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What happens to people diagnosed with tuberculosis? A population-based cohort

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SUMMARY

We examined different patient outcomes following diagnosis of tuberculosis (TB). Incident cases were reported to the enhanced surveillance system in the East of England, between 2000 and 2003. For the 575 cases reported in 2001 and 2002, outcomes were assessed 1 year after initiating treatment. The crude clinical incidence rate of TB was 6·0 cases/100 000 person-years (pyr) [95% confidence interval (CI) 5·7–6·4], highest in the 25–29 years age group (14·9, 95% CI 12·9–17·1 cases/100 000 pyr) and among Black Africans (328·6, 95% CI 286·9–374·6 cases/100 000 pyr). Patients born abroad were 2·35 (95% CI 1·03–5·32) times more likely to be lost to follow-up than those born in the United Kingdom. Age at diagnosis (OR 1·05, 95% CI 1·04–1·07) and pulmonary disease (OR 2·73, 95% CI 1·21–6·15) were independently associated with mortality. Elderly patients and those with pulmonary TB appear to have worse outcomes despite treatment. Foreign-born patients may need closer follow-up to ensure favourable outcomes.

INTRODUCTION

Tuberculosis (TB) poses a significant global disease burden particularly in Africa, Asia, Eastern Europe and Latin America [1–3]. In 2002, the estimated incidence in England, Wales and Northern Ireland was 12·9 cases/100 000 per year, while the corresponding rate of reported TB in the East of England was 6·6 cases/100 000 per year [4]. New cases of the disease predominantly occur amongst ethnic groups from high-incidence countries, the homeless and those with material deprivation [4–6]. The proportion of elderly patients with TB in the United Kingdom is also said to have risen [7], although recent findings indicate the highest prevalence amongst young adult males [4].

Patients who have sputum smears positive for acid-fast bacilli are more infectious than sputum smear-negative cases [8–11]. Moreover, delayed treatment of infectious index cases is associated with increased latent TB infection within a community [12, 13]. Consequently, prompt identification and successful treatment of patients and contacts, particularly those with sputum smear-positive pulmonary TB, are fundamental to controlling the spread of the disease.

In England and Wales, Enhanced Tuberculosis Surveillance started in 1999 with the purpose of continuously providing information on the epidemiology of TB including evaluation of disease trends in various population subgroups. In 2002, TB treatment

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outcome surveillance commenced as part of enhanced surveillance to provide data for determining the effectiveness of TB control [14, 15]. Effective control requires that patients complete their planned treatment and remain traceable by the health system. Identification of patients at risk of inadequate treatment could permit the tailoring of interventions to control TB.

Little published information is available on patient outcomes after diagnosis with TB in England. One previous study [16] indicated an increase in mortality from TB in the elderly, who are also less likely to complete their anti-TB treatment [7]. However, these studies either excluded children or were prone to misclassification of deaths. Furthermore, previous studies have seldom examined the characteristics associated with important patient outcomes. We aimed to describe patient outcomes one year after diagnosis of TB and commencement of treatment, and to explore the factors associated with treatment completion, loss to follow-up and mortality.

METHODS

Study population

The study was set in the East of England, which has a population of 5 400 000 (Office for National Statistics, 2001). Incident TB cases were those reported from 2000 to 2003. In a population-based prospective cohort design, cases of TB reported during the years 2001 and 2002 were followed up for a year after the date of reporting.

Data collection

Cases were reported by clinicians through Enhanced Tuberculosis Surveillance to the Regional Coordinator in the East of England (C.B.). A confirmed case of TB was one that had been verified by culture of *Mycobacterium tuberculosis* complex. Probable cases were diagnosed clinically and commenced on treatment in the absence of a positive culture. The total number of reported cases excluded those that had been de-notified, which refers to patients initially reported through enhanced surveillance but subsequently determined as not having TB or those who were only receiving chemoprophylaxis against the disease [15].

