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# National Chlamydia Screening Programme
# External Peer Review: evidence pack

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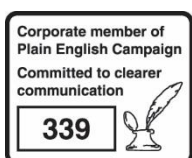
# Executive summary

The scientific evidence around chlamydia and its control has evolved significantly since the 1998 CMO Expert Advisory Group was called almost 20 years ago. At that time sexual health capacity was unable to deal with the significant need of the population and high rates of STIs, including chlamydia, were being found in sexually active young people. Testing methods have evolved significantly as novel nucleic acid amplification tests have been created and as such the costs per test have fallen along with the cost of treatment. Online service models have enabled services to provide high volume testing at much reduced cost. Compared with 1998 a much wider range of people to access services than was previously possible and testing has become widely practiced in the under 25s age group. Each year almost 1 in 3 sexually active young women access a chlamydia test.

Simultaneously evaluation of screening in various countries, and additional scientific studies has better clarified our understanding of the harms caused by chlamydia and the impact of testing and treatment. Since the original CMO Expert Advisory Group made its recommendations there have been a host of studies which have looked at specific aspects of chlamydia, its association with serious sequelae and the effects of screening on prevalence of chlamydia in the population. We include a summary of the current evidence in this pack. Specific aspects of the pack have been externally reviewed by national and international experts to ensure that what we publish is both comprehensive in scope and fair in its interpretation.

In addition, PHE has undertaken evaluation of the NCSP in order to understand the impact of the current chlamydia screening programme. Our findings from this programme of evaluation are also included in this evidence pack alongside our understanding of how the programme is being deployed and supported. We hope that by including this information the learning from the existing programme can inform planning for future chlamydia control activities.

There is consistent evidence that chlamydia leads to significant health harms including Pelvic Inflammatory Disease (PID), Ectopic Pregnancy (EP) and Tubal Factor Infertility and the infection is common in the population. Testing can accurately identify infection and treatment can effectively reduce a woman's risk of developing sequelae.

There is an absence of evidence that chlamydia screening has impacted population prevalence. However there are considerable challenges in measuring such a change.

The National Chlamydia Screening Programme has resulted in a significant increase in STI testing capacity in England. Screening was originally delivered through dedicated screening services but in recent years screening has been integrated into existing sexual and reproductive health services.

The service has supported the uptake of novel technologies and service delivery models. Present NCSP guidance aims to help commissioners focus on quality of the service this is supported by the data collected by PHE as part of the NCSP monitoring and quality assurance.

Monitoring chlamydia screening delivery has changed to a simpler and more comprehensive system which enables local commissioners to understand where and how chlamydia screening is being delivered. Testing is higher in women, approximately 1 in 3 women aged 15-24 have tested for chlamydia in the past year. In addition testing is higher in the more deprived.

Evaluating the impact of the NCSP has proved difficult as no simple accurate measures exist to monitor changes in chlamydia prevalence or sequelae. Monitoring the frequency of diagnosed PID and EP has not provided clear evidence of an impact of chlamydia screening on these disease outcomes in England to date. The NCSP is currently exploring the potential for chlamydia serology to be used to generate accurate affordable methods for monitoring both prevalence and trends in sequelae.

While our estimates of the costs and utilities used in chlamydia screening cost effectiveness studies have remained largely the same over time. However our estimates of progression rates have changed while simultaneously the validity of dynamic models, which estimate transmission interruption, has been questioned. This has reduced our confidence in prior cost effectiveness analyses.

Stakeholder reviews have suggested that the national programme has value in engaging young people and improving their knowledge and testing, but weaknesses exist which need to be addressed both nationally and locally.

# Acknowledgements

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# Glossary

| | |
|---|---|
| 95% Confidence interval | A group of continuous or discrete adjacent values that is used to estimate a statistical parameter (such as a mean or variance) and that tends to include the true value of the parameter a predetermined proportion of the time if the process of finding the group of values is repeated a number of times |
| Caldicott principles | Principles outlined in the 1997 Caldicott Report providing guidance to avoid undermining patient confidentiality |
| Commissioning | The process used by health services and local authorities to: identify the need for local services; assess this need against the services and resources available from public, private and voluntary organisations; decide priorities; and set up contracts and service agreements to buy services. As part of the commissioning process, services are regularly evaluated. |
| Cost-effectiveness analysis | An analysis that assesses the cost of achieving a benefit by different means. The benefits are expressed in non-monetary terms related to health, such as symptom-free days, heart attacks avoided, deaths avoided or life years gained (that is, the number of years by which life is extended as a result of the intervention). Options are often compared on the cost incurred to achieve 1 outcome (for example, cost per death avoided). |
| Coverage | The number of chlamydia tests divided by the population (expressed as a percentage of a given age group) |
| Deprived area | An area which is lacking in material benefits considered to be basic necessities in a society |
| Detection rate | The number of chlamydia diagnoses per head of the 15 to 24 year-old population |
| Disutility estimate | The degree to which a commodity or activity fails to satisfy human wants |
| Educational attainment | The highest level of education an individual has successfully completed. |

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| Full STI screen | For most asymptomatic population, this would entail testing for chlamydia, gonorrhoea, syphilis and HIV. MSM could also expect to be tested for HBV. |
| Future costs discount rate | A discount rate applied to costs to account for time preference |
| Health and Social Care Act | Act of the Parliament of the United Kingdom, which provided for extensive reorganisation of the National Health Service in England, removing responsibility for the health of citizens from the Secretary of State for Health. Health care funds were transferred from primary care trusts to clinical commissioning groups |
| Incidence | The number of new cases of a disease among a certain group of people during a specific period of time. It is different from prevalence. |
| Incremental cost-effectiveness | Ratio of the difference in costs between 2 alternative programmes to the difference in effectiveness between the same 2 interventions ratios |
| Occupational class | Within the context of the classification, jobs are classified in terms of their skill level and skill content. |
| Online testing | A service provision which allows for young people to request a chlamydia testing kit online |
| Opportunistic screening | Screening offered to people who are consulting health services for another reason. Includes outreach screening, where people who are being offered health promotion in non-health care settings are offered screening. |
| Prevalence | How common a disease or condition is within a population, either at a point in time or over a given period of time (it includes new and existing cases). It is different from incidence. |
| Quality-adjusted life years (QALY) | A measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. 1 QALY is equal to 1 year of life in perfect health.

QALYs are calculated by estimating the years of life remaining for a patient following a particular treatment or intervention and weighting each year with a quality-of-life |

score (on a 0 to 1 scale). It is often measured in terms of the person's ability to carry out the activities of daily life, and freedom from pain and mental disturbance.

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| Register-based screening | Screening offered systematically via active invitation of the eligible population in a given age/demographic group. |
| Self-sampling | The process by which a person collects a specimen which is then sent to a laboratory for testing; the sampling may be performed in a healthcare setting or at home |
| 'Shire county' | County-level entity in England which is not a metropolitan county, typically with a population between 300,000 to 1.4 million |
| Testing service type | In the CTAD surveillance system, tests are coded as either; GUM; community sexual health service (CSHS); General Practice (GP); Pharmacy; termination of pregnancy (ToP); Internet (new category) or Other. Tests requested through a texting or postal system should be included in the Internet category. |
| White paper | Policy document produced by the Government that sets out their proposals for future legislation. |

# List of acronyms

| | |
|---|---|
| 95% CI | 95% confidence interval |
| BASHH | British Association for Sexual Health and HIV |
| BHIVA | British HIV Association |
| CASH | contraception and sexual health |
| CBO | community-based organisation |
| CCG | clinical commissioning group |
| CCP | Chlamydia care pathway |
| CDC | US Centers for Disease Control and Prevention |
| CEA | cost effectiveness analysis |
| CMO | Chief Medical Officer |
| CPP | chronic pelvic pain |
| CPRD | Clinical Practice Research Datalink |
| CSO | chlamydia screening office |
| CTAD | Chlamydia Testing Activity Dataset |
| DALY | disability-adjusted life years |
| DBS | Demographic Batch Tracing Service |
| DH | Department of Health |
| CDC | US Centers for Disease Control and Prevention |
| DRI | detection rate indication |
| ECDC | European Centre for Disease Prevention and Control |
| EHC | emergency hormonal contraceptive |
| ELISA | enzyme-linked immunosorbent assay |
| EO | epididymo-orchitis |
| EP | ectopic pregnancy |
| FES | field epidemiology services |
| FSRH | Faculty for Sexual Reproductive Health |
| GP | general practitioner |
| GUM | genitourinary medicine |
| GUMCAD | Genitourinary Medicine Clinical Activity Dataset |
| HES | hospital episode statistics |
| HIV | human immunodeficiency virus |
| HPA | Health Protection Agency |
| HPRU | Health Protection Research Unit |
| HSE | Health Survey for England |
| HSWP | HIV and STI web portal |
| HTA | Health Technology Assessment |
| HQIP | Healthcare Quality Improvement Partnership |
| ICER | incremental cost-effectiveness ratio |
| JSNA | Joint Strategic Needs assessment |

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|---|---|
| LA | local authority |
| LASER | Local authority sexual health, reproductive health and HIV epidemiology report |
| LGA | local government association |
| LGV | lymphogranuloma venereum |
| LSOA | lower layer super output area |
| MPES | multiparameter evidence synthesis |
| MSM | men who have sex with men |
| NAAT | nucleic acid amplification test |
| NAO | National Audit Office |
| Natsal | National survey of sexual attitudes and lifestyles |
| NCSP | National Chlamydia Screening Programme |
| NG | *Neisseria gonorrhoeae* |
| NGO | non-governmental organisation |
| NHS | National Health Service |
| NIHR | National Institute for Health Research |
| NNNG | non-NCSP, non-GUM |
| ODS code | Organisational Data Service code |
| ONS | Office for National Statistics |
| PCT | primary care trust |
| PEF | population excess fraction |
| PHE | Public Health England |
| PHOF | Public Health Outcomes Framework |
| PID | pelvic inflammatory disease |
| PII | patient identifiable information |
| PN | partner notification |
| POCT | point of care test(ing) |
| QALY | quality-adjusted life years |
| $R_0$ | basic reproduction number |
| RCT | randomised control trial |
| RUC | rural-urban classification |
| SCCI | Standardisation Committee for Care Information, previously Information Standards Board |
| SEU | Seroepidemiology Unit |
| SGSS | second generation surveillance system |
| SHF | sexual health facilitator |
| SHS | sexual health services |
| SRH | sexual and reproductive health |
| STI | sexually transmitted infection |
| TFI | tubal factor infertility |
| ToP | termination of pregnancy |
| UTLA | upper tier local authority |

# 1 Introduction

The National Chlamydia Screening Programme in England is an opportunistic screening programme targeting sexually active young people. NCSP policy is to offer testing for chlamydia infection to young men and women under 25 years of age[1] in a variety of appropriate clinical and non-clinical settings and then to provide rapid treatment and partner notification as well as retesting 3 months after an individual is found to be infected. It aims to both reduce the harms to those infected with chlamydia and to prevent onward transmission thereby reducing prevalence in the population.

Like all public health programmes, the delivery of the programme and the ongoing scientific research outside of the programme result in new understanding of the problem of chlamydia infection and how best to address it. This new information is rarely in the form of a seminal discovery which provides indisputable clarity on how to proceed. Usually it is accumulated with the slow and incremental steps which are the nature of good scientific research. As such it is essential for public health programmes such as the NCSP to regularly stop and take stock of developments which have occurred and to review what has been learned. It is also important that these are independently reviewed to ensure that stakeholders can be confident the recommendations are based on best evidence alone.

This evidence pack is intended to provide a resource to enable critical review of the NCSP's design and delivery by the External Peer Review Group. Herein we provide the evidence underpinning the programme's aims as well as an in-depth description of the programme, along with issues which the NCSP team sees on the horizon and recommendations from the NCSP team on specific items for the EPRG to consider.

The pack is a consolidation of the evidence as collated by the HIV/STI department and incorporates existing evidence in the peer reviewed literature, summaries of Public Health England's (PHE) activities undertaken to support and evaluate the chlamydia screening programme as it is delivered in England, and interviews with stakeholders of the programme. It provides a comprehensive look at the peer reviewed science and the knowledge and experience of experts in the topic area. In addition to the written document there are summary reviews of specific sections of the content by international and national experts on the epidemiology of chlamydia, its control and delivery of services in the English sexual health economy.

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[1] Various guidance documents use 'under 25 years' and '15-24 years' interchangeably. This policy has not be explicitly set out in early documents describing the NCSP however all measures of screening activity have used the 15-24 age group as a denominator. As such this document, when referring to "under 25" only includes those 15-24 years of age.

Much of what has been reviewed are systematic reviews, meta-analyses and written summaries. Much of this has effectively summarised the available evidence. Where we feel that we cannot add anything by summarising further we have directly extracted from these documents and the text is highlighted in grey.

Section 1 describes what we know, including the natural history of chlamydial infection, the background of the NCSP and the role of PHE.

Section 2 describes the current picture and what we've learnt, presenting the relevant surveillance systems, surveillance outputs, available data about the impact of the NCSP, and current evidence relating to the health economics. We also present stakeholder feedback.

# 2 *Chlamydia trachomatis*

This section describes the public health issues presented by genital infection with Chlamydia trachomatis and sets out the evidence underpinning the concept of chlamydia screening. This section draws on published key sources that we consider to be the highest quality and/or the most up-to-date and therefore the best evidence base for the purpose of this review:

- HTA Multiparameter Evidence Synthesis Report (Price et al. 2016)
- CDC JID Supplement (Gottlieb et al. 2010)
- ECDC Reports (European Centre for Disease Prevention and Control 2014, European Centre for Disease Prevention and Control 2014)
- Cochrane Review (Low et al. 2016)

Extracts adapted or abridged from these sources are shaded.

## 2.1   What is chlamydia?

*Chlamydia trachomatis* is a bacterium, belonging to the genus *Chlamydia*. Serotypes A-C cause ocular infections (trachoma); L1, L2, L3 and L2b are responsible for lymphogranuloma venereum (LGV) and serotypes D to K cause urogenital tract infections (Schachter 1999), which are the focus of this evidence pack. Genital infection with *C. trachomatis (*also termed 'chlamydia') is the most commonly diagnosed STI in the UK and elsewhere.(European Centre for Disease Prevention and Control 2014, Public Health England 2014) Pharyngeal and rectal infection with *C. trachomatis* can also occur, although these are not the focus of NCSP screening activities.

Untreated chlamydia can persist for several months or years, (Morre et al. 2002) and can cause a range of complications (Section 2.3). The acute symptoms of chlamydia infection include pain and abnormal discharge,(British Association of Sexual Health and HIV 2006) but a large proportion of people chlamydia remain asymptomatic.(Stamm 1999, Low et al. 2007, Simms et al. 2009)

Highly sensitive and specific nucleic acid amplification tests (NAATs) that detect the presence of *C. trachomatis* are available in most diagnostic laboratories in England, and can be performed on non-invasive samples (urine in men, self-taken vulvovaginal swabs or urine for women).(British Association of Sexual Health and HIV 2006)

Testing for infection with chlamydia can therefore be offered in a range of clinical and non-clinical settings. Once detected, chlamydia is easily and effectively treated with antibiotics.(British Association of Sexual Health and HIV 2006) BASHH guidelines recommend doxycycline or azithromycin for treatment of uncomplicated urogenital and pharyngeal infections and doxycycline for rectal infections.(Nwokolo et al. 2016)

A single dose (1g) of azithromycin or 7 days of doxycycline have been found to be equally efficacious for treatment of uncomplicated genital infections, with cures rates of 97% and 98%, respectively.(Lau et al. 2002) A meta-analysis of randomised control trials found a statistically significant increased benefit of doxycycline over azithromycin, but few studies were double-blind, placebo-controlled trials.(Kong et al. 2014) Azithromycin has been shown to be less effective than doxycycline in treatment of rectal chlamydia, though evidence is considered to be of poor quality.(Kong et al. 2015) To date, there are no RCTs comparing the efficacy of azithromycin and doxycycline for the treatment of pharyngeal infection.

The prevalence of chlamydia is highest among young adults. The third National Survey of Sexual Attitudes and Lifestyles (Natsal-3, carried out in 2010-2012), estimated the prevalence of *C. trachomatis* (as detected in urine) in sexually-active 16 to 44 year olds in Britain to be 1.5% (95% confidence interval [CI] 1.1%-2.0%) among women and 1.1% (95%CI 0.7%-1.6%) among men; prevalence among 16 to 24 year-olds was 3.1% (95%CI 2.2%-4.3%) in women and 2.3% (95%CI 1.5%-3.4%) in men.(Sonnenberg et al. 2013)

The immune system produces local and systemic antibodies against *C. trachomatis* and these can be detected in those with a current or previous chlamydia infection.(Persson 2002, van den Broek et al. 2014) The presence of anti-*C. trachomatis* antibodies may be useful as a proxy for measuring the population prevalence of chlamydia, and may also be used to understand the risk of complications following infection.

## 2.2   Pathogenesis of infection

While the relationship between chlamydia and poor reproductive outcomes is confidently demonstrated through epidemiological studies,(European Centre for Disease Prevention and Control 2014) the specific mechanism by which this occurs is not explicitly understood. Only a minority of women infected with *C. trachomatis* will go on to develop salpingitis and subsequent tubal dysfunction meaning that there are likely important host and organism factors which contribute to the risk of serious sequelae.

The initial response to, and clearance of, infection follows a predictable pathway. Innate immune responses are activated leading to neutrophil recruitment and eventual T cell recruitment leading to resolution of infection (Figure 2.1).(Darville et al. 2010) However there are 2 theoretical mechanisms for the development of scar tissue in the fallopian epithelium. These are defined as the "cellular paradigm" and the "immunological paradigm"; in truth, both may occur and both may be in part or wholly responsible for the presence of sequelae.

The cellular model purports that the damage to epithelial tissue comes from the innate immune responses to infection which are driven by the infected host epithelial cells which propagate inflammatory responses by recruiting further leukocytes. These clear the infection and instigate tissue remodelling and scarring through epithelial cell proliferation and release of proteases.(Stephens 2003, Darville et al. 2010)
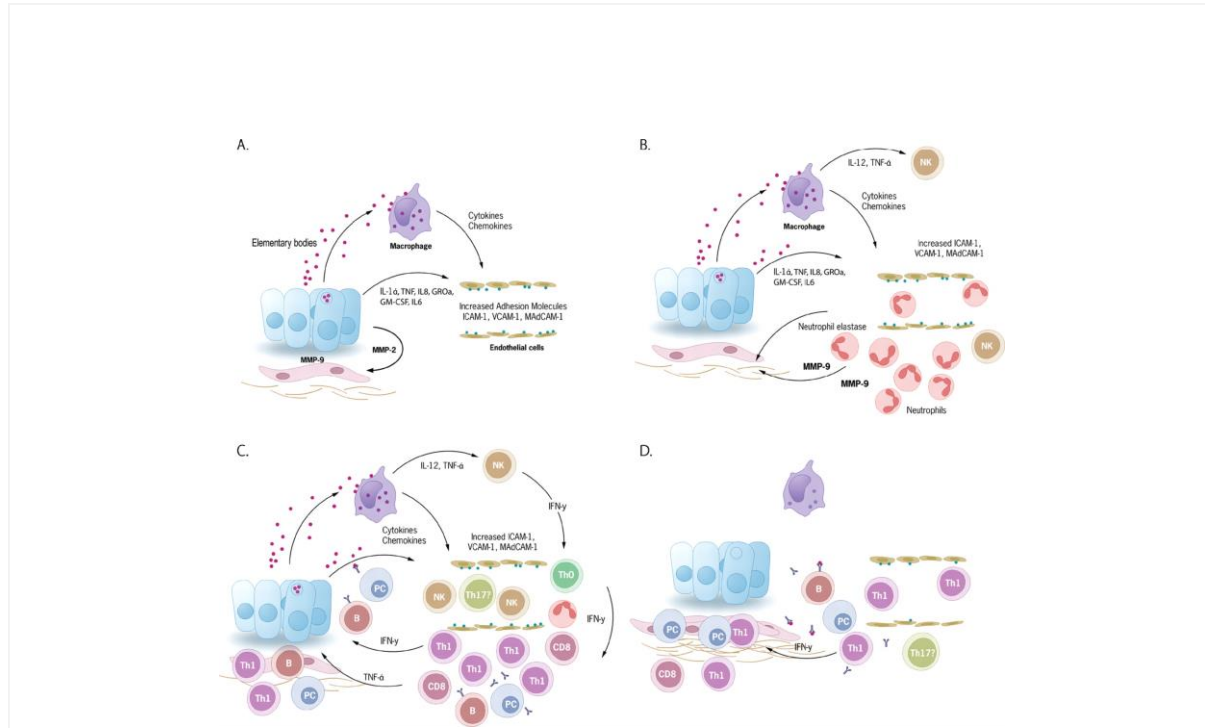
From: Pathogenesis of Genital Tract Disease Due to Chlamydia trachomatis
J Infect Dis. 2010;201(Supplement_2):S114-S125. doi:10.1086/652397
J Infect Dis | © 2010 by the Infectious Diseases Society of America

Figure 2.1 Pathogenesis of Genital Tract Disease Due to Chlamydia trachomatis (Darville et al. 2010)

(Low et al. 2011)Under the immunological paradigm, initial infection results in an adaptive immune response which clears the infection, leading to inflammatory responses which cause damage. These responses are also triggered by future exposures that will result in increased T cell responses and concomitant increases in tissue destruction.(Brunham et al. 1994)

The key difference between these 2 models is what they suggest for control measures. If the cellular paradigm is the dominant mechanism by which damage occurs then it is essential for a programme to reduce the total exposure time to chlamydia by reducing duration of infection. Under this paradigm, exposure itself is harmful from the start and given the relatively long period of infection, ongoing infection may lead to severe damage within the first infection event. However, if the immunological paradigm is dominant then damage occurs later in the first infection and any repeat infections are likely to have much greater impact on the woman's risk of sequelae. In this instance the priority would be to prevent re-infection through aggressive partner notification and retesting of positives.

The CDC convened an expert advisory meeting which concluded that:
The most conclusive pathogenesis data to date reveal that actively infected non-immune host cells are the driving force in the inflammatory response to chlamydia. In vitro and mouse data indicate that infected host epithelial cells not only drive influx of inflammatory cells, but also release tissue-damaging molecules directly. Mouse and in vitro data implicate neutrophils and

proteinases released from activated neutrophils in tissue pathogenesis and indicate an important role for chlamydia- induced activation of TLR2 in initiation of these responses. However, continued release of chemokines from infected host cells drives recruitment of not only innate neutrophils and monocytes, but also adaptive T cells and B cells.(Darville et al. 2010)

## 2.3   Sequelae and natural history of infection

Although largely asymptomatic, chlamydia presents a serious public health problem, as genital infection with *C. trachomatis* can cause several severe complications (Stamm 1999) which are associated with losses of quality of life and incur substantial healthcare costs.(Adams et al. 2007, Roberts et al. 2007, Aghaizu et al. 2011) Chlamydial infection can also cause sequelae in men, as well as lead to complication in neonates if the infection is vertically transferred from mother to infant during birth.

Chlamydia may also increase the risk of disease arising from other sexually transmitted pathogens, through facilitation of human immunodeficiency virus (HIV) transmission (Johnson et al. 2008) and potentially increasing the persistence of high-risk human papillomavirus (HPV),(Shew et al. 2013, Silva et al. 2013), although these risks have not been quantified and used substantially in the case for screening.

In women, infection with *C. trachomatis* can ascend the genital and reproductive tract and lead to pelvic inflammatory disease (PID). The clinical syndrome of PID is defined here as a spectrum of clinical disorders involving inflammation of the upper reproductive tract. This includes inflammation of the uterus, fallopian tubes (salpingitis), ovaries, or adjacent peritoneum. PID increases the risk of further sequelae such as ectopic pregnancy (EP) and infertility, specifically tubal factor infertility (TFI).

A systematic review by the European Centre for Disease Prevention and Control summarised: The progression of genital chlamydial disease can be conceptualised as a process with a 'two-phase temporal lag' (Cates et al. 1990), first from chlamydia to PID and then from PID to reproductive complications or chronic pelvic pain. Infection and pathological processes in fallopian tube cells are assumed to be necessary for progression to infertility and EP.(Darville et al. 2010) PID is the clinical syndrome that results from a vaginal or endocervical infection that ascends through the cervical canal to the endometrium, fallopian tubes and contiguous structures and usually presents with lower abdominal pain.(Hager et al. 1983, Workowski et al. 2010) PID can resolve spontaneously or after treatment without any pathological consequences. Inflammatory processes in the pelvic organs can, however, cause scarring and fibrosis, which result in further reproductive tract sequelae. Tubal damage can result in infertility, subfertility or ectopic implantation if pregnancy occurs.

At the time of the 1998 Chief Medical Officer (CMO) Expert Advisory Group's review of the evidence for a chlamydia screening programme,(Chief Medical Officer's Expert Advisory

Group 1998) the scientific consensus was that PID was strongly associated with chlamydia and that high rates of PID resulted from chlamydia. The evidence reviewed suggested that up to 30% of patients with chlamydia would develop salpingitis.(Stamm et al. 1984) However, a range of progression rates in observational studies have been reported,(Boeke et al. 2005), and the majority of evidence aligns with a rate lower than 30%. Evidence for the relationship between PID and chlamydia has been strengthened by the addition of data from RCTs showing a reduction in the incidence of PID when asymptomatic chlamydia is identified and treated.(European Centre for Disease Prevention and Control 2014) Both this review, as well as the more recent Cochrane Review on the effectiveness of screening for chlamydial infection found that the quality of evidence supporting chlamydia screening to reduce PID was of moderate quality.(Low et al. 2016)

Alongside this, further work in the field of chlamydia vaccine development has improved the understanding of the pathogenesis of PID due to chlamydia.(Darville et al. 2010) PID can resolve without any damage caused to the reproductive tract.(European Centre for Disease Prevention and Control 2014) However, PID can lead to scarring and fibrosis in the pelvic organs, which can in turn lead to serious long-term reproductive consequences including TFI and EP.(Robertson et al. 1987, Brunham et al. 1988, Chow et al. 1990, Westrom et al. 1992, Stamm 1999, Ness et al. 2008) The scarring and fibrosis of pelvic organs occur as a result of the immunological processes involved in response to chlamydia infection as described in 2.2.(Darville et al. 2010)

A detailed discussion of PID, natural history and the varying definitions is included in the appendix.

Different definitions of PID have been used in the literature, making it challenging to compare or combine results from different studies. Added to this, historical studies may no longer be accurate given changes in diagnostic techniques and clinical definitions. As pointed out within Price et al's HTA report, the best evidence on development of TFI and EP following PID suggests that salpingitis is a necessary condition for development of TFI and EP; while the presence of clinical signs and symptoms can be predictive of salpingitis, signs and symptoms alone does not equate to tubal damage that will lead to sequelae.(Price et al. 2016)

The best estimates (in our view) for progression from chlamydia to PID and risk of salpingitis progressing to TFI and EP are presented in Figure 2.2. Table 2.1 provides the sources of the progression rates used in the figure. These are the estimates we use throughout this report.
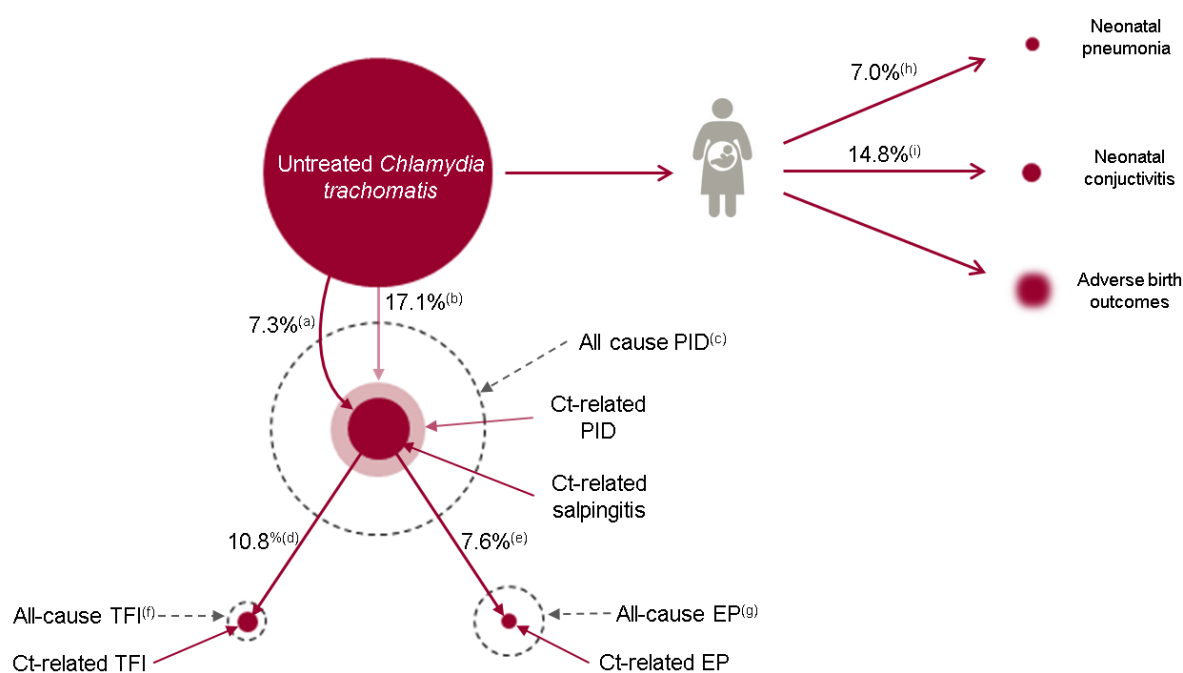
Figure 2.2 Progression from untreated genital C. trachomatis infection to sequelae in women, for source of progression parameters, see Table 2.1. Dotted lines show all-cause disease, while the inner circles show the percentage of disease progression from the previous state.

## Table 2.1: Progression rates and population excess fractions

| Parameter | Estimate (Values in brackets show credible intervals) | Notes | Reference | Key from Fig. 2.2 |
|---|---|---|---|---|
| **Progression rates** | | | | |
| Untreated *Chlamydia trachomatis* ➔ PID | 17.1% (5.6%-29%) | Includes diagnosed and undiagnosed PID. | (Price et al. 2016) | (b) |
| Untreated *Chlamydia trachomatis* ➔ salpingitis | 7.3% (2.2%-14.0%) | Based on an estimated proportion of 42.9% of PID cases where salpingitis is present.(Taylor-Robinson et al. 2009) | (Price et al. 2016) | (a) |
| Salpingitis ➔ tubal factor infertility | 10.8% (5.3%-18.1%) | The HTA report (Price et al. 2016) included the data from this study in their model, but allowed for different progression rates to TFI and EP by repeat PID and severity of salpingitis. The summary estimate is presented here and in Figure 2.2 for illustrative purposes. | (Westrom et al. 1992) | (d) |
| Salpingitis ➔ ectopic pregnancy (if conceive) | 7.6% (4.9%-10.3%) | | (Westrom et al. 1992) | (e) |
| Untreated *Chlamydia trachomatis* ➔ neonatal pneumonia (if infected at delivery) | 7.0% | The proportion of resulting cases of neonatal pneumonia/conjunctivitis in Figure x has been adjusted to allow for the proportion of women who give birth each year (5%). | (Rosenman et al. 2003) | (h) |
| Untreated *Chlamydia trachomatis* ➔ neonatal conjunctivitis (if infected at delivery) | 14.8% | | (Rosenman et al. 2003) | (i) |

| Population excess fractions | | | | |
|---|---|---|---|---|
| Proportion of PID attributable to *Chlamydia trachomatis* (women aged 16-44) | 19.7% (5.9%-38.1%) | | (Price et al. 2016) | (c) |
| Proportion of TFI attributable to *Chlamydia trachomatis* | 29% (9%-56%) | | (Price et al. 2016) | (f) |
| Proportion of ectopic pregnancies attributable to *Chlamydia trachomatis* | 4.9% (1.2%-12.1%) | The number of resulting EPs in Figure 2.2 has been adjusted to allow for the proportion of women who remain childless by age 45 (Office for National Statistics 2014). As this excludes women who have conceived but not delivered and those who have had an EP but never delivered, this will underestimate the number of women experiencing an EP. | (Price et al. 2016) | (g) |

\* We have not included chronic pelvic pain in the table: studies show that inclusion of CPP can have significant effects on economic models of Ct screening, however the evidence around the relationship is unclear.(Gottlieb et al. 2010, Jackson et al. 2014)

There are considerable uncertainties concerning the progression from chlamydia to associated sequelae.(British Association of Sexual Health and HIV 2006) However, available data suggest that in the region of 10% to 15% of untreated genital infections with *C. trachomatis* result in diagnosed clinical PID (Haggerty et al. 2010, Price et al. 2013); 10% to 15% of cases of salpingitis may then lead to TFI.(Price et al. 2013) Price et al estimated that progression to diagnosed and undiagnosed PID to be 17.1% (95% CI 5.6-29.0) (Table 2.1) Progression rates from chlamydia to other outcomes are less well understood.(Price et al. 2013) In a study evaluating all women treated for PID at the University of Lund between January 1960 and December 1984, it was estimated that 7.6% of women with salpingitis progressed to EP (Westrom et al. 1992).

In men, chlamydia can cause epididymitis (swelling of the epididymis, a tubular structure at the back of each testicle that carries sperm).(Stamm 1999) Decreased sperm counts and decreased sperm motility is commonly seen in cases of acute epididymitis and this pathology has been associated with increased levels of male infertility.(Cunningham et al. 2008) It has also been estimated that 2% of men with asymptomatic chlamydia develop epididymitis.(Welte et al. 2000, Welte et al. 2001)

*C. trachomatis* infection can be vertically transmitted during delivery, leading to neonatal conjunctivitis and chlamydial pneumoniae.(Jain 1999, Stamm 1999, Rours et al. 2008) Chlamydial infection during pregnancy has been associated with several adverse birth outcomes. Chlamydia has been associated with preterm birth (Rours et al. 2011, Liu et al. 2013, Folger 2014) as well as low birth weight (Borges-Costa et al. 2011, Johnson et al. 2011), miscarriage or still birth.(Baud et al. 2011, Campbell et al. 2011) Rosenman et al estimated that 14.8% of babies born to mothers with chlamydia developed neonatal conjunctivitis and 7% developed neonatal pneumonia.(Rosenman et al. 2003) To-date, the

evidence to support chlamydia screening during pregnancy is considered weak (a lack of RCTs) and in the UK, screening of pregnant women is not recommended.(Thorne 2011)

### 2.3.1 Immunity and re-infection

Genital infection with Ct confers, at best, only partial immunity to subsequent infection.(Batteiger et al. 2010) Therefore re-infections are possible either from untreated or new sexual partners. Re-infection with chlamydia is common and those who test positive for chlamydia are at greater risk of testing positive at subsequent tests than those who test negative.(Lee et al. 2004) Studies have found that around 10% to 15% of young adults diagnosed with chlamydia also test positive at their next test (Rietmeijer et al. 2002, LaMontagne et al. 2007, Batteiger et al. 2010, Walker et al. 2012, Gotz et al. 2013, Gotz et al. 2013, Turner et al. 2013, Woodhall et al. 2013) and that the percentage testing positive at a repeat test is around 2 to 3 times higher in those with an initial positive than in those with an initial negative test.(Rietmeijer et al. 2002, LaMontagne et al. 2007, Batteiger et al. 2010, Walker et al. 2012, Gotz et al. 2013, Gotz et al. 2013, Turner et al. 2013, Woodhall et al. 2013) Repeat diagnoses may be due to re-infection due to incomplete treatment of sexual partner(s), re-infection due to continuing risk behaviour (ie unprotected sex with new or existing partners) or detection of a persistent infection due to incomplete or ineffective treatment. The extent to which treatment affects the development of protective immunity is unclear.(Brunham et al. 2005, Brunham et al. 2008, Batteiger et al. 2010)

#### 2.3.1.1 Abrogated immunity

The precise relationship between chlamydia infection and subsequent immunity is unclear. It has been proposed that the individuals, when treated, fail to develop immunity to infection and therefore have become more susceptible to further infection.(Brunham et al. 2008) In a modelling study using data from case rates in British Columbia, Brunham et al. hypothesised that high levels of testing would lead to higher rates of repeat infections, if treatment prevents development of protective immune response. This notion of 'abrogated immunity' is a contested hypothesis,(Batteiger et al. 2010) and immunological evidence for this is yet to be provided. Further research is required to understand the duration of infection when immunity develops and how testing and treatment programmes would interfere with this.

## 2.4 Chlamydia screening rationale and evidence of effectiveness

One way of trying to control chlamydia at the population level and reduce the adverse consequences associated with infection is to screen asymptomatic people for current chlamydia infection. By reducing the duration of infection, chlamydia screening is expected to reduce an individual's risk of developing complications.(Oakeshott et al. 2010, Herzog et al. 2013)

Patients with chlamydia can then be offered information, further tests and appropriate treatment to reduce their risk and/or any complications arising from the disease or condition.(Wilson et al. 1968) In the case of chlamydia screening, people diagnosed with

chlamydia following asymptomatic testing can be offered treatment and advised that their sexual partners should also be screened and treated (hereafter termed 'partner notification').

Criteria for determining whether a disease or condition is a suitable target for screening have been adapted since originally set out by Wilson and Jungner,(Wilson et al. 1968) with an emphasis on the need for evidence of effectiveness, cost effectiveness, evaluation and quality assurance in any screening programme (Table 2.2).(Holland et al. 1990, Raffle et al. 2007, Andermann et al. 2008, National Screening Committee 2015)

**Table 2.2 Criteria for determining suitability targets for screening and how chlamydia fulfils these criteria (Wilson et al. 1968, National Screening Committee 2015)**

| Condition | Qualification |
|---|---|
| Important public health problem | Yes. The most commonly diagnosed STI in the UK. Untreated chlamydia infections can have serious long term consequences that incur substantial costs and QALY-losses. |
| Recognisable latent or early symptomatic stage | Yes. The majority of infections are asymptomatic. |
| Natural history understood | Relatively well but with uncertainty around specific progression rates from infection to sequelae. |
| Precise and acceptable test | Yes, NAATs have high specificity and sensitivity and require specimens which patients find acceptable (Pimenta et al. 2003) |
| Accepted and effective treatment | Yes. Safe, effective antibiotics to treat chlamydia infection are available and included in clinical guidelines.(British Association of Sexual Health and HIV 2006) |
| Cost of screening economically balanced | Uncertain. Evidence from mathematical modelling studies and cost-effectiveness analyses is mixed and is not strong for some kinds of screening provision. |
| Benefits outweigh the harms | Yes. Reductions in PID shown by clinical trials. The harm caused by false positive results and associated unnecessary anti-biotic usage (and negative impact on relationships) are balanced by the benefit to women's reproductive health. |

As an infectious disease, screening for chlamydia includes a strong element of infection control through treatment of the infected individual and their sexual partner(s). In contrast to many other screening programmes such as screening for breast cancer or for cervical cancer. Chlamydia screening is therefore expected to confer benefits at a population level by reducing transmission and thereby the incidence of infection and chlamydia-related complications. By reducing both the average duration of infection and the incidence of infection, chlamydia screening is expected (assuming all else is equal) to lead to a fall in the prevalence of chlamydia, given the relationship prevalence = incidence x duration.(Price et al. 2014) (See Appendix)

### 2.4.1 How chlamydia control in England compares to chlamydia control in other European countries (ECDC guidance)

The National Chlamydia Screening Programme in England is an opportunistic (as opposed to register-based) screening programme for genital chlamydial infection, targeting sexually active women and men under 25 year old who attend appropriate services. A full description of the programme's history and current delivery is provided in Chapter 3.

In 2014, the 26 member EU/EEA member nations reported 396,128 cases of chlamydia infection, with an overall notification rate of 187 per 100,000 persons.(European Centre for Disease Prevention and Control 2016) There is significant variation in notification rates between member nations, which is a reflection of differences in chlamydia testing and case finding. Notification rates remain highest in young adult women and higher in heterosexuals than homosexuals.

In Europe, 20 countries have comprehensive surveillance systems, while 6 have sentinel systems. Four countries (Denmark, Norway, Sweden and the UK) account for 83% of all reported cases. The UK contributes 60% of reported cases, due to the inclusion of data from the NCSP, which has resulted in a large number of chlamydia diagnoses.

In 2014 Denmark, Iceland, Norway, Sweden, the UK and Finland had notification rates greater than 200 cases per 100,000. These countries all have chlamydia control strategies either recommending active screening or widespread opportunistic screening. Data from population-based prevalence surveys show that rates of chlamydia infections in the general population is relatively homogeneous across European countries and that prevalence rates from population-based surveys are closest to notification rates in countries that also reported the highest notification rates.(European Centre for Disease Prevention and Control 2014)

The overall increase in reported cases over the past decade is clearly largely (and possibly entirely) due to the implementation of chlamydia control programmes with improved diagnostic tools such as improved NAATs, increased case detection and improved surveillance systems.(European Centre for Disease Prevention and Control 2013)

### 2.4.2 Effectiveness of chlamydia screening on sequelae

The section above has summarised the evidence for the rationale of chlamydia screening. This section summarises the empirical evidence of its effectiveness in research studies and in practice. This section draws heavily on the Cochrane review of the effectiveness of screening for genital chlamydia infection.(Low et al. 2016)

The potential for chlamydia screening to interrupt the development of tubal pathology has been shown in 4 randomised controlled trials (RCT) that have investigated the effectiveness of a single offer of a chlamydia screen on the risk of developing PID within 1 year (European Centre for Disease Prevention and Control 2014). A recent Cochrane Review meta-analysis of

these studies (Figure 2.3) reported the pooled risk ratio of all-cause PID after 1 year of follow-up for women invited to have a chlamydia screen to be 0.68 (95%CI 0.49-0.94).(Low et al. 2016) Uptake of screening in the intervention arm varied between 29% and 100% and the reduction in the risk of PID was greater in studies with higher rates of uptake of chlamydia screening.(European Centre for Disease Prevention and Control 2014) The risk of PID was 32% lower in women who were part of the intervention arm than in women in the control arm. Following a pre-specified sensitivity analysis, the summary estimate from the 2 trials at low risk of bias shows a less strong effect than the trials at high or unclear risk of bias. The authors concluded that there was moderate quality evidence indicating that detection and treatment of chlamydia infection can reduce PID in women.(Low et al. 2016)

While there is evidence to support the belief that chlamydia screening will interrupt the development of sequelae the evidence for screening's impact on population prevalence is lacking. Evidence from observational data that was used to support chlamydia screening in the early 2000s has since been questioned in the public health literature.(Low 2007, Low et al. 2009, Sheringham et al. 2012) In particular, more recently with hindsight, more attention has been given to potential confounding with secular changes such as the HIV prevention messages in the late 1980s and early 1990s that led to a reduction in sexual risk behaviour, which in turn reduced STI transmission during this period. It is therefore likely that the role of chlamydia screening in reduced diagnoses of chlamydia in observational studies spanning that time was overstated by some studies.(Low 2007, Fine et al. 2008, Sylvan et al. 2008)

Re-appraisal of the early RCTs by Scholes et al. and Østergaard et al. highlighted some important methodological issues.(Low et al. 2009) In the Scholes study, more effort was made to invite women in the screening group to take part, and they were followed up more rigorously than controls.(Scholes et al. 1996, Low et al. 2009) In the Østergaard study, participants were randomised before they had consented to take part, almost half of the participants did not provide information at follow up, and assessment of whether someone had PID or not at follow up was not blinded.(Østergaard et al. 2000, Low et al. 2009) Thus the effect of chlamydia screening may have been either over- or underestimated in these studies.

Compared to the 2 earliest RCTs by Scholes and Østergaard that found around 50% reduction in the risk of PID within 1 year of screening,(Scholes et al. 1996, Østergaard et al. 2000) more recent studies have found smaller and non-statistically-significant effect sizes.

| Study or Subgroup | Screening offer Events | Total | No offer Events | Total | Weight | Risk Ratio M-H, Fixed, 95% CI | Blinding of outcome assessment (detection bias) |
|---|---|---|---|---|---|---|---|
| **1.2.1 Low risk of detection bias** | | | | | | | |
| Andersen 2011 | 23 | 4000 | 74 | 11459 | 41.7% | 0.89 [0.56, 1.42] | Low risk |
| Oakeshott 2010 | 15 | 1273 | 23 | 1290 | 24.9% | 0.66 [0.35, 1.26] | Low risk |
| **Subtotal (95% CI)** | | **5273** | | **12749** | **66.6%** | **0.80 [0.55, 1.17]** | |
| Total events | 38 | | 97 | | | | |
| Heterogeneity: Chi² = 0.54, df = 1 (P = 0.46); I² = 0% | | | | | | | |
| Test for overall effect: Z = 1.13 (P = 0.26) | | | | | | | |
| | | | | | | | |
| **1.2.2 High risk of detection bias** | | | | | | | |
| Scholes 1996 | 9 | 1009 | 33 | 1598 | 27.8% | 0.43 [0.21, 0.90] | Unclear risk |
| Ostergaard 2000 (1) | 2 | 230 | 5 | 221 | 5.6% | 0.38 [0.08, 1.96] | High risk |
| **Subtotal (95% CI)** | | **1239** | | **1819** | **33.4%** | **0.42 [0.22, 0.83]** | |
| Total events | 11 | | 38 | | | | |
| Heterogeneity: Chi² = 0.02, df = 1 (P = 0.90); I² = 0% | | | | | | | |
| Test for overall effect: Z = 2.52 (P = 0.01) | | | | | | | |
| | | | | | | | |
| **Total (95% CI)** | | **6512** | | **14568** | **100.0%** | **0.68 [0.49, 0.94]** | |
| Total events | 49 | | 135 | | | | |
| Heterogeneity: Chi² = 3.24, df = 3 (P = 0.36); I² = 7% | | | | | | | |
| Test for overall effect: Z = 2.34 (P = 0.02) | | | | | | | |
| Test for subgroup differences: Chi² = 2.68, df = 1 (P = 0.10), I² = 62.6% | | | | | | | |

Favours screening offer  Favours no offer

Footnotes
(1) Ostergaard 2000: Design effect 3.77 applied to raw data (Intervention N=867, control N=833, intervention events n=9, control events n=20)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Figure 2.3 Reduced risk of pelvic inflammatory disease (PID) within 1 year associated with a single offer of a chlamydia screen among women: Forest plot of comparison: 1 Offer of chlamydia screening vs usual care (inactive control), Incidence of PID at 12 months (intention-to-treat). From (Low et al. 2016)

Oakeshott et al. reported a 35% reduction in risk of PID at 1 year (risk ratio [RR] 0.65, 95%CI 0.34-1.24) (Oakeshott et al. 2010) and Andersen et al. reported a smaller 11% reduction (RR 0.89, 95%CI 0.56-1.42).(Andersen et al. 2011) The interpretation of these findings needs to consider further errors and uncertainties. In the study by Oakeshott et al, around one-fifth of women in both the intervention and control arms were tested outside of the study between the time of enrolment and follow up, suggesting the effectiveness of the single chlamydia test of infection may have been underestimated.(Oakeshott et al. 2010) In the Andersen study, 9% of women were tested as part of routine care in the first 3 months of the study, again suggesting that the study impact may be underestimated.(Andersen et al. 2011)

This is likely to have reduced the effect size in both studies. Andersen et al. used prescription information to measure cases of PID in community settings.(Andersen et al. 2011) It is likely that many cases of PID will have been missed,(Nicholson et al. 2010, Andersen et al. 2011) which adds further uncertainty to the findings from this study. The magnitude of the effect seen in these 2 studies was substantially smaller than that reported in the 2 earlier RCTs by Scholes and Østergaard that found around 50% reduction in risk of PID within 1 year of screening.(Oakeshott et al. 2010) The Oakeshott trial's limitations also illustrated the significant challenges of delivering chlamydia screening that has a detectable effect even in a research context, eg achieving participation by sufficient numbers of young people to adequately power the study, given the rates of PID and measurement errors in estimating the rates of PID.(Sheringham 2010)

### 2.4.3  Effectiveness on reducing prevalence

At the outset of the NCSP, surveillance systems were established to collect data on numbers of tests and diagnoses among the target population tested through the NCSP (see Chapter 4). No baseline survey of chlamydia prevalence was carried out prior to the start of the NCSP. Subsequently, available data were collected to try to monitor the impact of the programme in terms of the frequency over time of some chlamydia-related sequelae – PID and EP (see chapter 4). The Natsal-2 survey did occur immediately before the initial roll out of the NCSP and Natsal-3 occurred 10 years later however this period encompassed a long roll out period and higher volume screening had only been ongoing for 3 years when Natsal-3 took place;(Erens et al. 2001, Erens et al. 2013) we discuss this in Chapter 7.

While there is evidence to support the belief that chlamydia screening will interrupt the development of sequelae the evidence for screening's impact on population prevalence is lacking. Evidence from observational data that was used to support chlamydia screening in the early 2000s has since been questioned in the public health literature.(Low 2007, Low et al. 2009, Sheringham et al. 2012) In particular, more recently with hindsight, more attention has been given to potential confounding with secular changes such as the HIV prevention messages in the late 1980s and early 1990s that led to a reduction in risky sexual behaviour, which in turn reduced STI transmission during this period. It is therefore likely that the role of chlamydia screening in reduced diagnoses of chlamydia in observational studies spanning that time was overstated by some studies.(Low 2007, Fine et al. 2008, Sylvan et al. 2008)

The effectiveness of chlamydia screening to reduce prevalence of infection was called into question with the publication of a cluster RCT of register-based chlamydia screening in the Netherlands in 2010. In the Chlamydia Screening Implementation (CSI) project,(Gotz et al. 2013) 16 to 29 year-old women and men living in 3 areas of the Netherlands were offered chlamydia screening annually for 3 years. Postal invitations were used to offer screening. Those who accepted used an internet site to request a home sampling kit, which was then posted to a laboratory for testing. The study was conducted with stepped-wedge implementation, with those in the first phase being sent 3 yearly invitations, and the final group participating only in the final round of screening.

The study found no statistical evidence of a difference in the percentage testing positive for chlamydia among those tested or in estimated prevalence and no difference between areas that had participated in all 3 rounds of screening versus those in the comparison group who had been offered screening only once. Many challenges exist in measuring the effect of screening as people may become re-infected by sexual partners who are not screened and treated; in this study data on partner treatment were only available for 42% of infected participants. This study had lower uptake than expected (16% in round 1, decreasing to 10% in round 3), which may have limited the impact of screening on transmission.

The implications of the findings from these RCTs for the expected impact of chlamydia screening on population health in England are unclear. There are some important differences between the study interventions or populations which limit the generalisability of findings from the RCTs. Only 1 of these RCTs of chlamydia screening and PID investigated the impact of repeated offers of chlamydia screening. While the RCT in the Netherlands did investigate the impact of 3 rounds of annual offers of screening, the intervention was delivered using a registry to send invitations, which differs to the opportunistic approach in England making a direct comparison to the NCSP challenging.(van den Broek et al. 2012) The NCSP has a higher level of uptake, thus it could be expected that the NCSP would have a greater impact than the CSI trial.

The Australian Chlamydia Control Effectiveness Pilot (ACCEPt) is a chlamydia testing pilot program commissioned by the Australian Government Department of Health.(Hocking 2012) A randomised controlled trial (RCT) was undertaken to support increased testing in GP clinics in rural towns in Australia. Preliminary results showed that in GP clinics which received a multifaceted support package (intervention), the prevalence of chlamydial infection dropped from 5% to 3.4%, while in those clinics which did not receive the additional support saw a smaller decline in prevalence, from 4.5% to 3.4%. Annual chlamydia testing rates increased from 8.1% to 20.0% in the intervention group, compared to a smaller increase from 8.1% to 12.7% in the control group.(Hocking 2016) Final results of the trial, including the impact of the trial on diagnoses of PID, have yet to be published.

## 2.5   Horizon scanning

We are aware of several studies and control programmes designed to measure the burden of genital chlamydia infection and increase rates of testing.

The Netherlands Chlamydia Cohort Study (NECCST) is following a cohort of women of reproductive age prospectively for at least 10 years to investigate disease progression of chlamydia and the role of host-genetic biomarkers.(Hoenderboom et al. 2017) Participants were selected from among those of the Chlamydia Screening Implementation.(van den Broek et al. 2010) Disease history is based on previous test outcomes, self-reported infections and presence of antibodies against Ct. Outcomes including pregnancy, PID, EP and female subfertility are determined by self-reporting. Preliminary results suggest more women (10%) with a history of chlamydia have long-term complications when compared to women with no history of chlamydia (7.9%).(Hoenderboom et al. 2016) Final results are expected in the coming years.

A systematic review of adverse birth outcomes associated with untreated Ct infection in women has been registered with PROSPERO.(Mao et al. 2017) This review will explore the relationship of untreated chlamydia with infertility and other adverse outcomes of pregnancy, which will better inform the cost-benefit analysis of treatment policies. The study has already identified that chlamydia infection is associated with increased risk of serious sequelae including stillbirth, neonatal death, EP or subsequent infertility.[J. Tucker, personal communication] These studies were categorised as being of low quality due to their design (observational) and risk of selection bias and confounding. However the authors were not able to confirm a direction of the bias.[J. Tucker, personal communication] The results of this systematic review and meta-analysis are expected later in 2017.

A systematic review is currently being undertaken by researchers in the UK to explore barriers and facilitators to chlamydia testing in general practices, based on theories of behaviour and behaviour change. The review will explore the facilitators and barriers to testing in young people and general practitioners and map them to theoretical model of behaviour change.(McDonagh et al. 2017)

Female participants of a large community-randomised trial of HPV vaccination strategies in Finland (2007-2014, ClinicalTrials.gov NCT00534638)(Lehtinen et al. 2015), were invited at follow-up to participate in a *C. trachomatis* screening trial: the findings of this study are not yet published.

## 2.6   Summary

There is good evidence that genital infection with Ct is one cause of PID, and that PID (and more specifically, salpingitis) can lead to EP and TFI. Appropriate screening tests are widely

available, as are safe and effective treatments. There is moderate evidence that screening females for genital chlamydial infection offers a direct benefit of reduced progression to PID at 1 year. The ECDC meta-analysis reported the pooled risk ratio of all-cause PID after 1 year of follow-up for women invited to have a chlamydia screen to be 0.68 (95%CI 0.49-0.94).(Low et al. 2016)

Chlamydia incidence and prevalence is difficult to accurately measure and monitor. However, there is good evidence from national surveys and from surveillance data that *C. trachomatis* infection remains very common amongst young sexually active males and females. There is an absence of evidence that screening as currently practiced in England (or elsewhere) has substantially lowered the frequency of *C. trachomatis* infection in the target population (young sexually active adults).

# 3 Delivery of the National Chlamydia Screening Programme

This section provides an overview of the implementation and evolution of the National Chlamydia Screening Programme since its inception in 2003. The current arrangements for commissioning and delivery of the programme are described, along with details of PHE's activities in implementing, supporting and monitoring programme delivery.

## 3.1 History of the NCSP

### 3.1.1 The decision to introduce chlamydia screening in England (1996–2000)

During the late 1990s and early 2000s there was growing interest in chlamydia screening as a possible control measure in England. The RCT by Scholes et al. published in 1996 and subsequent trial by Østergaard et al. in 2000 provided strong evidence in the late 1990s and early 2000s in support of chlamydia screening, having reported a significant reduction of around 50% in PID among those invited to screen compared to the control arm.(Scholes et al. 1996, Østergaard et al. 2000)

Observational data from Sweden and the USA were also considered to support the argument for chlamydia screening (Pimenta et al. 2000); increases in testing in women in Sweden had been found to correlate with a fall in the number of diagnoses made (Herrmann et al. 1995) and in the US, a before-and-after study found the percentage testing positive among women attending family planning clinics in Wisconsin to be lower after the implementation of a selective screening policy.(Hillis et al. 1995)

In 1996, the CMO convened an Expert Advisory Group to formally review the case for chlamydia screening. The group reported in 1998 and in light of the high rates of diagnoses being made in existing services, the evidence that chlamydia was associated with infertility and analyses which suggested that over time total costs would fall in response to reduced prevalence it proposed that chlamydia screening be introduced in England as an opportunistic basis, targeted towards young women and delivered in general practice and community sexual and reproductive health services.(Chief Medical Officer's Expert Advisory Group 1998)

### 3.1.2 Establishment of the NCSP and national implementation (2001–2008)

Following the CMO's report and 2 pilots of chlamydia screening in 1999,(Chief Medical Officer's Expert Advisory Group 1998, Department of Health 2001, Sheringham et al. 2012) the first national strategy for sexual health and HIV was published in 2001. The strategy included the planned roll-out of a national screening programme for chlamydia in targeted groups (women attending specialist sexual health services (SHS), seeking termination of

pregnancy (ToP) or having their first cervical smear) from 2002, with a broader national programme to follow.(Department of Health 2001)

In 2004, the Public Health White Paper accelerated the schedule, promising national provision by 2007 and announced funding to support implementation.(Department of Health 2004) The NCSP was implemented on a phased roll-out basis in 2003, with national implementation by March 2008 (Figure 3.1).
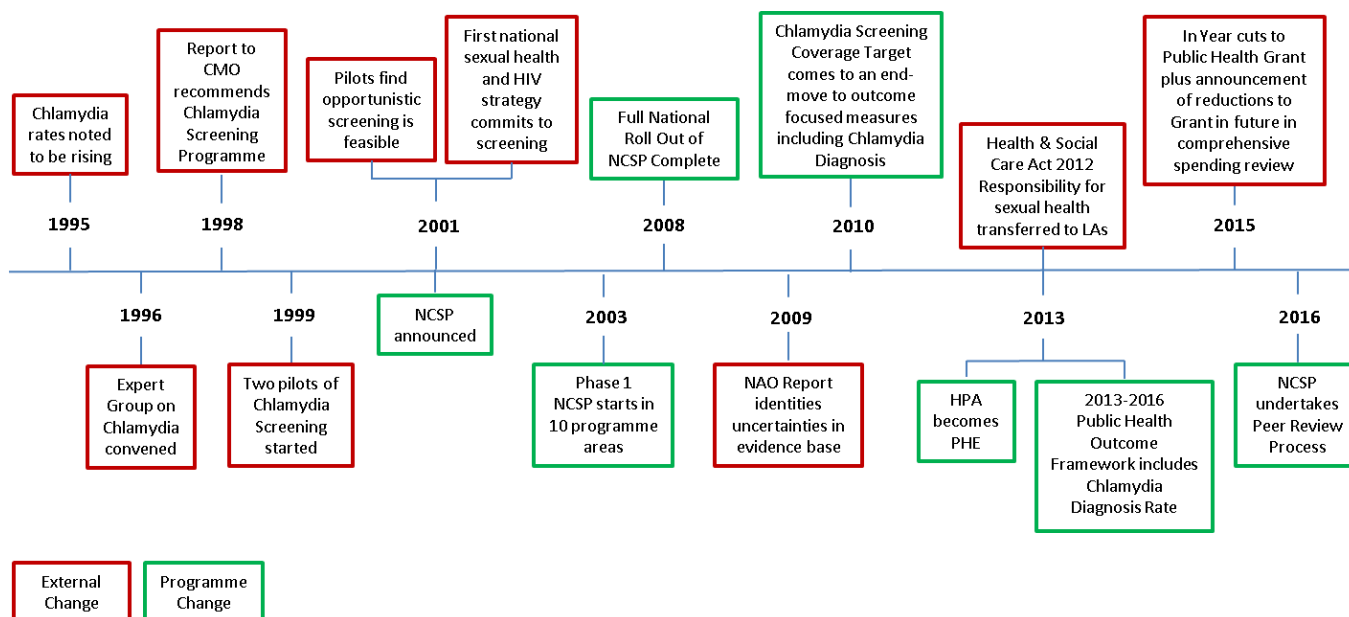


Figure 3.1 Timeline of key events in the history of the NCSP, 2003 to present

## 3.2   Changes in NCSP implementation

### 3.2.1   Performance management and public health indicators

In the early years of the programme, a modelling study was used to estimate the reductions in level of coverage required to reduce prevalence.(Turner et al. 2006) In 2007, prior to the nation-wide roll out of the NCSP, the Department of Health (DH) set a Local Development Plan, commonly referred to as a 'Vital Signs Indicator' (VSI) target of 15% of young people between 15 and 24 being screened through NCSP.(DH/NHS Finance Performance & Operations 2008)

During the financial year 2007-08, 4.9% of 15 to 24 year-olds were reported to the Programme as having been tested, against a target of 15%.(National Audit Office 2009) During this time commissioning of CT screening was the responsibility of local PCTs which were accountable to the Department of Health (DH) and so the DH added chlamydia screening targets to the Vital Signs Indicators for PCTs. The vital signs indicators were a set of indicators to monitor PCT performance. This performance management could have serious implications for Trusts and so its presence effectively drove up chlamydia screening as the introduction and implementation of these targets led to a step change in the number of tests and diagnoses

reported in each year. For 2008-2009 onwards, DH set Primary Care Trusts (PCT) progressively increasing annual testing rates of 17, 25 and 35% of under-25s, for the 3 years 2008-2009 to 2010-2011. Coverage targets were not met in 2007/2008, but were almost met in later years, partly due to the inclusion of tests performed in specialist SHS, which did not initially contribute towards the targets.(National Audit Office 2009) An inadvertent effect of this increase in testing capacity was to support local achievement of 48 hour waiting targets in UGM services. As increased testing capacity helped local clinics to redirect low risk individuals from specialist services.

