A model to evaluate the cost effectiveness of condom distribution (CD) schemes, developed for NICE public health guidance on condom distribution schemes and sexually transmitted infections (STIs)

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EXECUTIVE SUMMARY

Background

This report examines the potential economics of condom distribution (CD) schemes for the prevention of sexually transmitted infections. It should be read in conjunction with a companion report of the evidence for the effectiveness of such schemes prepared by The National Institute for Health and Care Excellence (NICE).

Methods

An economic model is used to bring together data from a number of different sources in order to estimate outcomes including sexually transmitted infections (STIs) avoided, quality adjusted life years (QALYs) gained, costs for a total England catchment population, overall cost per QALY gained and where relevant numbers of unintended pregnancies avoided as a secondary outcome. Cost and health impacts for a lifetime horizon are estimated for different age groups and genders. Costs are calculated from a public sector perspective. The analysis uses a simple steady state Bernoulli Process model to estimate the impact of changes in condom usage on STI cases, which has been used in previous NICE assessments including guidance on young people's contraceptive services. Probabilistic sensitivity analysis, scenario analyses and threshold analyses are used to explore the economic outcomes.

The analysis focuses on CD schemes in four populations:

Multi-component CD scheme in young people, based around C-Card services:

A scheme targeted at young people aged 13-24 aiming at increasing condom use and reducing condom failure. A base-case scenario population of young people aged 13-24 was assessed using the effectiveness evidence from a controlled study in Sweden of a multi-component intervention in a high-school setting (1) which found a relative risk of 'ever using' a condom of 1.23 in the intervention group compared to control. C-card scheme costs are estimated from four published reports which give the costs of C-card schemes in England (2-5), and were within a small range, giving a mean cost of £0.48 per person in the target intervention. In addition three scenarios were tested;

1. With a narrower age group from 13-18 as the population (in line with the effectiveness study population)

2. With condom breakage reduced in the intervention group using a relative risk of 0.8 following a study by Macaluso et al. (6), which showed breakage reducing with increased experience in condom use
3. With higher prevalence of HIV (average UK prevalence rates)

A threshold analysis was carried out, to identify the combination of costs and effectiveness required to make a scheme cost effective at £30,000 per QALY, or to make a scheme dominant (i.e. QALY improving and cost-saving). An existing model developed for NICE was used to explore the potential impact of this intervention upon pregnancy outcomes.

CD schemes for men who have sex with men (MSM), black Africans, and the general population

As there is limited effectiveness data for these 3 populations, threshold analysis was conducted to identify the combination of costs and effectiveness data required for a CD scheme to be cost effective or cost saving. This was conducted for each population (using population-specific inputs), for low, central and high estimates of HIV prevalence.

Results

Condom distribution schemes for young people

The baseline analysis targeted at the 13-24 years is most representative of the existing C-card scheme in the UK. The quality of life effects are heavily influenced by the impact of a small number of HIV cases prevented. The model predicts that a scheme with costs in the region of a typical C-Card scheme could be expected to have a cost per QALY gained in the region of £17,411 per QALY gained. However, it should be cautioned that the evidence for effectiveness in this broader age group is not demonstrated.

When C-Card is considered for the narrower age-group (13-18 years), which is most coherent with the study population of the Larsson study (16-20 with mean age of 17), a mean cost per QALY of £45,856 compared with no C-card is estimated, meaning it would not be cost-effective at the £20-30,000 per QALY gained level. This is due to lower rates of sexual activity and underlying prevalence of STIs in the younger age group.

Whilst reduced condom breakage might improve cost effectiveness, the impact is estimated to be small (the cost per QALY gained reduces to around £14,469). In the scenario with higher prevalence

of HIV, the increase in HIV cases averted by CD schemes makes them cost-saving overall (£10m savings compared with £3.5m scheme costs across England in the target population).

The analysis exploring the potential impact of the C-card on pregnancies suggests that the costs saved from preventing or delaying a small number of pregnancies in those aged under 18 are significantly greater than savings from STI prevention. For example, at a relative risk of 1.22 savings from STIs are estimated to be less than £764,000 (compared with a scheme cost of £1,543,000) in the cohort of English young people aged 13-18, whereas pregnancy-related savings are estimated at around £11m (including government Benefits). If these pregnancy-related savings were to be included within the cost effectiveness estimates (and excluding the impacts of pregnancy upon QALYs), the base case scenario becomes cost-saving (total savings over £10m). If government Benefits are excluded, the additional £318,000 savings shift the cost per QALY gained for the base case to around £12,000.

Condom distribution schemes for men who have sex with men

If a scheme is effective on this sub-group the increased QALYs and savings from preventing HIV are much larger than the impacts from other STIs. The threshold analysis suggests that even schemes with relatively high costs per person can be cost effective if a small improvement in condom use can be achieved and demonstrated. For example, even at the lowest HIV prevalence estimates, a scheme which gave a relative risk of condom use of 1.04 compared with baseline would be cost effective even at £10 per person in the target population (twenty times the cost suggested for a multi-component C-card scheme).

Condom distribution schemes for black Africans

If a scheme is effective on this sub-group the increase in QALYs are mainly from HIV prevention, although in terms of cost savings, HIV, PID and chlamydia prevention are all important. The threshold analysis suggests that due to the higher prevalence of HIV in this sub-group, effective schemes could be cost-saving at relatively high cost. For example, even at the lowest HIV prevalence level, a scheme with relative risk of condom use of 1.04 would be cost effective even at £10 per person.

Condom distribution schemes for the General population scheme

If a scheme is effective in this broad population the increase in QALYs are mainly from HIV prevention, although in terms of cost savings, HIV, PID and chlamydia prevention are all important.

The threshold analysis suggests that schemes need to balance cost and effectiveness to be cost effective. For example, at central HIV prevalence estimates, a scheme with relative risk of condom use of 1.1 would have to cost around £1 per person in the target population or less to be cost effective.

Limitations and further research

The economic modelling is subject to a number of limitations. The economic impact of CD schemes was based on very limited effectiveness evidence, with a high degree of variability in CD scheme designs, costs and effects being suggested by the available evidence. The model structure and underlying assumptions may also have simplified the transmission of STIs.

Obtaining robust evidence is difficult because of the sensitive nature of the topic and the challenges around conducting research in this area. Nonetheless, In order to understand the economics of CD schemes in the UK it is imperative to have evaluations that demonstrate the impact of these schemes on behaviour change and condom usage in UK-relevant populations.

1 BACKGROUND

1.1 Purpose of this report

The purpose of this report is to evaluate the cost effectiveness of a range of condom distribution (CD) schemes to encourage the effective use of condoms, and subsequently reduce the cases of sexually transmitted infections (STIs) in England. It accompanies the evidence review report on the effectiveness of CD schemes undertaken by the team at the National Institute for Health and Care Excellence (NICE).

This report considers the cost effectiveness of CD schemes to which reduce the cases and the direct consequences of STIs. The report additionally includes an exploratory analysis of the impact that CD schemes may have on unintended pregnancies, as the schemes evaluated may have this benefit, either directly as a target of a CD scheme, or indirectly as a consequence of increased effective use of condoms.

1.2 The role of economic evaluation within the NICE process

NICE was established in the UK in 1999 with a mandate from the Department of Health to appraise the health benefits and costs of new and established health technologies and clinical practice. NICE guidance now covers England, with the devolved UK nations having their own separate decision making systems. In 2005, NICE's remit expanded to include public health. When money is spent on new health interventions within the health or wider public sectors, either existing interventions will be displaced or the budget will expand. Therefore a rational and coherent framework is required to help inform decisions about which interventions should be recommended for reimbursement.

An economic evaluation is a comparative analysis of the costs and consequences of two or more competing interventions. There are several methods of economic evaluation specific to health. A cost effectiveness analysis (CEA) values consequences in a natural unit of health (for example, life years gained or case averted), a cost-utility analysis is a form of CEA which values consequences using a generic measure of health (often the Quality Adjusted Life Year – QALY). A cost-consequences analysis will compare a range of alternative outcomes against the net costs between competing choices, but will not necessarily infer the value of these consequences to society. For any economic evaluation, it is important that all consequences are captured, even when they extend far into the future. An efficient decision is one where the benefits gained by the new intervention are greater than the benefits forgone by services and interventions displaced due to any additional costs being imposed on the constrained system.

An economic model is a method of objectively combining a range of data and evidence to inform an economic evaluation of the cost and consequences of alternative interventions. Models also allow extrapolation into the future, where required, and can quantify the uncertainty in the structure of the model, and the parameters within.

In order to assess the impact of assumptions and uncertain evidence in a model and upon its results, sensitivity analysis is a key stage of any economic evaluation. This involves varying assumptions and parameters to assess their impact on the models results. If the results change significantly, then it may be worth investing in generating more reliable evidence to inform the decision. Within a model, all key uncertainties and assumptions should be tested to evaluate their impact on the model's results.

Because a CEA does not provide a direct comparison of the value of the effects and the costs, decision rules are required. If comparing two treatments, one may cost more but also provide more QALYs. The problem for decision-makers is determining how much extra benefit is required to justify the extra expenditure, because there is an opportunity cost associated with allocating resources. A cost effective treatment is one where, given limited resources, its use will contribute to the maximisation of health benefits. Traditionally, the output of a CEA is reported as a ratio of the difference in costs and difference in effects between two alternatives, the incremental cost effectiveness ratio (ICER), as demonstrated in Box 1.

$$ICER = \frac{(C_a - C_b)}{(E_a - E_b)} \quad [1]$$

Where:
a = Intervention A
b = Intervention B

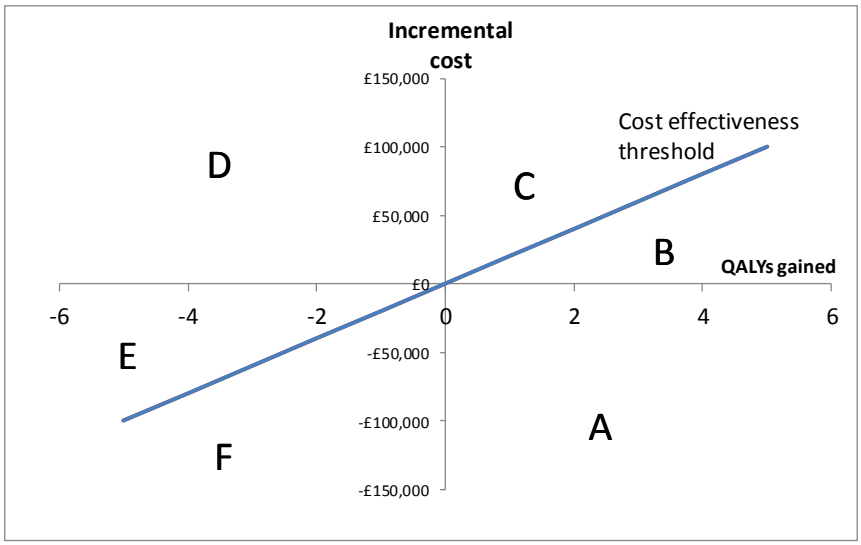
C = Costs

E = Effects

$$ICER = \frac{\Delta C}{\Delta E} \quad [2]$$

Box 1: Incremental Cost Effectiveness Ratio

The ICER can be interpreted as the incremental cost per incremental unit of effect, as represented in equation [1]. For decision makers, there are six possible situations when using an ICER presented in Figure 1.



A	New intervention dominates conventional therapy (i.e. more effective and cost saving)
B	New intervention more effective but greater cost (cost effectiveness better than threshold) compared to conventional
C	New intervention more effective but greater cost (cost effectiveness worse than threshold) compared to conventional
D	New intervention dominated by conventional (ie less effective and greater cost)
E	New intervention less effective but cost saving (cost effectiveness worse than threshold) compared to conventional
F	New intervention less effective but cost saving, (cost effectiveness better than threshold) compared to conventional

Figure 1: The cost effectiveness plane

With situations A and D, the solution for decision-makers is very straight forward. With situation A, the new intervention is better than the conventional therapy and is also cost saving, the new intervention is said to dominate the conventional therapy and clearly provides good value for money. In B the new intervention is less effective and costs more than the conventional therapy, is said to be dominated by the existing therapy and is clearly not good value for money.

In situations B and C, the new intervention is better than the existing therapy but costs more. In situation B the incremental cost per unit benefit gained (in most cases the QALY gained) is better than a notional threshold value, and in situation C the cost effectiveness in worse than the threshold

In situations E and F the new intervention is less effective than the conventional therapy but cost saving. In situation F the cost saved per unit of health benefit foregone implies that the cost effectiveness might be considered favourable, that is reinvesting this cost saving elsewhere may realise greater health benefits elsewhere in the system. By contrast in situation E the cost

effectiveness is worse than the conventional therapy. The cost effectiveness evidence is one of several factors that determine a positive or negative decision by NICE.

Within the current analysis, health outcomes are considered and valued using a QALY. Also presented are absolute numbers of cases of STIs averted due to an effective condom distribution (CD) scheme.

1.3 Existing cost effectiveness evidence of condom distribution (CD) schemes

NICE carried out a review of the effectiveness evidence of CD schemes. The full review is available elsewhere (7). The review identified 20 studies across a range of settings (healthcare, schools, outreach and community) and in both single-component (condom availability only) and multi-component (availability with education, advice or support) styles. Overall, the quality of the studies was considered to be poor, with only one study meeting all or most of the checklist quality assessment criteria and 6 meeting some of the criteria. In addition, 16 of the studies were US-based and only two were based in the UK.

Overall there was some limited evidence from three studies showing that multi-component schemes in high schools can increase condom use at last intercourse without increasing sexual activity. There was also some evidence that multi-component community or outreach schemes targeted at high-risk individuals can increase condom use. There was mixed evidence around the effectiveness of multi-component schemes in healthcare settings, with some evidence that schemes increased condom acquisition but no evidence of increased usage. There was mixed evidence of the effectiveness of single-component schemes in high schools, with some studies reporting increases in condom use and others reductions or no change. There was no evidence of the effectiveness of single component schemes targeted at high-risk individuals in increasing condom use.

