Development and evaluation of screening strategies for *Chlamydia trachomatis* infections in an STD clinic

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Abstract

Objectives—To identify predictors for *Chlamydia trachomatis* infection among visitors of an STD clinic in Amsterdam in 1986–1988. To design predictor-based screening programmes for *C trachomatis*. To evaluate the chosen screening strategy in 1993.

Methods—In 1986–1988, 947 heterosexual men and 648 women participated in the study. A medical history was recorded, a physical examination took place and samples were taken for laboratory diagnostics. Information for 1993 was available from routine databases.

Results—*C trachomatis* infections in heterosexual men in 1986–1988 (prevalence 15.8%) were independently associated with: age under 26 years, being an STD contact, coitarche below 13, last sexual contact with a non-prostitute, (muco)purulent urethral discharge and ten or more leukocytes per microscopic field of urethral smear or urine. For women (prevalence 21.5%) independent predictors were age under 26, no history of STD, being an STD contact, cervical friability, (muco)purulent cervical discharge, presence of clue cells and ten or more leukocytes per field of urethral smear. Screening men with one anamnestic predictor for *C trachomatis* and ten or more leukocytes in smear or urine (59% of men) would detect 93% of the cases in 1986–1988. For females only universal screening proved to be suitable. After the introduction of a screening strategy in 1989 (universal for women, indicated by urethritis for men), a strong decline was found in the *C trachomatis* prevalence for all subgroups in 1993, excluding prostitute's clients and Turkish men.

Conclusions—In 1993 the overall *C trachomatis* prevalence had declined among the attendants of the STD clinic. It seems likely that this fall was caused both by the screening programme and the reduction of risk behaviour.

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Keywords: *Chlamydia trachomatis*; screening strategy

Introduction

Nowadays it is widely recognised that *Chlamydia trachomatis* is the most common

sexually transmitted bacterial pathogen in industrialised countries. Clinical features of urogenital chlamydial infections include urethritis, proctitis, mucopurulent cervicitis, epididymitis and pelvic inflammatory disease. However, *C trachomatis* infections are often asymptomatic or cause only mild (non-specific) signs or symptoms. In women infections may result in severe sequelae, such as infertility or ectopic pregnancy. Asymptomatic infections may represent an important reservoir for the agent and treating patients who have symptoms along with their partners may not be effective in reducing the prevalence of *C trachomatis* infection. Screening may offer an additional strategy for the control of *C trachomatis* infection, but selective screening, based on single historical or clinical risk factors, was found to have a relatively low predictive value.^{1–5} Combinations of these factors will increase this value.^{6–10}

The aim of this study was to estimate the STD prevalence among visitors attending a sexually transmitted disease (STD) clinic in Amsterdam from 1986 to 1988 and to study predictors for *C trachomatis* infection in order to identify potential high-risk subgroups. Until the start of the study the detection of *C trachomatis* was by cell culture (the gold standard at that time) and was not routinely performed among attendants, but on medical grounds only. To achieve cost reduction in comparison with universal screening, the predictors for *C trachomatis* infection were used to design selective screening programmes. From 1989 onwards, material for the diagnosis of *C trachomatis* infection was routinely collected for all women attending the clinic as well as for men with urethritis and, since October 1991, for all men in general.¹¹ The effect of this strategy was studied with respect to the prevalence and the risk factors for *C trachomatis* infection in the clinic population in 1993.

Population and methods

Study population 1986–1988 The study was carried out at the STD clinic in Amsterdam between September 1986 and December 1988. The first eight men and first four women who visited the clinic on two days each week were enrolled in the study. The 2:1 ratio for sampling was based on the gender distribution among visitors in the preceding years. Individuals with a prior visit in the past four weeks were excluded. Other exclusion criteria were plans to leave the Netherlands within six

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weeks and use of antibiotics in the past four weeks. After receiving information about the study, participants had to sign an informed consent form. All participants were questioned by a physician (JSAF, JARH) about age, nationality, native country, drug use in the past three months, age at first sexual contact, sexual preference, type (casual, steady, commercial) of last and former sexual contacts, number of sexual contacts (past month, half year and lifetime), condom use for casual contacts in the past six months, history of STD and genitourinary complaints. Additionally, women were asked about their menstrual cycle, current type of contraceptives and for oral contraceptives about the period of use. A physical examination was carried out and samples of blood and specimens for culture and direct microscopy were obtained. In the analysis presented here, homosexual men were excluded.

For heterosexual men, urethral samples were taken for culture for *Neisseria gonorrhoeae* and for *C trachomatis* and if discharge was available for Gram-staining. The urethral discharge was categorised as mucous, mucopurulent or purulent. The number of leukocytes was determined in the Gram-stained smear or in first catch urine if less than ten leukocytes were present in the discharge smear. Non-gonococcal urethritis was diagnosed when on average ten or more leukocytes per field were found (magnification 400 $\times$) in the absence of intracellular diplococci.

