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

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Objective The aims of this study were to determine cost effectiveness of screening for *Chlamydia trachomatis* in hospital-based antenatal and gynaecology clinics, and community-based family planning clinics. Additionally, women's views of screening were determined in the hospital-based clinics.

Design Cost effectiveness based on decision model. Model probabilities were generated for a hypothetical sample of 250 women in each age group in each setting, based on prevalence studies, published data and expert opinion. A prospective observational study was used to generate data on prevalence and acceptability.

Setting Antenatal, gynaecology and family planning clinics in Aberdeen, Edinburgh and Glasgow.

Sample Prevalence was estimated in 2817 women. Acceptability was determined in 484 women.

Methods An economic evaluation was performed using prevalence data from this and a previous study, and using outcome data from the literature and observational work. Incremental cost effectiveness ratios were estimated for each age group and clinical setting. Sensitivity analyses were performed to determine the robustness of incremental cost effectiveness ratios to changes in the incidence of long term sequelae and costs. The prevalence of infection was determined by nucleic acid amplification of urine samples or endocervical swabs. Knowledge of *C. trachomatis* and women's views of screening were determined using structured questionnaires.

Main outcome measures Direct health service costs of screening, incidence and costs associated with adverse sequelae, women's views of screening and prevalence of infection.

Results The estimated cost of screening 250 women in each age group in each the four sample populations (total population of 3750) is £49,367, while preventing 64 major sequelae. This represents a net cost of £771.36 in preventing one major sequela. Selective screening of all women under 20 years and all patients attending abortion clinics were shown to be the most cost effective strategies. These results were relatively insensitive to changes in estimated parameters, such as uptake rate, probabilities and unit costs of all major sequlae averted. Prevalence (95% CI) of infection in the highest risk groups (those aged under 20 in both antenatal and abortion clinics) was 12.1% (8.6–16.7) and 12.7% (7.3–21.2), respectively. The majority (>95%) of women agreed with a policy of regular screening for *C. trachomatis*, and screening in the settings employed in this study was largely acceptable.

Conclusions A single episode of screening for *C. trachomatis* does not result in net cost savings. Currently recommended strategies of screening for *C. trachomatis* in women under 25 years of age in abortion clinics are supported by our data on prevalence and acceptability. These data also suggest that hospital-based screening strategies should be further extended to include younger women attending antenatal clinics and all women of reproductive age attending colposcopy clinics.

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INTRODUCTION

Chlamydia trachomatis is the most common bacterial sexually transmitted disease in the developed world and is now a major public health problem.[1] The annual UK health service costs of treating the complications of *C. trachomatis* are estimated to be greater than £100 million. Screening and appropriate treatment of *C. trachomatis* in asymptomatic women has been shown significantly to reduce the risk of developing pelvic inflammatory disease.[2,3] A strategy of screening asymptomatic women has been suggested by the Chief Medical Officer's Expert Advisory Group (UK), the Scottish Intercollegiate Guideline Network (Scotland), the Centers for Disease Control (USA) and the Canadian Task Force on Periodic Health Examination.[4–7] Each of these protocols aims to target those most at risk of ascending infection.

Cost effectiveness analyses of opportunistic screening of patients attending healthcare clinics, or specific high risk groups, have been shown to be cost effective at prevalences between 2% and 6%.[8–10] Evidence from the current literature suggested that there are only a few situations where screening would not be cost effective. However, the economic impact of selective screening of different age groups and risk factors is still unclear. There is a lack of detailed information on the prevalence of *C. trachomatis*, particularly in low risk asymptomatic women attending clinics in hospital-based settings, on which to analyse cost effectiveness. Additionally, the acceptability of screening for *C. trachomatis* (crucial for an effective screening programme) has not been studied in detail.[11,12] The purpose of this study was to model the cost effectiveness of screening women in different age groups and healthcare settings compared with no screening, from the perspective of the National Health Service (NHS) in Scotland. We also sought to add to the information required to deliver an effective and efficient screening programme in antenatal and gynaecology clinics by determining prevalence of *C. trachomatis* using nucleic amplification techniques in three settings where screening has been recommended: antenatal, colposcopy and abortion clinics. Additionally, we determined women's knowledge and views of screening for *C. trachomatis*.

