Warwick Medical School

**Detection & Identification of Infectious Agents (DIIA)**
**Innovation Platform: Health Econometrics**

# ECONOMIC ANALYSIS REPORT

## Point of Care Tests for Sexually Transmitted Infections (STIs)

***Prepared by Division of Health Sciences, Warwick Medical School***
***for***
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# Detection & Identification of Infectious Agents (DIIA) Innovation Platform: Health Econometrics

## Area: Sexually Transmitted Infections (STIs)

# Introduction:

A number of clinical/disease areas have been prioritised by the Technology Strategy Board (TSB) and Department of Health (DH) for the DIIA Innovation Platform. To support commissioning of technology development for detection of sexually transmitted infections (STIs) in humans, a scoping review has been undertaken to help identify the specific requirements for new diagnostic test development and likely economic payback for point of care (POC) tests for STIs in the UK.

This report presents economic analysis findings for the following two STIs:

- Genital *Chlamydia trachomatis* (Chlamydia)
- Neisseria gonorrhoeae (*N gonorrhoeae*)

# Framework:

An evaluative framework was developed within which any new POC diagnostic technology could be considered. The final framework was agreed with the TSB and Department of Health. The study adopted a pre-defined methodology. The health economics team undertook literature reviews, evidence synthesis, and economic modelling/early-health technology assessment (HTA) of POC tests for each infection type. Independently, a scientific team examined the characteristics of existing laboratory tests for these infections and outlined the performance parameters required for an 'ideal' POC test. These ideal test parameters were then used in economic modelling, along with evidence from the literature review.

The health economic scoping study was based on two main elements: (i) **UK burden of illness:** estimation of national costs associated with each infection (including mortality, morbidity and treatment costs) and the cost of diagnosis and screening using current tests; (ii) **UK economic model:** POC testing scenarios were mapped against existing tests to estimate any clinical or cost consequences (on positives detected, false negatives/false positives reported, infections transmitted, and healthcare and mortality costs) and the likely impact of widespread POC test introduction was estimated. The main analysis focused on estimating incremental direct costs on moving from current tests to a new POC test. For different scenarios, the model estimated the total cost of resource use and the number of infections detected. Historical costs extracted from the literature were inflated to 2007/08 prices. A one-day workshop was held in which preliminary findings from the model were presented to national experts. The model was then further refined based on expert opinion and additional information provided by group members. The model excluded longer term impact on antibiotic resistance which is difficult to quantify robustly in monetary terms.

## 1.1 Introduction

Sexually transmitted infections (STIs) are a major global cause of acute illness, infertility, long-term disability and death, presenting significant medical, social, and economic problems.[1] An estimated 333 million new curable STIs occur every year among men and women aged 15 to 49 years worldwide.[2] The World Health Organization estimates that this figure includes 150 million *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections, the majority of which occur in developing countries.[3] If untreated, both these STIs can cause serious long term complications, especially those affecting the reproductive health of women.

Both infections also facilitate HIV transmission, a fact which is particularly important in the developing world.[4] Of the estimated 40,000 to 80,000 new HIV infections that occur each year, 5,052 or more could result from the facilitating effects of syphilis, chlamydia, gonorrhoea, and genital herpes on HIV transmission.[5] In urban Africa, it has been estimated that for each female *N gonorrhoeae* case prevented, 1.0 DHLY (discounted healthy life years) would be saved; and 1.3 DHLY for each Chlamydia case prevented.[6]

A syndromic approach to management of STIs has served as a major step towards improved management in developing countries.[7, 8] A recent study in Taiwan reports that syndromic management is cost-effective for male patients attending STD clinics with symptoms (urethral discharge symptoms and genital ulcers).[9] However, this approach does not address the issue of asymptomatic or subclinical STIs.[10, 11] In the western world, case management is therefore usually based on laboratory-confirmed diagnosis.[12] The economic analysis below therefore excludes any consideration of syndromic management.