2 METHODS

2.1 Overview of methods

A conceptualisation of the decision problem was undertaken to help understand the potential impact of CD schemes on population health and services, including NHS, public and third sector providers.

A conceptual model was developed based on an initial mapping review to inform what might be included with the economic model. The conceptual model is provided in Figure 2.

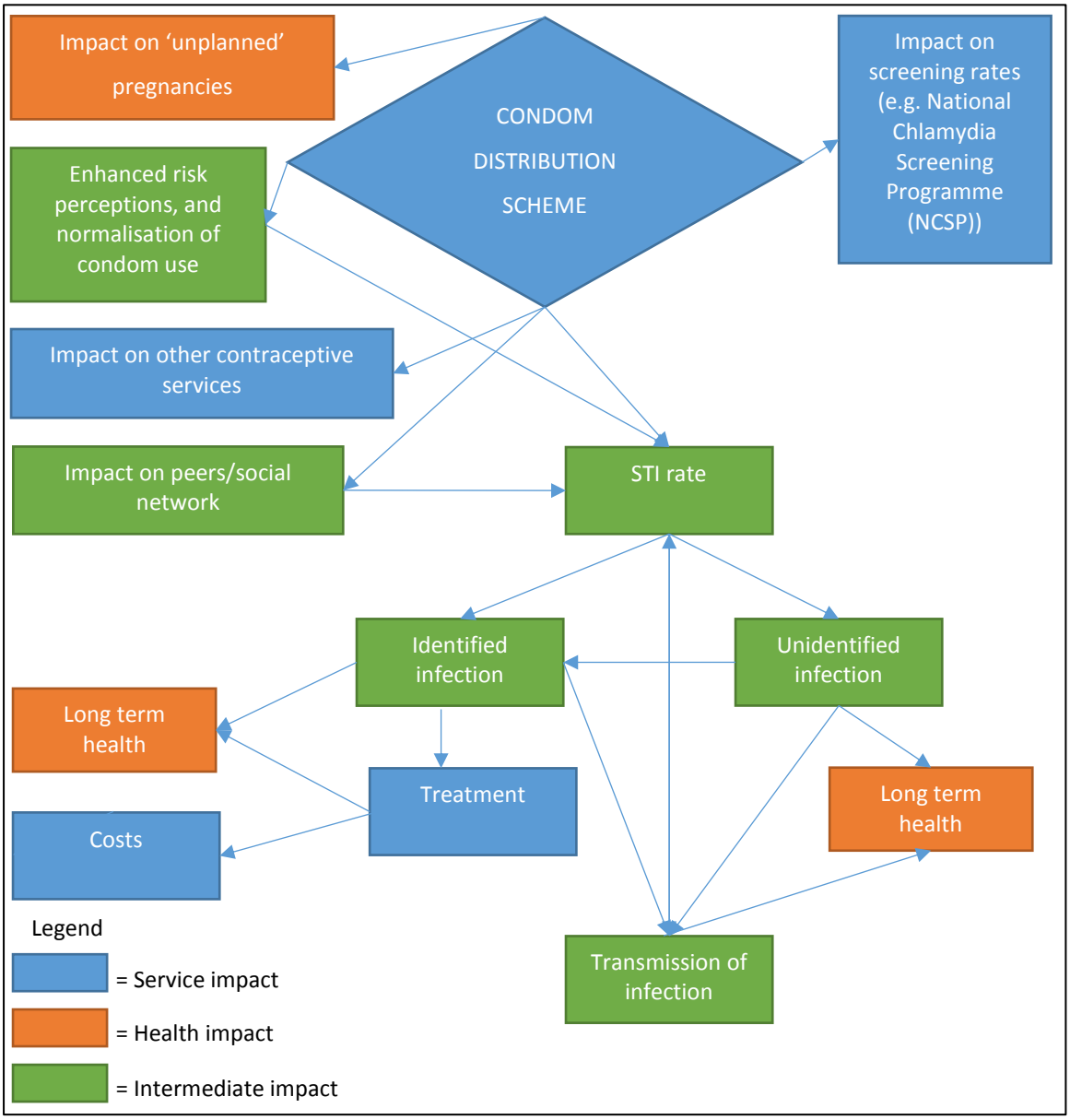


Figure 2: Conceptual model of the impact of CD schemes

Based on this conceptual model, and the review of effectiveness and economic evidence, a health economic model has been developed. From this model, CD schemes are applied to provide an incremental comparison of the costs and consequences of alternative CD schemes, compared to no CD scheme. This model, 'the general model', is explained in the next section.

2.2 Generic Model

2.2.1 Economic model scope

2.2.1.1 Population

A general model was created, from which models for specific sub-groups could be developed. The primary hypothetical population of the general model is all people at risk of a sexually transmitted infection (STI). This is deemed to be all people in England who are sexually active. The general model has a national (England) population ranging from 13-90 years of age. The age bounds of the population can be modified so that the costs and consequences of a scheme that targets a particular sub-population can be clearly identified and quantified. These sub-groups include people who are at the greatest risk of acquiring an STI, are defined within the model by their age, gender and background prevalence of STIs. This population can be further defined by changing model parameters controlling their number of sexual contacts, and condom usage, along with background prevalence of particular STIs. This enables evaluations of CD schemes in subpopulations of particular interest. We report results of analyses for four specific groups of interest:

1. Young people (ages 13-24 in the base case)
2. Men who have sex with men (MSM)
3. Black Africans
4. The general population

Prisoners are excluded from the scope due to being covered by the NICE guideline on the physical health of people in prisons that is currently being developed.

The use of condoms for contraception will not be considered in the base case analysis. It is however recognised that CD schemes may also directly or indirectly reduce unintended pregnancies, and so an analysis is conducted exploring the impact of CD schemes on unintended pregnancies in young people. The economic model does not capture additional benefits of reducing vertical transmission from mother-to-child of HIV or syphilis, where severe consequences for newborns (congenital syphilis, paediatric HIV infections) could be averted in both of cases. Furthermore, syphilis in pregnancy is associated with foetal death, spontaneous abortion, stillbirth or premature birth, low

birth weight due to intrauterine growth restriction and perinatal death, as well as serious sequelae in live born infected children. Consideration of these benefits may result in additional cost savings and QALY gains.

2.2.1.2 Intervention and comparators

The model was used to assess four population groups,:

- Young people: to understand the impact of C-card; a multi-component scheme which provides free condoms, with or without lubricant, together with training, information and other support.
- Men who have sex with men: to understand the impact of CD schemes that provide or distribute free condoms and lubricant, specifically where these target MSM.
- Black Africans: to understand the level of effectiveness required to make a scheme cost effective in this sub-group with higher HIV prevalence.
- General population: to understand the impact of CD schemes available to the general public, providing free or cheap condoms and lubricant.

Details of the general model are set out in this section. Specific details of the separate modelling methods for each of these sub-groups are set out in sections 2.3, 2.4, 2.5 and 2.6 respectively.

Within the economic model, it is assumed that a CD scheme will have a per capita cost for the population or sub-population of interest, and will result in an absolute increase in the proportion of the population who regularly use condoms. This will be compared to the current background use of condoms without a particular CD scheme.

2.2.1.3 Outcomes

Outcomes are presented in terms of the number of specific STIs averted within a population. The STIs modelled are:

- Chlamydia
- Gonorrhoea
- Human Immunodeficiency Virus (HIV)
- Syphilis

Also modelled is Pelvic Inflammatory Disease (PID), an infection that occurs in some women who have either chlamydia or gonorrhoea.

The following outcomes will be presented:

- Cost per Quality Adjusted Life Year (QALY) gained – Each STI case averted will correspond to a cost and QALY gain. For some STIs, this gain may be very small; however for others, such as HIV, the gain is likely to be significant.

The cost of an STI case assumes that a person with a symptomatic infection will present at either a GP surgery or a Sexual Health or Genitourinary Medicine (GUM) clinic. The cost includes this presentation, any tests required, treatment and any follow-up consultations required.

2.2.1.4 Perspective

CD schemes may be provided by the public, private or charitable sector. A public sector perspective will be taken for the economic analysis. This is in line with the NICE methods for guidance development (8).

2.2.1.5 Discounting

The analysis uses a lifetime horizon for costs and QALYs for cases of HIV averted. Costs are discounted at 3.5% per annum, QALYs are discounted at 3.0% per annum due to the data available for this parameter.

2.2.2 General modelling methodology

The model was developed within Microsoft Excel. The model enables the economic evaluation of a CD scheme by comparing its net costs incurred and benefits accrued relative to current practice.

A per-capita per-year cost of a CD scheme is introduced to the model, and a subsequent increase in the proportion of people using condoms will result in a decrease in the number of cases of STIs in one year. The model does not have a time-varying/dynamic process but rather estimates directly a 'steady state' STI acquisition rate under the status quo and CD scheme scenarios and associated cost-effectiveness, which also enables the budget impact of any CD scheme to be clearly demonstrated for implementation purposes.

The model uses an established Bernoulli Process model (now called the "STI model" for clarity), which estimates the number of STIs in a cohort of people (9). The STI model has been used in other economic evaluations in related areas (10), including the NICE Public Health guideline for Contraceptives (11), and the discontinued Sex and Relationship Education guideline(12)

The STI model assumes that the proportion of the population who acquire a particular STI is a function of the prevalence of an STI, the proportion of the population who use condoms, the transmission rate of the STI, the condom failure rate, and the number of sexual contacts (per year).

$$W = v(\Big(g\big(1 - ((1 - tk)^s)\big)\Big) + \Big((1 - g)\big(1 - ((1 - t)^s)\big)\Big))$$

Where:

W= Proportion of population acquiring an STI

v = Prevalence of an STI

g = Proportion using condoms

t = Transmission rate

k = Condom failure rate

s = Acts of sexual intercourse per annum

Using this STI model allows the proportion of people using condoms (g) to be adjusted, while all other parameters are held constant (for the specific population under consideration). Increasing g will reduce the number of STI cases acquired, which enables a CD scheme to be evaluated via this STI model estimating the total number of STI cases averted and sensitivity analyses exploring the impact of the different scheme in population subgroups etc.

The sources of data for each of these parameters are reported in the subsequent sections.

The model is not a dynamic infection transmission model, due to data and resource constraints. The appropriateness of this model and the simplifications that it requires should be considered alongside the models results. These are discussed further in the discussion section.

2.2.3 Model schematic

A model schematic is provided in Figure 3 which shows how costs and outcomes are estimated in the model. A whole population of people is modelled for one year. Proportions of this population will develop an STI, which will incur health care costs and dis-benefit health (QALYs). For the CD scheme arm of the model, there is a per-patient-per-year cost (an incremental cost compared to current practice) for providing the scheme to the population. The effectiveness of the CD scheme is

modelled as an absolute increase in condom use, and the subsequent reduction in the number of STI cases.

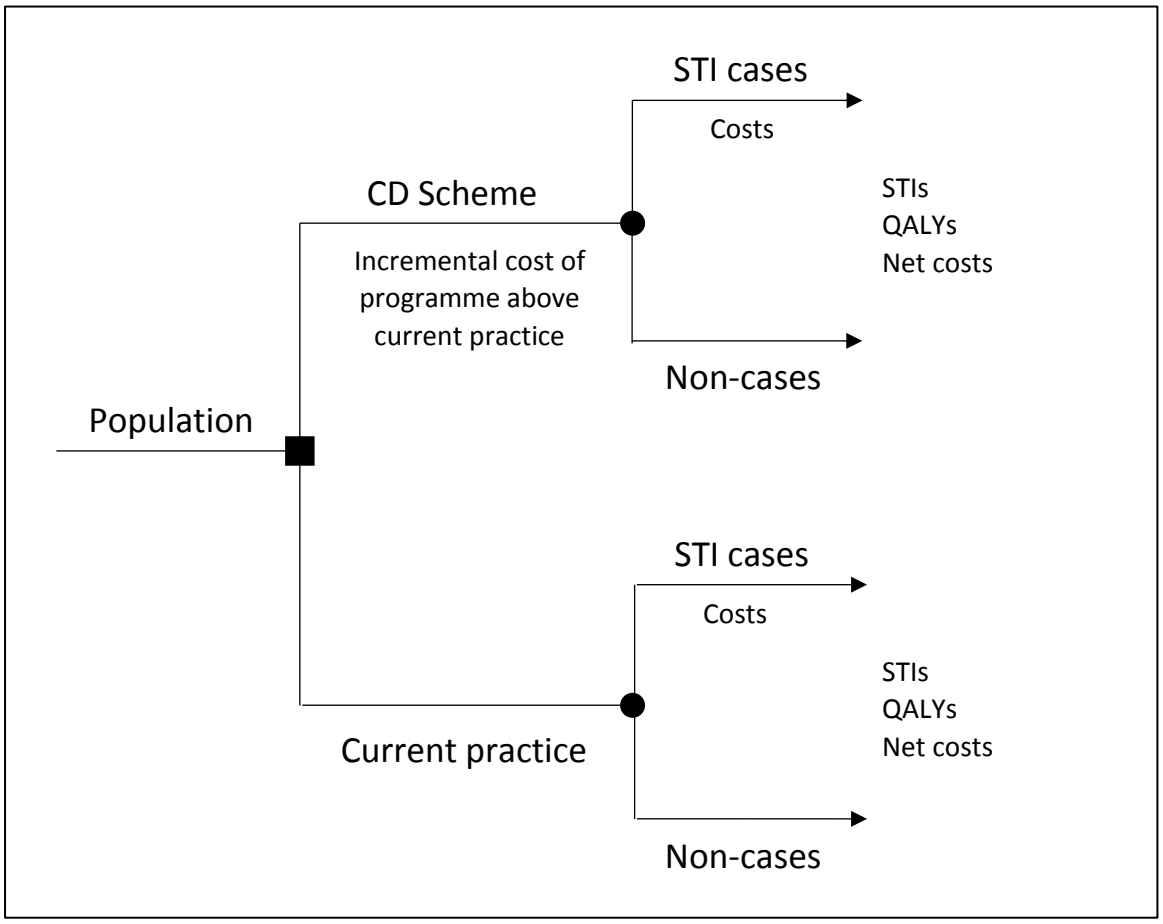


Figure 3: Decision model schematic

2.2.4 Uncertainty

A probabilistic sensitivity analysis (PSA) was conducted to assess the impact of parameter uncertainty upon the model output. This involves assigning an appropriate statistical distribution to uncertain parameters in the decision model. A random draw from each distribution is taken simultaneously, and the model run a large number of times (5,000 was found to reach reasonable stability whilst being feasible in terms of run time) to quantify the parameter uncertainty in the model. This quantification can be represented as the probability of an intervention being cost-effective at a particular ICER threshold, λ, and visually using cost effectiveness acceptability curves (13). All results presented, base cases, scenarios and threshold analyses, are probabilistic.