In some areas the coverage targets were met by identifying easy-to-access groups of young people. Many of those groups were at very low risk of STIs and as such the testing of these groups had minimal benefits to population health. However, the VSI was crucial to achieving national coverage for chlamydia screening in under-25s, driving up testing rates and increasing knowledge of the risks of chlamydia in the target age group. The VSIs, including the chlamydia screening coverage target, came to an end in 2010 and there was a desire across government to move away from process measures to outcome indicators.

Prior mathematical modelling had shown that screening and treating infected individuals would reduce prevalence of chlamydia and the scale of this reduction was dependent upon the number of infections identified.(Kretzschmar et al. 2009) Chlamydia control remained a public health priority, and an indicator relating to chlamydia diagnoses (later renamed 'detection') was established and subsequently included in the Public Health Outcomes Framework for England.(Public Health England 2013) As such, the new recommendation was that local areas aim to achieve a number of positive diagnoses rather than tests.

Since 2013, the DH recommends that local areas aim to achieve a detection rate (defined as the number of chlamydia diagnoses per head of the 15 to 24 year-old population) of 2,300 per 100,000 or higher. This number is a reflection of the number of cases found through screening and was not a measure of local prevalence. Seeking and testing prevalent cases of chlamydia leads to higher DRI rates. The aim of the detection rate indicator (DRI) recommendation of 2,300 per 100,000 was to drive the development of services which seek to identify infected individuals thereby ensuring that accessibility was not prioritised at the expense of addressing need.

From its inception, the NCSP has used audits as a means of measuring progress as well as eliciting information and feedback from programme managers, implementers and key stakeholders. The first audit in 2006 developed a QA framework and undertook a baseline survey of all participating programmes, with the aim of determining area that were working well and which might be shared with others as well as sections that required development and change. It focused on governance, training and data collection, as well as collection data on case management.

The second audit, in 2008, focused on similar topics and included response from both stakeholders and the NCSP. Further audits have focused on turnaround times (2009, 2010,

2011), time to treatment (2010, 2011), PN (2009, 2011, 2016), internet testing (2013), retesting (2015) and equity of access (2012). The 2017 audit will cover turnaround times, retesting, treatment and PN. The audits are described in further detail in Section 4.2.3.

### 3.2.2 Commissioning and delivery

Whilst the NCSP is a national programme, it has always been the responsibility of local areas to commission and deliver screening to their population. However the recommended NCSP delivery model has changed over time since the programme's inception. In the early years of the programme chlamydia screening delivery was organised in each area through a dedicated Chlamydia Screening Office (CSO) with a local coordinator responsible for local delivery and reporting of activity data to the Health Protection Agency (HPA), now PHE. Chlamydia testing was conducted in primary care and community sexual health services but also in non-traditional settings such as pubs, clubs, sporting events and festivals.

Commissioning the programme was the responsibility of PCTs from its inception until March 2013. The 2012 Health and Social Care Act moved the responsibility of chlamydia screening to LAs which were statutorily required to provide open access STI and contraceptive services but the specific details of what those services entailed were not described in any legislative instruments.(Government of the United Kingdom 2012)

Since 2010, the NCSP has encouraged the integration of chlamydia screening services into appropriate sexual health services for young adults. (National Chlamydia Screening Programme 2010) In addition to continued provision in specialist SHS, local areas are advised to focus on provision in general practice, community sexual and reproductive health services, pharmacies, termination of pregnancy (ToP) clinics. Individuals tested in these services tend to have a much higher risk of chlamydia than the general population.(Adams et al. 2004, Simms et al. 2009, Public Health England 2015) These settings present sustainable options for screening in services that can address other aspects of sexual health including contraception and other STI testing and interventions.(Public Health England 2015)

The NCSP has been a driver of innovation in service delivery. The NCSP was amongst the first NHS services to offer clinical care accessible online. The offer of self-sampling services on a local or regional footprint where young people can order test kits from a website, collect urine sample or swabs at home and return by post for laboratory analysis has been a service staple since 2008.(National Audit Office 2009) Currently up to 89% of LAs offer online testing.(Hollis et al. 2017) These services have the advantage of being universally accessible, are used by young people who may not otherwise have contact with services and serve a high need population as reflected in the high positivity of those tested.

The use of remote health advisors and prescribing clinicians are being adopted more widely across the sexual health system for example in London,(London Councils 2017) Hampshire, Portsmouth and Southampton where services are being transformed to encompass

comprehensive STI testing online and postal treatment for uncomplicated genital chlamydia infection.

## 3.3 The NCSP as it currently stands

In 2015, more than 1.5 million chlamydia tests were carried out by young people across England. Assuming 1 test per person, an estimated 32% of young females and 13% of young males were tested.(Public Health England 2016)

### 3.3.1 Aims of the NCSP

The NCSP's current aims are set out in the NCSP Standards (7th edition).(National Chlamydia Screening Programme 2016) This states that the NCSP aims to:

- prevent and control chlamydia through early detection and treatment of asymptomatic infection
- reduce onward transmission to sexual partners
- prevent the consequences of untreated infection
- raise awareness and skills of health professionals to screen for chlamydia, and provide the information young adults need to reduce the risk of infection and transmission

PHE advocates the integration of high quality chlamydia screening as core part of the offer of sexual health care that all young people should receive.

Delivery of the programme is through a variety of settings, allowing young people to take responsibility for their sexual health regardless of their location or proximity to specialist clinics. The offer of a chlamydia test in a wide range of settings is well received by young people and helps to normalise STI testing. For many young people the offer of a chlamydia test will be their first contact with sexual health services and as such provides an important opportunity to support young people by improving knowledge and attitudes.(National Chlamydia Screening Programme 2016) Offering a test in a variety of services is a key aspect of the Making Every Contact Count advice.(NHS Health Education England 2017)

### 3.3.2 How Chlamydia Screening is Commissioned

Local Authorities (LA) are the responsible body for commissioning chlamydia screening. LAs currently receive a ring fenced public health grant. Within the public health ring fence LAs determine how much they spend on each of their public health responsibilities. Provision of open access services for STIs and contraception is a mandated service. How this mandate is delivered and the shape of sexual health services is for the LA to determine, based on local need and informed by national guidance.(Public Health England 2015)

### 3.3.3 Provision of screening services

Chlamydia screening is delivered by a wide range of local service providers including specialist SHS and SRH clinics, GPs, pharmacists, ToP, prison health care services, outreach services, youth workers, education providers, online self-sampling services.

The NCSP currently recommends that at least 70% of chlamydia tests are provided through online or "core services" defined as specialist SHS, SRH clinics and GPs.(National Chlamydia Screening Programme 2016) This reflects the drive over the past 5 years to ensure that chlamydia screening is delivered as part of a comprehensive sexual health service.

Successive UK governments and national public health bodies have identified GPs as an important facilitator in the provision of sexual health services through increased testing, partner follow up and prevention.(Department of Health 2013) An estimated 303.9 million primary care consultations occur every year,(Hippisley-Cox et al. 2009) and almost 75% of young people attend their general practice annually.(Salisbury et al. 2006) General practice is an accessible and acceptable setting for patients' to receive sexual health services.(Lazaro 2008, Prost et al. 2009, Hogan et al. 2010, Pollard et al. 2013) Despite this, universal or consistent offer of chlamydia screening in general practice has been a challenge for the programme and levels of screening vary significantly between practices. In 2013, only 5% of practices tested more than 10% of their 15-24 year old population.(Town et al. 2015) Approaches other than opportunistic screening have been developed in general practice, in particular case finding through rapid risk assessment.(Pillay et al. 2013, Pillay et al. 2014)

### 3.3.4   Who is tested

#### 3.3.4.1   Young people

The NCSP recommendation is that all sexually active young people under the age of 25 have universal access to chlamydia testing. This is based on existing research literature and surveillance data which shows that STI prevalence is highest in this age group.(Fenton et al. 2005, Health Protection Agency 2012, Sonnenberg et al. 2013)

#### 3.3.4.2   Screening in men

The NCSP included recommendations for opportunistic screening in men from the start of the programme. Men were included to highlight the role of both sexes in controlling onward transmission and in preventing reproductive complications in women and to increase both sexes' ability to take responsibility for their sexual health.(National Chlamydia Screening Programme 2007)

A study by Johnson et al (Johnson et al. 2010) looking at testing data from the South East region of England prior to roll-out of the NCSP, found that testing of males focused on institutional settings, such as universities and military, where there is a low yield of positives, and limited capacity for expansion. By contrast, the testing of females, especially in urban environments, was mainly through established healthcare services, such as GP offices and

SH centres. The authors recommended that future strategies should prioritise increasing male testing in healthcare settings.

To address the disparity in screening between genders, the NCSP introduced a 'Men too' strategy in 2007.(National Chlamydia Screening Programme 2007) This strategy considered evidence that young men often lack knowledge about chlamydia and chlamydia screening, and have certain misconceptions about the nature of the test that put them off being tested. The aims of the 'Men too' strategy were to raise awareness of the importance of screening men, both for their own SRH and to contribute to preventing reproductive morbidity in women. This was followed up in July 2009 by a document entitled "Involving young men in chlamydia screening: A practical guide" (National Chlamydia Screening Programme 2009), targeting commissioners and service providers. The guide is designed to improve access to high-quality chlamydia screening services by young men.

### 3.3.4.3 Sexual orientation

The current NSCP standards state that people of all sexual orientations should be offered screening but that men who have sex with men (MSM) should be advised, even if asymptomatic, to have a full STI screen, including a test for HIV and hepatitis B as required.(National Chlamydia Screening Programme 2016) There is evidence that urine testing alone misses possible asymptomatic rectal and pharyngeal infections in MSM.(McMillan et al. 2008) Non-clinical venue providers should ensure that MSM presenting for testing are aware of the need to attend a local clinical venue for appropriate testing.

BASHH Standards state that: In some individuals, such as MSM, extra genital testing (rectal and pharyngeal) may be indicated due to their sexual history. Extra genital testing is a routine component of the sexual health testing of MSM but should not be considered a tool for population screening within the NCSP. It should only be undertaken in settings with experienced sexual health service providers. Where indicated extra genital testing should be performed in line with BASHH management standards.(Bacterial Special Interest Group 2006)

MSM should be offered the option of attending a venue competent to offer rectal chlamydia and gonorrhoea swabbing since there is a high rate of asymptomatic rectal infection in those practicing anal sex.(Patton et al. 2014)

### 3.3.5 When testing is recommended

The NCSP recommends that sexually active young people get tested regularly and on change of partner. The meaning attached to 'change of partner' may vary between individuals. Because a test may not be positive if the infection was acquired within the last 2 weeks the NCSP advises that providers consider the timing since last sexual intercourse when providing a test for chlamydia. Individuals may choose to test before sexual intercourse with a new sexual partner but this will miss infection in the new partner unless both are tested.

### 3.3.6  How much screening is recommended

The chlamydia detection rate is used to provide commissioners with a measure of their chlamydia control activities and to enable them to monitor changes in service provision. Chlamydia DRIs exhibit considerable geographic variation and, in 2015, 20% of Upper Tier Local Authorities (UTLAs) achieved a detection rate of 2,300 or above, lower than in previous years, largely due to a reduction in total testing.

As part of the Chlamydia Care Pathway (CCP), commissioners and providers are shown how increases in partner notification and retesting of positive cases can lead to higher positivity rates and in turn more effective improvement in their local detection rate for a fixed level of resource.

The DRI was considered a more appropriate measure of programme performance as treating infections is thought to reduce subsequent ill health and having a higher detection rate would be expected to lead to greater reductions in chlamydia prevalence.(Department of Health 2012) As with the use of a coverage target there are some potential limitations of using a detection rate to monitor programme performance. Detection rate will depend on volumes of testing, who is being tested, as well as the underlying prevalence in each area. It is therefore feasible that areas with high underlying prevalence in the population may be able to achieve the specified diagnosis rate of 2,300 per 100,000 more easily than those who have a low underlying prevalence of infection.

In areas of particularly high or low prevalence this may create a perverse incentive where screening activity required to reach a specified diagnosis rate would be inverse to sexual health need. However LAs are encouraged to consider local needs across sexual health when commissioning services to rather than consider this as a fixed target.(Department of Health 2012)

### 3.3.7  Chlamydia screening and deprivation

The NCSP does not explicitly recommend targeting testing in young people from more deprived areas. Analysis of 2008 NCSP data showed that although total coverage was low, coverage was higher in deprived populations, where young people were also at increased risk of testing positive for infection.(Sheringham et al. 2009, Sheringham et al. 2011).

A later systematic review found that that there was relatively strong evidence across multiple indices of deprivation, that disadvantaged young people had an increased risk of having chlamydia,(National Statistics 2015) including lower educational attainment, lower occupational class and residing in a deprived area.(Crichton et al. 2015) Socioeconomic disadvantage was associated with chlamydia infection in both men and women. There was weaker evidence that prevalence estimates also varied by gender and age. The authors concluded that their review provides evidence of a consistent association between

socioeconomic disadvantage and higher risk of Chlamydia infection. From the UK-specific papers, they also found an association between increasing area-level deprivation and chlamydia infection (combined OR from meta-analysis of 3 studies 1.76, 95% CI 1.15 to 2.71). This association may reflect a number of factors including social variation in engagement with Chlamydia control programmes. Chlamydia screening could therefore reduce or increase health inequalities, depending on service provision and uptake by different socioeconomic groups.

A recent report in the BMJ analysed the 2015 CTAD national data to account for deprivation.(Chandrasekaran et al. 2016) The authors found that LAs in the highest deprivation quintile were more likely to reach the DRI than LAs in the least-deprived quintile for both males and females. While LAs can influence the location of chlamydia testing through commissioning arrangements, the association between deprivation and attaining the recommended level suggests that using the chlamydia diagnosis rate to compare performance across LAs is difficult.

A response to this paper was made by the NCSP team (Woodhall et al. 2016) which noted that this finding supported reviewing service delivery at the local level– such as the support provided by the CCP – which emphasised the importance of chlamydia screening delivery in socioeconomically deprived areas and that within a single LA area, levels of deprivation will vary.

Woodhall and colleagues analysed data from Britain's third National Survey of Sexual Attitudes and Lifestyles (Natsal-3) and found that many young people with risk factors had not recently been tested for chlamydia.(Woodhall et al. 2015) The authors also reported that although many risk factors associated with infection were also associated with testing, important risk factors such as deprivation were not associated with comparable increases in testing. They concluded that greater screening and prevention efforts among individuals in deprived areas and those reporting risk factors for chlamydia may reduce undiagnosed prevalence and transmission.

### 3.3.8  Pregnancy and maternity

Current BASHH guidelines state that "neonatal chlamydia is a significant cause of neonatal morbidity".(Nwokolo et al. 2016) The infection is passed vertically through direct contact with the maternal genital tract and can result in neonatal conjunctivitis and/or pneumonia though may remain asymptomatic. The guidelines recommend that while NAAT testing is not validated in this patient group its high accuracy in diagnoses of genital infections and its high specificity suggests that it would be effective and diagnosing neonatal infections with C. trachomatis. As such they recommend that chlamydia should be considered in all infants who develop conjunctivitis within 30 days of birth and that if found they are treated with oral antibiotics.

In March 2011, the UK National Screening Committee found that although the burden of disease was likely high in the antenatal population (estimated prevalence of between 2-4%) there was insufficient evidence to support a recommendation for antenatal screening.(UK National Screening Committee 2011) This was based on the uncertainty around the likely benefits of screening over routine care in terms of the benefits to the neonate and did not consider any wider public health benefits such as impact on transmissions or prevalence.

This view on chlamydia screening was shaped by the studies reported by Preece et al. in the late 1980s.(Preece et al. 1989, Preece et al. 1989) This was an analysis of the UK's largest prospective study of chlamydia screening and provided a firm steer away from screening during pregnancy. The current guidelines were due to be reviewed in 2014/2015. Systematic antenatal screening of all pregnant women for chlamydia is currently not recommended by the National Screening Committee in the UK.

### 3.3.8.1 How to undertake a chlamydia screen

The diagnosis is made on detection of the bacteria rather than identifying symptoms of infection. Chlamydia tests are based on laboratory analysis either of a genital swab or a urine sample. Samples are analysed in specialist laboratories using a process known as the NAATs, which detects the genetic material of C. trachomatis in the sample being tested. NAATs are both highly sensitive and specific, reducing the likelihood that a person will be misdiagnosed. In 2004-05 the Department provided £7 million to fund the equipment required to conduct NAATs in NHS laboratories, although this allocation was not specific to the Programme.(National Audit Office 2009)

Point of care tests (POCT), which provide a diagnosis in less than 2 hours, are available at some local services.(Harding-Esch et al. 2017)

### 3.3.9 Treatment (get result, give treatment)

Once tested services are expected to ensure that patients are notified of their results; reducing the time to treatment may also have an impact on transmissions. Patients are able to select the preferred method of notification (SMS, phone, email, post); if positive, 3 attempts to contact will be made, using more than 1 notification method. The patient will be asked to contact their local provider for treatment.

Treatment is provided in the service itself or through prescription to be collected in a pharmacy. The NCSP recommends that treatment be provided within 6 weeks of testing. All treatment should be in accordance with current BASHH guideline.(National Chlamydia Screening Programme 2016) The guidelines recommend treatment with azithromycin 1g in a single dose or doxycycline 100mg twice daily for 7 days. When contraindicated, amoxicillin, ofloxacin or erythromycin may be used.(Department of Health 2004)

### 3.3.10 Notify partners

Partner notification (PN) (also known as contact tracing) is the process of providing access to sexual contacts who may have been at risk of infection from an index case. This includes supportively providing advice to contacts about possible infection, and providing treatments for infection. PN is important as it reduces onward infection and re-infection and the complications of infection, as well as being an effective way of identifying chlamydia positive individuals.(McClean et al. 2012, Public Health England 2016) PN is a key part of basic care for individuals infected with chlamydia [BASHH reference] and is recommended by the NCSP. In addition the high positivity of contacts and the relatively low cost of PN per index case means that increasing PN effectively reduces the cost per case identified through the NCSP.(Turner et al. 2011)

Re-infection with chlamydial and gonorrhoeal infection is common and it is estimated that 11–12% of 16 to 19 year-olds presenting at a specialist SHS with an acute STI will become re-infected within a year.(Hughes et al. 2015) This highlights the importance of PN for the care of both individuals and their sexual partners. This applies to infection detection, reducing onward infection and re-infection, and the complications of infection.

PN has mainly been undertaken by specialist health advisers based in specialist SHS, with these activities documented through the Genitourinary Medicine Clinical Activity Dataset (GUMCAD) reporting. In wider settings, the delivery of PN varies between LAs with some carried out solely by sexual health specialists and with others engaging GP and other providers. GP or practice nurses face specific challenges in PN compared to sexual health services, including treatment of non-registered patients and a lack of staff confidence in discussing issues surrounding sexual health and PN.(Cassell et al. 2015)

There is a drive to improve PN delivery as partner management is 1 of the 4 stages of the CCP, following the BASHH PN Guidance that states 4 auditable outcome measures.(McClean et al. 2012) As set out in the standards, information on the extent of partner notification needs to be collected; however there is no existing reporting mechanism to capture this information outside of specialist SHS.

### 3.3.11 Prevent re-infection (retesting)

Available evidence suggests that individuals diagnosed with chlamydia have an increased risk of subsequent infection, thus it is important that patients are advised to retest. The NCSP introduced, in late 2013, a recommendation that any young person that tested positive for chlamydia should be offered a retest at around 3 months.(PHE, Discussing chlamydia retesting with young adults, 2014) The method of advising and following up with patients requiring retesting varies by provider and will depend on balancing cost and care implications.

## 3.4   The Chlamydia Care Pathway

In light of the local responsibility for delivery of chlamydia screening the NCPS has focused its resources on hands on support for local commissioners to enable them to identify and focus on those aspects of chlamydia screening which need improvement.

Chlamydia screening in England is not simply the provision of testing: it is best conceptualised as a series of essential components, which when combined form the 'Chlamydia Care Pathway' (CCP) (Figure 3.2). The components of the CCP are described in more detail below.

By using the existing data collected by PHE for each step in the pathway, the CCP provides commissioners and providers with a supported and systematic approach to evaluating local chlamydia activities with the aim of improving outcomes for users and services. The CCP describes the individual steps which, when taken together, represent comprehensive case management for an episode of chlamydia testing, diagnosis and treatment as recommended by the NCSP. The CCP tool allows local areas to explore and review local chlamydia activities and to create and instigate data driven action plans to improve service provision and outcomes. Systematic review of each care component against this framework will highlight where resources could be most effectively deployed and where interventions are most likely to result in tangible, measurable improvements.

Effective application of the CCP:

- provides a concise review of the effectiveness of local chlamydia activities
- clearly identifies where improvements can be achieved informing decision making on how to make best use of finite resources
- supports the wider sexual and reproductive health system: this is a supportive process both for commissioners and providers which we hope will support partnership working locally
- is a standardised approach that can be used in any sexual health or primary care setting
- ensures participants receive intensive support from the NCSP team in preparing for the workshop, planning improvements, implementation of action plans, and evaluation
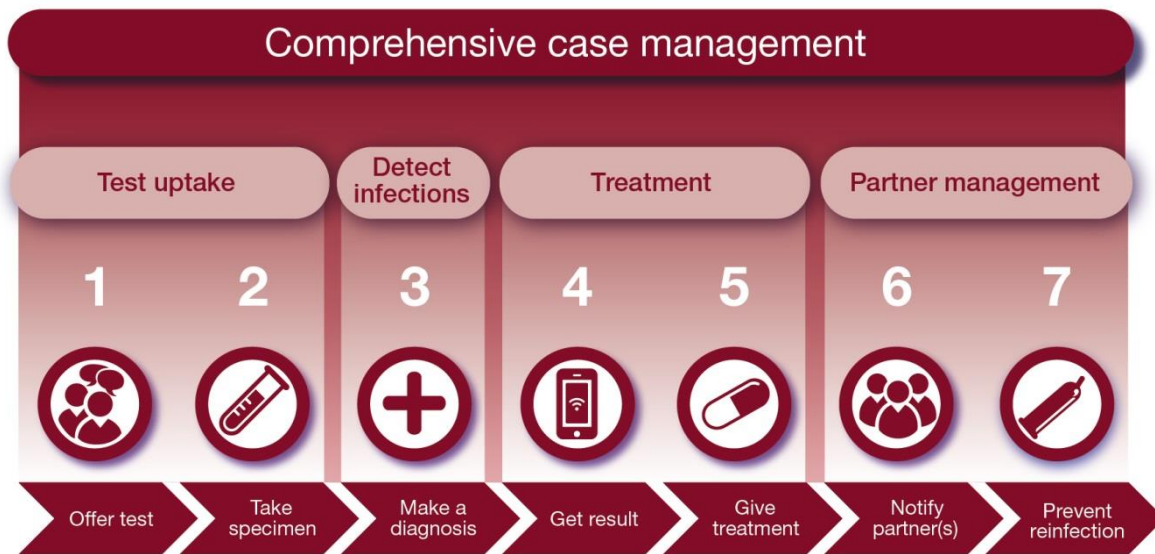
Figure 3.2 Overview of the Chlamydia Care Pathway

### 3.4.1 Offer test

| Recommendation | The NCSP recommends that all sexually active 15 to 24 year olds are offered a test for chlamydia annually or on change of sexual partner (whichever is soonest). |
|---|---|
| Rationale | The rationale for this recommendation is the desire to detect incident and not just prevalent infections in order to have largest impact on health outcomes. Opportunistic screening is focussed on the age group with the highest prevalence of chlamydia (sexually active 15 to 24 year olds).(Sonnenberg et al. 2013)<br><br>Sexual behaviours determine incidence of infection and re-infection and suggest annual screening in those who are chlamydia negative, or sooner if change of partner. |
| Measures | • offer rate: proportion of 15 to 24 year olds receiving an annual test. Defined as numbers offered a chlamydia test by testing service type divided by footfall by testing service type |

### 3.4.2 Take specimen

| Description | Chlamydia screening should be offered across primary care, sexual and reproductive health (SRH) and specialist SHS settings; routine medicals, contraceptive / emergency hormonal contraceptive consultations, abortion referral and 'call' opportunities (eg asthma check), and be supplemented by high quality online remote testing services2. |
|---|---|
| Rationale | The likelihood of a test being performed relies upon several factors relating to the person (patient and practitioner), venue (physical testing environment) and macro level dynamics relating to commissioning landscape (resources, variety of options, integration of services etc.).<br><br>Once a suitable specimen has been provided there are factors relating to the laboratory that impact on outcomes (specimen type, test and platform used, result management etc.).<br><br>There are many opportunities for testing that are not taken, representing missed opportunities for testing.<br><br>Positivity varies by settings. Therefore, it is advisable to first concentrate testing within high positivity settings before commissioning testing in alternative settings. For example, in 2015 positivity in specialist SHS settings was approximately 10.4%, CSHS 9.3%, Pharmacies 8.4%, GP 5.9%, ToP services 6.2%, Internet 8.4%.<br><br>However, it is important to offer testing in a variety of settings as providing tests from only 1 setting leads to a fall in the detection rate indicator. For example, when more than 50% of tests are provided in specialist SHS the DRI starts to fall.<br><br>Therefore, it is recommended that testing is first integrated into specialist SHS and SRH services and then provided through Primary Care (general practice and pharmacy) and the internet before any targeted outreach is considered. This can be conceptualised as a pyramid of testing provision with each layer being saturated before moving to the next level. The order may be driven locally by positivity rates and other factors specific to a region. |

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2 However, remote testing should not be offered to young people under 16 years old, as Fraser competency cannot be assessed under these circumstances. If it appears that a person under 16 has accessed a test without a face to face consultation, a suitably trained HCW must liaise with them in line with local and national guidelines

| Measures | • uptake rates (proportion of those offered a test who receive a test)<br>• coverage (proportion of eligible population who receive a test)<br>• level of integration/normalisation (proportion tests done in core testing service type) |
|---|---|

### 3.4.3  Make a diagnosis

| Description | NAATs must be used as these are the best platform to detect chlamydia infections. The result of the test can be either reactive (positive), negative, equivocal (also referred to as indeterminate) or inhibitory (also known as 'invalid'). The NCSP Standards contain the algorithm that should be followed in the course of chlamydia testing (Figure 3.2). |
|---|---|
| Rationale | For personal and public health benefit is it necessary to detect those with an infection. Cost effectiveness of screening will, in part, depend on the DRI. This is a measure of coverage and positivity, which are both important factors in chlamydia screening but do not incentivise the correct screening activity when taken in isolation from each other. |
| Measures | • DRI (number of detected infections per 100,000 population 15 to 24 year olds)<br>• positivity (total number of positive tests/ total number of tests) |

### 3.4.4  Get result

| Description | Communication of the test result to the person who tested |
|---|---|
| Rationale | All those who have a test for chlamydia should receive their result. In order to receive treatment, the young person needs to be informed of their test result. Time with an untreated infection and infections that are not treated present a missed opportunity and are likely key components of disease transmission, therefore, timely communication of a positive result can aid infection control.<br><br>The way in which a result is communicated varies widely. It is worth considering the method chosen and how this may impact on time to treatment. For example, many services will text a negative result but only text those with a positive result to say the result is ready and ask them to contact the clinic. This may delay treatment in those with a positive result. |

| | |
|---|---|
| Measures | • time from test to result: All those tested receive a result within 10 working days from the date of the test (≥95%) |

### 3.4.5 Give treatment

| | |
|---|---|
| Description | Person with positive chlamydia test receives treatment |
| Rationale | Once an infection has been detected it requires treatment. Time to treatment will have an impact on infection transmission as well as sequelae of untreated infection. Therefore reducing the time between knowledge of a positive test result and receiving treatment is important.

Reducing the opportunities for transmission between testing positive and completing treatment can be achieved by 1) reducing the time between test and treatment (time to treatment), 2) reducing the episodes of unprotected sexual intercourse in that period or 3) both.

The majority of services are able to provide treatment to individuals with a positive test within 14 days. (Public Health England 2014) |
| Measures | • all those with a positive result should receive their result AND treatment within 2 weeks of the test date (≥95%) [proposed combined standard]
• proportion treated (total number index treated/ total number index patients) |

### 3.4.6 Notify partner(s)

| | |
|---|---|
| Description | Process of identifying and notifying sexual partners who may be at risk of infection or be unaware of having an infection. |
| Rationale | A critical part of disease management and interruption of infection transmission is to identify infected partners of those with an infection.

Focussing on partners is a high yield area for detecting infection. Identifying and treating them will limit the risk of re-infection for the index, improve their individual health and prevent onwards.(St Lawrence et al. 2002)

Focussing effort on improving PN outcomes may be more cost effective than increasing coverage of some groups. (Turner et |

| | al. 2011) Doubling the efficacy of PN from 0.4 to 0.8 partners per index case would reduce the costs per infection diagnosed for a limited additional investment.(Althaus et al. 2014) |
|---|---|
| Measures | • % of index cases documented as offered at least 1 discussion, which may be a telephone discussion, for the purpose of PN with a health care worker with the appropriate documented competency (≥97%) (British Association of Sexual Health and HIV 2006)<br>• % of index cases having the outcome of (an) agreed contact action(s), or the decision not to contact, documented for all contacts (≥97%) (British Association of Sexual Health and HIV 2006)<br>• number of all contacts of index cases whose attendance at a Level 1, 2, or 3 SH service was documented as reported by the index case, or by a health care worker, within 4 weeks of date of the first PN discussion (at least 0.6 contacts per index case) (British Association of Sexual Health and HIV 2006)<br>• number of all contacts of index cases whose attendance at a Level 1, 2, or 3 SH service was documented as verified by a health care worker, within 4 weeks of the date of the first PN discussion (at least 0.4 contacts per index case) (British Association of Sexual Health and HIV 2006) |

### 3.4.7  Prevent re-infection

| | |
|---|---|
| Description | Follow up consultation with index patient 2 weeks after treatment and retest 3 months after treatment among those who initially test positive |
| Rationale | BASHH – "Follow up by phone may be both more efficacious and cost effective than by re-attendance. This is an important part of the management of chlamydial infection and it has a number of objectives including: Following up partner notification; re-enforcing health education; ensuring compliance with treatment and abstinence from sexual intercourse until partner(s) have completed antibiotics (if treated with azithromycin waiting 7 days); retreat non-compliant and/or re-exposed individuals." (Apoola et al. 2004, British Association of Sexual Health and HIV 2006) |

| Measures | • proportion of those who initially test positive who are retested 3 months after treatment |
|---|---|

## 3.5 Horizon scanning

The implementation of rapid tests, whereby results are available within 2 hours of a sample being provided, as point-of-care tests (POCTs) where tests are conducted and results and treatment are provided within 1 consultation, would allow for personalised and rapid STI management. In a recent service evaluation of POCT in a SH clinic, patients were unwilling to wait more than 2 hours for their results. The development of diagnostic tests with a turnaround time closer to 30 minutes, with high accuracy, would enable test-and-treat strategies to be implemented and would allow for immediate and accurate patient management, reduced risk of developing sequelae, and less patient loss to follow-up.(Harding-Esch et al. 2017)

In response to the difficulty of providing high quality sexual health services through primary care novel models of service delivery are being piloted. A Bristol based primary care research group are piloting a centralised, telephone-based STI management service for GPs. This model of care ensures that GPs are able to provide effective PN services.(CLAHRC West 2017)

To address issues that were not being commonly reported, the NCSP created a schedule for carrying out an annual audit with a core focus on age, sex and test information (positivity etc.). Each year a single additional output would be measured including time to treatment, partner notification and use of internet testing. It was decided that these 3 additional outputs should be combined into a single annual audit to provide for more detailed evaluations of service delivery.

## 3.6 Summary

The NCSP has undergone significant changes since its implementation and is now very much integrated with other sexual health services. The NCSP has increased testing capacity in England dramatically. In addition the service has supported the uptake of new technologies such as NAATs tests in the early 2000s to the use of internet based services in more recent years.

Over the past 5 years there has been a concerted drive to integrate chlamydia screening into sexual health services as part of an offer of a comprehensive sexual health service. Pressure on councils and providers to do more with less money has also been driving innovative and data driven solutions. In response to this challenge the NCSP advises that service investment is prioritised based on need of the population served as identified by the positivity of the services. The NCSP has a strong drive to improve the quality of care and to increase focus on PN and follow-up retesting of diagnosed patients.

# 4 Public Health England's role in supporting the delivery of chlamydia screening

PHE (and previously HPA) provides national leadership for the programme, including tools, resources and activities to support local implementation of the programme. These fall into the following main categories:

- local delivery support, including CCP and service evaluation
- guidance documentation
- quality assurance
- expert clinical and scientific advice on chlamydia screening
- output monitoring
- outcome surveillance
- communication with professionals
- health promotion and communication with young people

Each of these is described in more detail below, or in subsequent chapters.

When the NCSP was instigated the role of the Health Protection Agency was to oversee the commissioning of the service and the DH provided earmarked budgets to enable the HPA to do this. At that time key support included provision of service specifications, specific policy decision making and monitoring delivery through data and quality assurance. In the intervening years the nature of the programme has changed in line with the restructuring of the HPA into PHE; the new role of PHE in the public health system is described in the appendix. The NCSP has moved from a standalone clinical service to an integrated testing service which sits within the wider sexual health service.

## 4.1  National strategic support

The national NCSP team also provides an easily accessible source of up to date policy, clinical and scientific advice and information on chlamydia and related issues for local public health teams and providers. The clinical lead for the programme is a specialist SHS consultant who provides clinical input into the programme and responds to clinical queries that arise. The clinical lead provides advice to clinical teams and commissioners on a wide range of issues from treatment efficacy, to dual CT/NG testing, to multi-site sampling. The clinical lead also sits on several BASHH committees such as the national audit group and the bacterial STI specialist interest group as a representative of the NCSP.

The NCSP evaluation team have lead responsibility for keeping up to date with current research and evidence on chlamydia and related issues. They are available to respond to specific queries relating to the current evidence base. These queries are often linked to proposed service model changes. The team also provides a monthly publication update on chlamydia related literature. Whilst these updates are not based on full literature searches, they are based on a structured PubMed search.

This support can be accessed directly or via the Sexual Health Facilitators (SHF) team who have direct relationships with both the national team and local providers and commissioners, thereby providing a swift and meaningful response. Figure 4.1 shows the interaction between the various public health stakeholders involved in the NCSP.

Department of Health
- sets sexual health policy in England
- sets public health outcomes framework (PHOF)

↓

Health and wellbeing boards, and directors of public health
- set strategic priorities and objectives through the JSNA
- inform commissioning priorities

↓

Local authority (LA) commissioning leads and sexual health leads
- design of services and clinical pathways
- commissioning and contract monitoring
- commission the chlamydia diagnoses rate indicator within the PHOF and NCSP standards

↓

NHS, third sector and private sector providers
- service delivery in a range of settings

PHE:
-supports DH policy setting through provision of evidence and data
-sets itself own priority areas for action to support delivery of policy objectives and in consultation with external stakeholders
-supports and facilitates the commissioning and delivery of chlamydia screening, treatment and partner notification
- monitors diagnoses rates, coverage, proportion testing positive and testing by venue type
- evaluates impact of screening on incidence of sequelae, prevalence of infection and secondary benefits

PHE function delivered through dedicated national team and regional/ local sexual health leads and facilitators

Figure 4.1 Public Health stakeholders involved with the NCSP and their roles and responsibilities.

The NCSP is also involved with a variety research programmes, such as the Health Protection Research Units (HPRU) at the University of Bristol, University College London (UCL) and Imperial College. The NCSP also collaborates on the development and testing of testing strategies and diagnostic tools in conjunction with St George's, University of London. A full list of research activities and key publications is included in the appendix.

## 4.2   Quality assurance

The NCSP is committed to supporting the highest possible standards in the commissioning and provision of chlamydia screening. The NCSP Quality Assurance (QA) framework has a pragmatic and flexible approach, consisting of a number of components, which combined, enable the NCSP to continue to contribute to quality and service improvement at programme level. These components are:

1.  Standards
2.  Guidance
3.  Audits and surveys
4.  Monitoring incidents and disseminating lessons learnt
5.  Surveillance data
6.  Benchmarking

### 4.2.1   Standards

The NCSP has minimum standards for local implementation of chlamydia screening plans (aligned to those of BASHH on providing sexual health services).(National Chlamydia Screening Programme 2016) They provide a set of quality standards against which local programmes can monitor themselves. These are minimum specifications to help programmes set up local agreements and contracts, and facilitate quality assurance procedures and monitoring.

The standards cover the necessary structures for local programmes, including patient pathways, data collection and quality assurance. The standards have been regularly updated throughout the duration of the NCSP, to reflect changes in technology and the commissioning environment. There are also summary sheets to assist both providers and commissioners with the implementation of the standards.

### 4.2.2   Guidance

We provide guidance and support to both commissioners and providers for applying the standards. Guidance publications can be found online at the gov.uk website under chlamydia screening.

A key aspect of support to local areas by the national team is the provision of a range of guidance on different elements of the programme. These have been developed and updated over the life of the programme in response to needs and gaps identified by our stakeholders – either providers or commissioners. They also reflect the changing focus of the programme from coverage targets to detection rate indicator and an emphasis on all aspects of the pathway including retesting.

Guidance documents are developed in consultation with key stakeholders to ensure they are relevant and practical. Guidance also includes position statements, NCSP programme material and translated patient information leaflets.

Some examples of currently available guidance documents are shown in Box 4.1.

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**Box 4.1: Examples of currently available guidance documents**

- Chlamydia diagnosis rate calculator tool: a simple calculator that local areas may use to assist them in calculating the necessary coverage that must be achieved by each testing service type to reach the recommended diagnosis rate. (Public Health England 2014)
- Chlamydia: commissioning internet based screening: guidance on how to ensure that internet-based chlamydia screening is of high quality and meets the quality standards of the National Chlamydia Screening Programme (NCSP).(Public Health England 2015)
- Chlamydia screening in general practice and community pharmacies: including suggested sections that commissioners may wish to include in their contracts with providers of chlamydia screening (Public Health England 2014)
- Chlamydia retesting discussion guide: provides advice on how to include the retesting conversation within the patient care pathway.(Public Health England 2014)
- Towards achieving the chlamydia detection rate: considerations for commissioning: outlines ways to improve the effectiveness and value for money of chlamydia screening in a LA's population of 15 to 24 year olds. (Public Health England 2014)
- Making it work: a guide to whole system commissioning for sexual health, reproductive health and HIV: aims to support all those commissioning sexual health, reproductive health and HIV services in the new environment. It highlights the importance of putting service users and their needs at the heart of commissioning to ensure they experience integrated, responsive services, and emphasises the importance of tackling the wider determinants of health. (Public Health England 2015)

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Detailed guidance documents on the Chlamydia Testing Activity Dataset (CTAD) surveillance system are also available (Chapter 5).

### 4.2.3  Audits and surveys

Clinical audit is a key component of the NCSP's quality assurance framework. Since the full implementation of the programme there have been annual audits on a range of topics relating to patient management (Figure 4.2).
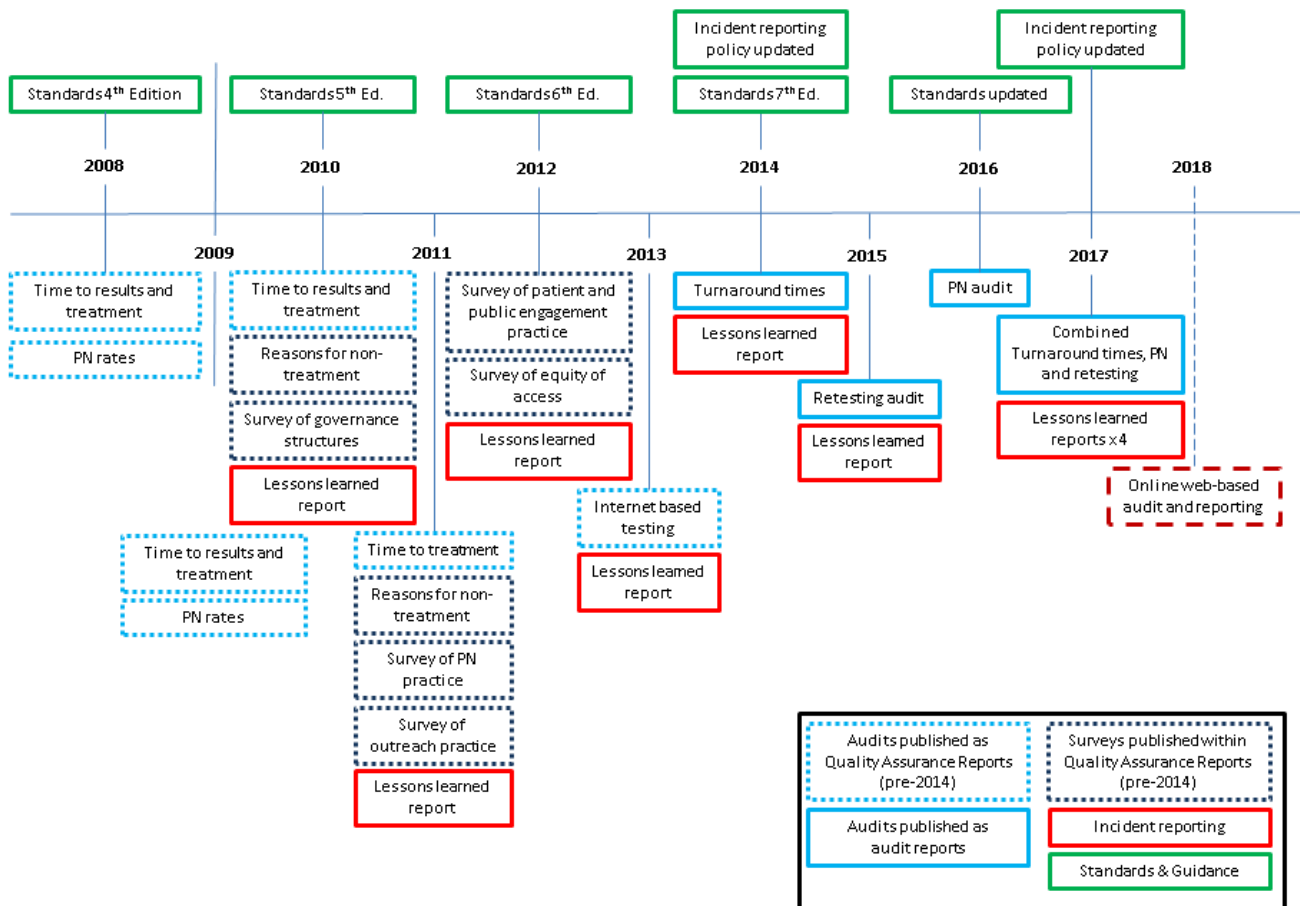


Figure 4.2. Timeline of audits undertaken by the NCSP.

Between 2008 and 2013, annual Quality Assurance Reports were published. These reports contained findings from audits, re-audits and surveys on a range of governance and process issues. During this time period, local programmes were responsible for analysis of their own data and reporting whether or not they met the defined standards.

From 2014 onwards, there was a change in audit methodology. Local programmes completed an audit tool which was then returned to the NCSP QA team for analysis. Local audit results are fed back to the relevant areas and a national report is published with results for England as a whole. This audit data is also used to populate relevant components of the Chlamydia Care Pathway data packs. Audit tools are made available for services to download from the gov.uk website. These audit tools present key outputs against performance standards as well

as more detailed information in a number of tables and charts. This facilitates services to undertake self-assessments, or measure progress when implementing changes outside of the NCSP annual audit cycle.

In 2017 the existing audit tools for turnaround times, partner notification and retesting were combined into a single audit tool. This reduced the need for duplicating data entry and allows services to audit against multiple standards without having to conduct multiple audits. In addition, a web-based audit tool is being developed that will allow areas to assess performance against these 3 audit outcomes. It is anticipated that this web-based approach will be ready to pilot in 2018.

### 4.2.4 Monitoring Incidents and dissemination lessons learned

The NCSP monitors incidents in relation to the programme and disseminates anonymised 'lessons learned' reports when required.(Public Health England 2015) The summaries show what went wrong, how it was investigated locally and what was put in place to prevent it from happening again. Our Incident Reporting Policy has recently been updated (April 2017) to ensure it is in line with the latest development in governance arrangements between commissioners and providers and national bodies involved in managing incidents. It does not replace existing local reporting procedures.

We do not get involved in local incident investigation and management, but we will offer support if local investigations do not lead to satisfactory outcomes. Numbers of incidents that are reported appear low (given that between 1.5 and 2 million chlamydia tests are undertaken annually), there were 3 in 2013-2014, 4 in 2014-2015, 6 in 2015-2016, and 1 in 2016-2017. As a national team, we are uniquely positioned to disseminate these, allowing providers and commissioners to check their local arrangements and minimise the risk of similar incidents occurring elsewhere. Through our network of sexual health facilitators and the national team attending local meetings, we continue to encourage the reporting of incidents to us.

Examples of summarised lesson learned reports are:

- test request forms that went missing
- request form with an altered date of birth
- computer system upgrade failure
- discarded test samples

### 4.2.5 Surveillance systems

PHE maintain 2 relevant surveillance systems, CTAD and GUMCAD,(Health Protection Agency 2011, Health Protection Agency 2012) are used to inform service improvement. The SHF team has ongoing discussions in local areas about their data, including the quality of the data. Both CTAD and GUMCAD are essential to populate 4 out of the 7 steps in the CCP, which are used to facilitate workshops in local area to determine which parts of the pathway work well and where improvement is required.

### 4.2.6 Output monitoring / surveillance

Output monitoring data on number of screens and diagnoses by LA, testing service type, gender and age; plus information on data quality are available to commissioners and providers via the HIV/STI portal on a quarterly basis. Annual testing and diagnosis data are available through the Sexual and Reproductive Health profiles,(Public Health England 2017) allowing comparisons to be made over time and between areas. This is a very valuable resource for local areas to understand their local epidemiology and assess the impact of local activity. More detail on this is provided in the Chapter 5.

### 4.2.7 Benchmarking

The NCSP continues to use benchmarking so service providers and commissioners can assess their performance in order to inform service improvement. By identifying areas that perform well on certain auditable outcome measure or in other elements of the CCP, we can further drive quality improvement. We do this through data analysis as well as in our design and reporting of audits. NCSP audit tools apply to different screening settings and venues and facilitate benchmarking against performance standards, or for example the standard achieved by the top 10% of audit participants.

### 4.2.8 Education and learning

Members of the national team attend local programme area meetings when requested. These occasions often contain an element of education and learning for example when audit findings are presented or a team's dedicated teaching sessions is used to work through their CCP indicators. These opportunities are used to explain concepts such as positivity, chlamydia detection rate, and principles of information governance and data quality.

We also continue to work with related organisations in sexual health including BASHH, Faculty for Sexual Reproductive Health (FSRH), the British HIV Association (BHIVA), and the Healthcare Quality Improvement Partnership (HQIP).

## 4.3 Local delivery support

### 4.3.1 The Sexual Health Facilitator Team

The national NCSP team includes a team of 9 Sexual Health Facilitators (SHFs) who support local areas in the effective and efficient commissioning and delivery of sexual health services, including chlamydia screening. The SHFs are managed directly by the NCSP nationally and are located in each of the 9 PHE Centres across England (Figure 4.3).

## Sexual Health Facilitator Team

PHE's Centres- local presence

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Figure 4.3 Geographical Distribution of Sexual Health Facilitator Team

The role of SHFs has changed greatly since the inception as part of the roll out of the NCSP. Originally the SHFs were focused solely on chlamydia screening, working directly with chlamydia screening offices and screening managers. Local programmes developed various aspects of screening strategies and processes with guidance from the SHFs.

After the implementation of the Health and Social Care Act in 2012,(Government of the United Kingdom 2012) there was a strong push to integrate within core services; as local authorities took on more elements of sexual health service provision, the existing network of SHFs was utilised to support local decision making on a range of sexual health issues. This led to changes in local networks and meetings; evolving from chlamydia screening meetings to larger meetings with commissioners, providers and voluntary agencies that cover a wide range of topics, including termination of pregnancy, contraception and other STIs. They enabled an emphasis on community outreach compared to the standard sexual health services that had existed prior. SHFs developed and linked with wider sexual health professionals, enabling a focus on making sexual health accessible for young people.

The SHFs maintain relationships with their local commissioners and providers. The team works with all LAs in their area, with support being tailored for each LA depending on local needs and level of input required. Whilst PHE's primary relationship is with each LA public health teams, the SHFs will also work with local providers and clinicians, NHS England colleagues, non-governmental organisations (NGOs) and community based organisations (CBOs) with relationships with Clinical Commissioning Groups (CCGs) being mediated by LA public health colleagues.

This allows 2-way communication of potential impacts of new policy and also provides an opportunity for commissioners to raise incidents or concerns felt in their LA. This has in turn led to an expanding role for SHFs with their time being split across HIV, ToP, contraception and STIs; chlamydia now only makes up a small part of their roles. This has led to chlamydia screening being seen as part of the sexual health services rather than a standalone programme as it was previously. They will also take issues raised by other partners within the network and feed this up to the NCSP, PHE and the Government to try and mediate any problems.

The range of support provided by the team will include, but is not limited to:

- Provision, support and training in use of sexual health data and other national resources
- Support for implementation of national programmes; reviewing efficiency and effectiveness of programmes, including the CCP
- Facilitating or supporting local commissioners and provider networks
- Education and training events on sexual health issues of current concern
- Bespoke support for local areas, including building capacity especially with those new to sexual health commissioning
- Advice around service redesign and service innovation, ensuring service specifications are in line with national guidelines and best practice, and that service design is based on available evidence
- Supporting the improvement of data quality for key sexual health surveillance systems
- Sharing evidence of what works from national and international data, case studies and events – drawing on the knowledge and expertise of the both fellow SHFs and the wider NCSP team.

See also Section 5.3.5.

The NCSP team also provides support to the long established English Sexual Health Commissioners Group. This is a network which brings together sexual health commissioners (primarily LA commissioners) 3 times per year, and provides an online forum for advice and information. This is a key mechanism by which the NCSP is able to communicate with, and seek views and input from, LA commissioners.

The SHF team contribute to a range of activities at local, PHE Centre and national level (The structure of PHE is explained in the appendix). These activities are reflected in PHE internal delivery plans and progress is monitored through relevant governance arrangements.

The work of the SHF is integral to delivery of the CCP, as outlined below.

### 4.3.2  Application of the CCP

For each step of the pathway, specific outcomes and indicators have been defined in order to help highlight steps where more attention may be required (Section 3.4). This helps guide local action planning and allow those using the care pathway to benchmark and measure the impact of all changes made.

To support the application of the CCP the NCSP team have developed a CCP Tool. This tool presents the relevant data for each component of the CCP and is used as the basis for discussions with local areas. It uses both national surveillance data, as well as local audit data and allows the assessment of service quality at each step.

During 2016-2017, a total of 28 workshops were delivered. These were attended by 127 out of 152 LAs, representing 84%. Nearly half (13 out of 28) of the workshops had a combined attendance of both commissioners and providers covering multiple programme areas, which enabled sharing of practices in a wider forum. In addition, there were a further 8 workshops which were combined commissioner/provider for 1 area only, allowing for frank discussions between local key stakeholders. A total of 324 delegates attended the workshops, consisting of 189 providers and 135 commissioners. Participant feedback has been very positive: 86% found the CCP approach 'very good' or 'excellent'.

## 4.4   Health service evaluation

The NCSP supports LAs to undertake evaluation of sexual health services and interventions. The most common form of this is through advice and support from members of the SHF team to commissioners and providers, although other members of the NCSP team are often involved. This is generally done on an ad-hoc basis, with input ranging from provision of advice on design and evaluation of services to assistance with data analysis or more comprehensive input to an evaluation framework. Examples of such input include:

- advising on evaluation of text message service to increase uptake of retesting (Angel et al. 2015)
- evaluation of an online chlamydia testing service using service and national surveillance data (Hollis, submitted)
- evaluation of a pilot of internet requested Chlamydia test kits in 25 - 34 year olds (Shaw et al. 2016)
- excellence in chlamydia screening outcomes on a shrinking budget (Foster et al. 2015)

In some instances, evaluation of specific interventions or components of the screening pathway has taken a more formal approach. For example in 2013-2014, PHE (the NCSP and PHE Primary Care Unit) led the implementation and evaluation of a national pilot of an educational intervention in general practice, known as '3Cs&HIV'. The intervention was

designed as a follow-on from a randomised controlled trial (McNulty et al. 2014) and aimed to improve GP staff's skills and confidence to increase chlamydia testing rates, provide condoms and contraceptive information (3Cs) plus HIV testing according to national guidelines.

The pilot was implemented using a step-wedge design and incorporated quantitative and qualitative evaluation.(Town et al. 2016) Although the programme was offered to a large number of GP practices across England, chlamydia screening did not increase. A qualitative follow-up study found that attendee numbers were low, the intervention content was not adhered to such that practice staff were unaware of ongoing trainer support, chlamydia kits were not always available to clinicians and when they were, patients were not encouraged to complete the test immediately and supporting material such as videos and posters weren't used.

## 4.5    Evaluating the impact of the NCSP

Local areas rely on the national team to provide information on the impact the programme is having on prevalence of chlamydia and its sequelae. Some data on pelvic inflammatory disease (PID) and ectopic pregnancies are available on the Sexual and Reproductive Health profiles; however interpretation of these data in relation to chlamydia screening activity at a local level is complex. More detail is provided in chapter 5.

## 4.6    Health promotion and patient and public involvement

Until 2016, the NCSP's main online presence for young people was its own dedicated, bespoke website developed with public involvement and review. Following the inception of PHE, all legacy websites, including public facing sites, have been migrated onto gov.uk for professional audiences and NHS Choices for public audiences. NHS Choices now provides the key source of information on chlamydia and signposting to local services for young people.

The PHE twitter account is the official feed of Public Health England, providing news updates on the work of the organisation. The NCSP team have posted on this in a timely manner for example when EastEnders (UK TV soap opera) ran a chlamydia storyline.

The NCSP produces a patient information leaflet for young people who are being offered a chlamydia screen.(Department of Health 2009, TNS-BMRB 2010) This was originally developed as part of a NCSP public involvement activity with the input of young people and subsequent revisions were shared with young people for input. This leaflet is available on the gov.uk website for providers to download and print off for use with patients.

Local service providers also produce their own materials on chlamydia and related issues aimed at young people. PHE is not responsible for the content of these materials but would always encourage people to reference information available through the NCSP. We do not have capacity to comment on materials produced by other bodies. A small selection of information from local providers can be found at Royal Cornwall Hospitals NHS Trust;

Checkurself; Leeds Sexual Health. Information is also available via national broadcast websites including Channel 4 and the BBC.

Probably the most significant, and certainly the most large scale health promotion activity linked to the NCSP was the "Chlamydia – Worth Talking About" mass media campaign launched in 2009. This was part of a wider "Sex – Worth Talking About" campaign aimed at young people that also focused on contraception, teenage conceptions and condoms.(Department of Health 2009) This campaign included TV, radio, online, print media and advertising activity with the aim of raising awareness, encouraging conversations about chlamydia, normalising testing and increasing the number of young people aged 15 to 24 years having a chlamydia test.

The campaign was successful in raising awareness of chlamydia (Department of Health 2009, TNS-BMRB 2010); and there was an association between the campaign and increased testing of high risk individuals.(Gobin et al. 2013) As part of the "Chlamydia - Worth talking about" campaign, the NCSP developed a Facebook page ("Say yes to the test") with the aim of encouraging young people discuss chlamydia screening. As of March 2017 this Facebook page still has over 50,000 likes, although the page has not been actively used or monitored since 2010.

There has been no national mass media campaign on sexual health aimed at young people since "Sex – Worth Talking About". PHE has recently completed the initial scoping phase to decide the focus for a potential social marketing campaign in 2017. Based on a consideration of PHE priorities within the sexual health field, and the research undertaken, we expect the campaign to be aimed primarily at young people and to focus on condom normalisation, as part of a wider suite of education and action around STI prevention.

The NCSP maintained a phone line and an email inbox, which provided a mechanism for professionals and young people to raise queries about the programme and were managed by the national team with local queries being passed on as appropriate. A review of activity was undertaken in 2016 and the decision was made to close the phone line. The email box remains current and is monitored on a daily basis. The inbox receives a small number of queries each month, mostly relating to local service delivery, eg provision of results and requests for resources. The majority of queries relate to data, such as CTAD requests, (24%) followed by requests for resources (posters, testing kits, leaflets) (21%), and 'professional queries around managing patients' (13%).

Since its inception the NCSP has worked with the public in a variety of ways to shape the development of the NCSP in a meaningful way. At the national level, the development of patient information leaflets involved extensive public involvement, and members of the public, in particular young people as service users have been engaged in various research studies soliciting feedback on their experience with the NCSP. In local areas it is expected that the

local health service will be engaging members of the public in their own Patient Involvement, Participation and Engagement activities.

## 4.7   Horizon scanning

In response to findings of the Survey of Commissioners of Sexual Health Services, PHE is developing tools and guidance for undertaking service evaluations. This guidance will ensure that local teams are able to undertake meaningful evaluation of novel service delivery models and to share best practice efficiently. This will enable local chlamydia screening services to evaluate novel delivery and care models and to share best practice and lessons on activities which were ineffective.

## 4.8   Summary

The direct support for local chlamydia screening services has changed from a model of delivery oversight to delivery insight. The current NCSP service aims to provide local teams with high quality measures of the key aspects of their service delivery and outputs as well as reviewing best practice and the evidence underpinning policy recommendations. A recent focus has been on improving the Chlamydia Care Pathway, by providing LAs with data, tools and training to identify and address areas needing improvement.

# 5 Data collection

CTAD enables unified, comprehensive reporting of all chlamydia data to effectively monitor the impact of the NCSP through estimation of population testing coverage, percentage of all tests that are positive and detection rates. PHE release a variety of quarterly and annual reports that present data on STI services and diagnoses in a variety of different ways and are available to a variety of different audiences.

## 5.1    Surveillance history

Genital chlamydia is not a notifiable disease in England and data on testing and diagnoses required to support monitoring of the NCSP is captured through active surveillance systems. Surveillance and monitoring systems for chlamydia and other STI have evolved since the NCSP was launched. Initially data on chlamydia testing and diagnoses were collected through 3 information systems. These were:

- the National Chlamydia Screening Programme core data return, which began in April 2003. This collected disaggregated data on all tests/screens carried out in healthcare and non-healthcare sites which were registered with the programme, and reported data on those screened using an approved NCSP form. This was labour intensive as it required over 100 CSOs to send NCSP disaggregate data to the then HPA.
- the Genitourinary Medicine Clinic Activity Dataset (GUMCAD) surveillance system-still in use, and which replaced the aggregated KC60 return in 2009; collects disaggregate data on all chlamydia diagnoses made in specialist SHS, including GUM clinics.
- the non-NCSP non-GUM (NNNG) aggregate laboratory data return, which was launched in April 2008 and was a voluntary reporting system, reports aggregated laboratory testing data, compiled by laboratories themselves, CSOs or PCTs, on chlamydia testing among those aged 15 to 24 years performed outside of GUM clinics and not reported on the NCSP form.