## 1.2 Economic burden of disease

### 1.2.1 Genital *Chlamydia trachomatis* (Chlamydia): Economic burden of disease

***Chlamydia mortality:***
The peak age group for chlamydia infection is 16–19 years in women and 20–24 years in men.[13] However, there is a negligible longer-term risk of death, mainly associated with ectopic pregnancies and with increased HIV transmission. Therefore, for the purposes of this economic analysis, the **mortality cost associated with chlamydia is assumed to be zero.**

***Chlamydia morbidity:***
Chlamydial genital tract infections can cause a range of clinical disorder.[14] Since chlamydia is asymptomatic in 70-90% of cases many infections remain untreated.[15] Once diagnosed, the infection is easy to treat. Women sustain the most severe consequences of untreated infection, including pelvic inflammatory disease (PID), chronic pelvic pain, ectopic pregnancy, and tubal infertility. If undiagnosed, chlamydia leads to PID in 10-40% of cases, with infertility resulting in up to 20% of these women, and the risk of ectopic pregnancy greatly increases in others, although some researchers suggest these figures may overestimate the effect.[16] Associated disorders are less serious in men, principally limited to epididymitis.[17]

The national morbidity burden associated with undiagnosed chlamydia depends on the number of such cases in any one year. The prevalence of undiagnosed chlamydia is similar in men and women.[18] In 2007, the national screening programme in England screened 270,729 people (target group aged under 25 years); the positive rate was 9.3% (9.5% in women and 8.4% in men) identifying a total of 24,236 cases.[19] A further 121,986 UK diagnoses of genital *Chlamydia*

infections were made in GUM clinics (79,557 in people aged under 25 years). Thus, a total of ~146,300 chlamydia cases were diagnosed in 2007 in the UK.

The number of cases undiagnosed will depend on the underlying prevalence in the whole population. The British National Survey of Sexual Attitudes and Lifestyles 2000 found chlamydia in 2.2% of men and 1.5% of women aged 16–44 years.[20] Similar figures of 2.3% in men and 2.9% in women aged 15–40 year olds are reported in an Amsterdam study which sampled 4,560 patients from general practice lists.[21] A recent UK study found a higher prevalence of ~6% (5.0% in men and 7.2% in women) in 528 patients tested from GP practice lists.[22] A figure of 5% has been used for the UK in another study.[23] Applying a rate of ~6% to the population in England aged 16-25 (~5.62 million people) indicates a total figure of ~340,000 infections. The number diagnosed in this age group through screening in 2007 is only 43% of this figure. Thus, any estimate of national morbidity costs based on diagnosed cases alone is likely to undervalue the actual economic burden of chlamydia infection.

In terms of health related quality of life (HRQoL), the subclinical state of PID is reported to lead to no reduction (health utility = 1). Although there is a significant impact on women's health status due to ectopic pregnancy (0.58) and due to clinical PID (0.65), both are of a limited duration (2-6 weeks) so are also usually set to zero.[14] Similarly, although chronic pelvic pain (health state 0.6) can be of much longer duration, this is difficult to quantify accurately. For the purposes of the present economic analysis, the latter was also set at zero.

More problematic is the longer-term impact of infertility on women's HRQoL. In the US, there are roughly 1 million cases of PID each year leading to approximately 150,000 to 200,000 women becoming involuntarily infertile as a result of bilateral obstruction of the fallopian tubes. At least a quarter of such cases in the US can be attributed to chlamydial infection.[24] In the UK, the figure is thought to be probably nearer 50%.[25] Of women with infertility, only those with a pregnancy wish, who undergo *in vitro* fertilisation (IVF) treatment or have unsuccessfully undergone IVF treatment, are assumed to experience a decreased utility.[26]

Finally, if the infection is not treated it may be passed on to the newborn.[17] From 30% to 40% of infants born to mothers with untreated chlamydial infection during pregnancy will develop neonatal conjunctivitis, and up to 22% will develop pneumonia.[27, 28]

Because the impact of the various clinical consequences above of chlamydia infection could not be quantified in terms of HRQoL, it is not possible to estimate the number of QALYs lost.

**All the sequelae above were instead built into the economic model** in terms of their likelihood and the cost of treatment (see **section 1.5**). The model excluded any estimate of QALYs lost or of psychological morbidity due to infertility, though this may be considerable.