In women, first rectal samples for *N gonorrhoeae* and *C trachomatis* culture were taken. After the cervix was wiped, endocervical discharge was categorised as mucous, mucopurulent or purulent. The swab test was used for visualising the discharge. Then endocervical samples were taken for cultures for *N gonorrhoeae* and *C trachomatis* and for Gram-staining. The cervix was also evaluated for ectopy, erythema and cervical bleeding induced by taking samples (hereafter called cervical friability). Finally, urethral material was taken for cultures for *N gonorrhoeae* and *C trachomatis* and for Gram-staining. A sample of the oropharynx for *C trachomatis* and *N gonorrhoeae* culture was only indicated when the patient reported orogenital sexual contact in the preceding six months. A patient was defined *C trachomatis* positive if at least one of the samples was found positive by cell culture.

Statistical methods Univariate analyses identified significant predictors of *C trachomatis* infection in 1986–1988 using the χ^2 test and the two-tailed Fisher exact test. The analyses were done separately for heterosexual men and women. Variables associated with *C trachomatis* infection ($p \leq 0.05$) were further analysed by logistic regression analysis to identify independent predictors. A variable was included in the logistic model if the likelihood ratio test was significant ($\alpha = 0.05$) or when the beta coefficient of a variable already in the model changed by at least ten percent. Odds ratios (OR) are presented with 95% confidence limits (95% CL).

Various sets of independent predictors of *C*

trachomatis infection were used to develop screening strategies. For each strategy the proportion of the target population to be tested, the sensitivity and the positive predictive value (PPV) were calculated. The criteria for an appropriate screening programme were defined as a sensitivity of 90% for men and 95% for women (because of more severe complications). Also, the prevalence in the population to be screened had to exceed the prevalence in the target population in order to be cost-effective. The former prevalence corresponds with the PPV. A PPV was chosen, that is, arbitrarily, 1.5 times the prevalence in the target population.

At first, all independent predictors for *C trachomatis* infection were included in the screening programme. Subsequently, the predictors were dropped one by one until eventually 90% and 95% of the infected men and women respectively were detected by the programme (theoretical approach). In addition, in a more medical approach the sensitivity and PPV of the independent predictors for *C trachomatis* infection reported during the medical history were calculated and the surplus value of predictors originating from the physical examination and laboratory diagnostics was studied. Finally, data from visitors in 1993 were used to estimate the influence of the chosen screening strategy.

Population STD clinic 1993 Data were collected routinely for all visitors attending the STD clinic. Information on direct microscopy and results of the physical examination were not entered in the database. Available computerised data include age, nationality, history of STD, sexual preference, being an STD contact or not, existence of commercial sexual contacts and current STD diagnoses. In 1993 *C trachomatis* infection was diagnosed by culture for women and by enzyme-linked immunosorbent assay (ELISA) or culture for men. A previous evaluation of culture and ELISA in comparison with an expanded gold standard using also polymerase chain reaction results, revealed that the sensitivity of the cell culture of cervical swabs and the ELISA was 71.1% and 65.8%, respectively.¹² The difference between the sensitivity of culture and ELISA was even less for male urethral swab specimens (personal communication GJJ van Doornum). The data were compared with those from the period 1986–1988 to determine whether the screening strategy implemented in 1989 had changed the *C trachomatis* infection prevalence.

Results

Non-participation in the study

During the period 1986–1988 2,175 visitors were eligible for the study. The participation rate was 84%. For 91% of the non-participants information on diagnoses and demographic and sexual characteristics was available from the routine data. Analyses showed that male non-participants were younger (on average two years), had a foreign nationality more often (especially Morocco

Table 1 Sociodemographic and sexual characteristics of 947 heterosexual men and 648 women attending an STD clinic in Amsterdam, 1986–1988

Variable	Men n	(n = 947) %	Women n	(n = 648) %
Native country				
The Netherlands	526	55.5	467	72.1
Surinam/Antilles	137	14.5	69	10.6
Morocco	43	4.5	6	0.9
Turkey	47	5.0	2	0.3
Other	194	20.5	104	16.0
Number of partners last month				
1	533	56.3	410	63.3
2–5	319	33.7	120	18.5
≥ 6	8	0.8	65	10.0
none	79	8.3	40	6.2
Orogenital contact ≤ 6 mnd	478	50.5	472	72.8
Passive anal contact ≤ 6 mnd	—	—	82	12.7
Work as prostitute	0	0.0	96	14.8
History of STD*	604	63.8	319	49.2
Diagnosis of current STD				
gonorrhoea	101	10.7	37	5.7
chlamydia	150	15.8	139	21.5
(inclusive gonorrhoea + chlamydia)	18	1.9	17	2.6

*History of gonorrhoea, chlamydia, syphilis, urethritis, genital herpes or condylomata acuminata and salpingitis for women.

and Turkey), reported a history of gonorrhoea less often but had a current gonorrhoea more often, compared with the 1173 men participating in the study (all significant differences, data not shown). For females no significant differences were found. Further results are only presented for heterosexual men and all women.

