ORIGINAL ARTICLE

Screening for tuberculosis: the port of arrival scheme compared with screening in general practice and the homeless

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Thorax 2002;**57**:45–49

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Revised version received 23 August 2001
Accepted for publication 29 August 2001

Background: Tuberculosis is increasing in London, especially in those recently entering the UK from an area of high incidence. Screening through the port of arrival scheme has a poor yield and has been considered discriminatory.
Methods: A study was undertaken to compare the yield and costs of screening new entrants in a hospital based new entrants' clinic (1262 referrals from the port of arrival), general practice (1311 new registrations), and centres for the homeless (267 individuals) using a symptom questionnaire and tuberculin testing if indicated. Clinical outcome measures were cases of tuberculosis, tuberculin reactors requiring chemoprophylaxis and BCG vaccinations. Cost outcomes were cost per individual screened and cost per individual per case of tuberculosis prevented.
Results: Verbal screening limited tuberculin testing to 16% of those in general practice; most were tested at the other two locations. Intervention (BCG vaccination, chemoprophylaxis or treatment) occurred in 27% of those who received tuberculin testing. Attendance for screening was 17% of the port of arrival notifications (63% had registered with a GP), 54% in primary care, and 67% in the homeless (42% registered with a GP). Costs for screening an individual in general practice, hostels for the homeless, and the new entrants' clinic were £1.26, £13.17 and £96.36, respectively, while the cost per person screened per case of tuberculosis prevented was £6.32, £23.00, and £10.00, respectively. The benefit of screening was highly sensitive to the number of cases of tuberculosis identified and case holding during treatment.
Conclusion: Screening for tuberculosis in primary care is feasible and could replace hospital screening of new arrivals for those registered with a GP.

The incidence of tuberculosis in Greater London has risen from 23 to 35 per 100 000 over the last 10 years, against a general fall in notifications.[1 2] The highest rates occur in those recently arrived in the UK.[3] Tuberculosis fulfils most of the criteria set by Barker and Rose as a disease suitable for screening.[4] It is an important disease with a high prevalence globally, transmitted by inhalation of infected droplets coughed into the air by a person with smear positive pulmonary tuberculosis, producing disease in a minority (~10%) after a period of incubation.[5] Tuberculin testing identifies infected individuals with a high sensitivity, if poor specificity, and is safe, cheap and well tolerated.[6] Treatment is considered one of the most cost effective interventions of modern medicine[7] and preventive treatment before active disease develops is also effective.[8 9]

The port of arrival scheme currently offers screening for tuberculosis to those coming from an area of high incidence and who intend to stay in the UK for more than 6 months. This scheme has had a poor yield[10 11] and has been considered discriminatory.[12] We have compared this scheme with screening in general practice and in centres for the homeless.

METHODS

Setting

Hackney, an inner London borough in the East End, has a population of 205 000, 40% of whom are from ethnic minorities. The availability of cheap housing has made the borough a common first destination for new entrants and refugees. Screening took place in three settings: (1) a new entrants' clinic at the Homerton Hospital as part of the port of arrival scheme (1996); (2) a large general practice with academic affiliations (April 1997 to February 1998); (3) centres for the homeless comprising three hostels, an emergency accommodation centre, and a drop in centre (winter 1997/8). Lower Clapton health centre offers a registration health check which includes screening for tuberculosis; it has a list size of 10 500 patients with about 1000 new registrations each year. Comparison was therefore made with the previous year's port of arrival scheme to ensure that additional screening in primary care did not adversely affect the hospital based screening results.

Screening

The East London Tuberculosis Service has guidelines for the management of tuberculosis which are adapted from national recommendations.[13] New entrants are treated as "contacts", a variation endorsed by the subsequent recommendations of the Joint Tuberculosis Committee of the British Thoracic Society.[14] The East London Clinical Effectiveness Group at the local university department of general practice adapted these further. Name, sex, date of birth, and ethnicity/country of origin were recorded either manually on a proforma (new entrants' clinic and homeless screening) or on a prompting template developed for the EMIS general practice computer system. A simple questionnaire elicited any relevant symptoms (cough, sputum, haemoptysis, fever, night sweats, weight loss, malaise, anorexia, or lymph gland enlargement), BCG vaccination status, and residence in an area with a high incidence of tuberculosis during the previous 18 months. No action was required if the individual:

- had no symptoms, was not a new entrant and had a BCG scar;
- had no symptoms or contact with tuberculosis and was over 35 years of age;
- had already been screened.