***Costs to society:***
In the UK, the annual cost to the tax payer of investigating and treating chlamydia and its complications is estimated at over £100 million.[29]

### 1.2.2 Neisseria gonorrhoeae: Economic burden of disease

***N gonorrhoeae mortality:***
There is similarly a negligible risk of death associated with *N gonorrhoeae* infections. The number of infections is also significantly lower than for chlamydia. Therefore, once again, the **mortality cost can be assumed to be zero.**

***N gonorrhoeae morbidity:***
As with chlamydia, gonorrhoea can cause a range of clinical disorder, primarily in women.[30] However, there is still considerable uncertainty about the natural history of acute gonococcal infection.[26] Infection is frequently asymptomatic in women, which can create a large pool of undetected infections. Women with untreated cases of gonorrhoea have a 16% probability of developing PID [31-33]; reported figures range from 10% to 40%.[30] PID once again leads to various disorders, including chronic pelvic pain, ectopic pregnancy, and tubal infertility. For men, associated disorders are less serious; they are largely limited to acute urethritis and epididymitis.[30]

If the infection is not treated in a pregnant woman it may be passed on to the newborn. Complications of untreated gonococcal infection in the neonate include conjunctivitis, ophthalmia, arthritis, and adverse pregnancy outcomes.[34]

In 2007, 18,710 cases of uncomplicated *N gonorrhoeae* were identified in UK GUM clinics.[19] The prevalence of gonorrhoea is far lower than for chlamydia, with figures of 1% (vs 6% for chlamydia) reported in US populations [35]; 1% prevalence has been used in economic modelling [33]; and figures of 0.1–2.8% are reported for asymptomatic young women.[36] Applying a conservative rate of 1% to the population in the UK aged 16-25 years (~6.6 million people) would indicate a total figure of 66,000 *N gonorrhoeae* infections in this age group. The total number diagnosed in 2007 is 28% of this figure, indicative of a larger proportion of undiagnosed infections than for chlamydia. If this is the case, a national morbidity cost based on diagnosed cases is likely to underestimate the full economic burden of this disease.

As with chlamydia, the impact of the various clinical consequences of *N gonorrhoeae* infections on HRQoL is not recorded. Therefore, it is not possible to estimate the number of QALYs lost. However, **all these sequelae are built into the economic cost model** (see **section 1.5**).

## 1.3 Cost of current treatment and control

### 1.3.1 Chlamydia: Cost of current treatment and control

***Chlamydia treatment:***
Once identified, treatment will encompass relief of symptoms, rapid eradication of *Chlamydia trachomatis*, and contacting sexual partners. Drug treatment is relatively inexpensive with a one-dose antibiotic treatment available, estimated at a total cost per case of £61-£65 in the UK.[17] Based on 146,300 detected chlamydia infections, annual drug costs (2007/08) are estimated to be **£8.92 - £9.51 million per annum**. (£1.48 - £1.58 million for cases identified through screening)

Management of chlamydia also requires that sexual health education is provided to promote risk reduction in future sexual behaviour.

***Chlamydia screening (national programme):***
Screening of asymptomatic female populations for chlamydia has been advocated by several authors.[37-41] Various studies have examined the cost-effectiveness of active and opportunistic screening in different populations [32, 42, 43] Research has demonstrated that several years after the introduction of a screening programme, there are reduced hospitalisation rates for ectopic pregnancy [44] and for PID [40] as well as a decrease in diagnosed chlamydia infections.[37, 40] The evidence indicates that age-selective screening is cost-effective when compared with no screening.[45] Most studies assess screening in a female population. A focus on screening women only assumes that partners will be picked up by partner notification programmes.[45] However, these programmes have been shown to reach only 50% to 60% of partners.[46] Also research indicates that asymptomatic chlamydia is as common in men as women.[47] Furthermore, although

opportunistic screening of women in Sweden was initially associated with a reduced prevalence, subsequent increases highlighted the need to screen men as well.[48]

Opportunistic screening has been piloted in the UK [49, 50] and the Netherlands [51], demonstrating that this approach is feasible and acceptable. In 2003, the House of Commons Health Committee report on sexual health recommended phased introduction of a national programme of opportunistic screening in men and women in England.[52] Screening was to be offered to everyone under 25 (men and women) attending selected health service settings, including family planning clinics, GUM clinics (individuals not normally receiving a sexual health screen), antenatal/ gynaecology clinics, military facilities, university medical practices, and general practices. The introduction of more sensitive nucleic acid amplification tests (NAATs) to replace lower sensitivity enzyme immunoassays was also recommended. The Department of Health pump primed the implementation of the programme, providing up to £150,000 to each locality in England for the first year, and full funding for years 2 and 3, after which all local programme costs were to be picked up by PCTs. Recently, Adams et al have cast doubt on the cost-effectiveness of opportunistic chlamydia screening as implemented in the English National Chlamydia Screening Programme.[17]