Characteristics of the study population

General characteristics for the participants are shown in table 1. The mean age for the 947 heterosexual men was 32 years (range 14–74) and for the 648 women was 28 years (range 15–53). The mean age at first sexual contact was 17, both for men (range 6–38) and

women (range 7–32). For men a foreign native country was more common than for women, 44% and 28%, respectively. Approximately half of the women and two-thirds of the men reported a history of STD.

CT prevalence and predictors of infection

The prevalence of *C trachomatis* infection, 15.8% for heterosexual men and 21.5% for women, exceeded the prevalence of gonorrhoea, 10.7% and 5.7%, respectively. Urogenital symptoms were less present in *C trachomatis*-infected women (52%: symptoms of vaginal discharge, dysuria, frequent miction of small amounts or lower abdominal pain) than in infected men (69%: symptoms of dysuria or urethral discharge).

Predictors that were significant in univariate analyses but not in logistic regression analyses are presented in table 2. Those that were significant in both the univariate and logistic regression analyses are shown in table 3. *C trachomatis* infections in heterosexual men were independently associated with: age below 26 years, being an STD contact, age at first sexual contact below 13 years, last sexual contact

Table 3 Independent predictors of Chlamydia trachomatis infection in female and heterosexual male visitors of an STD clinic in Amsterdam 1986–1988, identified by logistic regression analysis

	Corrected OR	95% CL
Heterosexual men:*		
Age (years) (ref: 26–35)		
< 26	1.59	1.00–2.51
36–45	0.60	0.33–1.11
> 45	0.31	0.10–0.93
Contact/warned (ref: no)		
Yes	2.53	1.50–4.26
Age first sexual contact (years) (ref: > 18)		
< 13	2.50	1.01–6.21
13–18	1.58	0.88–2.83
Unknown	1.57	0.38–6.58
Last sexual contact with prostitute (ref: no)		
Yes	0.48	0.25–0.93
Appearance urethral discharge (ref: none)		
Mucous	2.18	1.31–3.64
Mucopurulent	5.21	2.93–9.26
Purulent	2.02	1.07–3.80
Number of leukocytes in smear or urine (ref: 0)		
1–9	2.33	0.20–26.32
≥ 10	29.41	3.98–200.0
Women:†		
Age (years) (ref: 26–35)		
< 26	1.73	1.05–2.85
36–45	0.76	0.34–1.68
> 45	0.31	0.04–2.68
History of STD (ref: no)		
Yes	0.56	0.35–0.90
Contact/warned (ref: no)		
Yes	1.57	0.99–2.49
Cervical friability (ref: no)		
Yes	2.00	1.19–3.34
Not applicable/unknown	1.12	0.27–4.64
Appearance cervical discharge (ref: none/mucous)		
(muco)purulent	1.71	1.07–2.73
Unknown	1.85	0.45–7.66
Clue cells (ref: negative)		
Positive	2.26	1.44–3.55
Number of leukocytes in smear (ref: 0)		
1–9	1.44	0.83–2.51
≥ 10	4.09	2.31–7.22

*Final model, 919 men: –2log L = 631.937, p = 0.0001. Besides for the variables shown in the table, the OR was also corrected for observed confounding effects of native country. †Final model, 619 women: –2log L = 516.644, p = 0.0001. Besides for variables shown in the table, the OR was also corrected for observed confounding effects of interim bleeding, cervical ectopy and length of use of oral contraceptives.

Table 2 Predictors that were only univariately associated with Chlamydia trachomatis infection in female and heterosexual male visitors of an STD clinic in Amsterdam 1986–1988

	<i>n</i>	<i>%CT positive</i>	<i>χ²-test, p-value</i>
<i>Heterosexual men:</i>			
Native country			
European	576	17.0	0.033
Turkey	47	8.5	
Other Asian country	63	6.3	
Condom use in casual contacts			
Always	105	4.8	0.15
Almost always	70	12.9	
Often	72	16.7	
Sometimes	60	20.0	
Never	355	18.0	
Urethral discharge			
Absent	579	10.2	< 0.001
Present	362	25.1	
<i>Women:</i>			
Contraceptives			
None	153	15.7	< 0.001
Oral contraceptives (OAC)	310	29.7	
Intra Uterine Device (IUD)	65	18.5	
Condom/other barrier method	71	12.7	
Operation	34	5.9	
Length of use OAC			
< 0.5 year	49	24.5	0.031
0.5–3 years	114	38.6	
3 or more years	157	24.8	
Interim bleeding			
No	538	19.9	0.003
Yes	74	35.1	
Swabtest			
Negative	480	19.0	< 0.001
Positive	122	33.6	
Cervical ectopy			
Absent	327	15.3	< 0.001
Present	300	29.3	
Gonorrhoea culture			
Negative	601	20.3	0.001
Positive	37	46.0	

