the commissioning of sexual and reproductive health services.

All users of the tool are encouraged to review and understand this summary and sections 1 to 5 of the report, as the contents are necessary to effectively interpret the results produced by the tool. Those interested in a more detailed explanation of the methodology are encouraged to also review Appendices 1 and 2. Appendix 3 gives links to other tools and evidence that may be valuable for sexual health commissioners.

Good sexual and reproductive health and wellbeing is an important contributor to overall wellbeing. In 2013, commissioning arrangements for sexual, reproductive health and HIV were introduced as part of the implementation of the Health and Social Care Act 2012. Under these arrangements, local authorities receive a ring-fenced grant that should be used only for public health functions.

Healthcare commissioners are increasingly being challenged to prioritise high value interventions due to constraints being placed on local authority budgets, while meeting their statutory responsibilities. In terms of sexual and reproductive health service provision, PHE has recently identified priority areas for improvement such as: reducing rates of sexually transmitted infections (STIs), increasing participation in chlamydia screening, reducing the transmission and early death from HIV, and reducing unwanted pregnancies especially among teenagers.

The recent consensus statement on reproductive health will support the development of an action plan (to be published in 2020) to inform local prioritisation and planning (PHE, 2018a).

About the tool

The return on investment (ROI) tool presented in this report was made in Microsoft Excel. It quantifies the costs and benefits associated with a range of sexual and reproductive health (SRH) interventions. The tool focuses on young people (aged 15 to 24) as a population subgroup.

This subgroup was selected following an initial evidence review, which identified more and higher quality evidence for this group compared to the other groups under consideration, namely men who have sex with men (MSM) and women across the life course. PHE may decide to extend this tool or develop additional ROI tools for these groups in the future.

The following interventions are included within this ROI tool:

- condom distribution via C-card schemes (all genders)
- condom distribution via school and college-based programmes (all genders)
- full STI test via online service (all genders)
- chlamydia screening (cis- and transgender men)
- e-partner notification (all genders)
- additional emergency contraception provision when emergency contraception is given (cisgender women and transgender men)
- oral contraceptive provision when emergency contraception is given (cisgender women and transgender men)
- reduced time from diagnosis to treatment (all genders)

The model is based on multiple data sources that ask people their sex or gender but do not explicitly collect their gender identity or whether it is the same as the sex assigned at birth. Because of this, we assume that people's declared sex or gender is the same as their sex assigned at birth. This is unlikely to affect the aggregate results of the tool, but it limits the value of the tool for assessing the specific effect of interventions on transgender individuals.

These interventions represent a subset of SRH services identified by PHE. They reflect interventions which have sufficient evidence to be modelled effectively within the scope of this tool. They do not cover all services, or even all services which represent good value for money. As such, other interventions which are not covered by this tool should also be considered in commissioning decisions.

The decision to model female chlamydia screening only reflects availability of evidence, and does not prejudge the outcome of the recent consultation on National Chlamydia Screening Programme (NCSP) policy.

The interventions included do reflect a range of settings (for example, sexual health clinics, education settings, online and pharmacies) and type of services (STI testing, condom distribution and other contraception).

The evidence review undertaken for this tool involved 2 literature searches of sexual and reproductive health interventions to identify evidence for the cost effectiveness of interventions. These reviews resulted in 26 papers being identified following review and analysis. Papers were assessed against criteria (detailed in Appendix 1), and 8 were selected to form the basis of the interventions modelled in this tool.

The tool itself is based primarily on 2 models recreated from peer reviewed sources, with a model of STI prevention, testing and treatment derived from Sadler et al (2017) and the pregnancy model based upon PHEs pre-existing Contraception ROI tool (PHE, 2018b).

The ROI tool can be used by healthcare commissioners to assess which of these sexual and reproductive health interventions represent the best value for money for their locality, bearing in mind the tool's limitations in this comparison (see Section 5).

They can enter their own local data on population and prevalence, the amounts being spent and the associated local uptake of the interventions to produce an estimation of ROI.

The tool is intended to be set up and run in various scenarios by users; as such, results vary depending on the scenario. However, Figure 1 provides some example results from a scenario detailed in Section 4.

A scenario is a package of the interventions the user is interested in, for instance they could set the current scenario to what services they currently invest in and future scenario to a different package they are interested in and calculate the ROIs of changing their allocation.

In this example, everything but the uptake of the interventions is left unchanged. Also, the ROI of interventions is calculated for eligible populations across the whole of England compared to a no intervention scenario, where none of these interventions are used.

The no-intervention scenario acts as a baseline to calculate an ROI against. It is not intended for planning purposes, as for some interventions, for example, chlamydia screening, it is not a viable option.

Understanding the tool's results and limitations

Figure 1: Tool results from an example scenario

Step 3. Results — Review the model results for the different scenarios being specified in the previous step and how they should be interpreted

Select scenario results to display: Current vs No Intervention

	Extra program cost	STI cases	STI diagnoses	STI sequelae	Unplanned pregnancies	Local authority cost savings	NHS cost savings	Other cost savings	ROI exc. QALYS	ROI inc. QALYS
Pregnancy and STI Interventions										
C-card scheme	£2,225,390	-7,891	-4,809	-241	-1,136	£1,120,963	£7,332,785	£6,336,414	6.6 to 1	11.6 to 1
Condom availability in schools	£873,955	-527	-344	-2	-515	£308,501	£2,230,201	£2,595,927	5.9 to 1	6.9 to 1
STI Interventions only										
Online STI service	£24,823,399	0	75,727	-4,504	0	(£6,107,925)	(£3,485,285)	£0	-0.4 to 1	5.2 to 1
E-partner notification	£226,786	0	477	-24	0	(£186,102)	(£40,612)	£0	-1.0 to 1	4.3 to 1
Chlamydia screening: women	£26,510,059	0	44,733	-4,805	0	(£3,549,443)	£2,458,870	£0	0.0 to 1	1.3 to 1
Reduced time from test to result	£0	-1,171	-553	-79	0	£40,832	£41,507	£0	N/A to 1	N/A to 1
Pregnancy Interventions only										
Extra emergency contraception	£431,868	0	0	0	-670	£390,832	£2,662,401	£3,677,610	15.6 to 1	15.6 to 1
Oral contraception with EHC	£4,170,118	826	359	93	-4,441	£3,652,579	£17,048,164	£24,773,734	10.9 to 1	10.3 to 1

Click here for a larger image

The example scenario suggests that the ROI figures are generally considerably above one, meaning that the benefits from spending in this area far outweigh the costs. A return on investment figure of one means the benefits in terms of costs saved and health improved are equal to the costs of the intervention.

These results suggest that continued investment across these services is attractive where budgets allow.

In this scenario, the benefits of spending on contraceptive interventions outweigh the costs and spending is cost-saving to the government in the longer term.

The benefits of spending on STI testing interventions also outweighs the costs, but spending is not directly cost saving, because more diagnoses leads to higher treatment costs; however, the additional benefits in terms of health more than compensate for these additional costs.

The tool has several limitations, some of which could materially affect the results. The main limitation is that the STI model is a static model, focusing on those tested and treated rather than the whole population.

This means that the ROI figures underestimate the true ROI of STI interventions, as they do not capture the benefits of cases averted by additional testing and treatment.

This limitation particularly affects the ROIs of chlamydia screening, online testing and e-partner notification. The value for the ROI of chlamydia screening is consistent with the evidence base for chlamydia screening as summarised by PHE in 2019 and reviewed prior to recommendations for changes to the NCSP.

Other limitations include that all sex is assumed to occur between people of opposite sex, which limits the tool's ability to focus on MSM or women who have sex with women (WSW).

The model also makes simplifying assumptions about distribution of sexual activity and STIs, and that estimates of health loss associated with each of the diseases modelled do not capture all possible complications.

Finally, the STI model and pregnancy model have different approaches and scopes, which makes it difficult to compare outcomes of interventions targeting these different outcomes. Users are encouraged to focus on comparison of interventions with similar outcomes.

1) Introduction

Good sexual and reproductive health and wellbeing is an important contributor to overall wellbeing. In 2013, commissioning arrangements for sexual, reproductive health and HIV were introduced as part of the implementation of the Health and Social Care Act 2012.

Local government responsibilities for sexual health services were further detailed in 'The Local Authorities (Public Health Functions and entry to Premises by Local Healthwatch Representatives) Regulations 2013'.

Most sexual health services are commissioned by local authorities, and include:

- contraception
- STI testing and treatment
- sexual health aspects of psychosexual counselling
- sexual health specialist services
- HIV social care
- wider support for teenage parents

In 2013 the Department of Health published a framework for sexual health improvement (DHSC, 2013). This included the aim of reducing inequalities and improving the position in 4 priority areas:

- reduce STI rates
- reduce HIV transmission rates and avoidable deaths
- reduce unplanned pregnancies
- continue to reduce 'under 16 and 18' conception rates

The quality of sexual and reproductive health and HIV services rely in part on effective commissioning. Appendix 3 details many of the resources that are available to support local authority commissioners. However, these tools have not specifically addressed the relative value for money from a range of different interventions.

There is a growing base of literature which has evaluated SRH interventions for their impact and cost-effectiveness. A good example is contraception, for which an investment of £1 is estimated to return £9 of cost savings to the government (PHE, 2018b).

PHE's contraception tool gives different results from the tool detailed in this report because it uses a different methodology, and reviews contraception more broadly. This evidence base is identifying clear benefits in terms of health outcomes and costs savings from various sexual health interventions.

PHE commissioned Optimity Advisors to synthesise this growing body of evidence into the ROI tool detailed in this report. The tool allows users to tailor health economics evidence to their local setting to inform the commissioning of sexual and reproductive health services. Local commissioners can use the evidence generated from this ROI tool to propose investments in this area and commission any of the interventions in this tool with confidence that the evidence suggests that their benefits outweigh their costs.

The complexity of commissioning for sexual and reproductive health services demonstrates the importance of collaborative approach with local authorities. Existing PHE guidance, tools and publications emphasise that, in addition to local authorities, stakeholders also include NHS commissioners (clinical commissioning groups (CCGs) and NHS England), service providers, local public health practitioners, as well as service users.

While the ROI tool is primarily aimed at local authority commissioners, the advent of Integrated Care Systems raises distinct opportunities for sharing the risks and benefits from interventions across the health system.

This ROI tool has the potential to support delivery of a variety of national guidance and action plans, best practice guidance for diagnosis and treatment, and national screening programmes. It can also be adapted to analyse local priorities and needs based on local data.

Previously, PHE has identified priority areas for improvement through the Public Health Outcomes Framework, such as: reducing rates of STIs, increasing participation in chlamydia screening, reducing the transmission and early death from HIV, and reducing unwanted pregnancies especially among teens. The recent consensus statement on reproductive health will support the development of a new action plan to inform local prioritisation and planning.

The large number of interventions related to sexual and reproductive health meant it was impractical to include all possible interventions in the ROI tool. Therefore, Optimity Advisors and the project's steering group agreed that it would be best to produce a more comprehensive tool for services for young people, rather than a tool including a more limited number of interventions for all target groups. Other important sub groups considered were MSM and women across their life course.

Optimity Advisors carried out an initial evidence review and proposed that the tool should focus on young people, as there appeared to be higher quality evidence for this group than others. PHE may decide to extend this tool or develop new ROI tools for these other target groups.

This report is designed as a companion guide to users of the Sexual and Reproductive Health Return on Investment Tool published by Public Health England (PHE).

All users of the tool are encouraged to review and understand the Executive Summary and sections 1 to 5 of the report, as the contents are necessary to effectively interpret the results produced by the tool. Section 2 details the interventions modelled in this tool and how their costs and effects were estimated.

Section 3 gives a non-technical summary of the model; this section is intended to give all users a fundamental understanding of the model framework.

Section 4 details an example scenario that users can work through to understand how to use the tool and review its results. Section 5 highlights the main limitations to users, as these are essential to contextualise the results for decision making.

Interested users would also benefit from reviewing the technical appendices. Appendix 1 gives interested users a better understanding of the evidence review protocol.

Appendix 2 reviews the model structure in considerable technical detail.

Appendix 3 gives links to further commissioning resources PHE offers for SRH commissioners.

2) Interventions modelled in this tool

The interventions in Table 1 are modelled within this ROI tool. They are included because they have sufficient evidence to be modelled effectively within the scope of this tool. They do not cover all SRH interventions, or even all SRH interventions that represent good value for money.

Users should understand that this tool conveys the best available current evidence on the value for money of tested interventions, but that evidence base is imperfect and not universal across interventions. The interventions included do reflect a range of settings (for example, sexual health clinics, education settings, online and pharmacies) and types of interventions (STI testing, condom distribution and other contraception).

Though only some services are modelled in the tool, the results show tentative evidence that SRH services represent good value for money in general, as these interventions were not cherry-picked because they are particularly cost-effective.

Against that backdrop, commissioners should understand that these interventions are included because of their evidence-base, but that many other services are likely to offer value for money and should be considered in commissioning decisions. Also, the exact designs of these interventions are not set in stone and could be tailored to fit a local context and objectives.

For instance, 2 of the interventions focus on distributing additional contraception to those who seek emergency contraception; though these interventions focus on the contraceptive pill and additional emergency contraception, it seems reasonable to expect that giving advice on long acting reversible contraception or condoms at these opportunities may also represent value for money.

Similarly, the condom distribution schemes modelled both involve gatekeepers to condom provision; however, reducing the gatekeeping processes while maintaining safeguarding requirements might increase uptake and reduce costs.

Table 1: Interventions included in the model

Pregnancy and STI interventions			
Intervention	**Description**	**Unit Cost**	**Effect**
C-card scheme	A C-card entitles users to free condoms, following a consultation on condom usage and STIs with a health worker. The consultation generally explains how to use the scheme and signposts young people to other relevant services.	£11.61 Unit cost per C-card user Author calculations based on (Jablonskas, 2010; Lincoln County Council, 2010; Sadler et al, 2017).	RR: 1.84 Relative risk of condom usage for those who uptake the card. Based on a Swedish school-based condom card programme (Larsson et al, 2006). This result has come from a slightly different intervention in a different country, so should be treated with caution. The relative risk (RR) above was adjusted for card uptake.
Condom availability in schools	Condom availability programmes in schools are schemes where condoms are offered to students for free, along with education, from school staff such as school nurses. The potential population is based on the 15-17 year old population – where young people could also be in other education setting, for example, colleges.	£10.67 Unit cost per pupil, at a school or college offering condoms. It includes school nurse time and condoms. This cost is calculated based on 40% of pupils using the service, as observed in Blake et al (2003).	RR: 1.31 Blake et al (2003) compared condom use in schools with condom availability programmes in the United States of America to those that did not. An offsetting effect on the use of other contraception was observed, and is incorporated to the model.