Various costs have been reported for chlamydia screening. The average cost per screening offer has been estimated at approximately £15 for negative screens and £38 for positives.[53] In 2007, 270,729 people were screened in England. Based on these figures, an **annual screening cost of £4.64 million** can be calculated for 2007. Other researchers have estimated a total cost per screening invitation of £20.37, (including NHS costs of £13.55 and average patient costs of £6.82); administrative costs accounted for 50% of the overall cost.[54] The same authors report that the cost of proactive chlamydia screening in the NHS is comparable to that of opportunistic screening. In another study, EIA testing for chlamydia is reported to cost £2.88 per sample.[55] For large scale testing of pregnant women for *Chlamydia trachomatis*, the use of pooled urine samples has been reported to reduce unit costs to 56% in the Netherlands without reducing performance.[56]

***Chlamydia diagnosis (GUM clinics):***
Some patients continue to present at GUM clinics for a diagnosis (i.e. not for sexual health screens). In 2007, a further 121,986 chlamydia cases were diagnosed in the UK through this route, the majority (79,557) in those aged 16-24. The reported prevalence in people presenting themselves for testing is 17.3%.[23] Applying this prevalence rate produces a total figure of 705,121 patients tested. This equates to an **annual diagnostic cost of £12.41 million** (once again assuming £15 for a negative test and £38 for a positive).

Based on the calculations above, the **annual cost for chlamydia testing in the UK is currently £17.05 million** for an estimated 975,800 people being tested (28% through the English national screening programme).

### 1.3.2 N gonorrhoeae: Cost of current treatment and control

***N gonorrhoeae treatment:***
The emergence of ciprofloxacin-resistant *N gonorrhoeae* strains in the USA has made treatment with cephalosporins such as ceftriaxone necessary in some cases.[57] In the UK, although it can be anticipated that resistance to penicillins, tetracyclines, and quinolones will all exceed 5%; actual treatment failures are rare because gonorrhoea treatment is frequently combined with a tetracycline or macrolide to manage possible co-incidental chlamydial infection.[58] Drug treatment for gonorrhoea involves a relatively inexpensive single dose estimated at £2.55 per person (drug cost only). [59] It has been suggested that routine dual therapy (treating for chlamydia without testing for this infection) could be cost-effective for populations in which chlamydial infection accompanies 20%–40% of gonococcal infections.[60]. This is because the cost of therapy for chlamydia is less than the cost of testing.

Based on 18,710 gonorrhoea cases in 2007 and a treatment cost (drug only) of £2.55, annual drug costs are estimated to be **£0.05 million per annum**.

***N gonorrhoeae screening:***
In the USA, gonorrhoea screening is being implemented in several areas, although no structured guidelines are yet in place. A recent study compared different screening strategies for gonorrhoea and concluded that no screening strategy was cost-saving.[30] However, at a 3% prevalence of gonorrhoea the most cost-effective screening strategy was to test women < 25 years with specific risk factors (i.e. pregnant, drug use, new sexual partner <30 days). Sensitivity analysis identified a threshold of 4.75% gonorrhoea prevalence above which this screening strategy would become cost-saving over not screening. The authors therefore recommended screening for women <25 years with specific risks in populations with a gonorrhoea prevalence of ≥4.75%. A cost-effectiveness analysis examining gonorrhoea screening in emergency departments has also found that point-of-care testing is significantly more cost-effective than urine based diagnostics, primarily because it improves the proportion of infected women treated.[26] Although selective screening seems to be cost-saving in high prevalence populations, such as emergency department patients, another analysis suggests that general population-based screening for gonorrhoea would not be cost-saving.[30]

A number of cost-effectiveness analyses have examined combining chlamydia and gonorrhoea testing.[61-63] In a study in an emergency department setting, screening women aged 18 to 31 years for *Chlamydia trachomatis* and gonorrhoea was reported to be cost-saving over not screening if the chlamydia prevalence exceeds ~6%.[61] Universal screening of women for chlamydia and gonorrhoea has also been found to be cost-saving in a detention setting.[64] However, a recent editorial has advised that gonorrhoea screening in women is not recommended unless chlamydia screening is already offered because chlamydia prevalence is higher than gonorrhoea in nearly all settings.[65]

There is no national gonorrhoea screening programme in the UK, and no policy of combined screening for *Chlamydia trachomatis* and *N gonorrhoeae*.