2.2.5 General model parameters

2.2.5.1 Sexual activity and contacts

Age and gender-specific data for the proportion of people who are sexually active, and the corresponding rate of sexual contacts for people over 16 were taken from the third National Survey of Sexual Attitudes and Lifestyles (NATSAL-3) publication (14). These data are provided in Table 1. For those between 13 and 16, the NATSAL-3 dataset was analysed to provide these data. It was assumed that those under 13 are not sexually active. Data were not available on the number of sexual contacts (if sexually active) if under 16 years old, and so it was assumed that this would be equal to those aged 16-24. These data are generic and apply across all three modelled groups.

Table 1 Sexual activity and contacts, by age and gender

Age	Sexually active		Sexual contacts (if active) per 4 weeks)		Source
	Men	Women	Men	Women	
13	4.4%	2.3%	5.1[1]	5.8[1]	NATSAL-3 dataset
14	11.8%	8.5%	5.1[1]	5.8[1]	
15	26.0%	21.4%	5.1[1]	5.8[1]	
16-24	75.9%	77.0%	5.1	5.8	Mercer 2013 Lancet[3]
25-34	90.1%	91.8%	5.4	4.9	
35-44	92.5%	80.8%	4.1	4.0	
45-54	86.4%	85.0%	4.1	3.5	
55-64	76.3%	63.7%	3.2	2.5	
65+	59.8%	42.1%	2.3	1.4	
[1]Assumed equal to 16-24 data					

2.2.6 Modelling quality adjusted life years (QALYs)

Depending on the particular STI, QALYs were modelled in one of two ways. Either an absolute QALY reduction due to an STI was found in the literature and applied in this model. Or a disutility for an STI was found, and multiplied by an estimate of time from symptom onset to cure, to estimate the QALY reduction. All values and sources are provided in Table 2. The data used for HIV from Farnham et al. (2013) (15) assumes people are diagnosed when infected, with a CD4 count above 500, and is discounted at 3% per annum due to being an American study (compared to 3.5% per annum which is recommended by NICE).

Table 2 QALYs for STIs

STI	Disutility (95% CI)	Condition length (weeks)	QALY gained (95% CI)	Source
Chlamydia	0.103	1	0.002	Turner et al. (2013) (16)
Gonorrhoea	0.103	2	0.004	Turner et al. (2013) (16)
HIV			4.45 (4.34–4.47)	Farnham et al. (2013) (15)
Syphilis	Primary 0.0072 (0.0065, 0.0079) Secondary 0.041 (0.036, 0.045) Primary:Secondary – 70:30	18.7	0.0026 (0.0023–0.0028)	Tuite et al. (2014) (17) Suktankar (2014) (10)
PID	0.1	13	0.025	Looker et al. (2015) (18)

2.2.7 Modelling the cost of an STI averted

All costs are in 2015 prices. For each STI, the cost of a 'case averted' was assumed to be equivalent to self-identification of an STI and attendance at a GP surgery or GUM clinic, along with the cost of any diagnostic test and subsequent treatment. For all STIs except HIV and PID, this cost is simply a cost of treatment with no expected follow-up costs for further health intervention. For HIV, there is a much more significant lifelong cost of treatment, health care consultations and follow-up costs. For PID there is the risk of further complications, and so external published data have been used (12).

This assumption may be an underestimate of the true cost of a case being averted, due to the significant health resources spent on promotion, screening and public health interventions to reduce the total number of STIs, as well as the total number of undiagnosed STIs. However, it is not possible to fully quantify all of these diagnostic, screening and public health interventions and attribute them to each case of a particular STI, and therefore they are not included within this analysis.

2.2.7.1 Modelling the cost of an HIV case averted

In 2011 the Health protection agency published a report which stated that Investing in the prevention of HIV infection should be a priority as it was estimated that the lifetime cost saving per infection prevented was be between £280,000 and £360,000 (19).The same value taken from a 2009 report published by the same agency was used by the Faculty of Public Health of the Royal College of physicians in their submission to the House of Lords select committee on HIV and AIDS in the UK (20). Public Health England published similar reports in 2012, 2013, 2014 and 2015 but none of them contained an estimate of the lifetime treatment cost associated with HIV infection.

In 2015 a paper published by Nakagawa et al (21) the lifetime cost of HIV treatment was estimated to be £360,800 which when discounted at 3.5% per annum would fall to £185,200. However, the authors suggested that switching to generic drugs once pharmaceutical patents expire could reduce the lifetime cost of treating a 30 year old gay male infected with HIV in 2003 who lived till the age of 72 years by more than half to £179,600 which again once discounted at 3.5% per annum would fall to £101,200. These costs are based on the assumptions that the standards of care are those specified in the 2012 edition of the guideline published by the British HIV association and assuming that generic drugs would only cost 20% of the branded versions. The cost year used in the analysis is 2013 (assuming this is listed in the Unit Costs of Health and Social Care 2015 (22) as the cost year 2012/13) then inflating these costs to 2014/15 result in costs of £368,084; £188,939; £183,226 and £103,243.

In the analysis we use the cost of £103,243 and assume a 95% confidence interval of £82,594 to £123,892.

2.2.7.2 Modelling the cost of a PID case averted-

For this analysis, the total cost of a case of PID was taken from a report to the National Collaborating Centre for Women's and Children's health that considered the full cost of a case of PID, including future complications and hospitalisations (12) . The mean total cost for PID was estimated to be £2,846 assuming that the cost year used in the report is 2009 then (assuming this is listed in the Unit Costs of Health and Social Care 2015 (22) as the cost year 2008/09) then inflating these costs to 2014/15 result in costs of £3,124 since no confidence interval is placed around these costs we have assumed that the limits of the 95% confidence interval are +/-20% of the mean cost.

2.2.7.3 Appointment cost

For each of the remaining STIs, it is assumed that in each case a person will develop symptoms and present at their GP. A sensitivity analysis is that they will present at a Sexual Health or Genitourinary Medicine (GUM) clinic. The costs of an appointment at one of these services are provided in Table 3.

Table 3 Cost of an STI averted: Appointment costs

Cost component	**Unit Cost (£)**	**Source**
GP Appointment	67.90	Unit Costs of Health and Social Care 2015[£]
GU Medicine appointment	62.39	National Schedule of Reference Costs 2013/14[$]
[£]11.7 min consultation, excluding admission costs [$]WF01B (Non-admitted Face to Face Attendance, first. Non-consultant led outpatient)		

2.2.7.4 Testing cost

For some STIs, diagnosis can be confirmed by an examination; however other may require one or more diagnostic test. The testing regimen and cost for each STI are provided in Table 4.

Table 4 Cost of an STI averted: Diagnostic testing

STI	**Test**				**Total cost**
	NAATs	**Cell Culture**	**Blood**	**Cytology**	
	£6.84[£]	£6.84[£]	£3.00[$]	£7.77[%]	
Chlamydia	X				£6.84
Gonorrhoea	X	X			£13.68
Syphilis		X	X		£9.84
[£]NHS Costs of Diagnostic Services – DAPS07 - 2013/14 National Schedule of Reference Costs [$]NHS Costs of Diagnostic Services – DAPS05 - 2013/14 National Schedule of Reference Costs [%]NHS Costs of Diagnostic Services – DAPS01 - 2013/14 National Schedule of Reference Costs					

2.2.7.5 Treatment cost

A micro-cost estimation of the treatment for each STI was conducted. Because the treatment is often antibiotic therapy, there are a range of different regimens and antibiotics which may be used.

For each STI, the appropriate NHS regimen has been costed using BNF 2016 drug prices, and the mean, minimum and maximum cost of treatment estimated. Some STIs have alternative treatment regimens, and in these cases the cost has been averaged. The treatment costs are summarised in Table 5.

Table 5 Cost of an STI averted: Treatment cost

Condition	**Treatment cost (£, 2016)**		
	Mean Cost	**Minimum**	**Maximum**
Chlamydia	2.92	0.48	11.91
Gonorrhoea	8.98	4.76	16.71
Syphilis	13.82	1.65	25.54

2.2.7.6 Total cost of an STI case averted

As well as the initial appointment, there may be subsequent follow-up appointments to either initiate treatment after a positive diagnostic test result, or to ensure curation after treatment. Minimum and maximum number of visits were determined based on NHS treatment pathways for STIs, and averaged to provide the expected number of visits for each STI (see Table 6).

Table 6: Cost of an STI averted: Number of appointments

STI	Expected number of visits	Minimum	Maximum
Chlamydia	1.5	1	2
Gonorrhoea	2.5	2	3
Syphilis	2.5	2	3

The total cost per STI case averted, as well as upper and lower bounds for sensitivity analysis, are provided in Table 7. The minimum and maximum estimates are based on the maximum and minimum number of visits, treatment costs, and the maximum estimate includes GUM appointments rather than GP practice appointments.

Table 7 Cost of an STI averted: Total cost

STI	Cost (£)		
	Mean	Minimum	Maximum[£]
Chlamydia	121.92	75.76	166.58
Gonorrhoea	206.17	129.24	280.61
Syphilis	210.59	133.66	285.03
[£]Maximum includes GUM appointment cost			

2.2.8 Effectiveness evidence

A systematic review of comparative assessments of condom distribution schemes has been undertaken by NICE and is reported separately. The systematic review focuses on single and multi-component condom distribution schemes in a range of settings including high school (secondary) education, healthcare, commercial and community and outreach. The effectiveness evidence from each setting and specifically how it relates to the potential economic impact of CD scheme in each setting is discussed in the specific sections relating to each model below.

Details of the specific models, including their parameters are set out in the following sections

2.3 Young People Model

2.3.1 Economic model scope

This model was intended to capture the effects of implementing a C-Card scheme. These schemes provide young people free access to condoms (and in some schemes lubricant) through a range of outlets (for example, pharmacies, community centres, clinics and schools) using a personal card. The precise age range for C-Card schemes varies by implementation. The base case analysis uses a target age range of 13-24, however the effectiveness evidence is taken from a study with a slightly younger population and thus a scenario analysis for ages 13-18 years is presented. In order to register for the card the young person must attend a one-to-one session with a trained provider, enabling them to talk through sexual health and relationship issues, receive a condom demonstration and discuss contraception. For under 16's this includes an assessment of Fraser competence. Unlimited supplies can be accessed, but the young person must undergo further periodic one-to-one meetings to maintain access. It is hypothesised that this scheme would not only increase condom usage, through both availability and education, but also improve correct condom usage and therefore reduce condom failure rates through breakage and slippage.

2.3.2 Effectiveness evidence

The review undertaken by NICE identified a number of studies of multi-component interventions for young people. However, these were all limited to school-based studies and do not fully represent the kind of offering that a C-CARD scheme provides. Evidence from these studies was somewhat mixed as regards the effectiveness of multi-component schemes. A quasi-experimental study (23) identified a small significant effect on increasing reported condom use at last intercourse (OR 1.36) in school pupils in the USA using an intervention which combined education and free condom availability.

A before and after study (24) reports a non-significant increase in the reported use of a condom at last intercourse (OR 1.12) amongst school pupils in the USA using an intervention which involved abstinence counselling, availability of sexual health advice and free condom availability.

A good quality controlled study (1) identified a larger, significant increase in reported 'ever having used' a condom (OR 2.11) amongst school pupils in Sweden, using an intervention which involved a number of lessons about contraception and condom use with free condom availability.

The highest quality study, that by Larsson *et al.* (1) was chosen to give the estimated level of effectiveness in the base case scenario. A relative risk of condom use of 1.23 was applied to baseline

condom use in the intervention scenario to give the increased rate of condom use after the intervention.

Because this effectiveness evidence was not specific to the C-card scheme, it is feasible that the effectiveness of the C-Card itself is somewhat different. Although the C-card scheme has a set of generic implementation principles, each implementation is intended to be designed locally with participation of the target population, costs are, therefore, quite specific to each locality running the scheme. In order to improve the understanding of the cost effectiveness of the C-card under a range of possible cost and effectiveness scenarios, a threshold analysis was carried out, to identify the combination of costs and effectiveness required to make a scheme cost effective at £30,000 per QALY, or to make a scheme dominant (QALY improving and cost-saving).

A scenario is included where condom failure due to breakage rate is reduced, with an odds ratio of 0.8, based on the results of Macaluso *et al*., (6) discussed below.