Outcome data was collected on standardized reporting forms by physicians and TB specialist nurses, and returned to the regional TB surveillance coordinator for collation. Forms were completed 10–12 months after the start of therapy. If outcome data had not been received for a case after fourteen months from the start of treatment, a reminder form was sent out.

Anonymized information on reported cases included demographic, clinical and bacteriological characteristics. Outcomes were classified as treatment completion, loss to follow-up and vital status one year after initiation of anti-TB therapy. Treatment completion was defined as successful completion of a prescribed course of anti-TB treatment within 12 months of commencement. Loss to follow-up included outcomes that were unknown to the clinician and those that were not reported to the surveillance coordinator. Reporting clinicians determined whether TB caused death (considered to be the main cause of death), contributed to death (considered to be contributory to death but was not the main cause) or was incidental to death (not related to death) or whether the association between TB and death was unknown. However, our analyses considered all-cause mortality.

Postcodes were linked to enumeration districts to produce the Townsend Index. This score is a composite measure of material deprivation based on four factors [17] (unemployment, overcrowding, car ownership and home ownership) derived from the 2001 population census for England and Wales, and takes into account the mean and standard deviation relative to England and Wales. A higher score denotes greater deprivation and a score above 0 implies that the deprivation was greater than the mean for England and Wales. Ward level Townsend scores were categorized into quartiles including least ($-5{\cdot}43$ to $-1{\cdot}14$), low ($-1{\cdot}13$ to $+1{\cdot}80$), high ($+1{\cdot}82$ to $+4{\cdot}73$) and highest deprivation ($+4{\cdot}74$ to $+8{\cdot}28$).

Statistical analysis

We estimated the crude, age, gender and ethnic-specific incidence rates of TB from cases reported to the surveillance unit of the East of England, between 2000 and 2003. Incidence rates were derived by dividing the number of reported cases by the person years (pyr) at risk, obtained by multiplying the estimates of the population of the East of England at the middle of the 4-year observation period (2001) by four. Rates were expressed per 100 000 pyr at risk.

Ninety-five per cent Poisson confidence intervals (95% CI) were calculated for incidence rates.

One year after initiation of anti-TB chemotherapy, the number and proportion of cases with available information on different TB treatment outcomes was determined. Independent *t* tests, Pearson χ^2 test and Fisher's exact test were used to compare the following patient characteristics between population subgroups: age, gender, country of birth, Townsend score, disease site, previous illness episode, sputum smear test result and number of years since entry to the United Kingdom for foreign-born cases. Stepwise logistic regression was used to examine the association between these variables and patient outcomes. We examined differences in characteristics of patients with missing data on covariates with those for whom data was available. For all statistical tests, a two-tailed *P* value $<0{\cdot}05$ was considered statistically significant. Analyses were performed using Intercooled STATA 8.0 (Stata Corporation, College Station, TX, USA).

RESULTS

Between 2000 and 2003, 1300 cases of TB were reported, 127 having been de-notified. The crude incidence rate of TB was 6·0 cases/100 000 pyr (95% CI 5·7–6·4). The highest incidence rate (14·9, 95% CI 12·9–17·1 cases/100 000 pyr) occurred in the 25–29 years age group, while the lowest was in the 10–14 years age group (0·8, 95% CI 0·4–1·4 cases/100 000 pyr). The age-adjusted incidence rates were 7·1 and 5·3 cases/100 000 pyr for males and females respectively. Black Africans had the highest rates (328·6, 95% CI 286·9–374·6 cases/100 000 pyr) while rates were lowest in the White ethnic group (2·3, 95% CI 2·1–2·5 cases/100 000 pyr). There was a positive correlation between TB incidence and the proportion of the population with a Townsend Index $\geqslant 0$ (Spearman's rank correlation coefficient $=0{\cdot}63$, $P<0{\cdot}001$).