Prior to 2012, data from these sources were combined to estimate total chlamydia testing coverage and diagnoses in England; however they did not provide comprehensive disaggregate data and collection was resource intensive. In 2012 NCSP created and implemented the Chlamydia Testing Activity Dataset (CTAD) to enable direct laboratory based reporting to the HPA (now PHE).

## 5.2    CTAD Surveillance System

The Chlamydia Testing Activity Dataset (CTAD) Surveillance System collects data from all laboratories which are NHS or LA commissioned to carry out chlamydia testing in England (Figure 5.1). In 2016, 116 laboratories reported to the CTAD surveillance system.
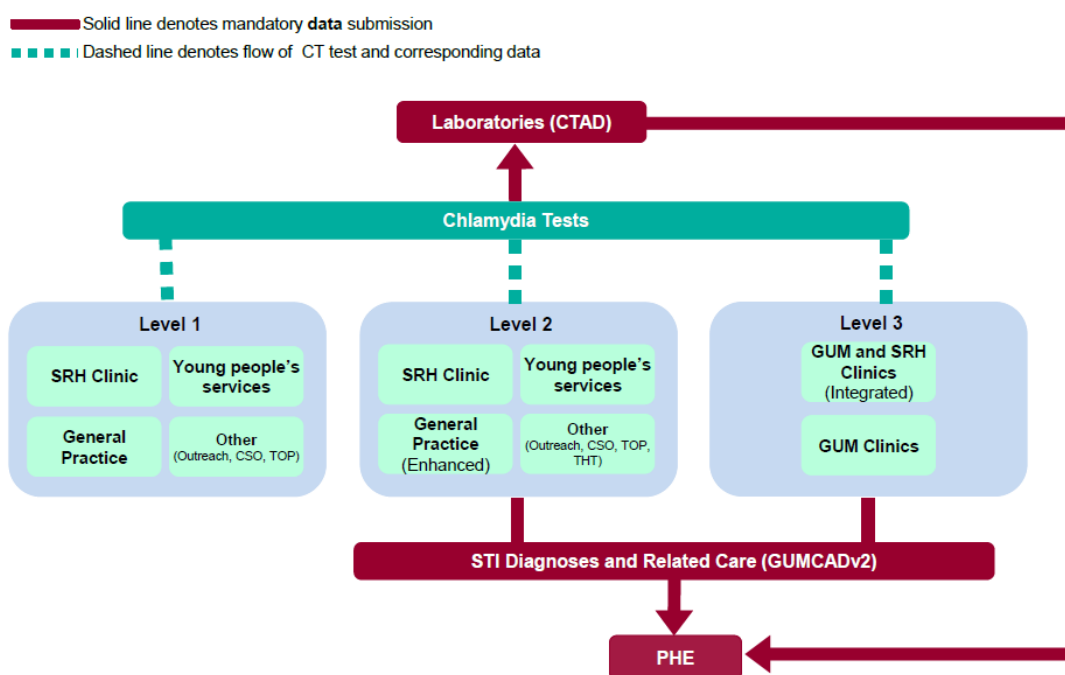


Figure 5.1 Data submission pathway summary for GUMCADv2 and CTAD

### 5.2.1 Data collected

CTAD collects testing and diagnoses data from all publically commissioned laboratories. It also collects simple demographic data including gender, age and ethnicity and sufficient identifiers to de-duplicate records.

The data collection was approved by the Information Standards Board (now Standardisation Committee for Care Information, SCCI) and is considered mandatory for laboratories to report. Any changes required to variables or coding must go through the amendment process which is managed by SCCI.

### 5.2.2 Data submission

Laboratories create a disaggregate extract from their local IT systems, based on the CTAD specification.(Health Protection Agency 2011) They submit this to PHE each quarter via a secure online HIV & STI Web Portal (HSWP) (Table 5.1). The web portal submission process incorporates automatic validation checks on data extracts to ensure they comply with basic data integrity rules on format, coding and conflicts.

Further checks and amendments are made after all the data have been received each quarter to enforce additional data integrity rules, referred to as 'data cleaning'.
The most important steps taken in cleaning the data are:

- deduplication within 42 days: Only 1 test is kept for an individual within a 6 week period. Tests with a positive result take precedence over a test with a negative result. This is standard amongst PHE surveillance systems.
- deduplication of multisite tests: A patient may have a sample taken for more than 1 anatomical site in 1 testing episode. For example, a patient may be tested for genital, rectal and pharyngeal chlamydia; the laboratory would report these as 3 separate tests (distinguishable using "specimen type" variable) to CTAD. The cleaning process would flag 2 of the tests as duplicates, preferentially keeping a positive in the final data for publication.
- attributing each test to a local authority area: NCSP monitoring is presented on the basis of patient area of residence. During cleaning area is assigned using available data according to the following algorithm of preference: postcode of residence; postcode of GP; testing service postcode; GP code postcode; venue code postcode; NCSP clinic postcode.
- the Demographic Batch Tracing Service (DBS) is used to supplement the data collected through the patient postcode, GP postcode and GP code variables The CTAD team provide NHS number and date of birth for records missing a patient postcode to the PHE Information systems team who then use the DBS system to ascertain missing area of residence data.

## 5.2.3 GUMCAD substitution

Due to the longstanding legal right of patients in England to have truly anonymous STI testing specialist sexual health services (SHS) do not share patient identifiable information (PII) such as postcode of residence data with laboratories when requesting tests due to the confidentiality offered by these services. The open access nature of specialist SHS, and the cross boundary flow of service users, means that the specialist SHS data in the CTAD surveillance system cannot be attributed to a patient LA of residence, only LA of the service.

Specialist SHS do, however, share LSOA of patients' residence (which can be mapped to LA of residence) with PHE through the GUMCAD surveillance system.(Public Health England 2016)

To enable all chlamydia data to be available by patients' LA of residence, CTAD specialist SHS data are stripped from the CTAD surveillance system and substituted by GUMCAD specialist SHS data as shown in figure 5.2 below. This process is carried out by the CTAD surveillance team on a quarterly basis.
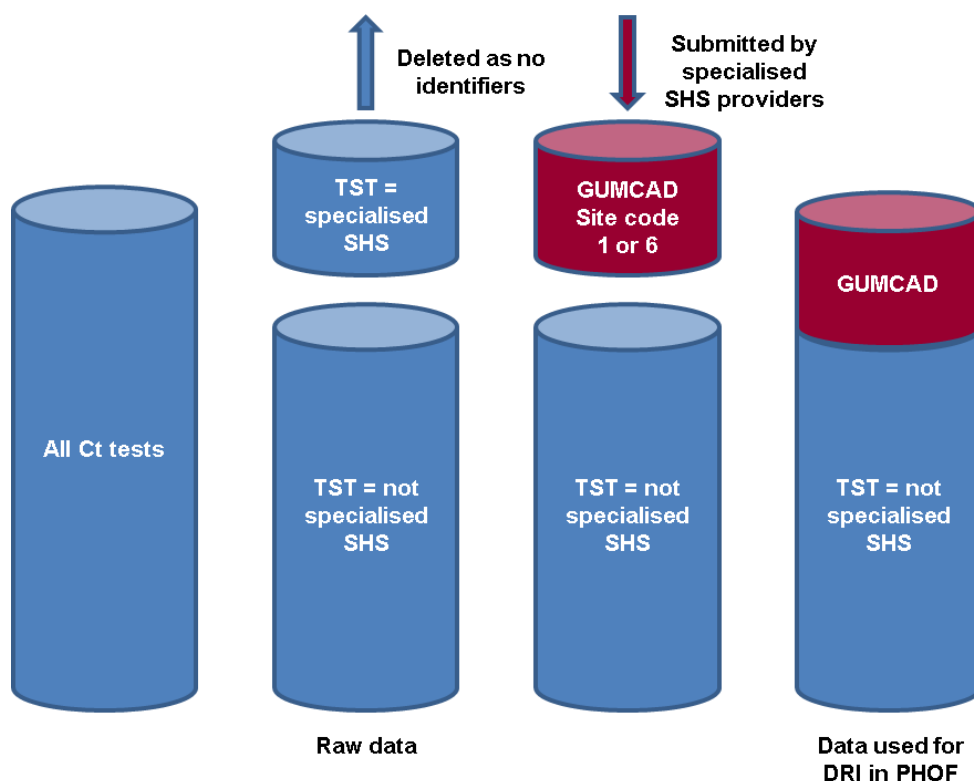
Figure 5.2 Restructuring process for data

## 5.2.4 Publication schedule

Annual calendar-year NCSP data are Official Statistics, and are published in June/July each year, together with other PHE STI data publications. Data for quarters 1, 2 and 3 are published around 12 weeks after the end of each quarter, for example data for Q1 January–March are released at the end of June/beginning of July. October–December data are released together or after the annual data publication to comply with Official Statistics data sharing restrictions.

Data users may request additional breakdowns of the data that are not included in the published data tables or available on the web portal by completing a data request form and sending it to the dedicated CTAD team email. The data team aims to provide the data within 2 weeks but this may be longer during busier periods such as after the annual data release.

Table 5.1 provides details on the regularly published NCSP outputs along with information on their usage, source and restrictions on access.

## Table 5.1 Routine NCSP data outputs

| Output | Source | Release | Information | Level of data | Availability | Usage |
|---|---|---|---|---|---|---|
| Sexual and Reproductive Health Profiles | Online tool | Annual | Range of topics including teenage pregnancy, abortions, contraception, HIV and STIs, as well as the wider influences on sexual health (alcohol/drug use). | Local Authority, PHE centre, PHE region, England. | Public, front facing website with no access restrictions. | The Profiles assist in commissioning and Joint Strategic Needs Assessment (JSNA) at the local level by providing interactive maps, charts and tables. |
| Health Protection Report (HPR) | NCSP website | Annual | Trends in testing coverage, percentage of tests that are positive and the chlamydia detection rate. | Local Authority, PHE region, England. | Published on main public accessible NCSP website with no restrictions. | Provides a commentary and interpretation on the NCSP data tables that are published at the same time. |
| HIV and STI Web Portal | HIV and STI web portal | Quarter | Chlamydia tests and diagnoses by demographic and service type breakdowns for a chosen time period.<br><br>Laboratories also upload their data onto the HSWP for quarterly submission to CTAD. | Local Authority, PHE region, England. | Released on web portal with access restricted to authorised users. | Users, such as LA sexual health commissioners, NSCP team members and SHFs, can generate reports that are downloadable in excel and PDF formats. |
| Local authority sexual health, reproductive health and HIV epidemiology reports (LASERs) | HIV and STI web portal | Annual | Local level data on testing and diagnoses of STIs and HIV, as well as clinic attendances and other services provided, with analyses and breakdowns by small geographical area and key STI prevention groups. Data | Local Authority. | Released on web portal with access restricted to authorised users. | To describe STIs, HIV and reproductive health in the local area to inform JSNA so that commissioners can effectively target service provision. |

| | | | on contraception, with some conception and abortion statistics included. | | | |
|---|---|---|---|---|---|---|

## 5.2.5 Information governance

PHE surveillance data collections and other public health staff have specific permission granted by the National Information Governance Board (NIGB) in 2011 under The Health Service (Control of Patient Information) Regulations 2002 (Government 2006) (also known as 'section 251 support') to process identifiable data for public health purposes where neither full anonymisation nor consent are practicable.

Patient identifiable information is securely retained within PHE servers in accordance with Code of Practice for Information Security Management, BS ISO/IEC 27002; and is only accessible to individuals involved in processing and validating the data.

Aggregate data on tests and diagnoses by service and age/gender population groups are available via a secured restricted access web portal to individuals who need access to commission and monitor sexual health services.

## 5.2.6 Relevant documents

More detailed information on CTAD and GUMCAD surveillance can be found in the following published documents:

- CTAD specification and technical guidance (Public Health England 2015)
- CTAD commissioning guidance (Public Health England 2015)
- GUMCADv2 technical guidance and specification (Health Protection Agency 2012)
- Guidance on chlamydia test and diagnosis reporting in CTAD and GUMCADv2 (Public Health England 2016)

## 5.3   Data quality

It is important that the surveillance data used to monitor NCSP activity are of a high quality because:
- high quality data ensure the PHOF indicator (national and LA level) and other measures used nationally and locally such as percentage coverage and test positivity, are an accurate representation;
- high quality data supports planning and evaluation of services locally and can inform policy decisions locally and nationally;
- high quality data submitted to PHE reduces the need for parallel local data collection processes and can lead to resource savings locally.

CTAD evaluation began in 2010-2011, the capturing and submission of CTAD data started in January 2012. The capturing of NCSP and NNNG data continued until September 2012, providing 9 months of parallel surveillance, to check that CTAD was capturing all the required data. This early evaluation showed that data quality needed to improve. Whilst the data collection provided an accurate measure of the number of chlamydia tests performed (as all laboratories were submitting data), the quality of data reported for i) patient postcode of residence required for accurate allocation of tests to LA of residence and ii) testing service type required for accurate reporting of data by testing service were poor for some laboratories. To address these issues the national CTAD team set up a data quality improvement work stream and was included in the HIV&STI Department business plan. The work stream aimed to increase the quality of the data and increase user confidence in the accuracy and utility of the surveillance data.

### 5.3.1 Quality monitoring

The NCSP CTAD commissioning guidance sets out the standards expected and indicators were developed to monitor these.(Public Health England 2015) Quality measures and outputs are shared through:

- data quality and completeness reports on the web portal: Users are able to select a laboratory and a time period and generate a report to show the completeness of variables and coding breakdowns, ie percentage of records with a test date; percentage of tests by specimen type.
- quarterly data quality bundle: a comprehensive set of resources that provide quarterly and annual trend data on quality indicators. The bundle is uploaded onto a file sharing section of the web portal for download by SHF and FES regional colleagues.
- meetings: data quality is discussed and progress presented at a variety of internal and external meetings:
    - o sexual health data subgroup quarterly teleconferences between surveillance colleagues in regional FES teams and PHE Colindale HIV & STI surveillance leads
    - o data quality action planning and progress catch ups with SHF team members (see below for further details)
    - o CTAD steering group
    - o NCSP team meetings thrice yearly
    - o English commissioners meetings 3 times a year: national level updates provided when required.
- conferences and events: data quality improvement work has been presented at 2 conferences to date: i) PHE applied epidemiology conference in Warwick 2016 ii) PHE Quality Event in 2017. Dissemination of data quality work via these means supports the sharing of best practice.

### 5.3.2  Improvement work

To determine which laboratories to focus improvements efforts on The CTAD team analyse data submissions to identify the laboratories with the poorest quality submissions to direct the team's quality improvement efforts with laboratories, with the support of local SHF and FES teams. Benchmarking against other laboratories and regions are also used. This improvement process is a cycle involving interaction between the national CTAD team and key stakeholders around the country (Figure 5.3).



Figure 5.3 CTAD data quality improvement cycle

The CTAD team undertake a range of actions to monitor and improve data quality and train local and regional PHE colleagues in CTAD data quality issues. They develop data quality reports, log issues, actions taken and outcomes and organise data audits if necessary to clarify the cause of any discrepancies. These 'lessons learnt' reports are published online as part of the NCSP quality assurance framework. If there are issues with submissions, they request resubmission of data to correct problems.

The team engage locally to improve data quality and build trust to ensure that LAs place data quality on their local risk register. This involves holding data quality meetings with relevant local teams and checking that existing contracts and reporting forms meet CTAD requirements.

### 5.3.3 Quality outcomes

There have been substantial improvements in data quality since the work stream began. A major improvement has been in the completion of a key indicator- postcode of residence. Completion of this variable for non-specialist SHS tests in England improved from 67% in 2012 to 85% in 2016. The difference between the number of tests carried out in specialist SHS added though GUMCAD and those removed from CTAD has reduced from 8,224 (5.7%) in 2012 to 4,427 (3.5%) in 2016.

To improve the accuracy of the substitution of GUMCAD and CTAD specialist SHS data, organisation data service (ODS) codes form the NHS were included. These codes identify organisations across health and social care. Since this was introduced in January 2016, completion of this variable has increased from 28% to 85%.

### 5.3.4 Engagement with internal and external stakeholders

Collection, validation, and quality assurance of the CTAD surveillance system requires PHE to liaise with a broad range of internal and external stakeholders.

#### 5.3.4.1 Data submitters

The CTAD team at PHE are in direct contact with laboratory personnel who submit data to CTAD. When a laboratory has a problem submitting or has a submission rejected they are able to contact the CTAD team by email or phone for assistance. The web portal generates automatic emails to submitters to remind them of upcoming deadlines. It also emails after data has been submitted to indicate completeness and confirm whether or not it met the required standard too be accepted into the database.

#### 5.3.4.2 Field epidemiology services (FES)

PHE regional FES teams are engaged with the surveillance system on a number of levels. They assist during the annual publication process in checking and validating the data, work with SHF and national CTAD team members to resolve data quality issues and publish regional outputs using the dataset. The CTAD team work with the GUMCAD team to jointly run Masterclass seminars to support the FES teams by focussing on the dataset background, cleaning and analyses and data quality. The CTAD team support regional FES colleagues through an induction process when requested.

#### 5.3.4.3 Sexual health facilitator (SHF) network

The SHF team are engaged with local commissioners and providers and are therefore key to resolving local CTAD data quality issues. As they are embedded within local PHE Centres and sexual health forums, they are in a good position to liaise with our stakeholders. Through this network we are able to disseminate information related to the CTAD surveillance system and data quality and also request feedback.

### 5.3.4.4    Steering group

The CTAD steering group met regularly during the development and implementation phases of the CTAD surveillance system. The group now only meet when there is an upcoming change, most recently in 2015.

### 5.3.4.5    Communications with professionals

In addition to the data activities described above, PHE (and previously HPA) has undertaken a range of activities since the programme's inception with the aim of engaging with health care professionals and those responsible for commissioning chlamydia screening activity. In order to improve the knowledge and understanding of those working on chlamydia screening and care the NCSP team communicate through a wide range of mechanisms. Some examples of work undertaken during the life of the programme are shown in Box 5.1.

**Box 5.1: Examples of PHE communication with professionals**

- presentations, workshops and talks at national and local network events and conferences including British Association of Sexual Health and HIV (BASHH) annual conference
- annual NCSP conferences were held in the earlier years of the programme with the last national chlamydia only event aimed at commissioners and providers being held in 2013
- national chlamydia annual reports published from inception until 2011.
- 'Chlamydia Connects' newsletter - well regarded regular newsletter with large opt in mailing list. This newsletter ceased as a result of new guidance on newsletter activity following formation of PHE in 2013. Other regional newsletter such as the North West Sexual Health Newsletter also provide vehicles for disseminating information about chlamydia screening
- participation in training and teaching events and workshops on request
- leading workshops on key research issues relevant to chlamydia screening with international academic colleagues, for example, meeting on use of Ct serological methods as a tool for epidemiological surveillance and research (Oxford 2016)
- roundtables held with professionals on the importance of chlamydia screening and discussions published in key professional
- formal consultation exercises to inform NCSP standards and recommendations, for example, on change of recommendation on retesting of those who have tested positive (December 2012)
- professional champion role to promote screening in general practice and community pharmacy included front line support as well as articles in professional journals as well as attendance at local, regional and national events

## 5.4   CTAD surveillance system: commentary

The switch to the CTAD surveillance system from the previous 3 systems in place has led to a reduced overall workload on local areas. The CTAD laboratory based information is more efficient as currently, all tests are processed through laboratories. Quarterly submission and publications enable regular monitoring of activity.

The surveillance system reports on diagnoses and tests, and thus a broader range of outputs and useful intelligence can be taken from analysis of the surveillance system, compared to other PHE systems that only collect diagnoses, for example second generation surveillance system (SGSS). This is of particular importance for chlamydia, where testing coverage needs to be high and include asymptomatic testing in order for infections to be detected and prevalence reduced in the population at highest risk of infection.

Many parts of the country commission chlamydia testing from private laboratories that hold contract with several local authorities. While these laboratories should comply with the mandatory reporting systems, in reality the CTAD team has had to work with SHFs and commissioners to ensure that reporting good quality data takes place.

It has been possible to use the CTAD system to implement surveillance for other infections. In 2016, sentinel surveillance for LGV was initiated through the existing CTAD system and 2 laboratories currently report on a monthly basis.

In designing the surveillance system to minimise impact on services and submitters, there were some compromises and as such the dataset has some limitations in terms of accuracy and utility.

The most significant limitation of the surveillance system is that specialist SHS tests reported to CTAD from laboratories do not have patient demographic variables. As discussed above, substitution with the GUMCAD dataset is required to produce a comprehensive dataset. Combining data from 2 surveillance systems is not ideal in terms of accuracy, timeliness and effort. A further associated consideration is that the accuracy of the substitution is dependent on accurate and consistent coding of testing service type. PHE has been monitoring this using a proxy measure which shows that nationally the substitution is good, but regional variation in substitution accuracy is suspected.

## 5.5   Horizon scanning

### Internet testing

The surveillance system may have to continue to evolve as the way services are commissioned and delivered changes in England. 1 example of this is the move to an online specialist SHS service for the majority of London boroughs. The CTAD surveillance team has been working with the GUMCAD surveillance team to manage the growth of internet testing.

This has involved developing a survey of specialist SHS and use of the web portal to ensure accurate data reporting of internet based testing.

### Point of care testing

In the future POCT for chlamydia may be introduced into routine clinic settings and this would remove the opportunity to capture these tests in the CTAD surveillance system. PHE must continue to be aware of new information flows and plan for how any omitted testing can be included. See Section 3.5 for further discussion on horizon scanning for POCT.

## 5.6 Summary

Over time the mechanism for monitoring the delivery of the NCSP has changed to both reduce the total burden and cost to the healthcare system but also to improve quality and accuracy of reporting. The current CTAD system enables local services to understand, in depth, which clinics and services are providing screening to high need populations and enable the ongoing assessment of changes to those services. In addition, the system enables other infectious disease surveillance objectives to be monitored such as assessment of LGV burden in the population and the rapid identification of changes to chlamydia epidemiology in the population. Collaborating/sharing data with other sexual health datasets allows PHE and stakeholders to produce a more holistic understanding of population needs and areas for improvement.

# 6 Surveillance outputs

This section provides a summary of what is known about the current delivery of the chlamydia screening programme using the CTAD Surveillance System. Data are presented in line with the steps of the Chlamydia Care Pathway and more detailed tables are provided in the appendix.

## 6.1 Surveillance metrics

The data report national- and LA-level activity on population coverage of testing; test positivity; and chlamydia DRI. The chlamydia detection rate is a PHOF indicator and a measure of chlamydia control activity. These metrics are calculated as:

**Coverage =** (number of chlamydia tests / population aged 15 to 24) x 100
**Test positivity =** (chlamydia diagnoses / chlamydia tests) x 100
**Detection rate =** (chlamydia diagnoses / population aged 15 to 24) x 100,000
**Retesting rate =** (a further chlamydia tests within 7 to 14 weeks following an initial diagnoses / chlamydia diagnoses) x 100

## 6.2 Surveillance data

### 6.2.1 Trends 2000-2012, pre CTAD data

Figure 6.1 shows the reported rates of chlamydia tests and diagnoses conducted in specialist sexual health services and non-specialist services by sex and age group for the years 2000-2012 leading up to the introduction of CTAD. (Chandra et al. 2017)
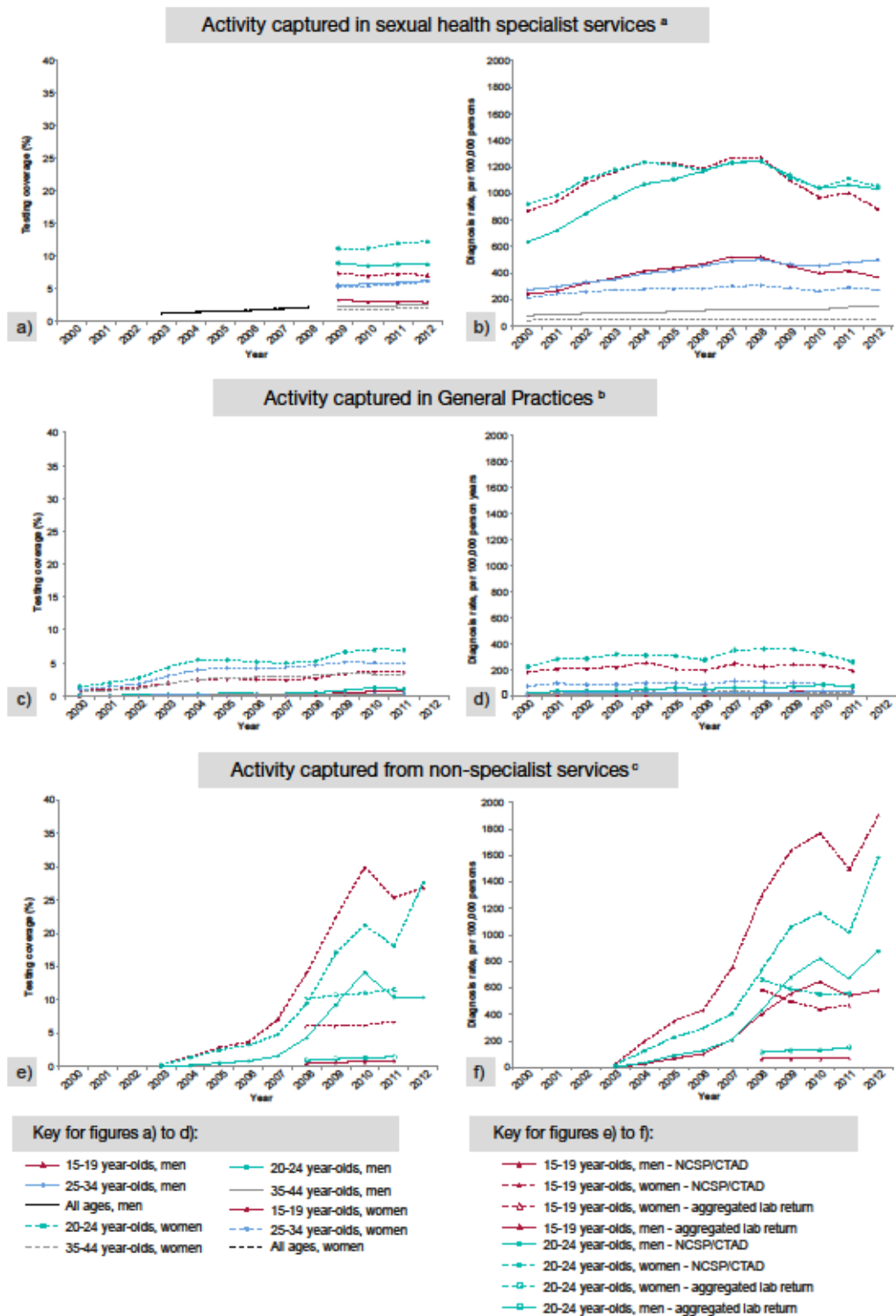
Figure 6.1 Reported rates of chlamydia tests and diagnoses captured in specialist sexual health services and non-specialist services by sex and age group, 2000-2012. Figures a), c) and e) show tests; figures b), d) and f) show diagnosis rates

a. All ages for tests done in specialist services include 15 to 90 year-olds; testing activity was not broken down by age pre-2009. Diagnoses captured in specialist services incorporate both uncomplicated and complicated chlamydia diagnoses. Testing data in specialist services are available from 2003 to 2012 and diagnosis data are

available from 2000 to 2012.Data captured in specialist services are from the UK monitoring and surveillance systems KC60 statistical return (2000 to 2008) and the Genitourinary Medicine Clinic Activity Dataset (GUMCAD, 2009 to 2012).

b. Activity rates within general practices are by person-years; data captured from 2000 to 2011 are for 15 to 44 year-olds. Data for general practices are captured in the Clinical Practice Research Datalink (CPRD, 2000 to 2011).

c. Testing and diagnosis data in non-specialist services capture data for 15 to 24 year-olds only. Data captured in non-specialist services are from UK monitoring and surveillance systems National Chlamydia Screening Programme (NCSP) statistical return (2003 to 2011), aggregated laboratory return (2008 to 2011) and the Chlamydia Testing Activity Dataset (CTAD, 2012). CTAD captures data for all ages, only data for 15 to 24 year-olds are displayed here.

### 6.2.2   Current situation

For patients aged 15 to 24 years old, all chlamydia tests and diagnoses were extracted from the Chlamydia Testing Activity Dataset (CTAD) and Genitourinary Medicine Clinic Activity Dataset (GUMCADv2) for the calendar year 2015. The data for 2015 were used as this was the latest year of complete data available when the Peer Review evidence pack was undertaken. Both disaggregate data sources capture information including location, patient age, gender and test result. Location of residence was included in both CTAD and GUMCADv2 using postcode and Lower Super Output Area (LSOA) of residence respectively.

LSOA population estimates, rural/urban classification and deprivation quantile (Index of Multiple Deprivation, IMD) were obtained from the Office for National Statistics (ONS).(Statistics 2016) OAs are treated as 'urban' if they were allocated to a 2011 built-up area with a population of 10,000 people or more, while all remaining OAs are classed as 'rural'. The urban and rural domains are then subdivided into 6 broad settlement types based on the population density of the wider surrounding area of a given OA.(Bibby et al. 2013)

The Index of Multiple Deprivation 2015 is the official measure of relative deprivation for small areas (or neighbourhoods) in England.(National Statistics 2015) The Index ranks every small area in England from 1 (most deprived area) to 32,844 (least deprived area).

## 6.3   Test uptake

In 2015, over 1.5 million chlamydia tests were carried out in England among young people aged 15 to 24 years. A total of 128,450 chlamydia diagnoses were made among this age group, equivalent to a detection rate of 1,887 per 100,000 population nationally. Measures of uptake among those offered are not collected at a national level, therefore the data utilised for this section focuses on test results.

### 6.3.1   By age and gender

The NCSP currently screens more than twice as many women aged 15 to 24 years old than men with 1,079,826 women screened for chlamydia in 2015, compared with 446,279 men. An estimated 32% of young females and 13% of young males were tested for chlamydia, assuming 1 test per person. Further variation can be seen when this is broken down further into the age groups of 15 to 19 years old and 20 to 24 years old (Figure 6.2). Coverage is

around 9% greater in the 20 to 24 age group than in the 15 to 19 year old age group with the trend consistent across the genders.

Positivity nationally was around 8.4% with positivity in men being higher than that in women, 10.1% to 7.7% respectively. In 15 to 19 year olds the positivity was consistent across genders at a level of around 9%; however this was not true of the 20 to 24 year old group. Positivity rose to over 10.5% in males whilst dropping to 6.8% in females (Figure 6.2). Natsal-3 reported a similar pattern with a higher prevalence in 20 to 24 year old men than the younger age group; however whilst they reported greater testing in 15 to 19 year olds men, the CTAD data for 2015 suggests the opposite.(Woodhall et al. 2015)
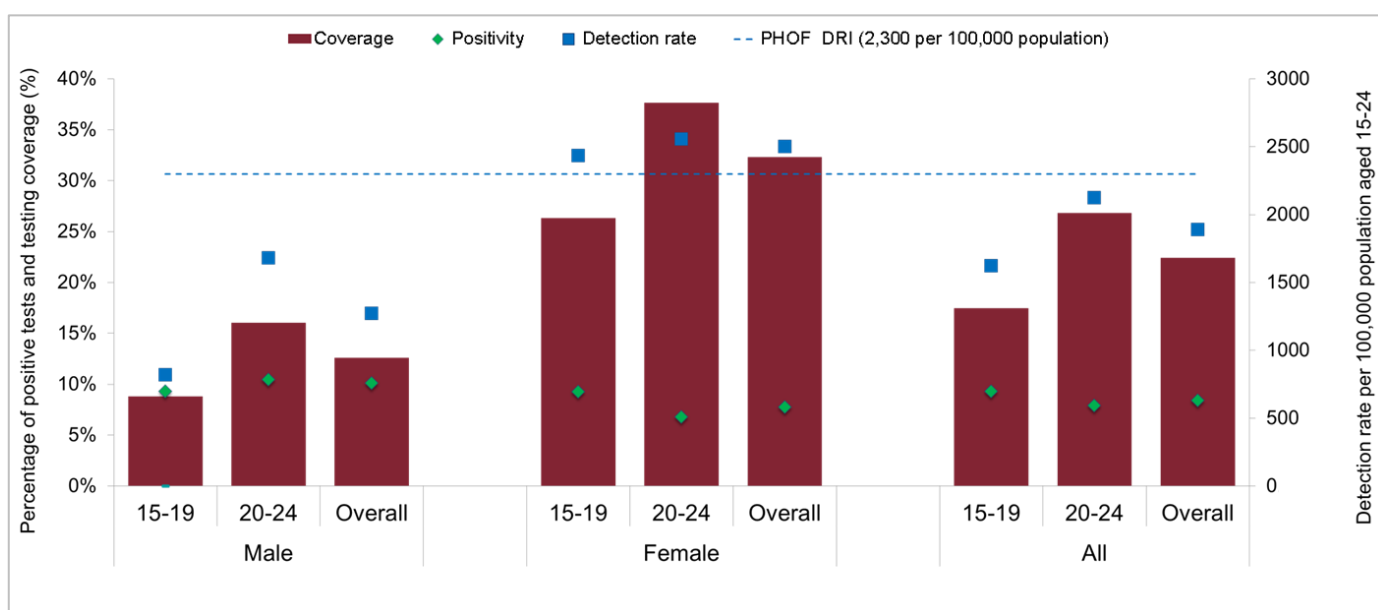


Figure 6.2 Coverage, proportion of positive tests and detection rate by Age and Gender in England, 2015

Nationally a DRI of 1,887 was achieved against the target of 2,300; although this varied substantially across the ages and between males and females. The DRIs achieved for women were 2,435 and 2,557 for 15 to 19 and 20 to 24 age groups, respectively. The DRI in males was 818 and 1,679 for 15 to 19 and 20 to 24 year olds, respectively.

### 6.3.2  By testing service type and gender

Chlamydia screening is offered through a wide range of services and the utilisation of testing services varies. Testing at SRHs accounts for 53% of all tests carried out in England in 2015; GPs provide just under a fifth of tests, with Pharmacy and ToP services accounting for around 2.5%. Just over 5% of tests were coded as "Internet tests"; however it must be noted that this CTAD code is relatively new and therefore it is possible that some online tests may have been coded under another service.

The "Other" testing type covered 19% of all tests in 2015 and this covers a wide range of services including chlamydia screening offices, antenatal and obstetric services, military,

education, occupational health, prison, youth services, outreach, NHS walk-in centres and hospitals. This was combined with tests coded with "Unknown" testing type for these analyses. It is may be important, though challenging, to gain a better understanding of this category as it makes up a similar amount of tests as GPs.

There was different usage of test services between the genders as nearly half of all tests for men came from specialist SHSs whereas it was only a third in women (Figure 6.3). This is consistent with the variation in activity reported by Chandra et al. modelling trends from 2000 to 2012, which suggested that greater activity is captured for men in specialist services.(Chandra et al. 2017) In contrast, a quarter of tests in females are from GPs but only 10% in men; perhaps highlighting differences in health seeking behaviour. This highlights the need for a variety of providers to be commissioned to meet the needs of both men and women. Commissioners need to be aware of the demographics of the young people in their LA. Both Pharmacy and Internet tests are similar between genders with 1% and 5% of tests, respectively.

Positivity, nationally, was highest in tests received from specialist SRHs and SRH clinics, both at around 10% (Figure 6.3). Pharmacy and Internet tests each had a positivity of 8.4%, while GP testing was found to have the lowest level of just below 6%. Males had a higher positivity across all service types except for Other and it is of note that the Other service type in fact had a marginally higher positivity than GPs.
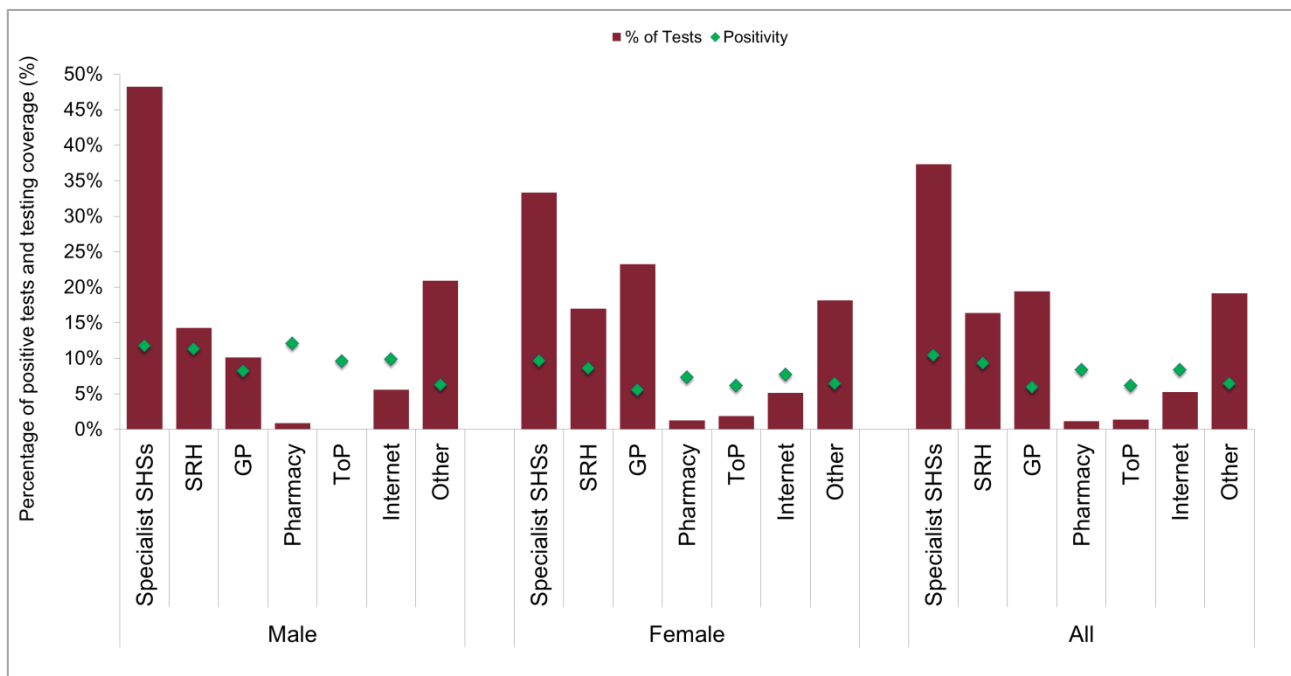


Figure 6.3 Coverage, proportion of positive tests and detection rate by Testing Service Type and Gender in England, 2015

The evaluation of DRIs for testing service types was limited due to the unavailability of data on footfall of patients for a denominator.

### 6.3.3   By ethnicity

The impact of STIs, including chlamydia, remains high in Black ethnic minorities. Ethnicity data collected from GUMCAD is 99% complete, but for CTAD ethnicity data is 49.3% complete for 15-24 year olds. Data from 2015 show that rate of diagnoses for chlamydia were highest in Black and Mixed ethnicities (Figure 6.4). The other category included records listed without a specified ethnicity and those listed as "Other" by the patient.
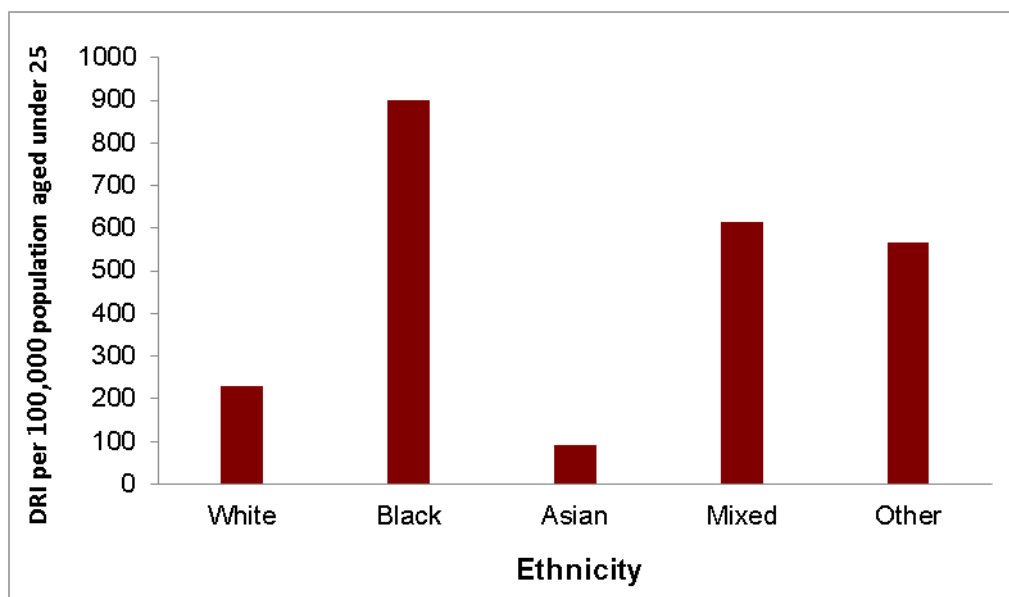


Figure 6.4 Rates of chlamydia by ethnicity in England, 2015

### 6.3.4   By Upper Tier Local Authorities

Chlamydia detection rates exhibit considerable geographic variation and, in 2015, 20% of Upper Tier Local Authorities (UTLAs) achieved a detection rate of 2,300 or above. However this is lower than previous years and has fallen in 2016, largely due to a reduction in total testing. Between 2015 and 2016 the total testing figure fell by 8.4% while total diagnoses only fell by 1.2%. In 2015, the median UTLA detection rate was 1,837 per 100,000 population aged 15-24 (IQR 1,537-2,198). In contrast to previous years the 2015 rates show fewer outliers - with either very low or very high detection rates – this is a reflection of the strong improvements in the data quality of the Chlamydia Testing Activity Dataset which has been achieved over the past 3 years.(Local Government Association 2014)

### 6.3.5   By deprivation and gender

Testing coverage was observed to be at its highest in areas of high deprivation, Quantile 1, with a continual decrease towards the least deprived Quantile 5 (Figure 6.5). The highest level of overall coverage was just under 30% and coverage in Quantile 5 was around half of that in Quantiles 1 and 2. Quantile 2 had a slightly higher level of coverage than that seen in Quantile 1, 26.4% to 29.8%. This trend was consistent between men and women, following the overall

trend that coverage in women was regularly at a level more than double that observed for the male population.

Positivity in males and nationally followed a consistent trend of being highest in Quantile 1, dropping in Quantile 2 and then gradually decreasing by around 0.4% across quantiles (Figure 6.5). Positivity in females decreased by more than half from Quantile 1 (8.5%) to Quantile 2 (4.2%), before following the trend seen in the other categories. This is supported by the results from Natsal-3 that found higher prevalence of chlamydia in women living in more deprived areas.(Woodhall et al. 2015) The positivity of females in Quantiles 2 to 4 was half that in males; however this variation was not seen in the coverage data.
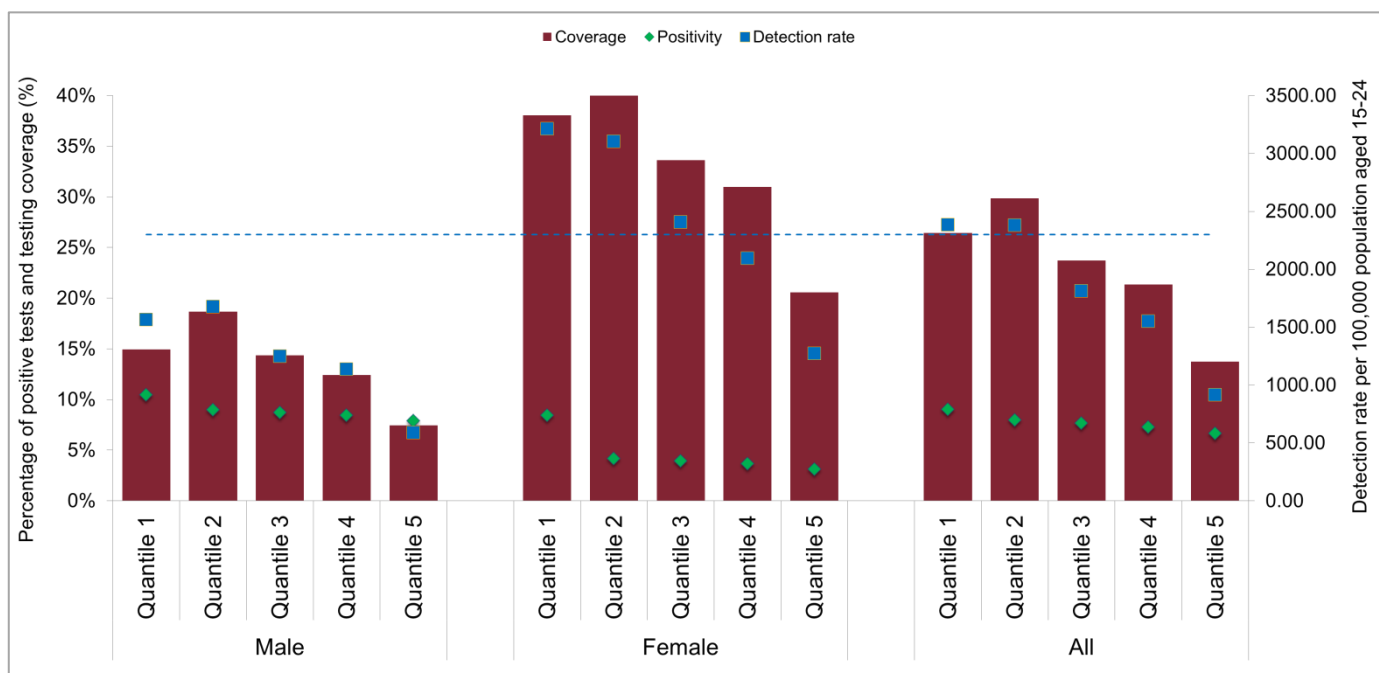


Figure 6.5 Coverage, proportion of positive tests and detection rate by Deprivation Quantile and Gender in England, 2015

As has been seen previously, the DRI was significantly lower in males than females and in fact the lowest DRI for females in Quantile 5 of 1,270 is equal to the national DRI for males. The DRI was achieved nationally in Quantiles 1 and 2, 2,384 and 2,381 highlighting that whilst we are meeting targets in the more deprived areas, there is work to be done in others.

### 6.3.6 By rural urban classification and gender

By breaking LSOAs into their rural-urban classifications (RUC), it was possible to evaluate the difference coverage achieved between areas in urban and rural settings. Categories A1, B1, C1 and C2 refer to urban areas and D1, D2, E1 and E2 refer to areas classified as rural. Figure 6.6 shows a significant difference between coverage levels across the categories.
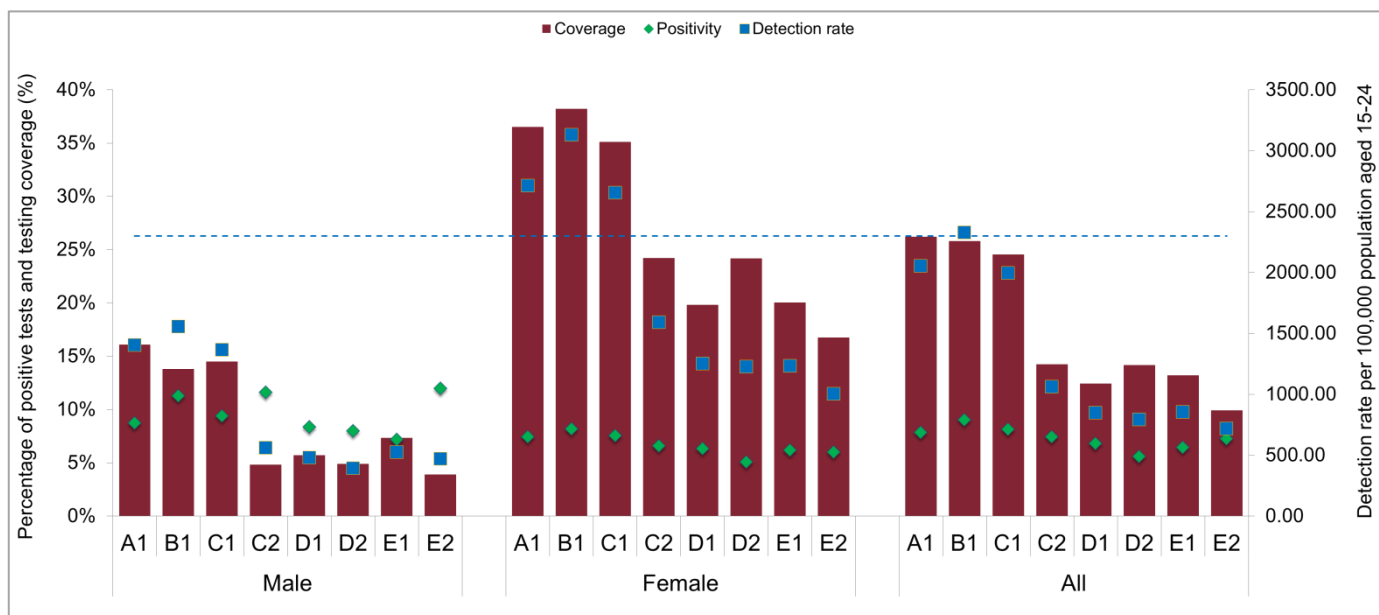
Figure 6.6 Coverage, proportion of positive tests and detection rate by RUC and Gender in England, 2015

The RUC classifications were collapsed into 2 major classes of Urban and Rural (A1-C2 and D1-E2) (Figure 6.7). Around 86% of the English population of 15-24 year olds live in urban areas and they account for 93% of all Chlamydia tests in 2015, with a testing coverage of 25.3%. This is double that achieved in rural areas, 12.75%, likely due to the difficulties of providing services in a sparsely populated area. Urban areas returned a positivity of 8.0% whilst 6.6% of all tests carried out in rural areas were positive.

The DRIs of the urban classes were almost twice that of the rural classes with only class B1 meeting the national target with a value of 2,328 (Figure 6.6). When the major classes were compared, urban areas had a DRI of 2,035 compared to 846 for rural areas, highlighting the significant challenge rural areas face to reach the national target. In fact, if positivity remained constant in rural areas, they would need to almost triple the numbers of tests they are currently processing to reach a DRI of 2,300.
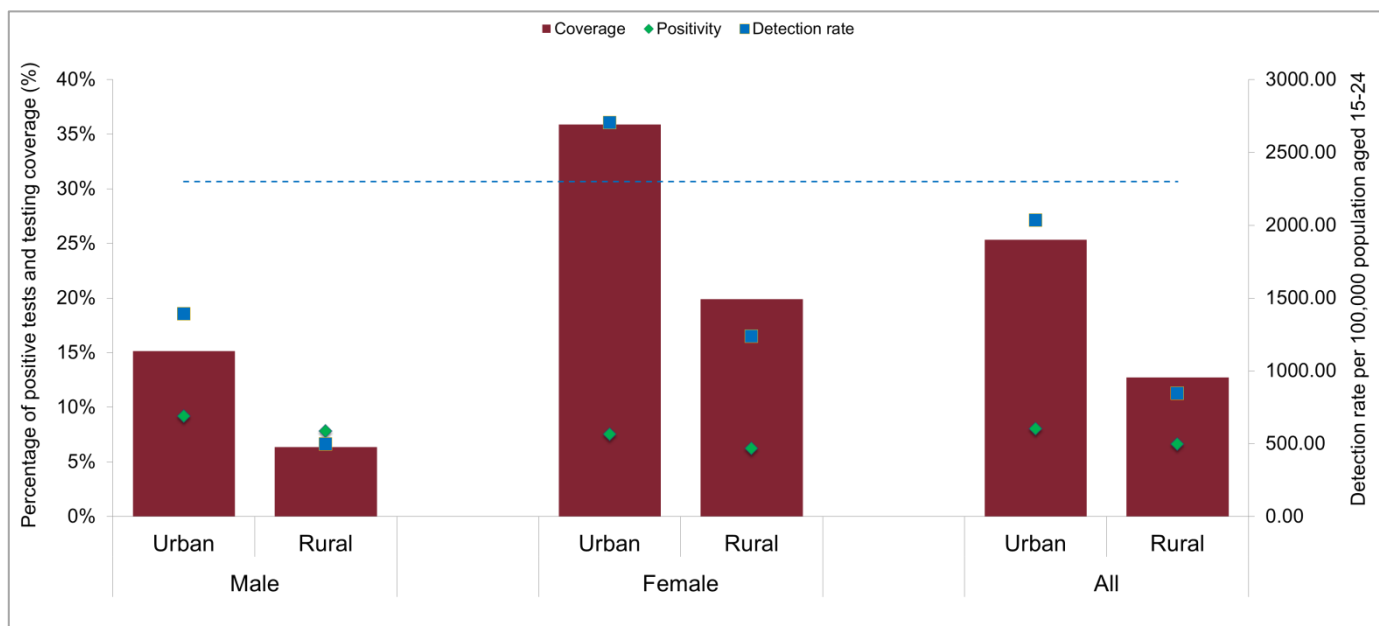
Figure 6.7 Coverage, proportion of positive tests and detection rate by Rural vs Urban and Gender in England, 2015

## 6.4  Treatment

The NCSP has guidelines regarding turnaround times for result notification, and if found positive, time to treatment: These were measured in a recent audit (England 2014) and were:

- 90% of patients to be notified of their result within 10 working days- 2013 indicator level
- 95% of patients to be notified of their results within 10 working days- 2014 indicator level
- 95% of positive patients to receive treatment within 6 working weeks from the date of the test

The findings of the NCSP audit report on turnaround times, published in November 2014, are summarised in Table 6.1. They found that the 2013 result notification standard was met such that 94% of people tested were notified of their result within 10 working days, exceeding the 2013 standard by 4%. However, the updated 2014 standard indicator level of 95% was not met.

**Table 6.1 Audit outcome against the turnaround time standards at national level**

| Standard | Indicator | Actual | Difference |
|---|---|---|---|
| Those tested notified of result within 10 working days | 2013: at least 90% | 94% | +4% |
| Those tested notified of result within 10 working days | 2014: at least 95% | 94% | -1% |
| Those testing positive treated within 6 weeks of test date | At least 95% | 91% | -4% |

The treatment turnaround time standard was not met – of those who tested positive, 91% were treated within 6 working weeks of the test date, an underachievement of 4% against the standard of 95%. The reported levels varied across providers (Figure 6.8) with only 39% of providers reaching the standard level.
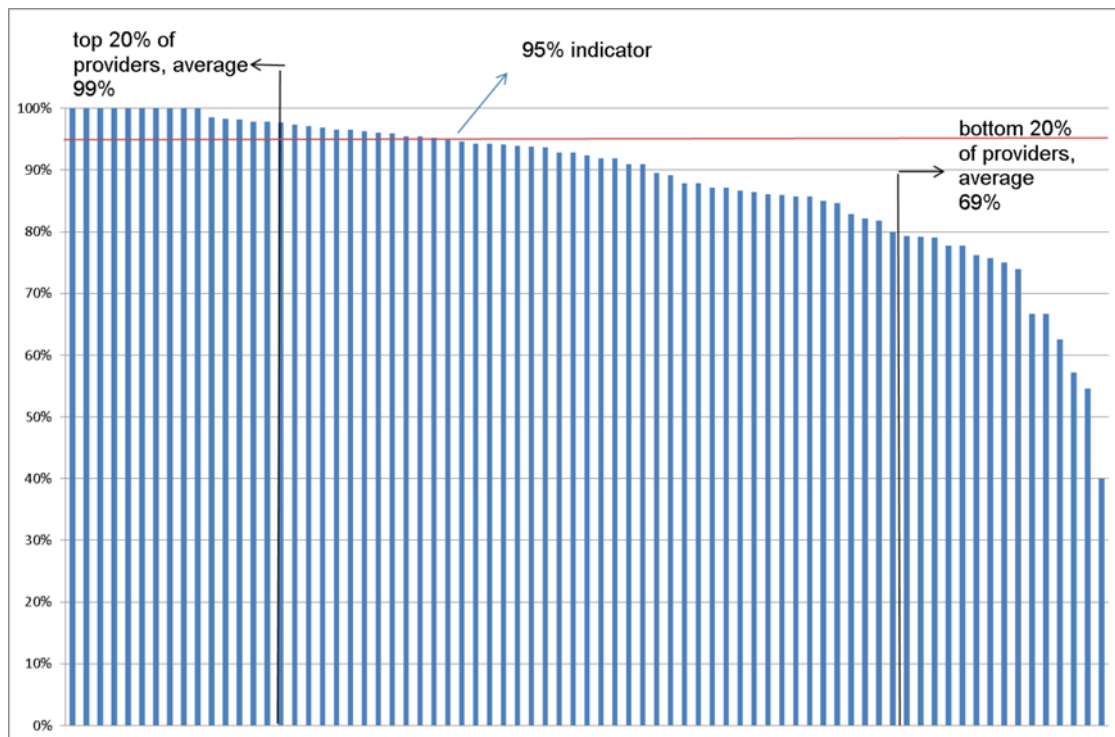


Figure 6.8 Proportion of test results notified within 10 working days by provider

Both the notification and the treatment standard were met in 84% of positive patient. Of those who did not receive the treatment within 30 working days, nearly one-third received it after this period (Figure 6.9). Of the remaining two-thirds, the majority were "lost to follow up"; hence treatment could not be provided or confirmed.
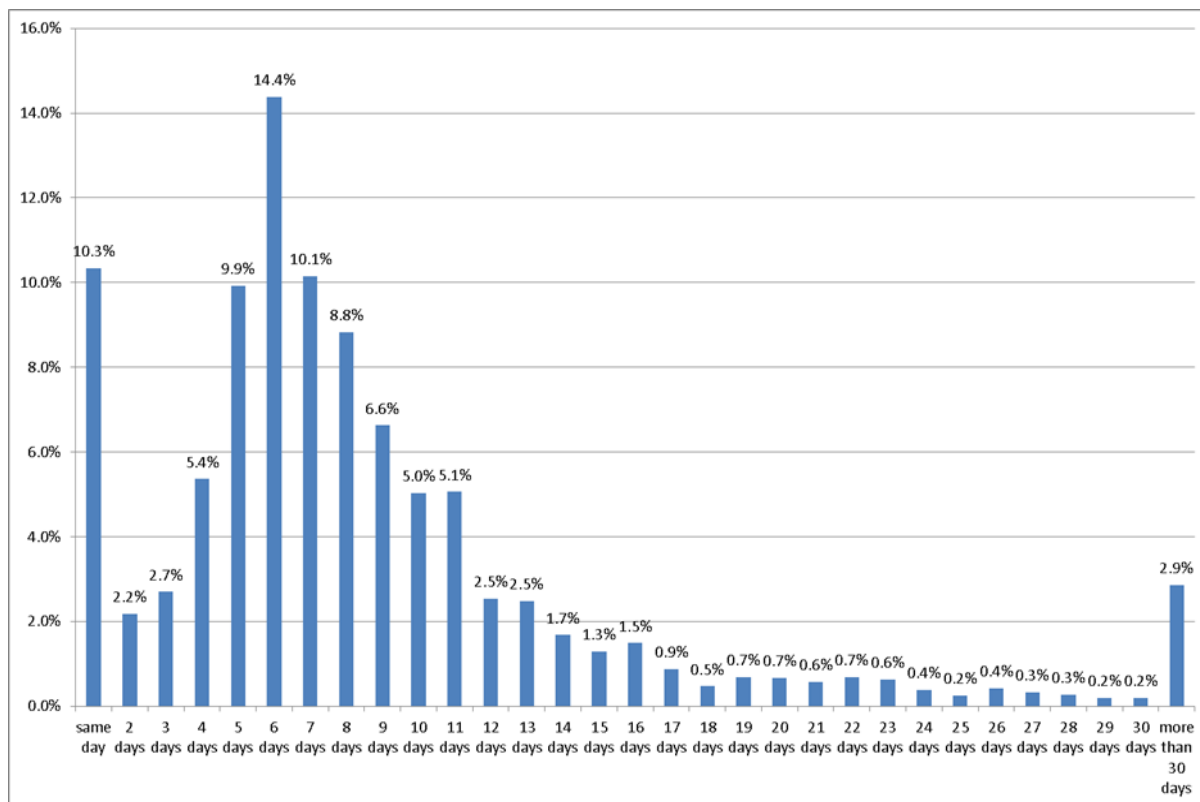
Figure 6.9 Treatment provided by number of days (proportion of patients, n=3619)

## 6.5 Notify partners

The findings of the NCSP audit report on partner notification, published in May 2016, are summarised in Table 6.2. The audit covered 2,439 index patients and collected information from 62 SH providers. They show that there is significant room for improvement, with only 92% of index patients offered a PN discussion, compared to a target of 97%.