STI only interventions			
Intervention	**Description**	**Unit Cost**	**Effect**
Online STI service	STI self-sampling kits accessed via the internet. This is based on a programme called SH:24.	£33.92 Cost per person returning a test, given by SH:24.	RR: 2.07 Wilson et al (2017) estimated the relative risk of test uptake when offered online testing compared to the control group.
E-partner notification	Electronic partner notification based on a tool by SXT.	£2.00 Cost of partner notification per index patient, offered by SXT.	Chlamydia RR: 1.10 Gonorrhoea RR: 1.76 Syphilis RR: 1.50 HIV RR: 1.11 Oliveira (2019) estimated the relative risk per condition of increased number of contacts tested per index case.
Chlamydia screening: women	Chlamydia screening (based on the National Chlamydia Screening Programme) for females only.	£54.50 Average cost of a chlamydia test for a woman in a screening setting.	61% reduction in pelvic inflammatory disease (PID) (Price et al, 2016)
Reduced time from test to result	Rapid sexual health testing through an in-house laboratory (Dean Street Express, London).	No default cost provided – no appropriate cost proxy could be found.	Chlamydia: 3 per 1,000 Gonorrhoea: 0.1 per 1,000 Whitlock et al (2017) estimated cases of chlamydia and gonorrhoea prevented due to reduced time to test result, reducing transmission during that time.

Pregnancy only interventions			
Intervention	**Description**	**Unit Cost**	**Effect**
Extra emergency contraception	Advanced provision of (additional) emergency contraception to those requesting emergency contraception.	£5.20 Cost per person: tariff + indicative NHS price for levonorgestrel.	31% compared to 19% Ekstrand et al (2010) found an increase in use of emergency contraception after unprotected sex compared to control group (without an increase in sex without contraception).
Oral contraception with emergency hormonal contraception	Provision of oral contraception, alongside emergency contraception, for those requesting emergency contraception.	£50.21 Cost per person: pill cost plus fifteen minutes of pharmacist time. Plus follow on costs of additional pills and a GP or SRH appointment to receive additional pills for those who continue past the initial pills.	34% compared to 10% Michie et al (2014) estimated the proportion using oral contraception at 6-8 weeks. It was assumed there was 40% discontinuation in pill use based on a selection of evidence (Balassone, 1989; Moreau et al, 2007; Rosenberg and Waugh, 1998). The gain in pill use was assumed to come proportionately from other methods of contraception including no method.

3) Model non-technical summary

The tool captures outcomes that relate to STIs and unintended pregnancies. The results are estimated using 2 separate but related models, which are set out briefly below, and in detail in Appendix 2. As with any model, this process is imperfect, and users are strongly encouraged to read and understand Section 5 on Tool limitations before using the results for decision making.

STI model

Users can tailor certain aspects of this model. They can select a geographic region of interest, and over-ride the population or disease prevalence data which feed into the model. They can also select the uptake, costs and effectiveness of each of the interventions targeting STIs.

The STI model has baseline parameters for contraception use, testing rates, partner notification rates, and diagnosis and treatment rates. Interventions affect this baseline based on the evidence reviewed. These parameters then influence other variables for the following STIs: chlamydia, gonorrhoea, genital warts, syphilis and HIV.

These variables are the number of each STI, and the proportion which are tested and treated. For HIV it is assumed that treatment is delayed, rather than it never occurs. Partner notification happens for some confirmed cases.

Each STI case, treated or untreated, has a cost and health outcome associated with it, as do the resulting disease sequelae (complications). The costs captured are treatment costs, testing costs, and partner notification costs. These costs and health outcomes are then converted into monetary values and aggregated.

The model is static, so only captures the direct effects on those receiving interventions, not the wider population effects because the effects of preventing onward transmission to sexual partners is not accounted for. Consequently, the ROIs for interventions that impact STIs are likely to underestimate the true ROIs.

This model captures the benefits and costs associated with the STI cases that occur in a population over a year, even if those benefits or costs fall some years in the future (for example, in the case of long-term disease complications).

Unintended pregnancy model

As with the STI model, users can select a geography of interest and override the population data. They can also update the uptake, costs and effectiveness of interventions which aim to reduce unintended pregnancies.

The unintended pregnancy model uses the same baseline parameters for contraception use as the STI model; interventions affect this baseline contraception use. The types of contraception modelled are condoms, the pill, IUD, implant, emergency contraception and no method. These forms of contraception all have different failure rates; as such, changing the pattern of contraception use influences the number of unintended pregnancies.

The model captures the costs of benefits and tax credits, and public services, which arise from unintended pregnancies. These costs may fall to national government, local authorities, or the NHS. These include the child's education, health care costs, child benefits and tax credits, and costs associated with birth.

Unintended pregnancies can either be unwanted (the mother does not want to get pregnant ever) or mistimed (the mother wants to get pregnant in the future). Where births are unwanted, the full value of these costs is included, where pregnancies are mistimed only some of the costs are incurred, based on the difference in the value of money now or in the future. These costs are quantified over a 10-year timeframe.

ROI calculation

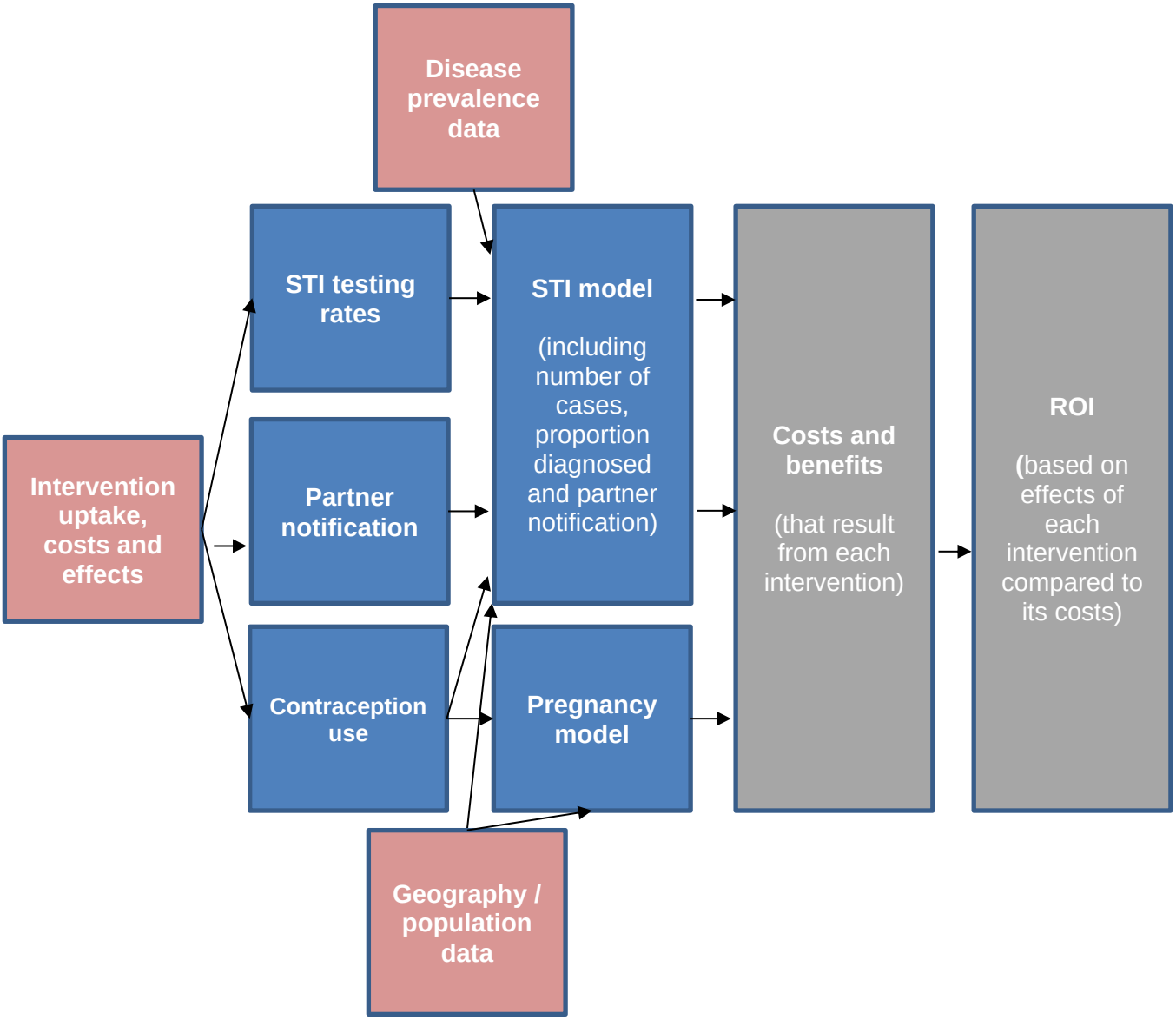
If the interventions lead to health benefits, they are measured by Quality Adjusted Life Years (QALYs). These benefits are assigned a monetary value of £60k per QALY, the standard cross-government figure, so they can be included in the ROI (see Appendix 2 for more details). The monetary values of the benefits of the intervention (in terms of costs saved and health gains) are then compared to the costs of delivering the intervention in order to calculate an ROI, this formula is shown by Equation (1).

$$\text{Intervention ROI} = \frac{\text{Intervention benefits}}{\text{Intervention cost}} \quad (1)$$

The tool reports ROIs for interventions both including these health benefits and excluding them, focusing on monetary benefits only.

At the highest level, the model steps to estimate this ROI are shown in Figure 2. The red boxes indicate data and assumptions that users can override in the tool's dashboard. The blue boxes are the inner workings of the model that users do not have access to. The grey boxes are results stages the user observes in the dashboard.

Figure 2: simplified model schematic



Intervention mapping

The interventions are described in detail in the Intervention section of the report (Section 2). Table 2 shows how each intervention interacts with the back-end models (an X indicates that intervention affects those outcomes). Each intervention affects baseline parameter values and thus either impacts STIs outcomes, unintended pregnancy outcomes, or both.

Table 2: Mapping of which outcomes each intervention affects

Intervention	Baseline parameter impacted	STI outcomes	Unintended pregnancy outcomes
C-card scheme	Condom use	X	X
Condom availability in schools/colleges	Condom use	X	X
Online STI test	All STI testing rate	X	
E-partner notification	Partner notification rate	X	
Chlamydia screening: women	Chlamydia testing rate	X	
Extra emergency contraception	Emergency contraception use		X
Oral contraception with EHC	Pill use	X	X
Reduced time from test to result	Diagnosis speed	X	

4) Using the tool and interpreting results

The user interface for the tool was developed by Optimity Advisors. They undertook considerable engagement with potential end users in order to design an interface that is user-friendly and offers users with the most relevant information for commissioning services.

The tool dashboard is broken down into 3 steps:

1. The model default parameters are estimates of national disease prevalence and ONS population estimates for the locality specified, but some of these parameters can be overwritten.
2. Each intervention has default assumptions around its uptake (which is based on a feasible value), and its unit cost and effect size (which is based on literature). These parameters can be overwritten.
3. The tool estimates results for each intervention tailored to the locality, this includes the health impact, financial impact across different areas of government and ROI.

The following section gives an account of how to use the tool, what can be updated and how to interpret the results. It also gives an example of how to answer the following 2 questions:

- what would be impact of offering the Online STI Service to all young people across England?
- what would the costs and benefits be of trialling the condom availability in schools programme in 10% of English schools and colleges?

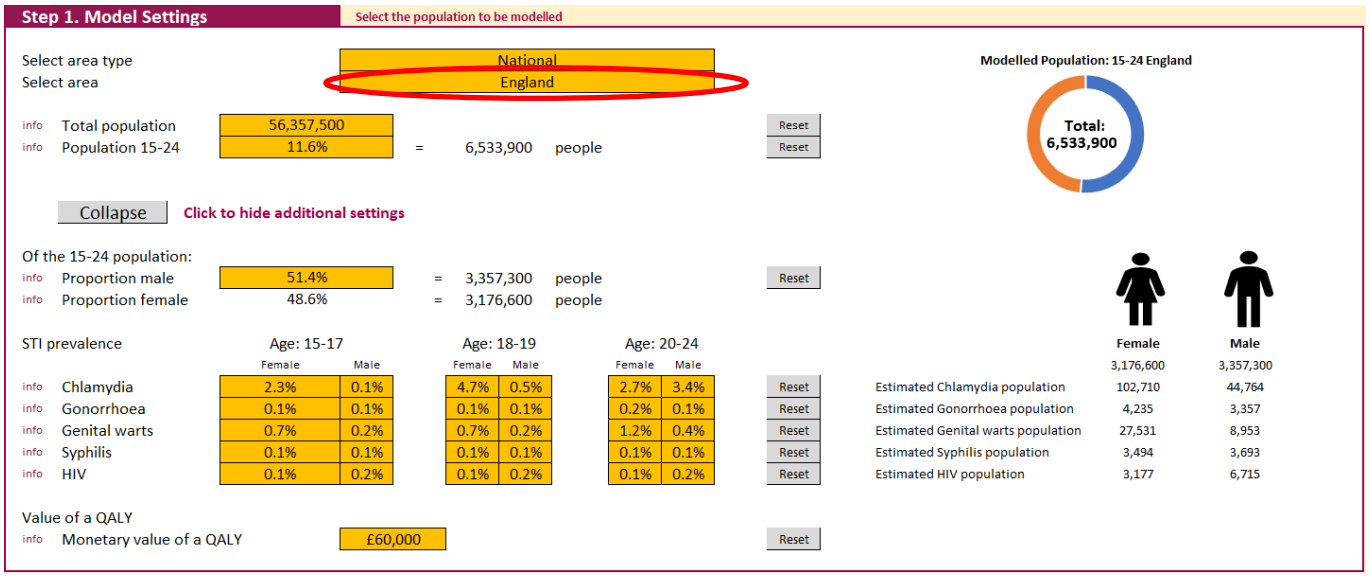
This is simply an example, which may help users to understand how to tailor the tool to their needs.