2.3.3 Model-specific parameters

2.3.3.1 Condom usage and failure

Age-specific data for the proportion of people routinely using condoms were taken from an Office of National Statistics (ONS) publication. (25) It was assumed that under-16s were the same as 16-19 year olds. These data are provided in Table 8. All these studies date from prior to 2000, but despite varying results, there is reasonable evidence that failure rates reduce with experience. None of the measures closely matches the experience gained through C-card, which is based on one-to-one training, whereas the studies report on experience gained over time of using condoms. Therefore we would have to assume that the instruction received through C-card registration, and availability of free condoms speeds up the process of familiarisation and practising with condoms in advance of them being needed for sex with a partner. The most appropriate study was Macaluso et al. because it compared usual use with new users (as opposed to other studies which compared those who had been using condoms for several years), and included both breakage and slippage in its failure rates, hence this study was chosen, giving, an overall failure rate of 3.62% (2.3% breakage and 1.3% slippage). In the base case, no change in failure rates will be assumed. In a scenario, breakage rates will be adjusted in accordance with the results of this study (Odds ratio 0.8).

Table 8 Condom use (percentage by age)

Age	Condom use (%)	Source
16-19	54%	Lader & Hopkins. ONS Contraception and Sexual health report, 2008/9 (25)
20-24	54%	
25-29	41%	
30-34	46%	
35-39	27%	
40-44	10%	
45-49	13%	

Several studies were identified which give differential breakage and slippage rates by experience. Macaluso *et al*. (6) reported slightly lower odds of failure amongst those with usual past condom use compared with those who rarely or never used a condom (OR = 0.8). Messiah *et al.* (26) reported higher failure rates for people with fewer years of condom use (7.8% for less than 5 years use and 1.4% for over 5 years use). In the same study rates by age and by years of sexual experience did not follow a similar pattern. Frezieres *et al.* (27) reported lower breakage and slippage rates (0.9%) with latex condoms over 6 months of recorded use in a trial, than in the first 5 uses (1.6%). Vessey *et al.* (28) reported higher failure rates per 100 woman-years in groups with longer experience using condoms (6.0% if <24 months, 4.0% if 25-48 months and 3.6% if 49+ months).

All these studies date from prior to 2000, but despite varying results, there is reasonable evidence that failure rates reduce with experience. None of the measures closely matches the experience gained through C-card, which is based on one-to-one training, whereas the studies report on experience gained over time of using condoms. Therefore we would have to assume that the instruction received through C-card registration, and availability of free condoms speeds up the process of familiarisation and practising with condoms in advance of them being needed for sex with a partner. The most appropriate study was Macaluso et al. because it compared usual use with new users (as opposed to other studies which compared those who had been using condoms for several years), and included both breakage and slippage in its failure rates, hence this study was chosen, giving, an overall failure rate of 3.62% (2.3% breakage and 1.3% slippage). In the base case, no change in failure rates will be assumed. In a scenario, breakage rates will be adjusted in accordance with the results of this study (Odds ratio 0.8).

2.3.4 Modelling sexually transmitted infections (STIs)

As well as data regarding the sexual activity and condom utilisation in a population, to determine the number of STI cases in a population, the background population prevalence and transmission rate of each STI are required.

2.3.4.1 Prevalence

For Chlamydia, Gonorrhoea and Syphilis the number of cases for 2014, stratified by age group and gender, was taken from data published by Public Health England[1]. For HIV data was obtained from the HIV New Diagnoses and Death Database[2], with the gender split for each age assumed to be pro-rata with the overall sex ratio. This data is presented in Table 9.

It was assumed that the numbers given in the Public Health England data referred to the number of cases reported in each age group and therefore the data was divided by the number of years in each age group and further divided by the population in each at risk group to give the percentage prevalence of Chlamydia, Gonorrhoea, HIV and Syphilis by age group and gender for young people. The PSA is based upon beta distributions according to the case numbers presented in Table 9, giving mean rates presented in Table 10.

The base case estimates for HIV prevalence are based on diagnosis rates and so may underestimate the true prevalence of HIV. Therefore, a higher HIV prevalence scenario was also modelled, based on the estimated overall prevalence of HIV in the UK (not available by age) of 0.19% stated in the 2015 HIV Situation Report (29). This was assumed to follow the same pattern by age and sex as HIV incidence, giving the prevalences shown in Table 11.

[1] Public Health England. Table 2: STI diagnoses & rates by gender, sexual risk and age group, 2010 – 2014.London. Public Health England, Colindale

[2] Public Health England. United Kingdom National HIV surveillance data tables. London. Public Health England, Colindale

Table 9: Prevalence of STI cases 2014 from Public Health England data

Age group	Chlamydia		Gonorrhoea		HIV		Syphilis		Total at risk population	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
13–14	56	817	7	60	24	8	0	0	628,933	598,876
15–19	14,724	41,995	1,693	2,629	545	182	61	32	1,670,664	1,584,088
20–24	32,921	47,768	6,031	2,853	1,532	512	396	49	1,829,362	1,774,376
25–34	25,869	23,299	10,738	2,048	1,192	398	1,319	102	3,672,381	3,694,976
35–44	7,279	4,322	5,077	525	841	281	1,245	43	3,559,027	3,600,040
45–64	3,806	1,576	2,783	245	319	107	963	34	6,712,115	6,885,167
65+	253	45	156	9	157	53	45	3	4,185,891	5,119,288

Table 10: Mean prevalence values used in the model for Chlamydia, Gonorrhoea, HIV & Syphilis in the young people analysis.

Age group	Chlamydia		Gonorrhoea		HIV		Syphilis	
	Male	Female	Male	Female	Male	Female	Male	Female
0 – 12	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
13 – 14	0.009%	0.136%	0.001%	0.010%	0.004%	0.001%	0.000%	0.000%
15 – 19	0.881%	2.651%	0.101%	0.166%	0.016%	0.006%	0.004%	0.002%
20 – 24	1.800%	2.692%	0.330%	0.161%	0.015%	0.005%	0.022%	0.003%
25 – 34	0.704%	0.631%	0.292%	0.055%	0.042%	0.014%	0.036%	0.003%
35 – 44	0.205%	0.120%	0.143%	0.015%	0.033%	0.011%	0.035%	0.001%
45 – 64	0.057%	0.023%	0.041%	0.004%	0.017%	0.006%	0.014%	0.000%
65+	0.006%	0.001%	0.004%	0.000%	0.004%	0.001%	0.001%	0.000%

Table 11: High prevalence scenario (young people) – overall HIV prevalence = 0.19%

Age group	HIV	
	Male	Female
13 – 14	0.054%	0.019%
15 – 19	0.229%	0.081%
20 – 24	0.209%	0.072%
25 – 34	0.586%	0.195%
35 – 44	0.471%	0.155%
45 – 64	0.243%	0.079%
65+	0.053%	0.014%

2.3.4.2 Transmission rate in the absence of condom use

Estimating the probability of transmission between an infected person and an uninfected person from one unprotected sexual contact is difficult due to the ethical implications of this research. Therefore the data for this important parameter are in some cases are old and limited. Rates and sources are presented in Table 12.

Table 12 Transmission rate

STI	Transmission rate (per 1 sexual contact)		Source
	Men	Women	
HIV	0.12%	0.39%	Boily et al. (2009) (30)
Chlamydia	45%	45%	Wang et al. (2000) (31)
Gonorrhoea	53%	53%	Wang et al. (2000) (31)
Syphilis	61.8%	61.8%	Alexander et al. (1949)(32)

2.3.4.3 Pelvic Inflammatory Disease

Pelvic Inflammatory Disease (PID) is an infection that often occurs during a case of chlamydia or gonorrhoea in women. Rather than estimate cases of PID independently it was considered as a function of the number of cases of Chlamydia and the number of cases of Gonorrhoea. PID can have a significant impact on a women's quality of life and in some cases can be a serious condition requiring hospitalisation and surgery. Data were found providing the proportion of chlamydia and gonorrhoea cases that result in PID (see Table 13).

Table 13 STIs that lead to PID

STI (leading to PID)	Proportion	Source
Chlamydia	16% (6 – 25%)	Price et al. (2013) (33)
Gonorrhoea	0.9% (0.1 - 1.8%)	Unpublished conference abstract (Australian data) (9)

2.3.5 Exploratory analysis around pregnancy outcomes: young people

In order to provide an indication of the relative impact of the interventions upon pregnancy outcomes compared with STI outcomes, an exploratory analysis has been undertaken. This is limited to interventions targeted at young people (14 – 18) because it makes the simplifying assumption that all pregnancies within this population are unintended. It would not be possible given the data available to distinguish between intended and unintended pregnancies, and therefore to assess the potential impact of the interventions within the general population. This exploratory analysis uses an existing model developed for NICE Public Health Guidance 51[1].

[1] A detailed description of this model can be found at: https://www.nice.org.uk/guidance/ph51/documents/contraceptive-services-for-socially-disadvantaged-young-people-additional-consultation-on-the-evidence-cost-effectiveness-modelling-report2

The analysis presented here assumes that the intervention targets people aged 14 – 18 years, and that all pregnancies within this age group are unintended. It is assumed that there is a 50% probability that the intervention delays the pregnancy and a 50% probability that the intervention prevents the pregnancy. Within the PSA, this probability is varied from 0% to 100%. For those pregnancies which are delayed, they are assumed to be delayed until the person is aged 19 – 24 years. The delayed births are equally divided over this age range.

Within the model, the probability of becoming pregnant by age and the probability of having an abortion by age have been updated using the latest national statistics (34). The model has been updated to use the same condom failure rate as the STI model, with a mean of 3.6% (6). The cost savings predicted by the model have also been uplifted to 2014/15 prices (35).

2.3.6 Costing the C-card scheme

To cost the C-card scheme a rapid search identified a small number of published documents from local schemes in England and Wales, of which 5 provided overall costs of their schemes: Derbyshire (5), Lincolnshire (3), Nottinghamshire (2), Newcastle and North Tyneside (2, 4) and Lambeth (36). When compared to ONS census 2011 published population statistics for the numbers of teenagers aged 13-24 in each area (37), four of the five schemes gave costs between £0.33 and £0.68 per head of teenage population per annum, with Lambeth having higher costs of £1.21 per head of teenage population. In addition, as a sense check, bottom-up costings were developed with the help of experts with experience of running schemes in both rural and urban areas. In these examples the main costs were staff time to manage the scheme and train new providers and the costs of condoms (and lube, although this was requested less often and is not offered in all c-card schemes). Additional costs included the cost of the card itself, cost of an online registry (where used), promotion/advertising costs (including web sites) and costs of travel and distribution. These costings generated a possible range of costs of between £0.31 and £0.51 per head of teenage population. An estimated cost of £0.48 per head of teenage population was chosen to be representative of the four lower-cost published schemes (see Table 14), and a normal distribution with mean £0.48 and standard error £0.07 applied in the PSA.

Table 14 C-card scheme costs

Parameter	Mean cost (SE)	Sources
Cost per head of population (13-24)	£0.48 (£0.07)	(2-5)

2.4 Men who have sex with men (MSM) model

2.4.1 Economic model scope

This model was intended to capture the effects of implementing a CD scheme targeted at those with a high risk of STIs, specifically MSM (ages 17-90). Such component schemes may be low-cost and aim to increase availability of condoms to MSM of all ages, by providing access to free condom packs in a variety of venues, especially those frequented by gay men, including pubs, clubs, shops and taxis. It is hypothesised that these schemes would increase condom usage by reducing barriers to their availability and purchase.

2.4.2 Effectiveness

The review identified only one single component scheme targeted at MSM (38), which was considered a high quality before-and-after study. This study followed the London-based 'RubberStuffers' initiative in 1996, and surveyed MSM on their condom use before and after the introduction of the scheme, which distributed up to 300,000 free condoms each year. Despite improvements in possession of condoms, the study did not show a significant increase in the use of condoms during anal intercourse. The review did include a US-based multi-component study targeted at high-risk individuals including MSM (39), and this study did show increased condom usage amongst those accessing the service (odds ratio = 1.37), suggesting that multi-component schemes could be more effective, however, the review evidence was extremely limited, and the one UK-based study is now quite old. Therefore, there was no evidence on which to base a model of a CD scheme for MSM.

Due to a lack of effectiveness evidence, no base-case model was analysed. Instead a range of effectiveness and cost options were assessed using a threshold analysis, to identify the combination of costs and effectiveness required to make a scheme cost effective at £30,000 per QALY, or to make a scheme dominant (QALY improving and cost-saving).

2.4.3 Model-specific parameters

2.4.3.1 Condom usage and failure

Data on condom use specific to MSM was available from the published 2008 UK Gay Men's Sex Survey (40). This online survey gave overall condom use at last anal sex within 6 months. Results were broken down by region, and because the sample was heavily weighted towards London, the

results were weighted according to the overall English population to give an overall rate of condom use of 52.7%. This was assumed to apply across all ages. Results of two more recent surveys (the European MSM Internet Survey) were provided via personal communication from Ford Hickson[1] and confirmed that in both 2010 and 2014 condom use rates remained fairly stable in more recent years, with a slight decrease in the numbers of men reporting always using a condom.

As discussed in the previous model, an overall failure rate of 3.62% (2.3% breakage and 1.3% slippage) was used, based on Macaluso et al. (6).

2.4.3.2 Modelling sexually transmitted infections (STIs)

As well as data regarding the sexual activity and condom utilisation in a population, to determine the number of STI cases in a population, the background population prevalence and transmission rate of each STI are required.

2.4.3.3 Prevalence

For men who have sex with men the number of cases of Chlamydia, Gonorrhoea, HIV and Syphilis diagnosed in 2014 was again taken from data published by Public Health England[2]. For Gonorrhoea, HIV and Syphilis the number of cases diagnosed in 2014 among MSM was presented stratified by age group. However for Chlamydia numbers were not presented for the whole of England although they were presented for each Public Health England Centre (PHEC). The data for the London PHEC was used to estimate the number of cases occurring in men who have sex with men in the whole of England in 2014 on a pro-rata basis.

For MSM the total at risk population was again only presented stratified by age group. A value of 2.8%[3] was used to estimate the number of men in the male population who had sex with other men. Relevant data is presented in Table 15.