**Table 6.2 Audit outcome against the partner notification standards at national level**

| Measure | Standard | Audit results |
|---|---|---|
| Proportion of index patients offered a PN discussion | 97% | 92% |
| Proportion of contacts reported to have attended a sexual health service within 4 weeks of the date of the first PN discussion. | 0.6 | 0.53 |
| Proportion of contacts whose attendance at a sexual health service was verified by a healthcare worker within 4 weeks of the date of the first PN discussion. | 0.4 | 0.29 |

Patient or healthcare worker reported attendance did not reach the standard of 0.6 contacts reported to have attended SHS and there is a wide range in performance (Figure 6.10).
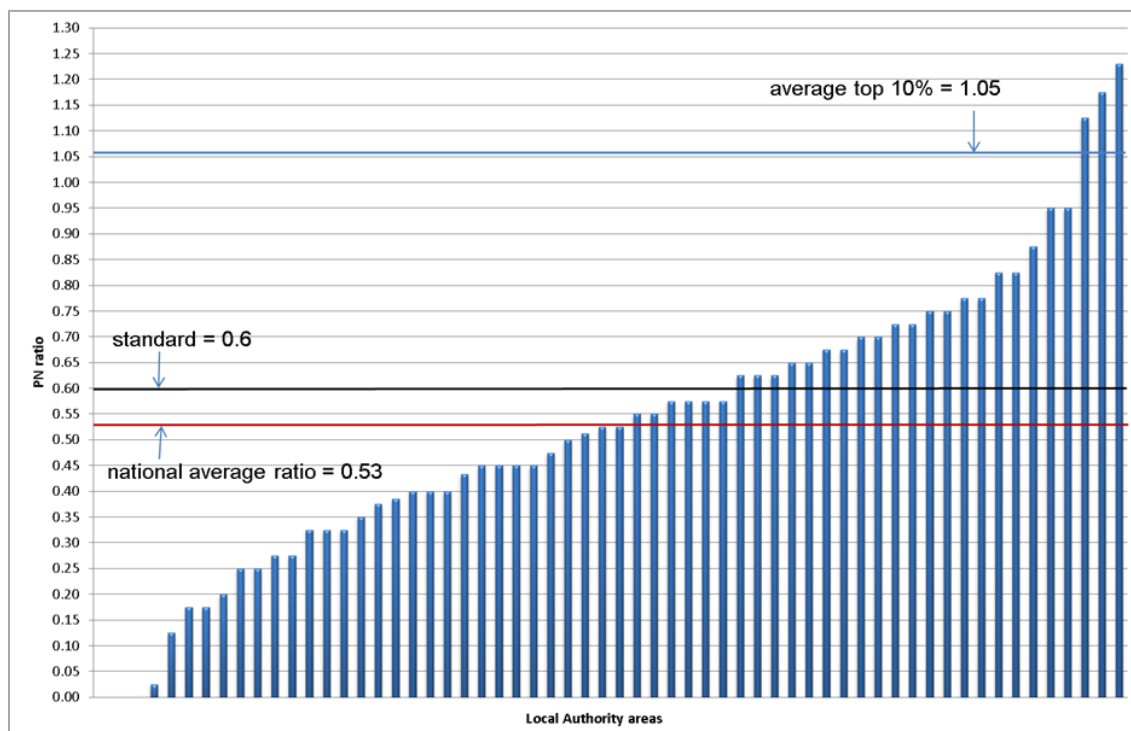
Figure 6.10 Range in chlamydia reported Partner Notification ratio

In terms of partner outcomes, there were several findings from the audit and these are summarized in Table 6.3. It is important to note that of all possible contacts (n=2,886), only 71% (2,047) were deemed 'contactable' and the proportion of contactable contacts that attended a sexual health service is significantly higher at 82% (1,674/2,047). Nearly one-third (675) of the 2,186 contacts with a documented outcome were informed of the risk of infection.

## Table 6.3 Partner outcomes in chlamydia screening

| PN outcome | Number | Proportion |
|---|---|---|
| record made that contact informed of risk of chlamydia infection, but not known to have had a chlamydia test (a) | 675 | 31% |
| contact had a positive test in your service (b) | 378 | 17% |
| contact not known to have been informed of risk of chlamydia infection (c) | 324 | 15% |
| contact already known to have chlamydia infection (d) | 206 | 9% |
| contact had a positive test in another service (e) | 166 | 8% |
| contact had a chlamydia test, but result not known (f) | 176 | 8% |
| Other | 106 | 5% |
| contact had a negative test in your service | 86 | 4% |
| contact had a negative test in another service | 69 | 3% |
| Total | 2,186 | 100% |

Of those that proceeded to have a chlamydia test, 62% (544/875) were found to be positive, indicating that PN is an effective way of identifying chlamydia positive individuals. The majority of contacts were reported to have attended a sexual health service within 5 days of the PN discussion with the index patient (average 3.2 days). This will help in reducing the time for onward transmission and risk of re-infection.

The audit is the main source of national data as PN data are not collected through CTAD; however this will change as the annual audit will now report on PN, Internet testing and retesting. GUMCAD routinely reports data on PN at specialist SHS clinics (Table 6.4) and from this it was reported that there were 107,252 new diagnoses in 2015 with 59,390 PN contacts made (55%). 52,840 of these contacts were tested (89%), with 38% diagnosed with a positive Chlamydia test.

**Table 6.4 Number of contacts and diagnoses made through PN at specialist SHS in England, 2012 – 2015**

| Variable | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| Number of new diagnoses (a) | 99,183 | 104,174 | 108,853 | 107,252 |
| Number of PN contacts (b) | 53,910 | 57,096 | 59,521 | 59,390 |
| Number of PN contacts tested (c) | 47,307 | 51,065 | 53,104 | 52,840 |
| Number of PN contacts diagnosed (d) | 17,482 | 18,900 | 20,176 | 19,879 |
| PN Ratio (b:a) | 0.54 | 0.55 | 0.55 | 0.55 |
| Percentage of PN contacts diagnosed (d/c) % | 37% | 37% | 38% | 38% |

## 6.6   Prevent infection

This section presents the findings of the first national audit on retesting of those who tested positive for chlamydia published in October 2015. The audit found that few patients (8%) retest in the NCSP recommended time period of around 3 months following treatment for the initial infection (Figure 6.11). Of those retested, a higher than average number of positive tests are detected compared to the national average for 2014: the positivity of those retesting between 10 and less than 14 weeks is 11%, compared to 8% national positivity rate (all tests).
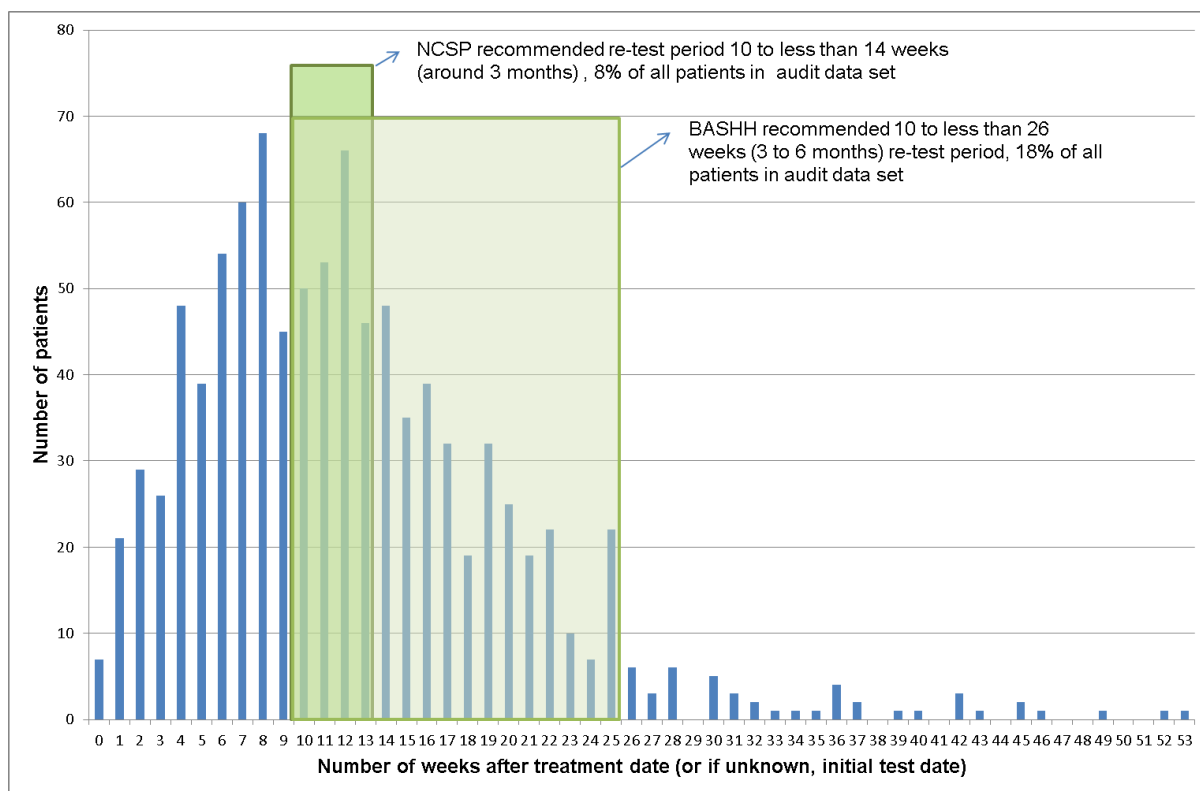
Figure 6.11 Retesting by number of weeks following treatment date

Nationally, 968 patients (34%) came back for retesting at any point in time, ranging from the same day as the date of treatment to just over 1 year later (0 to 53 weeks).

The most commonly used recall methods are:

- a conversation with the individual about retesting when they were given their initial positive test result, without any further reminder (32%).
- a text message sent to the individual when they should test again (30%)
- retesting advised at follow-up call 2 weeks after treatment with a further text message reminder sent at 3 months (19%)
- the proportion of patients that return for a retest between 10 and less than 14 weeks for these recall methods ranges from 5% to 12%

Two of the recall methods attract relatively high positivity rates: having a conversation about retesting when given the initial test result and no further reminder (9%) and sending a text message when to test again (20%).

The highest proportion of patients that have a retest between 10 and less than 14 weeks (at any service testing type) are those that initially attended a SRH/CASH clinic (11%), followed by home sampling kits (9%), and specialist SHS (7%) (Table 6.5). Nearly two-thirds of patients (64%) returned to the same testing service type for their retest as the one they attended for their initial test (at any point in time). This was particularly the case for patients using sexual

and reproductive health services/ contraceptive and sexual health services (SRH/CASH) and specialist SHS, and for those that used home sampling kits.

Home sampling kits or postal testing kits are increasingly used and appear acceptable and effective for retesting. For patients who had a positive retest result, the 2 most common risk factors for re-infection are:

- reporting unprotected sexual intercourse between treatment and retesting
- reporting a new sexual partner since being treated

Overall, 34% of those who tested positive for chlamydia came back for a retest at any point in time across all service testing types.

**Table 6.5 Retest rate at any service type by initial testing service type**

| Numbers retesting by initial service testing type | Numbers by service testing type | Numbers retested between 10 and less than 14 weeks (c) | % retest rate between 10 and less than 14 weeks (c/a) |
|---|---|---|---|
| SRH/CASH clinic | 833 | 92 | 11% |
| Home sampling kit | 385 | 35 | 9% |
| General practice | 344 | 21 | 6% |
| Outreach and Education | 335 | 17 | 5% |
| Specialist SHS | 298 | 21 | 7% |
| CSO | 220 | 14 | 6% |
| Other, incl prison/young offenders institute, military, ToP, gynae, AandE, antenatal | 214 | 8 | 4% |
| Not recorded | 124 | 1 | 1% |
| Community Pharmacy | 100 | 6 | 6% |
| **Total** | **2,853** | **215** | **8%** |

Of the 968 patients that came back for retesting at any point in time, 134 retested positive for chlamydia, a positivity rate of 14%. The positivity was higher among men (19%) than women (12%). The positivity of those retesting between 10 and less than 14 weeks is 11%, and those between 10 and 26 weeks is 16%.

Retesting data is also reported on the web portal using the reference period of 7 to 14 weeks (Table 6.6) rather than the 10 to14 weeks range used in the 2015 audit. After removing any tests missing the required identifiers (5.9%), there were 1,273,834 tests with 108,196 resulting in positives. Just over 13% of Index positives were retested within 7 to 14 weeks and of these tests, 15% were positive for chlamydia.

These results showed a slightly higher level of retesting compared to the samples used in the audit and again returned a much higher positivity than the national rate for all tests, 15% to 8% respectively.

**Table 6.6 2015 retest rate within 7-14 weeks from HIV and STI Web Portal**

| % tests with valid identifiers | Initial tests (a) | Index positives (b) | Retested within 7-14 weeks | | Positive at 7-14 week retest | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | Index positives retested (c) | % retested ((c/b*100) | Index positives retested positive (d) | % retested positive ((d/c*100) |
| 94.10% | 1,273,834 | 108,196 | 14,356 | 13.3% | 2,184 | 15.2% |

## 6.7   Horizon scanning

### Local variation in prevalence

A recent study has presented a modelling method by which local prevalence may be estimated from infection, testing and treatment processes using a model-based framework.(Lewis et al. 2017) The model assumes high health-seeking behaviour of infected, symptomatic individuals and that asymptomatic incident infections are proportional to asymptomatic diagnoses. The authors also estimate that prevalence in each sex predicts incidence in the other, which may not hold true in same-sex pairings. The model predicted that prevalence would be higher in deprived areas in line with Natsal-3 findings. Although limitations exist in the modelling methodology, the process described should be further explored as a potential means of measuring local prevalence.

### Ethnicity

To better understand behavioural factors and address disparity across ethnic groups, Public Heath England is collaborating with UCL and the London School of Hygiene and Tropical Medicine as part of the National Institute for Health Research (NIHR) HPRU on blood-borne and sexually transmitted infections. The research aims to improve understanding of the behaviours, attitudes, and other factors influencing STI risk and support the delivery of timely interventions which maximise the patient and public health benefit.

### Retesting

The audit report contained recommendations for commissioners and providers of future chlamydia screening:

- ensure patients who test positive for chlamydia return for a retest and that this takes place around 3 months following treatment
- review local performance and audit results against these national findings (NCSP retest monitoring tool can be used to undertake local audits)

- enable access to patient information for audit and operational purposes between previous and new providers of sexual health services
- re-enforce sexual health promotion messages, including:
  - to always use a condom correctly and consistently, and until all partners have had a sexual health screen
  - to reduce the number of sexual partners and avoid overlapping sexual relationships
  - that sexually-active under 25-year-olds should be tested for chlamydia annually and on change of sexual partner
- ensure effective care pathways are in place for patients using home or postal sampling kits(Public Health England 2015)

## 6.8   Summary

Since the inception of the NCSP the rates of testing for chlamydia have risen dramatically. Since 2008 total coverage has been high with up to 1 in 3 women in the target age range being tested for chlamydia each year. Testing is higher in women than men and in the areas of highest deprivation. These are also the populations who benefit the most from testing. The quality of screening care is varied and many services are not achieving the standards of care set out by PHE. Testing of sexual partners and retesting of diagnosed patients both yield high positivity.

# 7 Evaluating the impact of the NCSP

As the majority of chlamydial infections are asymptomatic, it is not currently possible to monitor the prevalence or incidence of chlamydia. The NCSP instead measures changes in sequelae and as well as changes in the prevalence of antibodies against C. trachomatis. The data from the serology studies is being used in modelling exercises. We are exploring other means of monitoring the impact of the NCSP.

## 7.1   Introduction

Chlamydia screening is expected to have an impact on the following outcomes (related to the aims of the NCSP):
  i)   the incidence and prevalence of chlamydia infection;
  ii)  the frequency of chlamydia-related sequelae;
  iii) health professional and young adults' knowledge of chlamydia;
  iv)  awareness of chlamydia screening and impact on sexual and health-seeking behaviours.

Accepting the absence and impracticality of a RCT of the effect of chlamydia screening as practiced in England, PHE has aimed to evaluate the impact of screening on the health outcomes i) and ii) above, using largely observational analyses of routinely available data collected during (and some prior to) implementation of the NCSP and supplementary studies. Given the relatively small and long-term effects of chlamydia screening and multiple aetiologies of the sequelae, firm conclusions about the outcome of screening are difficult to attain.

Overall evaluation of impact requires cautious interpretation of the information from these methods combined, and in the light of information obtained outside PHE's outcome evaluation work streams. In many cases, our evaluation has focussed on changes over time, which should be interpreted in the context of the ongoing delivery of the chlamydia screening programme and other changes in sexual health and health care delivery and data collection.

Adverse, unintended outcomes are also feasible and have been considered. PHE's activities in this area are described, along with the strengths and limitations of outcome measurement and what is known to date about the impact of the NCSP on each outcome listed above.

## 7.2   Incidence and prevalence of genital chlamydia infection

Chlamydia screening is expected to remove prevalent cases of chlamydia from the pool of infections and to prevent transmission by diagnosing and treating an individual before they would otherwise infect their sexual partner(s). The NCSP is therefore expected to reduce both the prevalence and incidence of chlamydia.

As the majority of chlamydia infections are asymptomatic,(Stamm 1999, Low et al. 2007, Simms et al. 2009) the incidence of chlamydia cannot be observed. Studies to directly measure incidence would need to be based on frequent and repeated chlamydia testing, have high- or at least non-biased- participation rates, be large and run over (or repeatedly within) the time of interest. Such an approach is not feasible for evaluating the impact of chlamydia screening at a national level. Studies to measure prevalence would similarly be required to be large, non-biased and sustainable or repeatable. PHE has explored the feasibility of alternative means of measuring chlamydia incidence and prevalence and related, or proxy, measures.

## 7.2.1   Measuring prevalence

In 2011 the HPA conducted a pilot of a cross-sectional survey of chlamydia prevalence among young women, using postal invitations with anonymous testing for chlamydia. The pilot achieved a low response rate (14%). This method was concluded to be prohibitively expensive and likely subject to substantial bias (Woodhall et al. 2015) and was not, therefore, considered an appropriate means of prevalence monitoring.

Repeated national surveys which incorporate biological measurement offer a means of monitoring chlamydia prevalence over time. The only estimates in the UK come from the National Surveys of Sexual Attitudes and Lifestyles (Natsal), a series of stratified probability sample surveys of the general population, resident in Britain. PHE has been a partner on Natsal-2 and Natsal-3, and has been closely involved in the use of this survey for the evaluation of chlamydia screening (and other STI control strategies). Natsal-2 (Erens et al. 2001) (conducted in 1999-2001) and Natsal-3 (Erens et al. 2013) (conducted in 2010-2012) measured chlamydia prevalence in urine specimens among the sexually-experienced (ever had sex) population. Comparisons between the surveys found there to be no significant difference in prevalence estimates between surveys, even after adjusting for differences in tests used in each survey. However, comparisons between the surveys had limited power due to the sample size available.(Sonnenberg et al. 2013)

## 7.2.2   Monitoring the proportion testing positive

An alternative to measurement of prevalence is to use the proportion testing positive among those tested as a proxy for prevalence. This will be a biased indicator of population prevalence due to the differences between the population tested for chlamydia and the general population. Additionally, changes in the proportion testing positive over time are affected by changes in the population tested, which may not always be possible to fully capture in the data available.(Miller 2008, Woodhall et al. 2015)

Detailed analysis of changes in the proportion testing positive among those tested through the NCSP found a decline in the proportion testing positive between 2000 and 2011.(Woodhall 2015) Declines were seen across a range of demographic and behavioural subgroups and in all testing venues (Figure 7.1). Changes in the distribution of venue testing types could explain some, but not all, of this observed decline. However there was evidence of unmeasured

confounding, suggesting that even after adjusting for sexual behaviour or stratifying by venue, trends in percentage testing positive will still be subject to unmeasured confounding and cannot be reliably attributed to there having been a change in the incidence or prevalence of infection. Surveillance data on proportion testing positive alone does not, therefore, provide a sufficiently reliable measure of chlamydia infection over time for the purposes of evaluating chlamydia screening.

**Women**

**Men**

a) By age group



b) By sexual risk group[x]



c) By venue type of testing[y]
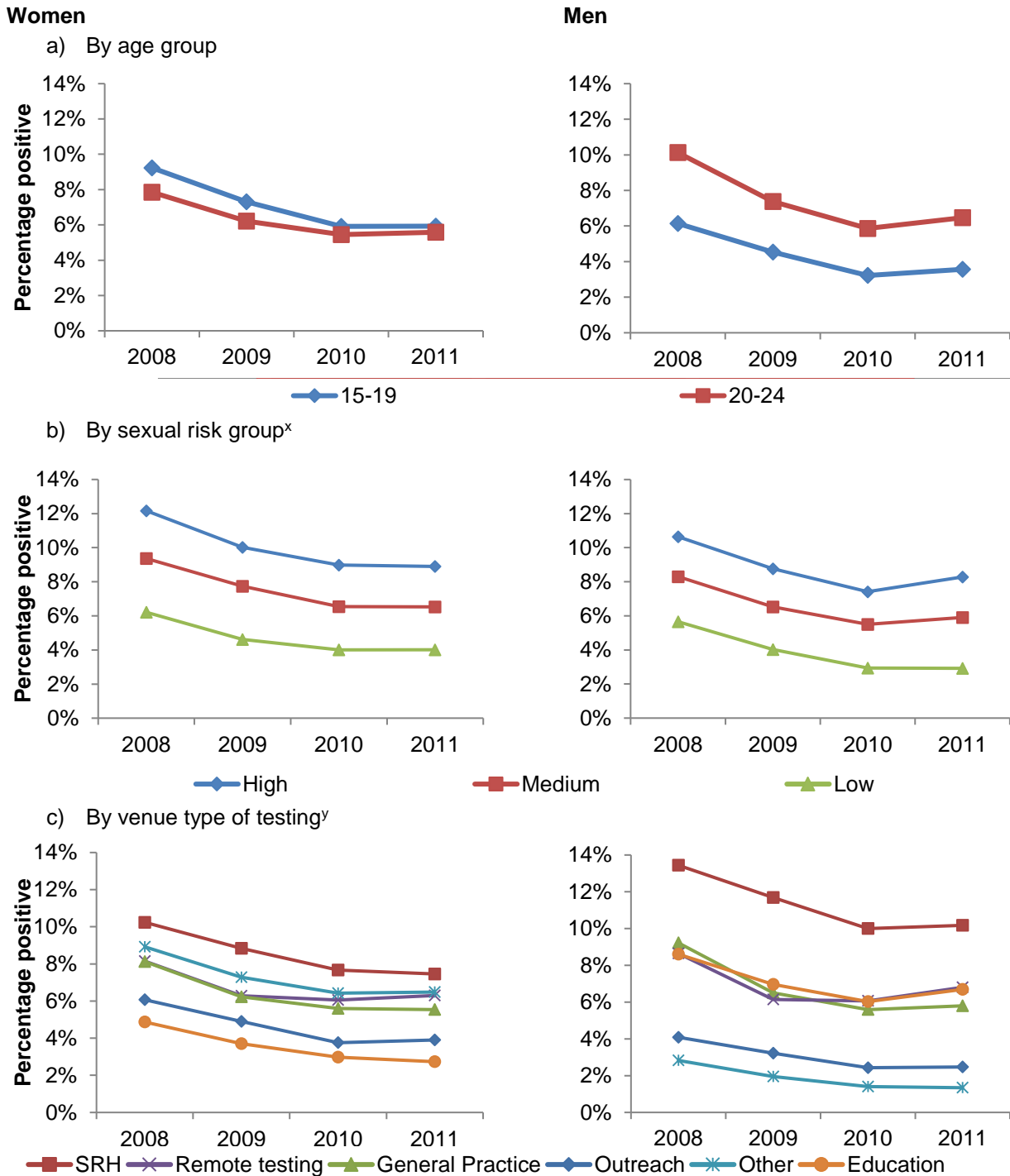


Figure 7.1 Percentage testing positive by year and gender, stratified by age group (a), sexual risk group (b), and venue of test (c)(NCSP dataset, 15 to 24 yea-old women and men, 2008 to 2011) (Woodhall 2015)

[x]Sexual risk group: High: more than 1 sexual partner in the last year and at least 1 new sexual partner in the last 3 months; Medium: either more than 1 sexual partner in the last year or at least 1 new sexual partner in the last 3 months; Low: neither more than 1 sexual partner in the last year nor at least 1 new sexual partner in the last 3 month; [y]SRH: Sexual and reproductive health services; Outreach: tests performed in non-clinical settings including entertainment and leisure venues; Remote testing: tests performed without face to face contact with a health professional at the time of test, includes tests performed through the internet.

### 7.2.3 Monitoring exposure to antibody-inducing chlamydia infection

Identification of chlamydia-specific antibodies in a serum specimen indicates past exposure(s) to infection and can be used as a measure of cumulative risk of infection, subject to reasonable assumptions, about the probability of seroconversion and the duration of detectable antibody persistence. Studies of the age-specific seroprevalence of antibodies against chlamydia, by birth-cohort and over time, have therefore been explored to monitor changes in the population's exposure to chlamydia infection. These studies have been based on an ELISA specific for Pgp3, a highly immunogenic antigen encoded by the chlamydia plasmid.(Wills et al. 2009)

#### 7.2.3.1 Seroepidemiology Unit studies

A readily available source of samples is PHE's Seroepidemiology Unit (SEU), a large (200,000+ samples) collection of sera. Samples are archived residues of specimens submitted for routine microbiological and biochemical diagnostic testing in NHS labs. Samples are anonymised prior to archiving, retaining age, sex, date of collection and source laboratory. Since 2008, an increasing proportion of samples have had the source clinic specialty (GUM or non-GUM) associated with them. If the source is not specified, the sample is labelled 'unknown'; an undetermined proportion of the 'unknown' samples will have come from GUM clinics.

Residual serum samples from the SEU were taken at 3-yearly intervals between 1993 and 2002 and yearly from 2007 to 2010. Those labelled as having come from GUM clinics were excluded from the analysis as GUM clinic attendees are known to have a higher risk of chlamydial infection. Between 1993 and 2002, seroprevalence increased in 17-24 year olds. From 2007 to 2010, age-standardised seroprevalence decreased concurrent to increasing rates of chlamydia screening for asymptomatic chlamydial infections, as shown by Horner et al.(Horner et al. 2013)

This study was subsequently extended to include serum samples from 2010 to 2015.(Migchelsen et al. 2017) As in the original study, samples from GUM clinics were excluded from the analysis. Data were standardised against the 2015 general population of England. The age-standardised Pgp3-seroprevalence across 7,585 serum samples was 20.3% in 2007 and 15.5% in 2015 (Fig. 7.2), though logistic regression showed no decreasing trend over the nine-year time period when adjusted for age (aOR=0.98, p=0.0536)
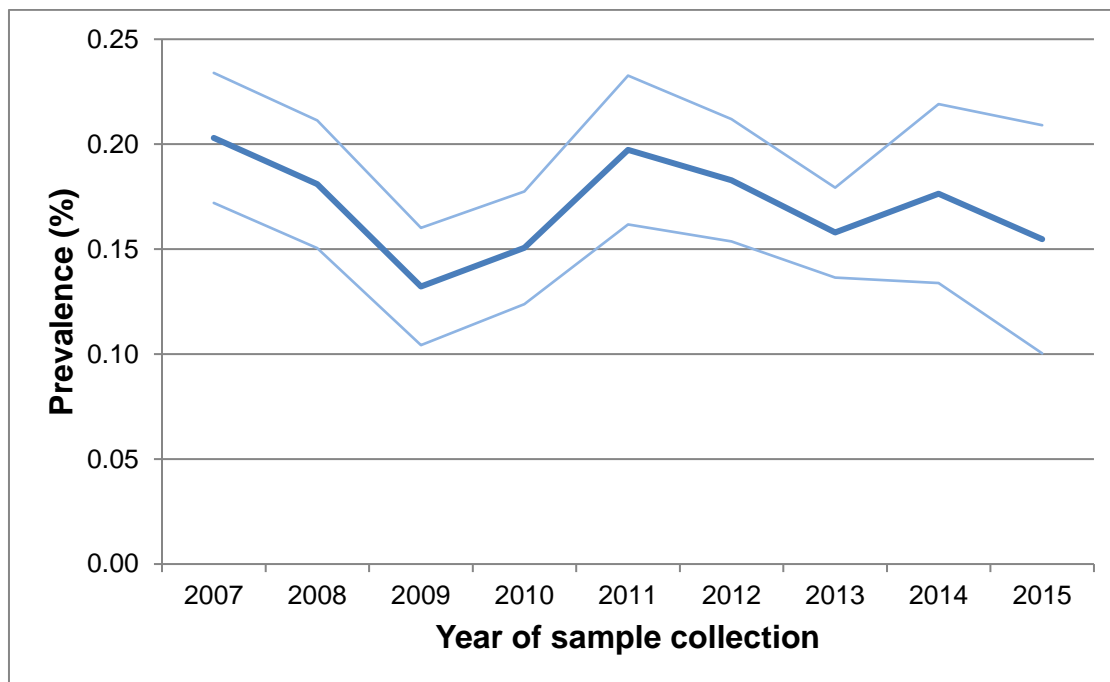
Figure 7.2 Age-standardised Pgp3-seroprevalence of 17 to 24 year old women (95%CI)

Additionally, we explored trends in seropositivity based on the level of exposure of women to the NCSP. For this, we assumed sexual debut at the age of 16.(Macdowall et al. 2015) Women who were 16 and under in 2008, when the NCSP was rolled-out nation-wide, are considered to have a high level of exposure to the NCSP. Those who were 17 to 24 in 2008 are likely to have begun having sex before the full implementation of the NCSP and are thus considered to have partial exposure to the NCSP. Finally, those 25 and older in 2008 are outside the official remit of the NCSP and are thus considered to have only limited to the NCSP. Figure 7.3 shows the seroprevalence of anti-Pgp3 antibodies by level of exposure. Logistic regression adjusted for age shows that the level of exposure has no effect on seroprevalence.
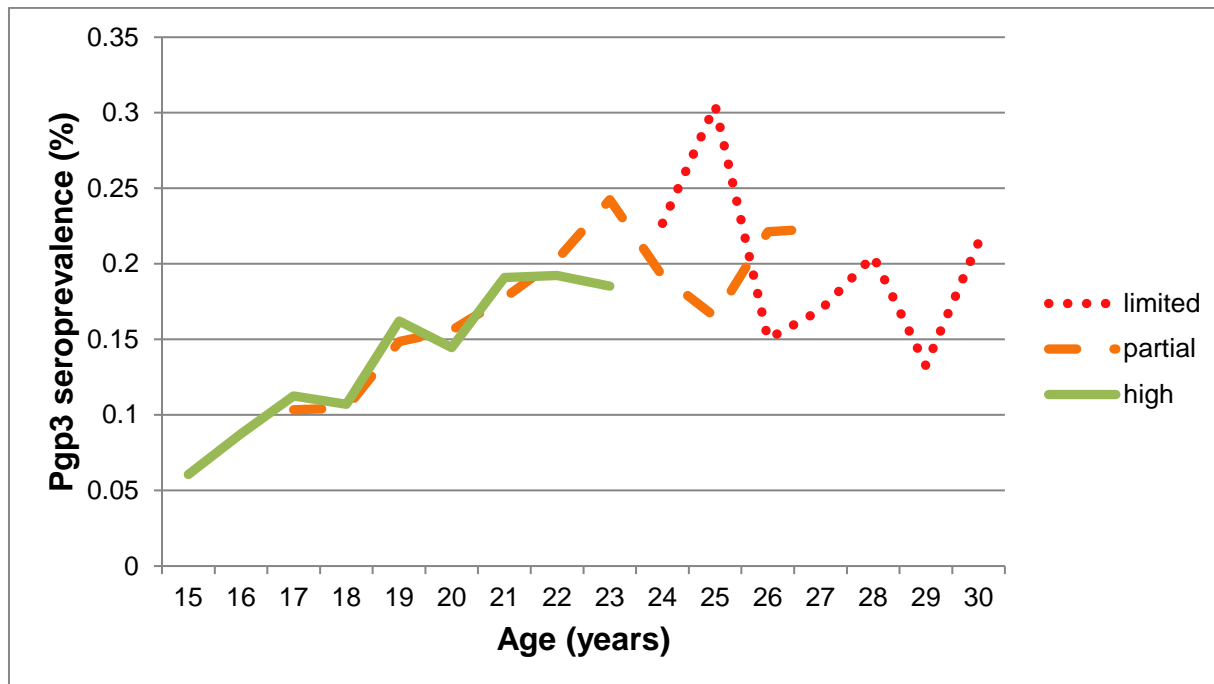
Figure 7.3 Age-specific Pgp3 seroprevalence by level of exposure to NCSP

In these analyses, it is important to note that the analysis is limited by the representativeness of the samples used. We have yet to determine if the samples from the SEU are truly representative of the general population of England, though previous studies suggest it is, at least for relatively common infections.(Osborne et al. 2000, Horner et al. 2013, Mesher et al. 2016) There is no information as to selection bias in the sample source over time; reasons for requiring a blood sample are likely to vary by age, for example with more antenatal specimens for peak child-bearing ages.

### 7.2.3.2   GUM study

In 2012, serum samples were obtained from the HPA Unlinked Anonymous Survey of Genitourinary Medicine Clinic Attendees (GUM Anon). These samples are from women aged 16 to 34 and represent women at higher risk of chlamydia. Serum samples were collected every other year between 1998 and 2008, and in 2009. In these samples, the seroprevalence decreased in under-20s, and remained constant in the older age groups (Figure 7.4).(Woodhall et al. 2013)
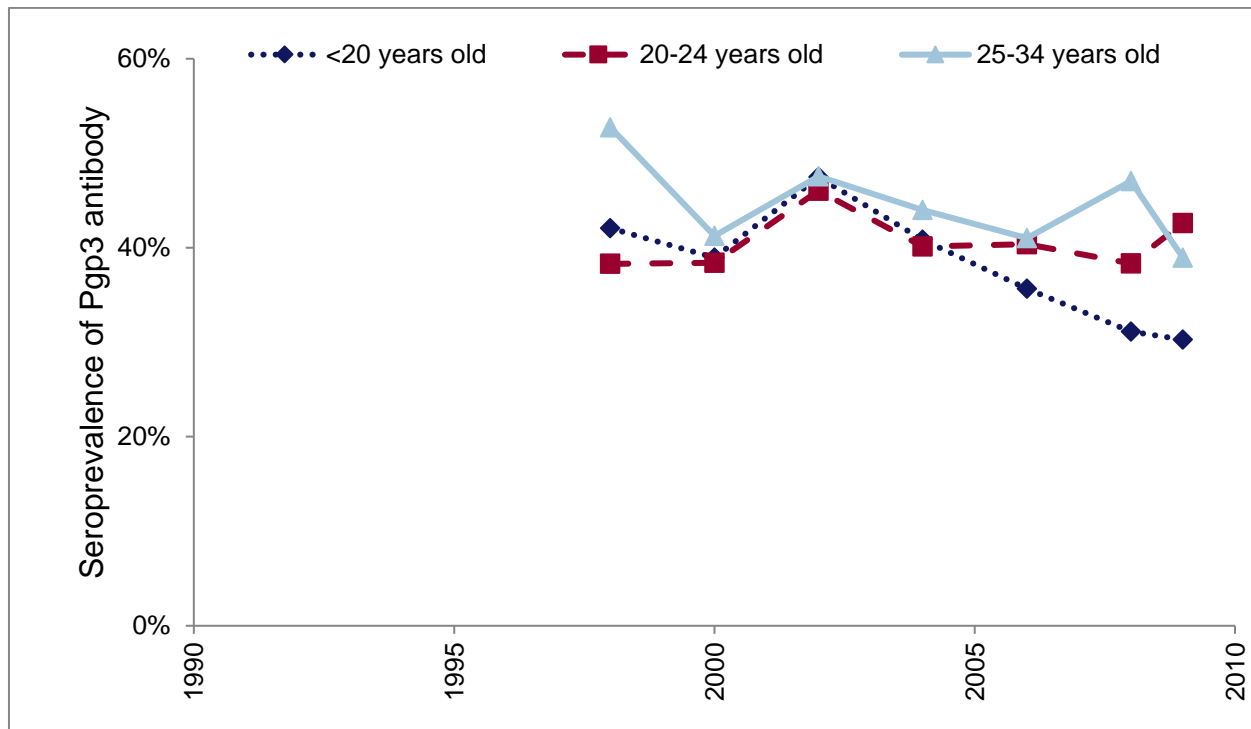
Figure 7.4 Seroprevalence of chlamydia (Pgp3) antibody by age group and year of sample collection from GUM clinic attendees.

### 7.2.3.3    Health Study for England

Most recently, samples from the nationally-representative Health Survey for England (HSE) have been tested using the assay.(Woodhall et al. 2017) This study measured the prevalence of antibodies against Pgp3 among 16 to 44 year old women and men in 2010 and 2012 and compared them to health and lifestyle factors. Additionally the seroprevalence trends among 16 to 24 year old women were investigated over 10 time points from 1994 to 2012. This study showed that seroprevalence increases with age in both men and women and that seroprevalence in greater in women than men. There was a non-significant decline in seroprevalence in 16 to 24 year old women from 2008 to 2012 (Figure 7.5).(Woodhall et al. 2017)
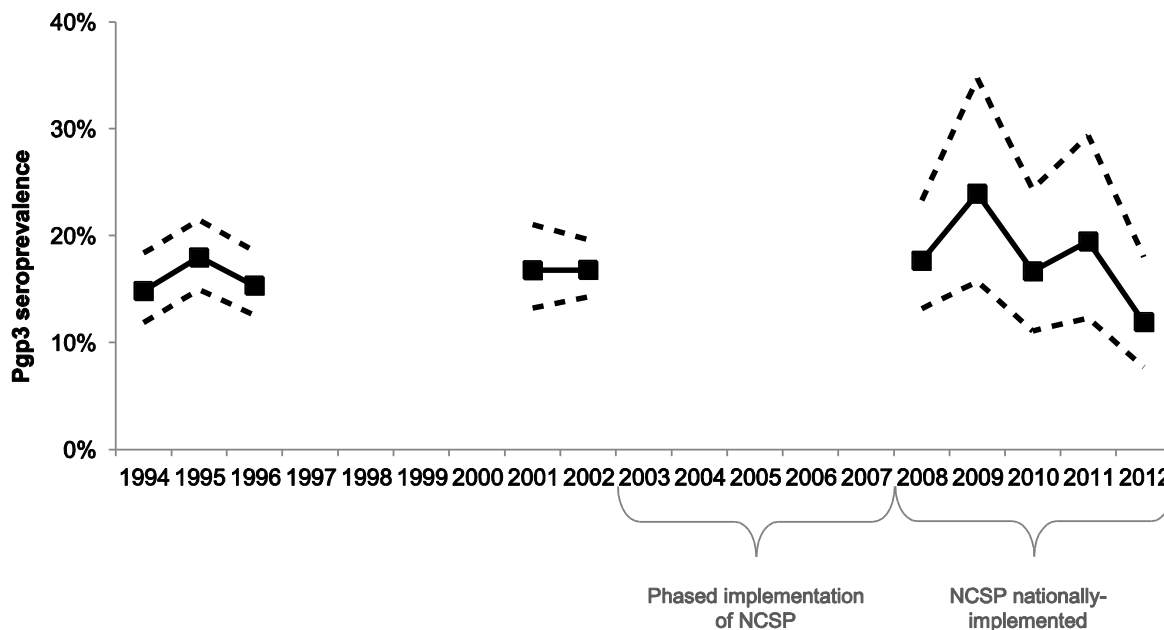
Figure 7.5: Pgp3 seroprevalence by year (16- to 24-year-old women, HSE 1994 to 2012). Solid lines show point estimates; dashed lines show 95% confidence intervals.

### 7.2.3.4    Estimation of incidence from seroprevalence data

Estimates of the incidence of *C. trachomatis* are hard to obtain. Incidence can be estimated directly by follow-up of initially uninfected individuals and testing again several months later.(Barnett et al. 2001, LaMontagne et al. 2007, Walker et al. 2012) While this is certainly the most direct approach, estimating incidence in terms of number of infections per total time at risk represents a lower bound, because individuals may clear infection and become re-infected during the follow-up period.(Price et al. 2015) Another method is to use chlamydia prevalence data, which is far easier to obtain, and then generate an estimate of incidence by dividing prevalence by average disease duration,(Price et al. 2015) which can be estimated from studies of spontaneous clearance in untreated individuals.(Golden et al. 2000, Simms et al. 2009, Price et al. 2015) In the UK it has been established that the estimates generated by these 2 methods are quite compatible, as long as account is taken of clearance rates, and estimates are appropriately calibrated to the general population.(Price et al. 2014, Price et al. 2015)

*The following reports collaborative work in progress which is led by Prof. Tony Ades, Bristol University, as part of the work programme of the NIHR HRPU for Evaluation.*

The mathematical relation between age-and-time-related cumulative primary incidence and age-and-time-specific incidence is well known (Becker 1989, Keiding 1991) and this has been used to estimate incidence from seroprevalence data for infections where seroprevalence can be interpreted as a direct estimate of cumulative primary incidence. This is appropriate for the many infections in which primary incidence is the specific public health concern, such as

toxoplasmosis and HIV (Ades et al. 1993, Ades et al. 1994, Marschner 1994), and the common infections of childhood (Griffiths 1974, Anderson et al. 1982) .
In the case of chlamydia the relationship relation between incidence and seroprevalence is considerably more complicated, for 2 reasons. First, chlamydia is an infection that spontaneously clears and in which previous exposure offers no protection: overall incidence is therefore the indicator that needs to be estimated rather than the incidence of primary infection.

Second, assays for *C. trachomatis*-specific serum antibody have relatively poor sensitivity and specificity,(Persson 2002, Johnson et al. 2008) which must be taken into account before credible estimates of incidence – and then incidence itself - can be obtained.

This work in progress is showing how both primary infection and reinfection rates can be estimated from seroprevalence data, taking into account not only the sensitivity and specificity of the test assay, but also the relation between sensitivity, repeat infection, and time since infection. This approach relies on a complex synthesis of 2 distinct types of data: i) age- and time-specific seroprevalence data, and ii) information on the specificity (Wills et al. 2009) and sensitivity of the test assay. This work is using the above seroprevalence data from the SEU,(Horner et al. 2013) and data on pgp-3 test performance from a survey of GUM clinical attenders (Horner et al. 2013) where information was obtained on the sensitivity of the *C. trachomatis* antibody assay as a function of time since infection and repeat infection. Data on specificity are taken from a paediatric sample.(Wills et al. 2009)

Findings have been reported from each of 6 different models of pgp-3 sensitivity and specificity. These range from no adjustment (ie assuming perfect sensitivity and specificity, to a model which i) accounts for specificity ii) allows for a high sensitivity in women who have had a repeat infection, and iii) in which sensitivity falls off at a decreasing rate with time since first infection. This latter model is the only one that realistically reflects what is known about sensitivity and specificity.(Wills et al. 2009, Horner et al. 2013) The other models have been examined in order to understand the impact of adjustments for sensitivity and specificity on estimates of incidence based on seroprevalence, and on model fit.

### 7.2.4  Mathematical modelling to simulate prevalence

Further to the mathematical model and cost-effectiveness analysis developed by HPA in 2006, (Turner et al. 2006, Adams et al. 2007) PHE developed an age and sex stratified deterministic model to investigate the impact of increased testing of asymptomatic young adults for chlamydia on infection prevalence in England. Data on rates of chlamydia testing and diagnosis were used to parameterise the model and estimate the observed effects on population prevalence. This approach was intended for use both as a means of estimating population prevalence in the absence of a robust outcome measure and to explore the relationship between testing and prevalence. This work failed to create a credible model, ie a model that fitted to available data and produced feasible results.

Through personal communications we understand other modelling groups are also finding realistic chlamydia modelling problematic, with models parametrised with observed testing practices tending to predict declines in chlamydia infection that are inconsistent with experience in England and elsewhere.

### 7.2.5  Summary of current evidence of the impact of chlamydia screening on prevalence and incidence

There is some evidence to support there having been a decrease in the frequency of chlamydia infection since the national implementation of the NCSP in 2008, specifically:

- Specifically, the declining trend in percentage testing positive seen in most subgroups, which remained after adjusting known confounders. This is consistent with the hypothesis that chlamydia prevalence among heterosexual young adults has declined in recent years. However there was evidence of unmeasured confounding, meaning that it is not possible to reach a definitive conclusion of declining prevalence using these data alone.
- The decrease in estimated Pgp3 seroprevalence (using the indirect Pgp3 ELISA) among 17 to 24 year-old women in England between 2007 and 2010 using residual sera submitted for routine microbiological or biochemical investigations is consistent with there having been a decrease in age-specific cumulative incidence in the years following the national implementation of the NCSP.(Horner et al. 2013) Additional data from 2011-2015 show that seroprevalence has further decreased, but that there is no clear downward trend.(Migchelsen et al. 2017)

However, other analyses from population-based probability samples do not support there having been a decrease in incidence or prevalence of infection following the national implementation of the NCSP.

- Comparisons between population prevalence as measured in Natsal-2 (2000) and Natsal-3 (2010) did not provide evidence to support or suggest a net decrease in prevalence in the decade between these surveys, although this should be considered a null finding rather than a negative one due to low power to detect the likely effect size for the level of screening activity
- Natsal-3 also provided evidence of ongoing transmission, with infection found among those recently tested (and presumed successfully treated)(Woodhall et al. 2015)
- Analysis using stored sera from participants in the HSE showed that Pgp3 seroprevalence among 16 to 24 year-old women decreased between 2008 and 2012, but that this observed decrease was not statistically significant. Importantly, there was no notable difference in age-specific Pgp3 seroprevalence between birth cohorts exposed to high levels of opportunistic screening and those who became sexually active before widespread screening.(Woodhall et al. 2017)

In summary, there is no strong empirical evidence to support the hypothesis that chlamydia screening, as delivered in practice, has been associated with a measurable reduction in either the incidence or prevalence of chlamydia infection among young adults up to 2012. (Figure 7.7)

Given the increases in screening over the last decade, this lack of empirical evidence is perhaps surprising. So long as the detected infections were adequately treated, this increase in detection of chlamydia infections should have reduced their duration (relative to the counterfactual of there having been no national screening programme). Reducing the average duration of infection is expected to reduce the number of transmission events (given the relationship R0=βcD 3) and also decrease the prevalence of infection (given prevalence=incidence x duration). (A detailed description is provided in the appendix) However, the limited power of the available studies/analyses makes the current conclusion that there is an absence of evidence for any reductions of public health interest.

There are several possible explanations for no measurable reduction in incidence or prevalence:

- screening might not have been in place for long enough to have had a meaningful effect on transmission dynamics of infection in the population up to the point where analyses have been conducted
- chlamydia screening up to 2012 may not have been diagnosing a high enough proportion of infections to lead to substantial interruptions in transmission. Findings from both the Pgp3 seroprevalence study and Natsal-3 suggest that a high proportion of infections may go undiagnosed
- gaps in testing coverage may present opportunities for ongoing transmission among young adults. Although testing rates are generally higher in those reporting risk factors for chlamydia, in Natsal-3 at least one-quarter of women and around half of men reporting a risk factor associated with prevalent infection had not been recently tested
- testing frequency in relation to time since infection and rate of partner change may also have been insufficient to meaningfully interrupt transmission. The NCSP recommends that young adults be screened on change of sexual partner, with the aim of reducing the period between time of infection and time of treatment. The extent to which this recommendation is emphasised in health promotion activities is unclear, as is our understanding of whether clinicians and young adults interpret this recommendation as a need to test at the end of a relationship or to test soon after having a new sexual partner

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[3] Where β denotes the average probability that an infected individual will infect a susceptible partner over the duration of their relationship; c denotes the average number of new partners acquired per unit of time; and D the average duration of infection. Brunham, R. C. (2005). "Insights into the epidemiology of sexually transmitted diseases from Ro= BcD." Sexually transmitted diseases **32**(12): 722-724.

- reductions in incidence and prevalence that could be expected by high diagnosis rates may have been attenuated by re-infections due to incomplete treatment of sexual partner(s) and new sexual partners and by incomplete treatment of a proportion of those diagnosed with chlamydia (Figure 7.6)
- a reduction effected by screening may have been masked by an increase in the underlying risk of transmission due to sexual behaviour may have changed over the time period of expansion of chlamydia screening. Although there was no notable increase in reported numbers of sexual partners among women or men between Natsal-2 (2000) and Natsal-3 (2010), the proportion reporting sexual debut before age 16 increased with subsequent birth cohorts (Woodhall 2015) and there was an increase in both oral and particularly anal sex (Mercer et al. 2013) which may indicate some increase in higher risk sexual behaviours and practices. However, if the underlying risk of STI has changed, this was not reflected in differences in the prevalence of non-vaccine HPV types, which did not differ between surveys
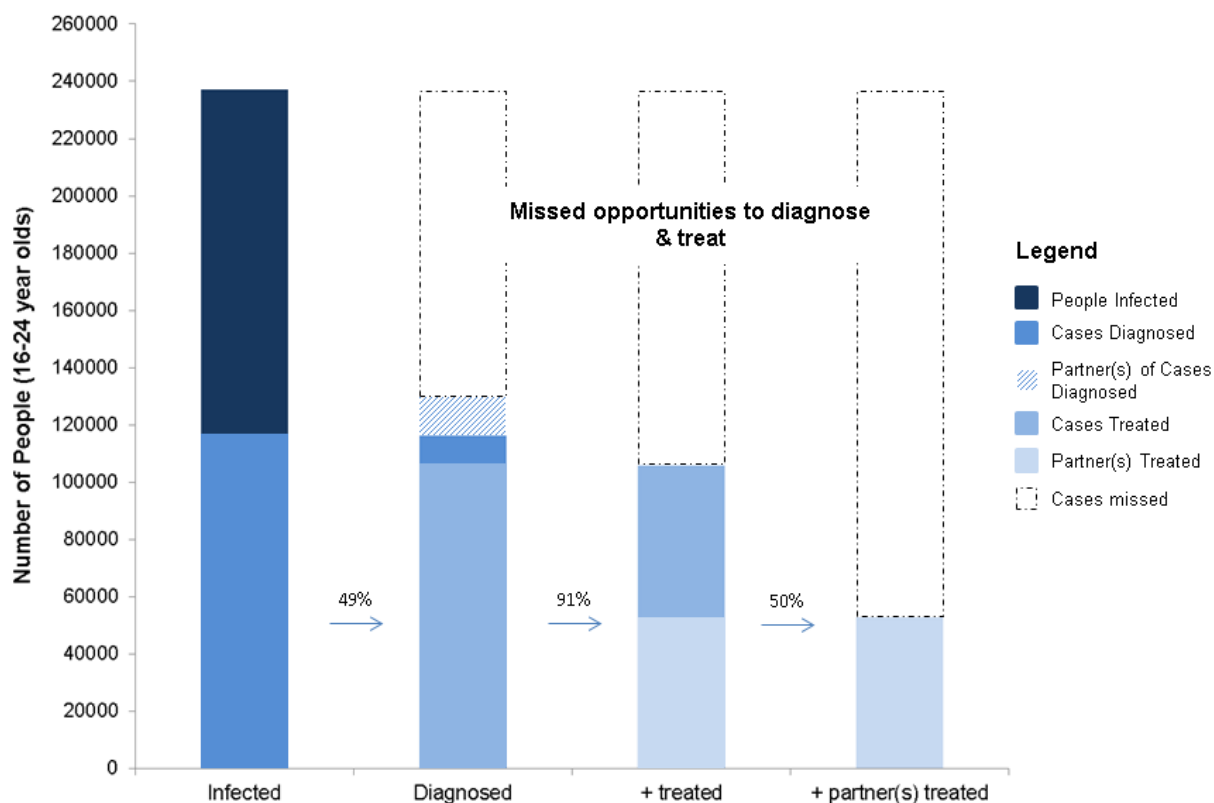


Figure 7.6 Illustrative figure of the care cascade, showing the missed opportunities to diagnose and treat chlamydial infections at each stage of contact with patients. Of the total number of 16-24 year olds infected, only 49% of them are diagnosed. Of these, 91% will be treated in a timely manner (within 6 weeks). About half of those will have their partners treated, leaving the other half at risk for re-infection from their untreated partner.
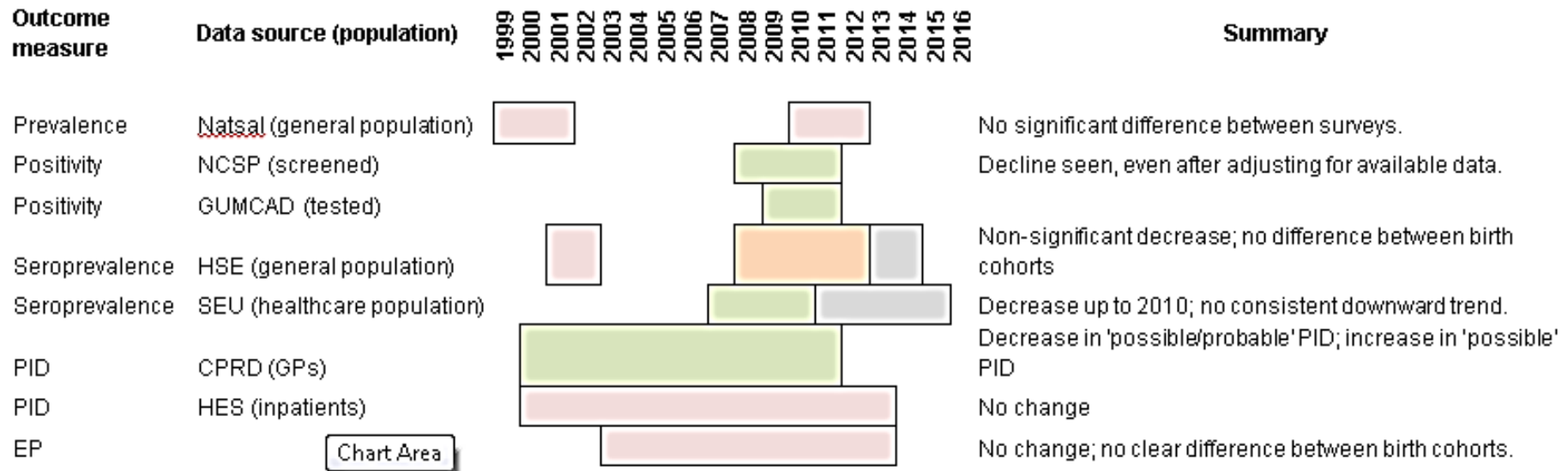
Figure 7.7 Summary of outcome measures, data sources and availability by year. Colour of box shows outcome: pink- no difference over time; amber- non-significant difference; green- significant difference, grey- data/samples available, results not yet completed

## 7.3   Chlamydia-related sequelae

Chlamydia screening is expected to prevent chlamydia-related sequelae by:

- reducing the duration of infection in an individual through treatment, thereby reducing the damage caused by the body's inflammatory response to an infection. This can be considered as the impact on sequelae at an individual level; and
- preventing infections through interruption of transmission and reducing incidence of infections. This can be considered as the impact on sequelae at a population level

Here we mostly review evidence for a measurable impact (direct and indirect) on PID and ectopic pregnancy in women. Chronic pelvic pain (CPP) and TFI have not been a target for PHE's outcome evaluation. We briefly mention the current evidence relating to epididymitis in men and neonatal pneumonia and neonatal conjunctivitis in neonates born to infected mothers. 2 general approaches are addressed: measuring changes in sequelae over time and measuring the population excess fraction.

### 7.3.1   Monitoring the frequency of pelvic inflammatory disease (PID)

PHE has used data from GPs using the Clinical Practice Research Datalink (CPRD), which comprises anonymised, patient-level medical records of a representative sample of patients (approximately 10% of the UK population) registered in GPs in England.(French et al. 2011, Public Health England 2015) Data from the genitourinary medicine clinic activity dataset (GUMCADv2) has been used to look at PID diagnoses made in specialist SHS clinics.(Sile et al. 2014) Data from the hospital episode statistics (HES) dataset has been used to investigate diagnoses in hospital inpatient settings.(Public Health England 2015)

Rates of 'definite' or 'probable' PID in 15 to 44 year old women attending general practice (where most diagnoses are made) fell in England by 9% per year from about 400/100,000 to 180/100,000 between 2000 and 2011 (Figure 7.8). The reduction was seen in all age groups but was most marked in women aged 15 to 24 (Figure 7.9).(French et al. 2011, Ross et al. 2014, Public Health England 2015) This was a time when the NCSP was being scaled-up and could therefore have contributed to this decline. Other developments may also have had an impact on PID rates in GP settings, including improved access to sexual health services and the roll-out of NAATs.(Skidmore et al. 2006) PID rates in primary care plateaued between 2008 and 2011, which may reflect reaching a relatively steady-state period, where rates of PID are maintained at a lower level in the presence of widespread screening. While the overall rate of diagnoses per population has decreased, there has been a divergent trend in diagnoses categorised as 'probable/definite' PID and those categorised as 'possible' PID, with the latter having consistently risen over the analysis period.(French et al. 2011, Public Health England 2015)

Figure 7.8 Rates of PID among 15 to 44 year old women diagnosed in GP (definite + probable) and GUM

Fewer diagnoses of pelvic
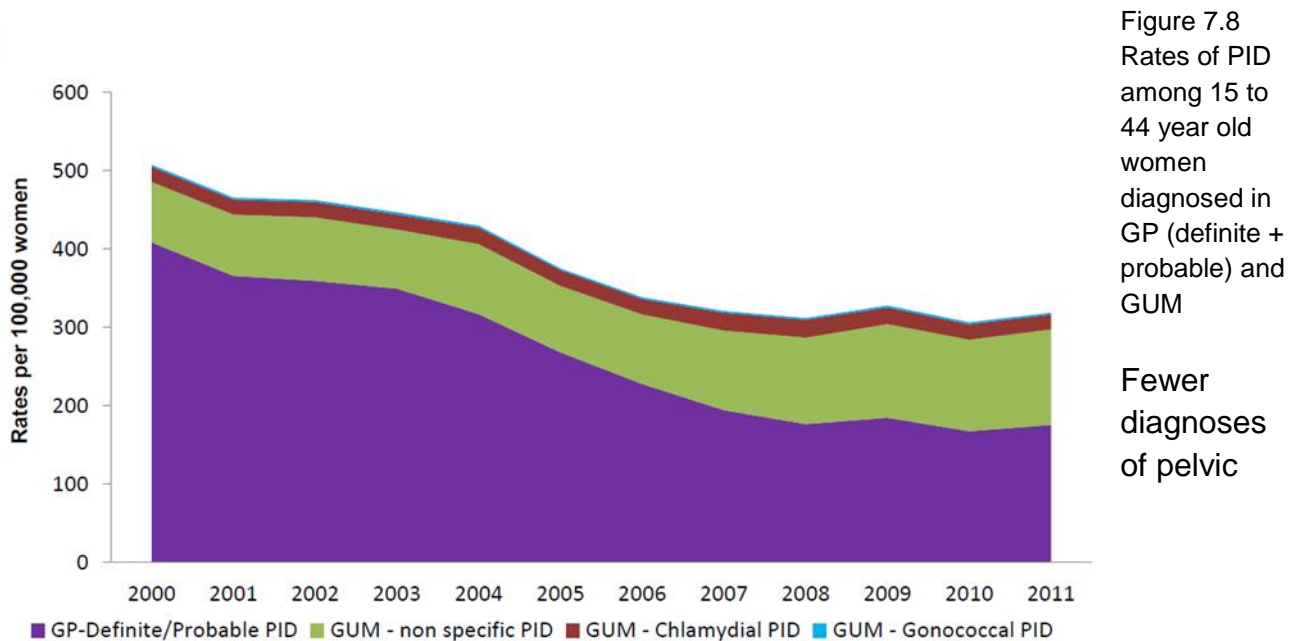
inflammatory disease are made in sexually transmitted infection clinics. Although the number of cases seen in this setting in England rose by 27% between 2003 and 2012, this probably reflects an increase in clinic capacity leading to more women being seen rather than a true increase in incidence.(Ross et al. 2014)
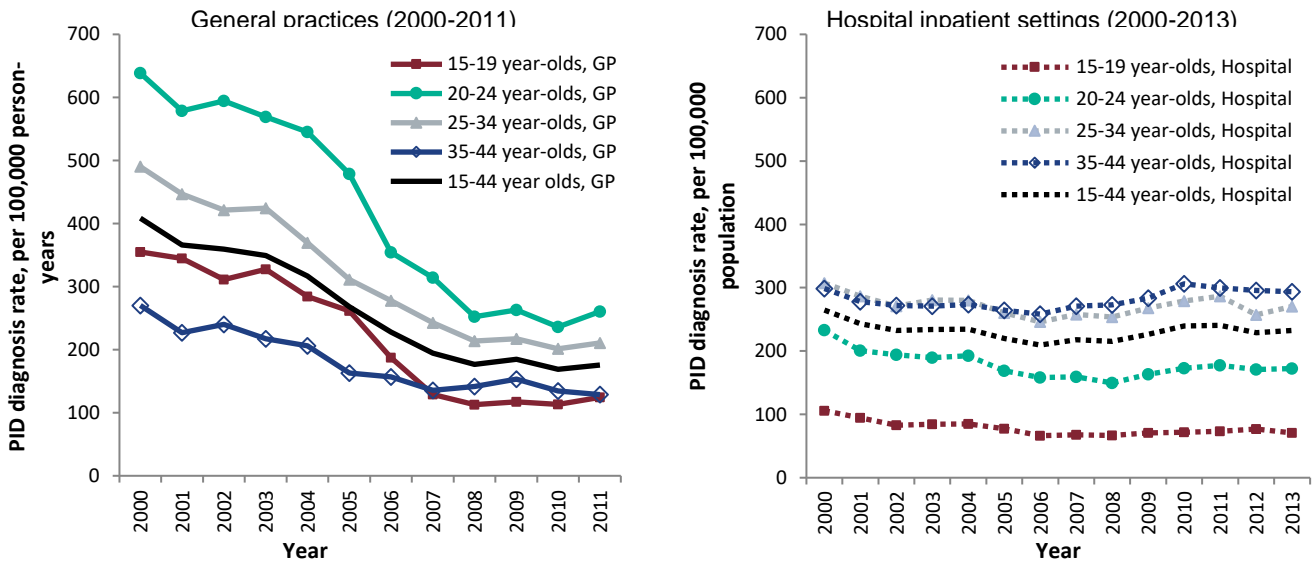


Figure 7.9: Pelvic inflammatory disease (PID) diagnosis rates by age group (15 to 44 year-old women) in general practices and hospital inpatient settings. (Public Health England 2015)

The age distribution of women diagnosed with PID varies between healthcare settings, with women diagnosed in hospital settings being older than those diagnosed in GP settings. This likely reflects differences in attendance patterns, diagnostic coding practices and possibly in aetiologies.