***N gonorrhoeae diagnosis (GUM clinics):***
The 2004 updated British Association of Sexual Health and HIV (BASHH)/ National guidelines on gonorrhoea include reference to detection of *N gonorrhoeae* by nucleic acid amplification tests (NAATs). [66] A NAAT testing cost of $US14 per test (2002 prices) is reported for urine and cervical specimens; this includes labour, consumables and equipment costs [26] A similar figure has been estimated for antibody tests (ELISA) at ~€7.8-8.4 (2004 prices) [67]. A lower figure is reported for culture tests at US$5 (2001 prices). [33].

Other patient management costs, including contacting and treating sexual partners and providing sexual health education, will be similar to those for chlamydia.[53]

18,710 gonorrhoea cases were diagnosed in GUM clinics in 2007, of which 50% (9,410) were in young people under 25 years old. Assuming a prevalence of 20%, in patients presenting at GUM clinics for testing (similar to that observed for chlamydia) would indicate at total figure of ~93,550 patients tested. This represents an **annual diagnostic cost of £1.83 million** (once again assuming £15 for a negative test and £38 for a positive).

## 1.5 Estimating the economic benefits which new tests could provide

### 1.5.1 Overview of economic analysis and model used

***Current testing scenarios (Table 1):***
**Table 1** presents an overview of the UK status quo for *Chlamydia trachomatis* and *N gonorrhoeae* testing. Comparative data are provided for the technical performance (sensitivity/specificity) of tests currently used; times to result; and the location of testing. The numbers of patients being tested annually is also estimated. For *Chlamydia trachomatis* population screening tests are distinguished from those identified by other means.

The final two columns in **Table 1** summarise the economic impact of each infection in the UK, as detailed in sections 1.2 and 1.3 above.

***New testing scenarios (Table 2):***
**Table 2** presents the characteristics of an 'ideal' new test for detecting these infections.

A costing model has been constructed in Excel to estimate the impact on national level costs of moving from the current status quo to implementation of one of the new tests. We also modelled various future scenarios.

***The economic model:***
A cost model was constructed in Excel to estimate the costs of screening, diagnosis and treatment of chlamydia and gonorrhoea infections, and the development and treatment of complications in undiagnosed cases (i.e. PID, infertility, ectopic pregnancy etc). In our analysis we focused on estimating incremental direct costs on moving from current tests to the proposed new test. For different scenarios, the model estimated the total cost of resource use and the number of infections detected.

***Data in the model:***
The model parameters were based on the highest level of evidence available from our review of the literature. An overview of the parameter values used is shown in **Table 3a**.

***Probabilities:***
For screened populations, our model used the prevalence rate of 9.3% for chlamydia in the national screening programme (higher than general population rates) [68] and 1.75% for gonorrhoea (based on incidence rate difference).

For GUM clinics (diagnostic) we used the reported rate of 17.5% for Chlamydia and an assumed rate of 20% for gonorrhoea.

Incidence rates used for the UK population were 800/100,000 for chlamydia [69] and 196/100 000 for 20–24 year old men and 133/100 000 for 16–19 year old women in 2005 for gonorrhoea.[70]

We hypothesised that false negatives (FN) would result in infection transmission as well as clinical complications. Thus, better test sensitivity will decrease the number of FN cases and lead to savings due to fewer infections as well as the associated cost of medical conditions caused by undetected chlamydia and gonorrhoea.

For chlamydia the infection transmission rate is reported at 40% (male-to-female, single exposure), and the female-to-male transmission rate has been estimated as 32%. Other investigators report similar transmission rates for both sexes. [71] For modelling we assumed a transmission rate of 0.4 for male-to-female and female-to-male.

For gonorrhoea the male-to-female transmission rate is 80% and the transmission rate from females to males is approximately 20%.[72] For modelling we assumed 0.5 transmission rate as the average of those stated above.

Currently there are more women screened for chlamydia than men. The number of men aged under 25 accessing screening has increased each year, from 7% in 2003/04 to 21.1% in 2006/07. [73]. For modelling purposes we used a figure of 21% to account for the older age groups undergoing diagnostic testing in GUM clinics. For gonorrhoea, we assumed 25% of those tested are male.

More than 60% of newborns who deliver through a chlamydia-infected cervix will acquire the infection.[71] We used a figure of 60%.