Table 4 Sensitivity (Sens), positive predictive value (PPV) and absolute (N) and relative (%) number of *Chlamydia trachomatis*-screened men in different screening strategies

Criteria: Sens 90%, PPV 23.7%				
<i>Theoretical approach</i>				
Screening in case random	Sens (%)	PPV (%)	N	%
6	0	0	1	0.1
5	9	57	23	2.4
4	37	41	133	14.1
3	83	29	425	45.1
2	98	20	727	77.2
1	100	17	902	95.8
of all 6 independent predictors of chlamydia trachomatis (see table 3) are present.				
<i>Medical approach</i>				
Screening in case of	Sens (%)	PPV (%)	N	%
1 anamnestic predictor*	95	18	795	84.4
2 anamnestic predictors	47	25	277	29.4
1 anamnestic + (muco)purulent discharge	71	29	363	38.5
1 anamnestic + ten or more leucocytes	93	25	554	58.8

*anamnestic predictors: age below 26 years, being traced as an STD contact, age first sexual contact below 13 and last sexual contact with a non-prostitute.

Table 5 Sensitivity (Sens), positive predictive value (PPV) and absolute (N) and relative (%) number of *Chlamydia trachomatis*-screened women in different screening strategies

Criteria: Sens 95%, PPV 32.3%				
<i>Theoretical approach</i>				
Screening in case random	Sens (%)	PPV (%)	N	%
7	<1	100	1	0.2
6	9	92	13	2.0
5	32	64	69	10.8
4	52	46	158	24.6
3	79	35	312	48.7
2	91	27	468	73.0
1	99	23	599	93.4
of all 7 independent predictors of chlamydia trachomatis (see table 3) are present.				
<i>Medical approach</i>				
Screening in case of	Sens (%)	PPV (%)	N	%
1 anamnestic predictor*	86	26	455	71.0
1 anamnestic + 1 physical†	96	24	553	86.3
1 anamnestic + laboratory‡	96	24	551	86.0
1 anamnestic + 1 physical + 1 lab.	94	25	534	83.3

*anamnestic predictors: age below 26 years, no history of STD and being traced as an STD contact.

†physical predictors: (muco)purulent cervical discharge, cervical friability.

‡laboratory predictors: clue cells positive, ten or more leukocytes in urethral smear.

with a non-prostitute, (muco)purulent urethral discharge and at least ten leukocytes per field in a Gram-stained urethral smear or in first catch urine (table 3). For women independent predictors were: age below 26 years, no history of STD, being an STD contact, cervical friability, (muco)purulent cervical discharge, presence of clue cells and ten or more leukocytes per field in a Gram-stained urethral smear (table 3).

Screening strategies

Different sets of the above mentioned independent predictors of *C trachomatis* infection (six for men, seven for women) were used as selection criterion for screening. The aimed PPV of 1.5 times the observed *C trachomatis* infection prevalence corresponded with 23.7% for men and 32.3% for women. Figure 1 shows the sensitivity, the PPV and the number of heterosexual men tested for *C trachomatis* in different strategies. In the theoretical approach an increasing proportion of the target population was offered screening, with a declining number of predictors. As a consequence, the PPV declined from 57% to 17% with increasing sensitivity. If screening would be restricted to men meeting random 6, 5, 4 or 3 of all 6 predictors, only 0%, 9%, 37% and 83% of the

infected cases would be identified, respectively. Offering *C trachomatis* screening to men with two predictors (77%) would identify 98% of the infected men, but the PPV would be too low (20%). Also, specific combinations of two predictors did not yield a sensitivity of 90% and a PPV of 24% at the same time. The best single criterion was the presence of ten or more leukocytes in urethral smear or urine (69% of all men); sensitivity 98%, PPV 23%. The medical approach showed that the presence of at least one anamnestic predictor would not satisfy the screening criteria (table 4): sensitivity 95%, PPV 18%, percentage to be tested 84. If the presence of (muco)purulent discharge was included in the screening strategy, in addition to one (random) anamnestic predictor, the sensitivity was too low (71%). However, if the presence of ten or more leukocytes was included, again in addition to one anamnestic predictor, the criteria were satisfied with 59% of the population tested and a sensitivity of 93% and PPV of 25%. Further expansion of the criteria with information on discharge did not result in an increase of sensitivity or PPV.