Step 1: Model settings

The user can focus on different local populations of interest such as a local authority or CCG. The most locally relevant published data from the ONS will be applied to the model for population size, proportion aged 15 to 24 and gender distribution. National estimates of disease prevalence from various sources will be applied. This data can be over-written by the user if they have more recent or locally relevant data available to them and can be reset back to the default populated value.

In the example shown by Figure 3 the user selects England (circled in red), the default location for the model. The user does not override any of the default population or disease prevalence rates, as they do not think they have any additional evidence, and adjusting these numbers does not help them to answer their questions.

Figure 3: Screenshot from the model setting on the Dashboard tab of the ROI tool



Click here for a larger image

Step 2: Model interventions

The user can view the sexual and reproductive health interventions that have been included within the ROI tool. There are 3 scenarios which the user can use to calculate ROIs: the current scenario, a future scenario and a no intervention alternative scenario (where uptake for all these interventions is 0). If users are trying to explain the value offered by these services in general, then comparing their current service levels using the current scenario to no intervention scenario is recommended.

However, if users are trying to calculate the ROI of changing from their current service level to a future hypothetical service level, then users are recommended to use the current scenario for their current service level and the future scenario for what they would like to achieve. In the default view the user observes the current scenario compared to the no intervention scenario.

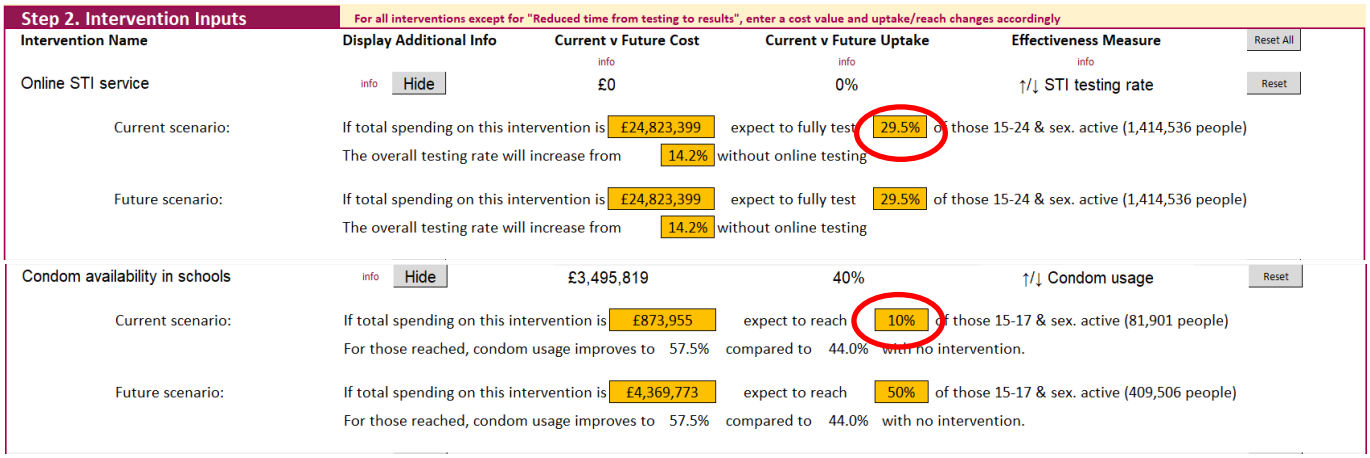
Also, current and future scenarios are specified to have the same costs and uptake by default. However, the user can edit these values to model different scenarios. For example, they could investigate the ROI of increasing uptake of an intervention to 20% compared to 10%.

One intervention, reduced time to test result, requires a user inputted cost for the ROI to be calculated, because the study this intervention is based on did not cost the intervention.

In the example shown in Figure 4, the user has left the testing rate of the Online STI Service to at 29.5% because that is the testing rate observed in areas that have offered online testing to young people. They have also reduced the uptake of condoms availability in schools to 10%, in order to see how much a trial implementation on 10% of the English population might cost, and what the returns would be.

The user did not make any other changes to the default effectiveness or other variables, as they did not have additional evidence to that reflected in the tool.

Figure 4: Snapshot of some of the intervention-specific parameters in the ROI tool



Click here for a larger image

Step 3: Model results

The user can view the outputs that are produced by the settings input in Step 1 and Step 2. The user is able to specify which sets of results they would like to view, and they have the option of comparing current uptake to no intervention, hypothetical future uptake to no intervention and current versus future practice.

Figure 5 shows the results. They were only interested in one package of interventions, and so the setting for which package of interventions is being modelled is left on Current vs No Intervention (circled in red). If they were also interested in the ROI of 20% trial compared to 10% trial for the condoms in schools, they could have put the future scenario uptake as 20% in step 2 and then changed the scenario to future vs current.

Figure 5: Snapshot of the results of the ROI tool for an example set of parameters

Step 3. Results Review the model results for the different scenarios being specified in the previous step and how they should be interpreted

Select scenario results to display: Current vs No Intervention

	Extra program cost	STI cases	STI diagnoses	STI sequelae	Unplanned pregnancies	Local authority cost savings	NHS cost savings	Other cost savings	ROI exc. QALYS	ROI inc. QALYS
Pregnancy and STI Interventions										
C-card scheme	£2,225,390	-7,891	-4,809	-241	-1,136	£1,120,963	£7,332,785	£6,336,414	6.6 to 1	11.6 to 1
Condom availability in schools	£873,955	-527	-344	-2	-515	£308,501	£2,230,201	£2,595,927	5.9 to 1	6.9 to 1
STI Interventions only										
Online STI service	£24,823,399	0	75,727	-4,504	0	(£6,107,925)	(£3,485,285)	£0	-0.4 to 1	5.2 to 1
E-partner notification	£226,786	0	477	-24	0	(£186,102)	(£40,612)	£0	-1.0 to 1	4.3 to 1
Chlamydia screening: women	£26,510,059	0	44,733	-4,805	0	(£3,549,443)	£2,458,870	£0	0.0 to 1	1.3 to 1
Reduced time from test to result	£0	-1,171	-553	-79	0	£40,832	£41,507	£0	N/A to 1	N/A to 1
Pregnancy Interventions only										
Extra emergency contraception	£431,868	0	0	0	-670	£390,832	£2,662,401	£3,677,610	15.6 to 1	15.6 to 1
Oral contraception with EHC	£4,170,118	826	359	93	-4,441	£3,652,579	£17,048,164	£24,773,734	10.9 to 1	10.3 to 1

Click here for a larger image

The interventions and their results are then stratified into 3 separate groups also shown by Figure 5: Pregnancy and STI interventions, STI interventions only and pregnancy interventions only. Such stratification has been implemented to encourage users to compare similar interventions, with similar modelling approaches, to each other.

The user is presented with the extra program cost associated with each intervention and a breakdown of the impact the intervention has in terms STI cases, STI diagnoses, STI sequelae and unplanned pregnancies.

The associated cost savings are then displayed stratified by who they accrue to (local authority, NHS or other) and ROI metrics. Any bracketed red numbers in the cost savings columns are negative – meaning that the intervention leads to greater costs in this area, rather than cost savings.

The user can use the tool to answer the questions they are interested in. They would find that the Online STI Service has an estimated ROI 5.2, where this estimate includes the monetised value of health gains. Most of the benefits come from the health gain, as there are additional costs to the NHS and local government due to more intensive STI treatment.

They also find the national rollout would cost £24.8m. They have read the limitations in Section 5 of this report however, so know that there may be more cost savings due to reduced STI prevalence, which are not captured by this model.

The ROI for condom availability in schools is 6.9. The user also observes that condom availability programmes in schools and colleges are highly cost saving across Local Authorities, the NHS and other government departments.

And they can contextualise the estimated programme costs of £0.87m against the current budget for SRH services across England. The user also has the ROI figures for the other interventions to act as tentative comparison figures when presenting these figures to a decision maker.

Users may note that the ROI (including health benefits) for chlamydia screening is lower than the other interventions. This result is partly due to the limitation (in Section 5 Model Limitations) that the model does not capture all the benefits of screening, but does fully capture its costs. PHE (2019) summarised the considerable evidence base underlying the NCSP in more detail.

The parameters used in this ROI regarding the costs and value of health benefits of chlamydia screening are consistent with that evidence base as used to inform the review of the National Chlamydia Screening Programme (NCSP) policy in 2019.

As such, the ROI we report is similar to the expectations and understanding underlying the recommendations made for NCSP policy in 2019. Similarly, users may note that the online STI service and e-partner notification interventions have negative ROI estimates (excluding health benefits), which is largely driven by the same limitation.

Finally, the user can expand the results to display additional results. These additional results disaggregate differences in cases diagnosed associated with a specific intervention by STI type, QALYs consequently gained, and the associated pregnancy outcomes over 10 years.

The tool also breaks down which parts of the government incurs / saves costs and what types of costs are saved (for example, birth costs, abortion costs, education costs). Figure 6 shows and example of a selection of what is available for each intervention, where the Online STI Service is selected (circled in red).

Figure 6: Snapshot of more granular results for an example intervention

Select to view by intervention: Online STI service

STI Outcomes (lifetime)

Difference in cases [index population only]

0.0	fewer cases of chlamydia
0.0	fewer cases of gonorrhoea
0.0	fewer cases of genital warts
0.0	fewer cases of syphilis
0.0	fewer cases of HIV

Difference in diagnoses [index population + partners]

71,817.6	more diagnoses of chlamydia
1,366.3	more diagnoses of gonorrhoea
0.0	more diagnoses of genital warts
1,135.8	more diagnoses of syphilis
1,407.7	more early diagnoses of HIV

Economic outcomes

	exc. QALYs	inc. QALYs
Return on Investment	-.4 to 1	5.2 to 1
Net benefit	-£34,416,609	£103,882,954

Financial outcomes *Positive = saving, negative = cost*

Local authority cost savings	
STI costs	
Treatment costs	-£4,480,210
Testing costs	-£1,259,719
Costs of partner notification	-£367,996
Pregnancy costs	
Public health services for children	£0
Children in care	£0
Total local authority cost savings	**-£6,107,925**

Click here for a larger image

5) Tool limitations

This tool aims to reconcile evidence and use consistent methods to compare interventions as effectively as possible, this approach is a big improvement compared to simply reviewing economics literature on sexual and reproductive health, which will be based on very disparate methods. However, it is never possible to analyse different interventions in a fully comparable manner.

This section highlights some of the main limitations of the tool, that should be considered when interpreting the results. All users of the tool should understand these limitations before using the results. These limitations mean that the ROIs for different interventions (for example, additional emergency contraception compared to chlamydia screening) are not directly comparable. Users who are interested in learning more about the reasons for these limitations should refer to Appendix 2, which sets out the technical detail underlying the model.

1. Static rather than dynamic modelling approach

The model that drives the results of the ROI tool utilises a static modelling approach rather than a dynamic approach. This means parameters such as disease prevalence are assumed to be constant, rather than modelled as changing dynamically over time. As a result, the model only includes benefits to the patients who are tested and receive treatments because of interventions, and not subsequent effects on other individuals who they have sexual contact with.

Avoiding future infections is a key reason for preventing, testing and treating STIs and so this is a considerable limitation of the model. ROIs calculated for STI interventions will underestimate the health and financial benefits of these interventions, and so the true ROIs. This will particularly affect some of the testing interventions (online testing, e-partner notification and chlamydia screening).

2. MSM, WSW and transgender populations are not modelled explicitly

The model assumes all sex is between individuals of opposite sex. The model assumes that infection following sexual activity occurs at the transmission probabilities associated with heterosexual sex. This assumption simplifies the model in line with suggestions from the Steering Group and concerns about the lack of evidence for some parameters specific to MSM.

Though MSM will be included in prevalence estimate and diagnosis data, this assumption means that differences in uptake of interventions within MSM are missed. Similarly, WSW may be at higher risk of unplanned pregnancy in their teens, but this differential risk is not captured.

Finally, the model is based on multiple data sources that ask people their sex or gender but do not explicitly collect their gender identity or whether it is the same as the sex assigned at birth. Because of this, we assume that people's declared sex or gender is the same as their sex assigned at birth and, as a key limitation, that people have risk of STIs and pregnancy associated with their declared gender. These modelling decisions were made for practical purposes and do not reflect a lack of need or priority of evidence for the sexual health of LGBT individuals.

The overall impact of these assumptions is likely to be small because same-sex sexual activity constitutes a small proportion of total sexual activity in young people. When commissioning services for young MSM, who tend to be at higher risk of gonorrhoea, syphilis and HIV, users should note that STI testing interventions are likely to have higher ROI values than for young people in general; this would not be true for chlamydia screening, which is likely to be more cost effective in women due to female specific sequelae.

Users should also note that WSW are more likely to have unintended pregnancies as teens.

3. Probability of sex with someone with an STI equal to prevalence.

The model assumes that the probability of a sex act being with someone who has an STI is equal to the prevalence. This simplifying assumption is necessary for the mathematical modelling of the impact of behavioural inputs on STI outcomes. However, it ignores potential behavioural dynamics in partner selection and greater risk of STIs in those who have more sex. Without access to data on these dynamics, the impact of this assumption is uncertain.

4. Pregnancy outcomes and STI outcomes are not directly comparable

In addition to the key limitation described in 1. above, estimates of pregnancy outcomes and sexually transmitted infection outcomes do not have directly comparable components costed. For pregnancy, 10-year costs to the public sector are calculated (including wider effects such as education).

For sexually transmitted infections, only testing, treatment costs and quality of life impacts for patients and their partners are calculated - no wider indirect impacts (such as productivity losses from time off work) are considered.