Five hundred and eighty-four confirmed or probable cases of TB were initially reported during 2001 and 2002 (280 and 304 respectively); nine were found not to have TB and therefore excluded from the analysis. The characteristics of patients reported during 2001 and 2002 were not significantly different to those of patients reported in 2000 and 2003, and are shown in Table 1. A total of 343 (59·7%) patients had pulmonary TB and 124 (53·0%) of the pulmonary cases with known sputum smear results were positive for acid alcohol-fast bacilli. Extra-pulmonary disease was mostly localized to extra-thoracic lymph nodes (84, 36·2%), the pleura (33, 14·2%) and intra-thoracic lymph nodes (21, 9·0%). Other extra-pulmonary forms were TB of the bones (15, 6·5%) particularly the spine, gastrointestinal tract and peritoneum (9, 3·9%), the genitourinary system (8, 3·4%) and the central nervous system (7, 3·1%), especially meningitis. Eight (3·5%) patients had miliary or disseminated TB, 32 (13·8%) had mycobacteria localized in other body tissues, and 15 (6·5%) were diagnosed with TB in more than one extra-pulmonary site. The mean age of reported cases was 43·1 years (S.D. $=21{\cdot}2$), 55·2% were male.

Patient outcomes, following initiation of anti-TB therapy, are summarized in the Figure. In total, 439 (76·3%) patients completed treatment, 45 (7·8%) were lost to follow-up; 91 (15·8%) did not complete treatment of which 49 (53·8%) were reported to have died within a year of initiation of treatment.

Treatment completion

Patients who completed treatment were more likely to be younger (χ^2 for trend $=20{\cdot}8$, $P<0{\cdot}001$) and more deprived (χ^2 for trend $=5{\cdot}2$, $P=0{\cdot}023$). Patients with extra-pulmonary disease were also more likely to complete treatment compared to those with pulmonary TB (Table 1).

Loss to follow-up

Foreign-born patients were 2·35 (95% CI 1·03–5·32, $P=0{\cdot}041$) times more likely to be lost to follow-up compared to those born in the United Kingdom as shown in Table 2. Moreover, amongst the foreign-born cases, those who entered the United Kingdom more than 3 years prior to notification were less likely to be lost to follow-up than cases that were reported within 3 years of entry in the United Kingdom (Table 1). There was no significant association between deprivation and loss to follow-up.

All-cause mortality

A majority of deaths (57·1%) were reported to be TB-associated. Mortality was highest amongst older patients (χ^2 for trend $=50{\cdot}7$, $P<0{\cdot}001$), patients with pulmonary disease ($\chi^2=12{\cdot}2$, $P<0{\cdot}001$), patients born in the United Kingdom ($\chi^2=8{\cdot}3$, $P=0{\cdot}004$) and

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Table 1. *Characteristics of patients completing treatment or lost to follow-up within 12 months of initiation of anti-tuberculosis treatment*