METHODS

Women were recruited from those attending antenatal, colposcopy and abortion clinics at each of Aberdeen Royal Infirmary and Glasgow Royal Infirmary/Glasgow Royal Maternity/Princess Royal Maternity Hospitals between February 2001 and July 2002. Subjects were recruited into four age cohorts: up to 20 years, 20–24 years, 25–29 years and 30 years and above. The study was approved by each of the local research ethics committees. All subjects saw a researcher or midwife to discuss the study and gave written informed consent to their inclusion in all parts of the study.

Women were asked either to provide a first-void urine sample (women attending antenatal clinics in each of Glasgow and Aberdeen, and women attending abortion clinics in Glasgow) or to allow an endocervical swab to be taken (women attending colposcopy clinics in each of Glasgow and Aberdeen, and women attending the abortion clinic in Aberdeen). Urine samples were obtained at the booking antenatal visit or on admission for abortion. The endocervical swabs were taken at the time of colposcopy or at the abortion clinic. All samples in Glasgow were analysed using the LCx detection kit (Abbot Laboratories, Illinois, USA) according to the manufacturer's instructions. In Aberdeen, the samples were analysed using the BDProbeTec system (Becton Dickinson, Oxford, UK). Positive results were confirmed by repeat testing of the original sample.

The presence of symptoms or signs of *C. trachomatis* infection was explored systematically and recorded.

A subsample of women attending the study antenatal and colposcopy clinics who gave informed consent to the study were sent the acceptability questionnaire by post with a stamped address envelope. The questionnaire asked about women's knowledge of *C. trachomatis*, and their views on screening. Non-response was addressed with one further approach. Women attending abortion clinics were asked to complete the questionnaire on site following written consent. Sampling was opportunistic, and directed at recent attendees once the questionnaire had been developed.

An incremental cost effectiveness analysis based on a decision analytical model was performed. A decision analytical model was constructed to analyse a series of possible events associated with screening and not screening for *C. trachomatis* (Fig. 1). Major sequelae were defined as pelvic inflammatory disease, chronic pelvic pain, ectopic pregnancy, infertility, male urethritis, epididymitis, infantile conjunctivitis and infantile pneumonia. The respective baseline probabilities used in the model were based on data, generated both from the analysis of the cohort and from published literature (Table 1). The probabilities of developing individual sequelae and time to event were taken from the literature. The clinical management strategy and healthcare resource utilisation associated with all major sequelae were obtained from literature and discussions with the clinicians involved in the study (JN, SM). The effectiveness of screening was measured by the number of major sequelae averted.

Only direct health service costs were analysed. The costs associated with screening and treating associated adverse sequelae were calculated (Table 1). Because the numbers sampled in each age and clinic group reflected the sampling strategy, rather than the actual numbers attending these clinics in the population, costs have been calculated for a notional population of 1000 of each of antenatal, abortion and family planning clinic attenders (250 patients in each

