- 2 Hillman BJ. Evaluating magnetic resonance: what do we need to know? *Invest Radiol* 1986;21:289-91.
- 3 St Leger AS, Allen D, Rowsell KV. Procedures for evaluating innovative proposals. *BMJ* 1989;299:1017-8.
- 4 Dixon AK, Kelsey FI, Kingham JGC, McLean AM, White FE. Computed tomography in patients with an abdominal mass: effective and efficient? A controlled trial. *Lancet* 1981;i:1199-201.
- 5 Russell I, Williams A. Evaluation of computerised tomography: a review of research methods. In: Culyer AJ, Horisberger B, eds. *Economic and medical evaluation of health care techniques*. Berlin: Springer Verlag, 1983:298-379.
- 6 Anonymous. Body computed tomography: wanted or needed? [Editorial]. *Lancet* 1984;ii:961-2.
- 7 Moore AT, Dixon AK, Rubenstein D, Wheeler T. Cost benefit evaluation of body computed tomography. *Health Trends* 1987;19:8-12.
- 8 Cooper LS, Chalmers TC, McCally M, Berrier J, Sacks HS. The poor quality of early evaluations of magnetic resonance imaging. *JAMA* 1988;259:3277-80.
- 9 Shuman WP. The poor quality of early evaluations of MR imaging: a reply. *AJR* 1988;151:857-8.
- 10 Hillman BJ. The assessment of MR imaging. *AJR* 1988;151:858-60.
- 11 Siegel S, Castellau NJ. *Nonparametric statistics for the behavioural sciences*. New York: McGraw-Hill, 1988:298-303.
- 12 Gudex C, Kind P. *The QALY toolkit*. York: Centre for Health Economics, University of York, 1988. (Discussion paper No 38.)
- 13 Kind P, Rosser R, Williams A. Valuation of quality of life: some psychometric evidence. In: Jones-Lee MW, ed. *The value of life and safety*. Amsterdam: North-Holland, 1982:159-70.
- 14 Anonymous. The value of diagnostic tests [Editorial]. *Lancet* 1979;i:809-10.
- 15 Teasdale GM, Hadley DM, Lawrence A, et al. Comparison of magnetic resonance imaging and computed tomography in suspected lesions in the posterior cranial fossa. *BMJ* 1989;299:349-55.
- 16 Franken EA, Berbaum KS, Dunn V, et al. Impact of MR imaging on clinical diagnosis and management: a prospective study. *Radiology* 1986;161:377-80.
- 17 Kent DL, Larson EB. Magnetic resonance imaging of the brain and spine—is clinical efficacy established after the first decade? *Ann Intern Med* 1988;108:402-24.
- 18 Greenfield S. The state of outcome research: are we on target? *N Engl J Med* 1989;320:1142-3.

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Prevalence of *Chlamydia trachomatis* infection in women having cervical smear tests

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Abstract

Objective—To determine the prevalence of sexually transmitted diseases in patients with normal and abnormal cervical smears.

Design—A prospective study of asymptomatic women with normal cervical smears attending their general practitioner and newly referred patients with abnormal smears attending a colposcopy clinic.

Setting—A hospital based colposcopy clinic and an urban general practice (list size 5500) in north west Glasgow.

Subjects—197 asymptomatic women attending their general practitioner for cervical smear tests and 101 randomly selected patients attending the colposcopy clinic for investigation of abnormal smears

Main outcome measures—Presence of various sexually transmitted infections as determined by culture and serological tests.

Results—Of the 101 women with cytological abnormalities, six had current chlamydial infection proved by culture and none had gonococcal infection; of the 197 women with normal smears, 24 (12%) had a chlamydial infection and two had gonorrhoea. Serological studies for *Chlamydia trachomatis* specific antibody also indicated that a large proportion of patients had been exposed to this agent in both groups. There was no significant difference between the groups in the prevalence of any sexually transmitted disease studied.

Conclusion—A high prevalence of chlamydial infection is present in women in north west Glasgow irrespective of their cervical cytological state.

Introduction

The prevalence of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, herpes simplex virus, *Candida albicans*, and *Trichomonas vaginalis* infections in women varies with the clinical setting. In previous studies of asymptomatic women in general practice the prevalences of *C trachomatis* and *N gonorrhoeae* were 10.7%¹ and 0.9%² respectively, and prevalences of 3.8%^{3,4} and 1.8%⁵ respectively were recorded in hospital gynaecology practice. Controversy surrounds the prevalence of chlamydial infection as highly variable rates have been measured in different studies. Screening tests for chlamydia have not been readily available to general practitioners, and many doctors are not aware of the

local prevalence rate. This is an important factor when considering whether to screen asymptomatic patients.