	Number (%)* of cases					
	Treatment completion			Loss to follow-up		
Patient characteristic	Completed treatment ($n=439$)	Treatment not completed or outcome unknown ($n=136$)	P value†	Lost to follow-up ($n=45$)	Followed up ($n=530$)	P value†
Demographic characteristics						
Age group (years)			<0·001‡			0·085‡
0–24	87 (87·9)	12 (12·1)		8 (8·1)	91 (91·9)	
25–34	130 (79·3)	34 (20·3)		18 (11·0)	146 (89·0)	
35–49	83 (79·0)	22 (21·0)		8 (7·6)	97 (92·4)	
50–69	84 (73·0)	31 (27·0)		8 (7·0)	107 (93·0)	
⩾70	54 (59·3)	37 (40·7)		3 (3·3)	88 (96·7)	
Gender			0·135			0·584
Male	234 (74·1)	82 (25·9)		26 (8·2)	290 (91·8)	
Female	204 (79·4)	53 (20·6)		18 (7·0)	239 (93·0)	
Country of birth			0·185			0·036
UK-born	143 (75·7)	46 (24·3)		8 (4·2)	181 (95·8)	
Foreign-born	215 (80·8)	51 (19·2)		25 (9·4)	241 (90·6)	
Years since entry in the UK§			0·215			0·049
<4	114 (78·1)	32 (21·9)		22 (15·1)	124 (84·9)	
⩾4	77 (84·6)	14 (15·4)		6 (6·6)	85 (93·4)	
Townsend score			0·023‡			0·147, 0·921‡
−5·43 to −1·14 (least deprivation)	100 (69·9)	43 (30·1)		14 (9·8)	129 (90·2)	
−1·13 to +1·80	105 (76·1)	33 (23·9)		9 (6·5)	129 (93·5)	
+1·82 to +4·73	103 (78·6)	28 (21·4)		5 (3·8)	126 (96·2)	
+4·74 to +8·28 (highest deprivation)	109 (81·3)	25 (18·7)		14 (10·4)	120 (89·6)	
Disease attributes						
Site of disease			0·001			0·224
Extra-pulmonary	194 (83·6)	38 (16·4)		22 (9·5)	210 (90·5)	
Pulmonary	245 (71·4)	98 (28·6)		23 (6·7)	320 (93·3)	
Sputum smear test¶			0·555			0·574
Negative	81 (73·6)	29 (26·4)		6 (5·5)	104 (94·5)	
Positive	87 (70·1)	37 (29·8)		9 (7·3)	115 (92·7)	
Previous tuberculosis			0·057			0·298‖
No	354 (78·1)	99 (21·9)		37 (8·2)	416 (91·8)	
Yes	41 (67·2)	20 (32·8)		2 (3·3)	59 (96·7)	

* Missing data have been omitted.
† Pearson χ^2 test unless otherwise indicated.
‡ χ^2 test for trend.
§ Foreign-born cases.
¶ Pulmonary tuberculosis cases.
‖ Fisher's exact test.

those who reported a previous TB episode ($\chi^2=5·5$, $P=0·019$). Notably, few (8, 3·8%) patients with extra-pulmonary TB were reported to have died.

After adjustment for variables that remained significant during stepwise logistic regression, only increasing age [odds ratio (OR) 1·05, 95% CI 1·04–1·07]

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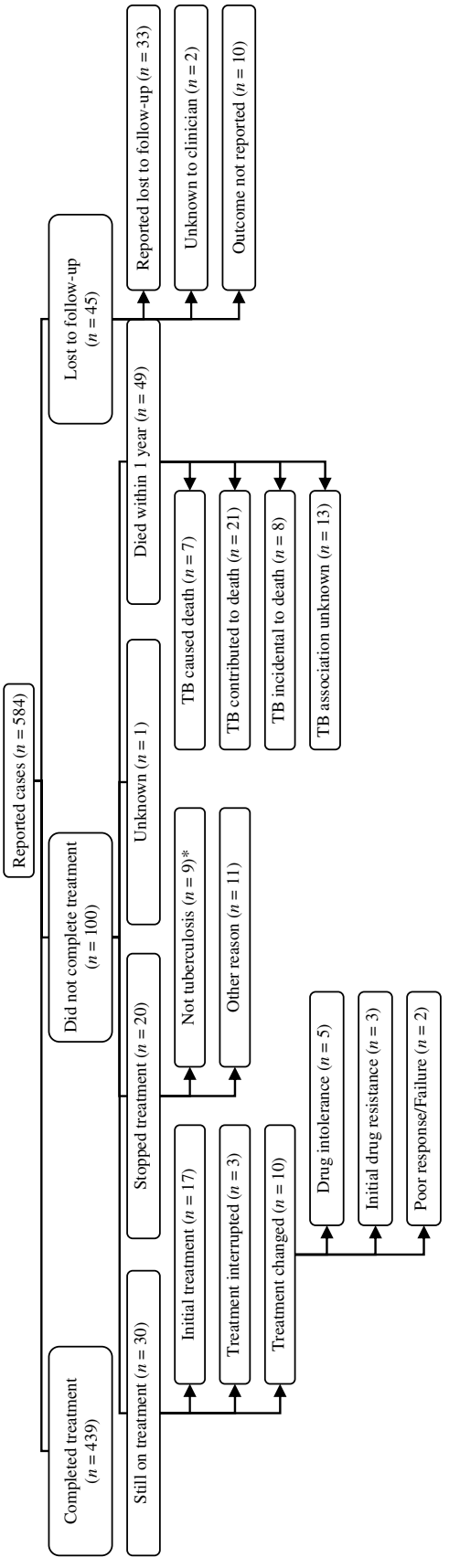