For women, the only satisfying strategy in the theoretical approach, with respect to the sensitivity, would be to test women with one predictor (sensitivity 99%). However, the criterion for PPV would not be met (23%) and still 93% of all women had to be tested. (table 5) No strategies based on single predictors could be found to improve the sensitivity and the PPV at the same time. Also, the medical approach did not offer satisfying results. With the information from the medical history only, the sensitivity was too low (86%). If the presence of cervical friability or (muco)purulent discharge was included as criterion, the sensitivity rose to 96%, but the PPV remained too low. Using the information on the presence of clue cells and the number of leukocytes showed similar results.

Based on the interim analyses of the data from 1986 and 1987, it was decided to screen all women as well as all men with urethritis on the presence of *C trachomatis*, from 1989 onwards. Since October 1991 all men were tested.

Evaluation of chosen screening strategy

The prevalence of *C trachomatis* infection in men decreased from 15.8% in 1986–1988 to 7.5% in 1993 and for women from 21.5% to 7.3%. Also, the prevalence of gonorrhoea had declined in 1993, to 5.4% for men and 1.9% for women. The observed decrease in *C trachomatis* infection may be due to changes in the composition of the population, rather than to a real drop in the prevalence. In order to determine whether this was the case, the characteristics of visitors and the prevalence in several subgroups of 1986–1988 were compared with those of 1993. Heterosexual men in 1993 had a Turkish nationality more often, were prostitute's clients more often and were an STD contact less often as compared with the study population in 1986–1988 (table 6). Thus, in 1993 an increase was observed in the

Table 6 Characteristics of visitors attending an STD clinic in Amsterdam in 1986–1988 (sample) and in 1993 (total group) and Chlamydia trachomatis prevalences in the different subgroups.

	1986–88	1993	1986–1988 (% chlamydia trachomatis 15.8) Chlamydia trachomatis prevalence in the subgroup	1993 (% chlamydia trachomatis 7.5) Chlamydia trachomatis prevalence in the subgroup
Heterosexual men				
Nationality*	n = 947	n = 5615		
Dutch	72.9	52.5	18.1	7.5
Moroccan	4.1	6.2	12.8	6.1
Turkish	5.1	20.8	8.3	8.1
Other	18.0	20.5	10.1	7.3
Age‡				
< 26 years	21.8	23.3	24.4	10.9
26–35 years	51.1	46.8	16.5	7.5
36–45 years	18.3	20.5	9.9	5.3
> 45 years	8.8	9.4	4.8	3.8
Prostitute client*				
Yes	28.0	34.3	5.7	6.8
No	72.0	65.7	19.9	7.8
Being an STD contact*				
Yes	13.8	6.1	25.4	9.1
No	86.2	93.9	14.4	7.4
Former gonorrhoea/syphilis				
Yes	42.0	30.0	16.9	8.0
No	58.0	70.0	15.2	7.3
Current diagnosis of gonorrhoea	10.7	5.4	17.8	12.3
Women				
Nationality	n = 648	n = 4548	1986–1988 (% chlamydia trachomatis 21.5) Chlamydia trachomatis prevalence in the subgroup	1993 (% chlamydia trachomatis 7.3) Chlamydia trachomatis prevalence in the subgroup
Dutch	86.3	71.7	21.3	7.1
Moroccan	13.7	28.3	23.9	7.7
Age‡				
< 26 years	37.2	37.1	31.1	12.0
26–35 years	43.9	41.2	18.9	5.2
36–45 years	15.6	16.6	11.0	3.2
> 45 years	3.3	5.2	4.8	2.6
Prostitute‡				
Yes	14.8	29.5	22.1	4.6
No	85.2	70.5	21.6	8.4
Being an STD contact‡				
Yes	34.5	12.5	32.1	16.8
No	65.5	87.5	16.2	5.9
Former gonorrhoea/syphilis‡				
Yes	25.3	21.5	14.8	3.5
No	74.7	78.5	24.0	8.3
Current diagnosis of gonorrhoea‡	5.7	1.9	46.0	29.4

*Only significantly associated with Chlamydia trachomatis in 1986–1988.
†Only significantly associated with Chlamydia trachomatis in 1993.
‡Significantly associated with Chlamydia trachomatis in 1986–1988 and 1993.

proportion of individuals at low risk for *C trachomatis* infection in 1986–1988 (see tables 2 and 3). However, this could not explain the decreasing *C trachomatis* infection prevalence in men, because the decline in *C trachomatis* was also found for high-risk subgroups like young age groups, STD contacts, men with Dutch nationality and those denying having sex with prostitutes (table 4). The prevalence remained constant in Turkish men and prostitute’s clients. In 1993 *C trachomatis* infections in men were still associated with young age, but they were no longer associated with Dutch nationality, being an STD contact or denial of having sex with prostitutes: this revealed a change in the risk profile of *C trachomatis*-infected men in 1993.