Cervical intraepithelial neoplasia is associated with exposure to multiple sexual contacts, a feature which also predisposes to the acquisition of sexually transmitted diseases.⁶ No study has compared the prevalence of sexually transmitted diseases in patients attending a colposcopy clinic for cytological abnormalities with that in patients in general practice from the same area whose smears are normal. We report such a study in north west Glasgow.

Patients and methods

REFERRALS TO COLPOSCOPY CLINIC

One hundred and one patients attending the colposcopy clinic at Stobhill Hospital were enrolled over one year. All were a subsample of consecutive new referrals selected at random. They had abnormal cytological findings as categorised by Papanicolaou class II with atypia (borderline nuclear abnormality; 20 cases) class III (mild to moderate dyskaryosis; 72 cases), class IV (severe dyskaryosis; eight cases), or class V (malignant cells; one case). All socioeconomic classes were represented, but most patients were in social class III. The age range of the patients was 19-58 years (mean 30).

At the initial visit full microbiological investigation was performed for *C trachomatis*, *N gonorrhoeae*, *T vaginalis*, *C albicans*, and herpes simplex virus. Swabs taken from the urethra, endocervix, and rectum were directly plated on to Thayer's medium for culture of *N gonorrhoeae* and the plates incubated at 37°C in a carbon dioxide enriched atmosphere for 48 hours. Cervical smears were obtained using an Ayres spatula. Tests for *C trachomatis* were performed by culture in McCoy cells on swab samples obtained from the endocervix. Positive cultures were identified when monoclonal antibodies (Microtrak-SYVA, United Kingdom) bound successfully to chlamydial inclusions.

In addition, blood was drawn for serological tests for chlamydia. Microimmunofluorescence tests were performed for *C trachomatis* strains D-K by using an antigen pool (IOL P2). Reciprocal antibody titres of *C trachomatis* specific IgG and IgM were evaluated for each sample and interpreted as: IgG titre <16, probably no previous exposure to a chlamydial agent; IgG titre >128, suggestive evidence of recent infection; IgG

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titre 16-128, evidence of past infection; IgM positive, evidence of probable current infection. Similarly, tests for *Chlamydia psittaci* (IOL 395) and *Chlamydia pneumoniae* (IOL 297) were performed to aid chlamydial evaluation but the results are not presented here.

A further endocervical swab was taken for tissue culture of herpes simplex virus. High vaginal swabs were taken and inoculated on to Sabouraud's medium and into trichomonas medium (Lab M) for culture of *C albicans* and *T vaginalis* respectively. After taking the swabs and the smear a full colposcopic assessment of the cervix was performed.

ATTENDERS IN GENERAL PRACTICE

One hundred and ninety seven asymptomatic patients attending for routine cervical smears were enrolled over two years in a single urban general practice in north west Glasgow comprising three partners and one trainee and with a list size of 5500. Patients with abnormal cervical smears were routinely referred to the colposcopy department at Stobhill Hospital. The enrolled patients with normal cytology were matched for age with those enrolled at the colposcopy clinic (range 19-58 years; mean 30). All socioeconomic classes were represented, most patients being in social class III. Endocervical and high vaginal swabs were taken and placed in Stuart's transport medium for culture of *N gonorrhoeae*, *C albicans*, and *T vaginalis*. Swabs taken from the endocervix were placed in chlamydial transport medium for culture of chlamydiae. Both Stuart's medium and chlamydial swabs were delivered to the laboratory the same day. Blood samples taken for serological study were analysed for chlamydial antibodies as described above. A Papanicolaou smear was taken with an Ayres spatula.

MANAGEMENT OF INFECTION

In both groups patients diagnosed as having *N gonorrhoeae* were referred to the genitourinary physicians. Patients with *C trachomatis* and *T vaginalis* were treated appropriately, as were their partners. Those patients in whom infection with *C albicans* was giving rise to symptoms were treated whereas patients in whom the infection was not causing symptoms were not.

STATISTICAL ANALYSIS AND ETHICS

Statistical analysis was by Fisher's exact test or the χ^2 test, as appropriate, depending on the number of positive results. p Values ≤ 0.05 were taken as significant.

The study was approved by the ethical committee, and all patients gave informed consent before enrolment.

Results

The table gives the culture and serological results in the two groups of patients. There was no significant difference between the groups in the results for *C*

trachomatis. Culture and serological results are not mutually exclusive whereas serological findings are. *C trachomatis* was cultured in six of the 101 patients with abnormal cervical smears and 24 (12%) of the 197 patients with normal smears. Thirteen patients with abnormal smears and 31 (16%) with normal smears had serological findings suggestive of probable current or recent infection (IgM positive or IgG titre >128). On summing all serological tests antibodies to *C trachomatis* were detected in 32 patients (32%) with abnormal smears and 67 patients (34%) with normal smears.

There was also no significant difference between the groups in the prevalences of infection with *N gonorrhoeae*, *T vaginalis*, and *C albicans* (table). The findings, however, disclosed an appreciable silent problem within general practice.