5. All interventions are modelled in isolation

The tool estimates the impact of each intervention separately to simplify the modelling and use evidence more directly. However, this means that returns are likely to be different when implementing these interventions in combination as opposed to individually (the results refer to returns when implemented individually). The impact of this effect is uncertain, as some interventions may be complementary in terms of return on investment, but some may not.

6. Evidence incorporated into the tool is uncertain and does not always match perfectly

All models are simplifications, and so can struggle to incorporate evidence directly. As such, sometimes parameters needed to be adjusted to be incorporated into the model (for example, because a study observes an outcome over a shorter time period).

Also, in this tool, sometimes evidence is drawn from settings other than England, as relevant evidence is not available in an English setting. As such, though the tool is evidence based, other authors may have made different modelling choices, and uncertainty in these modelling choices increases the uncertainty of the results.

7. Health loss associated with STIs is likely to be underestimated

The authors attempted to rigorously quantify the health loss associated with each of the STIs modelled. However, because 5 STIs were modelled that meant it was not practical to incorporate all the complications for each disease.

This means the estimates of the health loss (in terms of QALY loss per case) may underestimate the true health loss if all complications were incorporated.

Appendix 1) Evidence review details

At the outset of the project, Optimity Advisors conducted a mapping exercise to assess the current literature, previous projects, available tools and resources around sexual and reproductive health in England. Some of the resources reviewed included:

- PHE's Health Economics Evidence Resource
- NICE guidelines
- PHE contraceptive services ROI tool
- other tools and literature suggested by experts

An initial search of systematic reviews was also undertaken to inform the development of the search strategies. When the systematic reviews seemed relevant, they were further reviewed for inclusion and to identify other potentially relevant studies. Based on these preliminary findings Optimity Advisors undertook 2 further evidence reviews.

Search strategy for the initial evidence review

Optimity Advisors searched Medline, Embase, Econlit and the Cochrane Library for this review. The initial intention of this project was to model sexual and reproductive health interventions for 3 population groups:

- young people (aged 15 to 24)
- women across the life course
- men who have sex with men (MSM)

This initial search of evidence relating to all 3 population groups was structured to return high quality evidence on the cost-effectiveness of sexual and reproductive health interventions in the last 10 years. The search strategy included:

- terms for economic studies
- terms for the population (young people aged 15 to 24, women across the life course and MSM)
- terms for sexual and reproductive health
- additional relevant terms for example, chlamydia screening; emergency contraception

Abstracts of the 8,017 papers were screened using inclusion criteria (see Table 3) and checked for relevance to the specific interventions and sexual and reproductive health topics (for example, chlamydia screening).

Table 3: Inclusion criteria for the evidence review

Criteria	Inclusion criteria
Date	Study published after 2000.
Country	Published in Europe, USA, Canada, Australia or New Zealand.
Language	Study published in English.
Topic	Study focuses on the health and / or economic effects of sexual and reproductive health interventions.
Population	Study focuses on young people aged 15 to 24.
Interventions	Study focuses on interventions improving sexual and / or reproductive health by one of the six interventions.
Outcome	Studies that report relevant health or financial outcomes. Examples of relevant outcomes include: transition probability; infection rate; number of diagnoses; change in sexual behaviours; contraceptive usage; vaccination uptake and coverage; testing uptake.
Study Design	Studies that are systematic reviews or economic studies.

24 papers were returned which fit the inclusion criteria and each full text was assessed using a bespoke RAG (Red, Amber, Green) rating (see Table 4). RAG rating allows comparable assessment of options based on an increasing scale of appropriateness and / or validity of results (green being the most appropriate). Here a RAG rating was chosen to distinguish between the quality of the papers and the generalisability of the results.

Table 4: RAG rating of studies identified in the initial evidence review

Rating	Description	#Papers
Red	Papers did not have the required characteristics outlined below.	10
Amber	Paper included: • An effectiveness metric which would enable comparison to a baseline scenario and cross-comparison of interventions • Either direct reporting of intervention costs or sufficient information to be able to cost the intervention	6
Green	Paper included: • An effectiveness metric which would enable comparison to a baseline scenario and cross-comparison of interventions • Either direct reporting of intervention costs or sufficient information to be able to cost the intervention • A disease transmission model which could be reproduced within the back end of the tool	8

After this initial review, a decision was made to limit the scope to focus only on sexual and reproductive health interventions for young people (aged 15 to 24), as the evidence appeared to be the strongest for this group. The tool could be developed to expand the scope to all 3 population groups if sufficient evidence becomes available.

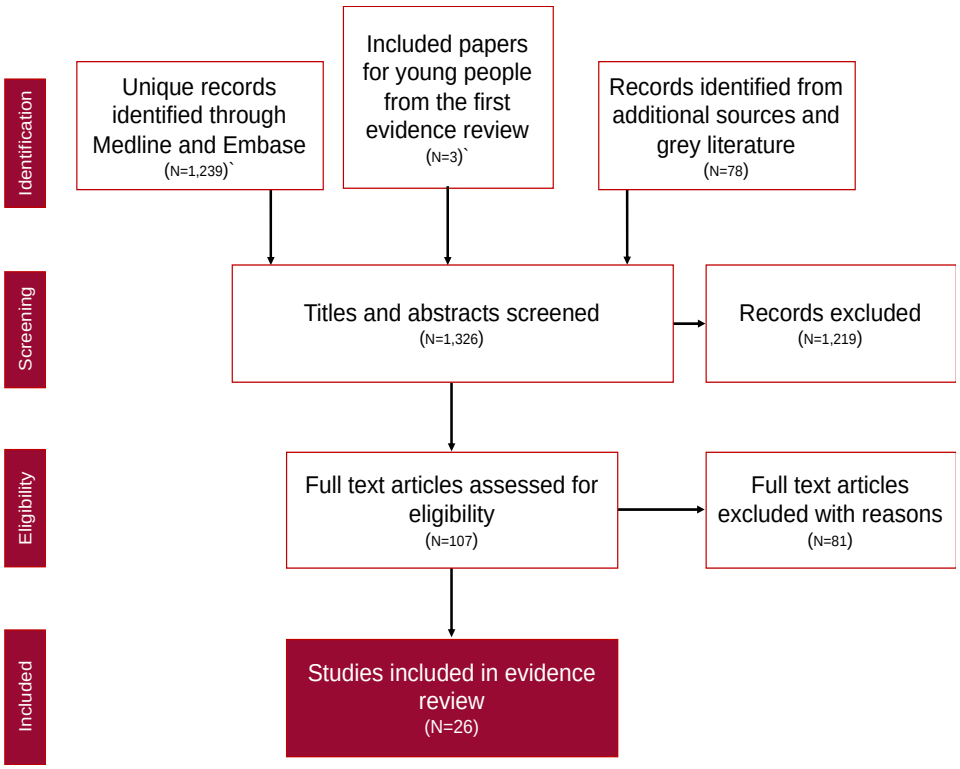
Search strategy for the second evidence review focused on young people

To capture these additional evidence sources and to reflect the change in scope of the tool to focus on young people aged 15 to 24, we conducted a second literature-search for systematic reviews of young people's sexual and reproductive health interventions. Systematic reviews were specified to identify literature that met inclusion criteria is a timely manner. The search terms for the second search included:

- terms for the population (young people aged 15 to 24)
- terms for sexual and reproductive health
- additional relevant terms for example, chlamydia screening; emergency contraception

In total, 1,239 titles and abstracts were returned after duplicates were removed. These abstracts were then screened for relevance and assessed via the criteria in Table 3. 98 full texts were returned and analysed and finally 17 papers were returned. Combined with the results of the first search and additional grey literature searching, 26 papers were retained for inclusion. Figure 7 shows the literature search prisma flow diagram.

Figure 7: prisma flow diagram for the second evidence review



Evidence modelled in the tool

From the 26 papers returned at the end of both evidence searches, 8 papers were selected which most closely matched the interventions to be modelled in the tool. The papers are listed in Table 1 in Section 2 (the Interventions modelled in this tool section) of the report.

Appendix 2) Modelling approach

This technical appendix has been written to set out all of the information required for users to interpret the results of the tool; however, users can contact HealthEconomics@phe.gov.uk to request the password to unlock the back sheets of the model if they think that would be beneficial to their understanding or further work in this area.

The ROI tool takes user inputs and other evidence-based assumptions and calculates an STI model and model of unintended pregnancies. The STI model incorporates STI testing, STI diagnosis rates, STI cases and partner notification. Interventions affect the variables associated with these components and those variables determine the outcomes patients experience.

The unintended pregnancy model captures the effects of contraception on unintended pregnancies. Where unintended pregnancies can be either mistimed (meaning the mother intended to get pregnant at a later date) or unwanted (where the mother never intended to get pregnant). The tool then aggregates the costs and benefits of the outcomes associated with the STI and unintended pregnancy models to produce overall results.

Data and assumptions used in both models

Population data

The population data used in the model are the 2017 estimates of 15 to 24 population in England from the Office for National Statistics (ONS) (ONS, 2019). These estimates show the population distribution within this group by age and sex. This distribution is assumed to stay constant regardless of the overall population inputted by the user. Table 5 shows the population distribution by age and sex.

The population data, as well as other sources of data or evidence in the tool, do not distinguish between people's declared gender and sex assigned at birth. This lack of additional data means the model assumes that people's declared gender is the same as their sex assigned at birth, as that is the only practical assumption. This limits the applicability of some of the tools finding to transgender individuals, who may have different sexual health needs from cis-gendered individuals.

Table 5: Population distribution

Female by age	Distribution (%)	Males by age	Distribution (%)
15	4.3	15	4.6
16	4.4	16	4.7
17	4.6	17	4.8
18	4.7	18	5.0
19	4.8	19	5.1
20	5.0	20	5.3
21	5.0	21	5.4
22	5.1	22	5.4
23	5.3	23	5.6
24	5.4	24	5.6

Source: ONS, 2017

Discounting

Costs are discounted at 3.5% per annum while health outcomes are discounted at 1.5% per annum, as recommended in Her Majesty's Treasury's (HMT's) Green Book, see Annex 6 for further details (HM Treasury, 2018).

Monetary value of a QALY

QALYs are incorporated into the ROI figure by converting a QALY gain (or loss) figure into a monetary value. This is down according to HMT's Green Book, where the monetary value of a QALY is £60k, see Annex 6 for further details (HM Treasury, 2018).

STI modelling

An STI model was used to determine how contraception use would influence the number of cases of chlamydia, gonorrhoea, genital warts, syphilis and HIV. In addition, pelvic inflammatory disease (PID) and tubal factor infertility (TFI) were modelled as sequelae of chlamydia, PID only was modelled as a sequela of gonorrhoea, and neurosyphilis and tertiary syphilis were modelled as rare sequelae of primary syphilis. This disease scope was based on a model produced for an evidence review by NICE (Sadler et al, 2017). However, this scope has been extended to incorporate additional disease sequelae and to model testing interventions as well.

Static vs dynamic transmission modelling

A range of STI models were evaluated to inform whether the tool should use a static or dynamic disease transmission model. Static models tend to be based on a decision tree with constant parameters, whereas dynamic models feature multiple different disease states which can be populated by different proportions of the population at different times.

The distribution of the population in the different disease states impacts the parameter values, most notably the prevalence rate. By capturing changes in prevalence over time, dynamic models capture the wider effects of an intervention, beyond the treatment group. However, dynamic models are computationally complex and difficult to calibrate; as such, it was deemed impractical for this tool, which is updatable in real time in Microsoft Excel.

The tool utilises a simpler static STI model. This limits the effects captured by the model to the index population and their partners. By limiting the effects to just the index population, it is likely that the static model will underestimate the ROI of STI interventions, as it does not capture the impact of testing interventions on reducing STIs and underestimates the benefits of STI prevention through contraception.

Mathematic definition

A Bernoulli model of HIV transmission developed by Pinkerton and Abramson was used to mathematically define the relationship between contraception use, sexual behaviours and STI transmission (Pinkerton and Abramson, 1996). This model was adapted by Wang et al (2000) and then by Nherera and Jacklin (2009) for modelling chlamydia, gonorrhoea and genital warts. It was subsequently followed and expanded by Sadler et al (2017) to include syphilis transmission.

The model (as used by Sadler et al) is shown by Equation (2):

$$Z = g(1-((1-tk)^s))) + (1-g)\times(1-((1-t)^s)) \quad (2)$$

Where

Z = Probability of transmission if partner has the STI

g = Probability of using a condom

t = Transmission rate of the STI per sex act

k = Condom failure rate

s = Acts of sexual intercourse per annum

Using this probability of transmission Z, the number of the population acquiring the given STI in a year can be estimated by multiplying this probability by the prevalence of the STI and the sexually active population. Using prevalence as the probability of a partner having an STI is a limitation, as people who have more sex are more likely to have an STI. They also be more likely to use condoms, but this assumption is necessary without more granular data on sexual behaviour.

Under this assumption previous authors have estimated new STI cases using Equation (3):

$$\text{New cases of STI} = \mathrm{v} \times \mathrm{Z} \times \mathrm{N} \qquad (3)$$

Where

W = Proportion acquiring STI

v = Prevalence of STI (probability partner has STI)

N = Sexually active population

However, Equation (3) has an important limitation. Z is a probability so it must be between 0 and 1 (inclusive). This means that new cases will be lower than the current number of prevalent cases; for diseases with average case durations less than a year, this cannot be true.

This issue is probably mainly due to Pinkerton and Abrahamson's (1996) model, which focused on HIV transmission risk in couples, being applied to other diseases and multiple partners.

Running the model based on Equation (3) leads to an estimated number of new cases that is far lower than the number of cases diagnosed in practice for conditions like gonorrhoea and chlamydia.