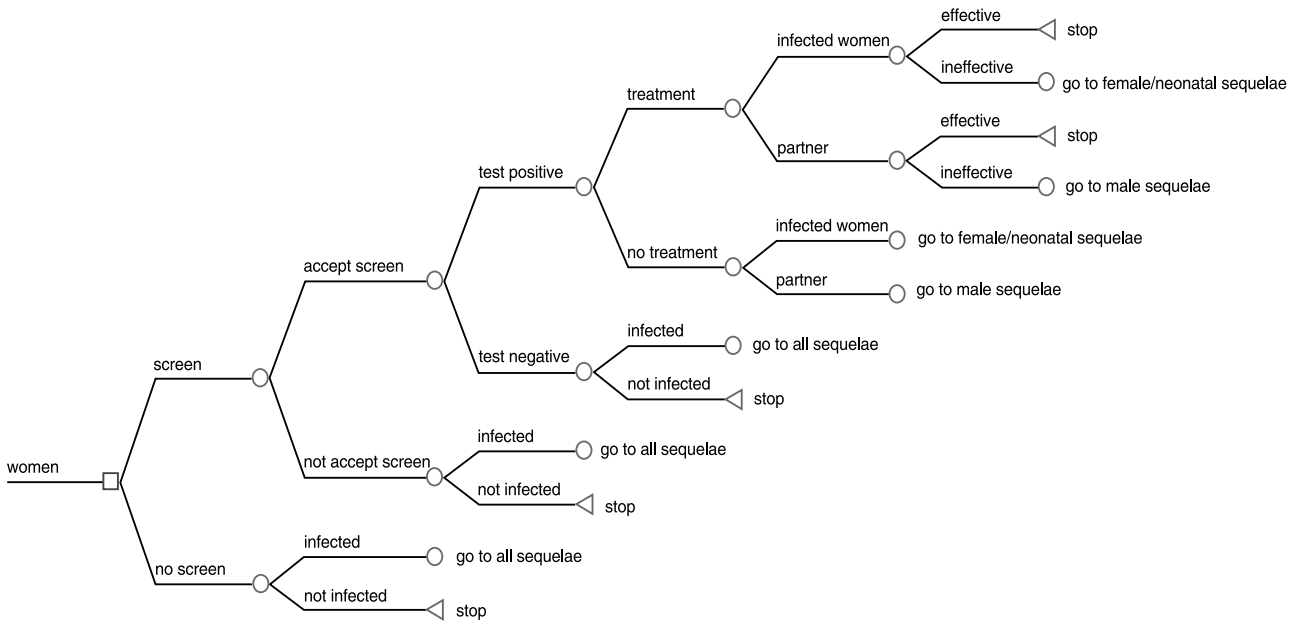

Fig. 1. Decision tree for the screening of *C. trachomatis*.

age group in each clinic) and 750 colposcopy clinic attenders (250 women in each age group, with women aged under 20 excluded since, as routine cervical screening does not start until the age of 20 years, women under 20 years do not commonly attend). The costs of screening included the costs associated with patient recruitment, test samples preparation, purchase of the diagnostic tests, follow up of test positive patients and drug treatments for those infected. The costs associated with managing adverse sequelae included costs of all clinical investigations, hospitalisations, general practitioner (GP) consultations and drug treatments.

Unit costs for all resources used were obtained from routine collected data and the literature (Table 1) by expert opinions, to obtain a net cost per patient associated with various major sequelae. Future costs and benefits were discounted at 5% and 3%, respectively, in accordance with Treasury and Department of Health guidelines. All costs were calculated at 2001 values (UK £).

Cost effectiveness is measured as a ratio of cost to effectiveness. An incremental cost effectiveness ratio is an estimate of the cost per unit of effectiveness of one strategy in preference to another. In this study, incremental cost effectiveness ratios presented as net costs per major sequela averted, comparing screening with no screening, were calculated for each individual age group and healthcare setting. Incremental cost effectiveness ratios are calculated by dividing the difference in cost (in this case, costs associated with screening and the costs of treating the major adverse sequelae that the particular strategy failed to prevent) by the difference in effectiveness (the number

Table 1. Estimated parameters—probabilities and costs.

Model input	Risk for event (%)	Cost estimate (£)
LCR test*		12
Sensitivity	100	
Specificity	99	
Test positive patient follow up†		6
Antibiotic treatment		9
Uptake by index patients	91	
Partner uptake	55	
Cure rate	95	
Partner transmission rate	68	
Female sequelae		
Pelvic inflammatory disease (PID)	30[2]	190
a. Symptomatic PID	40[25]	
b. Asymptomatic PID	60[25]	
Chronic pelvic pain	18[26]	111
Ectopic pregnancy	8[27]	2530
Infertility	12[27]	4540
Neonatal sequelae		
Conjunctivitis	30[25]	8
Pneumonia	15[25]	303
Male sequelae		
Epididymitis	2[28]	15
Urethritis	40[29]	15
Cumulative risk of sequlae	128	
Pregnancy rate	5	

* Cost of testing and nurse time associated with sample collection included.

