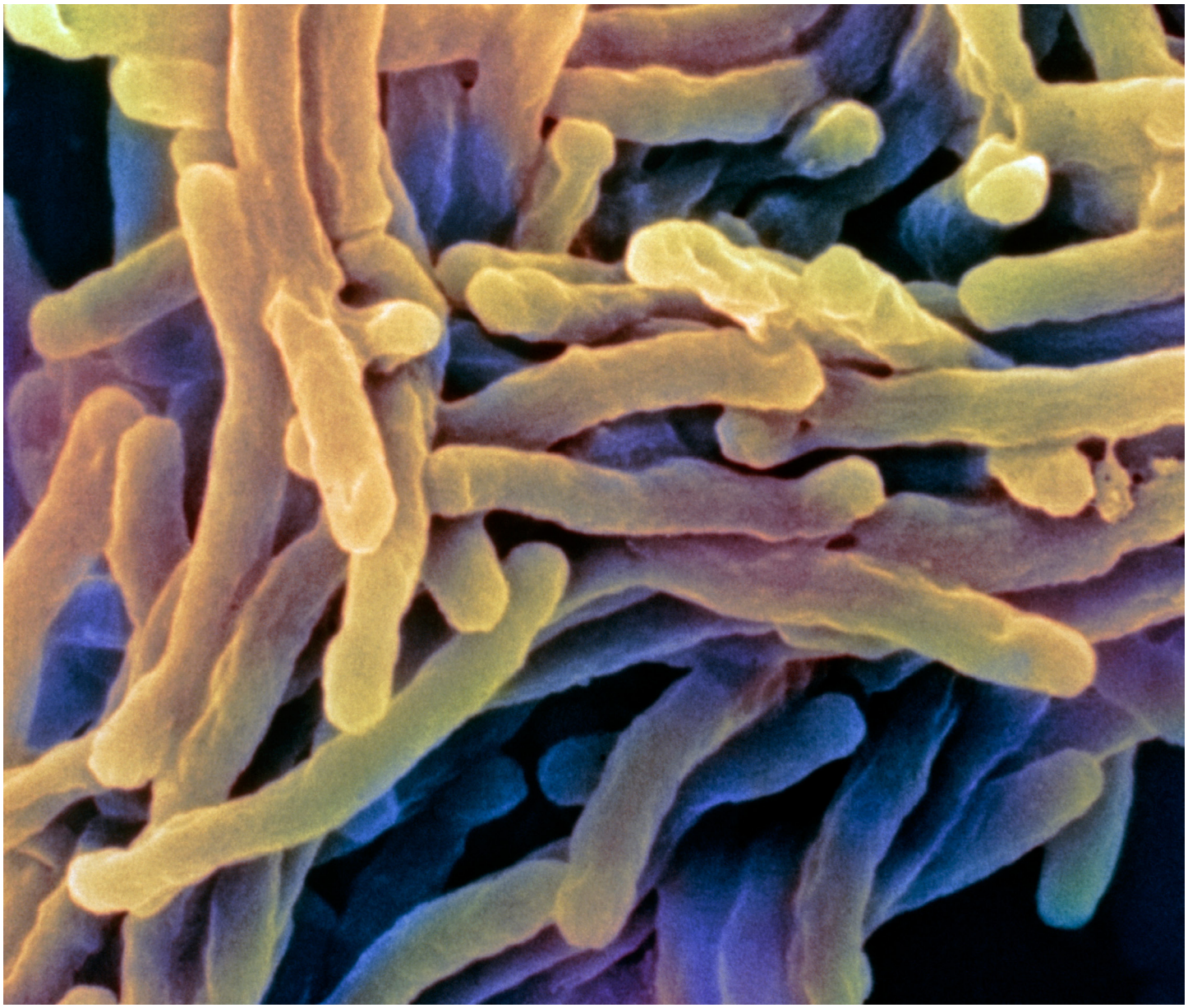
Health Protection Agency

Tuberculosis in the UK

Report on tuberculosis surveillance in the UK 2010



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Tuberculosis in the UK: Annual report on tuberculosis surveillance in the UK, 2010. London: Health Protection Agency Centre for Infections, October 2010.