Discussion

This study found no significant difference in infection rates between patients with normal and abnormal cervical smears. A high prevalence of genital *C trachomatis* infection (6% and 12% of patients in the two groups respectively) was determined by culture in asymptomatic patients in the Glasgow area.

The serological test used was the microimmunofluorescence test (Micro-IF) developed by Wang and Grayston,⁷ which has become established as a sensitive and specific test for chlamydial antibodies. Although useful in diagnosing recently acquired chlamydial infection in men with urethritis,⁸ the diagnostic use of this test in women is impaired by high background rates of chlamydial antibodies which can be measured in the absence of chlamydial isolation.⁹ The lack of specificity seen in some antibody studies may be explained by persistent antibody responses with or without chronic infections of internal organs, previously treated infections, and serological cross reactions with other non-genital chlamydial strains. Using "single antigen" or "whole inclusion" serological tests is likely to underestimate or overestimate respectively the prevalence of chlamydial antibodies specific for type. The microimmunofluorescence test with multiple antigens is a more reliable guide to type specific antibodies and has been particularly useful in prevalence studies such as this and in diagnosing chlamydial pneumonitis in neonates and the Fitz-Hugh-Curtis syndrome (perihepatitis) in women. The interpretation of chlamydial serological results, however, remains contentious.

In this study and with our criteria for interpreting the results of serological tests for *C trachomatis*, the prevalence of recent infection was increased by a further 4-6%. There also seemed to be a high rate of past infection (31 cases (31%) in the group with abnormal cervical smears, 59 cases (30%) in the group with normal smears). The high prevalence of chlamydial infection in our study, in other studies in the United Kingdom, and in other Western countries may warrant routine screening in women attending primary health care clinics. Although variations are seen due to differing demographic variables, factors associated with an increased risk of chlamydial infection are age (24 years or less), single marital state, use of oral contraceptives or no contraception, low socioeconomic class, intercourse with a new partner in the preceding two months, and living in an urban area.¹⁰ Some studies have found positive predictive variables for chlamydial infection¹¹ whereas others have not.¹² The decision whether to screen asymptomatic women should be based on the local prevalence rate. The high prevalence of chlamydial infection found in our series was presumably due to the population studied—that is, inner city, predominantly social class III.

Culture and serological results in the two groups of patients

	No (%) of women attending colposcopy clinic (n=101)	No (%) of women attending general practitioner (n=197)
<i>C trachomatis</i> (culture)	6 (6)	24 (12)
<i>C trachomatis</i> IgM positive	1 (1)	8 (4)
<i>C trachomatis</i> IgG titre >128	12 (12)	23 (12)
<i>C trachomatis</i> IgG titre 16-128	19 (19)	36 (18)
<i>C trachomatis</i> IgG titre ≤ 16	70 (69)	138 (70)
<i>T vaginalis</i> (culture)	1 (1)	6 (3)
<i>N gonorrhoeae</i> (culture)		2 (1)
<i>C albicans</i> (culture)	9 (9)	33 (17)
Herpes simplex virus (culture)		Not done

There was no significant difference between the groups in the prevalence of any infection studied.

Chlamydial infection is an important source of gynaecological morbidity, being commonly associated with acute and chronic pelvic inflammatory disease and therefore infertility.¹³ Both problems have a large impact on the provision of gynaecological services in a given area. Screening and treatment for chlamydial infection before transcervical instrumentation that breaches the internal cervical os may prevent iatrogenic pelvic inflammatory disease,¹⁴ especially when retained products of conception within the uterine cavity provide an ideal medium for bacterial growth. We think that in cases of termination of pregnancy our results justify prior screening for chlamydia in the west of Scotland and in other areas with similar prevalence rates. If screening facilities are lacking, prophylaxis may be justified. Screening has been endorsed by workers elsewhere in the United Kingdom.³

The high percentage of women with asymptomatic genital chlamydial infection makes the use of effective antibiotics—for example, a tetracycline or erythromycin—important in cases of pelvic inflammatory disease and suspected postpartum and postabortion endometritis. Treatment of the partners of patients with genital chlamydial infection is recommended in order to prevent reinfection and reduce the pool of genital chlamydial strains within the general population. For the gynaecologist this may entail shared management with the genitourinary physicians. In our study the prevalence of other sexually transmitted diseases was very low, which may reflect regional differences. This low prevalence, however, should not be regarded as unimportant.

We have detected a high incidence of chlamydial infection in both general practice and colposcopy clinics in Glasgow. General practitioners and gynaecologists should be more aware of the importance of investigating and treating chlamydial infection in both asymptomatic women and their partners.