Fig. Treatment outcomes of tuberculosis (TB) cases reported through the TB treatment outcome surveillance in the East of England between 2001 and 2002 (* excluded from the analysis).

and pulmonary disease site (OR 2·73, 95% CI 1·21–6·15) were independently associated with mortality within 12 months (Table 2).

DISCUSSION

The clinically reported incidence of TB in this setting was low but differed considerably by ethnicity, as reported in other studies [4–7]. When incidence rates amongst various ethnic groups are compared, they appear to reflect those from the patients' places of birth. Consequently, the high incidence amongst Black Africans was similar to the rate in most of Sub-Saharan Africa [2]. The high background risk of infection could offer a partial explanation, especially because a majority of foreign-born cases reported recent entry in the United Kingdom [8]. However, whether infection predominantly occurs in the country of birth would require molecular studies on latent infection among foreign-born individuals.

Completion of prescribed anti-TB treatment is often used as an outcome measure. The majority of patients in this cohort completed their treatment. It is also evident that failure to report treatment completion was mainly because of longer durations of drug therapy and the occurrence of death. Nevertheless, treatment completion was slightly lower than the national average of 78% [14] and the World Health Organisation (WHO) target of achieving 85% treatment success, except for cases aged <25 years [18–20]. Our results indicate that patients, who were younger, more deprived and those who had extra-pulmonary TB were more likely to complete treatment. The association between age and treatment completion was comparable to findings reported by the Health Protection Agency [14]. Older patients frequently have multiple pathologies and are likely to be on complex drug regimens making adherence to anti-TB treatment difficult. More importantly, they could have succumbed to the disease before completing planned treatment.

The comparatively greater proportion of more deprived patients completing treatment is not consistent with previous findings. Current smoking [21], patients running out of anti-TB agents during self-treatment [22] and unstable housing [23] have been linked to lower treatment completion rates. The seemingly higher proportion of treatment completion amongst more deprived patients in this study can be explained by the comparative excess in deaths of less deprived patients who were also older, before

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Table 2. *Association between patient characteristics and outcomes within twelve months of initiation of anti-tuberculosis treatment*

Patient characteristic	Loss to follow-up		Death			
	Univariate OR (95% CI)	*P* value	Univariate OR (95% CI)	*P* value†	Adjusted OR (95% CI)*	*P* value‡
Demographic characteristics						
Age group (years)						
0–24	1·00		1·06 (1·04–1·08)§	<0·001	1·05 (1·04–1·07)§	<0·001
25–34	1·40 (0·59–3·36)	0·448				
35–49	0·94 (0·34–2·60)	0·902				
50–69	0·85 (0·30–2·36)	0·755				
⩾70	0·39 (0·10–1·51)	0·172				
Female gender	0·84 (0·44–1·57)	0·585	0·82 (0·45–1·49)	0·520	—	—
Foreign-born¶	2·35 (1·03–5·32)	0·041	0·35 (0·16–0·73)	0·06	—	—
Townsend score						
−5·43 to −1·14 (least deprivation)	1·00		1·00		—	—
−1·13 to +1·80	0·64 (0·27–1·54)	0·321	0·79 (0·36–1·72)	0·555		
+1·82 to +4·73	0·37 (0·13–1·05)	0·060	0·74 (0·34–1·64)	0·463		
+4·74 to +8·28 (highest deprivation)	1·08 (0·49–2·35)	0·856	0·37 (0·14–0·98)	0·046		
Disease attributes						
Pulmonary tuberculosis	0·69 (0·37–1·26)	0·226	3·71 (1·70–8·09)	0·001	2·73 (1·21–6·15)	0·009
Positive sputum smear	1·36 (0·47–3·94)	0·575	1·27 (0·55–2·90)	0·574	—	—
Previous tuberculosis	0·38 (0·09–1·62)	0·192	2·45 (1·13–5·29)	0·023	—	—