Contents

Foreword

Challenges posed by tuberculosis cross social, geographical, professional, medical and scientific boundaries. Multidisciplinary and partnership working are essential to control the disease, underpinned by robust surveillance data which identifies where to focus effort.

I am pleased to introduce the 2010 report on tuberculosis in the UK. The HPA provides analysis of national surveillance data to inform the control of tuberculosis locally and nationally. This year, data are presented for use at local level. Information on social risk factors, directly observed therapy and the outcome of treatment for patients with multi-drug resistant disease are provided for the first time.

The HPA works in collaboration with the NHS and other partners to provide front line clinical services through specialist microbiological diagnosis and lead the investigation of local and national incidents and outbreaks. The report highlights the HPA national strain typing service, which will help identify areas where tuberculosis transmission is occurring and ensure the appropriate targeting of public health measures.

Rates of tuberculosis continue to increase in many parts of the country.

Case numbers are at their highest for nearly thirty years and now exceed 9,000 per year. Much of this rise affects disadvantaged communities including certain ethnic minority groups and those with social risk factors such as homelessness and drug/alcohol misuse. This concentration in particular sections of the community provides unequivocal evidence for a need to strengthen efforts to control the disease through a range of measures targeted at key risk groups and in particular urban areas.

Justin McCracken

Chief executive

Executive summary

The trend of a gradual rise in the number of tuberculosis cases observed over the last 20 years continued in 2009, with a 4.2% rise giving an overall rate of 15 cases per 100,000 population in the UK.

A total of 9,040 cases of tuberculosis were reported in 2009 with the majority of disease concentrated in urban centres. All 19 primary care organisations with a rate of 40 per 100,000 or more were in major urban areas. London accounts for 38% of cases, with a rate of 44.4 per 100,000.

The majority of patients continue to be young adults aged 15 to 44 years (60%) and non-UK-born (73%). Rates of disease in the non-UK-born are twenty fold higher (around 86 per 100,000) than for those born in the UK (around 4 per 100,000). The majority of non-UK-born patients (79%) were diagnosed two or more years after arrival in the UK.

Approximately one in ten cases had at least one social risk factor (homelessness, drug or alcohol misuse or imprisonment), with a quarter of these reporting more than one risk factor.

Gradual rises are noted in some drug resistance indicators. The proportion of cases resistant to isoniazid rose to 6.9% and the target limit of 7% was exceeded in London and the East Midlands. The proportion of multi-drug resistance in London is approaching 2% and pyrazinamide resistance increased from 0.7% to 1.0%. However, resistance to rifampicin has remained stable at 1.4%.

Information available for the first time in 2009 indicates that only eight percent of newly diagnosed cases started treatment under directly observed therapy (DOT). Among cases with a previous diagnosis of tuberculosis, drug resistance, and social risk factors, this rises to 30%, which is significantly below the target that all such cases should be treated under DOT.

Approximately one fifth of cases (19%) did not complete treatment within 12 months. No country in the UK or region of England met the 85% target for treatment completion.

Analysis of treatment outcome indicates that the majority of multi-drug resistant cases reported in 2007 were still on treatment after 12 months (82%) and 66% completed their treatment within 24 months.

The quality of the tuberculosis surveillance data is continually monitored and results are fed back through user and steering groups. Audits, matching studies and capture-recapture methods estimate the level of under-reporting of tuberculosis to be between 5 and 17%. Completeness of data fields is generally high and meets the targets set by the chief medical officer[1].

Recommendations

Tuberculosis control

- The national effort to control tuberculosis needs to be scaled up in order to halt the continuing rise in cases and ongoing transmission. This will require a coordinated and effective national programme with responsibility for strategic oversight of action at different points in the care pathway.
- The highest rates of disease occur in major urban areas. Specific urban control measures should be applied, using examples from cities in other western countries. Appropriate local mechanisms for governance and coordination of city-wide control activities should be instituted where appropriate.
- Control measures specifically targeting the non-UK-born population, homeless persons, drug users and prisoners, should be further developed.
- Identification and treatment of latent tuberculosis infection should be strengthened.
- The occurrence and level of transmission in the UK should be actively monitored using the data generated by the national strain typing service with appropriate use of fingerprinting data to target control activities.