It was again assumed that the numbers given in the Public Health England data referred to the number of cases reported in each age group and therefore the data was divided by the number of

[1] Sigma Research, London School of Hygiene & Tropical Medicine

[2] Public Health England. Table 2: STI diagnoses & rates by gender, sexual risk and age group, 2010 – 2014.London. Public Health England, Colindale

3. Erens B., et al. National Survey of Sexual Attitudes and Lifestyles II Reference tables and summary report. 2003. London. NATSAL, University College London.

years in each age group and further divided by the population in each at risk group to give the percentage prevalence of Chlamydia, Gonorrhoea, HIV and Syphilis by age group for MSM. This estimate of HIV prevalence was considered to the a lower estimate (being based on diagnoses), and therefore two more HIV prevalence levels estimates were calculated; a central estimate using overall prevalence of 5% (based on that estimated in the 2015 HIV in the UK Situation Report) (29), and a higher estimate using overall prevalence of 9.1% (based on PHE's update on HIV in MSM in London) (41) – both assumed to spread across age groups according to the spread in incidence. These HIV prevalence estimates are shown in Table 17.

Table 15: Prevalence of STI cases 2014 from Public Health England data for men who have sex with men

Age group	Men who have sex with men				
	Chlamydia	Gonorrhoea	HIV	Syphilis	At risk population
13 – 14	5	2	0	0	17,610
15 – 19	798	580	217	41	46,779
20 – 24	3,028	3,354	217	322	51,222
25 – 34	5,753	7,752	1,276	1,148	102,827
35 – 44	3,431	4,087	725	1,100	99,653
45 – 64	2,115	2,092	585	817	187,939
65+	146	95	35	31	117,205

Table 16: Mean prevalence values used in the model for Chlamydia, Gonorrhoea, HIV & Syphilis in the men who have sex with men analysis

Age group	Chlamydia	Gonorrhoea	HIV	Syphilis
0 – 12	0.000%	0.000%	0.000%	0.000%
13 – 14	0.026%	0.011%	0.000%	0.000%
15 – 19	1.705%	1.240%	0.464%	0.088%
20 – 24	5.911%	6.548%	0.424%	0.629%
25 – 34	5.595%	7.539%	1.241%	1.116%
35 – 44	3.443%	4.101%	0.728%	1.104%
45 – 64	1.125%	1.113%	0.311%	0.435%
65+	0.124%	0.081%	0.030%	0.026%

Table 17 Lower, central and upper estimates of HIV prevalence in MSM

Age group	Lower	Central	Higher
13 – 14	0.000%	0.000%	0.000%
15 – 19	0.464%	4.732%	8.605%
20 – 24	0.424%	4.321%	7.859%
25 – 34	1.241%	12.657%	23.019%
35 – 44	0.728%	7.421%	13.496%
45 – 64	0.311%	3.175%	5.774%
65+	0.030%	0.305%	0.554%

Pelvic Inflammatory Disease

Pelvic Inflammatory Disease is not relevant for the men who have sex with men

2.4.3.4 Transmission rate in the absence of condom use

Transmission rates for most STIs were assumed to be the same as in the general model. However, for HIV evidence was available on transmission rates specifically for anal intercourse (42). See Table 18 for rates and sources.

Table 18 Transmission rate

STI	**Transmission rate (per 1 sexual contact)**		**Source**
	Men	**Women**	
HIV (specific to anal intercourse)	1.4%		Baggaley et al. (2010) (42)
Chlamydia	45%	45%	Wang et al. (2000) (31)
Gonorrhoea	53%	53%	Wang et al. (2000) (31)
Syphilis	61.8%	61.8%	Alexander et al. (1949) (32) (43) (44)

2.5 Black African model

2.5.1 Economic model scope

This model was intended to capture the effects of implementing a scheme specifically targeted at black Africans, who have higher prevalence of some STIs, including, importantly, HIV.

2.5.2 Effectiveness evidence

For this intervention no base-case model was analysed. Instead a range of effectiveness and cost options were assessed using a threshold analysis, to identify the combination of costs and effectiveness required to make a scheme cost effective at £30,000 per QALY, or to make a scheme dominant (QALY improving and cost-saving).

2.5.3 Model-specific parameters

2.5.3.1 Condom usage and failure

Age-specific data for the proportion of people routinely using condoms were taken from an Office of National Statistics (ONS) publication. (25) It was assumed that under 16s were the same as 16-19 year olds. These data are provided in Table 24.

Table 19 Condom use (percentage by age)

Age	Condom use (%)	Source
16-19	54%	Lader & Hopkins. ONS Contraception and Sexual health report, 2008/9 (25)
20-24	54%	
25-29	41%	
30-34	46%	
35-39	27%	
40-44	10%	
45-49	13%	

As discussed in the previous models, an overall failure rate of 3.62% (2.3% breakage and 1.3% slippage) was used, based on Macaluso *et al.* (6).

2.5.4 Modelling sexually transmitted infections (STIs)

As well as data regarding the sexual activity and condom utilisation in a population, to determine the number of STI cases in a population, the background population prevalence and transmission rate of each STI are required.

2.5.4.1 Prevalence

Numbers of diagnoses of STIs in 2014 were available by ethnic group in PHE's STI annual data tables for chlamydia, gonorrhoea and syphilis (45). Numbers for the 'black or black British' group were

used. These were compared to 2011 census statistics for the number of people in the overall English population who were black, African, Caribbean or black British to give rates of STI diagnosis. In the absence of age-group-level data, the spread across age groups was assumed to be the same as for STI diagnoses in the general population. Data are summarised in Table 20.

For HIV, three estimates of overall prevalence were used; 1.46% and 3.84% (men and women respectively) were the lower level estimates, 1.79% and 4.55% were the central estimates and 2.33% and 5.28% were the upper estimated (based on the 2015 HIV in the UK Situation Report (29) central estimate and confidence interval, and consistent with the NICE HIV testing guideline[1]). In the absence of age-specific prevalence estimates, rates were assumed to vary across age groups in the same way as diagnoses in the general population. Data are summarised in Table 21.

Table 20 Mean estimated prevalence values used in the model for Chlamydia, Gonorrhoea & Syphilis in the black African analysis

Age group	Chlamydia		Gonorrhoea		HIV		Syphilis	
	Male	Female	Male	Female	Male	Female	Male	Female
13 – 14	0.015%	0.231%	0.003%	0.028%	0.231%	0.641%	0.000%	0.000%
15 – 19	1.491%	4.485%	0.286%	0.469%	0.987%	2.752%	0.006%	0.003%
20 – 24	3.044%	4.554%	0.932%	0.454%	0.901%	2.457%	0.037%	0.005%
25 – 34	1.192%	1.067%	0.826%	0.157%	2.524%	6.634%	0.061%	0.005%
35 – 44	0.346%	0.203%	0.403%	0.041%	2.026%	5.297%	0.060%	0.002%
45 – 64	0.096%	0.039%	0.117%	0.010%	1.046%	2.696%	0.024%	0.001%
65+	0.010%	0.001%	0.011%	0.000%	0.228%	0.492%	0.002%	0.000%

Table 21 Estimated lower, central and upper HIV prevalence for the black African analysis

Age group	Lower		Central		Upper	
	Male	Female	Male	Female	Male	Female
13 – 14	0.231%	0.641%	0.284%	0.759%	0.369%	0.881%
15 – 19	0.987%	2.752%	1.214%	3.261%	1.579%	3.784%
20 – 24	0.901%	2.457%	1.108%	2.911%	1.442%	3.378%
25 – 34	2.524%	6.634%	3.105%	7.861%	4.039%	9.122%
35 – 44	2.026%	5.297%	2.492%	6.277%	3.242%	7.283%
45 – 64	1.046%	2.696%	1.287%	3.195%	1.674%	3.707%
65+	0.228%	0.492%	0.280%	0.583%	0.364%	0.676%

[1] Available at: https://www.nice.org.uk/guidance/indevelopment/GID-PHG91/consultation/html-content

2.5.4.2 Transmission rate in the absence of condom use

Estimating the probability of transmission between an infected person and an uninfected person from one unprotected sexual contact is difficult due to the ethical implications of this research. Therefore the data for this important parameter are in some cases are old and limited. Rates and sources are presented in Table 22.

Table 22 Transmission rate

STI	**Transmission rate (per 1 sexual contact)**		**Source**
	Men	**Women**	
HIV	0.12%	0.39%	Boily et al. (2009) (30)
Chlamydia	45%	45%	Wang et al. (2000) (31)
Gonorrhoea	53%	53%	Wang et al. (2000) (31)
Syphilis	61.8%	61.8%	Alexander et al. (1949) (32) (43) (44)

2.5.4.3 Pelvic Inflammatory Disease

Pelvic Inflammatory Disease (PID) is an infection that often occurs during a case of chlamydia or gonorrhoea in women. PID can have a significant impact on a women's quality of life and in some cases can be a serious condition requiring hospitalisation and surgery. Data were found providing the proportion of chlamydia and gonorrhoea cases that result in PID.

Table 23 STIs that lead to PID

STI (leading to PID)	**Proportion**	**Source**
Chlamydia	16% (6 – 25%)	Price et al. (2013) (33)
Gonorrhoea	0.9% (0.1 - 1.8%)	Unpublished conference abstract (Australian data) (46)

2.6 General population model

2.6.1 Economic model scope

This model was intended to capture the effects of implementing a population-wide CD scheme. Schemes could include outlet schemes which provide condoms at a reduced price. An example of such a scheme is the 'Freedoms' online shop operated by Central and North West London Foundation Trust. This scheme provides a range of condoms and lubricants at a reduced price gained through the purchasing power of the Trust, and is freely available to UK residents to use online for home delivery. This scheme aims to improve condom use be reducing the cost barriers faced by people purchasing small quantities of condoms locally.

2.6.2 Effectiveness evidence

The NICE evidence review identified only one study on the provision of discounted condoms, and this study only reported outcomes for acquisition and not for condom use, therefore, no effectiveness evidence is available. Therefore, for this intervention no base-case model was analysed. Instead a range of effectiveness and cost options were assessed using a threshold analysis, to identify the combination of costs and effectiveness required to make a scheme cost-effective at £30,000 per QALY, or to make a scheme dominant (QALY improving and cost-saving).

2.6.3 Model-specific parameters

2.6.3.1 Condom usage and failure

Age-specific data for the proportion of people routinely using condoms were taken from an Office of National Statistics (ONS) publication. (25) It was assumed that under 16s were the same as 16-19 year olds. These data are provided in Table 24.

Table 24 Condom use (percentage by age)

Age	Condom use (%)	Source
16-19	54%	Lader & Hopkins. ONS Contraception and Sexual health report, 2008/9 (25)
20-24	54%	
25-29	41%	
30-34	46%	
35-39	27%	
40-44	10%	
45-49	13%	

As discussed in the previous models, an overall failure rate of 3.62% (2.3% breakage and 1.3% slippage) was used, based on Macaluso *et al.* (6).

2.6.4 Modelling sexually transmitted infections (STIs)

As well as data regarding the sexual activity and condom utilisation in a population, to determine the number of STI cases in a population, the background population prevalence and transmission rate of each STI are required.

2.6.4.1 Prevalence

See prevalence section of the young people model for prevalence of syphilis, gonorrhoea and chlamydia. For HIV, three prevalence levels were estimated. The lower level prevalence was based on diagnosis data (see section 2.3.4.1), whilst the central and upper estimates were based on overall prevalences of 0.19% (based on the 2015 HIV in the UK Situation Report) (29) and 0.4% respectively a value considered to represent "high prevalence" in the NICE HIV testing guideline[1]). In the absence of age-specific rates, these were assumed to be spread across age groups in the same way as incidence rates.

2.6.4.2 Transmission rate in the absence of condom use

Estimating the probability of transmission between an infected person and an uninfected person from one unprotected sexual contact is difficult due to the ethical implications of this research. Therefore the data for this important parameter are in some cases are old and limited. Rates and sources are presented in Table 25.

Table 25 Transmission rate

STI	**Transmission rate (per 1 sexual contact)**		**Source**
	Men	**Women**	
HIV	0.12%	0.39%	Boily et al. (2009) (30)
Chlamydia	45%	45%	Wang et al. (2000) (31)
Gonorrhoea	53%	53%	Wang et al. (2000) (31)
Syphilis	61.8%	61.8%	Alexander et al. (1949) (32) (43) (44)

2.6.4.3 Pelvic Inflammatory Disease

Pelvic Inflammatory Disease (PID) is an infection that often occurs during a case of chlamydia or gonorrhoea in women. PID can have a significant impact on a women's quality of life and in some cases can be a serious condition requiring hospitalisation and surgery. Data were found providing the proportion of chlamydia and gonorrhoea cases that result in PID.

