Cost effectiveness of home based population screening for *Chlamydia trachomatis* in the UK: economic evaluation of chlamydia screening studies (ClaSS) project

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ABSTRACT

Objective To investigate the cost effectiveness of screening for *Chlamydia trachomatis* compared with a policy of no organised screening in the United Kingdom.

Design Economic evaluation using a transmission dynamic mathematical model.

Setting Central and southwest England.

Participants Hypothetical population of 50 000 men and women, in which all those aged 16-24 years were invited to be screened each year.

Main outcome measures Cost effectiveness based on major outcomes averted, defined as pelvic inflammatory disease, ectopic pregnancy, infertility, or neonatal complications.

Results The incremental cost per major outcome averted for a programme of screening women only (assuming eight years of screening) was £22 300 (€33 000; $45 000) compared with no organised screening. For a programme screening both men and women, the incremental cost effectiveness ratio was approximately £28 900. Pelvic inflammatory disease leading to hospital admission was the most frequently averted major outcome. The model was highly sensitive to the incidence of major outcomes and to uptake of screening. When both were increased the cost effectiveness ratio fell to £6200 per major outcome averted for screening women only.

Conclusions Proactive register based screening for chlamydia is not cost effective if the uptake of screening and incidence of complications are based on contemporary empirical studies, which show lower rates than commonly assumed. These data are relevant to discussions about the cost effectiveness of the opportunistic model of chlamydia screening being introduced in England.

INTRODUCTION

Chlamydia trachomatis is the most commonly reported sexually transmissible infection in developed countries. The asymptomatic nature of the disease means that treatment is often delayed, leading to an increased risk of complications and transmission to partners. Complications in women include pelvic inflammatory disease, ectopic pregnancy, and infertility, along with neonatal complications in their children.[1]

Most published economic evaluations have suggested that screening for chlamydia is cost effective.[2] The validity of this conclusion has been questioned by a systematic review showing that all but two of the evaluations used static decision analytic models.[3 4] These models do not incorporate the dynamic effects of transmission of infectious diseases and can produce misleading results. Whether opportunistic screening approaches can control transmission of *C trachomatis* in the long term is also debated.[5] An alternative approach is to use population registers to proactively invite young adults to be screened.[1 6] Here we report the results of an economic evaluation comparing proactive register based screening with a policy of no organised screening.

METHODS

The evaluation was a cost effectiveness analysis based on "major outcome averted," which we defined as the occurrence of at least one episode of pelvic inflammatory disease leading to hospital admission, ectopic pregnancy, infertility, or neonatal complications due to chlamydia. We used a modelling approach because of the time lag between implementation and the realisation of any future benefits of chlamydia screening.

The chlamydia screening studies (ClaSS) project in the United Kingdom collected empirical data. Screening was offered proactively to women and men identified from patient registers of 27 general practices in Bristol and Birmingham. Participants collected specimens at home and mailed these to a laboratory.

We developed a new transmission dynamic simulation model.[1] The initial population was 50 000 virtual people aged between 12 and 62. We ran the model 40 times against the scenario of no organised screening for a total of 15 000 (simulated) days each time. We parameterised the model by using empirical data collected in one of the four components of the chlamydia screening studies project.[1 6-8] We used representative data from national studies where necessary.[9] We based incidence rates of long term complications associated with chlamydia on data from the Uppsala women's cohort study.[10]

We based the main inputs relating to transmission and progression of chlamydia on those in the original models.[11 12] We incorporated the probability estimates for pelvic inflammatory disease, ectopic pregnancy, and infertility into the model dynamically and independently. We used empirical data from the chlamydia screening studies project and from other sources to provide values for the number of partners, the frequency of changes of partner, and changes in these parameters by age.[1 6 13] We did not directly enter critical parameters such as population prevalence of chlamydia by age but made adjustments until the model reproduced the observed prevalence pattern.

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We prospectively collected primary data on costs and resource use. We used the costs of running the chlamydia screening studies project as a proxy for National Health Service costs of running a population screening programme.[8]

Analysis

In the base case analysis we compared proactive population screening with no organised screening but assumed that some background chlamydia testing would occur. We assumed that screening was offered annually for people aged 16-24 years.

We based the evaluation on three comparisons: screening women only versus no organised screening; screening men and women versus no organised screening; and screening men and women versus screening women only. No robust information exists for quality adjusted life years (QALYs) relevant to the sequelae associated with chlamydia. We therefore present our results as incremental cost effectiveness ratios in terms of the cost per additional major outcome averted by proactive population screening compared with a policy of no organised screening. We carried out a sensitivity analysis, in which the perspective was widened to represent a societal perspective.

RESULTS

The cost per screening invitation was estimated to be £14.65 (€21.69; $29.54).[18] The baseline results suggest that, after the introduction of home based postal screening, the prevalence of chlamydia would drop to a new equilibrium value, particularly in the younger age groups in whom prevalence was higher. The figure presents the impact of screening on the individual outcomes over time. Pelvic inflammatory disease and neonatal complications were by far the most frequent outcomes.