† Cost of 30 minutes nurse time.

Table 2. Percentage prevalence (95% CI) of *C. trachomatis* in each clinic population. Values are presented as proportion (*n*/*n*) and % (95% CI).

Age (years)	Antenatal clinics	Colposcopy clinics	Abortion clinics
<20	31/256		23/182
	12.1% (8.6–16.7)		12.6% (8.5–18.3)
20–24	18/404	14/158	24/211
	4.4% (2.8–6.9)	8.9% (5.2–14.5)	11.4% (7.7–16.5)
25–29	6/435	6/152	5/171
	1.4% (0.6–3.1)	3.9% (1.7–8.6)	2.9% (1.1–6.9)
≥30	3/434	9/203	6/206
	0.7% (0.1–2.1)	4.4% (2.3–8.4)	2.9% (0.6–5.1)
	$P < 0.001$	$P = 0.42$	$P < 0.01$

of major sequelae prevented by the particular strategy) in the comparison groups.

For the purpose of modelling, several key assumptions were made. It was assumed that 10 minutes of nurse time[13] was required for collecting and preparing screening samples and 30 minutes of nurse time to follow up test positive patients for treatment. A single dose of azithromycin was used in the basecase for treating test positive patients, and drug-induced adverse events were assumed to be negligible.

Prevalence data were entered onto a Microsoft Access Database, and analysed using SPSS. The χ^2 test was used within each clinic type to compare prevalences across the age cohorts. Logistic regression, with a positive test for *C. trachomatis* as the dependent variable, was used to explore variables which might be associated with an increased or decreased risk of *C. trachomatis* infection (age, clinic type, geographical region, Carstairs score,[14] symptoms of infection, signs of infection, having had a test for *C. trachomatis* within the previous six months, having a previous pregnancy, or [among pregnant women only] bleeding). The odds ratios (95% confidence intervals [CI]) associated with these variables were calculated. Variables which appeared significant when entered into a logistic regression model singly were then entered into a multiple logistic regression model to give adjusted odds ratios. The goodness of fit of the final model was tested by the method of Hosmer and Lemeshow.[15] The acceptability data were analysed using SPSS, with the χ^2 test used to explore differences between groups.

RESULTS

A total of 3132 women (1598 women in Aberdeen and 1534 women in Glasgow) were approached about the study. Only 49 (1.6%) declined to participate. Four women were ineligible, 255 (8.1%) were excluded for a variety of reasons, and a further 7 (0.2%) had unusable results, leaving a final sample size of 2817 (90% of those approached). Recruitment in the under 20 age group in colposcopy was abandoned within a few months of the start of the study, after it became clear there would be insufficient women in this group for analysis to be meaningful. Those women already recruited to this group were excluded from subsequent analysis.

The prevalence of infection by age group is shown in Table 2. The highest reported prevalence was in the under 20 age group, where the prevalence (95% CI) in women attending for abortion was 12.6% (8.5–18.3%) and 12.1% (8.6–16.7%) in women attending for antenatal care. There was a significant decline in prevalence with increasing age in both antenatal and abortion clinics, but not in colposcopy clinics.