[1] Available at: https://www.nice.org.uk/guidance/indevelopment/GID-PHG91/consultation/html-content

Table 26 STIs that lead to PID

STI (leading to PID)	**Proportion**	**Source**
Chlamydia	16% (6 – 25%)	Price et al. (2013) (33)
Gonorrhoea	0.9% (0.1 - 1.8%)	Unpublished conference abstract (Australian data) (46)

2.7 Summary of parameters

A full table of general model parameters is provided in Table 27

Table 27 General model parameters and distributions

Parameter	Value	Distribution (α,β) Rounded (unless specified)	Source
SEXUAL PRACTICE – CONDOM USE (By age)			
16-19	54%	None	(25)
20-24	54%		
25-29	41%		
30-34	46%		
35-39	27%		
40-44	10%		
45-49	13%		
SEXUAL PRACTICE – CONDOM USE (MSM)			
All ages	52.7%	None	(40)
CONDOM			
Breakage	3.6%	Beta (194, 9,704)	(6)
SEXUALLY ACTIVE – MEN			
16-24	75.9%	Beta (1,007, 320)	(14)
25-34	90.1%	Beta (952, 105)	
35-44	92.5%	Beta (682, 55)	
45-54	86.4%	Beta (68, 11)	
55-64	76.3%	Beta (533, 166)	
65-	59.8%	Beta (336, 226)	
SEXUALLY ACTIVE – WOMEN			
16-24	77.0%	Beta (1,246, 372)	(14)
25-34	91.8%	Beta (1,698, 152)	
35-44	90.8%	Beta (850, 86)	
45-54	85.0%	Beta (990, 175)	
55-64	63.7%	Beta (519, 296)	
65-	42.1%	Beta (266, 365)	
SEXUAL CONTACTS – MEN			
16-24	5.10	Gamma (0.50, 10.16)	(14)
25-34	5.40	Gamma (0.69, 7.82)	
35-44	4.10	Gamma (0.91, 4.51)	
45-54	4.10	Gamma (0.45, 9.08)	
55-64	3.20	Gamma (0.51, 6.33)	
65-	2.30	Gamma (0.41, 5.63)	
SEXUAL CONTACT – WOMEN			
16-24	5.80	Gamma (0.77, 7.51)	(14)
25-34	4.90	Gamma (0.92, 5.31)	
35-44	4.00	Gamma (0.76, 5.29)	
45-54	3.50	Gamma (0.69, 5.04)	
55-64	2.50	Gamma (0.54, 4.62)	
65-	1.40	Gamma (0.37, 3.78)	
PID			
% chlamydia	16.0%	Beta (9, 47)	(33)
% gonorrhoea	0.9%	Beta (4, 469)	(46)

TRANSMISSION RATES			
HIV – Men HIV - MSM HIV – Women	0.120% 1.400% 0.390%	Beta (10, 8,175) Beta (6, 394) Beta (5, 1,324)	(30) (42)
Chlamydia	45.000%	Beta (42, 52)	(31)
Gonorrhoea	53.000%	Beta (16, 14)	(31)
Syphilis	61.818%	Beta (68, 42)	
QALYs GAINED PER CASE AVERTED			
Chlamydia	0.002	-	(16)
Gonorrhoea	0.004	-	(16)
HIV	4.450	Normal (SD 0.0332)	(15)
Syphilis	0.003	Normal (SD 0.0001)	(17)
PID	0.025	-	(18)

3 RESULTS

3.1 Young People (C-Card) scheme

The economic results for the C-Card scheme include 1) a base case scenario for the C-Card scheme targeted at young people of age 13-24 years, presented in Table 28, with cost effectiveness plane shown in Figure 3 2) a scenario analysis for a narrower age group population between 13-18 years of age, presented in Table 29, with cost-effectiveness plane shown in Figure 4, 3) a scenario including an increased effect on condom failure rate, Table 30, 4) a scenario with higher HIV prevalence, Table 31 5) a two-way threshold analysis examining costs and effects of a multi-component young people CD schemes, Table 32, and an analysis of potential pregnancy outcomes in Table 33.

The baseline analysis targeted at the 13-24 years age group is in line with the generic C-Card principles. For young people, the QoL effects of CD schemes are heavily influenced by the large impact of a small number of HIV cases prevented. However, PID was also important. In terms of costs, PID prevention was the most cost-saving effect of the scheme, followed by both HIV and chlamydia. The model predicts that an intervention with effectiveness as per that demonstrated in Larsson et al. (1) and with costs in the region of a typical C-card scheme would be expected to increase QALYs and cost somewhat more than it saves, giving a cost of £17,411 per QALY gained. However, it should be cautioned that the evidence for effectiveness in this broader age group is not demonstrated, with the Larsson study being undertaken in the younger age group and specifically in a school setting.

When a narrower age range for C-Card is considered, 13-18 years Table 29, the population is most coherent with the study population of the Larsson study, from which the effectiveness is estimated and the population is coherent with the estimated impact on unintended pregnancies. In this case the reduced rates of sexual activity and underlying prevalence of STIs means that there is there is less scope for savings, with cost savings only covering around half of what it costs to deliver, meaning it would not be cost effective at the £30,000 level (ICER = £45,856).

The results of the scenario analysis where condom breakage was reduced (see Table 30) suggest that although reducing condom breakage through education has some influence on the effectiveness and cost effectiveness of the scheme (ICER reduces to £14,469), the impact of the kind of improvements reported in the studies identified was not great.

In the scenario with higher prevalence of HIV, the increase in HIV cases averted by CD schemes makes them cost-saving overall (£10m savings compared with £3.5m scheme costs across England in the target population).

Table 33 shows the results of an exploratory analysis around pregnancy outcomes, including the number of pregnancies and abortions avoided and the discounted cost savings associated with the avoided pregnancies for a range of relative risks associated with the intervention (which correspond to relative effects used within the two-way threshold analysis in Table 32). This includes Public Sector costs associated with abortion, miscarriage, maternity, low birth weight babies and government-funded Benefit payments. This analysis does not include the costs of the intervention or the cost associated with STIs because these are included within the main STI analysis.

This analysis suggests that the costs saved from preventing or delaying a small number of pregnancies in those aged under 18 creates significantly greater savings than those saved from STI prevention. For example, at RR = 1.22 savings from STIs are estimated to be less than £764,000 whereas pregnancy-related savings are estimated at over £11m (including government benefit savings), making the scheme cost-saving overall (saving over £10m). Even if benefit savings are excluded from the pregnancy cost analysis, savings of around £318,000 are estimated, shifting the ICER to around £12,000 for 13-24s.

Table 28: Probabilistic results obtained for multi-component (C-card) intervention in young people (13-24 years), effectiveness per Larsson et al. (20). Values (95% CI).

Cases per England population in target group	Young people, multi-component intervention					
	Chlamydia	Gonorrhoea	HIV	Syphilis	PID	Total
Conventional	64177 (30655, 85406)	6122 (2727, 8174)	27 (1, 84)	246 (53, 329)	7025 (1643, 13335)	77598 (37246, 103555)
Condom distribution	59904 (26664, 84816)	5744 (2290, 8129)	22 (1, 68)	232 (51, 328)	6572 (1330, 13128)	72474 (31937, 102719)
Incremental cases	-4272 (-10385, -361)	-378 (-931, -22)	-6 (-19, 0)	-14 (-38, 0)	-454 (-1432, -4)	-5123 (-12441, -439)
QALY gained	-8.43 (-20.5, -0.71)	-1.49 (-3.68, -0.09)	-34 (-119, -2)	-0.09 (-0.24, 0)	-11.34 (-35.81, -0.1)	55 (14, 136)
STI costs averted	-£520,867 (-£1,266,135, -£43,996)	-£77,950 (-£191,983, -£4,622)	-£568,408 (-£1,979,739, -£26,990)	-£2,943 (-£8,020, -£088)	-£1,417,171 (-£4,475,253, -£12,523)	-£2,587,340 (-£6,268,458, -£597,461)
Cost of CD scheme						£3,544,962
Incremental cost						£957,622 (-£2,723,496, £2,947,501)
ICER						£17,411
iNMB per person						£0.09 (-0.36, 0.83)

Figure 3: Cost-effectiveness plane for base-case analysis of a multi-component (C-card) intervention in young people (13-24 years), effectiveness per Larsson et al. (20).

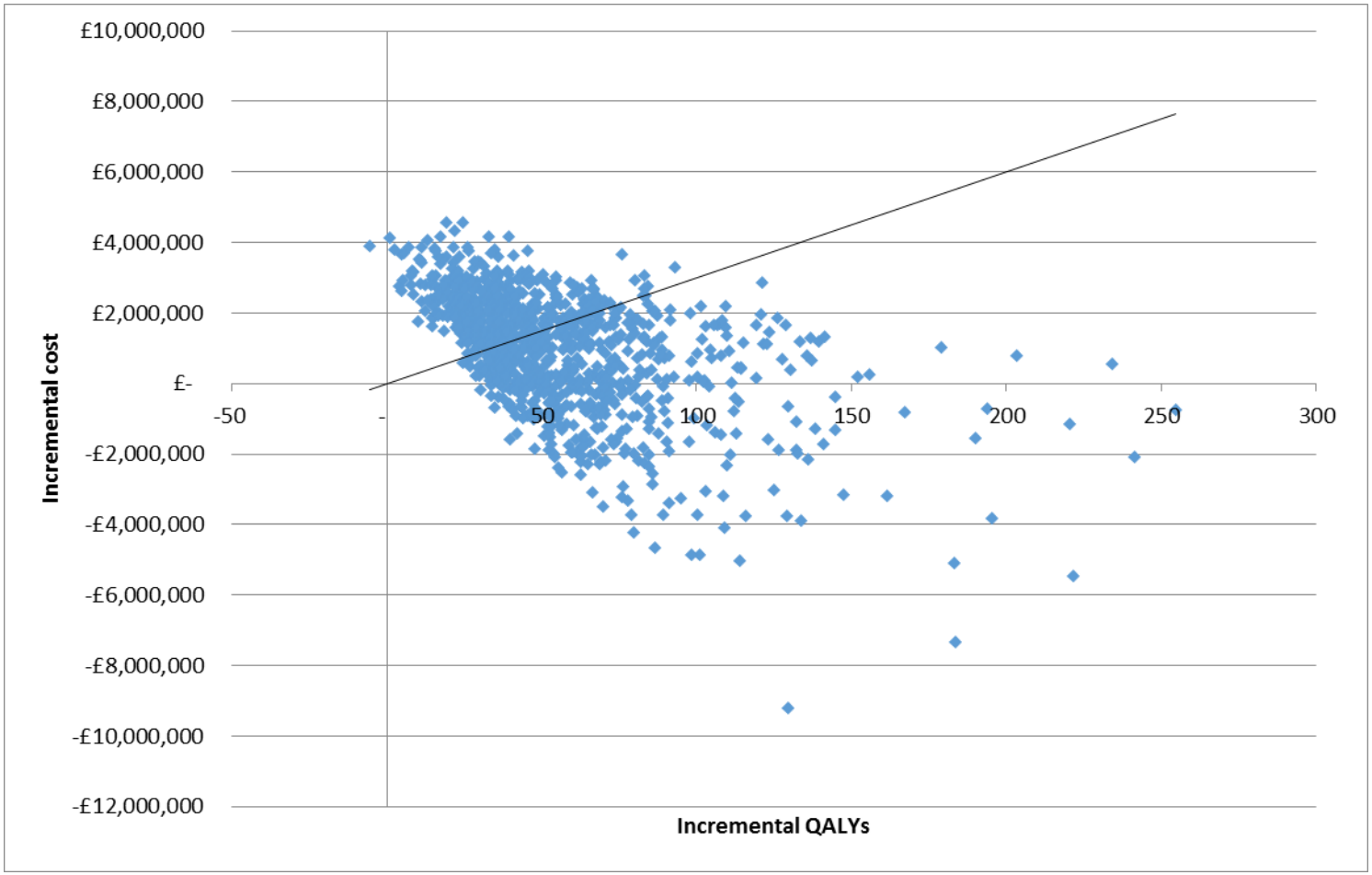


Table 29: Probabilistic results obtained for multi-component (C-card) intervention in young people (13-18 years), effectiveness per Larsson et al. (20). Values (95% CI).

Cases per England population of target age	**Young people, multi-component intervention**					
	Chlamydia	Gonorrhoea	HIV	Syphilis	PID	Total
Conventional	14453 (5686, 19936)	1121 (527, 1533)	7 (0, 21)	24 (10, 33)	1767 (344, 3433)	17372 (6727, 24116)
Condom distribution	13302 (4669, 19781)	1038 (415, 1527)	5 (0, 16)	22 (8, 33)	1632 (260, 3375)	15999 (5499, 23857)
Incremental cases	-1151 (-2857, -98)	-83 (-212, -6)	-2 (-6, 0)	-2 (-5, 0)	-135 (-426, -1)	-1373 (-3426, -117)
QALY gained	-2.27 (-5.64, -0.19)	-0.33 (-0.84, -0.02)	-11 (-39, 0)	-0.01 (-0.03, 0)	-3.38 (-10.64, -0.04)	17 (4, 44)
STI costs averted	-£140,346 (-£348,386, -£11,911)	-£17,170 (-£43,771, -£1,176)	-£178,792 (-£635,373, -£7,706)	-£363 (-£955, -£014)	-£422,276 (-£1,329,660, -£4,558)	-£758,947 (-£1,850,255, -£166,793)
Cost of CD scheme						£1,538,499
Incremental cost						£779,552 (-£311,756, £1,371,706)
ICER						£45,856
iNMB per person						-£0.09 (-0.42, 0.42)

Figure 4: Cost-effectiveness plane for scenario analysis of a multi-component (C-card) intervention in young people (13-18 years), effectiveness per Larsson et al. (20).