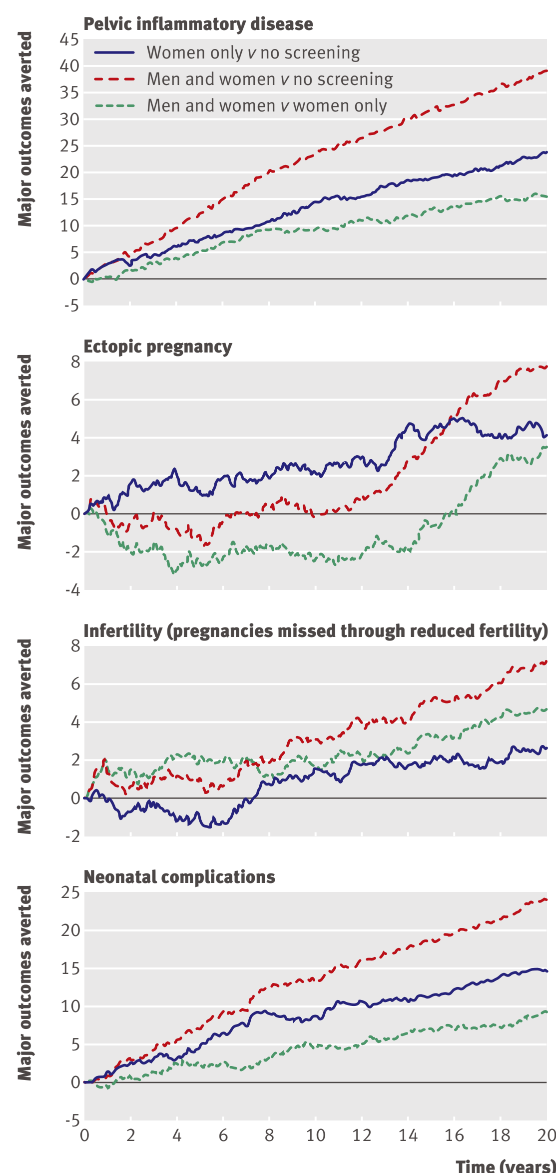
The table presents the results of screening under different scenarios up to eight years after the introduction of an annual invitation to be screened. In the base case (see bmj.com), the incremental cost effectiveness ratio per major outcome averted for screening men and women, compared with no organised screening, after eight years, was approximately £28 900. It was less costly to screen women only but also less effective, and the incremental cost effectiveness ratio per major outcome averted was approximately £22 300.

In the sensitivity analysis when the response rate for men and women was equated to that found for women only, the incremental cost effectiveness ratio for screening men and women improved. Decreasing the screening interval to six months led to less favourable ratios. Two yearly screening gave a slightly lower incremental cost effectiveness ratio. Including the person's private costs of screening, to adopt a societal perspective, increased the incremental cost effectiveness ratio for screening men and women to £41 300 per major outcome averted compared with no screening.

The assumptions surrounding the probability of developing pelvic inflammatory disease had the biggest single impact on the incremental cost effectiveness ratio. The cost applied to pelvic inflammatory disease in the base case was that for an episode needing inpatient treatment. When we used an estimated probability for developing pelvic inflammatory disease of 25%,[12] and assumed that all cases were admitted to hospital, the incremental cost effectiveness ratio fell by almost half to £10 200 per major outcome averted (table). The unit costs associated with other sequelae had to increase substantially to have a noticeable effect on the incremental cost effectiveness ratios.

DISCUSSION

The results of this economic evaluation suggest that proactively offered register based screening for *C trachomatis* with home collected specimens is an



Episodes of major outcomes averted by screening. In each diagram, cumulative outcomes refer only to those incurred up to given time for total simulated population (25 000 women initially, together with new female entrants as model was running)

expensive intervention, on the basis of levels of uptake achieved in our cross sectional survey and assuming that the incidence of chlamydia associated complications is lower than previously believed. We draw this conclusion from the incremental cost effectiveness ratios based on major outcomes averted, in which pelvic inflammatory disease is the most commonly avoided outcome.

Strengths and limitations

The main strength of our study is that we collected cost data prospectively alongside a series of empirical epidemiological and laboratory studies and used these in a dynamic mathematical model that gave the closest approximation to the real sexual behaviour of the population. The limitations of the study include the complexity of the model and the fact that the results are based on a single set of assumptions about mixing of partners and background rates of opportunistic screening. This scenario is consistent with empirical data, however, as the model was able to recapture the prevalence by age group observed in the chlamydia screening studies project. The large number of replications and the size of the hypothetical population also support the robustness of the model and the results.

Comparison with other studies

The structure and dynamics of our model are comparable to those on which the evaluation of the English national chlamydia screening programme is based.[14 15] The assumptions about duration of infection, transmission, and symptoms have also been used to evaluate both proactive and opportunistic screening approaches in other studies.[11 12 16 17] The sensitivities and specificities of the tests obtained from laboratory based studies in the chlamydia screening studies project were higher than those reported by a recent meta-analysis.[18] This would improve the cost effectiveness of our screening intervention.