In people diagnosed with gonorrhoea, co-infection with chlamydia is reported in 10–40% cases in the USA and UK; in people diagnosed with chlamydia, co-infection with gonorrhoea is reported in 20-40% overall.[70]

***Population tested:***
For *Chlamydia trachomatis* and *N gonorrhoeae* testing we estimated the economic benefit of replacing current tests with the new test in the current setting.

We estimated the economic benefit if a new combined test were used to detect gonorrhoea and chlamydia in all samples tested. We tested the sensitivity of the economic impact by varying the assumed testing throughput for chlamydia in the range 1 million – 5 million samples per annum, and for gonorrhoea in the range 100,000 – 1 million samples. The lower figures approximate to the current situation for both infections. For chlamydia, it was assumed that the additional 1-4 million samples tested (above the current 1 million) would exhibit a similar prevalence of *Chlamydia trachomatis* as screened samples (9.3%).

***Costs:***
For each testing scenario, we estimated the number of cases of untreated infection and subsequent sequelae in women and men, episodes of transmission to sexual partners, congenital infections prevented, as well as prevention costs, as the outcomes considered in this economic analysis. The sequelae and probabilities of outcomes from an untreated infection were derived from the literature and are shown in **Table 3b**. Published reports show the probability of PID ranges from 10% to 40%. We assumed a 25% probability of PID in our base case analysis for chlamydia, and 16% for gonorrhoea.[23, 33] For long-term sequelae, we included the probabilities of ectopic pregnancy and tubal infertility; chronic pelvic pain was excluded in this simple model. Additionally, we included the cost of transmission of infection to a male sexual partner, with subsequent epididymitis; urethritis costs are small and were excluded. For women, we also included impact on neonatal outcomes.

The cost of treatment of infection, PID, tubal infertility, and ectopic pregnancy were apportioned to untreated infections among women. Treatment costs for men were similarly apportioned. Ectopic pregnancies and tubal infertility are expected to occur in the future, so their cost was discounted. An amount was added to the basic drug cost of treatment for gonorrhoea to produce a total cost of £52.

Indirect and intangible costs associated with PID, including lost time from school and work, pain, anxiety, and the profound sense of loss due to infertility, were not included in the analysis. Thus, the costs cited in **Table 3b** are an underestimate when one considers the subsequent physiological sequelae and psychological morbidity.

The total predicted annual cost savings in **Table 2** were derived from incidence of complications and their estimated cost. Outcome of infection and associated costs were applied to the annual testing throughputs and cohorts of men and women described above.

### 1.5.2 Economic conclusions

**Table 4** shows that, if the new Point of Care test replaces current EIA testing in the manner described (at no increase to unit test cost), there is a predicted cost saving based on improved test performance for chlamydia and gonorrhoeae tests.

At current testing levels (Minimum scenario), the annual financial benefit predicted with the new test is a saving of £13.9 million (assuming no increase in unit test cost); £12.9 million for chlamydia and ~£1 million for gonorrhoeae. Under this scenario, which most closely approximates the current status quo, moving to the new test would detect an additional 37,500 (35% increase) chlamydia infections and 1,600 (9% increase) gonorrhoea.

The national saving at the higher throughput (Maximum scenario) is greater. A predicted saving of £47.2 million per annum; more sizeable for chlamydia (annual savings of £41.8 million) and smaller for gonorrhoea (annual saving of £5.4 million). In addition, 133,250 more chlamydia infections will be detected and 16,000 gonorrhoea.

The economic benefits above are modelled based primarily on the change in test sensitivity and specificity. Although the new test also offers a shorter turn-around time, we could not identify any data to enable us to model a decrease in time to result from 15 minutes to 5 minutes; we have therefore assumed that this would not produce a significant impact on treatment and final outcome costs.

***Emerging technologies:***
A **chlamydia rapid test** developed by the Diagnostics Development Unit at Cambridge University was recently reported in the BMJ. Compared with PCR, the sensitivity and specificity were 83.5% and 98.9% respectively.[74] Since this is not currently commercially available it was not included in current test figures for economic analysis.

A **chlamydia home testing kit**, promising next-day results, is also being marketed direct to women by companies provided in **Table 5**. Since our new test scenarios exclude self-testing, this possibility has not included in the present economic model. Large scale self-testing might impact on the national chlamydia screening programme, decreasing the number of people currently accessing this. But it is more likely not to impact on this group but to increase testing in other hard to reach groups who currently do not wish to make use of NHS services for this purpose.