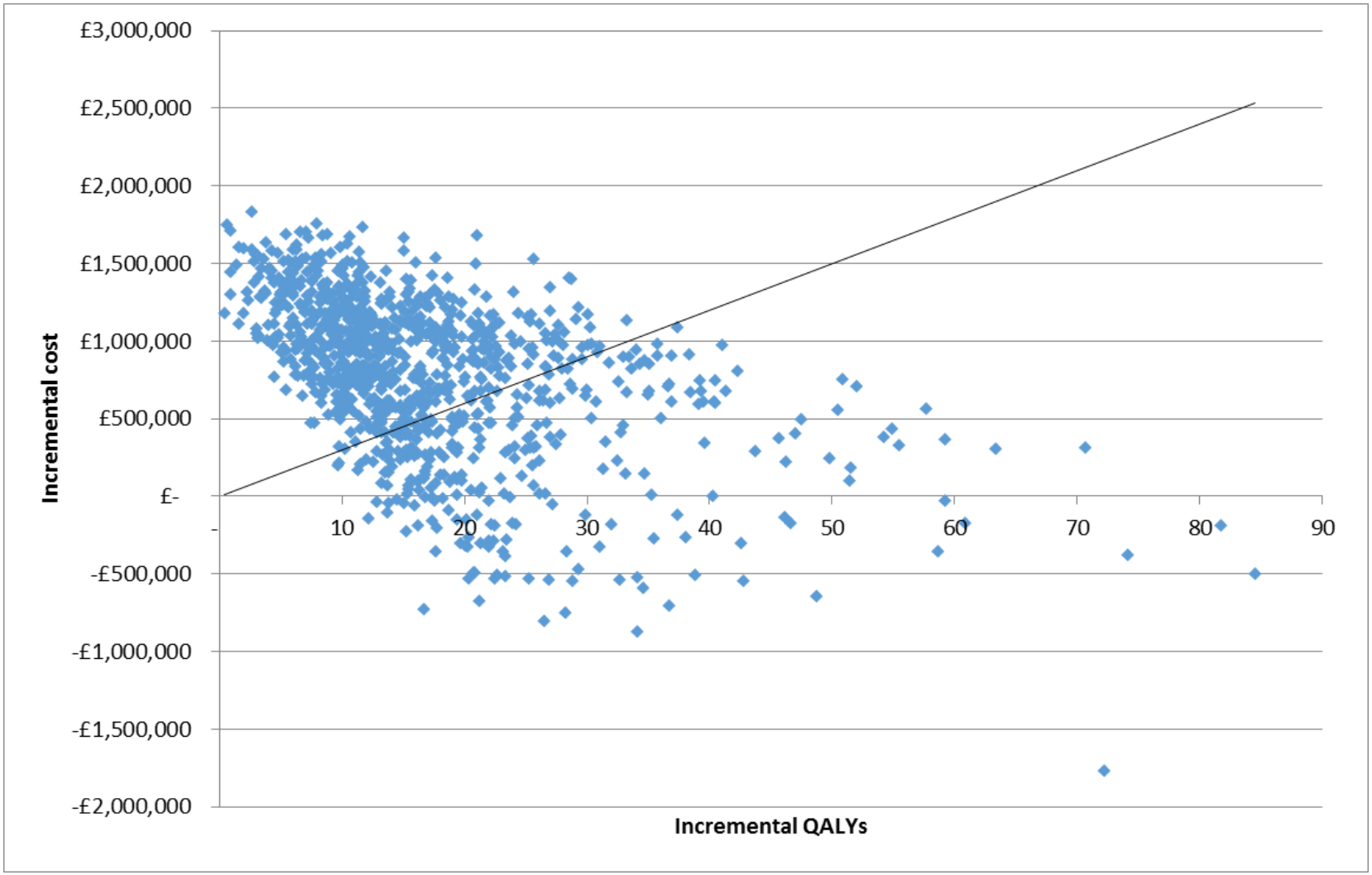


Table 30 Probabilistic results obtained for the young people C-Card model where condom breakage is assumed to improve. Values (95% CI)

Cases per England population in target group	**Larsson economic outcomes** **Young people, multi-component intervention**					
	Chlamydia	Gonorrhoea	HIV	Syphilis	PID	Total
Conventional	62436 (28798, 84086)	5971 (2601, 8076)	27 (1, 83)	241 (51, 327)	6839 (1459, 13123)	75514 (34522, 101875)
Condom distribution	57850 (24810, 83025)	5564 (2214, 8014)	21 (1, 67)	226 (48, 326)	6352 (1184, 12809)	70013 (29689, 101013)
Incremental cases	-4586 (-10751, -557)	-407 (-963, -38)	-5 (-19, 0)	-15 (-39, -1)	-487 (-1435, -8)	-5501 (-12926, -661)
QALY gained	-9.05 (-21.23, -1.1)	-1.61 (-3.8, -0.15)	-34 (-117, -1)	-0.09 (-0.24, 0)	-12.19 (-35.87, -0.19)	56 (14, 140)
STI costs averted	-£559,107	-£83,902	-£559,691	-£3,150	-£1,522,925	-£2,728,775
	(-£1,310,817, -£67,895)	(-£198,568, -£7,772)	(-£1,917,060, -£22,424)	(-£8,254, -£149)	(-£4,482,192, -£23,683)	(-£6,428,423, -£638,582)
Cost of CD scheme						£3,539,033
Incremental cost						£810,258 (-£2,889,390, £2,900,451)
ICER						£14,469
iNMB per person						£0.12 (-0.34, 0.85)

Table 31: Probabilistic results obtained for multi-component (C-card) intervention in young people (13-24 years) with higher HIV prevalence (=0.19% across all age groups in population), effectiveness per Larsson et al. (20). Values (95% CI).

Cases per England population of target age	**Young people, multi-component intervention**					
	Chlamydia	Gonorrhoea	HIV	Syphilis	PID	Total
Conventional	64063 (30077, 85437)	6129 (2697, 8169)	386 (19, 1217)	247 (53, 329)	6978 (1575, 13374)	77803 (36038, 104432)
Condom distribution	59809 (25838, 84873)	5753 (2289, 8131)	309 (15, 974)	233 (51, 328)	6524 (1262, 13224)	72629 (31047, 103456)
Incremental cases	-4254 (-10276, -381)	-376 (-925, -24)	-77 (-263, -3)	-14 (-38, 0)	-454 (-1450, -4)	-5174 (-12500, -572)
QALY gained	-8.4 (-20.29, -0.75)	-1.48 (-3.65, -0.1)	-475 (-1657, -18)	-0.09 (-0.24, 0)	-11.34 (-36.25, -0.09)	496 (40, 1688)
STI costs averted	-£518,701	-£77,428	-£7,938,701	-£2,891	-£1,416,928	-£9,954,650
	(-£1,252,842, -£46,421)	(-£190,623, -£5,010)	(-£27,113,377, -£294,774)	(-£7,961, -£093)	(-£4,529,500, -£11,011)	(-£29,089,132, -£1,719,544)
Cost of CD scheme						£3,541,896
Incremental cost						-£6,412,754 (-£25,547,236, £1,822,352)
ICER						Dominates
iNMB per person						£2.86 (-0.06, 10.12)

Table 32: Two way threshold analysis for the C-Card scheme in young people aged 13-24 years.

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	33,292,605	66,622,923	133,283,559	199,944,195	266,604,830	333,265,466	499,917,055	666,568,645	1,666,478,181	3,332,994,074	4,999,509,967
	1.020	128,939	295,591	628,895	962,199	1,295,502	1,628,806	2,462,066	3,295,325	8,294,882	16,627,478	24,960,073
	1.040	45,613	128,939	295,591	462,243	628,895	795,547	1,212,177	1,628,806	4,128,585	8,294,882	12,461,180
	1.060	17,838	73,389	184,490	295,591	406,692	517,794	795,547	1,073,300	2,739,819	5,517,351	8,294,882
	1.080	3,950	45,613	128,939	212,265	295,591	378,917	587,232	795,547	2,045,436	4,128,585	6,211,734
	1.100	Dominates	28,948	95,609	162,270	228,930	295,591	462,243	628,895	1,628,806	3,295,325	4,961,844
	1.120	Dominates	17,838	73,389	128,939	184,490	240,040	378,917	517,794	1,351,053	2,739,819	4,128,585
	1.140	Dominates	9,902	57,517	105,132	152,747	200,361	319,398	438,436	1,152,658	2,343,029	3,533,399
	1.160	Dominates	3,950	45,613	87,276	128,939	170,602	274,760	378,917	1,003,862	2,045,436	3,087,010
	1.180	Dominates	Dominates	36,355	73,389	110,422	147,456	240,040	332,625	888,131	1,813,975	2,739,819
	1.200	Dominates	Dominates	28,948	62,278	95,609	128,939	212,265	295,591	795,547	1,628,806	2,462,066
	1.220	Dominates	Dominates	22,888	53,188	83,489	113,789	189,540	265,291	719,796	1,477,305	2,234,813
	1.240	Dominates	Dominates	17,838	45,613	73,389	101,164	170,602	240,040	656,670	1,351,053	2,045,436
	1.260	Dominates	Dominates	13,565	39,204	64,842	90,481	154,578	218,675	603,256	1,244,225	1,885,194
	1.280	Dominates	Dominates	9,902	33,709	57,517	81,324	140,843	200,361	557,473	1,152,658	1,747,843
	1.300	Dominates	Dominates	6,728	28,948	51,168	73,389	128,939	184,490	517,794	1,073,300	1,628,806
	1.400	Dominates	Dominates	Dominates	12,283	28,948	45,613	87,276	128,939	378,917	795,547	1,212,177
	1.500	Dominates	Dominates	Dominates	2,284	15,616	28,948	62,278	95,609	295,591	628,895	962,199

Table 33: Analysis of pregnancy outcomes in the C-Card scheme in English young people aged 13-18 years.

	Incremental values			
Relative risk of condom use	No. of pregnancies avoided	No. of abortions avoided	Discounted cost savings associated with avoided pregnancies (excl. government-funded Benefits)	Discounted cost savings associated with avoided pregnancies (incl. government-funded Benefits)*
1	0	0	£0	£0
1.02	10	7	£28,874	£1,020,652
1.04	21	14	£58,052	£2,051,477
1.06	31	21	£86,430	£3,060,737
1.08	41	28	£115,594	£4,089,983
1.1	51	36	£145,218	£5,134,459
1.12	62	43	£172,736	£6,114,544
1.14	72	50	£202,818	£7,158,562
1.16	82	57	£230,929	£8,172,669
1.18	92	64	£259,808	£9,200,348
1.2	103	71	£289,337	£10,231,813
1.22	113	78	£317,908	£11,228,242
1.24	123	85	£347,550	£12,262,177
1.26	133	92	£374,582	£13,233,075
1.28	144	100	£402,719	£14,249,880
1.3	154	107	£433,241	£15,299,207
1.4	206	142	£577,722	£20,429,179
1.5	257	178	£724,414	£25,525,243

*Note that the costs associated with government-funded Benefits are based on a model of the system from 2010 and uplifted.

3.2 MSM scheme

There was no base case for this scheme, since there was no evidence for effectiveness from the one study in the review (38). Therefore, a range of scenarios were generated amongst the target population (MSM aged 17-90), with varying effectiveness (relative risk of condom use) and cost per person in the target population. The results are shown for lower, central and upper HIV prevalence estimates (respectively) in Table 34, Table 35 and Table 36.

In this sub-group the increased QALYs and savings from preventing HIV, if a scheme is effective, are much larger than the impacts from other STIs. The threshold analysis suggests that even schemes with relatively high costs per person can be cost effective if a small improvement in condom use can be achieved and demonstrated. For example, even at lower prevalence estimates, a scheme which gave a relative risk of condom use of 1.04 compared with baseline would be cost effective even at £10 per person in the target population (twenty times the cost suggested for a multi-component C-card scheme).

Table 34: Threshold analysis for MSM single component schemes: Lower HIV prevalence estimate()

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	164,881	343,058	695,875	1,067,622	1,426,396	1,797,072	2,668,920	3,548,726	9,029,812	18,169,377	27,114,332
	1.020	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	1,176	27,961	74,106	117,437
	1.040	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,609	27,770	50,936
	1.060	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	13,041	28,403
	1.080	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,637	16,704
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	1,131	9,990
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,702
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,504
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	104
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates

Table 35 Threshold analysis for MSM single component schemes: Central HIV prevalence estimate (5% overall)

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	1,284	18,841	54,429	90,376	124,823	161,886	248,028	342,455	880,937	1,741,197	2,655,130
	1.020	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.040	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.060	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.080	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates

Table 36 Threshold analysis for MSM single component schemes: Upper HIV prevalence estimate (9.1% overall)

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	Dominates	3,063	22,375	42,625	61,614	81,013	129,427	179,681	478,179	973,233	1,444,593
	1.020	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.040	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.060	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.080	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates

3.3 Black African scheme

There was no base case for this scheme, but a range of scenarios were generated amongst the target population (English black African population aged 18-90), with varying effectiveness (relative risk of condom use) and cost per person in the target population The results are shown for lower, central and upper HIV prevalence estimates (respectively) in Table 37, Table 38 and Table 39.

In this population the increase in QALYs are mainly from HIV prevention, although in terms of cost savings, HIV, PID and chlamydia prevention are all important. The threshold analysis suggests that due to the higher prevalence of HIV in this sub-group, schemes could be cost-saving, if effective, at relatively high cost. For example, even at the lower HIV prevalence level, a scheme with relative risk of condom use of 1.04 would be cost effective even at £10 per person.

Table 37 Threshold analysis for black African schemes: Lower HIV prevalence estimate

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	161,888	340,474	697,646	1,054,818	1,411,991	1,769,163	2,662,093	3,555,024	8,912,608	17,841,914	26,771,220
	1.020	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	1,160	27,948	72,595	117,241
	1.040	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,625	27,948	50,271
	1.060	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	13,066	27,948
	1.080	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,625	16,787
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	1,160	10,090
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,625
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,436
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	44
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates

Table 38 Threshold analysis for black African schemes: Central HIV prevalence estimate

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	133,342	283,376	583,442	883,509	1,183,575	1,483,642	2,233,808	2,983,974	7,484,971	14,986,634	22,488,296
	1.020	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	20,817	58,326	95,834
	1.040	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,063	20,817	39,572
	1.060	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	8,315	20,817
	1.080	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,063	11,440
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,814
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,063
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates

Table 39 Threshold analysis for black African schemes: Upper HIV prevalence estimate

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	110,702	238,089	492,863	747,637	1,002,411	1,257,186	1,894,121	2,531,056	6,352,668	12,722,021	19,091,374
	1.020	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	15,162	47,008	78,855
	1.040	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	15,162	31,085
	1.060	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	4,546	15,162
	1.080	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	7,200
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,423
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates

3.4 General population scheme

There was no base case for this scheme, since there was no outcome measure of condom use effectiveness from the one study in the review (47). Therefore, a range of scenarios were generated amongst the target population (English sexually active population aged 13-90), with varying effectiveness (relative risk of condom use) and cost per person in the target population The results are shown for lower, central and upper HIV prevalence estimates (respectively) in Table 40, Table 41 and Table 42.