Tuberculin (Heaf) testing was offered to:

- all new entrants, contacts, and symptomatic individuals under 35 years of age;
- those without a visible BCG scar;
- all the homeless regardless of age (for practical reasons).

Those over 35 years of age with symptoms or considered to be a very high risk (such as refugees from a war zone) were offered a chest radiograph, sputum examination, and blood testing as appropriate. Those with a Heaf test grade 0 or 1 without a BCG scar were offered BCG vaccination at the time of reading. Further investigation was offered to those with a grade 2 response but no BCG scar and all those with a grade 3 or 4 response. Preventive treatment was not recommended for those with a confirmed grade 2 response and no evidence of tuberculosis.

Access to the health service

To determine whether screening at the different locations addressed different populations, we asked new entrants and the homeless if they were registered with a local general practitioner (GP). Previous hospital records were identified from entries on the Patient Administration System for the Homerton and Royal Hospitals NHS trusts, searching by name and date of birth.

Data analysis and statistics

Nursing costs were calculated from salaries and time taken for the screening. The costs of medical equipment and materials were calculated from the requirements of tuberculin skin testing (one Heaf gun per 1000 tests at £20, disposable heads at £1 each, and ampoules of tuberculin at £5.89, assuming an 80% efficiency of use). Clerical costs were calculated from salary and time taken with an estimate for stationery and computing. Treatment costs were calculated as £201 for investigations (three chest radiographs, six sputum microscopic examinations and culture for tuberculosis for diagnosis and confirmed cure, two full blood counts, eight liver function tests), an inpatient stay of £7.28 days at £198 per day, eight outpatient visits at £63 per visit, drug costs of £191, and contact tracing of £360 per smear positive case.[1] BCG vaccination assumed 12 minutes for explanation, consent, vaccination, and follow up at 6 weeks and £1 per vaccine dose. Overheads were included in the cost of outpatient visits but not for general practice as health registration checks were already taking place. Chemoprophylaxis was calculated as £220 for a series of outpatient visits with liver function tests and £11 for 6 months treatment with isoniazid.

In order to compare the different settings, costs were standardised as cost per case of tuberculosis prevented. To assess this a positive tuberculin skin test was estimated to have a 10% risk of tuberculosis within the first 2 years of the test based on trials of chemoprophylaxis and local estimates of HIV infection in the new entrant population.[15–17] Statistical models of tuberculosis have consistently shown that each case of tuberculosis results in an average of 4.5 further cases, 3 (2.2–3.8) of which develop early.[18] Cases of tuberculosis prevented in the first 2 years after screening were included but not more distant prevention. An estimated 3600 BCG vaccinations are required to prevent one case of tuberculosis.[19] Attendance among the homeless population was defined as those returning for reading their Heaf test.

Comparisons were made using the χ^2 test. 95% confidence intervals for the incidence of tuberculosis were calculated using the direct standardisation method described by Morris and Gardner.[20]

RESULTS

Port of arrival scheme

The port of arrival notified 1262 new entrants as residents of Hackney in 1996. Two hundred and thirty five (18.6%) attended following an invitation for screening at the Homerton Hospital; complete data were available for 199 (table 1). Only 28 (12%) were over 35 years of age and 87 (37%) were under 16 years. Comparing ethnic groups, fewer new entrants from the Indian subcontinent attended (13/159 *v* 168/1103, $\chi^2=5.3$, $p<0.05$) but more had already registered with a GP (11/13 *v* 105/172). Three cases of tuberculosis were identified giving a point incidence of 1546 per 100 000 (lower 95% confidence level 197 per 100 000). All three had smear negative pulmonary disease; two had registered with a GP. Children under 16 accounted for eight BCG vaccinations and two preventive treatments.

Recent arrivals in Hackney tend to move frequently, staying with friends or relatives before finding a more settled home.