It is not possible within these routinely–collected data to distinguish between PID caused by chlamydia or due to other causes. In a recent meta-analysis using data from several studies, Price et al. estimated the population excess fraction of PID attributable to chlamydia to be 19.7% (95% CrI 5.9% to 38.1%) in women aged 16 to 44 years.(Price et al. 2016) Coding practices complicate interpretation of PID diagnosis rates, as diagnosis of PID is not based on standard diagnostic criteria. Clinical coding practices for PID have been found to vary by clinician (Morris et al. 2014) and likely vary by setting and over time. It is possible, but not demonstrated, that changes in the coding of PID by GPs over time could have influenced the decline in rates of probable/definite PID; it is possible that the increase in possible PID reflects a shift in coding practice toward less specific diagnoses, perhaps as GPs have become more aware of the diagnostic uncertainties. It could also be postulated that diagnoses of PID may be more readily made in women with a history of chlamydia diagnosis. This 'prior-suspicion' effect could be affecting the observed trends in PID diagnoses over a period when chlamydia testing has changed markedly.

### 7.3.2   The frequency of ectopic pregnancy (EP)

Data from the HES dataset have been used to investigate rates of EP diagnoses in hospital inpatient settings in England. Between 2003 and 2013, there were 96,234 EP diagnoses among 15 to 44 year-olds (1,046/100,000 conceptions) and 1.1% of conceptions in this age group resulted in an EP. EP rates were strongly associated with age, with rates higher in the oldest age-groups. A small increase in EP rates for all ages was observed between 2003 and 2013 after adjustment for age-group and geographical area (IRR: 1.01, 95%CI 1.00-1.01, p-value <0.0001) (Figure 7.10). There was no evidence of a decrease in age-specific EP rates between birth-cohorts who commenced sexual activity after, compared to before, full roll-out of the NCSP (Figure 7.11).(Chandra et al, in preparation)
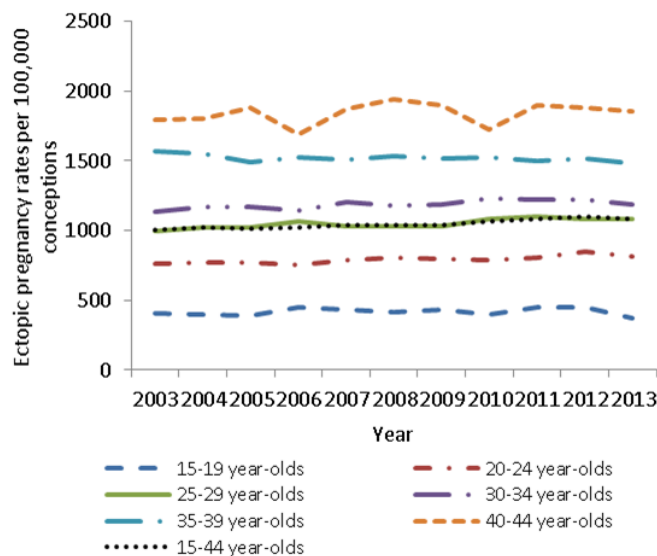
Figure 7.10: Ectopic pregnancy rates per 100,000 conceptions by age-group for women aged 15 to 44 years old, 2003-2013. (Chandra et al, in preparation)
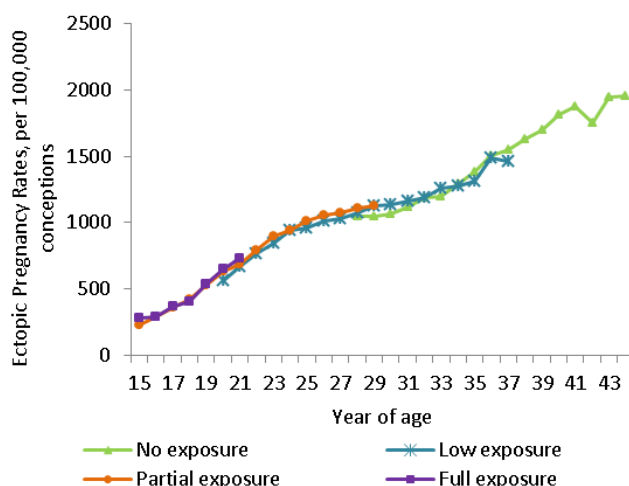


Figure 7.11: Ectopic Pregnancy rates per 100,000 conceptions for women aged 15 to 44 years old by year of age and birth-cohort with varying exposure to widespread chlamydia screening through the NCSP, 2003-2013.[4] (Chandra et al, in preparation)

It is not possible within these routinely–collected data to distinguish between ectopic pregnancies caused by chlamydia or due to other causes. Price et al. have estimated that 4.9% (95% CrI 1.2% to 12.1%) of ectopic pregnancies were attributable to chlamydia before the widespread implementation of chlamydia screening.(Price et al. 2016) Therefore only a

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[4] Birth-cohorts are grouped to reflect exposure to widespread chlamydia screening (national implementation from 2008; opportunistic screening offered to sexually active 15-24 year-olds). Full exposure represents women who were aged 16 years old or less in 2008 (born after 1991) who had many years of exposure to the national implementation of the NCSP since sexual debut. Partial exposure represents women who were aged between 17 and 24 years in 2008 (born between 1984 and 1991). Low exposure represents women who were aged more than 24 years in 2008 (born between 1976 and 1983) and were only exposed to the initial roll-out phase of the NCSP (from 2003). No exposure represents women aged more than 33 years in 2008 (born between 1966 and 1975) who were not exposed to any stage of the NCSP between the ages of 15 and 24 years.

very small reduction might be expected in rates of EP at a population level, which may not be readily detectable. Interpretation of EP rates is also complicated by changes in their diagnosis, management and treatment in recent years. More recently, EP are diagnosed before the onset of symptoms which may lead to less invasive (non-surgical) and earlier treatment and reduced morbidity and mortality (Chapter 8).(Van Den Eeden et al. 2005)

### 7.3.3 Other chlamydia-related sequelae

PHE has not measured infertility due to the overriding difficulties in determining any trends in chlamydia-related infertility due to changes in other causes of infertility and the impact of changes in access to infertility services on available statistics.

Epididymitis, orchitis and epididymo-orchitis (hereafter grouped and referred to as EO) have not been routinely monitored, however, patterns of EO diagnoses in specialist SHS clinics and inpatient settings in England in 2009-2011 have been investigated. The highest rates in specialist SHS clinics were among younger men; this is consistent with STI aetiology in this setting. Higher rates in hospitals were seen among older men, suggesting a more mixed aetiology.(Chandra et al. 2015)

### 7.3.4 Estimation of population excess fraction(s)

The population excess fraction (PEF) is the proportional reduction in disease risk that would be achieved by eliminating the exposure of interest from the population, assuming the exposure is causally related to the disease.(Price et al. 2016)

The PEF is a property of the disease and the exposure, but also of the time and place where the data were collected.(Price et al. 2016) The PEF measured in a setting without effective chlamydia screening would therefore reflect the potential benefit still to be gained through eliminating exposure to infection. In the presence of an effective screening programme, the population excess fraction of chlamydia on chlamydia-related consequences would be expected to be low, if screening has already reduced the risk of complications.(Davies et al. 2017)

Calculation of the PEF of upper genital tract sequelae attributable to chlamydia has not, to-date, formed part of PHE's core evaluation work. PHE has, however, collaborated on an HTA-funded research project which used multiparameter evidence synthesis (MPES) – a kind of statistical modelling that combines data from multiple sources – to investigate the natural history of chlamydia.(Price et al. 2016) Using data from the UK before the full implementation of the NCSP, this study estimated the PEF of PID attributable to chlamydia to be 35.3% (95% CrI 10.5% to 68.5%) in 16 to 24 year-olds, and 19.7% (95% CrI 5.9% to 38.1%) in 16 to 44 year-olds; the PEF of EP attributable to chlamydia was 4.9% (95% CrI 1.2% to 12.1%) of EP in women aged 16 to 44 years. The PEF of TFI attributable to chlamydia was estimated as 45% (95% CrI 28% to 62%). However this estimate was based on data from women seeking infertility treatment in the Netherlands rather than the UK. A study used data from women

attending an infertility clinic in the South West of England in 1985-1995 and estimated the PEF to be between 28.0% (95% credible interval: 6.9, 50.0) and 46.8% (95% credible interval: 23.2, 64.1). (Table 7.1)

**Table 7.1 Population excess fraction (PEF) estimates for chlamydia-related sequelae**

| Chlamydia-attributable Sequelae | PEF | 95% CIs |
|---|---|---|
| PID in 16 to 24 year-olds | 35.3% | 10.5 – 68.5% |
| PID in 16 to 44 year-olds | 19.7% | 5.9 – 38.1% |
| EP in 16 to 44 year-olds | 4.9% | 1.2 – 12.1% |
| TFI | 45% | 28 – 62% |

The current PEF of PID and other complications which are attributable to chlamydia and other complications in England is unknown.

### 7.3.5   Summary of what is known about the impact of the NCSP on chlamydia-related complications

There is some evidence to suggest that widespread chlamydia screening may have had an impact on rates of chlamydia-related complications, specifically:

- analysis of CPRD data from GPs is consistent with there having been a decrease in PID during the mid-2000s. This was a time when the NCSP was being scaled-up and could therefore have contributed to this decline, although this decline had started before the implementation of the NCSP and cannot be definitively attributed to the NCSP

However, limitations of the available using routinely collected data about chlamydia-related complications means that we are limited in our ability to confidently evaluate the impact of the NCSP on the frequency of these sequelae.

- the limitations in diagnostic coding for PID mean that interpretation of routinely-collected data will always be subject to considerable uncertainty. The contribution of changing diagnostic practices and changes in the incidence of disease caused by chlamydia and other causes cannot be reliably disentangled
- the PEF of EP which can be attributed to chlamydia is small (around 5% estimated before the implementation of the NCSP). The time between chlamydia infection and pregnancy may be considerable and vary. Detecting changes in EP rates in the population due to changes in chlamydia infection is therefore unlikely

In summary, while there is good evidence from randomised controlled trials and our understanding of chlamydia natural history in support of chlamydia screening reducing the risk and incidence of these sequelae (Section 2.3) demonstrating this impact in practice is limited both by the availability of robust outcome measures and the ability to identify any causal relationship in the context of an ongoing programme.(Bonell et al. 2011, Cousens et al. 2011)

## 7.4 Impact on knowledge and awareness and sexual and health-seeking behaviours

The NCSP aims to provide widespread access to screening, normalising chlamydia testing and increasing knowledge and awareness of chlamydia among young adults and health professionals. Chlamydia screening thus provides an opportunity for young adults to engage with sexual health services and professionals, which may lead to behavioural changes which reduce STI risks such as increased condom use, increased regular testing for chlamydia and other STIs and increased willingness to engage with sexual and reproductive health services. Conversely, it has been hypothesised that this may lead to a level of 'risk-compensation', whereby the ease of chlamydia testing and treatment could lead to young adults engaging in higher risk sexual activity (eg reduced condom use, more sexual partners).

In the past 5 years, PHE has commissioned 2 web-based surveys of 16-24 year-olds resident in England.(Public Health England 2014, Hartney et al. 2015) Both surveys were carried out by a market research company, which accessed existing panels of young adults who had volunteered to complete online surveys. The first survey (carried out in 2012; n=1,521), recruited people who had and had not been tested. The second survey (carried out in 2014, n=1,218) recruited only young adults who has ever been tested for chlamydia. Participants were asked about their knowledge of and attitudes towards chlamydia and chlamydia screening and about the perceived impact of chlamydia testing on their subsequent behaviour in relation to sexual behaviour and service use.

In the 2012 survey, there was strong evidence of an association between attitudes towards testing and having been tested. Those who agreed with the statement "My friends get tested for chlamydia" were more likely to have been tested for chlamydia. Those who agreed with the statement "I would be too embarrassed to ask for a chlamydia test" were less likely to have been tested.(Hartney et al. 2015) The 2014 survey asked about perceived impact of testing on attitudes towards chlamydia and chlamydia testing. Young adults found the experience of getting tested was a positive one in terms of reducing potential barriers to future testing: they were more likely to think that getting tested was easy, felt less embarrassed about asking for a test, and were less likely to think that testing was painful or uncomfortable. Testing had a normalising and destigmatising effect, in terms of making young adults more likely to think that testing was normal and approved of in their peer group. However only a quarter were more likely to think they were at personal risk of acquiring chlamydia after being tested. While normalising chlamydia testing and diagnosis is important in order for screening to be acceptable to young adults, increasing levels of awareness of personal risk may also help encourage regular testing.(Public Health England 2014)

The 2 surveys also found that young adults frequently reported a positive perceived impact of testing on likelihood of future testing, on sexual behaviour and on knowledge of how to prevent chlamydia. Around two-thirds of respondents reported that testing made them more likely to test for chlamydia again in the future; in 2012 41% reported that testing made them more likely to use condoms every time they had sex; in 2014 62% reported that getting tested

made them more likely to use condoms with a new partner (Figure 7.12); around 30% of respondents said that chlamydia testing would make them more likely to have fewer sexual partners in the future and in 2014 58% reported that testing would make them more likely to know how to avoid getting chlamydia. Positive impacts on knowledge and behaviours tended to be more often reported by those who had received more types of sexual health information at their last test and in those who had a new partner in the last 3 months. Respondents who had previously received a positive chlamydia test result were more likely to report both negative and positive behavioural consequences of testing (ie fewer 'unchanged'). This could be due to the complex psychosocial implications of receiving a positive test result compared to a negative one, including differences in levels of anxiety, concern for future reproductive health and desire to discuss the implications of a test result with a healthcare professional. It should also be noted that a small proportion of respondents in each case reported 'negative impacts' (less likely to test again, less likely to use condoms with new/every partner, less likely to have fewer partners in the future).
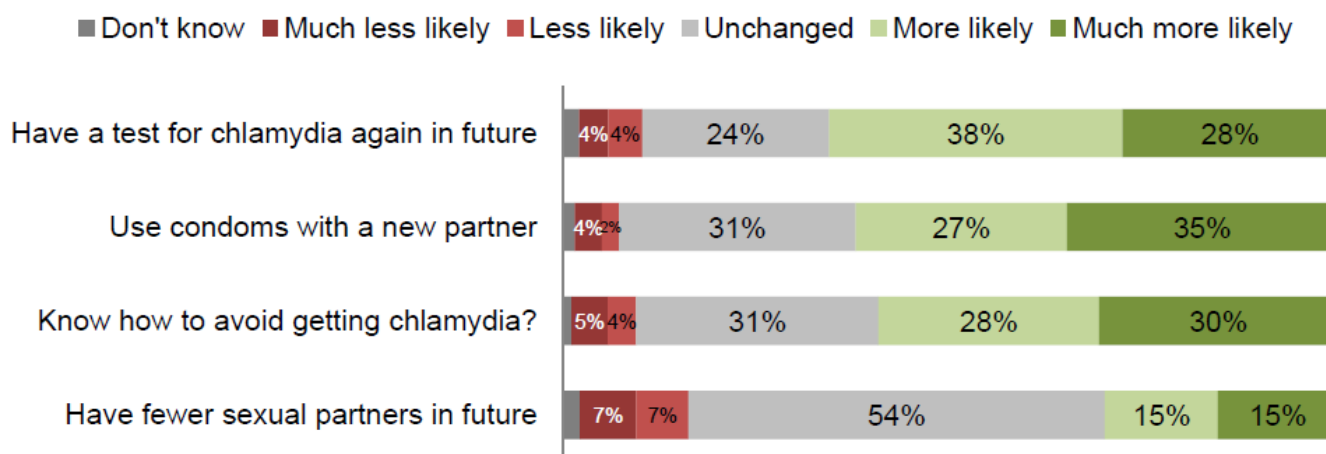


Figure 7.12 Changes to behaviour after being tested for chlamydia "Has getting tested for chlamydia made you more or less likely to..." (n=1,218)(Public Health England 2014)

Respondents reported that chlamydia screening resulted in changes to their subsequent knowledge or healthcare-seeking or sexual behaviour. Given that those with higher rates of partner change and unprotected sex are more likely to be tested regularly,(Woodhall et al. 2015) chlamydia screening provides an opportunity to deliver safer sex messages to young adults with higher risk of poor sexual health outcomes. While reporting a positive impact was more common among those who received more types of sexual health information with their last test, it was also observed among those who reported receiving no information. These findings suggest that chlamydia screening has a wider effect on young adults' sexual health beyond diagnosis and treatment alone.

Knowledge and awareness of NCSP guidance was assessed in an online survey of health care professionals in 2015 to 2016.(Currie et al. 2016) In a convenience sample of health care professionals working in specialist SHS or other sexual health services, knowledge of NCSP guidelines was variable. Over three-quarters of respondents were unaware of the NCSP's recommendation for annual testing, although around a third of respondents did recommend

annual testing in practice. Most respondents were aware of the NCSP's recommendation for testing on change of sexual partner and for retesting 3 months after a positive test, although knowledge (and implementation) of testing recommendations was generally lower in the non-GUM respondents, especially with regard to retesting after 3 months.(Currie et al. 2016)

## 7.5    Adverse outcomes

In evaluating the impact of the NCSP, it is important to understand whether screening is leading to any adverse outcomes as well as positive ones. The potential for risk compensation is one such potential adverse outcome, and has already been discussed above. Other potential adverse outcomes and PHE's approach to assessing them are set out below.

### 7.5.1    Development of antimicrobial resistance

The threat of antimicrobial resistance is a major public health priority. To date, no cases of treatment-resistant chlamydia have been identified and Chlamydia trachomatis is thought to have a high barrier to the development of resistance to antibiotic therapies. However, it is not possible to rule out the possibility that the bacteria will develop treatment-resistant mutations.(Horner 2006, Horner 2012)

Widespread use of antibiotics to treat chlamydia also has the potential of adversely affecting antimicrobial susceptibility for other bacteria. A connection between instigation of widespread chlamydia testing and treatment with azithromycin and the rise of azithromycin resistance in Neisseria gonorrhoeae (NG) has been proposed, but not substantiated.(O'Farrell 2016) No specific outcome measures have been collected to investigate this. If rising chlamydia treatment is the primary driver for the rise in azithromycin resistance (of any level) then one might expect to see to rising azithromycin resistance during large changes in chlamydia screening activity. The largest proportional and absolute year on year rise in chlamydia testing and treatment was between 2007 and 2010. However GRASP data shows no meaningful change in the proportion of isolates resistant to azithromycin during these years.(Public Health England 2014)

In addition there are several other potential drivers for azithromycin resistance which must be investigated. Recent surveillance data from Public Health England show that in primary care 1 in 5 cases of gonorrhoea are treated with azithromycin only. This suggests that a material proportion of cases of gonorrhoea are being treated sub-optimally in England and this may be a key driver of resistance. Furthermore azithromycin and other macrolides are frequently prescribed for non-sexually transmitted infections. During 2015 there were 200,000 diagnoses of chlamydia in all ages; however prescribing of macrolides exceeded 300,000 prescriptions per month.(EBM DataLab 2017)

### 7.5.2    Testing and treatment for gonorrhoea

The availability of assays using NAATs which simultaneously detect both *C. trachomatis* and *N. gonorrhoea* ('dual NAATs') presents a possibility that young adults screened for chlamydia

will also be tested for gonorrhoea, even though asymptomatic testing for gonorrhoea may not be clinically indicated. Unless properly confirmed, there is a risk of incorrect diagnoses being made as a result of lower sensitivity and lower prevalence of NAATs.(Public Health England 2014)

PHE carried out a survey of UK microbiological laboratories in 2013 to assess usage of dual NAATs. This surveyed showed that 85% of responders reported using dual NAATs but only 25% of laboratories confirmed gonorrhoea-positive results using a different nucleic acid target, as recommended by UK Standards for Microbiological Investigations. PHE subsequently issued guidance on testing for gonorrhoea that emphasised the importance of appropriate care pathways and consideration of screening in low prevalence areas.(Public Health England 2014)

No specific outcome measures are collected following this guidance.

### 7.5.3  Personal harms

Chlamydia screening can have less tangible adverse outcomes, particularly when the personal impact of screening is considered. An early qualitative review conducted in-depth interviews with participants in a population-based UK study of postal screening for chlamydia.(Mills et al. 2006) This study identified 4 particular themes: unease with sexual health issues, fear of informing sexual partners following a positive test result, the risk of infertility and possible co-infections, and the stigma associated with having an STI. Appropriate training for health providers should be undertaken to deal with potential adverse effects and their consequences.(Duncan et al. 2001)

## 7.6  Summary of issues in impact measurement

Table 7.2 summarises the strengths and limitations of different impact/outcome measures, as discussed above.

### 7.6.1  Population-based surveys

Repeat cross-sectional, population-based surveys specifically for detecting the prevalence and incidence of genital chlamydia in the general population are likely to be unfeasible due to the high costs. However surveys such as Natsal and the HSE, which are nationally representative, have relatively high response rates and collect data on a range of topics, will present better value for money than cross-sectional, chlamydia prevalence-specific postal surveys. Analysis of such surveys should focus on assessing prevalence in the context of reported screening and diagnoses and sexual behaviours rather than on direct comparisons of prevalence alone.

Additionally, the potential to incorporate the following measures into the HSE on a routine basis should be considered: current chlamydia infections (as measured using NAATs of urogenital specimens); previous infection with *C. trachomatis* (as measured using antibody

tests of serum specimens); sexual behaviour and reported chlamydia testing and diagnosis history. Boosting the available sample size among young adults in both future rounds of the HSE and Natsal surveys would increase the power available for comparative analyses and should be considered, using available data to determine the sample size required.

Trends over time in percentage testing positive for chlamydia among populations accessing testing should not be interpreted as trends in the underlying burden of disease without first ruling out or addressing sources of selection bias and confounders. Future analyses should also consider any changes in test technology that may affect the sensitivity and specificity of tests used.

## 7.6.2  Serosurveillance

Serology is providing a cheap and potentially effective tool for measurement of population prevalence and changes over time. Estimates of Pgp3 seroprevalence by birth cohort should be extended. In addition to continued use of sera from HSE participants, routine collections of residual sera from sentinel groups should be pursued, with appropriate consideration of the potential bias in each (eg sera collected for routine microbiological investigations, specialist SHS clinic attenders, antenatal populations, blood donors).

Future serum collections should incorporate measures of previous chlamydia diagnoses and sexual behaviour where possible to allow the measurement of the undiagnosed fraction of C. trachomatis infections and to reduce confounding of the relationship between chlamydia control interventions and antibody seroprevalence arising from changes in sexual behaviour over time.

Collecting serum samples as part of HSE or Natsal should be explored to link lifestyle factors, infection data and seroprevalence of *C. trachomatis*-specific antibodies. Advances in serological assays must also be taken into account as and when they develop.

## 7.6.3  Sequelae monitoring

Surveillance of PID in GP settings and EP rates in hospital settings should be discontinued. The limitations of these measurements, including multiple aetiologies, are such that interpreting them in the context of chlamydia screening will not provide strong evidence on the impact of the chlamydia screening. Conversely, surveillance of these conditions in their own right may prove of use to other public health departments.

Given the limitations with existing outcome measures, research to develop more robust outcome measures would be welcome. Studies have found elevated levels of cytokines and other inflammatory proteins in serum from clinically diagnosed PID patients.(Hsiao et al. 2010, Lee et al. 2010) However no studies have correlated specific biomarkers with upper genital tract infection or inflammation.(Darville et al. 2013) Identifying genes and proteins that could be used as a biomarker panel specific for upper tract inflammation, and ideally chlamydia-

attributable salpingitis or surveillance of PID, should be a future research aim although this would fall outside the remit of the NCSP.

Until such outcome measures are demonstrated to have utility in practice, they should not be incorporated into the routine monitoring and evaluation of the NCSP.

**Table 7.2: Summary of strengths and limitations of different outcome measures**

| Outcome measure | Setting | Strengths | Limitations | Considerations. |
|---|---|---|---|---|
| Population prevalence of chlamydia | Population-based surveys | Accurate and non-invasive diagnostic tests can be used (NAATs). Population-based surveys can estimate prevalence in the general population. A direct measure of chlamydia screening. | Population prevalence is estimated to be <5% among the target population for screening. Large samples sizes are therefore needed in order to detect changes in prevalence. | Surveys designed to specifically measure chlamydia prevalence will be costly and open to bias due to non-response. Incorporation of chlamydia prevalence measurement into existing population-based surveys (such as Natsal or HSE) will likely achieve higher response rates and better value for money |
| Chlamydia seroprevalence | Population-based surveys; leftover clinical sera | Can use residual specimens collected for purposes other than chlamydia testing. | Will underestimate cumulative incidence of chlamydia as existing tests are <100% sensitive and in some cases varies with number of infections and time since infection.<br><br>Sensitivity to detect a previous known chlamydia infection is lower among men for some tests. | Interpretation of seroprevalence has yet to be agreed upon.<br><br>A multiparameter evidence synthesis model of chlamydia incidence using seroprevalence data is under development at the University of Bristol.<br><br>Sufficient numbers of representative samples, or samples from stable populations, are needed for robust estimation of incidence. |
| Chlamydia proportion testing positive | All NHS-commissioned chlamydia tests. | Comprehensive data for England available through CTAD and GUMCADv2. | Proportion testing positive is dependent on the population tested; will be biased estimator of population prevalence.<br><br>Repeat testing can be difficult to distinguish | Incorporating sexual behaviour alongside testing data could be used to better estimate trends in proportion testing positive.<br><br>Collection of sexual behaviour data within |

| | | | without a unique identifier across all surveillance systems.<br><br>Trends over time will be affected by changes in testing policy and practice. | sexual health settings is planned for GUMCADv3.(Public Health England 2015) Incorporation of sexual behaviour data may be more easily achieved using online testing platforms. |
|---|---|---|---|---|
| Diagnosed pelvic inflammatory disease (PID) | GP records; GUM clinics; hospital inpatient/o utpatient episodes | Progression to PID is thought to occur relatively quickly (within 1 year) of chlamydia infection.<br><br>The PEF of PID to chlamydia in the absence of a screening programme is relatively high (~30%). | The diagnostic criteria for PID are not very specific.<br><br>Cannot distinguish between PID caused by chlamydia or due to other causes. Even where a chlamydia result is available alongside a PID diagnosis, this cannot be used to determine definitively whether PID has been caused by chlamydia. | Primary outcome of RCTs on which NCSP rationale is based.<br><br>It may be possible to implement a diagnosis based on signs and symptoms. The extent to which this could be implemented in clinical practice will likely vary by setting and may be more feasible to be used within a specific study or surveillance system than being implemented nationally.<br><br>The majority of PID is diagnosed in GP settings.<br><br>A higher proportion of PID in inpatient hospital episodes are among older women than in GUM clinics, suggesting a more mixed aetiology in hospital settings. |
| Diagnosed ectopic pregnancy (EP) | Inpatient episodes; outpatient episodes; GP records. | EP is a clear diagnostic code. | Cannot distinguish between EP caused by chlamydia or due to other causes.<br><br>Delay between *C. trachomatis* infection and EP diagnosis<br><br>PEF of EP attributable to chlamydia is small (estimated <5% before implementation of NCSP). In the presence of an effective screening | Interpretation of EP rates is complicated by changes in their management and treatment in recent years. More recently, EP are diagnosed before the onset of symptoms which may lead to less invasive (non-surgical) and earlier treatment. Outpatient data are not readily available. |

| | | | programme, only small reductions might be expected, which may not be readily discernible. The age distribution of chlamydia infections and pregnancy is very different, meaning there could be a long period between programme implementation and any changes in EP rates. | |
|---|---|---|---|---|
| Diagnosed epididymo-orchitis (EO) | GP records; GUM clinics; hospital inpatient/outpatient episodes | Progression to EO is thought to occur relatively quickly (within 1 year) of chlamydia infection. | Cannot distinguish between EO caused by chlamydia or due to other causes. | A higher proportion of EO in inpatient hospital episodes are among older men than in GUM clinics, suggesting a more mixed aetiology in hospital settings. |
| Diagnosed tubal factor infertility (TFI) | | | Cannot distinguish between TFI caused by chlamydia or due to other causes.<br><br>Delay between *C. trachomatis* infection and TFI diagnosis<br><br>TFI diagnoses will be particularly subject to changes in provision of infertility services within the NHS. | |
| Self-reported impact of NCSP on sexual and health-seeking behaviour | Web-based survey | A web-based survey can collect multiple data items simultaneously and recruit a specific population (with respect to age/gender/ethnicity). | Self-report – not clear whether actual behaviour change. Not random sample. Survey does not allow detailed investigation/follow up of causes. Costs of implementation. | One-off surveys can provide useful information. The value of repeated monitoring is less clear; the expected change in sexual behaviour we are looking for would need to be defined. |
| Self-reported knowledge and awareness of chlamydia screening | Web-based survey; in-clinic survey | A web-based survey can collect multiple data items simultaneously and recruit a specific population (with | Not a main outcome of screening programme (but *is* an aim of the NCSP) | One-off surveys can provide useful information. The value of repeated monitoring is less clear; the expected change in sexual behaviour we are looking |

| | | respect to age/gender/ethnicity). | | for would need to be defined. |
|---|---|---|---|---|
| | | | | |

## 7.7   Summary

Monitoring the frequency of diagnosed PID and EP has not provided clear evidence of an impact of chlamydia screening on these disease outcomes in England to date. This is not surprising given the multiple and changing aetiologies of these sequelae, the known and possible measurement errors in the available data sources (for example, and especially, in the definition and coding of PID), the usual weaknesses and limitations of ecological analyses, and the relatively moderate effect size that could be reasonably expected from screening as practiced to date.

We recommend ceasing surveillance of all-cause PID and EP for the purpose of evaluating chlamydia screening. We recommend continued study of biomarkers of chlamydia associated PID and EP (and TFI) that may become useful surveillance tools.

We have no accurate method for monitoring the incidence or prevalence of chlamydia at local level. National surveys have confirmed ongoing transmission and the risk factors for infection, as well as the characteristics of those accessing chlamydia testing. Measuring the prevalence of antibodies against *C. trachomatis* is being explored as a measure of past exposure and further research work may provide methods to use seroprevalence data to estimate incidence and prevalence.

# 8 The health economics of chlamydia screening in England

This section summarises the findings, assumptions and caveats of the 2 transmission dynamic mathematical models and cost-effectiveness analyses that informed the original recommendations and design of the NCSP and the experience and developments in modelling and cost-effectiveness analyses of chlamydia screening since.

## 8.1 Introduction

As mentioned in Chapter 2, the rationale for chlamydia screening as practiced in England has included, though not exclusively, the likely gains in health and well-being being achieved at a price that is found to be both consistent with other public health care interventions, and affordable.

## 8.2 Cost-effectiveness analyses

The design and implementation of the current English chlamydia screening programme was informed by 2 cost-effectiveness analyses (CEA) that used dynamic models of chlamydia transmission:

1. The 1998 CMO's Expert Advisory Group on *Chlamydia trachomatis* was informed by a mathematical model created by Townshend et al. of the DH. This model and CEA suggested that opportunistic chlamydia screening of young women would be cost saving in the medium term.(Chief Medical Officer's Expert Advisory Group 1998, Townshend et al. 2000)
2. PHE (then HPA) developed an individual-based transmission model and CEA to inform further/later development of policy and implementation.(Turner et al. 2006, Adams et al. 2007) This modelling work did not find chlamydia screening to be cost saving, but did find it to be probably cost-effective in some designs.

Further details of each model are given and discussed below.

**Analysing the Effectiveness of Chlamydia Screening.(Townshend et al. 2000)**

Two screening scenarios were considered in this analyses: i) screening symptomatic men and women presenting at health care settings, and all women attending ToP services; and ii) routine opportunistic screening at health care settings, such as family planning clinics or GPs, for women aged 16 to 25 not previously tested, or upon partner change, with rescreen after 1 year for 16 to 20 year olds or 2 years for 21 to 25 year olds. Both scenarios included immediate partner tracing, testing, and treatment if necessary. Table 8.1 summarises some of the key assumptions of this model.

This study estimated that under base case assumptions, after 5 years, 30,000 PID (lowest, 7,000; highest, 40,000), 7,000 cases of female infertility, and 700 ectopic pregnancies would be prevented each year, compared with baseline levels of 74,000, 30,000, and 3,000 cases, respectively. Chlamydia screening implementation in England and Wales was estimated to cost £26 million each year, with net saving reaching £3 million each year after 5 years, increasing to £13 million each year after 10 years: the initial outlay would be fully recouped after 12 years.

This study had a number of now doubted assumptions, including: the baseline prevalence was high (5%, mix. 2.5%, max. 10%); the progression parameters predicted very high numbers of prevented sequelae; the screening costs were very low; the sequelae management costs were relatively high. The finding of chlamydia screening being cost-saving is not now considered credible and this model is not now relied upon or used as a good source of evidence.

**Table 8.1 Progression probability to sequelae reported in Table 4 of Townshend et al., cost assumptions used in their model (Table 7 of the paper), and other assumptions applied; ranges were applied in sensitivity analyses.(Townshend et al. 2000)**

| **Screening** | | Cost (assumed 1999/2000 GBP prices) | Cost adjusted for inflation to 2015/2016 values |
|---|---|---|---|
| First test | | £12.41 | £19.55 |
| Retest | | £10.56 | £16.64 |
| Chlamydia detected by screening | | £9.00 | £14.18 |
| **Male** | Progression probability | | |
| Epididymitis | 0.04% | £210.00 | £330.88 |
| Urethritis | 50% | £9.00 | £14.18 |
| Infertility | 1% | (Not included) | (Not included) |
| **Female** | Progression probability (range) | | |
| Cervicitis | 25% | £9.00 | £14.18 |
| PID | 25% (10% to 40%) | £350.00 | £551.46 |
| Infertility | 10% (5% to 15%) | £2,100.00 | £3,308.75 |
| Ectopic pregnancy | 1% | £4,300.00 | £6,775.07 |
| **Neonatal** | Sequelae rates (applied to infected mothers) | | |
| Conjunctivitis | 17% | £35.00 | £55.15 |
| Pneumonia | 16% | £760.00 | £1,197.45 |
| **Other assumptions** | Base case value | Min. | Max. |
| Test sensitivity | 80% | 40% | 100% |
| Test specificity | 95% | 95% | 100% |
| Treatment success rate (included consideration for both treatment effectiveness of 100% and individual compliance of 90%) | 90% | 80% | 100% |
| Steady state incidence before screening policy begins | 600K | 300K | 1.2M |
| Steady state prevalence before screening policy begins | 5% | 2.5% | 10% |
| Future costs discount rate per year | 6% | | |

**The cost effectiveness of opportunistic chlamydia screening in England.(Adams et al. 2007)**

Three screening scenarios were explored in this study:

- Strategy 1- annual screen to women
- Strategy 2- annual screen to women with partner change in the last 6 months
- Strategy 3- annual screen for both genders

Different age cut-offs were explored for each scenario: <20, <25, <30, <35, <40 years old.

Table 8.2 summarises some of the key assumptions of this model.

This study estimated that, under base case assumptions, compared with no screening (prior to NCSP) and assuming a 10% progression to PID following chlamydia infection, all 3 screening strategies applied to an age cut-off of under 20 years old returned an average cost-effectiveness ratio (Incremental Cost-Effectiveness Ratio (ICER) when comparing intervention with no intervention) of under £20,000 per Quality Adjusted Life Year (QALY) gained, ie within the NICE recommended cost-effectiveness threshold.(National Institute for Health and Care Excellence 2013)

Screening was still cost-effective up to age 25 for Strategy 1, compared with no screening. However, screening both gender (Strategy 3) up to an age cut-off of 25 years old was above the "most plausible ICER of £20,000 per QALY gained", with an average cost-effectiveness ratio (ICER compared with no screening) of £27,269 per QALY gained.

Nonetheless, the ICER for mutually exclusive combinations of screening strategies and age cut-offs showed that Strategy 1 with age cut-off at 20 years old was the most cost-effective strategy (ICER £9,204 per QALY gained), whereas Strategy 3 with an age cut-off of 25 years old was still cost-effective (ICER £19,352 per QALY gained), both assuming the same 10% PID progression rate. This implies that if the health care provider is prepared to fund the intervention up to a threshold value of £20,000 per QALY gained, Strategy 3 with an age cut-off of 25 years old was still acceptable.

The authors highlighted the high degree of uncertainty in their findings, with ICER being highly sensitive to assumptions about PID progression rate.

**Table 8.2 Assumptions used in Adams et al. model.(Adams et al. 2007)**

| Screening | | Cost - 2004 GBP prices (Standard Deviation) | Cost - adjusted for inflation to 2015/2016 values |
|---|---|---|---|
| Screening (asymptomatic) and infected | | £31 (2) | £40 |
| Screening (asymptomatic) and not infected | | £20 (2) | £26 |
| Symptomatic infected and actively seeking treatment (men) | | £64 (6) | £82 |
| Symptomatic infected and actively seeking treatment (women) | | £61 (5) | £78 |
| Partner treatment | | £27 (2) | £35 |
| Do not accept screening offer | | £6 (1) | £8 |
| **Male** | **Progression probability** | | |
| Epididymitis | 2% | £142 (67) | £182 |
| **Female** | **Progression probability (range)** | | |
| Symptomatic PID | 1%, 10%, 30% | £137 (46) | £175 |
| Tubal factor infertility | Applied to symptomatic PID, 10.8%; half of women with TFI had an infertility investigation and treatment, and those not investigated or treated had no costs | £10,798 (4,279) | £13,805 |
| Ectopic pregnancy | Applied to symptomatic PID, 7.6% | £762 (329) | £974 |
| **Neonatal** | **Sequelae rates (applied to infected mothers)** | **Cost - 2004 GBP prices (Standard Deviation)** | **Cost (adjusted to 2015/2016 values)** |
| Conjunctivitis | Applied to infected women giving birth vaginally, 14.8% | £41 (4) | £52 |
| Pneumonia | Applied to infected women giving birth vaginally, 7.0% | £612 (555) | £782 |
| **Other assumptions** | **Baseline value** | **Min.** | **Max.** |
| Steady state prevalence before screening policy begins | 3.2% | | |
| Efficacy of partner notification with screening introduction | 50% | - | - |
| Future costs and effects discount rate per year | 3.5% | - | - |

## 8.2.1 Potential caveats and other issues

There are a number of issues to note with this modelling study. Firstly, relating to the detection and treatment of infections, the uptake of screening was assumed to be 50% of the eligible

population each year (assuming 85% attended health care settings in a year) and assumed to be random by risk of infection.

In 2015, the population of 15 to 24 year olds was estimated to be 6.81 million; based on the assumption that 85% attended a healthcare service; the eligible population was 5.79 million. There were 1.53 million tests undertaken within this group, therefore, assuming each test is done on a unique individual, the estimated uptake of screening would be 26.4% rather than the 50% used in the model. Note coverage is used as a proxy measure here. The risk of infection (ie positivity of tests) has, however, been higher amongst individuals tested by the NCSP than the population prevalence used to determine the number of infections detected by screening in this modelling study.

The reductions in transmission resulting from screening in the model would therefore have been overestimated due to the assumed higher coverage, but underestimated due to the assumed lower relative risk of infection amongst those screened.

Secondly, relating to the prevention of sequelae, this study attributed a 0% progression (ie a 100% reduction in risk of progression) from a screen detected chlamydia infection, ie assumed screening prevented all potential disease from each infection detected. The reduction in progression risk associated with screening is likely less than 100%, given screening detects prevalent infections and some duration of infection (and biological events causing progression) will have occurred before screen detection. See Table 2.1 for recent estimates.(Price et al. 2012) Also, this study applied progression rates from PID to EP and TFI of 7.6% and 10.8%, respectively, based on data from Westrom et al., for women with salpingitis.(Westrom et al. 1992) As rates of PID are far higher than rates of salpingitis, this may have overestimated chlamydia-associated (and screening-preventable) EP and TFI cases.

Thirdly, a technical aspect of this study has been criticized. Interventions were excluded if they were "dominated" but the method used did not exclude the "extended dominated" interventions. A paper debating this subject was published in STI.(Postma et al. 2008) If extended dominance was considered, then the next best alternative with which the NCSP screening strategy (Strategy 3 with an age cut-off of 25 years old) is compared with may be different and the ICER will also be different.

Perhaps more importantly, in terms of our confidence in this model, the substantial reductions in chlamydia prevalence predicted by this model have not been seen (Chapter 7) which – although the available evidence about prevalence reductions is inconclusive - throws doubt on the reliability of this transmission dynamic model and its predictions of changes in chlamydia prevalence.

### 8.2.2 Experience from mathematical modelling and CEA internationally

Roberts et al. conducted a systematic review of chlamydia screening models, identifying papers that were published up until 2004.(Roberts et al. 2006) They found only 2 dynamic models evaluating opportunistic chlamydia screening that incorporated reinfection and partner notification, one of which was the Townshend paper covered above, whilst the other was a paper by Welte et al. from the Netherlands.(Townshend et al. 2000, Welte et al. 2000) Both models suggest that under certain scenario assumptions, chlamydia screening will be cost-saving within 4 to 5 years. The authors also found other papers identified in their systematic review to suggest both opportunistic and register-based chlamydia screening to be cost-effective, that partner notification is an effective adjunct to screening, and NAAT testing and azithromycin treatment are cost-effective. However, the authors highlighted methodological issues with these papers, mainly about model structure – most being static modelling, that restricted outcomes were considered, and that most did not evaluate uncertainty around progression probability to chlamydia-related sequelae. Van Valkengoed et al. have studied the overestimation of progression probability to chlamydia-related sequelae and the impact of this on cost-effectiveness analyses: this work suggests that with updated evidence on progression parameters findings of cost-savings, and other CEA results, may well not stand.(van Valkengoed et al. 2004)

In the 2014 ECDC literature review on control of chlamydia in Europe, 10 publications on the cost-utility of chlamydia screening were identified, 9 of which found that at least 1 screening strategy would be cost-effective in the country studied.(European Centre for Disease Prevention and Control 2014) Only 1 out of the 10 papers took the English perspective: the paper described in the section above.(Adams et al. 2007) Kretzschmar et al. conducted a comparative evaluation of 3 dynamic models and found that although baseline prevalence in women and number of screening tests conducted were similar, individual models used different assumptions about baseline male prevalence, age-specific differences, and differences in treatment seeking and sexual behaviour.(Kretzschmar et al. 2009) These resulted in marked difference in predicted impact of chlamydia screening on reducing chlamydia prevalence, with reductions after 10 years in women aged 16 to 44 years old of between 4% to 85%.

A recent systematic review of chlamydia transmission models published in 2017 found earlier models predicted larger benefits of increased chlamydia screening, which will make screening more cost-effective as returns from investment in screening is higher.(Ronn et al. 2017) Key developments include improved understanding of the impact of chlamydia screening on PID, chlamydia prevalence, and uptake of screening.(Ronn et al. 2017)

## 8.3  Costs and quality of life estimates

### 8.3.1  Costs of chlamydia sequelae

In a recent publication, we assembled management costs for each chlamydia-related sequelae used in a number of published chlamydia screening economic evaluations.(Ong et

al. 2017) Not surprisingly, we found large variations in sequelae management costs used in different models, even among studies from the UK (Table 8.3).

**Table 8.3 Unit cost for individual chlamydia sequelae**, **adapted from (Ong et al. 2017)**

| (Reference); Country | PID | EP | TFI | CPP | Epididymitis | Neonatal Conjunctivitis | Neonatal Pneumonia |
|---|---|---|---|---|---|---|---|
| (Adams et al. 2007); England | £171 | £953 | £6,752 | ~ | £178 | £51 | £765 |
| (Roberts et al. 2007); England | £3,635 | £2,962 | £546 | ~ | £1,008 | £903 ** | |
| (Looker et al. 2015); Scotland | £163 | ~ | £2,115 | ~ | ~ | ~ | ~ |
| (Norman et al. 2004); Scotland | £271 | £3,615 | £6,486 | £159 | £21 | £11 | £433 |

(PID = pelvic inflammatory disease, EP = ectopic pregnancy, TFI = tubal factor infertility, CPP = chronic pelvic pain; ~ not considered; ** £903 for all neonatal complications, not separated by neonatal conjunctivitis or neonatal pneumonia)

When individual sequelae cost assumptions were combined together and progression to sequelae following an episode of chlamydia is standardised, we illustrate that different economic evaluations may have produced different cost-effectiveness results solely on the basis of the disparities in their assumptions about outcome costs (Figure 8.1). We concluded that for future evaluations, we need to ensure that our assumptions about the opportunity costs to manage chlamydia-related sequelae reflects the country perspective taken, as well as reflect current disease management pathway. We attempt to do so by clearly specifying the detailed disease care pathway and costing them (below). An outstanding item not considered in this paper was the screening cost, which we will study in further detail later in this section.
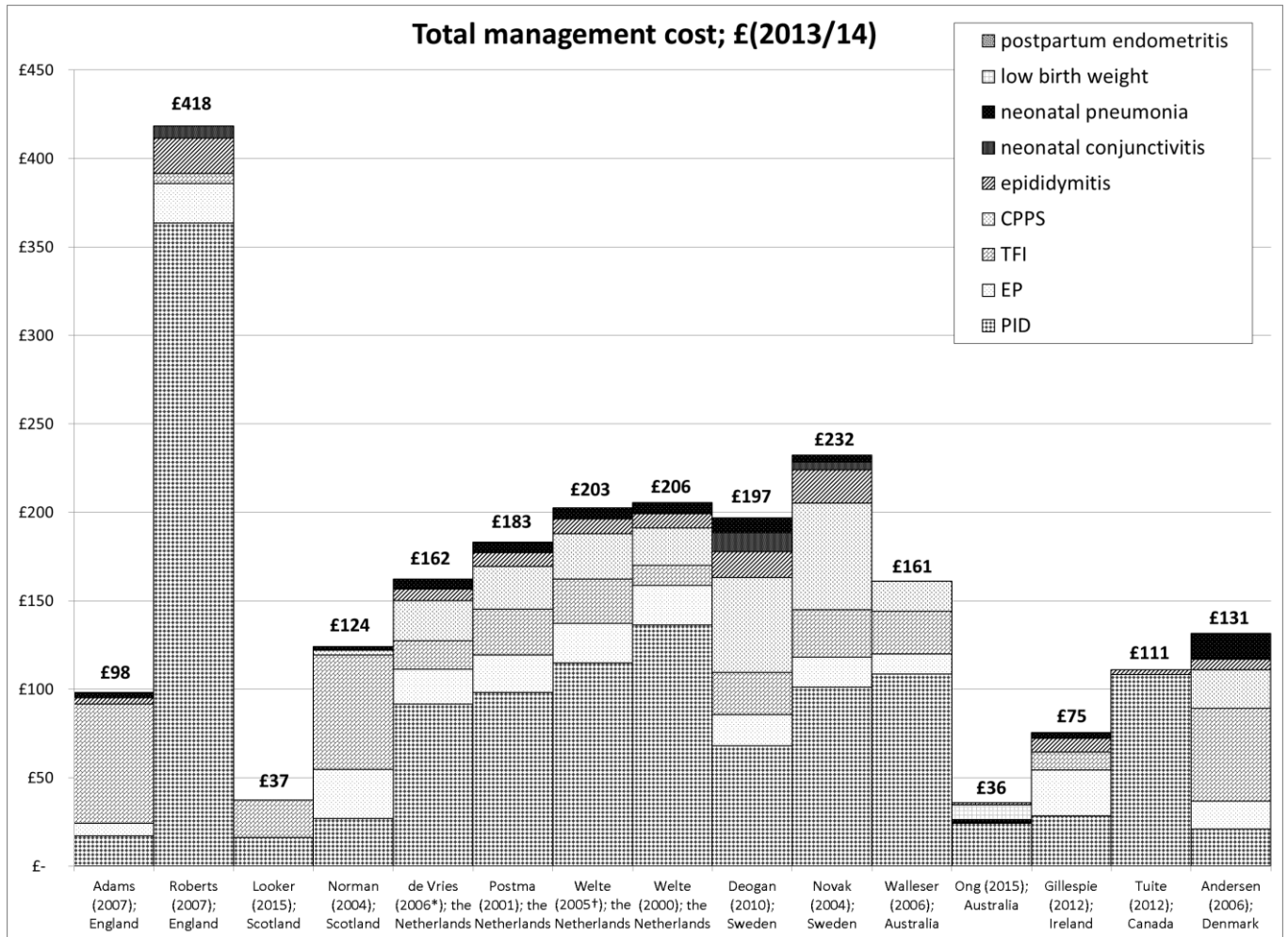
Figure 8.1 Contribution of each sequela to total estimated cost to manage sequelae per case of untreated chlamydia infection, calculated using a standard set of progression probabilities from untreated chlamydia infection to sequelae; numbers in GBP (2013/2014 values).

Given the significant differences in the estimated costs of managing chlamydia sequelae, even amongst studies from the UK, and considering that care pathways would likely have changed over time from when these estimates have been constructed, we undertook an exercise to provide our best estimate of the opportunity costs of managing these sequelae. We came across only 1 study in our rapid search of the literature on management costs for these sequelae. The study reported the opportunity cost of PID management in England, found from the POPI trial.(Aghaizu et al. 2011)

For all major chlamydia sequelae, we referred to national management guidelines for these diseases and used estimates of proportion of patients undergoing different management pathways from literature sources. The detailed components behind the final summary estimate are presented in the appendix. Table 8.4 outlines our current estimate of major chlamydia sequelae and compared these with previous estimates from Adams et al.(Adams et al. 2007) All costs were adjusted to 2015/2016 GBP values.

**Table 8.4: PHE current best estimate of chlamydia sequelae management costs compared with estimates used in (Adams et al. 2007)**
All values had been adjusted to 2015/2016 GBP values.

| Condition | PHE Estimate | Adams et al. |
|---|---:|---:|
| PID | £181 | £175 |
| EP | £1,462 | £974 |
| TFI | £11,600 | £13,805 |
| Epididymitis | £286 | £182 |
| Neonatal conjunctivitis | £169 | £52 |
| Neonatal pneumonia | £3,508 | £782 |

(PID = pelvic inflammatory disease, EP = ectopic pregnancy, TFI = tubal factor infertility)

### 8.3.2 Costs of chlamydia screening

In addition to differences in estimated cost of chlamydia-related sequelae management, we collated information on estimated cost of chlamydia screening, which were found to be slightly different even when all the estimates considered were from England. The collated information, adjusted to 2015/2016 GBP values, are presented in Table 8.4. A single summary screening cost for each row reflects the combination positivity rates of those screened, which is dependent on the screening site and coverage.

When we reviewed components within the NCSP screening pathway from the NCSP cost guidance 2009, we noted that some of the costs assumptions such as laboratory test costs and treatment costs have changed over time.(National Chlamydia Screening Programme 2009) The appendix shows how revisions to these component costs changed total screening costs.

The final row in Table 8.5 shows our best estimate of the cost of chlamydia screening under the NCSP, taking into account the CCP, positivity rate by testing site (eg GP, specialist SHS, internet etc.), and the screening site distribution. The CCP used was a modification of the Pathway Analytics detailed pathway,(Pathway Analytics 2013) whilst information on test positivity by and distribution of testing site was obtained from the 2015 CTAD data and NCSP audit data.

We found that the average screening cost, including those whose results were negative, was estimated to be around £52. The screening cost became £101 for a positive case, when resources used for treatment, partner notification, and recall for retesting were included.

**Table 8.5: Estimated chlamydia screening costs - all inflated to 2015/2016 GBP values**

| (Reference) | Cost per screen | Cost per chlamydia negative | Cost per chlamydia positive |
|---|---|---|---|
| **NCSP cost guidance 2009** | Range: £37 to £50 | £44 | £97 |
| **National Audit Office 2009 report** | £62 | | |
| **London integrated sexual health tariff (Primary refers to screening chlamydia only; additional refers to ST screening added on top of other specialist SHS)** | Primary total cost: £52 | | Primary total cost: £88 |
| | Additional total cost: £35 | | Additional total cost: £61 |
| **Portsmouth Contraceptive services tariff cost for chlamydia screening (including follow up of chlamydia positive + overheads)** | £50 | | |
| **SIGN Guidance 2009** | £16 | | £22 |
| **Roberts 2007** | £25 | | £67 |
| **Adams et al 2004** | £29 | | £44 |
| **Pilot study 2001** | Range: £40 to £52 | | |
| **PHE working estimate** | £52 | | £101 |

### 8.3.3 Quality of life estimates

A systematic review of QALY loss estimates used for chlamydia-related sequelae was reported by Jackson et al.(Jackson et al. 2014) QALY values combined the changes in quality of life (utility; disutility refers to reduction in utility) for a health state with the duration with which an individual's quality of life is affected by that health state. The authors found 19 economic evaluations and 5 primary health state valuation studies published up to December 2012. Eleven of the 19 economic evaluations used the same source for disutility estimates. Of the 5 primary health state valuation studies identified, only 1 used direct utility elicitation method. The authors noted the lack of discussion or exploration of the implications of using different assumptions around disutility values.

Besides the uncertainties that arise from differences in disutility estimates, there were also huge variations in assumptions about duration with which the disutility values applied to generate the final QALY values. Greater variations of duration of disutilities used in cost-effectiveness models were observed for longer term conditions, such as TFI and CPP, ranging from between 5 years to up to remaining lifetime for TFI. The degree with which these impact on the findings of cost-effectiveness model is unclear, as discounting of future disutility values may translate to minimal difference in the estimated QALY loss associated with these conditions the further they stretch into the future.

Table 8.6 summarises the range in disutility estimates and duration applied in published cost-effectiveness models for selected sequelae, extracted from Table 2 of Jackson et al., and the minimum and maximum estimated QALY losses calculated using these values.(Jackson et al.

2014) The final 2 column showed estimates from Adams et al.,(Adams et al. 2007) which we used in our analyses in the Section 8.4.

**Table 8.6: Ranges in disutility and duration of disutility used in published cost-effectiveness papers, extracted from Jackson et al.(Jackson et al. 2014) and Adams et al. (Adams et al. 2007); future values not discounted in this table**

| | | Jackson et al.'s Table 2 *Note: QALY loss calculated assuming perfect health = 1, min. QALY loss calculated by taking lowest disutility estimate multiplied by lowest duration, vica versa for max. QALY loss | | | | Adams et al. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *Min.* | *Max.* | QALY loss (Min.) | QALY loss (Max.) | | *Inpatient care* | *Outpatient care* | Overall disutility |
| PID | Utility estimate | 0.57 | 0.99 | 0.00 | 0.01 | Utility estimate | 0.57 | 0.63 | 0.01 |
| | Duration of disutility | 2 days | 12 days | | | Duration of disutility | 2 days | 10 days | |
| CPP | Utility estimate | 0.60 | 0.79 | 0.42 | 20.00 | Utility estimate | No data | | |
| | Duration of disutility | 2 years | Remaining lifetime | | | Duration of disutility | No data | | |
| EP | Utility estimate | 0.58 | 0.99 | 0.00 | 0.04 | Utility estimate | 0.23 | 0.66 | 0.03 |
| | Duration of disutility | 1 week | 31 days | | | Duration of disutility | 3 days | 28 days | |
| TFI | Utility estimate | 0.76 | 0.87 | 0.65 | 12.00 | Utility estimate | 0.82 | | 0.57 |
| | Duration of disutility | 5 years (or until successful IVF) | Remaining lifetime | | | Duration of disutility | 3 years and 60 days | | |
| Epididymitis | Utility estimate | No data | | | | Utility estimate | 0.30 | 0.46 | 0.01 |
| | Duration of disutility | No data | | | | Duration of disutility | 1 day | 7 days | |
| Neonatal conjunctivitis | Utility estimate | No data | | | | Utility estimate | 0.97 | | 0.00 |
| | Duration of disutility | No data | | | | Duration of disutility | 15 days | | |
| Neonatal pneumonia | Utility estimate | No data | | | | Utility estimate | 0.55 | 0.79 | 0.04 |

| | Duration of disutility | No data | Duration of disutility | 8 days | 61 days | |
|---|---|---|---|---|---|---|

## 8.4 Analyses to illustrate the implications of the current/above evidence relating to the health economics of chlamydia screening

The overall implications of updates in costs and benefits of chlamydia screening on the cost-effectiveness of a national screening programme are not easy to judge. This is due to the range in both the costs and benefits, and in the quantities to which these costs and benefits apply, in addition to the uncertainties about the indirect benefits of prevented infections. Health economics research that has found screening to be cost effective has been based on dynamic models in which transmission events were substantially lowered by screening. Currently, we are without good estimates of the number of transmissions being prevented, and without a dynamic model that predicts this outcome (and fits to other available data). Therefore, we cannot update full cost effectiveness analyses.