As such, the Equation (3) was adjusted to what is shown in Equation (4):

$$\mathrm{Y} = \mathrm{g}(1-(1-\mathrm{vte})^{\mathrm{s}})) + (1-\mathrm{g}) \times (1-(1-\mathrm{vt})^{\mathrm{s}}) \qquad (4)$$

Where:

Y = Probability of contracting an STI

g = Proportion of population who report condom use

v = Prevalence of STI (probability partner has STI)

t = Transmission rate of the STI per sex act

e = Effectiveness of condoms at preventing STIs

s = Acts of sexual intercourse per annum

Intuitively, this change means that now individuals are assumed to change their partner for every sex act, rather than having the same partner for a year. This is implied by the probability their partner has an STI being independent for each sex act. Neither of these models is perfect, as there will be some continuation in partners but also some mixing. However, (4) allows incidence to be greater than prevalence, which is critically important for STIs with short case durations, and leads to an estimate of the number of new cases that is much more realistic, as it is more consistent with the diagnosis activity we observe in young people.

Also e in (3) differs from k in (1), because it recognises that condoms do not have to fail (for example, break or slip) to allow the transmission of STIs; condoms can be ineffective for other reasons, as covered in the Condom efficacy at preventing STIs sub-section below.

$$\text{New cases of STI} = Y \times N \qquad (5)$$

Equation (5) now shows new cases of the STI are given by Y multiplied by the number of sexually active young people.

Model parameters

The parameters used in the model were derived from a range of sources, providing epidemiological, behavioural, costing and quality of life data, which drive the results of the model and are described in detail in the following sections.

The parameters used in previous STI models, primarily Nherera and Jacklin (2009) and Sadler et al (2017), provided a starting point which was expanded upon by updating the parameters with evidence from the literature and expert input.

Sexual activity and sexual acts

Age and sex-specific data for the proportion of people who are sexually active (defined as having had sex in the last year) and number of sex acts for those who are sexually active are taken from the third National Survey of Sexual Attitudes and Lifestyles (NATSAL-3) publication. This data is shown in Table 6.

For the proportion of the population that is sexually active data from NATSAL-3 was only available for ages 16 and above. The Steering Group provided expert opinion to estimate the proportion for the 15-year-old population.

The mean number of sex acts in the last 4 weeks, for those who are sexually active, was multiplied by 13 to estimate the annual figure. As with the proportion of the population that is sexually active, no data is provided for the number of sex acts for the under-16 population. In this case, it was assumed that the number of sex acts for the sexually active 15-year-old population is the same as that of the sexually active 16-year-old population.

Table 6: Proportion of population that is sexually active, and corresponding number of sex acts per annum, by age and sex.

Age	Sexually active (%)		Number of sex acts per annum	
	Female	Male	Female	Male
15	29	29	47	51
16	45	51	47	51
17	62	57	79	45
18	78	73	73	75
19	78	80	74	64
20	85	80	89	83
21	88	87	73	63
22	82	86	82	69
23	86	87	75	81
24	90	88	71	86

Source: NATSAL-3, expert opinion

Contraceptive use

Sex and young person specific data for contraceptive use is taken from NATSAL-3, it refers specifically to ‘the most usual method of contraception that you use with a partner these days?’. This data is shown in Table 7. The significant gender difference in the observed data may be explained by male partners ignorance of their female partner using an ‘invisible’ method such as the pill or implant.

It is assumed that the ‘usual method’ of contraception was used over the period. Condoms are modelled as being less than perfect at STI prevention, which should account somewhat for inconsistent use. It is assumed that the only contraceptive methods used are condoms, the pill, implant and intrauterine device (IUD) and that ‘no method’ users are the remaining population who are not using any of these 4 methods.

The impact of the assumption would be to overestimate the proportion of those using ‘no method’, as in reality a small proportion of the ‘no method’ group will be using alternative forms of contraception. This assumption does not impact STI outcomes, which are determined by condom use, it would impact outcomes related to pregnancies (as covered in Contraception effectiveness sub-section related to the pregnancy model).

However, the impact of this assumption is likely to be small. It is also assumed that 7.1% of sexually active 16- to 24-year-old women use emergency contraception in a given year in the base case. This is the value reported in the NATSAL-3 survey (Black et al, 2016).

Table 7: Usual method of contraception used by sexually active 16 to 24 year olds, by sex

Usual contraception method	Male (%)	Female (%)
Condom	56.2	31.5
Pill	30.5	43.5
Implant	5.2	10.1
IUD	0.8	1.8
No method	7.4	13.1

Source: NATSAL-3

Transmission rate

Transmission rates per STI are detailed in Table 8. With the exception of HIV, the STI transmission rates per act of sexual intercourse are assumed not to vary by age or sex. The transmission rates are applicable where no protection is used. The per act transmission rate was not available for genital warts, so a per relationship figure of 64% from Oriel (1971) was adjusted to a per act figure.

This adjustment assumed 10 acts per relationship, as is consistent with other literature (Turner et al, 2006). The syphilis figure is the mid-point of the range of values reported in Gray et al (2009); unfortunately, for syphilis only an MSM figure was available, so that is used, though it may be different to the value for heterosexual sex.

Table 8: STI transmission rate per act of sexual intercourse

STI	Transmission (%)	Source
Chlamydia	5.0	Althaus and Low (2011)
Gonorrhoea	4.3	Holmes et al (1970)
Genital Warts	9.7	Oriel (1971) and author calculations
Syphilis	1.0	Gray et al (2009)
HIV	Female 0.39 Male: 0.12	Boily et al (2009)

Condom efficacy at preventing STIs

Condoms are not totally effective at preventing STIs. Those who report being condom users may not always use them, condoms do not act as a perfect barrier to certain STIs (genital warts and syphilis) and they may malfunction by tearing or slipping. As such, Table 9 below reflects the effectiveness of condoms at preventing STIs.

Table 9: Estimated effectiveness of condoms based on RR of contracting the STI when condom use is reported compared to when it is not

STI	RR of contracting STI	Source
Chlamydia	0.42	Warner et al (2004)
Gonorrhoea	0.42	Warner et al (2004)
Genital Warts	0.35	Manhart and Koutsky (2002)
Syphilis	0.49	Koss et al (2009)
HIV	0.073	Pinkerton and Abramson (1997)

STI prevalence

The age-group-specific and sex-specific STI prevalence are provided in Table 10. Prevalence for chlamydia, gonorrhoea, genital warts and HIV are based on NATSAL-3, although these were adjusted in some cases to avoid zero prevalence assumptions. The prevalence rate for HIV is based on the 16 to 44 population. HIV prevalence is low, and so it is hard to estimate from a survey such as NATSAL; as such using the larger size of the 16 to 44 sample was thought to provide a more reliable estimate. This prevalence was sense checked against recorded diagnoses in this age group from PHE data and found to be consistent.

Prevalence data for genital warts is taken from NATSAL, which only reports incidence. As such, it was assumed that prevalence = incidence for warts, as the average case duration for a case of warts is probably less than one year, but warts exhibits recurrence in some cases.

Prevalence data for syphilis is taken from Korenromp (2018). The authors estimate prevalence for the 16 to 44 population in women in Europe, as such its applicability relies on assumed similarity between this population and the 15 to 24 population in England for men and women. Men have higher diagnosis numbers than women in England, but younger people have lower diagnosis numbers. So, it is uncertain if this figure is an underestimate or overestimate.

This estimate was sense checked against data on syphilis prevalence recorded by antenatal screening and young blood donors (both of whom are low risk groups) and found to be consistent.

Table 10: STI prevalence amongst sexually active population by age group and sex

STI	Age	Prevalence (%)	
		Female	Male
Chlamydia	16-17	2.3	0.1*
	18-19	4.7	0.5
	20-24	2.7	3.4
Gonorrhoea	16-17	0.1*	0.1*
	18-19	0.1*	0.1*
	20-24	0.2	0.1
Genital Warts	16-19	0.7	0.2
	20-24	1.2	0.4
Syphilis	15-49	0.11	0.11
HIV	16-44	0.1	0.2

Source: Natsal, Korenromp et al 2018 (Syphilis)
*Prevalence in the original source given as 0.0%, it was assumed that setting this at exactly 0 was an underestimate and as such this figure was set to 0.1%

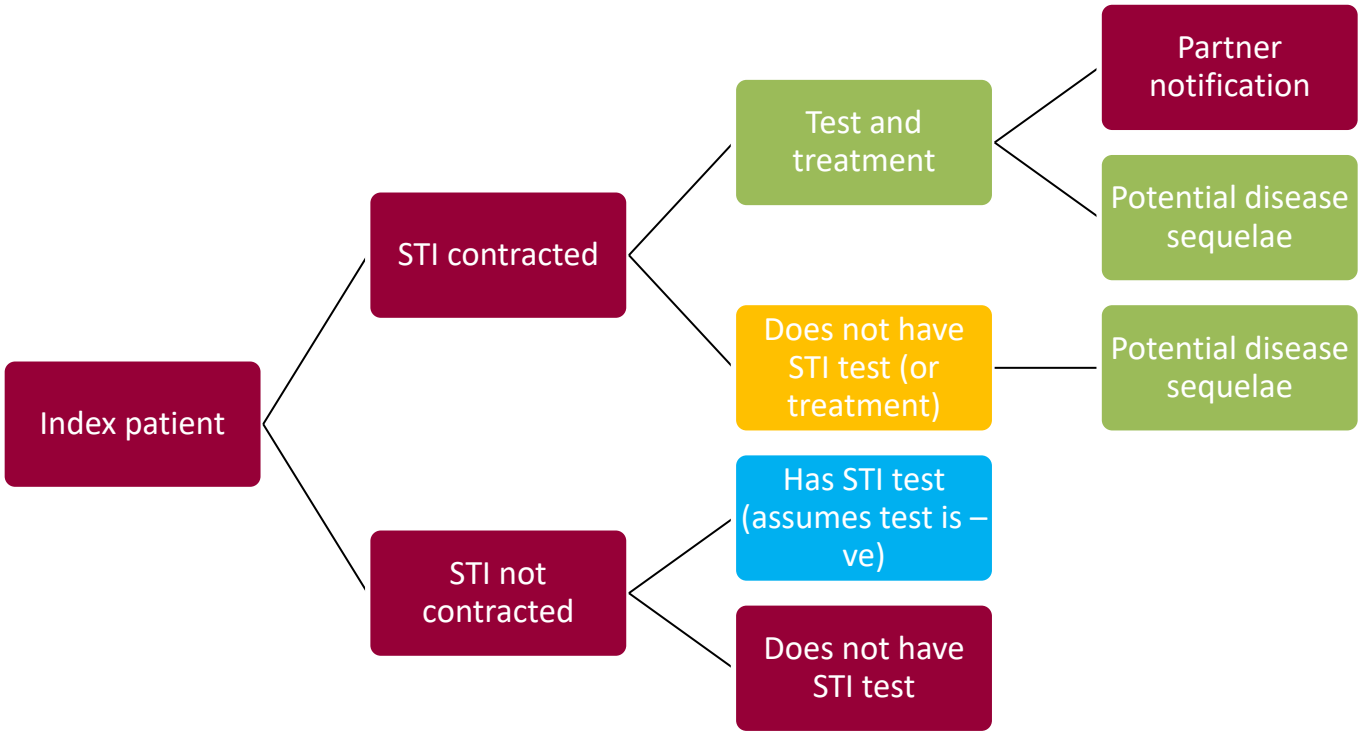
Outcomes

The model estimates health outcomes in terms of QALYs. QALYs are a unit of health, based on a year of life in full health. They capture health loss from both morbidity and mortality, which is important for our model, as the STIs are of varying severity, and only some are fatal. The model estimates the QALY loss and the treatment costs that result from the new cases of STIs (and associated sequelae) contracted by the simulated population over one year. This approach allows different interventions to be compared in respect to the number of STI cases averted, and the proportion tested and treated. The associated QALY gain and treatment costs avoided are then calculated.

Figure 8 shows the model structure for an index patient. Red boxes indicate a purely functional model stage; green boxes indicate a model stage with associated testing and treatment costs, and health outcomes; yellow boxes are states associated only with health outcomes; and blue boxes indicate purely testing steps.

Figure 8 shows that patients can either have the STI or not, and they can either be tested for the STI or not in the year modelled. If the patient has the STI and is tested then they can be treated and their partner(s) can be notified, this reduces the probability of disease sequelae and may improve their health outcome. Failure to test and treat infected patients has the opposite effect. In the case of HIV, it is assumed patients are diagnosed late, as opposed to not diagnosed, as the vast majority of HIV cases are diagnosed before death and the disease does not remit naturally. If the patient does not have an STI but is tested that incurs a cost with no benefit modelled.

Figure 8: Model schematic for an index patient for each disease



Probability of being diagnosed

The model requires the probability that someone is diagnosed given they have an STI. This is a difficult thing to estimate as there is no clear denominator (number of infected individuals) to link to PHE's activity data on diagnoses (Mapp et al, 2017). As such, where no previous estimate of diagnosis rate was available, NATSAL prevalence data was used to estimate the number of individuals infected in a given year. This figure was used to estimate what proportion of infected individuals are diagnosed. This is one of the least certain areas of the model, and should be improved upon in future iterations of this tool.

Equations (6) and (7) were rearranged in steps (8) to (10) in order to estimate the probability of diagnosis using Equation (11).

$$N_{INC} \approx \frac{N_{PREV}}{T_{MEAN}} \quad (6)$$

Where: N_{INC} is the number of incident cases in a year

N_{PREV} is the number of prevalent cases at a point in the year

T_{MEAN} is the mean case duration

Equation (6) is a basic epidemiological approximation of the relationship between incidence and prevalence. It is assumed to be strictly equivalent (rather than more or less equivalent) in the next steps (the ≈ becomes an =).

$$P_{DIAG} = \frac{N_{DIAG}}{N_{INC}} \quad (7)$$

Where: P_{DIAG} is the proportion of incident cases which are diagnosed

N_{DIAG} is the number of diagnosed cases recorded in a year

Equation (7) is a basic proportion calculation based on recorded diagnoses and estimated incidence.