* Logistic regression model of best fit.
† Wald test *P* value.
‡ *P* value from likelihood ratio statistics.
§ The odds ratio for an increase in age of 1 year.
¶ There was collinearity between country of birth and number of years since entry in the United Kingdom; the latter was omitted during regression analysis. Foreign birth was the only independent factor associated with loss to follow-up on stepwise multivariate analysis.

treatment completion. It is also conceivable that with universal access to anti-TB treatment, completion of long-term treatment should not differ significantly by deprivation except when patients have other risk factors like homelessness and alcoholism.

Little published evidence is available on loss to follow-up, particularly in England. The proportion of TB patients lost to follow-up was slightly higher than that reported (6%) by Conaty *et al*. [24] at a central London hospital. In our study, only foreign country of birth was associated with loss to follow-up, especially for patients who reported entry in the United Kingdom within the preceding 4 years. It is possible that this was because some foreign-born patients returned to their countries of birth or permanent residence. Studies elsewhere [25–27] have found an association between loss to follow-up or default and alcoholism, homelessness and foreign birth with uncertain legal status rather than the patient's country of birth.

About half of the foreign-born patients had pulmonary TB. Those who could not be traced were therefore potentially infectious and also at risk of antimicrobial resistance. Additionally, pulmonary cases had more unfavourable mortality experiences. This underscores the importance of enhancing follow-up of foreign-born cases on anti-TB chemotherapy, with the aim of ascertaining favourable outcomes. For example, attention should be paid to lifestyle and environmental factors that may adversely affect follow-up [26, 28, 29].

Directly observed treatment (DOT) has been recommended for patients with risk factors for poor adherence or default from treatment. In the United

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Kingdom, guidelines from the Joint Tuberculosis Committee recommend DOT for patients who are less likely to adhere, for example the homeless, alcohol or drug abusers, patients with a history of poor adherence; or those with multiple drug resistance [30]. Perhaps recent migrants should be added to this list of risk factors. Whereas evidence from systematic reviews indicate that the benefits and cost effectiveness of universal DOT relative to alternative adherence-promoting strategies, in a developed country setting, remain uncertain [31, 32], patients at risk of unfavourable outcomes are likely to benefit. Indeed, tailored approaches for such risk populations are an important component of the WHO's new Stop TB strategy to TB control [32].

We also found that pulmonary disease site and increasing age were independently associated with all-cause mortality. This study corroborates previous findings of the higher case fatality of pulmonary TB [8] compared to extra-pulmonary disease, largely because the latter mostly occurred as benign, less severe lymph node TB. Teale *et al*. [7] reported that elderly patients in the United Kingdom were at greatest risk of death from TB. Despite there having been no adjustment for disease site in the previous study, a preponderance of deaths amongst the elderly can be expected.

Findings elsewhere [33] have pointed to a higher age-related death rate amongst indigenous residents compared to immigrants, although the later were more likely to default on their anti-TB treatment. We did not find differential death rates by country of origin. Outcomes after diagnosis of TB therefore appear to vary by distribution of socio-demographic and clinical characteristics in different geographical settings and could be influenced by programmatic treatment strategies [27, 34–37].

Limitations

Surveillance data on sputum smear test and specimen culture were incomplete, potentially leading to misclassification of TB cases. Missing data though, had no effect on the association with patient outcomes. The relative contribution to death, treatment completion or loss to follow-up, of comorbid states and health behaviours such as smoking, alcohol and drug abuse, were beyond the scope of this study. Notably, HIV-seropositive TB patients seem to have different disease characteristics and outcomes [33, 38] regardless of adherence to drug treatment [39].