However, we can conduct relatively simple analyses using a static pathway of the progression of chlamydia infections with and without interruption by screening (Figure 2.2), parameterised with the costs and QALY loss estimates described above, to estimate the direct costs and direct benefits, and express the difference as a cost and as other measures of relevance/interest. Figure 8.2 shows our decision analytical tree structure to map out the costs and QALYs with or without opportunistic chlamydia screening offered in England. It was assumed that chlamydia testing in specialist SHS clinics will continue to be provided outside the national opportunistic chlamydia screening programme, ie in the absence of the English NCSP, specialist SHS testing still happens at the same frequency of testing and diagnoses.
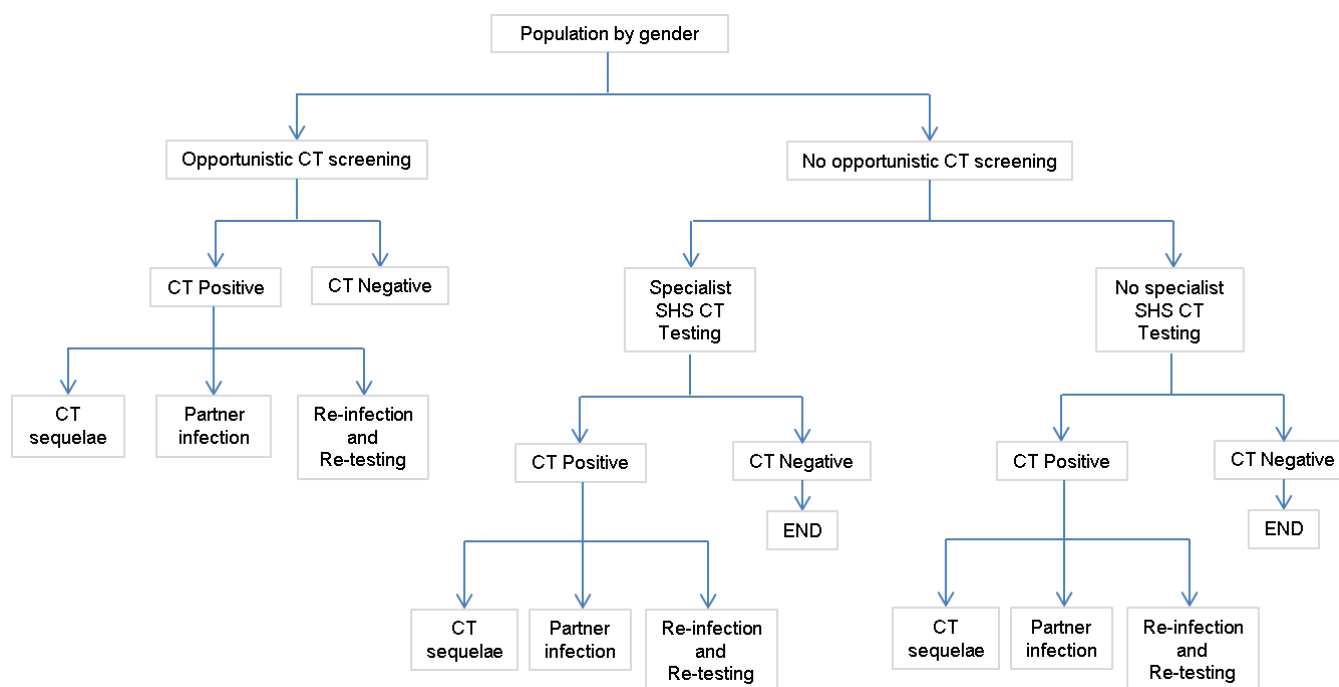
Figure 8.2: Pathway for economic analyses

An example of this is given in Table 8.7 which shows the costs and (direct) benefits, and difference expressed in pounds and in 3 other measures, for screening females aged 15 to 24years (vs no screening in addition to current GUM activity).

This shows how excess costs (over the standard of £20,000/QALY) could be balanced by i) prevented infections (ie the additional indirect benefits via reducing transmission), ii) additional QALY-losses that have not been factored in (such as QALY-losses due to chronic pelvic pain, and longer-term or even life-long QALY loss of childlessness due to TFI that is not successfully treated), or iii) reduced costs of screening.

The difference between costs and (direct only) benefits increases with lower screening positivity, eg for screening of lower positivity age groups; with lower costs and QALY-savings, eg for screening males, and with more expensive screening costs, eg in services with higher costs. The appendix contains tables of the parameter values and details of the pathway and other assumptions involved in these analyses.

**Table 8.7: Summary analysis of estimated direct costs/benefits of current chlamydia screening of females aged 15 to 24 years in England, assuming chlamydia positivity of 7.7%**

| Costs | |
|---|---|
| Cost per negative screen | £52 |
| Cost per diagnosis (ie per positive screen) | £101 |
| Average cost per screen (ie at 7.7% positivity) | £56 |
| **Direct benefits** | |

| | |
|---|---|
| Cost saved per diagnosis (ie per infection interrupted) | £89 |
| QALY saved per diagnosis | 0.0039 (ie £78 worth of QALY gain at £20,000/QALY) |
| **Difference between costs and direct benefits** | |
| Difference between above costs and benefits per screen in pounds (valuing QALY-savings at £20,000/QALY) | £33 |
| To reduce this difference to £0 we would need any one of below (or a combination of them): | |
| infections prevented in females per diagnosis (ie unestimated net benefits of PN and reduced transmission) | 4 |
| additional QALY-savings per diagnosis | 15-fold |
| reduction to costs of screening | 87% (ie to cost of <£6-7) |

Other options can be analysed in this simple way, for illustrative purposes. More complex analysis of this kind, incorporating uncertainty in some inputs, could be developed. Combinations of the 3 balancing factors in Table 8.7, and/or others (such as the other benefits of screening if these could be valued in pounds or QALYs) could be explored in further analyses of this type.

## 8.5 Discussion and implications

The experience of chlamydia screening in practice in England, and other new information that has become available since cost-effectiveness studies of chlamydia screening in England were done has changed our understanding of some of the parameters and assumptions in those models.(Townshend et al. 2000, Turner et al. 2006, Adams et al. 2007)

## 8.6 Horizon scanning

The NIHR HPRU on Modelling is conducting research into modelling of STI's including chlamydia: this may improve availability of working dynamic models to inform and evaluate chlamydia control. Some research is underway at Birmingham University into methods for disutility measurements for reproductive health: this may improve understanding and methods for measurement of health losses due to chlamydia. Given the high costs associated with TFI, and the dependency of these on diagnosis practices and treatment policies, policy changes to infertility treatment access guidelines and/or changes to the absolute costs of infertility treatments could impact on CEA of chlamydia screening.

## 8.7 Summary

The experience of chlamydia screening in practice in England, and other new information that has become available since cost-effectiveness studies of chlamydia screening in England were done (by DH and PHE, pre-2008) has changed our understanding of some of the parameters and assumptions in those models. There have been some updates to the estimated costs and QALY-losses/savings associated with chlamydia screening. However, our current best estimates of these parameters do not differ substantially (overall, at least) to

those previously used in the published PHE cost-effectiveness analyses (CEA) of chlamydia screening of young people. More important developments, and differences, relate to evidence about the rate of preventable sequelae (eg lower for screen-interrupted rather than prevented infections, lower progression to EP and TFI from all-cause PID), and about the impact of screening on the prevalence of infection (given the absence of evidence that the falls predicted by mathematical models are happening in reality). Overall, this reduces our confidence in previous estimates of the cost-effectiveness of chlamydia screening as practised in England. However, reliable CEA analysis cannot be redone until either empirical evidence of the impact of screening on prevalence is obtained or transmission dynamic models are developed that can fit to available data on screening activity and diagnosis rates, as well as to data on the frequency of sequelae.

# 9 Stakeholder views

This section describes the process by which the NCSP has involved people who may be affected by the decisions it makes or who can influence the implementation of its decisions. Stakeholders were asked for their opinions on the past delivery of the NCSP, its current involvement in chlamydia screening and how it can be adjusted in the future.

## 9.1    Summary of feedback from key informant interviews - COREQ (Tong et al. 2007)

We undertook stakeholder discussions to elicit feedback from SH commissioners and health professionals. Each member of the SHF team was asked to provide a list of names of possible interview subjects, both commissioners and health professionals. We purposively selected from the convenience sample of commissioners and health professionals to ensure that each PHE Region was represented. We also strove to have an even distribution of interview subjects from rural and urban LAs and selected from long-standing stakeholders and those newer to their position.

Participants were initially approached via their nominating SHF, asking if they would be willing to participate in our stakeholder engagement activity. Those who agreed were then contacted via email to arrange to participate. Participants were asked for 1 hour of their time, at a time convenient for them and were provided with the questions in advance. A total of 13 interviews were undertaken with individual stakeholders and 3 discussions were held with stakeholder groups as part of one of their routine meetings.

Our interviews followed a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis (Humphrey 2005), with specific questions designed to address each component of the analysis. We also included introductory questions to determine the relationship and role of each participant with the NCSP.

Participants were interviewed over the phone by 1 of 3 SHFs. To ensure that participants could speak freely, no SHF interviewed a commissioner or health professional with whom they regularly interact. Due to internal governance, we were unable to create an audio recording of the interviews; instead a member of the NCSP team acted as rapporteur and recorded key points from the interviews. In general, the discussions lasted between 45 and 60 minutes. Following the interview, the rapporteur sent their notes to the interviewer for confirmation.

Data was independently coded by 2 members of the NCSP team using an iterative coding tree. Three interviews were coded and analysed by the 2 team members for major and minor themes. The coding tree was then used to code an additional 3 interviews and the themes were further expanded upon to encompass new themes as the analysis progressed. Comments were allowed to fall into more than 1 code and once completed the comments

were extracted to an Excel spreadsheet and broken down under the 4 main SWOT categories.

The comment codes were tabulated to allow identify of the most commonly raised major themes; for ease of comprehension, the top 5 major themes were selected. They are presented in Table 9.1 along with the 5 major themes that were commented upon the most throughout the interview process. The themes are expanded upon in the following section, discussing minor themes that were identified and utilising quotes taken from the stakeholder feedback interviews.

**Table 9.1 Major Themes by SWOT category, ranked by number of comments**

| Strength | Weakness | Opportunity | Threat | Total Comments |
|---|---|---|---|---|
| Education | Resources | National Campaign | Resources | Resources |
| Engagement | Targeting of Programme | New Technology | Targeting of Programme | Targeting of Programme |
| Stigma | Harms | Collaboration | Evidence | National Campaign |
| Behavioural Change | Personal Health | Targeting of Programme | Lack of Advocacy | Collaboration |
| Resources | Testing Targets | Resources | National Campaign | New Technology |

## 9.1.1  Strengths

There were 5 main strengths that emerged from interviews with stakeholders throughout the structure of the NCSP and other care settings.

Theme 1: The first theme relates to improved **education** of both young people and healthcare providers about chlamydia and other STIs through the chlamydia screening programme.

The interviewees described how the programme provided face-to-face contact with young people, creating a platform for health providers to discuss wider sexual health issues. Some of the comments are listed below:

> *"Enables communication about sexual health"*
> Public Health Specialist Nurse, SF12
> *"Talk about not just chlamydia but also about potential risk taking behaviour and general sexual health"*
> Sexual Health Commissioner, SF5

Further to improving the awareness of chlamydia, it was seen as having a beneficial impact on the awareness of other STIs in their area:

> *"Led to Chlamydia being totally understood by young people...also helps with knowledge of other STIs"*
> Sexual Health Commissioner, SF2

This contact also provides an opportunity for healthcare providers to gain insights into young people, with one stakeholder commenting:

*"The NCSP is a fantastic gateway into young people's lives… allows providers to identify current and new social norms"*
Public Health Specialist Nurse, SF12

The structure of the NCSP is integrated throughout the country and it plays a role in the ongoing education of healthcare providers:

*"Provides a platform for guidance and data"*
Public Health Provider, SF4

Theme 2: The second theme focuses on how the NCSP has led to greater **engagement** from young people and healthcare providers.

Chlamydia screening is delivered in various manners across the country; however the network it works through has meant that healthcare providers are engaged in a wide range of settings:

*"GP s are still engaged... it's been embedded in the psyche of health professionals"*
Sexual Health Commissioner, SF1
*"Established and all health settings (GPs, pharmacies, etc.) are aware of the programme"*
Sexual Health Commissioner, SF3
*"Dedicated health workers based in school"*
Sexual Health Commissioner, SF11

Whilst the screening programme itself has enabled young people to be more engaged in sexual health with stakeholders finding that:

*"Through the screening programme, approaching sexual health could be done in a very positive and open way...linking it to contraception and EHC"*
Sexual Health Commissioner, SF5
*"Gives opportunity for interaction with young people about other sexual health issues"*
Sexual Health Commissioner, SF2

They also reported that young people were becoming more pro-active in accessing the system and helping shape its delivery:

*"Seeing more YP coming in on change of partner and wanting tested"*
Sexual Health Commissioner, SF2
*"Young people do look out for the service… we have a group of young people that act as mystery shoppers"*
Sexual Health Commissioner, SF11

Theme 3: The next theme raised regularly in the feedback describes the impact the programme has had on removing the **stigma** surrounding chlamydia infection and STI testing.

Our analyses would suggest that the NCSP has over time helped normalised chlamydia testing across the country as this became a consistent theme across the interviews:

> *"Young people have better relationship to and attitudes to testing… has become normalised… reduced stigma"*
> Sexual Health Advisor, SF8
> *"Has played a big role in normalising"*
> General Practitioner, SF13

One healthcare provider suggested that the impact of the screening programme on stigma has not just been on young people:

> *"Reduced stigma... in both young people and healthcare providers"*
> General Practitioner, SF13

Theme 4: Following on from the role the programme has been reported in playing in normalising testing, the next theme addressed **behavioural change** in those exposed to the NSCP.

With the NCSP influencing the views of chlamydia testing, the stakeholders provided more detailed explanations of how they have seen behaviours change to seeking tests:

> *"Definitely improved young people's sexual health… accepted in youth culture that they need to test and treat"*
> Sexual Health Commissioner, SF3
> *"Older women now asking for tests, probably affected by previous media campaign"*
> General Practitioner, SF13

Further it has enabled more open conversations between young people and providers:

> *"…less embarrassed then they were 7 years ago"*
> Sexual Health Provider, SF8
> *"Easier to talk to YP about sexual health"*
> Sexual Health Commissioner Group Meeting, GM1

Theme 5: The fifth most common strength of the NSCP raised in the feedback was regarding how the programme has affected **resources** for sexual health at the local level.

The rollout of the NCSP and continuing status as a statutory duty of local authorities has meant that it has provided greater resources for wider sexual health:

> *"Meant a significant amount of money has gone into sexual health facilities and marketing"*
> Sexual Health Commissioner, SF2

Whilst other strengths for sexual health commissioners included the structure and support from others within the programme and the collected data enabling the focusing of resources:

*"Loved the focus of a central point… support and leadership, excellent support from facilitators, opportunities for networking and sharing"*
Sexual Health Commissioner, SF11
*"The chlamydia data can highlight areas with other health needs (alcohol, deprivation, etc.)…focus on targeting and prioritising resources"*
Sexual Health Commissioner, SF3

## 9.1.2  Weaknesses

The interviewees were asked to detail any weaknesses they had observed in the NCSP over the time of their involvement in chlamydia screening.

Theme 1: The major weakness highlighted by the stakeholders was changes to the **resources** available for local authorities to deliver chlamydia screening.

Perhaps addressing the changes experienced over time, we see resources present as both a strength and a weakness of the programme. Whilst this is not a direct weakness of the NCSP and relates to wider budget cuts affecting local authorities across the country, it was so strong a theme that it needed to be included. Some stakeholders feel it is having a direct impact on how they can deliver the screening and question if it may be an effect of the programme itself:
*"Budget cuts have affected the resources and diminished staffing levels… working as hard as possible. It's really, really difficult managing patients that come in the door"*
Data and Information Manager, SF9
*"Screening costs a lot and a lot of money has gone into it... are we creating supplier – induced demand?"*
Director of Public Health, SF6

The limitation of funds also impacts the evaluation of novel techniques to implement chlamydia screening:
*"Hard to find money to test social media impact at local level"*
Sexual Health Commissioner, SF3

Further to just a lack of funding, stakeholders also reference a lack of local resources and staff as a harm to effective screening and treatment of young people:
*"General under resourced so can just about manage when everybody is in but struggle if 1 person is sick, annual leave or moved in to clinic for day etc."*
Sexual Health Advisor, SF8
*"Due to not having enough people on ground, people aren't getting the right information at the right time post a positive test"*
Sexual Health Provider, SF10
*"Weak message… more time, money and effort need put into the message"*
Public Health Advisor, SF4

<u>Theme 2:</u> The next theme stressed issues with the current **targeting of the programme**, including the scope of the NCSP and overall message.

The NCSP has strict guidelines on the scope of the programme and the populations that are being targeted. The stakeholder interviews raised a number of areas that local commissioners and providers felt needed to be addressed from their experience in their regions; first being the focus on females:

> *"Poor coverage for men… high positivity in 20 to 25 year old men tested but low percentage caught within screening programme"*
> Sexual Health Commissioner, SF2

Some felt that the way in which young people are targeted by the programme needs to change:

> *"Struggle to reach younger people…"*
> Sexual Health Commissioner, SF3
> *"Need to be sponsoring stuff in schools as it's a captive audience"*
> Public Health Specialist Nurse, SF12

Also, with changing sexual practices in young people (Woodhall et al. 2015); there may be a need to reassess how testing is being carried out:

> *"Seeing significant increase in number of young girls reporting engaging in anal sex, to avoid pregnancy… test not appropriate"*
> Sexual Health Provider, SF10

The interviewees suggested that the focus of the NCSP has changed over time and this has had an impact on the message delivered to the general population:

> *"Profile of NCSP and chlamydia has reduced dramatically…"*
> Data and Information Manager, SF9
> *"Focus has led to some thinking that chlamydia isn't a serious disease"*
> External Advisory Group Meeting, GM3

The NCSP was criticised for focusing too much on screening and not concentrating on promoting a message of personal prevention:

> *"Has reduced focus on primary prevention and risk management, eg condom usage"*
> External Advisory Group Meeting, GM3
> *"Message needs to be sent to healthcare providers about prevention… condoms have lost their focus"*
> Sexual Health Commissioner, SF1

<u>Theme 3:</u> The feedback suggested a number of potential **harms** from the targeting of the programme to both individuals and the NCSP itself.

Stakeholders felt that the impact of chlamydia testing on the individual and the harms it may have on both their physical and psychological health had not been addressed:

> *"Lack of data on long term illness from infection and consequences… no awareness of this in young people"*
> Public Health Provider, SF4
> *"If there was a positive test result... the potential impact on the personal relationship may be detrimental"*
> Sexual Health Commissioner, SF5
> *"Negative effects of testing include anxiety, worry, and impact on relationships"*
> Director of Public Health, SF6

The programme itself was reported to have had harmful effects on views towards sexual health in some areas:

> *"The huge initial programme that looked like scare tactics… money ran out… now not seen as serious issue"*
> Public Health Provider, SF4
> *"Increased stigma for other STIs"*
> External Advisory Group Meeting, GM3

Theme 4: Further to the potential harms, specific impacts on young people's views and approach to maintaining their own **personal health** were identified.

Commissioners and providers proposed that the programme led to changes in the care-seeking behaviour of young people through ambiguous messages:

> *"Young people get negative result… see no need to do more STI testing… we need a full STI screen"*
> Sexual Health Commissioner Group Meeting, GM1
> *"Makes under 25s blasé about infection risk for other STIs"*
> Sexual Health Provider, SF10
> *"NCSP gives an "all clear" message… seen as once and done... that can be misleading"*
> External Advisory Group Meeting, GM3

Additionally if this group of young people no longer actively seek care, then they could potentially be missed by the screening programme as:

> *"Too much focus towards those that are approaching SH services... missing high risk individuals not seeking care"*
> Sexual Health Commissioner, SF2

These changes to the way in which young people carry out risk assessments for their sexual activities have been reported by some of the interviewees:

> *"NCSP led partially to STIs seen as no issue for young people; get it and get treated"*
> Sexual Health Commissioner, SF2

> *"Young people discount other STIs as not relevant to them"*
> Sexual Health Provider, SF10
> *"Individuals get multiple negatives and then do not see need to test in future"*
> Sexual Health Commissioner, SF7

<u>Theme 5:</u> The final major weakness of the implementation of the NCSP was focused upon the **testing targets** that local authorities are expected to achieve.

The majority of comments regarding testing targets came from sexual health commissioners and they purveyed a strong resistance to both the current detection rate indicator (DRI) and the original testing targets used in the rollout of the NCSP:

> *"Original testing targets led to poor screening… some areas did screening of essentially non-sexually active populations."*
> Sexual Health Commissioner, SF2
> *"Huge amounts of money thrown at inappropriate testing… focus on volume and led to outreach focus"*
> Sexual Health Commissioner, SF7

In 2013, the testing targets were changed and instead of focusing on coverage, the DH recommended that local areas aim to achieve the detection rate of 2,300 per 100,000 of the 15 to 24 year old population. This target is set nation-wide and with varying populations and prevalence at local levels, commissioners describe it as being unachievable and as having a negative impact on staff morale and advocacy.

> *"Aims for an unreachable goal; creates a negative motivation for staff… DRI review would be appreciated"*
> Sexual Health Commissioner, SF3
> *"Targets act as "stick to beat you with"… produces defeatist attitude; we won't hit the target, so why bother?"*
> Sexual Health Commissioner Group Meeting, GM2

Some suggest that the DRI should be tailored to fit what local areas are likely to achieve:

> *"Needs to be measured against localised rates… national target unachievable… negative impact on programme support"*
> Sexual Health Commissioner, SF7
> *"Current target is still a bit one dimensional… some boroughs achieve without much effort... not one size fits all"*
> Sexual Health Commissioner, SF11

The proposition that a single national target is not suitable was emphasised by stakeholders in rural areas:

> *"In more rural counties, they've always had a low prevalence of STIs… hard to reach their targets"*
> Sexual Health Commissioner, SF1

*"For rural areas... very hard to hit DRI"*
Sexual Health Commissioner, SF1
*"Pattern in rural areas very different so national target unachievable"*
Sexual Health Commissioner, SF7

The statement regarding the varying pattern observed in rural areas is supported by the DRI data presented earlier in this evidence pack, which shows the contrast in testing between urban and rural local authorities.

### 9.1.3  Opportunities

There were a range of opportunities presented by the stakeholders as ways for the NCSP to improve the provision of chlamydia screening across England.

Theme 1: The first major theme was around a more concerted **national campaign** to promote the NCSP and deliver consistency in how screening is provided across the country.

The results of our interviews suggest that there is a strong desire for greater involvement in the NCSP in monitoring quality and providing guidance across the country:
*"monitor quality; comparing and contrasting what is right at each level… led at a national level"*
Sexual Health Commissioner, SF2
*"More communication from the NCSP, supporting providers more about where they're going right and where they're going wrong"*
Data and Information Manager, SF9
*"Audits and feedback… develop a live and interactive real time monitoring tool"*
Sexual Health Advisor, SF8

A number of interviewees felt that local areas were hindered in engaging other stakeholders as there was a lack of a strong national campaign regarding chlamydia screening:
*"Raise profile of STI and contraception in the media"*
Sexual Health Advisor, SF8
*"Repeated national advertising...Sex Worth Talking About campaign had "perfect" design"*
Public Health Specialist Nurse, SF12

This was also highlighted in the 2009 National Audit Office report.(National Audit Office 2009) (available in the appendix) Additionally, they suggested that the screening programme should be nationally led with a wider focus on all STIs:
*"National, free of charge service to young people and for all STIs... could do so much better nationally rather than locally"*
Sexual Health Commissioner, SF2

They also felt there was a requirement to increase usage of targeted advertising and social media to provide information to young people:

> *"Needs social media engagement… needs a very simple message focused on prevention using correct channels"*
> Sexual Health Commissioner, SF1
> *"Prioritise targeted advertising on TV or online"*
> Public Health Specialist Nurse, SF12

Some areas are already addressing this at a local level:

> *"Big push for this year to get providers to increase online presence for chlamydia and all STIs"*
> Sexual Health Commissioner, SF2

Theme 2: The next theme highlighted potential new technology that can the NCSP can take advantage of and incorporate into chlamydia screening to cut costs and improve coverage.

There has been an increase in the availability of service providers offering online testing and the responses from commissioners and providers in local areas was very positive and they suggested a range of ways in which they may incorporate it into their services:

> *"Easy access to screening and self-testing…via virtual services"*
> Sexual Health Advisor, SF8
> *"Likes technology... must embrace how young people respond… young people want it there and then or not at all"*
> Public Health Specialist Nurse, SF12
> *"Would offer through GP website... online testing and online treatment"*
> General Practitioner, SF13
> *"Postal Kit for all STIs screen...online ordering for young people"*
> Sexual Health Commissioner, SF2

POCTs were also highlighted as an opportunity that the NCSP should be pursuing as they will help clinically and financially:

> *"Test and treat at same time…would be the ideal scenario"*
> Sexual Health Commissioner Group Meeting, GM2
> *"PoC will help with accessibility and would be huge for us…financial savings in rent and clinic time"*
> Sexual Health Commissioner, SF3

Although some stakeholders, whilst positive about the benefits of PoC tests, were hesitant about other potential impacts they may have:

> *"Major impact for Commissioners but not necessarily for general population"*
> Sexual Health Provider, SF4
> *"Point of care testing is definitely a possible way forward, but… not entirely convinced about the partner notification element of that process"*

Sexual Health Commissioner, SF5

The interviews also identified novel approaches that local areas are trialling or that they feel should be pursued with help from the national NCSP team. One area is evaluating a new delivery mechanism for kits:

*"More self-care, even within service setting… exploring vending machines for kits"*
Sexual Health Commissioner, SF7

Whilst other areas feel more work needs to be done to engage young people in modern ways and take advantage of smartphones:

*"would like to see a national push to be where young people are… they always have a phone in their hands"*
Sexual Health Provider, SF10
*"A downloadable app would be a great step forward for chlamydia screening and NCSP could monopolise the market"*
Data and Information Manager, SF9

Theme 3: The next theme suggested there was a strong desire to see greater **collaboration** between different stakeholders within the NCSP and wider discussion of work done in areas across the country.

Whilst service provision was shifted from national to local led, a number of interviewees felt that there needed to be a more structured association between the various elements of the NCSP:

*"More conversations between national and local regions so feeding up and down... see how part of bigger picture"*
Sexual Health Provider, SF10
*"NCSP should support integration more and get involved with the services more, engaging with providers"*
Data and Information Manager, SF9
*"More centralised leadership... work to same standards and aim for gold practice… simpler to run and more coherent approach"*
Sexual Health Provider, SF4

A strong focus of the discussions was around the development of a mechanism for the sharing of good local practice to other areas through the SHFs and the national NCSP team:

*"Need to acknowledge good work of other areas"*
Sexual Health Commissioner, SF1
*"If chlamydia screening programme can show that the programme has had success in some areas, it needs to be shared"*
Sexual Health Commissioner, SF5
*"Share best practice from other locations… evidence based practice"*
Sexual Health Commissioner, SF3

<u>Theme 4:</u> In response to the weaknesses raised regarding the **targeting of the programme**, several stakeholders suggested potential opportunities for refocusing the NCSP to fit their local requirements.

There were 4 minor themes that were discussed as ways to address issues with the targeting of the programme; the first was adjusting the age range:

> *"Focus across all age ranges, locally they're seeing an increase in diagnoses in over 25s... it's not just a young person STI"*
> Sexual Health Commissioner, SF1

The next suggestion was to approach chlamydia screening in 2 ways, rather than just opportunistic screening:

> *"Do a version of the old and the new together… Health advisors being able to treat patients for chlamydia on an outreach basis and… offer the whole sexual health offer linked to the ISH services"*
> Data and Information Manager, SF9
> *"Target those at most risk... opportunistically treat those already engaged"*
> Director of Public Health, SF6

Some areas highlighted that as they carry out dual testing for chlamydia and gonorrhoea, this may cause issues:

> *"Still advertised locally as only chlamydia… it's a shock for people when they get a positive gonorrhoea result.*
> *Believe programme should be renamed 'Chlamydia and Gonorrhoea Screening Programme."*
> Sexual Health Advisor, SF8

Finally, as it was mentioned as a weakness, the need to adjust the NCSP message to prevention was raised as an opportunity:

> *"Focus on Prevention"*
> Sexual Health Commissioner Group Meeting, GM2
> *"The message became how easy it is to test and treat rather than focussing on prevention"*
> Sexual Health Commissioner, SF1
> *"Need to shift to prevention, not just test and treat"*
> Sexual Health Commissioner, SF1

<u>Theme 5:</u> The final theme addressed the ways in which **resources** can be utilised by the NCSP and local authorities to maximise provision of screening.

The commissioners and providers taking part in our analysis felt strongly about the impact of cuts to budgets and resources, however they suggested numerous approaches to improve the

use of the existing resources and how they would use any extra funding in the future. Gaining a better insight into local funding and adjusting how screening is seen were presented as options:

> *"Costing exercises to understand local priorities"*
> Sexual Health Commissioner, SF1
> *"Invest to save… reduced dramatically…less people attending GUM clinics, less costs"*
> Sexual Health Commissioner, SF2
> *"Financial incentive for practices to reach testing goal, like they do for diabetes and smoking cessation"*
> General Practitioner, SF13

In order to effectively deliver screening, areas felt they were lacking the promotional material that they had been provided with during the rollout of the programme:

> *"Sex Worth Talking About campaign; they had a great local response…materials provided were fantastic"*
> Public Health Specialist Nurse, SF12
> *"Promotional material needed"*
> Sexual Health Commissioner Group Meeting, GM1

### 9.1.4  Threats

Moving forward there may be a range of factors that could impact on how the programme is delivered, the interviewees were asked what these threats may be and how the NCSP could potentially address them.

Theme 1: The major threat facing the NCSP is reducing **resources** and funding; both addressed the ways in which resources can be utilised by the NCSP and local authorities to maximise provision of screening.

Resources have been a common theme throughout these analyses and this was considered the greatest threat to the future of the chlamydia screening. Stakeholders felt that at the local level they were limited in what they could do and that the range of services they provide could become limited:

> *"They do the best with what they've got, but it is very much limited compared to what it used to be"*
> Data and Information Manager, SF9
> *"Financing is unstable… need better funding of prevention programmes"*
> Sexual Health Commissioner, SF1
> *"Mandated to provide STI testing... but format up for grabs"*
> Public Health Specialist Nurse, SF12

The continuing reduction in resources available for sexual health services has impacts on healthcare providers, the delivery of the service and also wider sexual health issues:

*"Staffing in SH & YP services; a lot of pressure and problem with recruiting adequately trained staff"*
Sexual Health Commissioner, SF7
*"Some areas have capping of online services"*
Sexual Health Commissioner Group Meeting, GM1
*"In integrated sexual health, there is so much more to do than testing for chlamydia: other sexual health problems, safeguarding, domestic violence, and contraception"*
Data and Information Manager, SF9

Theme 2: The stakeholders felt that the current **targeting of the programme** could prove detrimental to the NCSP in achieving their aims in the future.

One of the group meetings of sexual health commissioners felt very strongly that the national focus must be shifted if young people were to be prevented from getting chlamydia:
*"Make Prevention a primary focus nationally"*
Sexual Health Commissioner Group Meeting, GM2
*"Seek testing and treatment rather than engaging in preventative behaviour "I can just take some tablets" "*
Sexual Health Commissioner Group Meeting, GM2

As mentioned in both the Weaknesses and Opportunities sections, it was felt by providers that the age range and focus on women were restrictive to providing the best care to their local populations:
*"Not just the 15 to 24 year old age group want testing... people change their date of birth to be able to do a screen, the over 24 year olds in particular"*
Data and Information Manager, SF9
*"Partners of young people are often older, so outside of the age range"*
Public Health Provider, SF4
*"Programme encourages a male perception that it's a women's issue"*
Public Health Provider, SF4

The interviewees also felt that there was a strong London focus, as well as a focus on urban areas over rural areas:
*"We need to be aware that England isn't just the big cities"*
Sexual Health Commissioner, SF1

Theme 3: The next theme was focused on a perceived lack of **evidence** for aspects of the NCSP and chlamydia screening in general.

The NCSP provides evidence and summaries of the concepts behind the screening programme, however several stakeholders from across the country suggested that more could be done to lend credence to the targets and impact of chlamydia screening:
*"Still not enough data... rationale based on outdated, foreign studies"*

General Practitioner, SF13

*"Need an English study that shows effect of screening on ectopic pregnancy, pelvic inflammatory disease, etc."*

General Practitioner, SF13

*"Age range… evidence base for it is not widely understood"*

Public Health Provider, SF4

Theme 4: The next theme suggested that commissioners and providers are facing a growing **lack of advocacy** for chlamydia screening in their local areas.

Perhaps due to the ambiguity over the evidence base for the NCSP and a lack of a strong national message, there is a reported lack of advocacy from people outside of the screening network. Interviewees suggested that:

*"Local authorities not seeing it as a priority… lacking support or strong message"*

Sexual Health Commissioner Group Meeting, GM1

Whilst a call for a stronger national message has been suggested as an opportunity for the NCSP, one stakeholder also suggests that these larger messages are often overlooked by local leaders and that a more personalised, local led approach can have a greater impact:

*"More helpful to hear from general public … different voices for different audiences- voice of a parent or teacher"*

Director of Public Health, SF6

Theme 5: The final theme was that PHE and the NCSP need to play a more direct role in promoting and driving the **national campaign**.

Following on from the requests for help with advocacy, stakeholders felt that there needed to be more national oversight for chlamydia screening for things that local areas cannot address themselves, such as:

*"Make Prevention a primary focus nationally"*

Sexual Health Commissioner Group Meeting, GM2

*"National Test Tariff… how difficult can it be?… would solve so many problems"*

Public Health Specialist Nurse, SF12

*"Need more support from PHE around training of staff… need to look at issue nationally as it is nationally driven"*

Sexual Health Commissioner, SF7

Finally, there were comments surrounding the current lack of national promotion and the under-utilisation of social media:

*"Services not being able to raise profile of testing"*

Sexual Health Commissioner, SF5

*"Comms team don't want to get involved… have very targeted social media to reach only YP and not offend older people"*

Director of Public Health, SF6
*"Subtle promotion will help with normalisation... frequent but in background"*
Public Health Provider, SF4

## 9.2   Summary

Feedback from stakeholders has improved our understanding of the current situation across the country, as well as added insight into the wider context of the NCSP. Numerous themes were identified across the 4 SWOT categories and there were occasionally contradictory statements; however this is to be expected when collecting feedback from a range of people from various roles and geographical regions.

The main themes overall were all reflected in the Opportunities (a national campaign, new technology, collaboration, targeting of programme, and resources) section suggesting that for the existing weaknesses and potential threats, there are steps that can be taken to pre-empt these hurdles and improve the delivery of the national chlamydia screening programme.

# 10 Conclusions

## Chapter 2 *Chlamydia trachomatis*

There is good evidence that genital infection with Ct is 1 cause of PID, and that PID (and more specifically, salpingitis) can lead to EP and TFI. Appropriate screening tests are widely available, as are safe and effective treatments. There is moderate evidence that screening females for genital chlamydial infection offers a direct benefit of reduced progression to PID at 1 year. The ECDC meta-analysis reported the pooled risk ratio of all-cause PID after 1 year of follow-up for women invited to have a chlamydia screen to be 0.68 (95%CI 0.49-0.94).(Low et al. 2016)

Chlamydia incidence and prevalence is difficult to accurately measure and monitor. However, there is good evidence from national surveys and from surveillance data that *C. trachomatis* infection remains very common amongst young sexually active males and females. There is an absence of evidence that screening as currently practiced in England (or elsewhere) has substantially lowered the frequency of *C. trachomatis* infection in the target population (young sexually active adults).

## Chapter 3 Delivery of the National Chlamydia Screening Programme

The NCSP has undergone significant changes since its implementation and is now very much integrated with other sexual health services.

The NCSP has increased testing capacity in England dramatically. In addition the service has supported the uptake of new technologies such as NAATs tests in the early 2000s to the use of internet based services in more recent years.

Over the past 5 years there has been a concerted drive to integrate chlamydia screening into sexual health services as part of an offer of a comprehensive sexual health service. Pressure on councils and providers to do more with less money has also been driving innovative and data driven solutions. In response to this challenge the NCSP advises that service investment is prioritised based on need of the population served as identified by the positivity of the services. The NCSP has a strong drive to improve the quality of care and to increase focus on PN and follow-up retesting of diagnosed patients.

## Chapter 4 Public Health England's role in supporting the delivery of chlamydia screening

The direct support for local chlamydia screening services has changed from a model of delivery oversight to delivery insight. The current NCSP service aims to provide local teams

with high quality measures of the key aspects of their service delivery and outputs as well as reviewing best practice and the evidence underpinning policy recommendations. A recent focus has been on improving the Chlamydia Care Pathway, by providing LAs with data, tools and training to identify and address areas needing improvement.

## Chapter 5 Data collection

Over time the mechanism for monitoring the delivery of the NCSP has changed to both reduce the total burden and cost to the healthcare system but also to improve quality and accuracy of reporting. The current CTAD system enables local services to understand, in depth, which clinics and services are providing screening to high need populations and enable the ongoing assessment of changes to those services. In addition, the system enables other infectious disease surveillance objectives to be monitored such as assessment of LGV burden in the population and the rapid identification of changes to chlamydia epidemiology in the population. Collaborating/sharing data with other sexual health datasets allows PHE and stakeholders to produce a more holistic understanding of population needs and areas for improvement.

## Chapter 6 Surveillance outputs

Since the inception of the NCSP the rates of testing for chlamydia have risen dramatically. Since 2008 total coverage has been high with up to 1 in 3 women in the target age range being tested for chlamydia each year. Testing is higher in women than men and in the areas of highest deprivation. These are also the populations who benefit the most from testing. The quality of screening care is varied and many services are not achieving the standards of care set out by PHE. Testing of sexual partners and retesting of diagnosed patients both yield high positivity.

## Chapter 7 Evaluating the Impact of the NCSP

Monitoring the frequency of diagnosed PID and EP has not provided clear evidence of an impact of chlamydia screening on these disease outcomes in England to date. This is not surprising given the multiple and changing aetiologies of these sequelae, the known and possible measurement errors in the available data sources (for example, and especially, in the definition and coding of PID), the usual weaknesses and limitations of ecological analyses, and the relatively moderate effect size that could be reasonably expected from screening as practiced to date.

We have no accurate method for monitoring the incidence or prevalence of chlamydia at local level. National surveys have confirmed ongoing transmission and the risk factors for infection, as well as the characteristics of those accessing chlamydia testing. Measuring the prevalence of antibodies against *C. trachomatis* is being explored as a measure of past exposure and further research work may provide methods to use seroprevalence data to estimate incidence and prevalence.

## Chapter 8 The health economics of chlamydia screening

The experience of chlamydia screening in practice in England, and other new information that has become available since cost-effectiveness studies of chlamydia screening in England were done (by DH and PHE, pre-2008) has changed our understanding of some of the parameters and assumptions in those models. There have been some updates to the estimated costs and QALY-losses/savings associated with chlamydia screening. However, our current best estimates of these parameters do not differ substantially (overall, at least) to those previously used in the published PHE cost-effectiveness analyses (CEA) of chlamydia screening of young people.

More important developments, and differences, relate to evidence about the rate of preventable sequelae (eg lower for screen-interrupted rather than prevented infections, lower progression to EP and TFI from all-cause PID), and about the impact of screening on the prevalence of infection (given the absence of evidence that the falls predicted by mathematical models are happening in reality). Overall, this reduces our confidence in previous estimates of the cost-effectiveness of chlamydia screening as practised in England. However, reliable CEA analysis cannot be redone until either empirical evidence of the impact of screening on prevalence is obtained or transmission dynamic models are developed that can fit to available data on screening activity and diagnosis rates, as well as to data on the frequency of sequelae.

## Chapter 9 Stakeholder views

Feedback from stakeholders has improved our understanding of the current situation across the country, as well as added insight into the wider context of the NCSP. Numerous themes were identified across the 4 SWOT categories and there were occasionally contradictory statements; however this is to be expected when collecting feedback from a range of people from various roles and geographical regions.
The main themes overall were all reflected in the Opportunities (a national campaign, new technology, collaboration, targeting of programme, and resources) section suggesting that for the existing weaknesses and potential threats, there are steps that can be taken to pre-empt these hurdles and improve the delivery of the national chlamydia screening programme

# 11 Appendices

- Natural History of PID
- Basic Reproductive Number
- Structure of PHE
- Research and key publications
- NCSP Auditable outcome measures
- CCP outcome indicators
- Costs associated with TFI management pathway
- Costs of chlamydia screening under the NCSP
- Parameter assumptions for economic analysis
- National Audit Office report: summary section

## 11.1 Natural history of PID

The most up-to-date and comprehensive estimates of the progression rates and population excess fraction estimates for *C. trachomatis* are presented in the Health Technology Assessment Report by Price et al (Price et al. 2016). These estimates have been derived using a multiparameter evidence synthesis approach, which combines data from multiple studies to provide estimates of the parameters of interest. One of the challenges in understanding the natural history of chlamydia infection is that evidence surrounding progression rates and population attributable fractions come from varied studies, many of which were conducted several years or even decades ago. Subtly different definitions of PID have been used throughout these studies, making them difficult to combine or compare and difficult to determine whether estimates have been appropriately applied.

One of the features of *C. trachomatis* that is often overlooked is the relationship between clinically-diagnosed PID based on signs and symptoms, salpingitis and subsequent development of TFI and ectopic pregnancy. As pointed out within the HTA report, the best evidence on development of TFI and ectopic pregnancy following PID suggests that salpingitis is a necessary condition for development of TFI and EP; while the presence of clinical signs and symptoms can be predictive of salpingitis, signs and symptoms alone does not equate to tubal damage that will lead to sequelae. Progression rates estimated from a study of female inpatients at University Hospital Lund (hereafter referred to as 'the Lund study'), reported by Westrom et al (Westrom et al. 1992, Westrom 1995), are more correctly applied to women with salpingitis than to women with clinical signs and symptoms of PID alone.

The HTA report deals with this issue by estimating the proportion of women with clinically-diagnosed PID that will have salpingitis, based on a study carried out in the 1990s in the UK by Taylor-Robinson et al (Taylor-Robinson et al. 2009). In that study, women with clinical signs and symptoms of PID were assessed laparoscopically for salpingitis (Table 11.1); women were graded according to the severity of their signs and symptoms to determine the

likelihood that they would have salpingitis. In women graded as 'almost certain/probable', 43% (12/28) were found to have salpingitis upon laparoscopy. This adjustment is then taken forward within the models to more correctly apply the progression rates estimated in the Lund study to women with salpingitis, not those with signs and symptoms only.

**Table 11.1: Relationship between clinical signs and symptoms and laparoscopically-verified salpingitis, adapted from Taylor Robinson et al.(Taylor-Robinson et al. 2009)**

| Clinical category* | With salpingitis at laparoscopy |
|---|---|
| Almost certain | 6/11 (55%) |
| Probable | 6/17 (35%) |
| Possible | 5/28 (18%) |
| Very unlikely | 5/56 (9%) |

*See Table 11.3 for definition of categories

In their mathematical model used to estimate the cost effectiveness of chlamydia screening in England, Adams et al applied progression rates from the Lund study to cases of what they called 'symptomatic' PID (Adams et al. 2007). This definition was not based on a set of defined clinical characteristics but rather was based on an assumed progression rate of 10% from untreated chlamydia to 'symptomatic' PID. The authors validated this assumption by comparing the outputs from their model to the number of diagnosed cases of PID reported in a study by Hughes et al (Hughes et al. 2004), which estimated the number of PID diagnoses per head of population based on data reported through the General Practice Research Dataset (GPRD). This is a dataset that holds the full medical records from a sample of ~10% of GP practices.

**Table 11.2: Comparison of PID rates in general practice reported in different studies using the General Practice Research Database (GPRD)***

| | (Hughes et al. 2004) | (French et al. 2011) | | (Nicholson et al. 2010) | | |
|---|---|---|---|---|---|---|
| Year of estimate | 2000 | 2000-2008 | | 2003 | 2004 | 2007 |
| Definition | PID | Definite/Probable PID | Definite/Probable/ Possible PID | PID (focus on acute cases) | | |
| **Incidence per 100,000 person years by age group** | | | | | | |
| 16-19 years | 917 | 333 | 733 | NR | NR | NR |
| 20-24 years | 1506 | 505 | 1358 | 284 | 304 | 142 |

*See Table 11.3 for definitions of PID used in French et al and Nicholson et al. Published definition used in Hughes et al is not available; Selected years and age groups are presented based on the reported data to provide broadly comparable estimates. The difference in years reported should be noted.

The definition of a PID diagnosis in Hughes et al's study (or indeed any other GPRD-based estimate) does not map directly onto other PID diagnostic criteria as diagnostic codes in GP settings don't specify clinical signs and symptoms but present diagnoses (eg 'PID, acute salpingitis, inflammatory disease of female organs). While salpingitis is listed as a diagnosis

within GP settings, it is unlikely that this is laparoscopically-verified salpingitis as it is an invasive procedure that is not widely performed.

Furthermore, the definition of PID used in the Hughes et al study was a broad definition that included diagnoses of pelvic pain as well as conditions more clearly coded as PID. Although the precise diagnostic codes used are not published, this difference can be seen in that the PID rates reported by Hughes et al are several-fold higher than the rates reported by French et al(French et al. 2011) in their analysis of GPRD data between 2000 and 2008 for what French termed 'definite/probable' PID, but comparable to French's rates of reported 'definite/probable/possible' PID, with the latter incorporating conditions labelled as pelvic pain along with those coded in the GP records more clearly as PID (Table 11.2).

It is likely therefore that, in applying the progression rates from salpingitis to TFI and EP that were reported in the Lund study (Westrom et al. 1992) to cases of 'symptomatic' PID as defined above, Adams et al are likely to have overestimated the number of TFI and EP cases resulting from untreated Ct, meaning that the cost effectiveness would have been overestimated (as their analysis would have assumed more cases of sequelae could have been prevented).

However, it should also be noted that the checks carried out by Adams et al to verify their assumed progression rate did not incorporate PID diagnoses made in GUM clinics or in hospitals that were not also recorded in GP clinics. This would have led to an underestimate of the overall number of 'symptomatic PID' cases in their model. It should also be noted that the progression rate arrived at in the HTA report from untreated CT to salpingitis was 7.3%, which is not dissimilar to the value of 10% progression used by Adams et al.

Differences in PID definitions are also of potential relevance when considering the evidence for progression rates from untreated CT to PID. The MPES work arrives at estimates of progression from untreated CT to TFI and to EP by combining estimates of progression from CT to PID and then from PID (with salpingitis) to TFI/EP. Estimates of progression from CT to PID are based on 4 prospective studies: Scholes et a l(Scholes et al. 1996), Ostergaard et al (Østergaard et al. 2000), Oakeshott et al (Oakeshott et al. 2010) and Rees et al (Rees 1980). In these studies, an outcome of PID was defined based on treatment or admission for PID (Østergaard et al. 2000), clinical diagnosis within medical records(Scholes et al. 1996), clinical diagnosis within medical records or a clinical presentation with some features of PID (Oakeshott et al. 2010) or undefined 'pelvic inflammation' (Rees 1980). The HTA report defines clinically diagnosed PID as women with 'probable' and 'definite' diagnostic criteria based on an adapted version of criteria used by Taylor-Robinson (Taylor-Robinson et al. 2009). However it is not clear how well the definitions of PID used within the studies used to estimate progression from CT to PID map to these criteria.

In the Lund study, the proportion of women with salpingitis who were subsequently found to have TFI was higher in women with severe PID and higher in women with repeat PID

episodes. The HTA report modelled the data to estimate progression to TFI by salpingitis severity and by number of PID episodes. Progression rates to TFI for women with 2 further PID episodes were estimated to be between 3 and 8 times higher than those with no further PID. Estimates produced in the HTA report include allowance for different progression rates based on a modelled distribution of episodes of PID salpingitis severity.

There are some important limitations to these estimates.

The estimates are heavily reliant on 2 studies. Firstly, the Lund study was a cohort of female inpatients at University Hospital Lund, who had been admitted with signs and symptoms suggestive of acute salpingitis between 1960 and 1984. Women were offered diagnostic laparoscopy, along with women undergoing laparoscopy for other pre-exploratory diagnoses. Women were followed up for several months to several years (depending on year of index laparoscopy). While this is an invaluable source of information, the age and setting of the study add considerable uncertainty to the generalisability of the estimates. The HTA report has addressed these limitations as far as possible by looking at consistency between multiple data sources, but this remains a limitation.

Secondly, the HTA report used data from the UK study by Taylor-Robinson to estimate the proportion of PID cases that are salpingitis. The data were collected from a single hospital in the 1990s, so it is unclear how applicable the findings are to all PID (diagnosed in and out of hospital and undiagnosed) now. Over time, clinical guidance has changed to treat women with less severe signs and symptoms, so the proportion of PID that is salpingitis (and also the progression to TFI and EP) is likely to be overestimated.

The HTA report also identifies some limitations in their estimates due to inconsistency between estimates. Models that correctly predict the risk of TFI following salpingitis seriously over-predict the risk of EP following salpingitis. The authors conclude this is likely due to salpingitis to EP rates being more subject to confounding given the multiple aetiology of EP.

The HTA reports that their 2 estimates of the proportion of TFI due to CT are inconsistent, one based on our prospective analysis of salpingitis and TFI, the other on retrospective serological data. The more conservative estimate of 29% is preferred.

The following tables present, for reference, a summary of definitions of PID and/or salpingitis that have been used in key studies and natural history parameters presented or referred to in the HTA report.(Price et al. 2016)

**Definitions of PID and/or salpingitis**

It is important to note that the same terminology is sometimes used to mean different things. The term PID and salpingitis have sometimes been used interchangeably, while in other

studies, PID is considered to be a specific collection of signs and symptoms, with salpingitis being present in some cases but not others.

Importantly, some studies have used terms to indicate certainty of diagnosis, which can either i) indicate the level of certainty that a specific set of signs and symptoms are salpingitis (Taylor-Robinson et al. 2009, Price et al. 2016) indicate that a specific set of signs and symptoms should be considered PID and ii) indicate that a set of medical diagnostic codes would be considered PID (Hughes et al. 2004) (French et al. 2011). It is important to note that these definitions do not necessarily map to each other, even though the same words or similar terminology is used.

The HTA report states that "the definition of 'probable' [PID] accords with the definitions used in our analyses of routine UK data from HES and GPRD." However the PID definitions in HES and GPRD are not based on clinical criteria. The overlap between definitions used in the HTA report, French et al (French et al. 2011) and the Taylor-Robinson (Taylor-Robinson et al. 2009) paper is unclear.

## Table 11.3: Definitions of PID and/or salpingitis reported in selected studies*

| Author (Journal, year) | Year of study | Country | Condition | Definitions | Notes |
|---|---|---|---|---|---|
| Westrom (STD 1992) (Westrom et al. 1992) | 1960-1984 | Lund, Sweden | Clinical suspicion of PID | Lower quadrant bilateral abdominal or pelvic pain of less than 3 weeks' duration and 2 or more of (1) abnormal vaginal discharge; (2)rectal temperature >38C; (3) vomiting; (4) menstrual irregularity; (5) urethritis symptoms; (6) symptoms of proctitis; (7) marked tenderness of female pelvic organs on bimanual examination; (8) adnexal mass; and (9) erythrocyte sedimentation rate >15mm/hour. | |
| Westrom (STD 1992) (Westrom et al. 1992) | 1960-1984 | Lund, Sweden | Laparoscopically verified acute salpingitis (also referred to as PID in this paper). | Visually verified acute salpingitis on laparoscopy. Subcategorised as: *Mild salpingitis*(fallopian tubes reddened and swollen, but freely movable with normal morphological appearance of fimbriated ends) *Moderate salpingitis* (fallopian tubes not freely movable and fimbriated ends abnormal or not clearly visible, and infectious exudate and fibrin deposits on serosal surfaces) *Severe salpingitis* (including pelvic peritonitis, abscess formation or both, significant impairment of laparoscopic visibility by inflammatory mases and lack of visibility of the ostia) | |
| Oakeshott et al (BMJ 2010)(Oak | 2004-2007 | London, UK | Probable or possible PID. | *Probable PID:* Clinical diagnosis of PID and treated; modified Hager's criteria (pelvic pain, cervical motion tenderness, uterine or adnexal tenderness). | |

| | | | | | |
|---|---|---|---|---|---|
| eshott et al. 2010) | | | | **Possible PID:** abdominal pelvic pain with features of PID, which may have responded to antimicrobial therapy but no record of cervical excitation or uterine or adnexal tenderness; or long standing abdominal pain consistent with endometriosis but some features of PID, eg uterine tenderness and unable to confirm if antimicrobial therapy had a benefit. | |
| Ostergaard (CID, 2000)(Øster gaard et al. 2000) | 1997 | Aarhus, Denmark | Diagnosed PID | Treatment for PID; Hospital admission for PID | |
| Scholes (NEJM, 1996)(Scho les et al. 1996) | 1990 | Washingt on, USA | Diagnosed PID. | Diagnosis of PID noted in medical records review. | |
| Rees (AJO&G 1980)(Rees 1980) | Unclear | Liverpool, UK | Pelvic inflammation | No specific definition provided. | |
| Taylor-Robinson (IJSA 2009)(Tayl or-Robinson et al. 2009) | 1990s | London, UK | Likelihood of salpingitis | Almost certain salpingitis: 6-8 points; Acute pelvic pain with or without adhesions and a majority of other signs. Probable salpingitis: 5 points Possible salpingitis: 4 points Very unlikely salpingitis: 1-3 points<br><br>Points given to clinical features as follows: acute pain-2; chronic pain-1; cervical motion/uterine tenderness-2; adnexal tenderness/mass-2; LGTI -1; raised ESR-1; fever-1. | |
| Taylor-Robinson (IJSA 2009) (Taylor-Robinson et al. 2009) | 1990s | London, UK | Salpingitis severity | **Mild adhesions**: filmy, not preventing tubal motility **Moderate adhesions:** Between mild and severe **Severe adhesions:** fibrous, preventing any tubal movement | Analysis does not distinguish between salpingitis severity |
| PEACH study(Ness et al. 1998, Peipert et al. 2001) | 1996-1999 | United States (Charlest on, Birmingha m, Providenc e, Atlanta, Philadelp hia, Pittsburgh , and Detroit) | Mild to moderate PID | 1) Pelvic discomfort for less than 30 days, 2) pelvic organ discomfort on bimanual examination, and 3) leukorrhea, mucopurulent cervicitis, and/ or known positivity for GC or CT via laboratory testing.<br><br>Exclusion criteria included: 1) being identified as "at risk" for acute morbidity in the outpatient setting (eg pregnancy, inability to tolerate an outpatient regimen, tubo-ovarian abscess, potential surgical abdomen); pelvic pain ≥30 days; allergy to study drugs; antibiotic treatment within 7 | |

| | | | | days of recruitment; gynecologic surgical procedure (including abortion) or delivery of an infant within the last 30 days; prior hysterectomy or salpingectomy; and homelessness | |
|---|---|---|---|---|---|
| Price (HTA 2016)(Price et al. 2016)<br><br>(The HTA report) | N/A | Estimatio ns based on England | PID, Clinical diagnosis of PID | For the purposes of this report we define clinically diagnosed PID as women with 'probable' and 'definite' diagnostic criteria. Definitions based on Taylor-Robinson et al (2009).<br><br>**Definite PID:** Recent-onset lower abdominal pain; cervical excitation with or without uterine/tenderness, with adnexal tenderness with or without mass, and clinically unwell, and LGTI<br>**Probable PID:** Recent-onset lower abdominal pain with (1) cervical excitation/uterine tenderness and adnexal tenderness or (2) cervical excitation/uterine tenderness or adnexal tenderness with evidence, LGTI or clinically unwell<br>**Possible PID:** Recent-onset lower abdominal pain and only 1 of the following: (1) cervical excitation/uterine tenderness or (2) adnexal tenderness OR Chronic lower abdominal pain, not clinically unwell and no evidence of LGTI and only 1 of the following: (1) cervical excitation/uterine tenderness or (2) adnexal tenderness | |
| Adams (STI, 2007)(Ada ms et al. 2007) | 2007 | Modelling : England | Symptomatic PID | PID diagnosed as would be within GP settings.<br>The model was used to generate a number of PID cases based on 3 presumed progression rates from untreated CT to PID.<br>1%, 10% 30%.<br><br>The numbers were checked against data from GP practices and concluded that 10% progression was most likely. | GP diagnoses only. |
| French (STD, 2011)(Fren ch et al. 2011) | Data covering 2000-2008 | England | PID | Based on GP diagnostic codes assigned during clinical consultations. Due to the nature of coding in GP practices, this definition considered 155 individual codes, which were further categorised into definite, probable, or possible PID. The full list of codes can be found in the supplementary material to French et al.(French et al. 2011)<br><br>**Definite:** This included codes referring clearly to pelvic inflammatory disease, endometritis and salpingitis.<br>**Probable:** This included codes that were less clearly defined as a PID diagnosis, including pelvic infection and pelvic adhesions. | |

| | | | | *Possible:* This largely consisted of codes referring to pelvic pain**.** | |
|---|---|---|---|---|---|
| Nicholson( Br J Gen Practice, 2010)(Nich olson et al. 2010) | Data covering 2003-2008. | UK | PID | Based on GP diagnostic codes assigned during clinical consultations. The code lists focused on acute cases, so that women with a code for chronic PID or its sequelae before the first acute code were excluded. Because the study research question concerns management, only codes that the researchers thought indicated that the GP was confident of the diagnosis of PID were used. Codes where the diagnosis may have been in doubt such as 'female pelvic infection' were excluded. The full list of codes can be found in Appendix 1 of Nicolson et al.(Nicholson et al. 2010) | |

*Selection of studies is based on those which contribute to or are closely related to estimates in the HTA report or those which have estimated national rates of PID in the UK/England.

## Progression rates

Progression rates and population excess fractions reported in the HTA report are summarised below. Progression rates from the Lund study are also included as these feature heavily in the HTA report and as the HTA report does not provide summary estimates for all of the parameters.