When potential risk factors for a positive result were analysed individually, each of age, clinic source, geographical region (Aberdeen or Glasgow) and Carstairs score appeared important (Table 3). However, in a multiple logistic regression model, only age, clinic type and geographical region of origin were significant (Table 3). Similar results were obtained whether Carstairs score was grouped into three categories prior to analysis (high [6 and 7], medium [3, 4 and 5] and low [1 and 2]), or analysed as seven ordered categories. Although none of the patients in the antenatal clinic had signs or symptoms of *C. trachomatis* which prompted testing by the primary clinician, on further questioning 9% had symptoms which could be attributable to *C. trachomatis* infection. Among the colposcopy and abortion clinics, 13% of women had symptoms or signs possibly attributable to infection with *C. trachomatis*. There was no difference in prevalence of *C. trachomatis* between those who did and those who did not have symptoms or signs potentially attributable to infection. Additionally, neither having a test for *C. trachomatis*

Table 3. Odds ratio of a positive test for *C. trachomatis* for the variables age, clinic attended, region and Carstairs score. The unadjusted results were obtained by use of each of the variables alone in a logistic regression process. The adjusted results were obtained by a backwards elimination. Carstairs score was not a significant factor in this model and the final model therefore included the variables age, clinic attended and region alone. Goodness of fit was confirmed by the method of Hosmer and Lemeshow.

Variable	Unadjusted		Adjusted	
	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*
Age*	0.881 (0.852–0.911)	<0.001	0.878 (0.846–0.912)	<0.001
Clinic attended†				
Abortion	2.07 (1.42–3.01)	<0.001	2.22 (1.23–3.99)	0.008
Colposcopy	1.61 (1.03–2.52)	0.036	1.75 (1.16–2.65)	0.008
Region‡	1.81 (1.28–2.55)	<0.001	1.65 (1.07–2.54)	0.023
Carstairs score§				
Each of 2–6		ns		
7	2.93 (1.23–6.92)	0.014		

* Odds ratio for every one year's increase in age.
† Compared with antenatal clinic as reference.
‡ Glasgow compared with Aberdeen as reference.
§ Compared with Carstairs 1 as reference.

Table 4. Women's views about appropriateness of testing for women and men.

Views	Responses	Antenatal (%)	Abortion (%)	Colposcopy (%)	*P*
Appropriate time to be tested?	Yes	71	84	81	0.004
	No	17	5	9	
	Don't know	12	11	10	
Appropriate clinic?	Yes	77	92	83	0.001
	No	16	3	3	
	Don't know	7	5	5	

within the past six months, having a previous pregnancy, nor (among pregnant women only) bleeding were associated with an increased risk of a positive result (data not shown).

Five hundred and twenty one women responded to the acceptability questionnaire (77% response rate). Thirty-seven were 50 years or more and were omitted from subsequent analyses. Within each clinic, respondents were evenly distributed among the four (antenatal or abortion) or three (colposcopy) age groups (data not shown), and were similar in other characteristics to the main sample.

Four hundred and five women (84%) thought that the clinic in which they were tested was the appropriate one to be tested, while 375 women (78%) thought that the timing of the test was appropriate (see Table 4). There was significant variation of viewpoint by respective clinic; women from the antenatal clinic were least likely to think that their clinic was the suitable place, although the response was still very positive. Responses were also positive to the suggestion that *C. trachomatis* screening could take place at the same time as a cervical smear test (89%).

Most women thought that men should be tested routinely (93%). A smaller number thought that they would want their partner to be tested (77%). Fewer thought that their partner would attend (46%).

Table 5. Prevalence, costs, sequelae averted, incremental cost effectiveness ratios by age and settings. Assuming population of 250 in each age and clinic setting (i.e. total population of 3750 women).

	Prevalence (%)	Sequelae averted	Cost of screening (£)	Incremental cost effectiveness ratio (£)
Universal screening	6.2	64	49,367	651
Selective screening by age				
Under 20 years	11	30	15,122	258
Under 25 years	7.9	54	25,988	344
Under 30 years	2.7	59	37,529	513
Selective screening by clinical setting				
Family planning clinic	5	16	18,919	694
Antenatal clinic	5	9	19,107	1196
Colposcopy clinic	6	25	16,105	621
Abortion clinic	8	13	18,655	433

The majority of women (93%) said that they had heard of *C. trachomatis*, successfully identified the definition of *C. trachomatis* from a list (99%) and identified that it could be caught through sexual intercourse (97%). Women who 'didn't know' if they had ever been tested were significantly less likely to know how *C. trachomatis* could be caught ($P < 0.001$). Fewer women knew that *C. trachomatis* could be caught more than once (63%), with women who had been screened before more likely to respond correctly ($P < 0.01$). The majority correctly identified that neither women nor men would always know if they had *C. trachomatis* (86%, women would not always know and 73%, men), those who had been previously tested were significantly more likely to be correct.