CONCLUSIONS

The population-based approach to TB surveillance provides a very useful basis for examining determinants of patient outcomes after diagnosis, despite the drawback of incomplete microbiological data. The majority of patients completed their recommended treatment and were followed up. Elderly patients were both less likely to complete treatment and at greater risk of death, suggesting the need for closer monitoring of TB treatment. Similarly, more attention should be drawn towards patients with pulmonary TB to guarantee completion of treatment, minimize spread and possibly avert premature death. Foreign-born TB patients, especially those reporting recent entry into the United Kingdom, might benefit from closer follow-up to ensure favourable outcomes.

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DECLARATION OF INTEREST

None.

REFERENCES

1. **Murray CJ, Lopez AD.** Global mortality, disability, and the contribution of risk factors: Global burden of disease study. *Lancet* 1997; **349**: 1436–1442.
2. **World Health Organisation.** *Treatment of Tuberculosis: Guidelines for National Programmes*. Geneva: World Health Organisation, 2003.
3. **Dye C.** Global epidemiology of tuberculosis. *Lancet* 2006; **367**: 938–940.
4. **Crofts J.** *Preliminary Annual Report on Tuberculosis Cases Reported in 2002 in England, Wales and Northern Ireland*. London: CDSC Tuberculosis Section, Health Protection Agency, 2004.
5. **Hawker JI, *et al.*** Ecological analysis of ethnic differences in relation between tuberculosis and poverty. *British Medical Journal* 1999; **319**: 1031–1034.
6. **Delgado JC, *et al.*** Ethnic-specific genetic associations with pulmonary tuberculosis. *Journal of Infectious Disease* 2002; **186**: 1463–1468.
7. **Teale C, Goldman JM, Pearson SB.** The association of age with the presentation and outcome of tuberculosis: a five-year survey. *Age Ageing* 1993; **22**: 289–293.