**Table 11.4: Progression rates from genital infection with Chlamydia trachomatis to PID, salpingitis, ectopic pregnancy (EP) or tubal factor infertility (TFI)**

| Parameter description | Estimated parameter value | Source | Description | Notes |
|---|---|---|---|---|
| Untreated CT to clinical (see table above) PID risk | 14.8% (95% CrI 4.8% to 24.8%) | HTA report | Estimate of the CT-to-PID progression risk from CT screening trials (POPI, Scholes, Ostergaard, Rees) | |
| Untreated CT to symptomatic and asymptomatic PID | 17.1% (95% CrI 5.6% to 29%) | HTA report. | Estimate of the CT-to-PID progression risk from CT screening trials (POPI, Scholes, Ostergaard, Rees) | |
| CT to EP | 0.2% | HTA report. | Not specified | |
| CT to TFI | 0.5% | HTA report. | Not specified | |
| CT to salpingitis | 7.3% (95% CrI 2.2% to 14.0%) | HTA report. | Based on CT to PID progression rate, adjusted for taylor-robinson data that showed that 43% of those with 'almost certain / probable salpingitis' had salpingitis. | This assumes that proportion of clinical PID with salpingitis does not vary by PID presentation / clinical signs, and applies the proportion with salpingitis to total, rather than clinical PID (as HTA report defines clinical PID as Taylor Robinson's definite/probable criteria). |

| | | | | |
|---|---|---|---|---|
| Salpingitis to TFI | 10.8% (141/1309) [of cases attempting pregnancy]<br><br>12.6% (165/1309) [of cases attempting pregnancy, includes 24 women who had been incompletely examined but had morphologically abnormal fallopian tubes on examination] | Lund study(Westrom et al. 1992) | Inpatients with clinical signs and symptoms of PID with laparoscopically verified acute salpingitis. | Rate of TFI increased with severity of salpingitis and number of PID. Thus this overall figure is highly dependent on the distribution of PID diagnoses / severity of salpingitis within the Lund cohort. |
| Salpingitis to EP | 7.6% (100/1309) [of cases attempting pregnancy] | Lund study(Westrom et al. 1992) | Inpatients with clinical signs and symptoms of PID with laparoscopically verified acute salpingitis. | Rate of EP increased with severity of salpingitis and number of PID.(Westrom 1995) Thus this overall figure is highly dependent on the distribution of PID diagnoses / severity of salpingitis within the Lund cohort. |
| PID, no salpingitis to TFI | 0% (0/451) [of cases attempting pregnancy] | Lund study(Westrom et al. 1992) | Inpatients with clinical signs and symptoms of PID without laparoscopically verified acute salpingitis. | |
| PID, no salpingitis to EP | 1.3% (6/451) [of cases attempting pregnancy] | Lund study(Westrom et al. 1992) | Inpatients with clinical signs and symptoms of PID without laparoscopically verified acute salpingitis. | |
| Salpingitis to TFI | Different rates given for progression according to number of PID episodes and severity of salpingitis. Rates increase with severity and number of PID | HTA report | Markov model, allowing for salpingitis in presence of first or repeat PID. Based on Lund study (Westrom et al. 1992). | |
| Salpingitis to EP | Different rates given for progression according to number of PID episodes and severity of salpingitis. Rates increase with severity and number of PID | HTA report. | Markov model, allowing for salpingitis in presence of first or repeat PID. Based on Lund study (Westrom 1995).<br>Assumes different risk of EP following salpingitis in hospital-diagnosed, non- | Method designed to address evidence gap regarding role of PID diagnosed and treated outside hospital and role of undiagnosed PID. |

| | | | | |
|---|---|---|---|---|
| | | | hospital diagnosed and undiagnosed PID. | |
| PID, no salpingitis to TFI | 0% | HTA report | | |
| PID, no salpingitis to EP | 0% | HTA report | | |
| Untreated *Chlamydia trachomatis* ➜ neonatal pneumonia (if infected at delivery) | 7.0% | Rosenmann et al(Rosenman et al. 2003) | Based on a pooled estimate from several studies from 1970s-1990s. Subject to error due to changing diagnostics. | Applied to data in Adams et al's model of cost effectiveness.(Adams et al. 2007) |
| Untreated *Chlamydia trachomatis* ➜ neonatal conjunctivitis (if infected at delivery) | 14.8% | Rosenmann et al (Rosenman et al. 2003) | Based on a pooled estimate from several studies from 1970s-1990s. Subject to error due to changing diagnostics. | Applied to data in Adams et al's model of cost effectiveness.(Adams et al. 2007) |

## Table 11.5: Population excess fractions reported in the HTA report

| Parameter description | Estimated parameter value | Source | Description | Notes |
|---|---|---|---|---|
| PID attributable to CT | 19.7% (95% CrI 5.9% to 38.1%) age 16–44 years; 35.3% (95% CrI 10.5% to 68.5%) in women aged 16–24 years. | HTA report. | If age-specific CT incidence, age-specific PID incidence and CT-to-clinical PID progression risk are put together, assuming progression risk is independent of age. | Unclear whether this is proportion of all PID or 'clinical' PID attributable to CT. |
| TFI attributable to CT | 29% (95% CrI 9% to 56%) | HTA report. | Based on analysis of the proportion of salpingitis due to CT and the relation between salpingitis and TFI and estimated prevalence of TFI. | Another estimate of 45% was arrived at through analysis of serological findings, but was inconsistent with other evidence. HTA report chose to go with lower estimate due to acknowledged limitations of the study. |
| EP attributable to CT | 4.9% (95% CrI 1.2% to 12.1%) | HTA report. | Based on analysis of 2 retrospective case control studies of EP & PID/salpingitis, combined with estimate of PID attributable to CT. | |
| TFI attributable to salpingitis | Assumes 100% | HTA report. | Assumption. | |
| EP attributable to salpingitis | 16-44 yr olds 27% (11%-46%) | HTA report. | Based on analysis of 2 retrospective case control studies of EP & PID/salpingitis. | Different values also reported for 16-24 and 25-44 yr olds. |

**Table 11.6: Additional progression parameters of relevance to the HTA report**

| Parameter description | Estimated parameter value | Source | Description | Notes |
|---|---|---|---|---|
| Proportion of PID that is salpingitis, proportion assessed on clinical criteria determining likelihood of salpingitis. | - 'almost certain / probable' salpingitis 42.9% (12/28) <br> - 'possible PID' salpingitis 17.9% (5/28) | Taylor-Robinson(Taylor-Robinson et al. 2009) | 112 women with lower abdominal pain who were laparoscoped. Study population in 1990s. | 42.9% Applied in HTA report to calculate CT to salpingitis. |
| Proportion of PID that is asymptomatic | 89% (pp 14 and 53) | Wolner-Hanssen(Wolner-Hanssen 1995) | 4/34 women investigated laparoscopically for infertility who were found to have adnexal or perihepatic scarring of probable infectious origin had no history of lower abdominal pain or pelvic infection and qualified for a diagnosis of silent PID. | This is proportion of PID that is asymptomatic among those with suspected infertility – not among all PID cases. Small numbers. Applied in HTA report. |

## 11.2  Basic reproductive number

The logical basis for this can be seen using the epidemiological concept of the 'basic reproductive number', denoted as $R_0$. $R_0$ is defined as the average number of secondary infections caused by an infected person in a totally susceptible population. For STI, $R_0$ is dependent on 3 parameters, such that $R_0 = \beta c D$, where $\beta$ denotes the average probability that an infected individual will infect a susceptible partner over the duration of their relationship; c denotes the average number of new partners acquired per unit of time; and D the average duration of infection.(Anderson et al. 1988) When $R_0$ is greater than 1, infection will spread through a population and the larger the value of $R_0$, the more quickly the infection will spread. Chlamydia screening, which is expected to reduce the average duration of infection (D), should therefore reduce $R_0$ and hence the incidence of infection.(Brunham 2005) Chlamydia screening is also expected to lead to a fall in the prevalence of chlamydia, given the relationship prevalence=incidence x duration.(Price et al. 2014)

## 11.3  Structure of PHE

## The public health system

**National government**

Responsible for national strategy, legislation and policy on the public's health and other decisions that influence the wider determinants of health

**Local government**

Responsible for improving the health of people in their area, addressing the full range of factors determining good health and developing healthy and sustainable communities

**The NHS**

Responsible for supporting patients to live more healthily as well as delivering health improvement interventions such as NHS Health Checks and support to stop smoking. The NHS also delivers specific public health services such as vaccinations and screening. A radical upgrade in prevention is to be reflected in the new place-based plans

**Public Health England**

- protects the country from threats to health, including outbreaks of infectious diseases and environmental hazards, in the UK and abroad
- improves the public's health and wellbeing
- improves population health through sustainable health and care services
- builds capacity and capability of the public health system

Through:

- application of evidence into practice, and influencing public health policy
- a place-based approach that engages local communities, building on their assets and addressing the wider determinants of health, including the built and natural environment
- a life course approach, promoting a holistic view of an individual's total health and wellbeing needs at every stage of life, seeing public health as one system for improving health and wellbeing

**THE PUBLIC**

Make choices around their lives and health, and are affected, informed and influenced by their physical and social environment. Supported by local and national government, the NHS, businesses, the voluntary and community sector and directly by PHE through its behaviour change and social marketing campaigns

**Voluntary and community sector**

Influences the public's health by providing people with volunteering opportunities, employment, goods, services and information. Provides advocacy for specific public health concerns

**Industry**

Influences the public's health by providing people with employment, goods, services and information

**Global public health**

Collaborating internationally to identify and address threats to health

**Scientific and academic community**

Apply scientific knowledge, methods and advanced technology to the prevention of disease and protection of the population against threats to health

Figure 11.1 The English public health system

Public Health England was established on 1 April 2013 to bring together public health specialists from more than 70 organisations into a single public health service.

PHE is an executive agency of the Department of Health, and a distinct delivery organisation with operational autonomy to advise and support government, local authorities and the NHS in a professionally independent manner.

IT employ 5,500 staff (full-time equivalent), mostly scientists, researchers and public health professionals.

There are 8 local centres, plus an integrated region and centre for London, and 4 regions (north of England, south of England, Midlands and east of England, and London).

PHE works closely with public health professionals in Wales, Scotland and Northern Ireland, and internationally.

## 11.4  NCSP research activities

### 11.4.1 MRC Study resulting in HTA report

PHE staff collaborated with the principle investigator at Bristol University (and others) on this major piece of research work.

The purpose of this project was to assemble all available evidence on the prevalence and incidence of Chlamydia trachomatis (CT) in the UK and its sequelae, pelvic inflammatory disease (PID), ectopic pregnancy (EP) and tubal factor infertility (TFI) to review the evidence base in its entirety, assess its consistency and, if possible, arrive at a coherent set of estimates consistent with all the evidence.

The study establishes a set of interpretations of the major studies and study designs, under which a coherent set of estimates can be generated.

The study was funded by the MRC and is reported in full in an HTA report "The natural history of Chlamydia trachomatis infection in women: a multi-parameter evidence synthesis.(Price et al. 2016)

Health Technology Assessment, No. 20.22. Malcolm J Price, AE Ades, Kate Soldan [PHE], Nicky J Welton, John Macleod, Ian Simms [PHE], Daniela DeAngelis [PHE], Katherine ME Turner, and Paddy J Horner.

### 11.4.2 3Cs and HIV

To support general practices and local areas increase screening, PHE piloted the 3Cs & HIV programme during 2013 to 2015. The pilot study focussed on supporting practices across England to:
- provide the '3Cs' offer of a chlamydia screen, signposting or provision of contraceptive advice and free condoms, during routine consultations with young adults (15 to 24 year olds)
- deliver HIV testing in adults (>= 16 years) in line with current clinical guidelines: raising awareness of indicator conditions where HIV testing should be considered and, in high prevalence areas, routine offer of HIV test to all new practice registrants

The 3Cs & HIV pilot was designed to strengthen sexual health work already funded and underway in local areas, being delivered by general practices. The pilot's design and evaluation was informed and guided by a GP and practice nurse advisory panel.

### 11.4.3 Natsal

PHE has been closely involved in the Natsal surveys. In the latest, Natsal-3, PHE was a partner organisation, contributed to questionnaire and survey design, conducted the testing

(and urine specimen management) for the work package "Population-based measures of Sexually Transmitted Infections", and co-authored publications (www.natsal.ac.uk/natsal-3/publications.aspx). (Prah et al. 2015, Sonnenberg et al. 2015, Tanton et al. 2015, Woodhall et al. 2015, Clifton et al. 2016)

### 11.4.4 Seroprevalence

PHE has engaged in several serological studies, to measure the prevalence of antibodies against Ct. Seroprevalence can be used as a measure of cumulative exposure to infection with Ct. Our research includes collaboration with the University of Bristol as part of the HPRU, the HSE, and PHE's Sero-Epidemiology Unit, as well as preliminary research with the UK BioBank. A full summary of PHE's seroprevalence work can be found in Section 7.2.3.1

### 11.4.5 eSTI[2]

The electronic self-testing instruments for STIs consortium, is led by St George's, University of London (SGUL) and PHE. eSTI2 collaborates with industrial partners and academia to develop rapid POC diagnostics to accelerate effective clinical management. They have developed technologies to improve sample preparation, enhanced diagnostic performance and reduce costs as well as delivering independent comprehensive diagnostic evaluations throughout the development process enabling companies to make evidence-based decisions.

### 11.4.6 ADREU

Applied Diagnostic Research and Evaluation Unit (ADREU) is a joint research group developed between St George's, University of London (SGUL), PHE and St George's University Hospital NHS Foundation Trust (SGHT). This multidisciplinary team has lead research into the public health benefits of novel and rapid diagnostic tests, which include reducing the risk of onward transmission of infection and development of potentially debilitating sequelae as well as enabling personalised treatment and increasing antibiotic stewardship. ADREU offers bespoke diagnostic accuracy evaluations for collaborating partners in academia, small and medium enterprises, and leaders in diagnostic development from proof-of-concept to late-stage evaluation, including providing data for regulatory approval. ADREU also provides insight into clinical and social impacts that STIs and rapid STI diagnostics can have on all aspects of the healthcare system.

PHE have been involved in developing partnerships that have enabled successful grant applications, such as the Innovate UK Small Business Research Initiative grant ("A Rapid Stratified Medicine Diagnostic Test To Direct Treatment For Symptomatic Patients Presenting In Sexual Health Clinic", grant number 971452), led by Atlas Genetics (awarded December 2015).

### 11.4.7 National Institute for Health Research Health Protection Research Units

Health Protection Research Units (HPRUs) are research partnerships between universities and Public Health England (PHE) and act as centres of excellence in multidisciplinary health protection research in England. NCSP is actively engaged in research with the 'Evaluation of Interventions' HPRU at the University of Bristol and the 'Blood Borne and Sexually Transmitted Infections' HPRU at University College London.

The study conducted by PHE of chlamydia serology amongst GUM clinic attenders was co-owned/co-funded by both these HPRUs.

## 11.5 NCSP Auditable outcome measures (National Chlamydia Screening Programme 2016)

Per NCSP standard, this document sets out the mandatory programme requirements plus additional screening recommendations. For 4 of the standards auditable outcome measures are also defined, as key considerations to inform local programme design and performance monitoring:

| Standard 1. Offering chlamydia testing |
|---|
| • **key performance indicator:** at least 70% of tests delivered in primary care, sexual and reproductive health (SRH) and genitourinary medicine (GUM) services (per upper tier/unitary local authority)* <br><br> * Primary care includes GP surgeries and community pharmacies. SRH includes sexual health clinics and abortion providers. |
| Standard 4. Notification of results |
| • **auditable outcome measure:** all those tested notified of result within 10 working days (from date of test)* <br> • **key performance indicator:** at least 95% of those tested notified of result within 10 working days <br><br> * Test date assumed as date on the test form. Notification date assumed as date provider sent text/left verbal message. |
| Standard 4. Turnaround time for treatment |
| • **auditable outcome measure:** all those testing positive offered treatment within 6 weeks of test date* <br> • **key performance indicator:** at least 95% of those testing positive treated within 6 weeks of test date <br><br> * Test date is assumed to be the date on the test form. |
| Standard 5. Partner notification |
| • **auditable outcome measure:** percentage of index cases documented as offered ≥one PN discussion (including telephone discussion) with a healthcare worker with the appropriate documented competency <br> • **key performance indicator:** at least 97% of index cases <br> • **auditable outcome measure:** percentage of index cases for whom outcome of agreed contact action(s), or decision not to contact, documented for all contacts. <br> • **key performance indicator:** at least 97% of index cases <br> • **auditable outcome measure:** number of all contacts whose attendance at a level 1,2, or 3 sexual health service was documented as reported by index case or healthcare worker (HCW), within 4 weeks of first PN discussion* <br> • **key performance indicator:** at least 0.6 contacts per index case for all clinics (in and outside London) and documented within 4 weeks of date of first PN discussion. <br><br> * This is the first discussion between the index case and a HCW (including telephone) for the purpose of PN, with the appropriate documented competency. |

## 11.6  CCP outcome indicators

Step 1 - Offer test

Measured by proportion of 15 to 24 year olds receiving an annual test.
Data sources are local data, CTAD data tables and ONS data.

Step 2 - Take specimen

Measured by uptake rates (proportion of those offered a test who receive a test), coverage (proportion of eligible population who receive a test) and level of integration (proportion of tests done in core testing service type).

Data sources are local data, CTAD data tables and ONS data.

Step 3 - Make a diagnosis

Measured by DRI (number of detected infections per 100,000 population 15 to 24 year olds) and positivity (total number of positive tests/total number of tests).

Data sources are local data, CTAD data tables and ONS data.

Step 4 - Patient notification

Measure all those tested that receive a result within 10 working days from the date of test (standard is greater or equal than 95%).

Data only available from local data (national audits).

Step 5 - Give treatment

Measure all those with a positive result that receive their result and treatment within 2 weeks of the test date (proposed standard is greater or equal than 95%) and proportion treated (total number index treated divided by total number index patients).

Data only available from local data (national audits).

Step 6 - Partner notification

Measure percentage of index cases documented as offered at least 1 discussion for purpose of PN (BASHH standard is greater or equal than 97%).

Measure percentage of index cases having the outcome of an agreed contact action or decision not to contact, documented for all contacts (BASHH standard is greater or equal than 97%).

Measure number of all contacts of index cases whose attendance at SH service was reported by index case, or by HCW, within 4 weeks of date of the first PN discussion (BASHH standard of at least 0.6 contacts per index case).

Measure number of all contacts of index cases whose attendance at SH service was documented as verified by a HCW, within 4 weeks of date of the first PN discussion (BASHH standard of at least 0.4 contacts per index case).

Data only available from local data (national audits).

Step 7 - Prevent re-infection (retesting)

Measure proportion of those who initially test positive who are retested 3 months after treatment.

Data sources are local data and CTAD data table.

## 11.7 Costs associated with TFI management pathway

Management of TFI follows the management pathway outlined in NICE CG 156 Fertility problems: assessment and treatment.(National Collaborating Centre for Women's and Children's Health 2013) The estimated cost per case of TFI in 2012/2013 GBP values is £6,287. Detailed calculations, including the proportions of IVF fresh/frozen cycles(Authority 2011) are available in Table 8c.

**Table 11.7 Breakdown of the detailed components behind the final summary estimate for TFI management**

| TFI management steps | Cost in £ (2012/2013) | References |
|---|---|---|
| Diagnosis | £551.13 | Philips Z et al. (2000)(Philips et al. 2000) |
| Tubal surgery for mild tubal blockage in 10% of TFI; assume to lead to successful pregnancies without further treatment in ~50% of patients | £146.43 | Payment by Results in the NHS: tariff for 2013 to 2014(Department of Health 2013) Akande VA et al. (2004)(Akande et al. 2004) |
| Surgery for hydrosalpinges prior to IVF; assuming 50% of women with TFI have hydrosalpinges | £818.00 | Akande VA et al. (2004)(Akande et al. 2004) Sharara FI et al. (1996)(Sharara et al. 1996) Bello TO (2004)(Bello 2004) Payment by Results in the NHS: tariff for 2013 to 2014(Department of Health 2013) |
| IVF: assuming all who intends to be pregnant, have mild TFI but ~50% failed to be pregnant after tubal surgery and will move on to have IVF, or who have moderate or severe TFI, 50% of all TFI cases of which are hydrosalpinges and have had surgery for hydrosalpinges; this means that 95% of all women with TFI who intends to be pregnant will move on to receive IVF; assuming 2.2 cycles per eligible women will be paid for by the NHS (Reference: NICE CG156 fertility costing report); 18% frozen cycles; including the extra cost of multiple births | £9,957.64 | NICE CG 156 Fertility problems: assessment and treatment (table 14.5)(National Collaborating Centre for Women's and Children's Health 2013) HFEA latest UK fertility treatment data and figures: 2010-2011(Authority 2011) |
| **Total cost of TFI management** | **£11,473.20** | |
| However, given that not all women with TFI will want to be pregnant, meaning that not all with TFI will have a diagnosis, the total cost will only incur in women intending to be pregnant; the proportions of women who want to be pregnant | 54.8% | Wellings K et al. (2013)(Wellings et al. 2013) |
| **This gives a total cost of TFI management that will be incurred only by individuals who know that they have TFI = 54.8%*£11,473.20** | **£6,287** | |

## 11.8 Cost of chlamydia screening under the NCSP – assuming 8% test positivity

- 2009 values were from the 2009 NCSP cost estimates/Elisabeth Adams spread sheet, not inflated to 2012/2013 values – to allow like-to-like comparison with 2014 estimates on prices – except for drug costs – but not pay (2014 pay were estimated using PSSRU 2013 estimates); inflation likely to have minimal impact on costs (7% increase)

- 2014 were values adjusted for salary, removing 30% indirect overheads because these have been included in the salary (reference: PSSRU 2013) and updated drug costs (reference: average May 2013 and May 2014 drug tariff) – but excludes recurring PHE NCSP co-ordination costs, including marketing (posters, leaflets, press, radio, internet), local training (venue hire, materials, food/drink), transportation, accommodation for field visits, meetings (accommodation, food/drink), which were estimated at a total of £200,000 for 2008/2009
- retesting costs have not been included here but would be the same as the chlamydia test cost (unless those retested have a different positivity, not 8%, and if so, change the green top bar only as these are the chlamydia notification/treatment/PN costs) plus staff time costs and communications to remind patients to come back for a retest after 3 months

1. If the test was requested by an asymptomatic individual (self-referral)

- CASH clinics uses sexual health consultants, so the total screening offer costs are comparatively higher than tests in other settings
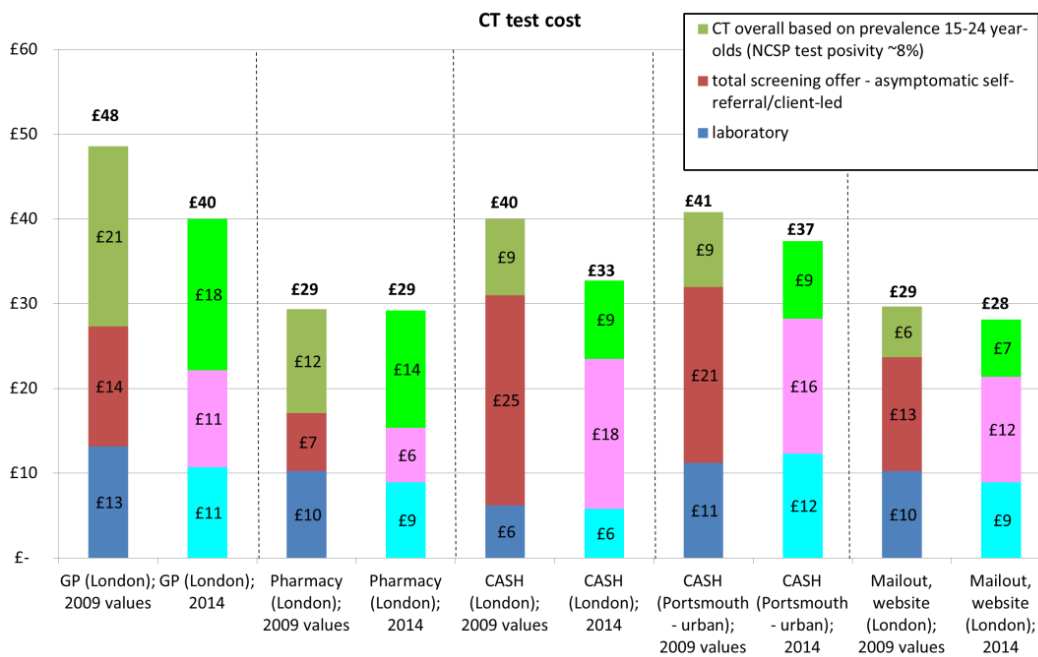


Figure 11.2 Chlamydia screening cost by asymptomatic client

2. If the test was requested by a clinician
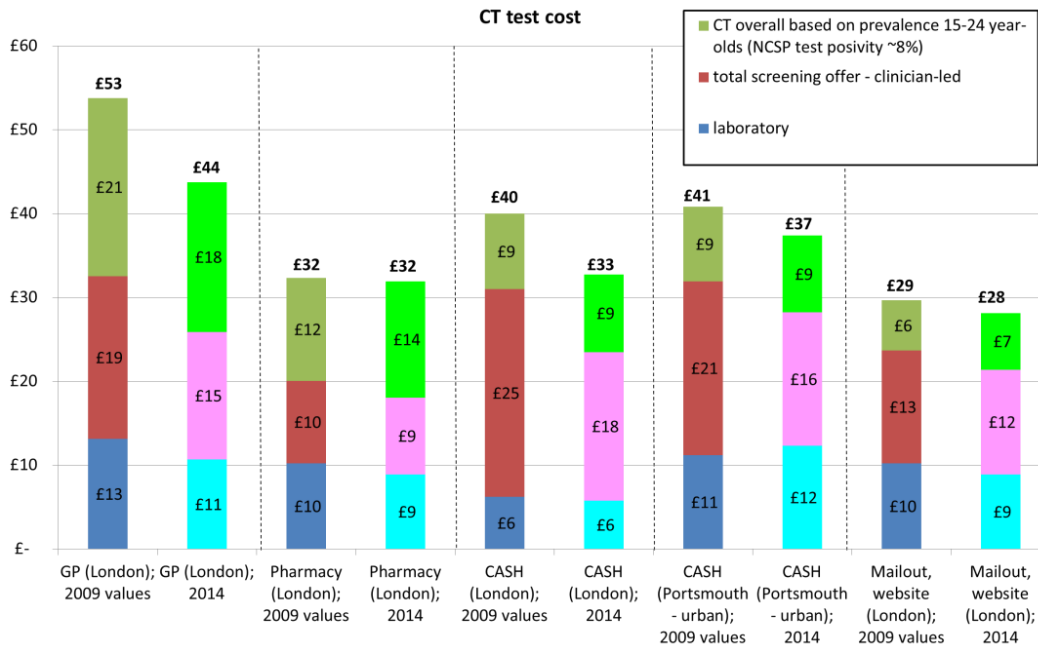


Figure 11.3 Chlamydia screening cost by a clinician

3. If the client has symptoms
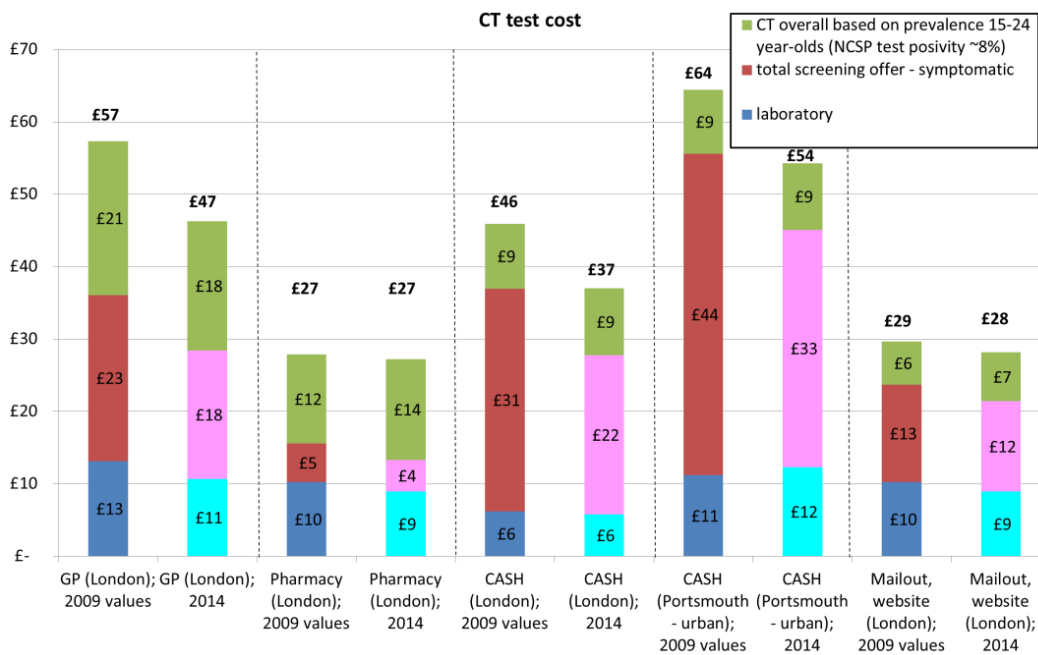


Figure 11.4 Chlamydia screening cost by symptomatic client

4. If the client is a partner of a chlamydia positive case

- note higher total screening offer cost, compared with requests by index patient, in GP settings – these are mostly staff time costs
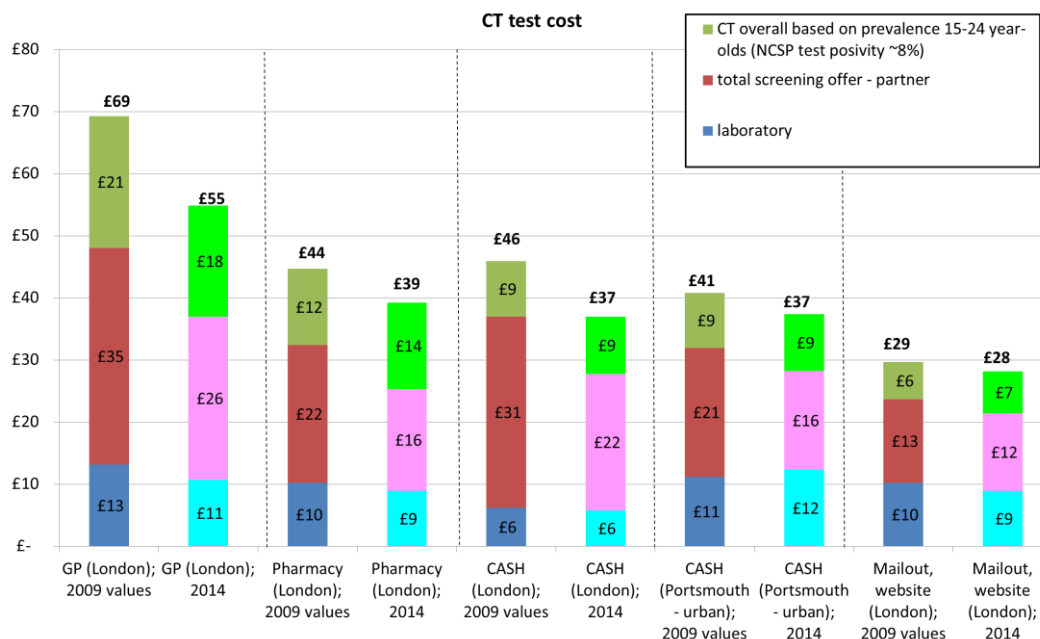
Figure 11.5 Chlamydia screening cost by a positive case

## 11.9 Parameter assumptions for economic analysis

### Table 11.8 Base case epidemiological parameter assumptions

| Parameter | Value (Female) | Value (Male) | Source/notes |
|---|---|---|---|
| **Model population size** | 100,000 | 100,000 | Assumption |
| **Age range (years)** | 15 to 24 | 15 to 24 | Current NCSP standard(National Chlamydia Screening Programme 2016) |
| **Population chlamydia prevalence** | 3.1% | 2.3% | Woodhall et al.(Woodhall et al. 2015), Natsal-3(Erens et al. 2013, Sonnenberg et al. 2013) |
| **Initial tests** | | | |
| **Initial opportunistic chlamydia screening coverage (excluding any specialist SHS testing)** | 21.5% | 6.5% | 2015 CTAD data; 2015 ONS population estimates, used as denominator to calculate coverage |
| **Positivity rate: initial opportunistic chlamydia screening (excluding any specialist SHS testing)** | 6.8% | 8.5% | 2015 CTAD data; 2015 ONS population estimates, used as denominator to calculate coverage |
| **Specialist SHS testing coverage (initial tests)** | 10.9% | 6.2% | 2015 CTAD data; 2015 ONS population estimates, used as denominator to calculate coverage |
| **Positivity rate: specialist SHS testing (initial tests)** | 9.6% | 11.8% | 2015 CTAD data; 2015 ONS population estimates, used as denominator to calculate coverage |
| **False positive test result** | 0.6% | 0.6% | Gaydos CA et al.(Gaydos et al. 2013) |
| **False negative test result** | 2.6% | 2.6% | Gaydos CA et al.(Gaydos et al. 2013) |
| **Partners** | | | |

| | | | |
|---|---|---|---|
| **PN contact rate** | 53.1% | 53.1% | Partner notification in chlamydia screening - National audit report(Public Health England 2016) |
| **PN positivity** | 62.2% | 62.2% | Partner notification in chlamydia screening - National audit report(Public Health England 2016) |
| **Partner transmission rate** | 62.2% | 62.2% | Assumed same as PN positivity |
| **Retesting** | | | |
| **Retesting rate (both specialist SHS and non-specialist SHS)** | 9.4% | 3.8% | Retesting of those who tested positive for chlamydia - National audit report(Public Health England 2015) |
| **Retesting positivity** | 12.3% | 19.0% | Retesting of those who tested positive for chlamydia - National audit report(Public Health England 2015) |
| **Probability of becoming re-infected following initial diagnosis** | 12.3% | 19.0% | Assumed same as retesting positivity |
| **Sequelae** | | | |
| **CT progression to PID** | 17.10% | | Price M et al.(Price et al. 2016) |
| **proportion of PID that is salpingitis and which will lead to EP or TFI** | 43.0% | | Sarah Woodhall's notes, Price M et al.(Price et al. 2016), itself derived from Taylor-Robinson.(Taylor-Robinson et al. 2009) |
| **salpingitis to EP rate** | 7.6% | | Westrom et al.(Westrom et al. 1992) |
| **salpingitis to TFI rate** | 10.8% | | Westrom et al.(Westrom et al. 1992) |
| **CT to CPPS rate** | 0% | | Assume 0% in base case |
| **CT to neonatal conjunctivitis rate** | 14.8% | | Adams et al.(Adams et al. 2007) |
| **CT to neonatal pneumonia rate** | 7.0% | | Adams et al.(Adams et al. 2007) |
| **CT to epididymitis rate** | | 2.0% | Adams et al.(Adams et al. 2007) |
| **Proportion conceived in age group 15 to 24, assuming numbers <15 to be small** | 3.9% | | 2015 ONS Dataset: Births by mothers' usual area of residence in the UK (n = 129,807) |
| **Proportion conceived over a lifetime** | 95.6% | | Sarah's notes, Price M et al.(Price et al. 2016); this is applied to EP rates |
| **Treatment success rate** | | | |
| **success rate at preventing progression to PID with female screened and detected** | 92.7% | | "7.3% difference in PID rates between screened and unscreened chlamydia positives"; Aghaizu A et al.(Aghaizu et al. 2011) |
| **success rate at preventing progression to neonatal complications with successful CT management** | 100.0% | | Assumption |
| **success rate at preventing progression to epididymitis with successful CT management** | | 100.0% | Assumption |

## Economic assumptions

Cost of chlamydia screening by test setting was calculated using a combination of patient care pathway and micro-costing items identified from Pathway Analytics. Screening cost was then stratified by specialist SHS or non-specialist SHS and weighted accordingly to CTAD 2015 reported distribution of number of screens and positive results by test setting by gender. It was assumed that retesting cost will be the same as an initial test cost. Management costs for chlamydia sequelae that had been identified were applied. Quality of life losses were based on Adams et al.(Adams et al. 2007), although adjustments were applied to the timing and duration of disutility, all assumptions are presented in Table 11.8.

Two future discount rates were explored, 1.5% and 3.5% per annum, for both costs and QALYs, in accordance with NICE public health methods guide.(National Institute for Health and Care Excellence 2012)

**Table 11.9: Economic parameter input values; Note 1: It was further assumed that partner testing and retesting of positive index cases will be occur in the same setting as the initial tests, which affects screening cost calculations.**

| Parameter | Value (Female) | Value (Male) | Source/notes |
|---|---|---|---|
| **Cost** | | | |
| **Non-specialist SHS: Positive test result** Note 1 | £100 | £99 | Detailed care pathway modified from Pathway Analytics, combined with number of tests by setting reported in 2015 CTAD. Male and female figures differed by combination of test setting used, as reported in 2015 CTAD. Male and female figures differed by combination of test setting used, as reported in 2015 CTAD |
| **Non-specialist SHS: Negative test result** Note 1 | £51 | £48 | Detailed care pathway modified from Pathway Analytics, combined with number of tests by setting reported in 2015 CTAD |
| **Specialist SHS: Positive test result** Note 1 | £102 | £102 | Detailed care pathway modified from Pathway Analytics, combined with number of tests by setting reported in 2015 CTAD |
| **Specialist SHS: Negative test result** Note 1 | £53 | £53 | Detailed care pathway modified from Pathway Analytics, combined with number of tests by setting reported in 2015 CTAD |
| **PID (discounted cost: 3.5% or 1.5%)** | £181 | | Assumed to occur in the same year as initial chlamydia infection |
| **EP (discounted cost: 3.5% or 1.5%)** | £1,231 or £1,357 | | Pathway costing using literature evidence on patient care pathway and national tariff; assumed to |

| | | | |
|---|---|---|---|
| | | | occur 5 years after initial chlamydia infection |
| **TFI (discounted cost: 3.5% or 1.5%)** | £4,883 or £5,384 | | Pathway costing using literature evidence on patient care pathway and national tariff; assumed to occur 5 years after initial chlamydia infection; an additional assumption that only 50% of TFIs will be diagnosed and treated, in line with previous assumptions by Adams et al.(Adams et al. 2007) |
| **CPPS** | Not considered in base case | | |
| **epididymitis (discounted cost: 3.5% or 1.5%)** | | £286 | Assumed to occur in the same year as initial chlamydia infection |
| **neonatal conjunctivitis (discounted cost: 3.5% or 1.5%)** | £169 | | Assumed to occur in the same year as initial chlamydia infection |
| **neonatal pneumonia (discounted cost: 3.5% or 1.5%)** | £3,508 | | Assumed to occur in the same year as initial chlamydia infection |
| **Future discounting (per annum)** | 3.5% or 1.5% | 3.5% or 1.5% | NICE Technology Appraisals methods guide; 1.5% used in sensitivity analysis in accordance with NICE Public Health Guidance methods(National Institute for Health and Care Excellence 2012) |
| **QALY losses** | | | |
| **Chlamydia infection (asymptomatic)** | 0 | 0 | Assumption |
| **Chlamydia infection (symptomatic)** | 0 | 0 | Assumption |
| **Chlamydia screening (positive diagnosis)** | 0 | 0 | Assumption |
| **Chlamydia screening (negative diagnosis)** | 0 | 0 | Assumption |
| **PID (discounted QALY losses: 3.5% or 1.5%)** | 0.010 | | Assumed to occur in the same year as initial chlamydia infection |
| **EP (discounted QALY losses: 3.5% or 1.5%)** | 0.027 or 0.030 | | Assumed to occur 5 years after initial chlamydia infection |
| **TFI (discounted QALY losses: 3.5% or 1.5%)** | 0.240 or 0.264 | | Assumed to occur 5 years after initial chlamydia infection; an additional assumption that only 50% of TFIs will be diagnosed and treated, in line with previous assumptions by Adams et al.(Adams et al. 2007) |
| **CPPS** | Not considered in base case | | |
| **epididymitis (discounted QALY losses: 3.5% or 1.5%)** | 0.011 | | Assumed to occur in the same year as initial chlamydia infection |

| neonatal conjunctivitis (discounted QALY losses: 3.5% or 1.5%) | 0.001 | | Assumed to occur in the same year as initial chlamydia infection |
|---|---|---|---|
| neonatal pneumonia (discounted QALY losses: 3.5% or 1.5%) | 0.037 | | Assumed to occur in the same year as initial chlamydia infection |
| Future discounting (per annum) | 3.5% or 1.5% | 3.5% or 1.5% | NICE Technology Appraisals methods guide; 1.5% used in sensitivity analysis in accordance with NICE Public Health Guidance methods.(National Institute for Health and Care Excellence 2012) |

## 11.10 National Audit Office

### Summary

1. In 2003 the Department of Health (the Department) launched the National Chlamydia Screening Programme in England; to date £150 million has been included in NHS allocations for the Programme. We estimate on the basis of survey data, that around £100 million has been spent on delivering the Programme. Funding is not 'ring-fenced' and local Primary Care Trusts (PCTs) decide local budgets. Chlamydia is the most commonly-diagnosed bacterial sexually transmitted infection and is increasing, especially in young people under the age of 25. The Programme aims to identify, treat and control this infection, which is often symptomless and can cause serious health problems including infertility.

2. The Programme has been coordinated nationally since November 2005 by the Health Protection Agency (the Agency), which facilitates and supports the implementation of the Programme and its monitoring and evaluation. The Agency does not allocate local budgets for the Programme, nor engage directly in performance management. The Programme is delivered locally by the 152 PCTs in England, who commission Chlamydia Screening Offices to coordinate the testing of young people under the age of 25.

3. Most testing under the Programme takes place in community health services such as doctors' surgeries and community sexual health services (family planning clinics). A significant amount of testing also occurs in other settings including schools, colleges and youth centres. Many PCTs also offer self-testing services in which young people order test kits from a website, produce a urine sample or swab and return the samples by post for laboratory analysis. This is because the Programme has an 'opportunistic screening' approach – in contrast to the systematic approach adopted by screening programmes for other conditions – aiming to reach young people without requiring them to visit a genito-urinary medicine clinic. This approach was adopted for chlamydia screening for a number of reasons, including the difficulty of maintaining an accurate register of young people, who tend to change their addresses frequently. The approach also reflects current government thinking which aims to

increase access to sexual health services for young people by developing primary care and other community services.

4. Our examination of the Programme has explored 2 main concerns: whether the Programme will be able to achieve its stated aims of reducing the levels of chlamydia infection in the population and the related consequences of untreated infection; and whether the delivery model, in which individual PCTs are free to devise and deliver testing and treatment services locally, is providing value for money. These issues are examined in detail in Parts 2 and 3 of this report.

## The Programme's effect on chlamydia infection and associated disease

5. The scientific evidence upon which the Programme is based is subject to debate: both the level of infection in the general population and the probability of chlamydia leading to related and potentially severe health complications are not well understood. A screening programme was recommended by an expert group appointed by the Chief Medical Officer; the Programme was launched without generally agreed, robust data on the levels of chlamydia infection in the general population of young people in England, to provide a baseline against which the impact of the Programme could be measured. There was, however, evidence that infection rates in young people attending healthcare services were high.

6. Modelling by the Agency, published in 2006, indicated that testing between 26-43 per cent of 16-24 year-olds, along with robust arrangements to trace and treat the sexual partners of infected people, would secure a significant impact on the prevalence of chlamydia. In 2008-09, the Agency estimates that 50 per cent of PCTs reached 26 per cent, through a combination of testing under the Programme, other tests in community settings which were not reported to the Programme, and tests in genito-urinary medicine clinics. For infectious conditions such as chlamydia, testing and treatment rates need to be high enough to control the spread of the infection as well as treating those infected. Lower impacts would be seen at lower testing rates, the model predicted. The Agency has developed plans to monitor changes in the prevalence of chlamydia which it expects will contribute to evaluating the Programme and is seeking funding to implement these. The Programme's local delivery by Primary Care Trusts

7. Following its launch in 2003, the Programme was rolled out in 3 successive phases. By March 2008, 1 year later than the Department's target date of March 2007, all PCTs were commissioning chlamydia testing under the Programme. During the financial year 2007-08, 4.9 per cent of 15 to 24 year-olds were reported to the Programme as having been tested, against a target of 15 per cent.

8. For 2008-09 onwards, the Department set PCTs a new national priority for local delivery, in the form of a 'Tier 2 Vital Signs indicator', including progressively increasing annual testing rates of 17, 25 and 35 per cent of under-25s, for the 3 years 2008-09 to 2010-11. This led to a step-change in activity by many PCTs in 2008-09 in an effort to deliver these rates. In fact,

PCTs across England achieved an average testing level of 15.9 per cent by the end of 2008-09, a large increase from the 4.9 per cent achieved in the previous year, although around half of this increase was due to the inclusion of chlamydia tests in community settings not registered with the Programme and tests which, although they took place in registered settings, were not reported to the Programme. In the first quarter of 2009-10 PCTs screened 4.1 per cent of the target population, compared to 2.9 per cent in the first quarter of 2008-09.

9. The costs of delivering the Programme are highly variable from place to place, indicating that there is scope for efficiency savings. In 2008-09 we estimate that the average cost per test delivered under the Programme was £56, including follow-up activities such as treatment of positive patients and partner notification, and local overheads. PCTs who have achieved higher testing rates tend to have lower costs per test; the Agency estimates, based on a detailed review of 7 PCTs who achieved the Vital Signs indicator of 17 per cent testing in 2008-09, that they paid around £45 per test, including follow-up activities and local overheads. However, some PCTs managed to pay much less and still reach the indicator. The Agency estimates that a cost of £33 per test is achievable, as screening volume increases, chlamydia screening gets better integrated in all community sexual health pathways, and collaborative procurement develops. This is in alignment with the evidence from our survey data. The Agency expects to have produced guidance for commissioners on costs at around the time of publication of this report.

10. There has been duplication of effort and cost in several aspects of the Programme which have been purchased in a fragmented way by multiple local commissioners: the marketing and advertising of chlamydia testing services (with at least 45 different brands across England); IT support including website development; and the procurement of testing kits, laboratory processing and treatment. It is likely that it would have been more cost-effective to deliver these elements of the Programme regionally or nationally, which would have produced economies of scale.

11. In 2008-09, 88 per cent of people who tested positive for chlamydia were recorded as having received treatment, against the Programme's standard of 95 per cent and 3 attempts to contact infected people. This means that an estimated 6,480 people who tested positive for chlamydia were not recorded as having received treatment. Without treatment, testing is wasted for the individuals concerned, since these people remain infected and may go on to infect others. The Agency intends to further prioritise collection of treatment data and promote local treatment structures and processes, with the aim of meeting the Programme standard of 95 per cent of patients being recorded as treated, by the end of 2010-11.

12. Most areas are not achieving the Programme's standards for tracing and treating the sexual partners of people who test positive. In 2008-09, nearly three-quarters of programme areas (72 per cent) failed to meet the Programme's recommended standards for partner treatment. Partners are very likely to be infected and failure to trace and treat them means

that the infection will continue to spread. Partner notification rates in genito-urinary medicine clinics, which are outside the Programme, are also lower than recommended standards.

13. There is evidence that young people's awareness of chlamydia as a serious health issue is high. Those who have had a chlamydia test report positive feelings about the experience, but in our survey 40 per cent of young people who were tested for chlamydia said that they had not received advice on issues such as contraception and safer sex when tested. Programme guidance, including a mandatory information leaflet for patients, promotes condom use which can prevent sexually transmitted infections including chlamydia, but at the local level, our survey indicates that some of those delivering the Programme have focused on the ease of testing and treatment for chlamydia to the detriment of guidance on prevention. The test should be used as an opportunity to provide wider guidance and promote safer sex, so helping to reduce infection rates in the long-term.

## Wider lessons for other NHS programmes

14. The Programme is an example of the difficulties which can arise when a national initiative is introduced into a locally-managed NHS, when influences and incentives for PCTs are not adequately addressed from the beginning and all aspects are locally commissioned, regardless of economies of scale. The Programme's implementation was limited until a Tier 2 Vital Signs indicator was introduced in 2008-09. The bias towards local commissioning of support services such as marketing and IT has led to inefficiencies.
Overall conclusion on value for money

15. The delivery of the Programme to date has not demonstrated value for money. Annual testing of between 26 and 43 per cent of young people is needed in order to significantly reduce the prevalence of chlamydia; only half of PCTs reached 26 per cent or more in 2008-2009, 6 years after the Programme's launch. While aspects of the Programme such as making contact with and treating infected young people and their sexual partners can be challenging, the core of the Programme involves delivering a straightforward test to a well-defined group of people. The Department introduced the Programme in a phased manner, in line with the availability of funding, reflecting the need to increase local capacity for testing, and the intention to develop new ways of engaging with young people about their sexual health. A more rapid roll-out, however, would have allowed PCTs to reach the necessary level of testing earlier, which is the key objective of the Programme.
The potential benefits which devolved delivery through PCTs and the phased roll-out could have offered, by refining the efficiency of local programmes before increasing activity, were not realised because the Department did not monitor PCT spending on the Programme, seek to evaluate the most cost-effective local programmes, or set up effective joint commissioning structures to secure economies of scale.

Furthermore, due to uncertainties in the scientific evidence on chlamydia, the Department does not know how often infection leads to serious health problems and hence whether it is cost-effective to invest so much public money in tackling this problem

We estimate that savings of £17 million could have been made in 2008-09, if all PCTs had delivered tests for £33 (the Agency's calculation of an achievable cost per test in established local programmes). Economies of £40 million per year could be made from 2010-11, when the Vital Signs indicator will increase to 35 per cent.

## Recommendations

a. The Programme is approaching the volume of testing where models suggest it will have a significant impact on the prevalence of chlamydia and the Agency is currently developing mechanisms to evaluate this. However, the Department needs to set out clearly what the Programme is trying to achieve. The Department, working with the Health Protection Agency, should:

i. define criteria for the success of the Programme, which should include the reductions in chlamydia prevalence which it aims to achieve, by when;

ii. complete current work to produce a clear picture of the total population coverage of chlamydia testing in each PCT by drawing together data which are used currently to report progress against the Vital Signs national indicator on chlamydia screening with that from genito-urinary medicine clinics;

iii. put in place the means to measure the agreed criteria for the success of the Programme including its impact on chlamydia prevalence and disease, in order to demonstrate whether the theoretical models which are a central factor in the justification for the Programme, are reflected in reality. The Department and the Agency should produce recommendations on this by summer 2010, when the results of the second year of the Programme's national operation will be available; and

iv. pursue research, in the longer term, to understand better the probability of chlamydia progressing to severe health complications and use this to inform the setting of further criteria for the Programme's success.

b. NHS resources are being poorly used because of limited guidance on the most efficient way to deliver testing and this may get worse now the programme is being rapidly expanded. The Department should introduce a number of key changes to improve the cost-effectiveness of the Programme:

i. PCTs have had limited benchmarks to guide their spending. The costs incurred by PCTs are highly variable. The Agency should make available results from its recent costing review. Further investigations should be conducted to investigate the reasons for cost variations at PCT level, to identify the most cost-effective testing strategies and provide guidance for commissioners on chlamydia screening, including a pricing guideline. The cost-effectiveness

assessment should include an evaluation of outreach events and 'remote' testing services such as those provided through websites.

ii. Many of those who take a chlamydia test are not receiving any advice about safer sex or the prevention of infection. The Department should ensure that the Programme supports and reinforces the key messages of its own advertising campaigns on sexual health, by making education and advice about sexual health an integral part of the testing process. Otherwise, any reductions in the level of chlamydia infection will only be sustained through the continuation of high levels of testing and treatment, which may not be cost-effective.

iii. If people who test positive for chlamydia are not treated, the money spent on testing is wasted for these individuals. Overall, an estimated 6,480 people, or 12 per cent of those who tested positive, were not recorded as having received treatment in 2008-09. Only 28 per cent of Programme areas met recommended levels for treating the partners of infected people. The Agency needs to improve data collection on the treatment of infected people, to highlight for poorer-performing PCTs how other areas are achieving much higher treatment levels, and also help them to meet the Programme's standards for tracing and treating partners. This should include an investigation of the effectiveness of different testing venues in securing treatment of people who test positive and their partners.

iv. Some aspects of the Programme are inherently more suitable for delivery at the national or regional level, rather than locally by PCTs. Alongside its plans for a national campaign on chlamydia testing, due in 2010, the Department should consider ways in which the message about chlamydia testing can be reinforced nationally while ensuring that consistent messages are delivered locally. The Department should also undertake reviews of online screening, data-gathering and testing kit procurement, with a view to putting national or regional arrangements in place.

v. The local strategic planning, commissioning and delivery models for chlamydia screening vary, both in approach and in degree of success. Most PCTs have assigned dedicated coordinating teams, but the scope of influence, seniority and management experience of those recruited also varies. Local PCTs need to provide appropriate support and training on key aspects of programme delivery, based on guidance provided by the Agency, to ensure that local co-ordinators can meet the requirements of their role and deliver efficient and effective local programmes.

vi. Mechanisms for influencing PCTs' spending or plans for chlamydia testing have been of limited effectiveness. The Department should establish arrangements which will better enable the Agency and Strategic Health Authorities to more effectively influence PCTs' strategies for chlamydia testing and to pursue more focused and cost-effective delivery arrangements for the Programme, including commissioning at a regional or national level.

# References

Office for National Statistics. www.ons.gov.uk.

Adams, E. J., A. Charlett, W. J. Edmunds and G. Hughes (2004). "Chlamydia trachomatis in the United Kingdom: a systematic review and analysis of prevalence studies." Sex Transm Infect **80**.

Adams, E. J., K. M. Turner and W. J. Edmunds (2007). "The cost effectiveness of opportunistic chlamydia screening in England." Sex Transm Infect **83**(4): 267-274; discussion 274-265.

Ades, A. E. and G. F. Medley (1994). "Estimates of disease inidence in women based on antental or neonatal seroprevalence data - HIV in New York City." Statistics In Medicine **13**(18): 1881-1894.

Ades, A. E. and D. J. NOKES (1993). "MODELING AGE-SPECIFIC AND TIME-SPECIFIC INCIDENCE FROM SEROPREVALENCE - TOXOPLASMOSIS." American Journal Of Epidemiology **137**(9): 1022-1034.

Aghaizu, A., E. J. Adams, K. Turner, S. Kerry, P. Hay, I. Simms and P. Oakeshott (2011). "What is the cost of pelvic inflammatory disease and how much could be prevented by screening for chlamydia trachomatis? Cost analysis of the Prevention of Pelvic Infection (POPI) trial." Sex Transm Infect **87**(4): 312-317.

Akande, V. A., D. J. Cahill, P. G. Wardle, A. J. Rutherford and J. M. Jenkins (2004). "The predictive value of the "Hull & Rutherford" classification for tubal damage." Bjog **111**(11): 1236-1241.

Althaus, C. L., K. M. Turner, C. H. Mercer, P. Auguste, T. E. Roberts, G. Bell, S. A. Herzog, J. A. Cassell, W. J. Edmunds, P. J. White, H. Ward and N. Low (2014). "Effectiveness and cost-effectiveness of traditional and new partner notification technologies for curable sexually transmitted infections: observational study, systematic reviews and mathematical modelling." Health Technol Assess **18**(2).

Andermann, A., I. Blancquaert, S. Beauchamp and V. Déry (2008). "Revisiting Wilson and Jungner in the genomic age: a review of screening criteria over the past 40 years." Bulletin of the World Health Organization **86**(4): 317-319.

Andersen, B., I. Van Valkengoed, I. Sokolowski, J. K. Møller, L. Østergaard and F. Olesen (2011). "Impact of intensified testing for urogenital Chlamydia trachomatis infections: a randomised study with 9-year follow-up." Sexually transmitted infections **87**(2): 156-161.

Anderson, R. and R. M. May (1982). "Directly transmitted infectious diseases; control by vaccination." Science **95**: 19-36.

Anderson, R. M. and R. M. May (1988). "Epidemiological parameters of HIV transmission." Nature **333**.

Angel, G., P. J. Horner, N. O'Brien, M. Sharp, K. Pye, C. Priestley, J. Macleod, K. J. Looker and K. M. Turner (2015). "An observational study to evaluate three pilot programmes of retesting chlamydia-positive individuals within 6 months in the South West of England." BMJ Open **5**(10): e007455.

Apoola, A., M. Boothby and K. Radcliffe (2004). "Is telephone follow-up as good as traditional clinic follow-up in achieving the proposed national outcome standards for chlamydia management?" Int J STD AIDS **15**(6): 376-379.

Authority, H. F. E. (2011). Fertility treatment in 2011: trends and figures.

Bacterial Special Interest Group (2006). Sexually Transmitted Infections: UK National Screening and Testing Guidelines, BASHH.

Barnett, S. D. and J. F. Brundage (2001). "Incidence of recurrent diagnoses of Chlamydia trachomatis genital infections among male and female soldiers of the US army." Sexually Transmitted Infections **77**(1): 33-36.

Batteiger, B. E., W. Tu, S. Ofner, B. Van Der Pol, D. R. Stothard, D. P. Orr, B. P. Katz and J. D. Fortenberry (2010). "Repeated Chlamydia trachomatis genital infections in adolescent women." J Infect Dis **201**(1): 42-51.

Batteiger, B. E., F. Xu, R. E. Johnson and M. L. Rekart (2010). "Protective immunity to Chlamydia trachomatis genital infection: evidence from human studies." J Infect Dis **201 Suppl 2**: S178-189.

Baud, D., G. Goy, K. Jaton, M. C. Osterheld, S. Blumer, N. Borel, Y. Vial, P. Hohlfeld, A. Pospischil and G. Greub (2011). "Role of Chlamydia trachomatis in miscarriage." Emerg Infect Dis **17**(9): 1630-1635.

Becker, N. G. (1989). Analysis of Infectious Disease Data. London, Chapman and Hall.

Bello, T. (2004). "Pattern of Tubal Pathology in Infertile Women on Hysterosalpingography in Ilorin , Nigeria." Annals of African Medicine **3**(2): 77-79.

Bibby, P. and P. Brindley (2013). The 2011 Rural-Urban Classification For Small Area Geographies: A User Guide and Frequently Asked Questions (v1.0), Office for National Statistics.

Boeke, A. J., J. E. van Bergen, S. A. Morre and J. J. van Everdingen (2005). "[The risk of pelvic inflammatory disease associated with urogenital infection with Chlamydia trachomatis; literature review]." Ned Tijdschr Geneeskd **149**(16): 878-884.

Bonell, C. P., J. Hargreaves, S. Cousens, D. Ross, R. Hayes, M. Petticrew and B. R. Kirkwood (2011). "Alternatives to randomisation in the evaluation of public health interventions: design challenges and solutions." J. Epidemiol. Community Health **65**(7): 582-587.

Borges-Costa, J., C. Matos and F. Pereira (2011). "Sexually transmitted infections in pregnant adolescents: prevalence and association with maternal and foetal morbidity." J. Eur. Acad. Dermatol. Venereol.

British Association of Sexual Health and HIV (2006). 2006 UK National Guideline for the Management of Genital Tract Infection with Chlamydia trachomatis.

British Association of Sexual Health and HIV (2006). "UK National Guideline for the Management of Genital Tract Infection with Chlamydia trachomatis."

Brunham, R. C. (2005). "Insights into the epidemiology of sexually transmitted diseases from Ro= BcD." Sexually transmitted diseases **32**(12): 722-724.

Brunham, R. C., B. Binns, F. Guijon, D. Danforth, M. L. Kosseim, F. Rand, J. McDowell and E. Rayner (1988). "Etiology and outcome of acute pelvic inflammatory disease." J Infect Dis **158**(3): 510-517.

Brunham, R. C. and R. W. Peeling (1994). "Chlamydia trachomatis antigens: role in immunity and pathogenesis." Infect Agents Dis **3**(5): 218-233.

Brunham, R. C., B. Pourbohloul, S. Mak, R. White and M. L. Rekart (2005). "The Unexpected Impact of a Chlamydia trachomatis Infection Control Program on Susceptibility to Reinfection." The Journal of Infectious Diseases **192**(10): 1836-1844.

Brunham, R. C. and M. L. Rekart (2008). "The arrested immunity hypothesis and the epidemiology of chlamydia control." Sex Transm. Dis **35**(1): 53-54.

Brunham, R. C. M. D. and M. L. M. D. M. Rekart (2008). "The Arrested Immunity Hypothesis and the Epidemiology of Chlamydia Control." Sexually Transmitted Diseases **35**(1): 53-54.

Campbell, S., J. Lynch, A. Esterman and R. McDermott (2011). "Pre-pregnancy predictors linked to miscarriage among Aboriginal and Torres Strait Islander women in North Queensland." Aust. N. Z. J. Public Health **35**(4): 343-351.

Cassell, J. A., J. Dodds, C. Estcourt, C. Llewellyn, S. Lanza, J. Richens, H. Smith, M. Symonds, A. Copas, T. Roberts, K. Walters, P. White, C. Lowndes, H. Mistry, M. Rossello-Roig, H. Smith and G. Rait (2015). "The relative clinical effectiveness and cost-effectiveness of three contrasting approaches to partner notification for curable sexually transmitted infections: a cluster randomised trial in primary care." Health Technol Assess **19**(5): 1-115, vii-viii.

Cates, W., Jr., R. T. Rolfs, Jr. and S. O. Aral (1990). "Sexually transmitted diseases, pelvic inflammatory disease, and infertility: an epidemiologic update." Epidemiol Rev **12**: 199-220.

Chandra, N. L., B. Sile, J. Saunders and S. C. Woodhall (2015). Exploring epididymitis diagnoses in hospitals and genitourinary medicine clinics as a possible outcome measure to evaluate chlamydia control programmes. International Union against Sexually Transmitted Infections, IUSTI.

Chandra, N. L., K. Soldan, C. Dangerfield, B. Sile, S. Duffell, A. Talebi, Y. H. Choi, G. Hughes and S. C. Woodhall (2017). "Filling in the gaps: estimating numbers of chlamydia tests and diagnoses by age group and sex before and during the implementation of the English National Screening Programme, 2000 to 2012." Euro Surveill **22**(5).

Chandrasekaran, L., B. Davies, J. W. Eaton and H. Ward (2016). "Chlamydia diagnosis rate in England in 2012: an ecological study of local authorities." Sex Transm Infect.

Chief Medical Officer's Expert Advisory Group (1998). Main report of the CMO's Expert Advisory Group on *Chlamydia trachomatis*. London: Department of Health.