Based on prevalences found in this and a previous study,[13] in the absence of screening 217 women out of this notional population of 3500 (6.2%) would be positive for *C. trachomatis* (Table 3) at a cost of £7806. A universal screening strategy, providing tests for the complete study cohort, would prevent 64 cases of major adverse sequelae at a cost of £49,367. This produced an incremental cost effectiveness ratio of £651, representing net cost per major sequelae averted.

Selective age-based screening was more cost effective than universal screening. The results of the analysis showed the younger the age group screened, the more cost effective the screening strategy. The incremental cost effectiveness ratios for selective screening of women under 20 years, under 25 years and under 30 years were £258, £344 and £513, respectively.

Selective screening by clinical setting was also shown to be less cost effective than universal screening, with the exception of colposcopy and abortion clinics (incremental cost effectiveness ratios = £621 and £433, respectively).

Table 6. Sensitivity analysis—impact of varying model input variables on incremental cost effectiveness ratios.

Incremental cost effectiveness ratios	**Basecase**	**Screening uptake**	**Probabilities of major sequelae**		**All input costs**	
		−50%	−20%	+20%	−50%	+50%
Universal screening	£651	£651	£857	£514	£325	£978
Selective screening by age						
Under 20 years	£258	£257	£352	£195	£128	£388
Under 25 years	£344	£343	£462	£264	£171	£517
Under 30 years	£513	£512	£679	£401	£255	£770
Selective screening by clinical setting						
Family planning clinic	£694	£694	£912	£549	£346	£1043
Antenatal clinic	£1196	£1195	£1560	£953	£597	£1796
Colposcopy clinic	£621	£621	£818	£490	£310	£934
Abortion clinic	£433	£433	£577	£337	£216	£651

This latter option was the most cost effective selective screening strategy by clinical setting.

Other selective screening scenarios on various age groups and clinical settings were also investigated. Selective screening of under 20 years was the most cost effective screening strategy irrespective of clinical settings (Table 5).

One-way univariate sensitivity analysis showed that the results of the model are relatively robust (Table 6). When varying estimates of screening uptake rate, the incremental cost effectiveness ratios of the basecase remained stable and the results of the model remained unchanged.

DISCUSSION

Asymptomatic carriage of *C. trachomatis* fulfils the Wilson and Junger criteria for a condition where screening is appropriate, and many expert groups now believe the case for screening for *C. trachomatis* has been made.[16] For a screening programme to be effective, it should be targeted at (sub)populations where the prevalence is highest, where screening is acceptable (and the uptake likely to be high) and where the additional costs of screening *versus* not screening are likely to be least. In this study, we determined the cost effectiveness, the prevalence and the acceptability of screening in a variety of hospital-based clinic settings, and these data will inform appropriate screening strategies.

Compared with no screening, selective screening of the most prevalent patient population was the most cost effective strategy, namely, screening abortion patients (the most prevalent healthcare setting) and patients under 20 years (the most prevalent age group).

In contrast to current literature, we did not find screening for *C. trachomatis* to be cost saving. These studies demonstrated cost savings with screening in population with prevalence between 3% and 10%.[17] However, the results from these models tend to be country specific and are not transferable to the general UK healthcare setting. This study was based on prevalence and resource data from a UK setting. The results showed that, based on universal screening, it would cost approximately £771 to prevent one major sequela. In addition, this model has taken into account the acceptability of screening by incorporating the rate of uptake. This is a particularly important factor in screening programmes. Although the acceptability rate recorded in this cohort was unusually high, sensitivity analysis has shown that the results were insensitive to varying uptake rate.