8. **Reider HL.** *Epidemiologic Basis of Tuberculosis Control*, 1st edn. Paris: International Union Against Tuberculosis and Lung Disease, 1999.
9. **Crofton J, Horne N, Miller F.** *Clinical Tuberculosis*, 2nd edn. London: Macmillan Education Ltd, 1998.
10. **Joint Tuberculosis Committee of the British Thoracic Society.** Control and prevention of tuberculosis in the United Kingdom: code of practice 2000. *Thorax* 2000; **55**: 887–901.
11. **Hayward AC, *et al.*** The molecular epidemiology of tuberculosis in inner London. *Epidemiology and Infection* 2002; **128**: 175–184.
12. **Alseda M, Godoy P.** Factors associated with latent tuberculosis infection in the contacts of tuberculosis patients. *Gaceta Sanitaria* 2004; **18**: 101–107.
13. **Ponticiello A, *et al.*** Risk factors for tuberculosis infection and disease. *Monaldi Archives of Chest Disease* 2002; **57**: 169–172.
14. **Antoine D, French C.** *First Annual Report on Tuberculosis Treatment Outcomes Surveillance in England, Wales and Northern Ireland: Outcome Results on Tuberculosis Cases Reported in 2001*. London: CDSC Tuberculosis Section, Enhanced tuberculosis surveillance, Health Protection Agency, 2004.
15. **Rose AMC.** Tuberculosis treatment outcome surveillance in England, Wales and Northern Ireland: Protocol. United Kingdom: Advisory Committee for Tuberculosis Treatment Outcome Surveillance in England, Wales and N Ireland, 2004.
16. **Doherty MJ, Spence DP, Davies PD.** Trends in mortality from tuberculosis in England and Wales: effect of age on deaths from non-respiratory disease. *Thorax* 1995; **50**: 976–979.
17. **Townsend P, Phillimore P, Beattie A.** *Health and Deprivation: Inequality and the North*. London: Croom Helm, 2004.
18. **Zumla A, Mullan Z.** Turning the tide against tuberculosis. *Lancet* 2006; **367**: 877–878.
19. **Lienhardt C, Rustomjee R.** Improving tuberculosis control: an interdisciplinary approach. *Lancet* 2006; **367**: 949–950.
20. **Sharma SK, Liu JJ.** Progress of DOTS in global tuberculosis control. *Lancet* 2006; **367**: 951–952.
21. **Chang KC, Leung CC, Tam CM.** Risk factors for defaulting from anti-tuberculosis treatment under directly observed treatment in Hong Kong. *International Journal of Tuberculosis and Lung Disease* 2004; **8**: 1492–1498.
22. **Kaona FA, *et al.*** An assessment of factors contributing to treatment adherence and knowledge of TB transmission among patients on TB treatment. *BMC Public Health* 2004; **4**: 68.
23. **Tulsky JP, *et al.*** Can the poor adhere? Incentives for adherence to TB prevention in homeless adults. *International Journal of Tuberculosis and Lung Disease* 2004; **8**: 83–91.
24. **Conaty SJ, *et al.*** Reasons for low reported treatment success in notified tuberculosis patients from a London hospital according to new outcome reporting. *Communicable Disease and Public Health* 2004; **7**: 73–76.
25. **Albuquerque MF, *et al.*** Prognostic factors for pulmonary tuberculosis outcome in Recife, Pernambuco, Brazil. *Revista Panamericana de Salud Pública* 2001; **9**: 368–374.
26. **Brainard D, *et al.*** Long-term outcome of inpatients with tuberculosis assigned to outpatient therapy at a local clinic in New Orleans. *Journal of Investigative Medicine* 1997; **45**: 381–387.
27. **Helbling P, *et al.*** Outcome of treatment of pulmonary tuberculosis in Switzerland in 1996. *Swiss Medical Weekly* 2002; **132**: 517–522.
28. **Coker R.** Just coercion? Detention of nonadherent tuberculosis patients. *Annals of the New York Academy of Science* 2001; **953**: 216–223.
29. **Raviglione MC, Uplekar MW.** WHO's new Stop TB Strategy. *Lancet* 2006; **367**: 952–955.
30. **Joint Tuberculosis Committee of the British Thoracic Society.** Chemotherapy and management of tuberculosis in the United Kingdom: recommendations 1998. *Thorax* 1998; **53**: 536–548.
31. **Volmink J, Garner P.** Directly observed therapy for treating tuberculosis. *Cochrane Database of Systematic Reviews* 2003; Art. no: CD003343.
32. **Garner P, Volmink J.** Families help cure tuberculosis. *Lancet* 2006; **367**: 878–879.
33. **Centis R, Migliori GB.** Evaluation of tuberculosis treatment results in Italy, report 1999. *Monaldi Archives of Chest Disease* 2002; **57**: 297–305.
34. **Samman Y, *et al.*** Treatment outcome of tuberculosis among Saudi nationals: role of drug resistance and compliance. *Clinical Microbiology and Infection* 2003; **9**: 289–294.
35. **Diel R, Niemann S.** Outcome of tuberculosis treatment in Hamburg: a survey, 1997–2001. *International Journal of Tuberculosis and Lung Disease* 2003; **7**: 124–131.
36. **Santha T, *et al.*** Risk factors associated with default, failure and death among tuberculosis patients treated in a DOTS programme in Tiruvallur District, South India, 2000. *International Journal of Tuberculosis and Lung Disease* 2002; **6**: 780–788.
37. **Diez Ruiz-Navarro M, *et al.*** Results of anti-tuberculosis treatment in six autonomous regions in Spain. *Medicina Clinica* (*Barcelona*) 2001; **117**: 574–580.
38. **Aliyu MH, Salihu HM, Ratard R.** HIV infection and sputum-culture conversion in patients diagnosed with Mycobacterium tuberculosis: a population-based study. *Wiener Klinische Wochenschrift* 2003; **115**: 340–346.
39. **Rocha M, *et al.*** The role of adherence in tuberculosis HIV-positive patients treated in ambulatory regimen. *European Respiratory Journal* 2003; **21**: 785–788.