Chow, J. M., M. L. Yonekura, G. A. Richwald, S. Greenland, R. L. Sweet and J. Schachter (1990). "The association between Chlamydia trachomatis and ectopic pregnancy. A matched-pair, case-control study." Jama **263**(23): 3164-3167.

CLAHRC West. (2017). "Sexually transmitted infections management in primary care." from clahrc-west.nihr.ac.uk/research/projects/sexually-transmitted-infections-management-in-primary-care/.

Clifton, S., C. H. Mercer, S. C. Woodhall, P. Sonnenberg, N. Field, L. Lu, A. M. Johnson and J. A. Cassell (2016). "Patterns of chlamydia testing in different settings and implications for wider STI diagnosis and care: a probability sample survey of the British population." Sex Transm Infect.

Cousens, S., J. Hargreaves, C. Bonell, B. Armstrong, J. Thomas, B. R. Kirkwood and R. Hayes (2011). "Alternatives to randomisation in the evaluation of public-health interventions: statistical analysis and causal inference." J. Epidemiol. Community Health **65**(7): 576-581.

Crichton, J., M. Hickman, R. Campbell, H. Batista-Ferrer and J. Macleod (2015). "Socioeconomic factors and other sources of variation in the prevalence of genital chlamydia infections: A systematic review and meta-analysis." BMC Public Health **15**: 729.

Cunningham, K. A. and K. W. Beagley (2008). "Male genital tract chlamydial infection: implications for pathology and infertility." Biol. Reprod **79**(2): 180-189.

Currie, S., S. Woodhall, J. Saunders and K. Dunbar (2016). Survey of Health Care Professionals' knowledge & adherence to National Chlamydia Screening Programme Guidance. BASHH.

Darville, T. and T. J. Hiltke (2010). "Pathogenesis of Genital Tract Disease Due to Chlamydia trachomatis." The Journal of Infectious Diseases **201**(Supplement_2): S114-S125.

Darville, T. M. and T. P. I. D. W. P. Committee (2013). "Pelvic Inflammatory Disease: Identifying Research Gaps-Proceedings of a Workshop Sponsored by Department of Health and Human Services/National Institutes of Health/National Institute of Allergy and Infectious Diseases, November 3-4, 2011. [Article]." Sexually Transmitted Diseases **40**(10): 761-767.

Davies, B., K. M. Turner, S. Leung, B. N. Yu, M. Frolund, T. Benfield, J. Blanchard, H. Westh and H. Ward (2017). "Comparison of the population excess fraction of Chlamydia trachomatis infection on pelvic inflammatory disease at 12-months in the presence and absence of chlamydia testing and treatment: Systematic review and retrospective cohort analysis." PLoS One **12**(2): e0171551.

Department of Health (2001). The national strategy for sexual health and HIV, Department of Health London.

Department of Health (2004). Best Practice Guidance for Doctors and Other Health Professionals on the Provision of Advice and Treatment to Young People under 16 on Contraception, Sexual and Reproductive Health. D. o. Health.

Department of Health (2004). Delivering Choosing Health: making healthier choices easier.

Department of Health (2009). Sex. Worth talking about: A campaign toolkit for teenage pregnancy and sexual health professionals.

Department of Health (2012). Improving outcomes and supporting transparency. Part 1: A public health outcomes framework for England, 2013-2016.

Department of Health (2013). A Framework for Sexual Health Improvement in England.

Department of Health. (2013). "Payment by Results in the NHS: tariff for 2013 to 2014." from www.gov.uk/government/publications/payment-by-results-pbr-operational-guidance-and-tariffs.

DH/NHS Finance Performance & Operations (2008). Operational plans 2008/09–2010/11: National Planning Guidance and "vital signs". D. o. Health.

Duncan, B., G. Hart, A. Scoular and A. Bigrigg (2001). "Qualitative analysis of psychosocial impact of diagnosis of Chlamydia trachomatis: implications for screening." BMJ **322**(7280): 195-199.

EBM DataLab. (2017). "OpenPrescribing.net."

England, P. H. (2014). National Chlamydia Screening Programme (NCSP): audit report on turnaround times.

Erens, B., S. McManus, J. Field, C. Korovessis, A. Johnson, K. Fenton and K. Wellings (2001). National Survey of Sexual Attitudes and Lifestyles II: Technical Report.

Erens, B., A. Phelps, S. Clifton, D. Hussey, C. H. Mercer, C. Tanton, P. Sonnenberg, W. Macdowall, A. J. Copas, N. Field, K. Mitchell, J. Datta, V. Hawkins, C. Ison, S. Beddows, K. Soldan, F. Coelho da Silva, S. Alexander, K. Wellings and A. M. Johnson (2013). The Third National Survey of Sexual Attitudes and Lifestyles (Natsal-3): Technical Report. London.

European Centre for Disease Prevention and Control (2013). STI laboratory diagnostics in Europe. Stockholm.

European Centre for Disease Prevention and Control (2014). Annual epidemiological report 2014 - Sexually transmitted infections, including HIV and blood-borne viruses. Stockholm, ECDC.

European Centre for Disease Prevention and Control (2014). Chlamydia control in Europe - a survey of Member States.

European Centre for Disease Prevention and Control (2014). Chlamydia control in Europe: literature review. Stockholm, ECDC.

European Centre for Disease Prevention and Control (2016). Annual Epidemiological Report 2016 – Chlamydia. . Stockholm.

Fenton, K. A., C. H. Mercer, A. M. Johnson, C. L. Byron, S. McManus, B. Erens, A. J. Copas, K. Nanchahal, W. Macdowall and K. Wellings (2005). "Reported sexually transmitted disease clinic attendance and sexually transmitted infections in Britain: prevalence, risk factors, and proportionate population burden." J. Infect. Dis **191 Suppl 1**: S127-S138.

Fine, D., L. Dicker, D. Mosure and S. Berman (2008). "Increasing chlamydia positivity in women screened in family planning clinics: do we know why?" Sex Transm Dis **35**(1): 47-52.

Folger, A. T. (2014). "Maternal Chlamydia trachomatis infections and preterm birth:the impact of early detection and eradication during pregnancy." Matern Child Health J **18**(8): 1795-1802.

Foster, S., V. Womack, S. Ainslie, K. Folkard, J. K. Dunbar and J. Saunders (2015). Securing excellence in chlamydia screening outcomes on a shrinking budget. BASHH Spring Conference. Glasgow.

French, C. E., G. Hughes, A. Nicholson, M. Yung, J. D. Ross, T. Williams and K. Soldan (2011). "Estimation of the rate of pelvic inflammatory disease diagnoses: trends in England, 2000-2008." Sex Transm Dis **38**(3): 158-162.

Gaydos, C. A., B. Van Der Pol, M. Jett-Goheen, M. Barnes, N. Quinn, C. Clark, G. E. Daniel, P. B. Dixon and E. W. Hook, 3rd (2013). "Performance of the Cepheid CT/NG Xpert Rapid PCR Test for Detection of Chlamydia trachomatis and Neisseria gonorrhoeae." J Clin Microbiol **51**(6): 1666-1672.

Gobin, M., N. Verlander, C. Maurici, A. Bone and A. Nardone (2013). "Do sexual health campaigns work? An outcome evaluation of a media campaign to increase chlamydia testing among young people aged 15–24 in England." BMC Public Health **13**(1): 484.

Golden, M. R., J. A. Schillinger, L. Markowitz and M. E. St Louis (2000). "Duration of untreated genital infections with Chlamydia trachomatis - A review of the literature." Sexually Transmitted Diseases **27**(6): 329-337.

Gottlieb, S. L., R. C. Brunham, G. I. Byrne, D. H. Martin, F. Xu and S. M. Berman (2010). "Introduction: The natural history and immunobiology of Chlamydia trachomatis genital infection and implications for chlamydia control." J Infect Dis **201 Suppl 2**: S85-87.

Gottlieb, S. L., D. H. Martin, F. Xu, G. I. Byrne and R. C. Brunham (2010). "Summary: The natural history and immunobiology of Chlamydia trachomatis genital infection and implications for Chlamydia control." J Infect Dis **201 Suppl 2**: S190-204.

Gotz, H. M., I. V. van den Broek, C. J. Hoebe, E. E. Brouwers, L. L. Pars, J. S. Fennema, R. H. Koekenbier, S. van Ravesteijn, E. L. Op de Coul and J. van Bergen (2013). "High yield of reinfections by home-based automatic rescreening of Chlamydia positives in a large-scale register-based screening programme and determinants of repeat infections." Sex Transm Infect **89**(1): 63-69.

Gotz, H. M., M. E. Wolfers, A. Luijendijk and I. V. van den Broek (2013). "Retesting for genital Chlamydia trachomatis among visitors of a sexually transmitted infections clinic: randomized intervention trial of home- versus clinic-based recall." BMC Infect Dis **13**: 239.

Government of the United Kingdom (2012) "Health and Social Care Act 2012." www. legislation. gov. uk/ukpga/2012/7/contents/enacted.

Government, U. (2006). National Health Services Act 2007.

Griffiths, D. (1974). "A catalytic model of infection for measles." Journal of the Royal Statistical Society (C)(23): 330-339.

Hager, W. D., D. A. Eschenbach, M. R. Spence and R. L. Sweet (1983). "Criteria for diagnosis and grading of salpingitis." Obstet Gynecol **61**(1): 113-114.

Haggerty, C. L., S. L. Gottlieb, B. D. Taylor, N. Low, F. Xu and R. B. Ness (2010). "Risk of sequelae after Chlamydia trachomatis genital infection in women." J Infect Dis **201 Suppl 2**: S134-155.

Harding-Esch, E. M., A. V. Nori, A. Hegazi, M. J. Pond, O. Okolo, A. Nardone, C. M. Lowndes, P. Hay and S. T. Sadiq (2017). "Impact of deploying multiple point-of-care tests with a 'sample first' approach on a sexual health clinical care pathway. A service evaluation." Sex Transm Infect.

Hartney, T., P. Baraitser and A. Nardone (2015). "Self-Reported Impact of Chlamydia Testing on Subsequent Behavior: Results of an Online Survey of Young Adults in England." Sexually Transmitted Diseases **42**(9): 486-491.

Health Protection Agency. (2011, 12/1/2011). "CTAD: Chlamydia Testing Activity Dataset." from www.gov.uk/guidance/chlamydia-testing-activity-dataset-ctad.

Health Protection Agency (2012) "Genitourinary Medicine Clinic Activity Dataset (GUMCAD): Access, specifications, guidance materials and policies." www.hpa.org.uk/gumcad#Guidelines_and_specifications.

Herrmann, B. and M. Egger (1995). "Genital Chlamydia trachomatis infections in Uppsala County, Sweden, 1985-1993: declining rates for how much longer?" Sex Transm. Dis **22**(4): 253-260.

Herzog, S. A., J. C. Heijne, P. Scott, C. L. Althaus and N. Low (2013). "Direct and indirect effects of screening for Chlamydia trachomatis on the prevention of pelvic inflammatory disease: a mathematical modeling study." Epidemiology **24**(6): 854-862.

Hillis, S. D., A. Nakashima, L. Amsterdam, J. Pfister, M. Vaughn, D. Addiss, P. A. Marchbanks, L. M. Owens and J. P. Davis (1995). "The impact of a comprehensive chlamydia prevention program in Wisconsin." Fam. Plann. Perspect **27**(3): 108-111.

Hippisley-Cox, J. and Y. Vinogradova (2009). Trends in consultation rates in general practice 1995/1996 to 2008/2009: Analysis of the QRESEARCH database, The Health and Social Care Information Centre.

Hocking, J. (2012). Australian Chlamydia Control Effectiveness PIlot: a trial to determine whether annual chlamydia testing in general practice can lead to a reduction in chlamydia prevalence. Trial ID: ACTRN12610000297022. Austrlia, University of Melbourne.

Hocking, J. (2016). Chlamdyia control- where to from here? Results from the Australian Chlamydia Control Effectiveness Pilot (ACCEPt). European Society for Chlamydia Research. C. O'Neal, I. N. Clarke, P. Horner and B. Van Der Pol. Oxford, UK.

Hoenderboom, B. M., A. A. Van Oeffelen, B. H. Van Benthem, J. Van Bergen, S. Ouburg, S. A. Morre and I. V. Van den Broek (2016). The Netherlands Chlamydia Cohort Study (NECCST): risk of long-term complicaitons after Chlamydia trachomatis infection in women, intermediate outcomes. European Society for Chlamydia Research. C. O'Neal, I. N. Clarke, P. Horner and B. van Der Pol. Oxford.

Hoenderboom, B. M., A. A. van Oeffelen, B. H. van Benthem, J. E. van Bergen, N. H. Dukers-Muijrers, H. M. Gotz, C. J. Hoebe, A. A. Hogewoning, F. R. van der Klis, D. van Baarle, J. A. Land, M. A. van der Sande, M. G. van Veen, F. de Vries, S. A. Morre and I. V. van den Broek (2017). "The Netherlands Chlamydia cohort study (NECCST) protocol to assess the risk of late complications following Chlamydia trachomatis infection in women." BMC Infect Dis **17**(1): 264.

Hogan, A. H., R. S. Howell-Jones, E. Pottinger, L. M. Wallace and C. A. McNulty (2010). ""...they should be offering it": a qualitative study to investigate young peoples' attitudes towards chlamydia screening in GP surgeries." BMC. Public Health **10**: 616.

Holland, W. W. and S. Stewart (1990). "Screening in health care: benefit or bane?".

Hollis, E., A. Harb, A. Talebi, A. Shah and N. Connor (2017). "O18 Internet testing for chlamydia reported through national surveillance in England." Sexually Transmitted Infections **93**(Suppl 1): A7-A7.

Horner, P. (2006). "The case for further treatment studies of uncomplicated genital Chlamydia trachomatis infection." Sex Transm. Infect **82**(4): 340-343.

Horner, P., K. Soldan, S. M. Vieira, G. S. Wills, S. C. Woodhall, R. Pebody, A. Nardone, E. Stanford and M. O. McClure (2013). "C. trachomatis Pgp3 antibody prevalence in young women in England, 1993-2010." PLoS One **8**(8): e72001.

Horner, P. J. (2012). "Azithromycin antimicrobial resistance and genital Chlamydia trachomatis infection: duration of therapy may be the key to improving efficacy." Sex Transm. Infect **88**(3): 154-156.

Horner, P. J., G. S. Wills, R. Reynolds, A. M. Johnson, D. A. Muir, A. Winston, A. J. Broadbent, D. Parker and M. O. McClure (2013). "Effect of time since exposure to Chlamydia trachomatis on chlamydia antibody detection in women: a cross-sectional study." Sexually Transmitted Infections **89**(5): 398-403.

Horner, P. J., G. S. Wills, R. Reynolds, A. M. Johnson, D. A. Muir, A. Winston, A. J. Broadbent, D. Parker and M. O. McClure (2013). "Effect of time since exposure to Chlamydia trachomatis on chlamydia antibody detection in women: a cross-sectional study." Sex Transm Infect **89**(5): 398-403.

Hsiao, P. C., P. H. Wang, Y. T. Tee, S. F. Yang, P. H. Su, Y. C. Chen, L. Y. Lin and H. T. Tsai (2010). "Significantly elevated concentration of plasma monocyte chemotactic protein 1 of patients with pelvic inflammatory disease." Reprod Sci **17**(6): 549-555.

Hughes, G. and N. Field (2015). "The epidemiology of sexually transmitted infections in the UK: impact of behavior, services and interventions." Future Microbiol **10**(1): 35-51.

Hughes, H., T. Williams, I. Simms and K. Fenton (2004). Trends in diagnosis and management of genital chlamydial infection and related sequelae in general practice to mid-2004: Analysis of data in the General Practice Research Database. Health Protection Agency Annual Conference, 2004.

Humphrey, A. S. (2005). "SWOT Analysis for Management Consulting." SRI Alumni Association Newsletter **December**: 7-8.

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

Jain, S. (1999). "Perinatally acquired Chlamydia trachomatis associated morbidity in young infants." J Matern Fetal Med **8**(3): 130-133.

Johnson, A. M. and P. Horner (2008). "A new role for Chlamydia trachomatis serology?" Sexually Transmitted Infections **84**(2): 79-80.

Johnson, H. L., K. G. Ghanem, J. M. Zenilman and E. J. Erbelding (2011). "Sexually transmitted infections and adverse pregnancy outcomes among women attending inner city public sexually transmitted diseases clinics." Sex Transm Dis **38**(3): 167-171.

Johnson, L. F. and D. A. Lewis (2008). "The effect of genital tract infections on HIV-1 shedding in the genital tract: a systematic review and meta-analysis." Sex Transm Dis **35**(11): 946-959.

Johnson, S. A., I. Simms, J. Sheringham, G. Bickler, C. M. Bennett, R. Hall and J. A. Cassell (2010). "The implementation of chlamydia screening: a cross-sectional study in the south east of England." Sex Transm Infect **86**(3): 217-221.

Keiding, N. (1991). "Age-specific incidence and prevalence: A statistical perspective." J.R.Statist.Soc.A **154**(3): 371-412.

Kong, F. Y., S. N. Tabrizi, C. K. Fairley, L. A. Vodstrcil, W. M. Huston, M. Chen, C. Bradshaw and J. S. Hocking (2015). "The efficacy of azithromycin and doxycycline for the treatment of rectal chlamydia infection: a systematic review and meta-analysis." J Antimicrob Chemother **70**(5): 1290-1297.

Kong, F. Y., S. N. Tabrizi, M. Law, L. A. Vodstrcil, M. Chen, C. K. Fairley, R. Guy, C. Bradshaw and J. S. Hocking (2014). "Azithromycin versus doxycycline for the treatment of genital chlamydia infection: a meta-analysis of randomized controlled trials." Clin Infect Dis **59**(2): 193-205.

Kretzschmar, M., K. M. Turner, P. M. Barton, W. J. Edmunds and N. Low (2009). "Predicting the population impact of chlamydia screening programmes: comparative mathematical modelling study." Sex Transm. Infect **85**(5): 359-366.

LaMontagne, D. S., K. Baster, L. Emmett, T. Nichols, S. Randall, L. McLean, P. Meredith, V. Harindra, J. M. Tobin, G. S. Underhill, W. Graham Hewitt, J. Hopwood, T. Gleave, A. K. Ghosh, H. Mallinson, A. R. Davies, G. Hughes and K. A. Fenton (2007). "Incidence and reinfection rates of genital chlamydial infection among women aged 16-24 years attending general practice, family planning and genitourinary medicine clinics in England: a prospective cohort study by the Chlamydia Recall Study Advisory Group." Sex Transm Infect **83**(4): 292-303.

LaMontagne, D. S., K. Baster, L. Emmett, T. Nichols, S. Randall, L. McLean, P. Meredith, V. Harindra, J. M. Tobin, G. S. Underhill, W. G. Hewitt, J. Hopwood, T. Gleave, A. K. Ghosh, H. Mallinson, A. R. Davies, G. Hughes and K. A. Fenton (2007). "Incidence and reinfection rates of genital chlamydial infection among women aged 16-24 years attending general practice,

family planning and genitourinary medicine clinics in England: a prospective cohort study by the Chlamydia Recall Study Advisory Group." Sexually Transmitted Infections **83**(4).

Lau, C. Y. and A. K. Qureshi (2002). "Azithromycin versus doxycycline for genital chlamydial infections: a meta-analysis of randomized clinical trials." Sex Transm Dis **29**(9): 497-502.

Lazaro, N. (2008). Sexually Transmitted Infections in Primary Care 2013, Royal College of General Practitioners and British Association of Sexual Health and HIV.

Lee, S. A., P. H. Wang, H. L. Chiou, M. C. Chou, H. T. Tsai and S. F. Yang (2010). "Markedly elevated plasma myeloperoxidase protein in patients with pelvic inflammatory disease who have A allele myeloperoxidase gene polymorphism." Fertil Steril **93**(4): 1260-1266.

Lee, V. F., J. M. Tobin and V. Harindra (2004). "Re-infection of Chlamydia trachomatis in patients presenting to the genitourinary medicine clinic in Portsmouth: the chlamydia screening pilot study - three years on." Int. J. STD AIDS **15**(11): 744-746.

Lehtinen, M., D. Apter, I. Baussano, T. Eriksson, K. Natunen, J. Paavonen, S. Vanska, D. Bi, M. P. David, S. Datta, F. Struyf, D. Jenkins, E. Pukkala, G. Garnett and G. Dubin (2015). "Characteristics of a cluster-randomized phase IV human papillomavirus vaccination effectiveness trial." Vaccine **33**(10): 1284-1290.

Lewis, J. and P. J. White (2017). "Estimating Local Chlamydia Incidence and Prevalence Using Surveillance Data." Epidemiology **28**(4): 492-502.

Liu, B., C. L. Roberts, M. Clarke, L. Jorm, J. Hunt and J. Ward (2013). "Chlamydia and gonorrhoea infections and the risk of adverse obstetric outcomes: a retrospective cohort study." Sex Transm Infect **89**(8): 672-678.

Local Government Association (2014). Tackling chlamydia Local government's new public health role.

London Councils. (2017). "London Sexual Health Transformation Programme." from www.londoncouncils.gov.uk/our-key-themes/health-and-adult-services/public-health/sexual-health-0/london-sexual-health.

Looker, K. J., L. A. Wallace and K. M. Turner (2015). "Impact and cost-effectiveness of chlamydia testing in Scotland: a mathematical modelling study." Theor. Biol Med Model **12**(1): 2.

Low, N. (2007). "Screening programmes for chlamydial infection: when will we ever learn?" BMJ **334**(7596): 725-728.

Low, N., N. Bender, L. Nartey, A. Shang and J. M. Stephenson (2009). "Effectiveness of chlamydia screening: systematic review." Int J Epidemiol **38**(2): 435-448.

Low, N., J. A. Cassell, B. Spencer, N. Bender, H. A. Martin, J. van Bergen, B. Andersen, B. Herrmann, F. Dubois-Arber, F. F. Hamers, L. M. van de and J. M. Stephenson (2011). "Chlamydia control activities in Europe: cross-sectional survey." Eur. J. Public Health.

Low, N., A. McCarthy, J. Macleod, C. Salisbury, R. Campbell, T. E. Roberts, P. Horner, S. Skidmore, J. A. Sterne, E. Sanford, F. Ibrahim, A. Holloway, R. Patel, P. M. Barton, S. M. Robinson, N. Mills, A. Graham, A. Herring, E. O. Caul, G. Davey Smith, F. D. Hobbs, J. D. Ross, M. Egger and G. Chlamydia Screening Studies Project (2007). "Epidemiological, social, diagnostic and economic evaluation of population screening for genital chlamydial infection." Health Technol Assess **11**(8): iii-iv, ix-xii, 1-165.

Low, N., S. Redmond, A. Uuskula, J. van Bergen, H. Ward, B. Andersen and H. Gotz (2016). "Screening for genital chlamydia infection." Cochrane Database Syst Rev **9**: CD010866.

Macdowall, W., K. G. Jones, C. Tanton, S. Clifton, A. J. Copas, C. H. Mercer, M. J. Palmer, R. Lewis, J. Datta, K. R. Mitchell, N. Field, P. Sonnenberg, A. M. Johnson and K. Wellings (2015). "Associations between source of information about sex and sexual health outcomes in Britain: findings from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3)." BMJ Open **5**(3): e007837.

Mao, J., W. Tang, R. Fu and J. Tucker (2017). "Adverse outcomes associated with untreated Chlamydia trachomatis infection in women: a systematic review and meta-analysis." PROSPERO.

Marschner, I. C. (1994). "Using time of first positive HIV test and other auxiliary data in back-projection of AIDS incidence." Statistics In Medicine **13**: 1959-1974.

McClean, H., K. Radcliffe, A. Sullivan and I. H. Ahmed-Jushuf (2012). BASHH Statement on Partner Notification for Sexually Transmissible Infections, BASHH.

McDonagh, L. K., J. M. Saunders, J. Cassell, H. Bastaki, T. Hartney and G. Rait (2017). "Facilitators and barriers to chlamydia testing in general practice for young people using a theoretical model (COM-B): a systematic review protocol." BMJ Open **7**(3): e013588.

McMillan, A., P. Kell and H. Ward (2008). "Diagnosing chlamydia and managing proctitis in men who have sex with men: current UK practice." Sex Transm Infect **84**(2): 97-100.

McNulty, C. A., A. H. Hogan, E. J. Ricketts, L. Wallace, I. Oliver, R. Campbell, S. Kalwij, E. O'Connell and A. Charlett (2014). "Increasing chlamydia screening tests in general practice: a modified Zelen prospective Cluster Randomised Controlled Trial evaluating a complex intervention based on the Theory of Planned Behaviour." Sex Transm Infect **90**(3): 188-194.

Mercer, C. H., C. Tanton, P. Prah, B. Erens, P. Sonnenberg, S. Clifton, W. Macdowall, R. Lewis, N. Field, J. Datta, A. J. Copas, A. Phelps, K. Wellings and A. M. Johnson (2013). "Changes in sexual attitudes and lifestyles in Britain through the life course and over time: findings from the National Surveys of Sexual Attitudes and Lifestyles (Natsal)." Lancet **382**(9907): 1781-1794.

Mesher, D., E. Stanford, J. White, J. Findlow, R. Warrington, S. Das, R. Pebody, R. Borrow and K. Soldan (2016). "HPV Serology Testing Confirms High HPV Immunisation Coverage in England." PLoS One **11**(3): e0150107.

Migchelsen, S., G. Wills, P. Horner, E. Linley, E. McClure, R. Pebody, K. Soldan, M. McClure, J. K. Dunbar and S. Woodhall (2017). A tool for evaluating the impact of the National Chlamydia Screening Programme in England? C. trachomatis antibody prevalence in young women in England (2007-2015). PHE Research and Applied Epidemiology Scientific Conference. Warwick.

Migchelsen, S., G. Wills, P. Horner, E. Linley, E. Mcclure, K. Soldan, M. Mcclure, K. Dunbar and S. Woodhall (2017). "P3.213 A tool for evaluating the impact of the national chlamydia screening programme in England: <em>c. trachomatis</em> antibody prevalence in young women in England (2007–2015)." Sexually Transmitted Infections **93**(Suppl 2): A172-A172.

Miller, W. C. (2008). "Epidemiology of chlamydial infection: are we losing ground?" Sexually Transmitted Infections **84**: 82-86.

Mills, N., G. Daker-White, A. Graham and R. Campbell (2006). "Population screening for Chlamydia trachomatis infection in the UK: a qualitative study of the experiences of those screened." Fam. Pract **23**(5): 550-557.

Morre, S. A., A. J. van den Brule, L. Rozendaal, A. J. Boeke, F. J. Voorhorst, S. de Blok and C. J. Meijer (2002). "The natural course of asymptomatic Chlamydia trachomatis infections: 45% clearance and no development of clinical PID after 1-year follow-up." Int. J. STD AIDS **13 Suppl 2**: 12-18.

Morris, G. C., C. M. Stewart, S. A. Schoeman and J. D. Wilson (2014). "A cross-sectional study showing differences in the clinical diagnosis of pelvic inflammatory disease according to the experience of clinicians: implications for training and audit." Sex Transm. Infect **90**(6): 445-451.

National Audit Office (2009). Young People's Sexual Health: The National Chlamydia Screening Programme.

National Chlamydia Screening Programme (2007). Men too...

National Chlamydia Screening Programme (2009) "Guidance for the commissioners on the cost of providing chlamydia screening in primary care and the community: a review of costs in practice across England in 2009."

National Chlamydia Screening Programme (2009). Involving young men in chlamydia screening.

National Chlamydia Screening Programme (2010). Towards best practice for chlamydia screening in Reproductive and Sexual Health Services (RSH).

National Chlamydia Screening Programme (2016). National Chlamydia Screening Programme standards (seventh edition), Public Health England.

National Collaborating Centre for Women's and Children's Health (2013). Fertility: assessment and treatment for people with fertility problems [partial update for NICE CG 156: Fertility problems anticipated in August 2016]. London.

National Institute for Health and Care Excellence. (2012). "Methods for the development of NICE public health guidance (third edition)." from www.nice.org.uk/process/pmg4/chapter/incorporating-health-economics.

National Institute for Health and Care Excellence (2013). Guide to the methods of technology appraisal 2013.

National Screening Committee. (2015, 2015). "Criteria for appraising the viability, effectiveness and appropriateness of a screening programme." Retrieved 5/7/2015, 2015, from www.screening.nhs.uk/criteria.

National Statistics (2015). The English Indices of Deprivation 2015. D. f. C. a. L. Government.

Ness, R. B., D. E. Soper, J. Peipert, S. J. Sondheimer, R. L. Holley, R. L. Sweet, D. L. Hemsell, H. Randall, S. L. Hendrix, D. C. Bass, S. F. Kelsey, T. J. Songer and J. R. Lave (1998). "Design of the PID Evaluation and Clinical Health (PEACH) Study." Control Clin Trials 19(5): 499-514.

Ness, R. B., D. E. Soper, H. E. Richter, H. Randall, J. F. Peipert, D. B. Nelson, D. Schubeck, S. G. McNeeley, W. Trout, D. C. Bass, K. Hutchison, K. Kip and R. C. Brunham (2008). "Chlamydia antibodies, chlamydia heat shock protein, and adverse sequelae after pelvic inflammatory disease: the PID Evaluation and Clinical Health (PEACH) Study." Sex Transm Dis 35(2): 129-135.

NHS Health Education England. (2017). "Making Every Contact Count." Retrieved 1 March, 2017, from www.makingeverycontactcount.co.uk/.

Nicholson, A., G. Rait, T. Murray-Thomas, G. Hughes, C. H. Mercer and J. Cassell (2010). "Management of first-episode pelvic inflammatory disease in primary care: results from a large UK primary care database." Br J Gen Pract 60(579): e395-406.

Norman, J. E., O. Wu, S. Twaddle, S. Macmillan, L. McMillan, A. Templeton, H. McKenzie, A. Noone, G. Allardice and M. Reid (2004). "An evaluation of economics and acceptability of screening for Chlamydia trachomatis infection, in women attending antenatal, abortion, colposcopy and family planning clinics in Scotland, UK." BJOG 111(11): 1261-1268.

Nwokolo, N. C., B. Dragovic, S. Patel, C. Y. Tong, G. Barker and K. Radcliffe (2016). "2015 UK national guideline for the management of infection with Chlamydia trachomatis." Int J STD AIDS 27(4): 251-267.

O'Farrell, N. (2016). "Control of gonorrhoea and chlamydia in the UK." The Lancet 388(10042): 342.

Oakeshott, P., S. Kerry, A. Aghaizu, H. Atherton, S. Hay, D. Taylor-Robinson, I. Simms and P. Hay (2010). "Randomised controlled trial of screening for Chlamydia trachomatis to prevent pelvic inflammatory disease: the POPI (prevention of pelvic infection) trial." BMJ 340: c1642.

Office for National Statistics. (2014). "Childbearing for Women Born in Different Years, England and Wales: 2013." from

www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/conceptionandferti
lityrates/bulletins/childbearingforwomenbornindifferentyearsenglandandwales/2014-12-04.

Ong, K. J., K. Soldan, M. Jit, J. K. Dunbar and S. C. Woodhall (2017). "Chlamydia sequelae cost estimates used in current economic evaluations: does one-size-fit-all?" Sex Transm Infect **93**(1): 18-24.

Osborne, K., N. Gay, L. Hesketh, P. Morgan-Capner and E. Miller (2000). "Ten years of serological surveillance in England and Wales: methods, results, implications and action." Int J Epidemiol **29**(2): 362-368.

Østergaard, L., B. Andersen, J. K. Møller and F. Olesen (2000). "Home sampling versus conventional swab samples for screening of *Chlamydia trachomatis* in women: a cluster randomised 1 year follow up study." Clinical and Infectious Disease **31**(4): 951-957.

Østergaard, L., B. Andersen, J. K. Møller and F. Olesen (2000). "Home sampling versus conventional swab sampling for screening of Chlamydia trachomatis in women: a cluster-randomized 1-year follow-up study." Clinical Infectious Diseases **31**(4): 951-957.

Pathway Analytics. (2013). "Integrated Sexual Health Tariff." Retrieved August, 2017, from www.pathwayanalytics.com/sexual-health/about-the-tariff.

Patton, M. E., S. Kidd, E. Llata, M. Stenger, J. Braxton, L. Asbel, K. Bernstein, B. Gratzer, M. Jespersen, R. Kerani, C. Mettenbrink, M. Mohamed, P. Pathela, C. Schumacher, A. Stirland, J. Stover, I. Tabidze, R. D. Kirkcaldy and H. Weinstock (2014). "Extragenital gonorrhea and chlamydia testing and infection among men who have sex with men--STD Surveillance Network, United States, 2010-2012." Clin Infect Dis **58**(11): 1564-1570.

Peipert, J. F., R. B. Ness, J. Blume, D. E. Soper, R. Holley, H. Randall, R. L. Sweet, S. J. Sondheimer, S. L. Hendrix, A. Amortegui, G. Trucco, D. C. Bass and P. I. D. E. a. C. H. S. Investigators. (2001). "Clinical predictors of endometritis in women with symptoms and signs of pelvic inflammatory disease." American Journal of Obstetrics & Gynecology **184**(5): 856-863.

Persson, K. (2002). "The role of serology, antibiotic susceptibility testing and serovar determination in genital chlamydial infections." Best Practice & Research in Clinical Obstetrics & Gynecology **16**(6): 801-814.

Persson, K. (2002). "The role of serology, antibiotic susceptibility testing and serovar determination in genital chlamydial infections." Best Pract Res Clin Obstet Gynaecol **16**(6): 801-814.

Philips, Z., M. Barraza-Llorens and J. Posnett (2000). "Evaluation of the relative cost-effectiveness of treatments for infertility in the UK." Hum Reprod **15**(1): 95-106.

Pillay, T. D., J. Mullineux, C. J. Smith and P. Matthews (2013). "Unlocking the potential: longitudinal audit finds multifaceted education for general practice increases HIV testing and diagnosis." Sex Transm Infect **89**(3): 191-196.

Pillay, T. D., J. Mullineux, C. J. Smith and P. Matthews (2014). "Republished: unlocking the potential: longitudinal audit finds multifaceted education for general practice increases HIV testing and diagnosis." Postgrad Med J **90**(1060): 86-91.

Pimenta, J., M. Catchpole, M. Gray, J. Hopwood and S. Randall (2000). "Evidence based health policy report. Screening for genital chlamydial infection." BMJ **321**(7261): 629-631.

Pimenta, J., M. Catchpole, P. Rogers, E. Perkins, N. Jackson, C. Carlisle, S. Randall, J. Hopwood, G. Hewitt and G. Underhill (2003). "Opportunistic screening for genital chlamydial infection. I: Acceptability of urine testing in primary and secondary healthcare settings." Sexually transmitted infections **79**(1): 16-21.

Pollard, A., C. Llewellyn, H. Smith, D. Richardson and M. Fisher (2013). "Opt-out testing for HIV: perspectives from a high prevalence community in south-east England, UK." Int J STD AIDS **24**(4): 307-312.

Postma, M. J., R. de Vries, R. Welte and W. J. Edmunds (2008). "Health economic methodology illustrated with recent work on Chlamydia screening: the concept of extended dominance." Sex Transm. Infect **84**(2): 152-154.

Prah, P., A. M. Johnson, A. Nardone, S. Clifton, J. S. Mindell, A. J. Copas, C. Robinson, R. Craig, S. C. Woodhall, W. Macdowall, E. Fuller, B. Erens, P. Sonnenberg, K. Wellings and C. H. Mercer (2015). "Asking about Sex in General Health Surveys: Comparing the Methods and Findings of the 2010 Health Survey for England with Those of the Third National Survey of Sexual Attitudes and Lifestyles." PLoS One **10**(8): e0135203.

Preece, P. M., A. Ades, R. G. Thompson and J. H. Brooks (1989). "Chlamydia trachomatis infection in late pregnancy: a prospective study." Paediatr Perinat Epidemiol **3**(3): 268-277.

Preece, P. M., J. M. Anderson and R. G. Thompson (1989). "Chlamydia trachomatis infection in infants: a prospective study." Arch Dis Child **64**(4): 525-529.

Price, M., A. Ades, D. De Angelis, N. Welton, J. Macleod, K. Soldan, I. Simms, K. Turner and P. Horner (2014). "Incidence of Chlamydia trachomatis infection in England: two methods of estimation." Epidemiology and Infection **142**(3): 562-567.

Price, M., A. Ades, D. De Angelis, N. J. Welton, J. MacLeod, K. Turner and P. Horner (2014). "Incidence of Chlamydia trachomatis infection in women in England: two methods of estimation." Epidemiology and infection **142**(03): 562-576.

Price, M. J., A. Ades, N. J. Welton, J. Macleod, K. Turner, I. Simms and P. J. Horner (2012). "How much tubal factor infertility is caused by Chlamydia? Estimates based on serological evidence corrected for sensitivity and specificity." Sex Transm. Dis **39**(8): 608-613.

Price, M. J., A. E. Ades, D. De Angelis, N. J. Welton, J. Macleod, K. Soldan, I. Simms, K. Turner and P. J. Horner (2013). "Risk of pelvic inflammatory disease following Chlamydia trachomatis infection: analysis of prospective studies with a multistate model." Am J Epidemiol **178**(3): 484-492.

Price, M. J., A. E. Ades, K. Soldan, N. J. Welton, J. Macleod, I. Simms, D. De Angelis, K. M. E. Turner and P. J. Horner (2015). "The natural history of *Chlamydia trachomatis* infection in women: a multi-parameter evidence synthesis." Health Technology Assesment **(in press)**.

Price, M. J., A. E. Ades, K. Soldan, N. J. Welton, J. Macleod, I. Simms, D. DeAngelis, K. M. Turner and P. J. Horner (2016). "The natural history of Chlamydia trachomatis infection in women: a multi-parameter evidence synthesis." Health Technol Assess **20**(22): 1-250.

Prost, A., C. J. Griffiths, J. Anderson, D. Wight and G. J. Hart (2009). "Feasibility and acceptability of offering rapid HIV tests to patients registering with primary care in London (UK): a pilot study." Sex Transm Infect **85**(5): 326-329.

Public Health England (2013). Public Health Outcomes Framework: Annual Chlamydia Diagnosis Rate (15-24 year olds) Frequently Asked Questions (FAQ). London, Public Health England.

Public Health England (2014). Audit report on turnaround times. National Chlamydia Screening Programme.

Public Health England (2014). Components of chlamydia screening & the impact of screening on behaviour: 2014 National Chlamydia Screening Programme web survey report. London, Public Health England.

Public Health England (2014). Guidance for the detection of gonorrhoea in England

Public Health England (2014). Information to support the commissioning of chlamydia screening in general practice and community pharmacies.

Public Health England. (2014). "NCSP: Annual chlamdyia diagnosis rate calculator tool." from www.gov.uk/government/publications/ncsp-annual-chlamydia-diagnosis-rate-calculator-tool.

Public Health England (2014). NCSP: chlamydia retesting discussion guide.

Public Health England (2014). Surveillance of antimicrobial resistance in Neisseria gonorrhoeae- Key findings from the the 'Gonococcal resistance to antimicrobials surveillance programme' (GRASP) and related surveillance data. London.

Public Health England. (2014, 2014). "Table 8: Number and rates of selected STI diagnoses in the UK, 2008-2012." Retrieved 6/2014, 2014, from www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables.

Public Health England (2014). Towards achieving the chlamydia detection rate: Considerations for commissioning

Public Health England. (2015, 2015). "Chlamydia Screening: 3Cs & HIV programme." Retrieved 3/30/2015, 2015, from www.chlamydiascreening.nhs.uk/ps/3cs_hiv.asp.

Public Health England (2015). Chlamydia Testing Activity Dataset (CTAD): Commissioning guidance.

Public Health England (2015). Chlamydia Testing Activity Dataset Dataset specification and technical guidance.

Public Health England (2015). GUMCADv3 Pilot- with PrEP Monitoring Module- Tehcnical guidance and specification.

Public Health England (2015). Internet-based chlamydia screening: guidance for commissioning.

Public Health England (2015). Making it work: a guide to whole system commissioning for sexual health, reproductive health and HIV.

Public Health England (2015). NCSP lessons learned: missing test request forms (March 2015).

Public Health England (2015). Rates of Pelvic Inflammatory Disease (PID) in England (2000-2013). Health Protection Report weekly report. London, Public Health England. **9**.

Public Health England. (2015). "Retesting of those who tested positive for chlamydia: National audit report." from www.gov.uk/government/publications/national-chlamydia-screening-programme-audit-report.

Public Health England (2016). Guidance on chlamydia test and diagnosis reporting in CTAD and GUMCADv2.

Public Health England (2016). Partner notification in chlamydia screening: National audit report.

Public Health England (2016). "Sexually transmitted infections and chlamydia screening in England, 2015." Health Protection Report **10**(22).

Public Health England. (2017). "Sexual and Reproductive Health Profiles." from fingertips.phe.org.uk/profile/sexualhealth.

Raffle, A. E. and J. M. Gray (2007). Screening: evidence and practice, Oxford University Press.

Rees, E. (1980). "The treatment of pelvic inflammatory disease." Am J Obstet Gynecol **138**(7 Pt 2): 1042-1047.

Rietmeijer, C. A., R. Van Bemmelen, F. N. Judson and J. M. Douglas, Jr. (2002). "Incidence and repeat infection rates of Chlamydia trachomatis among male and female patients in an STD clinic: implications for screening and rescreening." Sex Transm Dis **29**(2): 65-72.

Roberts, T. E., S. Robinson, P. Barton, S. Bryan and N. Low (2006). "Screening for Chlamydia trachomatis: a systematic review of the economic evaluations and modelling." Sex Transm. Infect **82**(3): 193-200.

Roberts, T. E., S. Robinson, P. M. Barton, S. Bryan, A. McCarthy, J. Macleod, M. Egger and N. Low (2007). "Cost effectiveness of home based population screening for Chlamydia trachomatis in the UK: economic evaluation of chlamydia screening studies (ClaSS) project." BMJ **335**(7614): 291.

Robertson, J. N., M. E. Ward, D. Conway and E. O. Caul (1987). "Chlamydial and gonococcal antibodies in sera of infertile women with tubal obstruction." J Clin Pathol **40**(4): 377-383.

Ronn, M. M., E. E. Wolf, H. Chesson, N. A. Menzies, K. Galer, R. Gorwitz, T. Gift, K. Hsu and J. A. Salomon (2017). "The Use of Mathematical Models of Chlamydia Transmission to Address Public Health Policy Questions: A Systematic Review." Sex Transm Dis **44**(5): 278-283.

Rosenman, M. B., B. E. Mahon, S. M. Downs and M. B. Kleiman (2003). "Oral erythromycin prophylaxis vs watchful waiting in caring for newborns exposed to Chlamydia trachomatis." Arch Pediatr Adolesc Med **157**(6): 565-571.

Ross, J. D. C. and G. Hughes (2014). "Why is the incidence of pelvic inflammatory disease falling?" BMJ : British Medical Journal **348**.

Rours, G. I., L. Duijts, H. A. Moll, L. R. Arends, R. de Groot, V. W. Jaddoe, A. Hofman, E. A. Steegers, J. P. Mackenbach, A. Ott, H. F. Willemse, E. A. van der Zwaan, R. P. Verkooijen and H. A. Verbrugh (2011). "Chlamydia trachomatis infection during pregnancy associated with preterm delivery: a population-based prospective cohort study." Eur J Epidemiol **26**(6): 493-502.

Rours, I. G., M. R. Hammerschlag, A. Ott, T. J. De Faber, H. A. Verbrugh, R. de Groot and R. P. Verkooyen (2008). "Chlamydia trachomatis as a cause of neonatal conjunctivitis in Dutch infants." Pediatrics **121**(2): e321-326.

Salisbury, C., J. Macleod, M. Egger, A. McCarthy, R. Patel, A. Holloway, F. Ibrahim, J. A. Sterne, P. Horner and N. Low (2006). "Opportunistic and systematic screening for chlamydia: a study of consultations by young adults in general practice." Br. J. Gen. Pract **56**(523): 99-103.

Schachter, J. (1999). Biology of Chlamydia trachomatis. Sexually Transmitter Diseases. K. K. Holmes New York, McGraw-Hill.

Scholes, D., A. Stergachis, F. E. Heidrich, H. Andrilla, K. K. Holmes and W. E. Stamm (1996). "Prevention of pelvic inflammatory disease by screening for cervical chlamydial infection." N Engl J Med **334**(21): 1362-1366.

Sharara, F. I., R. T. Scott, Jr., E. L. Marut and J. T. Queenan, Jr. (1996). "In-vitro fertilization outcome in women with hydrosalpinx." Hum Reprod **11**(3): 526-530.

Shaw, D., J. Saunders, J. Keal and S. Woodhall (2016). "O009 Evaluation of a pilot of internet requested Chlamydia test kits in 25 to 34 year olds." Sexually Transmitted Infections **92**(Suppl 1): A4-A4.

Sheringham, J. (2010). "Screening for Chlamydia." Bmj **340**: c1698.

Sheringham, J., P. Baraitser, I. Simms, G. Hart and R. Raine (2012). "Chlamydia screening in England: a qualitative study of the narrative behind the policy." BMC Public Health **12**: 317.

Sheringham, J., I. Simms, J. Riha, A. Talebi, L. Emmett, M. Macintosh and R. Raine (2011). "Will chlamydia screening reach young people in deprived areas in England? Baseline analysis of the English National Chlamydia Screening Programme delivery in 2008." Sex Transm Dis **38**(8): 677-684.

Sheringham, J., S. Sowden, M. Stafford, I. Simms and R. Raine (2009). "Monitoring inequalities in the National Chlamydia Screening Programme in England: added value of ACORN, a commercial geodemographic classification tool." Sex Health **6**(1): 57-62.

Shew, M. L., A. C. Ermel, B. A. Weaver, Y. Tong, W. Tu, L. M. Kester, C. Denski, J. D. Fortenberry and D. R. Brown (2013). "Association of Chlamydia trachomatis infection with redetection of human papillomavirus after apparent clearance." J Infect Dis **208**(9): 1416-1421.

Sile, B., S. C. Woodhall, S. Wetten, J. Ross, T. Williams, G. Hughes and K. Soldan (2014). How have PID rates changed during the era of chlamydia screening in England? Data from primary care and genitourinary medicine clinics, 2000-2012. CDC STD Prevention Conference. Atlanta, CDC.

Silva, J., F. Cerqueira and R. Medeiros (2013). "Chlamydia trachomatis infection: implications for HPV status and cervical cancer." Arch. Gynecol. Obstet.

Simms, I., A. Talebi, J. Rhia, P. Horner, R. S. French, R. Sarah and M. Macintosh (2009). "The English National Chlamydia Screening Programme: Variations in Positivity in 2007/2008." Sexually Transmitted Diseases **36**(8): 522-527.

Simms, I., A. Talebi, J. Rhia, P. Horner, R. S. French, R. Sarah and M. Macintosh (2009). "The English National Chlamydia Screening Programme: variations in positivity in 2007/2008." Sex Transm Dis **36**(8): 522-527.

Skidmore, S., P. Horner and H. Mallinson (2006). "Testing specimens for Chlamydia trachomatis." Sexually transmitted infections **82**(4): 272-275.

Sonnenberg, P., S. Clifton, S. Beddows, N. Field, K. Soldan, C. Tanton, C. H. Mercer, F. C. da Silva, S. Alexander, A. J. Copas, A. Phelps, B. Erens, P. Prah, W. Macdowall, K. Wellings, C. A. Ison and A. M. Johnson (2013). "Prevalence, risk factors, and uptake of interventions for sexually transmitted infections in Britain: findings from the National Surveys of Sexual Attitudes and Lifestyles (Natsal)." Lancet **382**(9907): 1795-1806.

Sonnenberg, P., C. A. Ison, S. Clifton, N. Field, C. Tanton, K. Soldan, S. Beddows, S. Alexander, R. Khanom, P. Saunders, A. J. Copas, K. Wellings, C. H. Mercer and A. M. Johnson (2015). "Epidemiology of Mycoplasma genitalium in British men and women aged 16-44 years: evidence from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3)." Int J Epidemiol **44**(6): 1982-1994.

St Lawrence, J. S., D. E. Montano, D. Kasprzyk, W. R. Phillips, K. Armstrong and J. S. Leichliter (2002). "STD screening, testing, case reporting, and clinical and partner notification practices: a national survey of US physicians." Am J Public Health **92**(11): 1784-1788.

Stamm, W. E. (1999). *Chlamydia trachomatis* infections in the adult. Sexually Transmitted Diseases. H. KK, P. F. Sparling, P.-A. Mardh et al. New York.

Stamm, W. E., M. E. Guinan, C. Johnson, T. Starcher, K. K. Holmes and W. M. McCormack (1984). "Effect of Treatment Regimens for Neisseria gonorrhoeae on Simultaneous Infection with Chlamydia trachomatis." New England Journal of Medicine **310**(9): 545-549.

Statistics, O. f. N. (2016). "Population Estimates for Lower Layer Super Output Areas in England and Wales by Single Year of Age and Sex, mid-2015."
from www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimates:.

Stephens, R. S. (2003). "The cellular paradigm of chlamydial pathogenesis." Trends in microbiology **11**(1): 44-51.

Sylvan, S. and B. Christenson (2008). "Increase in Chlamydia trachomatis infection in Sweden: time for new strategies." Arch Sex Behav **37**(3): 362-364.

Tanton, C., K. Soldan, S. Beddows, C. H. Mercer, J. Waller, N. Field, S. Clifton, A. J. Copas, K. Panwar, P. Manyenga, F. da Silva, K. Wellings, C. A. Ison, A. M. Johnson and P. Sonnenberg (2015). "High-Risk Human Papillomavirus (HPV) Infection and Cervical Cancer Prevention in Britain: Evidence of Differential Uptake of Interventions from a Probability Survey." Cancer Epidemiol Biomarkers Prev **24**(5): 842-853.

Taylor-Robinson, D., C. M. Stacey, J. S. Jensen, B. J. Thomas and P. E. Munday (2009). "Further observations, mainly serological, on a cohort of women with or without pelvic inflammatory disease." International Journal of STD AIDS **20**(10): 712-718.

Taylor-Robinson, D., C. M. Stacey, J. S. Jensen, B. J. Thomas and P. E. Munday (2009). "Further observations, mainly serological, on a cohort of women with or without pelvic inflammatory disease." Int J STD AIDS **20**(10): 712-718.

Thorne, C. (2011). UK National Screening Committee Policy Review Chlamydia screening in pregnancy: an evidence review.

TNS-BMRB (2010). COI on behalf of the Department of Health. 'Worth Talking About' Campaign evaluation 2010/2011. . D. o. Health. London.

Tong, A., P. Sainsbury and J. Craig (2007). "Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups." Int J Qual Health Care **19**(6): 349-357.

Town, K., A. Harb, E. Hollis, C. Lowndes, J. K. Dunbar and K. A. Folkard (2015). What is the distribution of chlamydia screening within general practices in England? Public Health England Applied Epidemiology Conference. P. H. England. Warwick.

Town, K., C. A. McNulty, E. J. Ricketts, T. Hartney, A. Nardone, K. A. Folkard, A. Charlett and J. K. Dunbar (2016). "Service evaluation of an educational intervention to improve sexual health services in primary care implemented using a step-wedge design: analysis of chlamydia testing and diagnosis rate changes." BMC Public Health **16**: 686.

Townshend, J. and H. Turner (2000). "Analysing the effectiveness of *Chlamydia* screening." Journal of the Operational Research Society **51**: 812-824.

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

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

Turner, K. M., P. J. Horner, L. Trela-Larsen, M. Sharp and M. May (2013). "Chlamydia screening, retesting and repeat diagnoses in Cornwall, UK 2003-2009." Sex Transm Infect **89**(1): 70-75.

UK National Screening Committee. (2011). "Screening for Chlamydia Infection in Pregnancy." Retrieved 13 January 2017, from legacyscreening.phe.org.uk/chlamydia-pregnancy.

van den Broek, I., C. J. Hoebe, J. E. van Bergen, E. E. Brouwers, E. M. de Feijter, J. S. Fennema, H. M. Gotz, R. H. Koekenbier, S. M. van Ravesteijn and E. L. de Coul (2010). "Evaluation design of a systematic, selective, internet-based, Chlamydia screening implementation in the Netherlands, 2008-2010: implications of first results for the analysis." BMC. Infect. Dis **10**: 89.

van den Broek, I. V., J. A. Land, J. E. van Bergen, S. A. Morre and M. A. van der Sande (2014). "Chlamydia trachomatis Antibody Testing in Vaginal Mucosal Material versus Blood Samples of Women Attending a Fertility Clinic and an STI Clinic." Obstet Gynecol Int **2014**: 601932.

van den Broek, I. V., J. E. van Bergen, E. E. Brouwers, J. S. Fennema, H. M. Gotz, C. J. Hoebe, R. H. Koekenbier, M. Kretzschmar, E. A. Over, B. V. Schmid, L. L. Pars, S. M. van Ravesteijn, M. A. van der Sande, G. A. de Wit, N. Low and E. L. Op de Coul (2012). "Effectiveness of yearly, register based screening for chlamydia in the Netherlands: controlled trial with randomised stepped wedge implementation." BMJ **345**: e4316.

Van Den Eeden, S. K., J. Shan, C. Bruce and M. Glasser (2005). "Ectopic pregnancy rate and treatment utilization in a large managed care organization." Obstet Gynecol **105**(5 Pt 1): 1052-1057.

van Valkengoed, I. G., S. A. Morre, A. J. van den Brule, C. J. Meijer, L. M. Bouter and A. J. Boeke (2004). "Overestimation of complication rates in evaluations of Chlamydia trachomatis screening programmes--implications for cost-effectiveness analyses." Int. J. Epidemiol **33**(2): 416-425.

Walker, J., S. N. Tabrizi, C. K. Fairley, M. Y. Chen, C. S. Bradshaw, J. Twin, N. Taylor, B. Donovan, J. M. Kaldor, K. McNamee, E. Urban, S. Walker, M. Currie, H. Birden, F. Bowden, J. Gunn, M. Pirotta, L. Gurrin, V. Harindra, S. M. Garland and J. S. Hocking (2012). "Chlamydia trachomatis incidence and re-infection among young women--behavioural and microbiological characteristics." PLoS. One **7**(5): e37778.

Walker, J., S. N. Tabrizi, C. K. Fairley, M. Y. Chen, C. S. Bradshaw, J. Twin, N. Taylor, B. Donovan, J. M. Kaldor, K. McNamee, E. Urban, S. Walker, M. Currie, H. Birden, F. Bowden, J. Gunn, M. Pirotta, L. Gurrin, V. Harindra, S. M. Garland and J. S. Hocking (2012). "*Chlamydia trachomatis* Incidence and Re-Infection among Young Women – Behavioural and Microbiological Characteristics." <u>PLoS ONE</u> **7**(5): e37778.

Wellings, K., K. G. Jones, C. H. Mercer, C. Tanton, S. Clifton, J. Datta, A. J. Copas, B. Erens, L. J. Gibson, W. Macdowall, P. Sonnenberg, A. Phelps and A. M. Johnson (2013). "The prevalence of unplanned pregnancy and associated factors in Britain: findings from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3)." <u>Lancet</u> **382**(9907): 1807-1816.

Welte, R., H. Jager and M. Postma (2001). "Cost effectiveness of screening for genital *Chlamydia trachomatis*." <u>Expert Review Pharmacoeconomics Outcomes Res</u> **1**(2): 145-156.

Welte, R., M. Kretzschmar, R. Leidl, A. Van den Hoek, J. Jager and M. Postma (2000). "Cost effectiveness of screening programmes for *Chlamydia trachomatis*." <u>Sexually Transmitted Diseases</u> **27**(9): 518.

Westrom, L. (1995). "Effect of pelvic inflammatory disease on fertility." <u>Venereology</u> **8**(4): 219-222.

Westrom, L., R. Joesoef, G. Reynolds, A. Hagdu and S. E. Thompson (1992). "Pelvic inflammatory disease and fertility. A cohort study of 1,844 women with laparoscopically verified disease and 657 control women with normal laparoscopic results." <u>Sex Transm Dis</u> **19**(4): 185-192.

Wills, G. S., P. J. Horner, R. Reynolds, A. M. Johnson, D. A. Muir, D. W. Brown, A. Winston, A. J. Broadbent, D. Parker and M. O. McClure (2009). "Pgp3 antibody Enzyme-Linked Immunosorbent Assay, a sensitive and specific assay for seroepidemiological analysis of Chlamydia trachomatis Infection." <u>Clinical and Vaccine Immunology</u> **16**(6): 835-843.

Wills, G. S., P. J. Horner, R. Reynolds, A. M. Johnson, D. A. Muir, D. W. Brown, A. Winston, A. J. Broadbent, D. Parker and M. O. McClure (2009). "Pgp3 antibody enzyme-linked immunosorbent assay, a sensitive and specific assay for seroepidemiological analysis of Chlamydia trachomatis infection." <u>Clin Vaccine Immunol</u> **16**(6): 835-843.

Wilson, J. M. G. and G. Jungner (1968). "Principles and practice of screening for disease." <u>Principles and practice of screening for disease.</u>(34).

Wolner-Hanssen, P. (1995). "Silent pelvic inflammatory disease: is it overstated?" <u>Obstet Gynecol</u> **86**(3): 321-325.

Woodhall, S. (2015). <u>Has opportunistic screening among young adults in England led to a reduction in Chlamydia trachomatis infection?</u>
<u>Identifying and appraising outcome measures for the evaluation of chlamydia control programmes.</u> PhD, University College London.

Woodhall, S. C., J. L. Atkins, K. Soldan, G. Hughes, A. Bone and O. N. Gill (2013). "Repeat genital Chlamydia trachomatis testing rates in young adults in England, 2010." <u>Sex Transm Infect</u> **89**(1): 51-56.

Woodhall, S. C., E. Hollis, N. Connor, K. Folkard and K. Dunbar (2016). "In support of a structured approach to service design and evaluation in chlamydia screening." <u>Sexually Transmitted Infections</u> **93**: 226-228.

Woodhall, S. C., P. Horner, K. Soldan, S. M. Vieira, G. S. Wills, R. Pebody, E. Stanford, G. Murphy, O. N. Gill and M. O. McClure (2013). <u>Seroepidemiology to evaluate chlamydia screening programmes: Results from two surveys of pgp3 antibody in residual stored serum samples in England. Poster presentation at the Joint Meeting of the 20th ISSTDR and 14th IUSTI Meeting</u>. Vienna.

Woodhall, S. C., T. Nichols, S. Alexander, F. C. da Silva, C. H. Mercer, C. Ison, O. N. Gill and K. Soldan (2015). "Can we use postal surveys with anonymous testing to monitor chlamydia

prevalence in young women in England? Pilot study incorporating randomised controlled trial of recruitment methods." Sex Transm Infect **91**(6): 412-414.

Woodhall, S. C., K. Soldan, P. Sonnenberg, C. H. Mercer, S. Clifton, P. Saunders, F. da Silva, S. Alexander, K. Wellings, C. Tanton, N. Field, A. J. Copas, C. A. Ison and A. M. Johnson (2015). "Is chlamydia screening and testing in Britain reaching young adults at risk of infection? Findings from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3)." Sex Transm Infect **92**(3): 218-227.

Woodhall, S. C., L. Torrone, D. Fine, S. G. Salomon, W. Nakatsukasa-Ono, K. Soldan and H. Weinstock (2015). "How do changes in the population tested for chlamydia over time affect observed trends in chlamydia positivity? Analysis of routinely collected data from young women tested for chlamydia in family planning clinics in the Pacific Northwest (USA), between 2003 and 2010." Sex Health **12**(6): 512-519.

Woodhall, S. C., G. S. Wills, P. J. Horner, R. Craig, J. S. Mindell, G. Murphy, M. O. McClure, K. Soldan, A. Nardone and A. M. Johnson (2017). "Chlamydia trachomatis Pgp3 Antibody Population Seroprevalence before and during an Era of Widespread Opportunistic Chlamydia Screening in England (1994-2012)." PLoS One **12**(1): e0152810.

Workowski, K. A. and S. Berman (2010). "Sexually transmitted diseases treatment guidelines, 2010." MMWR Recomm Rep **59**(Rr-12): 1-110.