Rearranging Equation (7) gives:

$$N_{INC} = \frac{N_{DIAG}}{P_{DIAG}} \quad (8)$$

Setting the N_{INC} term in Equation (6) equal to the N_{INC} in Equation (8) gives:

$$\frac{N_{DIAG}}{P_{DIAG}} = \frac{N_{PREV}}{T_{MEAN}} \quad (9)$$

Expanding $T_{MEAN} = P_{DIAG} \times T_{DIAG} + (1 - P_{DIAG}) \times T_{UN}$ gives:

$$\frac{N_{DIAG}}{P_{DIAG}} = \frac{N_{PREV}}{P_{DIAG} \times T_{DIAG} + (1 - P_{DIAG}) \times T_{UN}} \quad (10)$$

Rearranging for P_{DIAG} gives:

$$P_{DIAG} = \frac{N_{DIAG} \times T_{UN}}{N_{PREV} + N_{DIAG} \times T_{UN} - N_{DIAG} \times T_{DIAG}} \quad (11)$$

The assumed mean case durations for the STIs set out in Table 11, recorded diagnoses data from PHE Table 2 and NATSAL prevalence estimates were combined in Equation (11) to estimate the proportion of cases which are diagnosed. Table 12 shows the resulting estimates, combined with other pre-existing estimates of diagnosis rates.

Table 11: Assumed mean case durations for STIs without prior diagnosis estimates

	Mean case duration if diagnosed (years)	Mean case duration if undiagnosed (years)	Evidence used to make assumption
Chlamydia	0.17	1	Price et al (2016) Gottlieb et al (2010)
Gonorrhoea	0.17	1	Gottlieb et al (2010) Lovett and Duncan (2019)
GW	0.42	1.5	Ockenfels et al (2016) Yanofsky et al (2012)

The literature on the natural history of the STIs in Table 11 does not give definitive values for mean case with treatment or without. As such, these values are realistic assumptions that are consistent with available evidence but are subject to considerable uncertainty. These assumptions are necessary for the back calculations in the model.

Table 12: Assumed diagnosis rates by men and women for each of the STIs

	Men	Women	Source
Chlamydia	0.48	0.34	Calculation based on formula (10)
Gonorrhoea	0.74	0.54	Calculation based on formula (10)
GW	0.91	0.61	Calculation based on formula (10)
Syphilis	0.76	0.76	Tuite et al (2014)
HIV	0.71	0.71	Early diagnosis based on PHE (2018d)

Treatment for those diagnosed

It is assumed that 100% of people who are diagnosed with STIs other than HIV go on to receive treatment and are cured as a result. In reality, it is likely that a small proportion of diagnosed individuals do not adhere to their full course of treatment, and are not cured.

For most of the STI cases modelled, this proportion is likely so small that it is immaterial. However, this assumption is less likely to hold for gonorrhoea, as there is considerable antibiotic resistance in the UK, and so cases may require different or more intensive treatment than are assumed.

Baseline testing rates

The model includes 2 different types of testing, chlamydia only testing, or full STI testing for chlamydia, gonorrhoea, syphilis and HIV. These categories are those required by the 2 relevant interventions, which are chlamydia screening in women and online full STI test. The testing rates shown in Table 13 are calculated based on PHE's testing activity data for young people, divided by the number of sexually active young people. One of the interventions is chlamydia screening in women; therefore, the baseline testing rate assumes there is no chlamydia screening for women (so the chlamydia only testing rate is 0).

Table 13: Baseline testing rates assumed in the model

STI	Proportion of sexually active population getting tested
Chlamydia only (male)	0.044
Full STI test (male)	0.106
Chlamydia only (female)	0.000
Full STI test (female)	0.179

Effect of additional testing on diagnoses

Under STI testing interventions, the testing rate increases (either due to primary testing or testing due to partner notification). This increase will have an uncertain effect on diagnoses, because the relationship between the population testing rate and the population diagnosis rate is not necessarily linear.

A scenario with a low testing rate is likely to have a higher diagnosis rate per test. This is because, in because many of the patients who seek out testing will do so because they have a strong prior probability of having the STI (because they have symptoms, have been notified by a partner, or have engaged in risky sexual behaviour).

Additional testing will capture some of these high probability individuals, but will also capture more individuals with lower probabilities of having the STI (they may be with a new partner and want precautionary testing). As such, the diagnosis rate per test is likely to fall with additional testing.

For chlamydia and gonorrhoea, the reduction in the diagnosis rate modelled was based on the difference between diagnosis rates of chlamydia in screening settings compared to sexual health settings. For syphilis and HIV, this reduction was based on the difference between diagnosis rates of HIV in online testing, compared to testing in other settings. In practice, these reductions are subject to considerable uncertainty, particularly for gonorrhoea and syphilis where primary data were not available, and so are based on data for other STIs.

Rates of diagnosis through partner notification are not assumed to vary with the proportion of partners notified.

Sequelae

In addition to the STI outcomes, the model includes several sequelae that are caused by these STIs. Unfortunately, it was not practical to capture all sequelae associated with these STIs; for instance, chlamydia has additional sequelae not accounted for, such as ectopic pregnancy. This means that the treatment costs and health loss associated with disease sequelae are likely to be systematically underestimated by the tool. The most important sequelae were prioritised in order to avoid this materially affecting the results.

A proportion of chlamydia and gonorrhoea cases result in cases of PID, and a proportion of cases of chlamydia result in TFI. These proportions differ depending on whether the STI is treated or untreated. Also, a proportion of syphilis cases if untreated will lead to either tertiary or neurosyphilis. The rates of STI cases leading to sequelae are listed in Table 14.

In lieu of evidence on the probability of gonorrhoea causing PID over the time period of interest, the probability is assumed to be the same as for chlamydia, though related evidence suggests the probability for gonorrhoea is higher over a shorter time frame (Reekie et al 2014, 2017).

Because neurosyphilis and tertiary syphilis tend to occur at time lags of 15 to 20 years (Tuite et al, 2014), these rates were also adjusted to account for potential future testing after the model period, but before the sequelae occur.

In reality this adjustment for future testing is very challenging as syphilis is concentrated in high risk groups (for example, MSM) who may get tested very frequently on average, but there may be those who forgo testing entirely, particularly given syphilis in the latent stage tends to be asymptomatic. There is also a risk of permanent disability from neurosyphilis.

Table 14: Percentage of STI cases leading to sequelae

STI leading to sequela	(%)	Source
Untreated Chlamydia leading to PID	17.1	Price et al (2016)
Treated Chlamydia leading to PID	6.7	Calculation based on Price et al (2016), 61% reduction in risk due to treatment
Untreated Gonorrhoea leading to PID	17.1	Assumed equivalent to chlamydia in the absence of other data, and in line with Turner et al (2013)
Treated Gonorrhoea leading to PID	6.7	Calculation based on same 61% reduction as experienced in treated PID from chlamydia
Untreated Chlamydia leading to TFI	0.5	Price et al (2016)
Treated Chlamydia leading to TFI	0.2	Calculation based on same 61% reduction as experienced in treated PID from chlamydia
Syphilis not initially diagnosed leading to neurosyphilis	4.5	Calculation based on the probability of progression if untreated from Tuite et al (2014) and Sukthankar (2014) and an assumed testing rate over the intervening period
Neurosyphilis leading to permanent disability	30.0	Tuite et al 2014
Syphilis not initially diagnosed leading to tertiary syphilis	12.2	Calculation based on the probability of progression if untreated from Tuite et al (2014) and Sukthankar (2014) and an assumed testing rate over the intervening period

Modelling QALYs

Each case of an STI or sequela is associated with a QALY loss. Table 15 sets out the QALY loss associated with each STI and the sources of these estimates. In most cases, a distinction was drawn between the utility when untreated or treated, but, in HIV cases,this reflects diagnosis and treatment in the early stage (CD4>350) as opposed to the late stage (CD4<350).

A number of other adjustments were made:

- for chlamydia and gonorrhoea it was assumed that the symptoms occur before treatment, and so there was no QALY gain from treatment, just a cure of the underlying infection and so reduced probability of sequelae
- for genital warts, the untreated QALY value was based on the treated disutility, but applied for 18 months rather than 5
- for syphilis, the difference was derived from different stages of the disease, an assumption was made as to the stages an individual goes through before treatment occurred, compared to the early stages of syphilis if untreated
- for HIV, QALY scores from Farnham et al (2013) were adjusted with PHE diagnoses data on HIV at each stage, to estimate diagnosis-probability-weighted utility estimates for early and late diagnosis of HIV
- it is assumed that all PID and TFI cases are treated, both figures are based on the mid ranges (of disutility and case duration) reported by a systematic review (Jackson et al, 2014). TFI disutility lasts many years, so the disutility is discounts by 1.5% a year
- it is also assumed that all syphilis sequelae are treated. Also, disutility occurs with a considerable time lag from the initial syphilis infection, so the disutility reported by Tuite et al (2014) is discounted by 1.5% a year

Table 15: QALY loss per episode of the primary STI or related sequelae

STI / sequelae	QALY loss (treated)	QALY loss (untreated)	Source
Chlamydia	0.002	0.002	Institute of Medicine (2000) and author calculations
Gonorrhoea	0.002	0.002	Institute of Medicine (2000) and author calculations
Genital Warts	0.018	0.069	Woodhall et al (2011) and author calculations
Syphilis	0.0004	0.017	Tuite et al (2014) and author calculations
HIV	4.49	5.71	Farnham et al (2013) and author calculations
PID	0.004	n/a	Jackson et al (2014) and author calculations
TFI	4.21	n/a	Jackson et al (2014) and author calculations
Neurosyphilis	0.070	n/a	Tuite et al (2014) and author calculations
Permanent disability from neurosyphilis	2.20	n/a	Tuite et al (2014) and author calculations
Tertiary syphilis	0.075	n/a	Tuite et al (2014) and author calculations

Modelling treatment costs

In addition to the QALY loss associated with each STI case, each treated case incurs a treatment cost. The treatment costs for chlamydia, gonorrhoea, syphilis and HIV are sourced from Sadler et al (2017) and other papers and inflated to 2019 prices. The values, and a brief explanation of these costs is given in the Table 16.

Treatment costs for PID were taken from Ong et al (2017) because the majority of cases treatment does not include inpatient hospital care and thus average costs are significantly lower than the treatment costs provided in Sadler et al (2017).

In general, the STI treatment cost was assumed to be constant for attendance at a GP surgery or GUM clinic, and does not include the cost of testing for initial diagnosis.

Table 16: Treatment costs

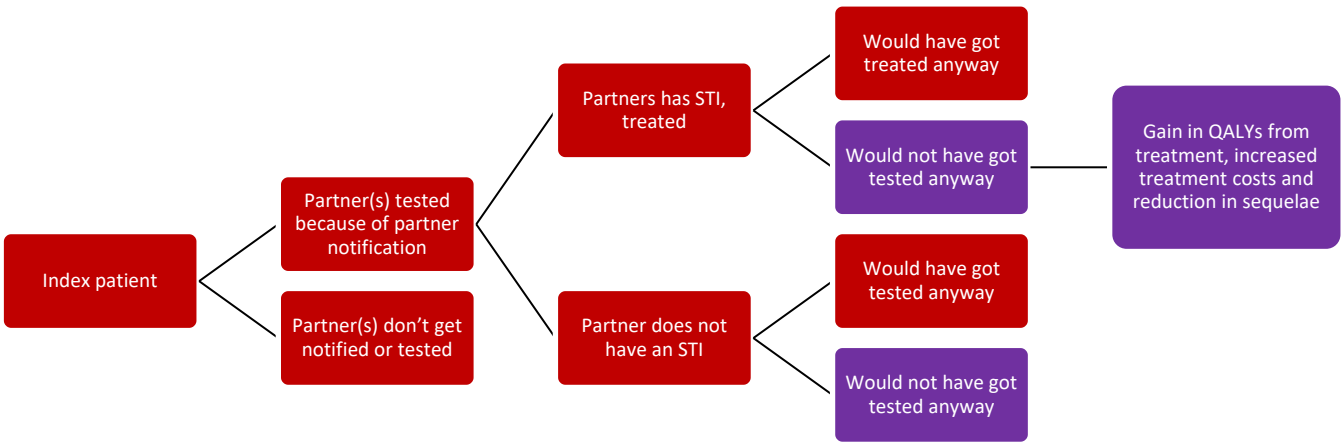
STI	Treatment Cost	Approach	Source
Chlamydia	£59	One-off treatment cost, costs are inflated and number of appointments adjusted (removed testing appointment as that is counted elsewhere and incorporated epidemiological treatment without an additional appointment for notified partners).	Sadler et al (2017) and author calculations
Gonorrhoea	£134		
Genital Warts	£118	One-off treatment cost for an episode inflated.	Desai et al (2011) and author calculations
Syphilis	£77	One-off treatment cost, costs are inflated and number of appointments adjusted (removed testing appointment as that is counted elsewhere and incorporated epidemiological treatment without an additional appointment for notified partners).	Sadler et al (2017) and author calculations
HIV	£214,465	Lifetime treatment cost, inflated and adapted for consistency with the model definition of late HIV diagnosis (CD4<350).	Ong et al (2019) and author calculations
HIV	£4,101	Additional lifetime treatment cost from early diagnosis, inflated and adapted as above.	Ong et al (2019) and author calculations
PID	£181	Full treatment cost, inflated.	Ong et al (2017)
TFI	£11,600	Full treatment cost.	PHE unpublished
Neurosyphilis	£4,220	One-off treatment cost, converted from CAD to GBP, inflated and discounted as costs occur with a time lag.	Tuite et al (2014) and author calculations

Permanent disability from neurosyphilis	£25,776	Lifetime treatment cost, converted from CAD to GBP, inflated and discounted as costs occur with a time lag.	Tuite et al (2014) and author calculations
Tertiary syphilis	£1,288	One-off treatment cost, converted from CAD to GBP, inflated and discounted as costs occur with a time lag.	Tuite et al (2014) and author calculations

Partner notification

In an extension from previous models, the model incorporates partner notification. This provides an additional means by which interventions can impact the number of STI cases tested for and treated. Partner notification is the practice of notifying the sexual partners of a recently diagnosed person that they may have been exposed to the STI. This model structure used for this extension is shown by Figure 9.

Figure 9: Model schematic for an index patient, partner notification



Within the model a number of partners per new STI diagnosis are notified and tested and, if found to have an STI, go on to receive treatment. This results in QALY gains from increased STI treatment and the avoidance of sequelae. This approach compares QALY outcomes with the counter factual case where there is no partner notification. In addition to a QALY gain, there will also be an impact on treatment costs because of the increased rate of treatment associated with additional diagnoses. Finally, partner notification itself will incur a cost, regardless of whether it results in any QALY or treatment outcomes.