Our results contrast with the very low reported incremental cost effectiveness ratios per major outcome averted that have often been found in studies using static decision models.[4] The different results between static and dynamic models of chlamydia screening have been reported.[19] Three evaluations based on a similar dynamic model to ours found opportunistic and proactive screening to be cost effective.[12 15 16] Two principal factors contribute to the differences in these results.

Firstly, the incidences of long term outcomes used in our model were based on population based cohort data from Sweden,[10] which observed a lower incidence of complications than the clinic based estimates used by other studies.[12 15-17] The most recent economic evaluation, which used an individual based dynamic model to examine the opportunistic screening used in the national chlamydia screening programme in England, showed that screening was not cost effective when the incidence of pelvic inflammatory disease was less than 10%.[15] In the base case, we included only severe pelvic inflammatory disease leading to hospital admission, because this was the most costly.

Summary of incremental cost effectiveness ratios after eight years

Scenario	Incremental cost effectiveness ratios (£/MOA): Women only *v* no screening	Men and women *v* no screening	Men and women *v* women only
Base case*, outcomes discounted at 3.5% (NICE)	22 300	28 900	41 300
Equal response rate 39%	22 300	25 200	28 900
Response 60% women, 40% men	18 200	22 400	29 300
Six monthly screening	29 800	34 200	40 400
Two yearly screening	19 600	27 100	44 000
Base case, outcomes discounted at 1.5% (UK Treasury)	20 600	26 600	37 900
Base case, outcomes not discounted	19 300	24 900	35 400
Incidence of PID=0.25, equivalent to Welte et al[12]	10 200	12 200	15 200
PID 25%; response rate 60% women, 40% men	6 200	9 400	17 000
Including private patient costs of attending for screening†	31 800	41 300	59 300
Adjustment in unit costs applied to sequelae			
PID £30 (based on outpatient visit and course of antibiotics)†	23 700	33 600	43 600
PID £30, infertility £3014 (based on intensive inpatient IVF treatment)†	23 600	30 500	43 400
PID and infertility £3014†	22 200	28 800	41 100
Omit complication costs†	24 300	31 200	44 100
All complications £3014†	21 100	27 300	39 000
All complications £6028†	17 900	23 400	33 800
Incidence equivalent to Welte, PID cost average £328‡	12 000	14 100	17 200

IVF=in vitro fertilisation; MOA=major outcome averted; NICE=National Institute for Health and Clinical Excellence; PID=pelvic inflammatory disease.
All results presented from perspective of NHS, with exception of "Including private patient costs of attending for screening."
*Base case response rate=39% women, 29% men.
†All other parameters as base case.
‡Assumes 10% of cases are severe and cost £3014 each, other 90% of cases cost £30 each.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Most published economic evaluations that have shown chlamydia screening to be cost effective have used static models that are inappropriate for evaluating an infectious disease

WHAT THIS STUDY ADDS

Proactively organised register based chlamydia screening using home collected specimens is not cost effective if the uptake of screening and the incidence of complications are lower than generally assumed

The cost effectiveness estimates were sensitive to assumptions about the incidence of major outcomes and uptake of screening but not to reasonable variation in the associated costs alone

Secondly, the screening uptake rate used by other studies is typically higher than we found in the chlamydia screening studies project. One recent study used a combined uptake rate in men and women of 48%.[16] We showed that a scenario that assumed a similar uptake and a high incidence of pelvic inflammatory disease had a much more favourable incremental cost effectiveness ratio of £6200 per major outcome averted.

Meaning of the study

The base case incremental cost effectiveness ratio suggests that screening women only, compared with no active screening, costs an additional £22 300 per major outcome averted. If we compare our incremental cost effectiveness ratio with the suggested threshold of £30 000 per QALY gained, for proactive screening to be considered cost effective the value for each case of pelvic inflammatory disease avoided would have to be more than 0.74 of a QALY. In other words, having pelvic inflammatory disease would have to be considered equivalent to being in a state equal to death for almost nine months.

Implications for research and policy

Our model could be further refined to explore the importance of differential uptake of chlamydia screening and re-screening according to factors including socioeconomic deprivation and sexual behaviour.

The programme costs of a proactive register based approach described in this study were similar to those estimated for opportunistic screening.[1 8 15 20] Future research should focus on rigorous evaluation of the relative effectiveness and cost effectiveness of alternative strategies to improve the uptake and regularity of chlamydia screening. More reliable data about the long term sequelae associated with chlamydia are also needed to reduce the uncertainty associated with this parameter in future modelling studies. Our evaluation of proactive population chlamydia screening, using a dynamic model incorporating realistic estimates of partner notification, the uptake of screening, and the incidence of severe complications, has shown it to be an expensive intervention that probably does not represent good value for money.

Participating individuals and institutions can be viewed at www.chlamydia.ac.uk.

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