# STIs: ECONOMIC TABLES

## TABLE 1: Overview and summary of current tests for genital *Chlamydia trachomatis* and *Neisseria gonorrhoeae*

| Clinical context | Current UK test context | | Current tests used | | | Current test capability | | Current economic impact | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of UK patients tested annually | Settings where tests undertaken | Type of tests used | Test process | Type of specimen | Time to perform test/result | Sensitivity/ Specificity | Annual Testing Cost | Annual Burden of Disease[1] |
| Chlamydia/ Gonorrhoeae | N/A | Laboratory | Nucleic acid amplification test (NAAT) Predominant test used | One step | Urine, endocervical | ~ 3h | ~95/98 | N/A | N/A |
| Chlamydia Screening | 270,730 | POC | EIA | One step | Urine | ~15 mins | ~70/95[2] | £4.64 million | Treatment: £1.48 - £1.58 million |
| Chlamydia Detection | 705,120 | POC | EIA | One step | Urine | ~15 mins | ~70/95 | £12.41 million | Treatment: £7.44 - £7.93 million |
| | | | | | | | | **Total: £17.05 million** | **Total: £8.92-£9.51 million** |
| | | | | | | | | **GRAND TOTAL = £26.0 – £26.6 million** | |
| Gonorrhoeae Detection | 93,550 | POC | EIA | One step | Endocervical, urine | ~15 mins | ~87/~87 | £1.83 million | Treatment: £0.05 million |
| | | | | | | | | **GRAND TOTAL = £1.88 million** | |

[1] Mortality costs assumed to be negligible.

[2] An assessment of a Chlamydia rapid test (currently not commercially available) developed by the Diagnostics Development Unit at Cambridge University was recently reported in the BMJ. Compared with PCR, the reported sensitivity/ specificity of this test is 83.5/ 98.9 respectively.[74]

## TABLE 2: Predicted likely economic benefits of new test for Genital chlamydia trachomatis and Neisseria gonorrhoeae

| | Main driver(s) for technology development | New test UK role | Target population/ sub-population | | Ideal new test requirement | | | | Predicted economics of new test | | Main driver for technology implementation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Target population to be tested | Number of UK patients | Time to result | Sensitivity / Specificity | Setting for test | Test process | Break-even Test Cost | Annual Cost saving[1] [Additional cases detected] | |
| Genital chlamydial and gonorrhoeae infections | Currently POC tests have a lower sens & spec than lab tests. Decrease time to result POC tests. Decrease in cost POC. | Detection and screening | Symptomatic patients/ contact tracing. UK screening programme high risk populations (i.e. women and men aged 16-24) | 1 million (Chlamydia)<br>100,000 (Gonorrhoeae) | < 5 mins | 95/95 | Point of care | Urine | £29.7[2] | £13.9 million [39,100] | Cost saving and more cases detected |

[1] Base case assumes ~1 million people enter system for chlamydia testing (28% through the national screening programme); and 100,000 for gonorrhoeae testing.

[2] Ratio of: [Current total spend on diagnosis (£18.8 m) + predicted savings due to improved test performance (£13.9 m)]/ Number of tests performed (1.1 million).

**Aims for new diagnostic tests**

- Identify infected patients and intiate treatment
- Use for screening of contacts to interupt transmission in non-symptomatic patients
- Avoid unnecessary and inappropriate antimicrobial therapy

**Requirements for new tests**

- Simple high throughput test or "pregnancy style" diffusion test
- <5 mins
- Sensitive and specific for *Neisseria gonorrhoeae* and /or *Chlamydia trachomatis*
- Available at the point of care
- Requires less technical expertise
- Allows testing using an easily obtainable sample