Table 1 Details and outcome of tuberculosis screening at three sites

	New entrants (total number of individuals)		
	Hospital	Homeless	General practice
Offered screening	1262	172 (267)	NK (1311)
Screened for tuberculosis	199*	172 (262)	45 (742)
Age >35 years with symptoms	3	4† (4)	0
Tuberculin Heaf tests	181	172 (262)	39 (117)
Non-attendance	54	45 (86)	9 (29)
Grade 0 or 1, BCG scar	0	0	4 (32)
Grade 0 or 1, no BCG scar	18	18 (29)	4 (14)
Grade 2	100	84 (111)	14 (28)
Grade 3 or 4	9	13 (21)	8 (14)
Outcome			
BCG vaccination	18	27	14
Chemoprophylaxis (started)	6	11	2
Chemoprophylaxis (completed)	5	6	2
Tuberculosis diagnosed	3	0	0
Access to NHS			
Registered with a GP (%)	62.7	41.9	100
Notified by port of arrival	All	9/172	0/45

NK=not known. *235 individuals were seen, but notes were missing for 36. †As tuberculin testing was carried out on all individuals, a further eight had a chest radiograph because of a positive (grade 3 or 4) tuberculin skin test, only one of whom was "white UK".

Administrative delays meant that appointments were often sent to addresses long since vacated. Almost two thirds (116 of 185 with PAS records known to have been completed before screening) had registered with a GP. During the same year 12 new entrants with tuberculosis who were resident in Hackney were referred by GPs and 12 by the accident and emergency department (19 of whom had been referred by the port of arrival scheme). We therefore examined the yield from screening in general practice.

Screening in general practice

Over half of all new patients registering with the Lower Clapton health centre attended for a registration health check. After questioning, only 16% required tuberculin skin testing (table 1). Although new entrants accounted for only 6% of all those screened, most (39/45) met the criteria for tuberculin skin testing. All of those with a grade 0 or 1 Heaf test response and no BCG scar were vaccinated. In contrast, only two of 14 with a positive Heaf test started (and completed) chemoprophylaxis. Five failed to attend the hospital for chemoprophylaxis, five proved to have a grade 2 response (one of whom developed tuberculosis in a neck lymph node the following year), one declined treatment as she was pregnant, and one had already received a course of preventive treatment. No new case of tuberculosis was identified. Opportunistic screening using the protocol resulted in a new diagnosis of tuberculosis in a Rwandan refugee who had registered at the practice shortly before screening for tuberculosis had begun (this case is not included in this analysis).

Screening in the homeless

An audit of the new entrants' clinic had identified those living in hostels or temporary accommodation as being least likely to have registered with a GP. We therefore targeted this population for screening in view of the high incidence noted in this group.[21]

Two thirds of the homeless population studied had been born abroad. Only one family declined screening out of the 267 approached. Four of those screened had symptoms that could have been due to tuberculosis, but only two of these came to the hospital for further investigation and in both an alternative diagnosis was made. One person had been treated for tuberculosis in the past. Attendance for reading of the Heaf test was especially poor in those born in the UK (41/90 failed to attend compared with 45/172 new arrivals; $\chi^2=10.1$, $p<0.01$). Only six of the 21 in whom it was recommended completed 6 months' preventive treatment with isoniazid (table 1). BCG vaccination was offered at the time of reading the Heaf test and was accepted by most (27/29). None of the hostel workers or their families gave a positive Heaf test (grades 3 or 4), although two of their children required BCG vaccination. Registration with a GP was especially likely if they had been born in the UK (51/90, 57%) compared with those born abroad (72/172, 42%; $\chi^2=5.1$, $p<0.05$). Although 103 had arrived in the UK in the previous 2 years, only nine had been referred by the port of arrival and four of these had attended the new entrants' clinic.

Comparison of screening yield and cost effectiveness

Failure to attend for reading of the tuberculin test was common (table 1). Having read the tuberculin test, the mean rate of intervention was 26.9%. The costs per person screened per case of tuberculosis prevented were comparable between primary care and the new entrants' clinic (£6.32 and £10, respectively) and were cheaper than screening the homeless (£23). Differences in the incidence of tuberculosis in the population screened accounted for the greater cost effectiveness of the new entrants' clinic (table 2). Sensitivity analysis demonstrated the important effect of identifying a case of tuberculosis. If a further case was detected at each location, the total costs per screened subject would become savings of £33, £6, and £11 for hospital based screening, general practice, and the homeless, respectively.