In this broad population the increase in QALYs are mainly from HIV prevention, although in terms of cost savings, HIV, PID and chlamydia prevention are all important. The threshold analysis suggests that schemes need to balance cost and effectiveness to be cost effective. For example, at central HIV prevalence estimates, a scheme with relative risk of condom use of 1.1 would have to cost around £1 per person in the target population or less to be cost effective.

Table 40: Threshold analysis for CD schemes targeted at the general population: Lower HIV prevalence ()

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	45,093,004	90,238,248	180,529,379	270,743,869	362,149,160	447,053,070	675,823,225	897,766,652	2,270,674,332	4,480,802,760	6,755,301,498
	1.020	197,110	423,050	870,225	1,329,326	1,765,912	2,226,064	3,373,326	4,473,812	11,307,582	22,463,198	33,649,274
	1.040	84,102	197,371	420,865	649,413	870,874	1,104,938	1,667,907	2,234,500	5,620,262	11,094,479	16,830,213
	1.060	47,047	122,162	273,486	421,762	574,711	725,647	1,110,163	1,479,861	3,735,135	7,459,136	11,244,167
	1.080	28,912	84,315	197,386	311,623	423,399	533,802	811,254	1,094,492	2,779,229	5,574,725	8,351,710
	1.100	17,441	62,443	153,587	241,227	329,952	425,239	647,470	870,494	2,236,085	4,473,834	6,736,111
	1.120	9,762	47,656	123,390	195,365	273,906	348,235	537,798	720,084	1,844,342	3,716,577	5,604,552
	1.140	4,199	37,089	100,139	165,504	226,404	294,151	455,341	613,240	1,569,707	3,177,021	4,810,891
	1.160	827	28,903	85,521	140,912	198,046	252,327	396,028	536,258	1,375,460	2,773,066	4,141,676
	1.180	Dominates	22,900	72,649	120,802	172,939	221,141	349,708	466,266	1,220,012	2,493,551	3,705,671
	1.200	Dominates	17,235	62,347	106,951	151,624	197,328	309,046	425,100	1,092,768	2,231,365	3,348,660
	1.220	Dominates	13,274	54,799	95,736	134,364	179,286	279,860	383,846	990,487	2,021,898	3,020,338
	1.240	Dominates	10,063	48,076	84,521	123,741	159,065	252,665	348,633	908,226	1,836,383	2,767,651
	1.260	Dominates	7,009	41,514	75,958	110,447	144,242	232,385	314,356	833,412	1,692,525	2,564,649
	1.280	Dominates	4,451	37,033	68,500	101,152	132,572	212,874	294,825	774,247	1,570,416	2,368,399
	1.300	Dominates	2,333	31,976	62,342	91,467	122,861	197,127	274,054	723,949	1,465,745	2,229,114
	1.400	Dominates	Dominates	17,295	39,913	62,410	84,594	141,398	198,962	535,690	1,102,418	1,663,972
	1.500	Dominates	Dominates	8,200	26,529	44,860	62,664	108,465	151,959	423,252	872,662	1,324,922

Table 41 Threshold analysis for CD schemes targeted at the general population: Central HIV prevalence (0.19% overall)

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	3,715,468	7,409,609	14,754,927	22,129,498	29,617,109	37,246,043	56,298,477	73,638,607	185,243,726	371,713,406	561,551,635
	1.020	931	19,543	56,866	93,915	132,395	166,321	261,764	347,095	910,531	1,829,294	2,754,098
	1.040	Dominates	1,066	19,257	38,681	57,031	75,083	122,006	170,174	448,922	909,269	1,359,076
	1.060	Dominates	Dominates	7,204	19,062	32,219	44,080	76,309	105,849	291,688	595,369	915,564
	1.080	Dominates	Dominates	1,067	10,200	19,223	28,210	51,652	75,102	215,078	450,422	677,671
	1.100	Dominates	Dominates	Dominates	4,752	12,237	19,519	38,505	56,642	167,762	354,856	538,632
	1.120	Dominates	Dominates	Dominates	1,009	7,043	13,249	28,031	44,544	135,570	293,468	441,570
	1.140	Dominates	Dominates	Dominates	Dominates	3,616	8,802	22,290	34,881	114,464	246,281	378,549
	1.160	Dominates	Dominates	Dominates	Dominates	1,201	5,862	17,135	29,165	98,767	215,494	330,801
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	3,262	13,467	23,861	86,124	192,666	292,149
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	1,005	10,087	19,754	75,553	169,814	262,331
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	7,970	16,015	66,105	151,689	237,371
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,522	13,203	59,721	135,765	217,405
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	3,607	11,095	53,426	125,625	198,736
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,142	8,976	49,689	113,749	179,964
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	1,278	7,661	44,267	105,644	166,715
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	843	29,256	75,007	122,172
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	19,617	56,904	94,926

Table 42 Threshold analysis for CD schemes targeted at the general population: Upper HIV prevalence (0.4% overall)

		CDS per person in target population costs										
		£ 0.10	£ 0.20	£ 0.40	£ 0.60	£ 0.80	£ 1.00	£ 1.50	£ 2.00	£ 5.00	£ 10.00	£ 15.00
CDS effectivenss (Relative Risk)	1.0001	1,788,497	3,558,681	7,025,437	10,488,671	14,264,087	17,839,848	26,523,398	35,162,493	87,815,743	176,707,108	265,499,729
	1.020	Dominates	814	18,608	36,472	54,451	71,018	114,772	162,334	421,063	877,372	1,317,323
	1.040	Dominates	Dominates	658	9,237	18,587	27,238	50,713	72,202	206,271	424,261	649,786
	1.060	Dominates	Dominates	Dominates	820	6,566	12,334	27,549	42,058	131,150	278,252	423,941
	1.080	Dominates	Dominates	Dominates	Dominates	766	4,811	16,161	27,165	93,847	202,410	310,808
	1.100	Dominates	Dominates	Dominates	Dominates	Dominates	837	9,495	18,243	70,678	157,821	247,455
	1.120	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,031	12,673	57,363	131,108	205,127
	1.140	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	1,835	8,337	46,197	109,139	172,412
	1.160	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,074	38,730	93,926	150,613
	1.180	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	2,541	31,969	81,172	130,388
	1.200	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	769	27,037	71,368	115,259
	1.220	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	23,542	62,630	104,976
	1.240	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	19,882	57,151	93,599
	1.260	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	17,415	50,644	84,959
	1.280	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	14,425	46,091	77,372
	1.300	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	12,684	41,794	70,651
	1.400	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	5,088	27,595	49,478
	1.500	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	Dominates	580	18,389	35,875

4 DISCUSSION AND CONCLUSION

4.1 Discussion of results

Overall the economic evidence base for CD schemes identified in the review is poor, with a heavy reliance on studies undertaken in the USA with potentially little applicability to the UK population.

The results of the four models presented here suggest that HIV prevention is the primary driver of health benefits and cost savings from CD schemes, with important secondary effects arising through PID prevention in schemes which target both sexes, and chlamydia prevention. The analysis suggests that schemes that target higher risk populations are more likely to be cost effective at higher cost and lower effectiveness. For the general population, a CD scheme with a relative risk of 1.10 would need to cost less than 20p per person to be cost effective in a low prevalence HIV population, but would be cost effective at £2 per person in a high prevalence HIV population. CD schemes for MSM and black African populations are more cost effective because of the higher prevalence of HIV, and in MSM the higher risk of transmission through anal intercourse. In the case of teenagers the higher prevalence of chlamydia in this subgroup increases the cost effectiveness of CD schemes.

For young people, restricting the analysis to STI prevention outcomes only, and assuming effectiveness in line with the best quality available study, a typical C-Card scheme would be cost effective at the £30,000 per QALY level but not cost saving. However, taking into account the cost savings associated with preventing or delaying pregnancies in teenagers these schemes are expected to be highly cost effective (and cost-saving if government benefits are included in the analysis). C-Card schemes are also intended to have a range of other STI-related benefits which have not been explicitly considered here, such as linking young people up with sexual health services to improve screening rates and improve prevention and treatment later in life.

For MSM, although the evidence was that single-component schemes are not effective in changing condom-use behaviour, the threshold analysis suggested that schemes targeted at this high-risk group could be cost effective even if considerably more expensive than the C-Card multi-component scheme. NICE's evidence review did include one multi-component study targeted at high risk of HIV individuals (39) (not just MSM) which was effective at increasing reported condom use. Therefore, in this group it is possible that more effective, if costlier, multi-component schemes could be the most cost effective.

For black Africans, threshold analysis suggested that CD schemes targeting this high risk population could be cost effective even at relatively high costs.

For the general population, threshold analysis suggested that CD schemes could be cost effective if they could be delivered at a relatively low cost, and have some effect. Outlet schemes that provide condoms at a reduced cost could be an example of such a scheme.

4.2 Limitations and further research

The economic impact of CD schemes was based on very limited effectiveness evidence, with a high degree of variability in CD scheme designs, costs and effects being suggested.

There were a number of limitations to the model and results presented here which should be borne in mind. In particular, because of the sensitive nature of the topic and the challenges around conducting research in this area, obtaining robust, recent evidence for many of the model parameters was difficult. For example, condom usage data were the same for young people as the general population, but could be quite different in reality.

For the C-card model, evidence was taken from a Swedish, school-based study. Although the study was of high quality, the intervention is not an exact match for the C-Card scheme, which is delivered quite differently, through a range of sites, and with a broader group of young people. This study also reported outcomes for reported 'ever condom used' versus 'never used' which could be over-estimating the level of effectiveness for regular condom use. In addition, C-Card costs were shown to be quite variable between areas, reflecting the differences in the way these schemes are delivered. The variability around typical scheme costs was reflected in the model through PSA, however, there do appear to be a number of schemes running at much higher costs, which could be much less cost effective. It was not clear why these schemes are more expensive, although all schemes incur different types of costs – for example, the bottom up costs we used for validation did not include any payments to outlets (e.g. pharmacies) for being part of the scheme. However, we did come across evidence of schemes that are paying retainers and fees to pharmacies in order to include them in the scheme.

Although the costs and health impacts of PID were included, it is known that repeated episodes of PID can increase the risk of infertility in women. The effects, either in terms of costs or quality of life were not considered in the model, but should be considered as wider benefits of PID prevention.

For the MSM model, HIV costs dominated the results. However, it should be noted that the costs were only available use present costs discounted at 3.0% (compared to NICE's recommendation of 3.5%) which could lead to slight overestimates in the HIV cost estimates.

Finally, the model itself simplifies the process of disease transmission. It assumes that every act of sexual intercourse is exposing a person to an STI, which may lead to an overestimate in the total number of STI cases, since in individual in a monogamous relationship with someone who does not have an STI is not at risk of transmission, even if they have unprotected sex. The model further assumes that there is no relationship between sexual activity level and STI prevalence level for a given person – the impact of this on STI transmission is unclear.

Using a static model assumes that over the model time horizon, at each act of sexual intercourse, there is a constant proportion of the population with each STI. In reality, for STIs from which people recover, if the recovery period is shorter (longer) than the average duration between acts of sexual intercourse, it is possible that the model overestimates (underestimates) the increase in STI prevalence. For STIs from which people do not recover (such as HIV), there will be an increased proportion of the population with the STI after each act of sexual intercourse. The model therefore likely underestimates the increase in HIV prevalence. This underestimate is more pronounced where sexual activity levels and HIV prevalence is higher.

In order to understand the economics of CD schemes in the UK it is imperative to have evaluations that demonstrate the impact of these schemes on behaviour change and condom usage in UK-relevant populations.

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Appendix A. C-card costings

To cost the C-card scheme a rapid search identified a small number of published documents from local schemes in England and Wales, of which 5 provided overall costs of their schemes: Derbyshire (5), Lincolnshire (3), Nottinghamshire (2), Newcastle and North Tyneside (2, 4) and Lambeth (36).
Four of the documents gave annual costs, either for a single year (Derbyshire, Newcastle and Lambeth) or for multiple years (6 years, Nottinghamshire). For Lincolnshire, the cost per annum of new registrants was provided, and combined with the stated number of new registrants, annual total scheme costs were calculated. Stated annual costs were inflated to 2015 prices using the CPI inflation index, and converted to cost per person in the target population (young people aged 13-24) using local authority, age-specific Census data from 2011.
When compared to ONS census 2011 published population statistics for the numbers of teenagers aged 13-24 in each area (37), four of the five schemes gave costs between £0.33 and £0.68 per head of teenage population per annum, with Lambeth having higher costs of £1.21 per head of teenage population.

Area	Target Population (people aged 13 to 24, Census 2011)	New registrations per annum	Cost per new registrant	Total scheme cost	Cost year	2015 Total scheme cost	Cost per person in target pop	Source
Lincolnshire	102,260	2,571*	£15.08*	£38,766	2010	£43,843	£0.43	Lincolnshire County Council Children's Services in Partnership with NHS Lincolnshire, 2010
Nottinghamshire	111,444	3,277*	N/A	£33,413*	2010	£37,789	£0.34	Jablonskas S., 2010
Derbyshire	106,846	N/A	N/A	£71,000*	2013	£72,609	£0.68	Varley E., 2014
Newcastle & North Tyneside	91,400	4,344*	N/A	£30,000*	2000	£41,433	£0.45	Newcastle & North Tyneside Health Promotion Department, 2000.
Lambeth	46,622	N/A	N/A	£56,000*	2014	£56,170	£1.20	Lambeth Southwark and Lewisham, 2014.
All costs are per annum *published value (others are calculated)								