Major differences in women attending the clinic in 1993 compared with the earlier study population of 1986–1988 were found for nationality (foreign nationality more often), being a prostitute (more often) and being an STD contact (less often) (table 4). Except for being an STD contact, these characteristics were not associated with *C trachomatis* in the study of 1986–1988. The declining number of STD contacts (directly related to the decreasing number of index cases) was not expected to account for the drop in *C trachomatis* infec-

tion prevalence. The decline in 1993 proved to be for all female subgroups (table 4). As a consequence, *C trachomatis*-infected women in 1993 were of young age, an STD contact and co-infected with *N gonorrhoeae* more often and had no history of STD more often, corresponding with the risk profile in 1986–1988.

Discussion

C trachomatis infections proved to be far more prevalent than gonorrhoea among heterosexual visitors of the STD clinic in 1986–1988. The *C trachomatis* prevalences of 15.8% for heterosexual men and 21.5% for women are comparable with results from other studies in similar populations.^{13–20} The *C trachomatis* infection prevalence for men may be a little overestimated because relatively few Turkish men participated and lower *C trachomatis* prevalences were found in this group. On the other hand, the lower age of the male non-participants may have caused an underestimation in the study. The independent predictors for *C trachomatis* infection, especially young age, mucopurulent discharge, cervical friability, ten or more leukocytes in urethral smear or urine and being an STD contact, correspond with those found by others.^{3 7 8 13 14 17 21} We found

that female visitors who reported a former STD were less likely to be presently infected with chlamydia compared with women without such history, after adjustment for other risk factors. Because *C trachomatis* infection and salpingitis represented more than half of the self-reported STD, the relationship might be explained by partial immunity for *C trachomatis* induced by a primary infection. For men we failed to demonstrate an identical association, which we cannot explain.

It is concluded that for heterosexual men selective screening for *C trachomatis* infections was satisfying. The best option would be to test those with one anamnestic predictor for *C trachomatis* infection in addition to ten or more leukocytes in smear or urine. This strategy would test only 59% of the heterosexual men, while detecting 93% of the *C trachomatis* cases. The actual choice in this clinic, screening men with urethritis, proved to be almost just as good: testing 69% of the men identified 98% of cases with a PPV of 23%. However, for women only universal screening proved to be suitable. This recommendation corresponds with the decision made for women in this STD clinic in 1989 and also corresponds with the updated set of guidelines for prevention and control of *C trachomatis* in the United States.²²

The contribution of a predictor to the proportion of cases detected in screening programmes depends on the magnitude of the association and the prevalence of the predictor in the population. Variables linked to less than 15% of cases or more than 85% of all individuals are of limited value as selection criteria, because they cannot discriminate properly between cases and healthy individuals.¹⁴ Efforts to design screening programmes in different health care settings regularly succeeded^{6-8,10} but were less successful as well.^{14,20,23-26} Available studies in STD clinics argue unanimously in favour of universal screening.^{14,20,26}

It must be noted that our study of 1986-1988 may have some shortcomings. The cell culture was used for the diagnosis of *C trachomatis* infection. However, recent developments in laboratory techniques demonstrate that the sensitivity of the culture is not 100%.²⁷⁻²⁹ Consequently, some individuals may have been wrongly classified as *C trachomatis* negative, resulting in an underestimation of the ORs. However, it is unlikely that a predictor strongly associated with *C trachomatis* infection was missed.

Because a decline in the prevalence of STD is to be expected some time after introducing screening, an evaluation is necessary and allows for adjustments.⁹ The *C trachomatis* infection prevalence in the STD clinic between 1986-1988 and 1993 decreased about 50% for men and 66% for women. Because of depletion of the reservoir of asymptotically infected, which are mainly females, the screening programme was probably more effective for women. In 1993 the *C trachomatis* prevalence was similar for men (7.5%) and women (7.3%).

The observed decrease may partly be artificial because for 1993 the entire STD population was used, including users of antibiotics in the past month, individuals with a prior visit in the past month and foreign travellers leaving the Netherlands within six weeks. These were excluded in 1986-1988. The declining prevalence in 1993 could not be explained by the increasing proportion of low-risk individuals, because the decrease was also observed in the high-risk groups. This suggests the success of the screening programme. The drop in the prevalence of *C trachomatis* infection may also be due to the reduction of high-risk behaviour, as supported by equally declining prevalences of gonorrhoea. The absence of a decline in *C trachomatis* among Turkish men and those visiting prostitutes may implicate that preventive campaigns for safer sex have not (effectively) reached these groups. Evidence for this was found by Haastrecht *et al*, who reported that the adoption of safer sexual practices in heterosexuals did not apply to the Turkish men.³⁰ Furthermore, it is supported by high levels of gonorrhoea, especially of penicillinase producing *N gonorrhoeae* found in other studies among these groups in Amsterdam.³¹ Specifically designed prevention efforts should be made to achieve a reduction in the prevalence of STD in this group.