Table 17: Partner notification and diagnostic assumptions

	Chlamydia	Gonorrhoea	Syphilis	HIV
Proportion of diagnoses leading to notification	0.49	0.41	0.63	0.73
Proportion of diagnoses leading to partner testing	0.43	0.35	0.48	0.63
Proportion of tested partners testing positive	0.39	0.36	0.12	0.04

Source: PHE Sexual Health Data Table 7, 2018. Data available on request

Table 17 shows assumptions about what proportions of diagnosed cases will lead to a partner being notified, what proportion of those notifications lead to testing and what proportion of tested partners result in positive diagnoses. Some patients who are tested following notification are not coded as such in data collection by sexual health services. This means that the estimated proportion of diagnoses leading to partner testing represents a lower bound of the true proportion.

Unintended Pregnancy Modelling

The second part of the tool is a model of unintended pregnancy. This model is adapted from the PHE Contraceptive ROI tool to predict the number of unwanted and mistimed pregnancies (PHE, 2018b). The report for this tool gives considerable additional detail on the data inputs and approach to costing pregnancies.

The number of pregnancies following intervention j is calculated according to Equation (12).

$$P_j = N \times \sum_i^n c_{ji} k_i \qquad (12)$$

Where:

P_j = Number of pregnancies for contraceptive distribution j
N = Number of sexually active women
n = Number of different contraceptive options (including no contraception)
c_{ji} = Proportion of women using contraception method i following intervention j
k_i = Failure rate for contraception method i

We assume that the number of planned pregnancies will stay constant regardless of the intervention because people intending to get pregnant will not be among the contraception adopters.

This means the change in unintended pregnancies associated with a contraception distribution under each intervention is equivalent to the difference in the number of pregnancies following the intervention and in the base case. As such, the change in unintended pregnancies under intervention j would is shown by Equation (13)

$$P_{uj} = P_j - P_b \quad (13)$$

Where:

P_{uj} = Change in unintended pregnancies under intervention j

This can be expanded using Equation (12) to give Equation (14)

$$P_{uj} = N \times \sum_i^n c_{ji} k_{ji} - N \times \sum_i^n c_{bi} k_{bi} \quad (14)$$

Where:

c_{bi} = Proportion of women using contraception method i in the base case

k_i = Failure rate for contraception method i

A proportion of unintended pregnancies will be mistimed and a proportion will be unwanted, with different costs in these cases. The change in mistimed pregnancies or unwanted pregnancies is then calculated by multiplying P_{uj} by the proportion of unintended pregnancies that are unwanted or mistimed respectively.

Parameters

These parameters are based on PHE's Contraception ROI Tool, which calculates the ROI of contraceptive services for 16 to 44 year olds. Where appropriate and feasible, parameters have been updated to reflect the 15 to 24 population. The following section describes the parameters used in the reproductive health model.

Contraception effectiveness

The failure rates for each method of contraception can be found in Table 18; they are taken from the PHE Contraceptive ROI Tool and based on Trussel (2011). These failure rates are based on proportion of couples who report this method experiencing unintended pregnancy, so reflects actual rather than optimal usage. Use of contraception for 15 to 24 year olds in the modelling base case has already been reported in Table 7.

This model assumes all sex is between people of opposite sexes, so it does not capture the dynamics of MSM and WSW, where WSW are at a higher risk of unplanned pregnancies in their teens (Hodson, Meads and Bewley, 2016).

Table 18: Annual failure rate by contraceptive type

Contraceptive	Failure rate (%)
Condom	18.0
Pill	9.0
Implant	0.1
IUD	0.5
No method	85.0

Source: PHE Contraceptive ROI tool

Proportion of pregnancies that are unintended

Table 19 displays the percentage of pregnancies that are unwanted and mistimed and the average number of years by which a couple would have preferred to delay the pregnancy.

The data for the percentage of unwanted and mistimed pregnancies is taken from the Centers for Disease Control and Prevention (CDC) Fertility, Family Planning and Reproductive Health of U.S women: 2002 National Survey of Family Growth, as relevant data for England was not available (CDC, 2005).

The number of years by which birth is delayed is also based on figures taken from the survey.

Table 19: Mistimed pregnancies

Age	Unwanted (%)	Mistimed (%)	Average years by which pregnancy is delayed
15	29	71	3.375
16	29	71	3.375
17	29	71	3.375
18	26	74	3.375
19	26	74	3.375
20	39	61	2.347
21	39	61	2.347
22	39	61	2.347
23	39	61	2.347
24	39	61	2.347

Source: CDC. Fertility, Family Planning and Reproductive Health of U.S women: 2002 National Survey of Family Growth.

Costs per unintended pregnancy

Table 20 displays the costs for different unintended pregnancy situations, which are adapted from the PHE Contraceptive ROI tool and uplifted to 2019 prices. These costs capture the discounted cost associated with children, and incorporate the probability of abortion and miscarriage. For unwanted pregnancies, the whole cost is averted when contraception is effective.

For mistimed pregnancies, some of the types of costs captured reflect the effect of the costs associated with children being brought forward, and so are calculated based on the difference in costs due to discounting. Abortion and miscarriage costs are assumed to be equal regardless of whether the pregnancy is unwanted or mistimed.

Within the tool results, costs are aggregated into local authority, NHS, and other government costs and take a 10-year timeframe (see PHE's Contraceptive ROI Tool for a more detailed methodological breakdown).

Table 20: Cost per pregnancy of different types of unintended pregnancy

Costs	Per unwanted	Per mistimed (19 years old or younger)	Per mistimed (20 years old or older)
Health care costs			
Birth costs	£2,021	£222	£157
Abortion costs	£407	£407	£407
Miscarriage costs	£80	£80	£80
Ongoing child healthcare costs	£6,722	£737	£521
Public health services for children	£406	£45	£32
Non-healthcare costs			
Education	£7,867	£862	£610
Child benefit	£1,856	£203	£144
Child tax credit	£2,914	£319	£226
Working tax credit (childcare)	£239	£26	£19
Income support for lone parents	£183	£20	£14
Housing benefit	£529	£58	£41
Maternity benefits	£172	£19	£13
Children in care	£1,056	£116	£82

Source: PHE contraceptive ROI tool, uplifted from 2018 to 2019, and adjusted for average mistiming by age

Appendix 3) Further information

Follow this link for the PHE Sexual and Reproductive Health ROI tool:
https://www.gov.uk/government/publications/sexual-and-reproductive-health-return-on-investment-tool

If you have any further questions about the tool, please email:
HealthEconomics@phe.gov.uk

Further resources on sexual health from PHE's Health Economics and Modelling Team can be found at:
https://www.gov.uk/government/publications/spend-and-outcome-tool-spot
https://www.gov.uk/government/publications/health-economics-evidence-resource

Further resources for commissioning sexual health services can be found at:
https://www.gov.uk/government/publications/commissioning-sexual-health-reproductive-health-and-hiv-services

https://www.nice.org.uk/guidance/ng68

https://www.gov.uk/government/publications/sexual-and-reproductive-health-in-england-local-and-national-data

https://www.gov.uk/government/publications/sexual-health-reproductive-health-and-hiv-services-evaluation-resources

https://www.gov.uk/guidance/commissioning-regional-and-local-sexual-health-services

https://www.brook.org.uk/about-brook/c-card-guidance

https://fingertips.phe.org.uk/profile/sexualhealth

References

1. Adams, E. J., Turner, K. M., & Edmunds, W. J. (2007). The cost effectiveness of opportunistic chlamydia screening in England. Sex Transm Infect, 83(4), 267-274; discussion 274-265. doi:10.1136/sti.2006.024364
2. Aghaizu, A., Adams, E. J., Turner, K., Kerry, S., Hay, P., Simms, I., & Oakeshott, P. (2011). What is the cost of pelvic inflammatory disease and how much could be prevented by screening for chlamydia trachomatis? Cost analysis of the Prevention of Pelvic Infection (POPI) trial. Sex Transm Infect, 87(4), 312-317. doi:10.1136/sti.2010.048694
3. Aiken, A., & Trussell, J. (2016). High hopes versus harsh realities: the population impact of emergency contraceptive pills. BJOG, 123(10), 1608. doi:10.1111/1471-0528.14136
4. Althaus, C., Low, N. (2011). Towards More Robust Estimates of the Per Sex Act Transmission Probability of Chlamydia Trachomatis. doi:10.1136/sextrans-2011-050108.180.
5. Balassone M. L. (1989). Risk of contraceptive discontinuation among adolescents. Journal Adolesc Health Care; 10(6), 527-33
6. Blake S. M., Ledsky R., Goodenow C., Sawyer R., Lorhmann D. Windsor R. 2003. Condom Availability Programs in Massachusetts High Schools: Relationships With Condom Use and Sexual Behavior, Am J Public Health.
7. Boily, M.-C., Baggaley, R. F., Wang, L., Masse, B., White, R. G., Hayes, R. J., & Alary, M. (2009). Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. The Lancet Infectious Diseases, 9(2), 118-129. doi:10.1016/s1473-3099(09)70021-0
8. Brown, J., Hess, K., Brown, S., Murphy, C., Waldman, A., & Hezareh, M. (2011). Heterosexual Anal Sex, Lubrication, HIV, and HSV-2 infection among women. Sexually Transmitted Infections, 87(Suppl 1), A175-A175. doi:10.1136/sextrans-2011-050108.179
9. Centers for Disease Control, (2002). Fertility, Family Planning, and Reproductive Health of U.S. Women: Data From the 2002 National Survey of Family Growth Series.
10. Chesson, H. W., Bernstein, K. T., Gift, T. L., Marcus, J. L., Pipkin, S., & Kent, C. K. (2013). The cost-effectiveness of screening men who have sex with men for rectal chlamydial and gonococcal infection to prevent HIV Infection. Sex Transm Dis, 40(5), 366-371. doi:10.1097/OLQ.0b013e318284e544
11. de Wit, G. A., Over, E. A., Schmid, B. V., van Bergen, J. E., van den Broek, I. V., van der Sande, M. A., . . . Kretzschmar, M. E. (2015). Chlamydia screening is not cost-effective at low participation rates: evidence from a repeated register-based implementation study in The Netherlands. Sex Transm Infect, 91(6), 423-429. doi:10.1136/sextrans-2014-051677
12. Department for Health and Social Care, (2013). A Framework for Sexual Health Improvement in England.

13. Desai, S., Wetten, S., Woodhall, S. C., Peters, L., Hughes, G., & Soldan, K. (2011). Genital warts and cost of care in England. Sex Transm Infect, 87(6), 464-468. doi:10.1136/sti.2010.048421

14. Ditkowsky, J., Shah, K. H., Hammerschlag, M. R., Kohlhoff, S., & Smith-Norowitz, T. A. (2017). Cost-benefit analysis of Chlamydia trachomatis screening in pregnant women in a high burden setting in the United States. BMC Infect Dis, 17(1), 155. doi:10.1186/s12879-017-2248-5

15. Ekstrand, M., Tydén, T., Darj, E., Larsson, M. (2013). Twelve-month follow-up of advance provision of emergency contraception among teenage girls in Sweden—a randomized controlled trial," Ups J Med Sci, 118(4), 271–275.

16. Farnham, P. G., Holtgrave, D. R., Gopalappa, C., Hutchinson, A. B., & Sansom, S. L. (2013). Lifetime costs and quality-adjusted life years saved from HIV prevention in the test and treat era. Journal of Acquired Immune Deficiency Syndromes, 64(2), e15-e18.

17. Gottlieb S. L., Martin D. H., Xu F., Byrne G. I., Brunham R. C. (2010) Chlamydia trachomatis genital infection and implications for Chlamydia control. The Journal of Infectious Diseases, 201(2), Supplement: S190-204

18. Gottlieb, S. L., Xu, F., & Brunham, R. C. (2013). Screening and treating Chlamydia trachomatis genital infection to prevent pelvic inflammatory disease: interpretation of findings from randomized controlled trials. Sex Transm Dis, 40(2), 97-102. doi:10.1097/OLQ.0b013e31827bd637

19. Gray, R. T., Hoare, A., Prestage, G. P., Donovan, B., Kaldor, J. M., & Wilson, D. P. (2010). Frequent testing of highly sexually active gay men is required to control syphilis. Sex Transm Dis, 37(5), 298-305. doi:10.1097/OLQ.0b013e3181ca3c0a

20. Hodson, K., Meads, C., Bewley, S. (2016). Lesbian and bisexual women's likelihood of becoming pregnant: a systematic review and meta-analysis. BJOG, 12(4), 393–402. DOI:10.1111/1471-0528.14449

21. Holmes, K. K., Johnson, D. W., & Trostle, H. J. (1970). An estimate of the risk of men acquiring gonorrhea by sexual contact with infected females. American Journal of Epidemiology, 91(2), 170-174.

22. HM Treasury, (2018). Central Government Guidance on Appraisal and Evaluation.

23. Huber, L. R., Hogue, C. J., Stein, A. D., Drews, C., Zieman, M., King, J., & Schayes, S. (2006). Contraceptive use and discontinuation: findings from the contraceptive history, initiation, and choice study. Am J Obstet Gynecol, 194(5), 1290-1295. doi:10.1016/j.ajog.2005.11.039

24. Institute of Medicine. (2000). Vaccines for the 21st Century: A Tool for Decisionmaking. Washington (DC): National Academies Press (US)

25. Ireland, J. A., Reid, M., Powell, R., Petrie, K. J., & AIDS. (2005). The role of illness perceptions: psychological distress and treatment-seeking delay in patients with genital warts. International journal of STD, 16(10), 667-670.

26. Jablonskas, S. (2010). Condom Card ('C Card') Distribution Scheme Reduction in teenage pregnancy rates and rates of sexually transmitted infections, promotion of safe sex and sexual health.