Improved case holding of those recommended for chemoprophylaxis would have had a significant effect on the cost effectiveness of the screening. Both patients who started preventive treatment from general practice completed their treatment, but a further five might have required treatment if they had visited the hospital. If all seven had received preventive treatment, screening in general practice would have been cost

Table 2 Costs of screening for tuberculosis

	Costs (savings) (£)		
Cost centre	Hospital	Homeless	General practice
Nursing*	7440	504	216
Medical equipment and materials†	476	287	207
Clerical‡	5185	18	Not applicable
Subtotal: screening process	13101	809	423
Treatment§	9477	2541	462
BCG vaccination¶	68	102	53
Subtotal: treatment costs	9545	2643	515
Total costs	**22646**	**3452**	**938**
Savings [no of cases prevented]**	(25 621) [9.5]	(1618) [0.6]	(594) [0.2]
Total	**(2976)**	**1834**	**344**
Cost per person screened	(12.7)	0.5	7
Cost per person screened per case prevented	10	22	6.32

*Calculated as time and % salary. General practice required 45 seconds for a verbal screening, 2.5 minutes for a Heaf test, and 2.5 minutes for the follow up reading; homeless screening required two half-days at each site for three nurses grades E, F and G; new entrant screening accounts for 40% of the tuberculosis nurse specialist at the Homerton Hospital. †Disposable Heaf gun heads £1 each; tuberculin costs £5.89 per 1 ml ampoule; Heaf guns cost £20 and can be used for 1000 tests. ‡Calculated as time and % of salary, including stationery. The additional cost to a registration health check was deemed negligible. §Chemoprophylaxis costs £220 for a series of outpatient visits and £11 for drugs; the cost for a case of tuberculosis is estimated at £2697, constituting £201 for investigations, an inpatient stay of 7.28 days at £198 per day, eight outpatient visits at £63 per visit, drug costs of £191, and contact tracing of £360 per smear positive case (35% of total[1]). ¶BCG vaccination assumes a total of 12 minutes for consent, vaccination, and follow up and £1 per vaccine dose. **Assumes that each case of tuberculosis gives rise to three others (or, more strictly, that infectious tuberculosis gives rise to nine other cases, three of which are infectious[18]) and that 10% of those infected have a life time risk of developing active tuberculosis.[8 9]

neutral (a saving of £1.28 per person screened). Similarly, if all 21 homeless individuals with a positive tuberculin test had received preventive treatment, there would have been a saving of £8.44 per subject screened.

DISCUSSION

This study shows that screening for tuberculosis in general practice as part of the registration health check is feasible. Screening was carried out entirely by the practice nurses and added less than 1 minute to the time for most patients who did not need a Heaf test. The initial costs of screening were minimal. Screening could be limited to a high risk group such as new entrants with a greater benefit:cost ratio, and might be more applicable to areas of the UK with a lower incidence of tuberculosis.

Could screening for tuberculosis be confined to general practice? Almost half of those registering with the Lower Clapton health centre did not attend for a registration health check. We have previously shown that health checks are subject to the "inverse care law"—that is, those who do not attend are likely to have increased morbidity and to come from a minority ethnic group.[22] A substantial proportion of homeless subjects and those attending the new entrants' clinic were not registered with a GP (table 1). Thus, the overlap with general practice was far from complete.

Could screening in general practice be limited to new entrants? The number of positive tuberculin responses did not differ significantly between new entrants and non-new entrants (table 1). Recent travel to an area where tuberculosis is endemic is an important risk factor for tuberculosis and may account for the rates of tuberculosis now being seen in ethnic minorities who have been born in the UK.[23] The homeless population in Hackney is unusual in its high proportion of new immigrants. Screening in general practice and in the homeless targeted groups at risk from tuberculosis because of their circumstances, whether overcrowding or moving into an area with a high incidence of tuberculosis, and was therefore inherently non-discriminatory. The port of arrival scheme had a low uptake[10 11]; no significant improvement or worsening of the scheme was observed in 1997 (5 year survey of new entrant screening, manuscript in preparation). Even so, the scheme was the most successful setting in which to discover new cases of tuberculosis and was also the most cost effective.