It is very likely that screening in addition to reduction of high-risk behaviour contributed to the decrease in the prevalence of *C trachomatis* infection among visitors attending the STD clinic. Unfortunately, these effects could not be unravelled because no data were available on sexual behaviours in 1993, such as the number of partners or the use of condoms. Independent predictors of *C trachomatis* infection are helpful in defining the criteria for screening programmes. At our STD clinic universal screening has been performed since 1989 for women and since October 1991 for men, although for men theoretically selective screening could be satisfactory. Nonetheless, universal screening was preferred by the physicians working in the clinic and selective screening was ended since the introduction of the cheaper ELISA for diagnosis in men. The risk profile of *C trachomatis*-infected women had not changed between 1986-1988 and 1993, but it had changed for men. Monitoring of predictors for *C trachomatis* infection is advocated. If the decrease in *C trachomatis* prevalence continues in the next few years, the criteria for screening need to be adjusted because the risk profiles for *C trachomatis* infections may have altered and universal screening may no longer be cost-effective over a predictor-based programme for selective screening.

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1 Nugent RP, Hillier SL for the investigators of the Johns Hopkins study of cervicitis and adverse pregnancy out-

- come. Mucopurulent cervicitis as a predictor of chlamydial infection and adverse pregnancy outcome. *Sex Transm Dis* 1992;19:198-202.
- 2 Rahm V-A, Gnarp H, Odland V. *Chlamydia trachomatis* among sexually active teenage girls. Lack of correlation between chlamydial infection, history of the patient and clinical signs of infection. *Br J Obstet Gynaecol* 1988; 95:916-9.
- 3 Malotte KC, Wiesmeier E, Gelineau KJ. Screening for chlamydial cervicitis in a sexually active university population. *Am J Public Health* 1990;80:469-71.
- 4 Theijs H, Rahm V-A, Rosen G, Gnarp H. Correlation between chlamydia infection and clinical evaluation, vaginal wet smear, and cervical swab test in female adolescents. *Am J Obstet Gynecol* 1987;157:974-6.
- 5 Parsons WL, Godwin M, Robbins C, Butler R. Prevalence of cervical pathogens in women with and without inflammatory changes on smear testing. *BMJ* 1993;306: 1173-5.
- 6 Handsfield HH, Jasman LL, Roberts PL, Hanson VW, Kothencbeutel RL, Stamm WE. Criteria for selective screening for *Chlamydia trachomatis* infection in women attending family planning clinics. *JAMA* 1986;255: 1730-4.
- 7 Addiss DG, Vaughn ML, Holzhuetter MA, Bakken LL, Davis JP. Selective screening for *Chlamydia trachomatis* infection in nonurban family planning clinics in Wisconsin. *Fam Plann Perspect* 1987;19:252-6.
- 8 Addiss DG, Vaughn ML, Golubjatnikov R, Pfister J, Kurtycz DFI, Davis JP. *Chlamydia trachomatis* infection in women attending urban midwestern family planning and community health clinics: risk factors, selective screening and evaluation of non-culture techniques. *Sex Transm Dis* 1990;17:138-46.
- 9 Addiss DG, Vaughn ML, Ludka D, Pfister J, Davis JP. Decreased prevalence of *Chlamydia trachomatis* infection associated with a selective screening program in family planning clinics in Wisconsin. *Sex Transm Dis* 1993; 20:28-35.
- 10 Stergachis A, Scholes D, Heidrich FE, Sherer DM, Kolmes KK, Stamm WE. Selective screening for *Chlamydia trachomatis* infection in a primary care population of women. *Am J Epidemiol* 1993;138:143-53.
- 11 van den Hoek JAR, van Haastrecht HJA, Fennema JSA, Kint JAPCM, van Doornum GJJ, Coutinho RA. Voorkomen en risicofactoren van infectie met *Chlamydia trachomatis* bij bezoekers van een geslachtsziekten polikliniek in Amsterdam (in Dutch) *Ned Tijdschr Geneesk* 1989;133:2392-6.
- 12 Ossewaarde JM, Rieffe M, van Doornum GJJ, Henquet CJM, van Loon AM. Detection of amplified chlamydial DNA using a microtiter plate-based enzyme immunoassay. *Eur J Clin Microbiol Infect Dis* 1994;13: 732-41.