27. Jackson, L. J., Auguste, P., Low, N., Roberts, T. E. (2014) Valuing the Health States Associated with Chlamydia trachomatis Infections and Their Sequelae: A Systematic Review of Economic Evaluations and Primary Studies. Value Health, 17(1), 116-130

28. Kingston, M., French, P., Higgins, S., McQuillan, O., Sukthankar, A., Stott, C., . . . Sullivan, A. (2016). UK national guidelines on the management of syphilis 2015. Int J STD AIDS, 27(6), 421-446. doi:10.1177/0956462415624059

29. Kinsella, K., Cross, R., & South, J. (2014). An evaluation of the condom distribution scheme (C-Card) with young people in Northeast England. Perspect Public Health, 134(1), 25-30. doi:10.1177/1757913913483245

30. Korenromp, E. L., Mahiane, S. G., Nagelkerke, N., Taylor, M. M., Williams, R., Chico, R. M., . . . Rowley, J. (2018). Syphilis prevalence trends in adult women in 132 countries - estimations using the Spectrum Sexually Transmitted Infections model. Sci Rep, 8(1), 11503. doi:10.1038/s41598-018-29805-9

31. Koss, C. A., Dunne, E. F., & Warner, L. (2009). A systematic review of epidemiologic studies assessing condom use and risk of syphilis. Sex Transm Dis, 36(7), 401-405. doi:10.1097/OLQ.0b013e3181a396eb

32. Larsson, M., Eurenius, K., Westerling, R., & Tyden, T. (2006). Evaluation of a sexual education intervention among Swedish high school students. Scand J Public Health, 34(2), 124-131. doi:10.1080/14034940510032266

33. Lee, C. A., Phillips, A. N., Elford, J., Janossy, G., Griffiths, P., & Kernoff, P. J. (1991). Progression of HIV disease in a haemophilic cohort followed for 11 years and the effect of treatment. British Medical Journal 303(6810), 1093-1096.

34. Lincoln County Council, (2010). C Card Condom Scheme – Evaluation July 2009 – July 2010.

35. Lovett A., & Duncan J. A., (2019). Human Immune Responses and the Natural History of Neisseria gonorrhoeae Infection. Front Immunol. 19(9), doi:10.3389/fimmu.2018.03187

36. Mandalia, S., Westrop, S. J., Beck, E. J., Nelson, M., Gazzard, B. G., & Imami, N. (2012). Are long-term non-progressors very slow progressors? Insights from the Chelsea and Westminster HIV cohort, 1988-2010. PLoS One, 7(2), e29844. doi:10.1371/journal.pone.0029844

37. Manhart, L. a. K., Laura. (2002). Do Condoms Prevent Genital HPV Infection, External Genital Warts, or Cervical Neoplasia? Sexually Transmitted Diseases.

38. Mapp, F., Wellings, K., Hickson, F., & Mercer, C. H. (2017). Understanding sexual healthcare seeking behaviour: why a broader research perspective is needed. BMC Health Serv Res, 17(1), 462. doi:10.1186/s12913-017-2420-z

39. Marrazzo, J. M., Celum, C. L., Hillis, S. D., Fine, D., DeLisle, S., & Handsfield, H. H. (1997). Performance and cost-effectiveness of selective screening criteria for chlamydia trachomatis infection in women: Implications for a national chlamydia control strategy. J Sexually transmitted diseases, 24(3), 131-141.

40. Mercer, C. H., Sutcliffe, L., Johnson, A. M., White, P. J., Brook, G., Ross, J. D., . . . Cassell, J. A. (2007). How much do delayed healthcare seeking, delayed care provision, and diversion from primary care contribute to the transmission of STIs? Sex Transm Infect, 83(5), 400-405. doi:10.1136/sti.2006.024554

41. Michie, L., Cameron, S. T., Glasier, A., Larke, N., Muir, A., & Lorimer, A. (2014). Pharmacy-based interventions for initiating effective contraception following the use of emergency contraception: a pilot study. Contraception, 90(4), 447-453. doi:10.1016/j.contraception.

42. Moore Jr, M. B., Price, E. V., Knox, J. M., & Elgin, L. W. (1963). Epidemiologic treatment of contacts to infectious syphilis. Journal Public health reports, 78(11), 966.

43. Moreau, C., Bouyer, J., Bajos, N., Rodriguez, G., & Trussell, J. (2009). Frequency of discontinuation of contraceptive use: results from a French population-based cohort. Hum Reprod, 24(6), 1387-1392. doi:10.1093/humrep/dep027

44. Nherera, L., Jacklin, P. (2009). A model to assess the cost-effectiveness of Sex and Relationship Education (SRE) developed for NICE public health guidance on personal, social, health and economic (PSHE) education.

45. Ockenfels, H. M. (2016) Therapeutic management of cutaneous and genital warts. Journal Dtsch Dermatol Ges, 14(9), 892-9, doi:10.1111/ddg.12838.

46. Office for National Statistics. (2019). Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2018

47. Oliveira A. S., Bilinska J., Mohammed H, Jarman J., Were J., Menon-Johansson A., Hamzah L. (2019). Partner notification: Increasing effectiveness with modern communication technology

48. Okulicz, J. F., Marconi, V. C., Landrum, M. L., Wegner, S., Weintrob, A., Ganesan, A. (2009). Clinical outcomes of elite controllers, viremic controllers, and long-term nonprogressors in the US Department of Defense HIV natural history study. J Infect Dis, 200(11), 1714-1723. doi:10.1086/646609

49. Ong, K. J., Soldan, K., Jit, M., Dunbar, J. K., & Woodhall, S. C. (2017). Chlamydia sequelae cost estimates used in current economic evaluations: does one-size-fit-all? Sex Transm Infect, 93(1), 18-24. doi:10.1136/sextrans-2016-052597

50. Ong, K. J., van Hoek, A. J., Harris, R. J., Figueroa, J., Waters, L., Chau, C., Croxford, S., Kirwan, P., Brown, A., Postma, M. J., Gill O. N., Delpech V. (2019) HIV care cost in England: a cross-sectional analysis of antiretroviral treatment and the impact of generic introduction. HIV Med. 20(6), 377-391. doi:10.1111/hiv.12725.

51. Oriel, J. D. (1971). Natural history of genital warts. British Journal of Venereal Diseases, 47(1), 1.

52. Pinkerton, S. D., & Abramson, P. R. (1996) Implications of Increased Infectivity in Early-Stage HIV Infection: Application of a Bernoulli-Process Model of HIV Transmission, Eval Rev.

53. Pinkerton, S. D., & Abramson, P. R. (1997). Effectiveness of condoms in preventing HIV transmission. Social science medicine, 44(9), 1303-1312.

54. Price, M. J., Ades, A. E., Soldan, K., Welton, N. J., Macleod, J., Simms, I., . . . Horner, P. J. (2016). The natural history of Chlamydia trachomatis infection in women: a multi-parameter evidence synthesis. Health Technol Assess, 20(22), 1-250. doi:10.3310/hta20220

55. Public Health England, (2018a). A consensus statement - Reproductive health is a public health issue.

56. Public Health England, (2018b). Contraception: Economic Analysis Estimation of the Return on Investment (ROI) for publicly funded contraception in England.
57. Public Health England, (2018c). National chlamydia screening programme (NCSP): data tables
58. Public Health England, (2018d). Progress towards ending the HIV epidemic in the United Kingdom.
59. Ratna, N. B., Meroe; Nardone, Anthony; Roberts, Andrew; Folkard, Kate (2018). A quantitative evaluation of the London 'Come Correct' Condom Card (C-Card) scheme: Does it serve those in greatest need?
60. Reekie, J., Donovan, B., Guy, R., Hocking, J. S., Jorm, L., Kaldor, J. M., . . . Liu, B. (2014). Hospitalisations for pelvic inflammatory disease temporally related to a diagnosis of Chlamydia or gonorrhoea: a retrospective cohort study. PLoS One, 9(4), e94361. doi:10.1371/journal.pone.0094361
61. Reekie, J., Donovan, B., Guy, R., Hocking, J. S., Kaldor, J. M., Mak, D. B., . . . Reproductive Health Outcome, I. (2018). Risk of Pelvic Inflammatory Disease in Relation to Chlamydia and Gonorrhea Testing, Repeat Testing, and Positivity: A Population-Based Cohort Study. Clin Infect Dis, 66(3), 437-443. doi:10.1093/cid/cix769
62. Rosenberg M.J., Waugh M.S. (1998) Oral contraceptive discontinuation: a prospective evaluation of frequency and reasons. American journal of obstetrics and gynecology, 179(3), 577-582
63. Sabin, C. A., & Lundgren, J. D. (2013). The natural history of HIV infection. Curr Opin HIV AIDS, 8(4), 311-317. doi:10.1097/COH.0b013e328361fa66
64. Sadler, S., Tosh, J., Pennington, R., Rawdin, A., Squires, H., Romero, C., . . . Chilcott, J. (2017). A cost-effectiveness analysis of condom distribution programmes for the prevention of sexually transmitted infections in England. Epidemiol Community Health, 71(9), 897-904.
65. Shepherd, J., Kavanagh, J., Picot, J., Cooper, K., Harden, A., Barnett-Page, E., . . . Price, A. (2010). The effectiveness and cost-effectiveness of behavioural interventions for the prevention of sexually transmitted infections in young people aged 13-19: a systematic review and economic evaluation. Health Technol Assess, 14(7), 1-206, iii-iv. doi:10.3310/hta14070
66. Singh, A. E., & Romanowski, B. (1999). Syphilis: review with emphasis on clinical, epidemiologic, and some biologic features. Clinical microbiology reviews, 12(2), 187-209.
67. Stoltey, J. E., & Cohen, S. E. (2015). Syphilis transmission: a review of the current evidence. Sex Health, 12(2), 103-109. doi:10.1071/SH14174
68. Sukthankar, A. (2014) Syphilis. Bacterial Infections II, 42(7), 394-398, doi:https://doi.org/10.1016/j.mpmed.2014.04.002
69. Trussell, J. (2011). Contraceptive failure in the United States. Contraception, 83(5), 397-404. doi:10.1016/j.contraception.2011.01.021
70. Tuite, A. R., Burchell, A. N., & Fisman, D. N. (2014). Cost-effectiveness of enhanced syphilis screening among HIV-positive men who have sex with men: a microsimulation model. PLoS One, 9(7), e101240. doi:10.1371/journal.pone.0101240

71. Turner, K. M. E., Adams, E. J., LaMontagne, D. S., Emmett, L., Baster, K., and Edmunds, W. J. (2006). Modelling the effectiveness of chlamydia screening in England. Sex Transm Infect. 82(6), 496–502.

72. Turner, K., Adams, E., Grant, A., Macleod, J., Bell, G., Clarke, J., & Horner, P. (2011). Costs and cost effectiveness of different strategies for chlamydia screening and partner notification: an economic and mathematical modelling study. BMJ, 342, c7250. doi:10.1136/bmj.c7250

73. Turner, K. M., Round, J., Horner, P., Macleod, J., Goldenberg, S., Deol, A., & Adams, E. J. (2014). An early evaluation of clinical and economic costs and benefits of implementing point of care NAAT tests for Chlamydia trachomatis and Neisseria gonorrhoea in genitourinary medicine clinics in England. Sex Transm Infect, 90(2), 104-111. doi:10.1136/sextrans-2013-051147

74. van der Helm, J. J., Geskus, R., Lodi, S., Meyer, L., Schuitemaker, H., Gunsenheimer-Bartmeyer, B., . . . Prins, M. (2014). Characterisation of long-term non-progression of HIV-1 infection after seroconversion: a cohort study. The Lancet HIV, 1(1), e41-e48. doi:10.1016/s2352-3018(14)70016-5

75. van Sighem, A., Pharris, A., Quinten, C., Noori, T., & Amato-Gauci, A. (2017). Reduction in undiagnosed HIV infection in the European Union/European Economic Area, 2012 to 2016. Journal Eurosurveillance, 22(48).

76. Wang, L. Y., Davis, M., Robin, L., Collins, J., Coyle, K., & Baumler, E. (2000). Economic evaluation of Safer Choices: a school-based human immunodeficiency virus, other sexually transmitted diseases, and pregnancy prevention program. Archives of pediatrics adolescent medicine, 154(10), 1017-1024.

77. Warner, L., Newman, D. R., Austin, H. D., Kamb, M. L., Douglas, J. M., Jr., Malotte, C. K., . . . Project, R. S. G. (2004). Condom effectiveness for reducing transmission of gonorrhea and chlamydia: the importance of assessing partner infection status. Am J Epidemiol, 159(3), 242-251. doi:10.1093/aje/kwh044

78. Warner, L., Stone, K. M., Macaluso, M., Buehler, J. W., & Austin, H. D. (2006). Condom use and risk of gonorrhea and Chlamydia: a systematic review of design and measurement factors assessed in epidemiologic studies. Sex Transm Dis, 33(1), 36-51. doi:10.1097/01.olq.0000187908.42622.fd

79. Whitlock G. G., Gibbons D. C., Longford N., Harvey M. J., McOwan A., Adams E. J., (2018) Rapid testing and treatment for sexually transmitted infections improve patient care and yield public health benefits, Int J STD AIDS, 29(5), 474-482. doi:10.1177/0956462417736431

80. Wilson, E., Free, C., Morris, T. P., Syred, J., Ahamed, I., Menon-Johansson, A. S., Palmer, M. J., Barnard, S., Rezel, E., Baraitser, P. (2017) PLoS Med, 14(12). doi:10.1371/journal.pmed.1002479

81. Woodhall, S. C., Soldan, K., Sonnenberg, P., Mercer, C. H., Clifton, S., Saunders, P., . . . Johnson, A. M. (2016). Is chlamydia screening and testing in Britain reaching young adults at risk of infection? Findings from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3). Sex Transm Infect, 92(3), 218-227. doi:10.1136/sextrans-2015-052013

82. Yanofsky V. R., Patel R. V., Goldenberg, G. (2012). Genital warts: a comprehensive review. J Clin Aesthet Dermatol. 5(6) 25-36.

83. Zulliger, R., Maulsby, C., Solomon, L., Baytop, C., Orr, A., Nasrullah, M., . . . Holtgrave, D. (2017). Cost-utility of HIV Testing Programs Among Men Who Have Sex with Men in the United States. AIDS Behav, 21(3), 619-625. doi:10.1007/s10461-016-1547-y