## TABLE 3a: Overview and variables used in economic model for genital *Chlamydia trachomatis* and *Neisseria gonorrhoeae*

| Variable | Base case value | Source/ Reference |
|---|---|---|
| Prevalence of | | |
| *Chlamydia trachomatis* infection | 800/100,000 | [69] |
| *Neisseria gonorrhoeae* infection | 133-196/100,000 | [70] |
| *C trachomatis* infection among patients with gonococcal infection | 10-40% | [70] |
| Sensitivity of test for | | |
| *C trachomatis* (EIA) | 0.70 | Table 2 |
| Specificity of test for | | |
| *C trachomatis* (EIA) | 0.95 | Table 2 |
| Sensitivity of test for | | |
| *N gonorrhoeae* (EIA) | 0.87 | Table 2 |
| Specificity of test for | | |
| *N gonorrhoeae* (EIA) | 0.87 | Table 2 |
| % of Men tested | | |
| *C trachomatis* | 21% | [73] |
| *N Gonorrhoeae* | 45% | Assumed |
| Transmission of *C trachomatis* infection | 40% | [71] |
| Transmission of *N gonorrhoeae* | 50% | [72] |
| Transmission of *infection to newborn* | 60% | [71] |
| **Cost of test for** | | |
| *C trachomatis* (EIA) | 2.88 | [55] |
| *N gonorrhoeae* (EIA) | similar | |
| Cost of treatment (drug cost only)against | | |
| *C trachomatis* (azithromycin) | £8.96 | [59] |
| *C trachomatis* (doxycycline) | £2.01 | [59] |
| *N gonorrhoeae* (ceftriaxone) | £2.55 | [59] |
| *N gonorrhoeae* (cefixime) | £3.78 | [59] |

**TABLE 3b: Overview of frequency and cost of complications for undetected genital *Chlamydia trachomatis* and *Neisseria gonorrhoeae***

| | ***Rates*** | | ***Unit cost (£) [17]*** |
|---|---|---|---|
| | ***Chlamydia*** | ***Gonorrhoeae*** | |
| ***Men*** | | | |
| Epididymitis | 2% [17] | 1%[69] | 142 |
| ***Women*** | | | |
| PID | 25% [26] | 16% [69] | 137 |
| ***Women with PID*** | | | |
| Ectopic preg | 7.6% [17] | Similar rates | 762 |
| Infertility | 10.8% [17] | Similar rates | 10,798 |
| ***Newborns from PID women*** | | | |
| Conjunctivitis | 14.7% [17] | Similar rates | 41 |
| Pneumonia | 7% [17] | Similar rates | 612 |

**TABLE 4: Annual savings which can be made following a move from current testing to the new combined test**

| Number Screened | Testing For | PID probability | Combined PoC Test Savings |
|---|---|---|---|
| ***Min Scenario*** | | | |
| 1,000,000 | Chlamydia | 25% | £12,924,268 |
| 100,000 | Gonorrhoea | 16% | £948,874 |
| **Total** | | | **£13,873,142** |
| ***Max Scenario*** | | | |
| 5,000,000 | Chlamydia | 25% | £41,806,587 |
| 1,000,000 | Gonorrhoea | 16% | £5,392,744 |
| **Total** | | | **£47,199,331** |

## TABLE 5: Home Testing Kits[1] for STIs

| ***Provider*** | ***Tests*** | ***Cost*** | ***Service type*** |
|---|---|---|---|
| *Boots* | *Chlamydia Test Kit* | *£24.47* | *Treatment through NHS or can be purchased at Boots*<br><br>*[http://www.boots.com]* |
| *Most Pharmacies* | *Clamelle Chlamydia Test Kit* | *£24.47* | *Treatment through NHS or participating pharmacies (must be purchased as it is not provided for free by Clamelle)*<br><br>*[http://www.clamelle.co.uk/]* |
| *Lloyds Pharmacy* | *Chlamydia home testing kit* | *£30.00* | *Free treatment if positive*<br><br>*[http://onlinedoctor.lloydspharmacy.com/]* |
| | Chlamydia and gonorrhoea test - | *£47.99* | *Free treatment if positive* |
| *Freetestme* | *Chlamydia test* | *Free* | *Free Chlamydia postal testing to 15 - 24 years olds. Free treatment is positive*<br><br>*[http://freetest.me.uk/]* |
| *STI Clinic* | *Chlamydia test* | *£29.95* | *Free treatment if positive*<br><br>*[http://www.thesticlinic.com/]* |
| | *Gonorrhoea test* | *£29.95* | *Free treatment if positive* |
| | *Chlamydia/Gonorrhoea Combination test* | *£39.95* | *Free treatment if positive* |
| | ***Full STI Screen*** *Chlamydia, Gonorrhoea, Herpes, Mycoplasma Genitalium, Ureaplasma Urealyticum/Parvum, Trichomonas Vaginalis, Gardnerella/Bacterial Vaginosis* | *£139.95* | *Free treatment if positive* |

[1] All services are confidential.

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