- 13 Thewessen EAPM, van der Meijden WI, Doppenberg HJAT, Mulder PGH, Wagenvoort JHT, Stolz E, Michel MF. Screening for cervical *Chlamydia trachomatis* infections in two Dutch populations. *Genitourin Med* 1990; 66:361-6.
- 14 Hart G. Factors associated with genital chlamydial and gonococcal infection in females. *Genitourin Med* 1992; 68:217-20.
- 15 Hook EW III, Reichart CA, Upchurch DM, Ray P, Celentano D, Quinn TC. Comparative behavioural epidemiology of gonococcal and chlamydial infections among patients attending a Baltimore, Maryland, sexually transmitted disease clinic. *Am J Epidemiol* 1992; 136:662-72.
- 16 Barnes RC, Katz BP, Rolfs RT, Batteigner B, Caine V, Jones RB. Quantitative culture of endocervical *Chlamydia trachomatis*. *J Clin Microbiol* 1990;28:774-80.
- 17 Pereira LH, Embil JA, Haase DA, Manley KM. Cytomegalovirus infection among women attending a sexually transmitted disease clinic: association with clinical symptoms and other sexually transmitted diseases. *Am J Epidemiol* 1990;131:683-92.
- 18 Lin J-S, Jones WE, Yan L, Withwein KA, Flaherty EE, Haivanis RM, Rice PA. Underdiagnosis of *Chlamydia trachomatis* infection. Diagnostic limitations in patients with low-level infection. *Sex Transm Dis* 1992;19: 259-65.
- 19 Rietmeijer CAM, Judson FN, Boele van Hensbroek M, Ehret JM, Douglas JM. Unsuspected *Chlamydia trachomatis* in heterosexual men attending a sexually transmitted disease clinic: evaluation of risk factors and screening methods. *Sex Transm Dis* 1991;19:28-35.
- 20 Hart G. Factors associated with genital chlamydial and gonococcal infection in males. *Genitourin Med* 1993;69: 393-6.
- 21 Magder LS, Harrison HR, Ehret JM, Anderson TS, Judson FN. Factors related to genital *Chlamydia trachomatis* and its diagnosis by culture in a sexually transmitted disease clinic. *Am J Epidemiol* 1988;28:298-308.
- 22 CDC. Recommendations for the prevention and management of *Chlamydia trachomatis* infections, 1993. *MMWR*; 42 (RR-11):1-36.
- 23 Weinstock HS, Bolan GA, Kohn R, Balladares C, Back A, Oliva G. *Chlamydia trachomatis* infection in women: a need for universal screening in high prevalence populations? *Am J Epidemiol* 1992;135:41-7.
- 24 Schachter J, Stonet E, Moncada J. Screening for chlamydial infections in women attending family planning clinics. Evaluation of presumptive indicators for therapy. *West J Med* 1983;138:375-9.
- 25 Winter L, Goldy S, Baer C. Prevalence and epidemiologic correlates of *Chlamydia trachomatis* in rural and urban populations. *Sex Transm Dis* 1990;17:30-6.
- 26 Kent GP, Harrison R, Berman SM, Keenlyside RA. Screening for *Chlamydia trachomatis* infection in a sexually transmitted disease clinic: comparison of diagnostic tests with clinical and historical risk factors. *Sex Transm Dis* 1988;15:51-7.
- 27 de Barbeyrac B, Pellet I, Dutilh B, Bébéar C, Dumon B, Géniaux M, Bébéar Ch. Evaluation of the *Amplicor Chlamydia trachomatis* test versus culture in genital samples in various prevalence populations. *Genitourin Med* 1994;70:162-6.
- 28 Kessler HH, Pierer K, Stuenkel D, Auger-Grumbach P, Haller E-M, Marth E. Rapid detection of *Chlamydia trachomatis* in conjunctival, pharyngeal and urethral specimens with a new polymerase chain reaction assay. *Sex Transm Dis* 1994;21:191-5.
- 29 Bianchi A, Scieux C, Brunat N, Vexiau D, Kermanach M, Pezin P, Janier M, Morel P, Lagrange PH. An evaluation of the polymerase chain reaction *Amplicor Chlamydia trachomatis* in male urine and female urogenital specimens. *Sex Transm Dis* 1994;21:196-200.
- 30 van Haastrecht HJA, van den Hoek JAR, Coutinho RA. Evidence for a change in behaviour among heterosexuals in Amsterdam under the influence of AIDS. *Genitourin Med* 1991;67:199-206.
- 31 Prins M, Bindels PJE, Coutinho RA, Henquet CJM, Doornum GJJ van, Hoek JAR van den. Determinants of penicillinase producing *Neisseria gonorrhoeae* infections in heterosexuals in Amsterdam. *Genitourin Med* 1994;70: 247-52.