Diagnosis and treatment

- Early diagnosis and prompt management of cases remain important. Clinicians should therefore have a high index of clinical suspicion in the risk groups described.
- Given the rise in extra-pulmonary manifestations, clinicians should have a high index of clinical suspicion especially among the non-UK-born population.
- Culture-confirmation remains low and should be improved by collection and submission of samples to laboratories wherever possible[2].

Tuberculosis surveillance

- HIV status should be included in tuberculosis surveillance to improve analysis of treatment outcome and transmission.
- Efforts to continue strengthening national and local tuberculosis surveillance should continue.

Introduction

Tuberculosis continues to kill an estimated 1.8 million people worldwide each year[3]. Following the recognition of the disease as a major global public health problem in the early 1990s, the World Health Assembly adopted a resolution calling for increased efforts to control tuberculosis. The adoption of the Millennium Development Goals (MDG) in 2000, in particular MDG 6 which focuses on tuberculosis, HIV and malaria[4], provided renewed drive for tuberculosis control efforts. Despite a slight decline in overall global incidence, meeting the MDG 6 target, the African and European regions are unlikely to meet the targets of halving prevalence and mortality set by the World Health Organization Stop TB Partnership[5].

Surveillance of tuberculosis aims to provide information to local teams to drive control efforts and, nationally, to inform policy. It is through surveillance that the general trends in cases can be determined and particular sub-groups of the population most affected are identified so that targeted action can be implemented. In the UK, the incidence of tuberculosis has increased steadily over the past two decades. Most of this increase can be attributed to a rise in tuberculosis in non-UK-born individuals and the ongoing low level of transmission of tuberculosis in UK-born individuals[6]. This annual report provides an update on recent trends and describes the detailed epidemiology of cases reported to the UK's enhanced surveillance systems.

This report, as in previous years, brings together data on the clinical characteristics of cases, laboratory confirmation of tuberculosis, species of *Mycobacterium tuberculosis* complex including *Mycobacterium bovis*, drug susceptibility tests and the outcome of treatment. In addition, a number of appendices are included, providing further data and describing in detail the methods used. The report also includes, for the first time, a summary of measures used to assure the quality of tuberculosis surveillance.

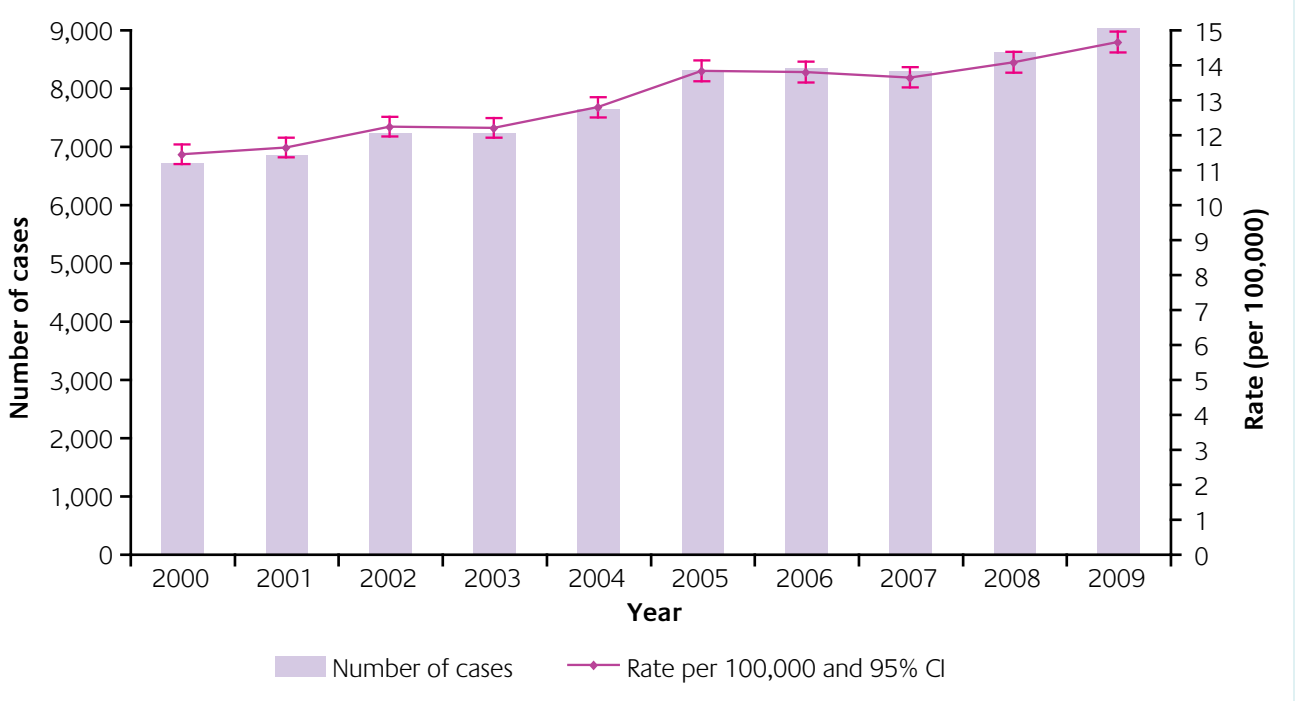
Further detailed data underlying this report for chapters 1-3 are available on our website http://www.hpa.org.uk/Topics/InfectiousDiseases/InfectionsAZ/Tuberculosis/