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- 1 Longhurst HJ, Flower N, Thomas BJ, et al. A simple method for the detection of Chlamydia trachomatis infections in general practice. *J R Coll Gen Pract* 1987;37:255-6.
- 2 Krogh C, Van Kirk J. A study of routine gonorrhea cultures in a family practice. *J Fam Pract* 1987;24:597-600.
- 3 Fish ANJ, Fairweather DVI, Oriel JD, Ridgway GL. Chlamydia trachomatis infection in a gynaecology clinic population: identification of high-risk groups and the value of contact tracing. *European Journal of Obstetrics and Gynaecology* 1989;31:67-74.
- 4 Ridgway GL, Mumtaz G, Stephens RA, Oriel JD. Therapeutic abortion and chlamydial infection. *BMJ* 1983;286:1478-9.
- 5 Mills A. Therapeutic abortion and chlamydial infection. *BMJ* 1983;286:1649.
- 6 Alberico S, Facca MC, Di Bonito L, Millo R, Casaccia R, Mandruzzato GP. Frequency of cervicovaginal infections in cervical intraepithelial neoplasia. *Eur J Gynaecol Oncol* 1988;9:252-7.
- 7 Wang S-P, Grayston T. Human serology in Chlamydia trachomatis infection with microimmunofluorescence. *J Infect Dis* 1974;130:388-97.
- 8 Bowie WR, Wang S-P, Floyd AJ, et al. Etiology of non-gonococcal urethritis: evidence for Chlamydia trachomatis and Ureaplasma urealyticum. *J Clin Invest* 1977;59:735-42.
- 9 Schacter J, Cles L, Ray R, Hines PA. Failure of serology in diagnosing chlamydial infection of the female genital tract. *J Clin Microbiol* 1979;10:647-9.
- 10 Aral SO, Holmes KK. Epidemiology of sexually transmitted diseases. In: Holmes KK, Mardh PA, Sparling PF, Weissner PJ, eds. *Sexually transmitted diseases*. New York: McGraw-Hill, 1984:126-41.
- 11 Handsfield HH, Jarman LL, Roberts PL, et al. Criteria for selective screening for Chlamydia trachomatis infection in women attending family planning clinics. *JAMA* 1986;255:1730-4.
- 12 Wood PL, Hobson D, Rees E. Genital infections with Chlamydia trachomatis in women attending an antenatal clinic. *Br J Obstet Gynaecol* 1984;91:1171-6.
- 13 Hare MJ. Pelvic inflammatory disease. *BMJ* 1986;293:1225-8.
- 14 Southgate L, Trehan J, Williams R. Detection, treatment, and follow up of women with Chlamydia trachomatis infection seeking abortion in inner city general practices. *BMJ* 1989;299:1136-7.

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Ventilatory function as a predictor of fatal stroke

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Abstract

Objective—To investigate the relation between ventilatory function and subsequent mortality due to cerebrovascular disease.

Design—Prospective longitudinal study.

Subjects—A total of 18403 male civil servants aged 40-64 years at entry examination for the Whitehall study.

Main outcome measure—Mortality from cerebrovascular disease (ICD8 430-438) after 18 years of follow up.

Results—In all, 262 men with sinus rhythm at entry died due to stroke during the 18 years of follow up. Compared with men with a forced expiratory volume in one second of ≥ 3.5 litres those with a value of < 3.0 litres were almost twice as likely to die of cerebrovascular disease (rate ratio adjusted for age and systolic blood pressure=1.88, 95% confidence interval 1.32 to 2.69). This increased risk occurred within each tertile of systolic blood pressure. Nested case-control analyses were used to control precisely for confounding effects of age, height, and smoking (by matching) and employment grade and physiological risk factors (by modelling). The effect of forced expiratory volume in one second was independent of age, height, smoking habits, employment grade, blood pressure, weight, cholesterol concentration, glucose tolerance, electrocardiographic abnormalities, history of chest pain, and history of intermittent claudication.

Conclusions—Measurements of ventilatory function may assist clinical decisions about whether to treat mild hypertension. Impaired ventilatory function and stroke may share common causes.

Introduction

Reduced ventilatory function is a predictor of mortality due to cardiovascular causes and non-fatal coronary heart disease.¹⁻⁸ Four studies have reported specifically the relation of ventilatory function to subsequent fatal⁶ or non-fatal^{2,5,9} cerebrovascular disease. An inverse association between spirometric indices and stroke was found in each case, although in none did it reach conventional levels of significance when adjusted for other risk factors.

This paper explores the relation between ventilatory function and mortality due to cerebrovascular disease among a cohort of middle aged civil servants who were followed up for 18 years. It also updates earlier findings from this cohort that related cardiovascular risk factors to fatal stroke.¹⁰

Methods

STUDY POPULATION

For the Whitehall study death certificates were obtained for 19018 male civil servants who were examined during 1967-9.¹¹ This analysis was limited to the 18403 men aged 40-64 years at examination and to deaths

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