The Chief Medical Officer's expert advisory group recommended that everyone with symptoms of chlamydial infection, all those attending genitourinary medicine clinics and those seeking abortion should be targeted for screening.[5] Opportunistic screening of sexually active women under 25 years and those over 25 with a new sexual partner or two or more sexual partners in the previous year was also encouraged. The findings of this study have generally supported these recommendations from an economic perspective. Selective screening has clear clinical and economic benefit compared with no screening and universal screening.

This study has potential limitations that are inherent to all cost effectiveness analysis. Based on a decision analysis, this study used estimates from several sources such as probabilities of clinical events reported in the medical literature and expert opinion on management of events. In an attempt to overcome the potential bias, all estimates were varied in the sensitivity analysis to determine the effect that variations would have on the results. The results of the sensitivity analysis showed that the results are relatively robust.

This model has been designed to investigate the most cost effective strategy for *C. trachomatis* screening, based on the assumption that a decision has been made to undertake screening and does not consider the relative cost effectiveness of screening compared with other uses of scarce NHS resources. To determine the relative value of a *Chlamydia* screening program to other healthcare programmes, a cost–benefit analysis is required in these settings.

We found that the prevalence of infection in young women attending for antenatal care was high—12.1% (95% CI 8.6–16.7%) in women under 20 years of age and 4.4% (2.8–6.9%) in women between 20 and 24 years of age. These prevalences are similar to those found in other studies of hospital-based antenatal patients.[18–20] Together, these data support a strategy of screening women under 25 years of age for *C. trachomatis* in hospital- or community-based antenatal clinics. Although widely recommended, such a strategy is not commonly adopted. This is perhaps surprising, since *C. trachomatis* in pregnancy is associated with additional complications including preterm delivery[21] (odds ratio [95% CI] of 2.2 [2.2–9.57] in association with *C. trachomatis* carriage at 24 weeks) and neonatal conjunctivitis and pneumonia. Additionally, the economic evaluation suggested that screening was only marginally less cost effective in this setting than in abortion clinics. We suggest that those caring for pregnant women should consider whether screening strategies should be introduced among their own patients.

In contrast to antenatal clinics, screening in abortion clinics is well established in the UK. The prevalences in the under 20 year and the 20–24 age group in abortion clinics in our study are similar to other recent UK data.[19,22] Fewer published data exist on the prevalence of *C. trachomatis* in women attending colposcopy. Overall prevalences of *C. trachomatis* of 3.0–7.9%[19,23,24] have been reported among otherwise unselected women attending colposcopy clinics, but these data were not further analysed by age. Notwithstanding, the prevalence in our study in women of 25 years and older (>4%), and the finding in this small sample that this figure does not decline with age, suggests that screening strategies in this setting should include older women.

Very few studies indeed have examined the acceptability by women (or men) of such routine screening.[7,8,12] Before undertaking the study, we hypothesised that screening might be more acceptable in the antenatal setting than elsewhere, as screening is routinely undertaken for a variety of other infective conditions in pregnancy (e.g. syphilis and rubella). We found that in all three settings there was a high level of acceptability of the test, although fewer antenatal patients than those attending other clinics responded positively to this question. The suggestion that men might not respond so positively is worth exploring in more detail; there are too few studies at present with which to compare our findings.

The study demonstrated a high level of first level knowledge about *C. trachomatis* although with the increasing sophistication of the questions the knowledge level dropped substantially. This knowledge will include information acquired during the process of informed consent as that patient was recruited into the study. The small group of women who had been previously tested had a much higher level of knowledge about the condition suggesting, not surprisingly, that experience with the condition increased knowledge.

SUMMARY

A single episode of screening for *C. trachomatis* does not result in net cost savings. Currently recommended strategies of screening for *C. trachomatis* in women under 25 years of age in abortion clinics are supported by our data on prevalence and acceptability. These data also suggest that hospital-based screening strategies should be further extended to include younger women attending antenatal clinics and all women of reproductive age attending colposcopy clinics.

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