The cost-benefit analysis was highly sensitive to the number of cases of tuberculosis identified. Although no cases of tuberculosis were identified through registration health checks in general practice during the study period, opportunistic screening using the protocol detected a new case of tuberculosis in a Rwandan refugee who registered shortly before screening at registration began. There is a huge variation in the ability of an individual to infect another.[24] We used a conservative estimate of infection, including only those who would develop tuberculosis early,[18] considering that the analysis should only include benefits obtainable within a 1–2 year period. One could argue that late reactivation exacts a greater financial penalty due to late detection. The cost of treatment is also a conservative estimate. It has been suggested that each case of drug sensitive tuberculosis costs £6050 and a drug resistant case costs £53 600.[25] Treatment of tuberculosis in the United States, estimated at $12–13 000 per case, was affected by the costs of hospital stay but was otherwise similar to the higher estimate.[26] Costing of the tuberculosis service at the Homerton Hospital in 1997, including costs of treatment supervision, were estimated to be £4535 per patient treated.[27] Using the higher estimates, all three settings for screening would have been cost effective, even with the low estimates for preventing new cases of tuberculosis. Successful case holding for preventive treatment would have further enhanced the cost effectiveness of screening for tuberculosis.

One of the most contentious issues of this study was how to compare screening for tuberculosis at the different locations. We chose the index of cost per person screened per case of tuberculosis prevented. This index allows the three clinical outcomes (diagnosis of tuberculosis, preventive treatment, and BCG vaccination) to be combined. It is, however, subject to the estimates of the value of preventive treatment and early diagnosis of tuberculosis, which themselves are disputed, but for which we chose the lower estimates and short term outcomes. We could reasonably have claimed that each case of tuberculosis prevented by chemoprophylaxis would be the cause of disease in three other individuals before diagnosis and therefore that only 2.5% of those receiving preventive treatment would otherwise have developed tuberculosis to give the same estimate of benefit. As the cost of treating tuberculosis rises, the benefit of screening also increases. This index can be used to predict how frequently a case of tuberculosis must be identified in order for screening to be judged worthwhile (local cost of treating tuberculosis divided by the cost per person screened per case of tuberculosis prevented). We have tried to make the costs of screening as transparent as possible so that other locations can readily calculate their own costs and compare their screening programmes.

The diagnosis of tuberculosis in the new entrants' clinic was approximately that predicted from the annual incidence in the same population. The mean duration of symptoms of tuberculosis before attending for medical advice is 8 weeks.[28] The probability of finding three cases was therefore low and suggests that those with concerns about their health may have attended the clinic more frequently than those who felt well. In order to demonstrate that screening in general practice for tuberculosis at registration is indeed worthwhile, a randomised controlled trial comparing practices screening for tuberculosis with those carrying out "usual care" in an area with a high incidence would be helpful, perhaps with an emphasis on those who fail to attend for their pre-registration health check. Referral to secondary care could occur at any stage of the screening process—for example, at the time of registration, after the initial verbal screening for tuberculin testing or, as in this study, for positive reactors only.

This study has shown that screening in general practice for tuberculosis is feasible, cheap to introduce, and could prevent significant transmission by early diagnosis and preventive measures. The data are still not sufficiently secure to suggest replacing the port of arrival scheme with an assured registration health check in primary care. However, they do suggest how we might examine new ways of reducing the burden of tuberculosis in London and address the problems raised by dispersal of asylum seekers to areas of the country where tuberculosis has to date been well controlled.

ACKNOWLEDGEMENTS

The authors thank Sarah Mott for coordinating numerous revisions of the GP protocol for screening.

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GB, JR, MB and CvdB conceived the studies, all authors contributed to the design; GB, JR, MB, MM, EB and CG collected data; GB and CG wrote the paper with the other authors, revising the draft. GB is the guarantor.

Conflict of interest: none

Funding: none

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