1 Tuberculosis case reports, UK, 2000-2009

Overall numbers, rates and geographical distribution

In 2009 in the UK, a total of 9,040 cases of tuberculosis were reported, a rate of 14.6 cases per 100,000 population (95% confidence interval (CI) 14.3-14.9) (Figure 1.1/ Appendix A i). This is an increase of 4.9% in the number of cases and a 4.2% increase in the rate compared with 2008.

Figure 1.1. Tuberculosis case reports and rates, UK, 2000-2009



CI – confidence interval

England accounted for the vast majority of cases in the UK (92%, 8286/9040); Scotland, Wales and Northern Ireland made up 5% (485), 2% (214) and 1% (55) of cases respectively.

Following several years of increases in England, the number and rate of tuberculosis cases remained relatively stable between 2005 and 2008. However, in 2009, both the number and rate of reports has again increased to 8,286 cases, a rate of 16 per 100,000 population (95% CI 15.7-16.3) (Appendix A ii). Rates of tuberculosis also increased in Scotland and Wales in 2009 to 9.3 (95% CI 8.5-10.2) and 7.1 (95% CI 6.2-8.2) cases per 100,000 respectively, while figures for Northern Ireland showed a decrease to 3.1 cases per 100,000 (95% CI 2.3-4.0).

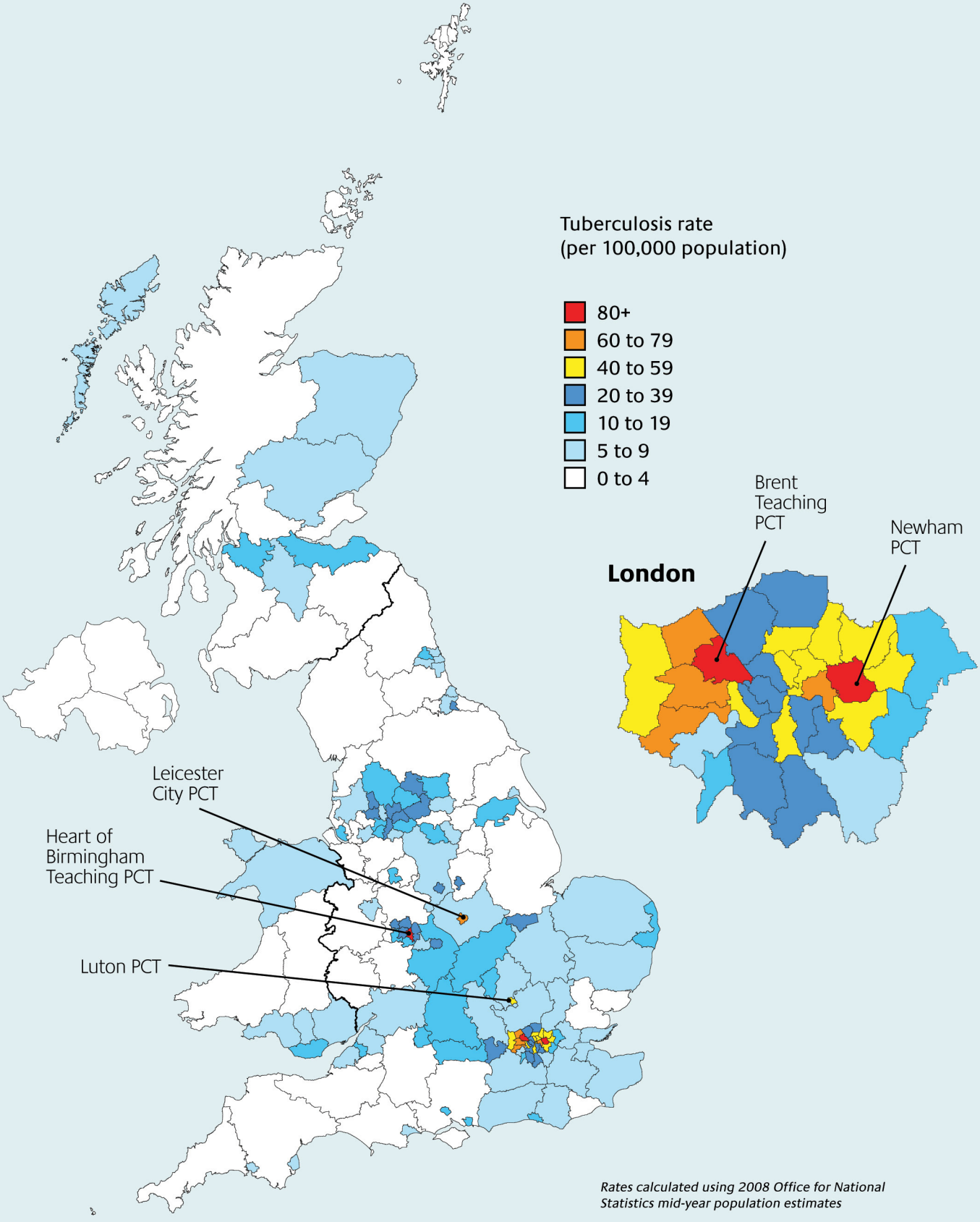
As in previous years, London accounted for the highest proportion of cases in the UK in 2009 (38%, 3440/9040) followed by the West Midlands (11%, 1018) (Figure 1.2/ Appendix A iii). The English region with the fewest cases was the North East (2%, 169).

London continues to have the highest rate of tuberculosis, with 44.4 cases per 100,000 in 2009 (95% CI 42.9-45.9) (Figure 1.2/Appendix A iv). The next highest rate in 2009, of 18.7 per 100,000 (95% CI 17.6-19.9), was seen in the West Midlands, the only region other than London to have a rate above the national average for England. Since 2000, rates have shown upward trends in all regions except for the East Midlands and the North East (Appendix A v).

Figure 1.2. Tuberculosis case reports and rates by region, England, 2009

Regional level data can mask variations between sub-regional geographic areas. The highest rates of tuberculosis are concentrated in Primary Care Trusts in England covering major urban areas (Figure 1.3). Areas with rates of 40 per 100,000 and over are considered to have a high incidence of tuberculosis; 19 out of 176 primary care organisations in the UK met this definition. Further analysis of time trends and other characteristics by Primary Care Trust, Health and Social Services Board, NHS Board and Local Health Board are presented in appendices A vi to x.

Figure 1.3. Three-year average tuberculosis case rates by primary care organisation*, UK, 2007-2009



*England – Primary Care Trusts (PCTs), Northern Ireland – Health and Social Services Boards, Scotland – NHS Boards, Wales – Local Health Boards

Demographic characteristics

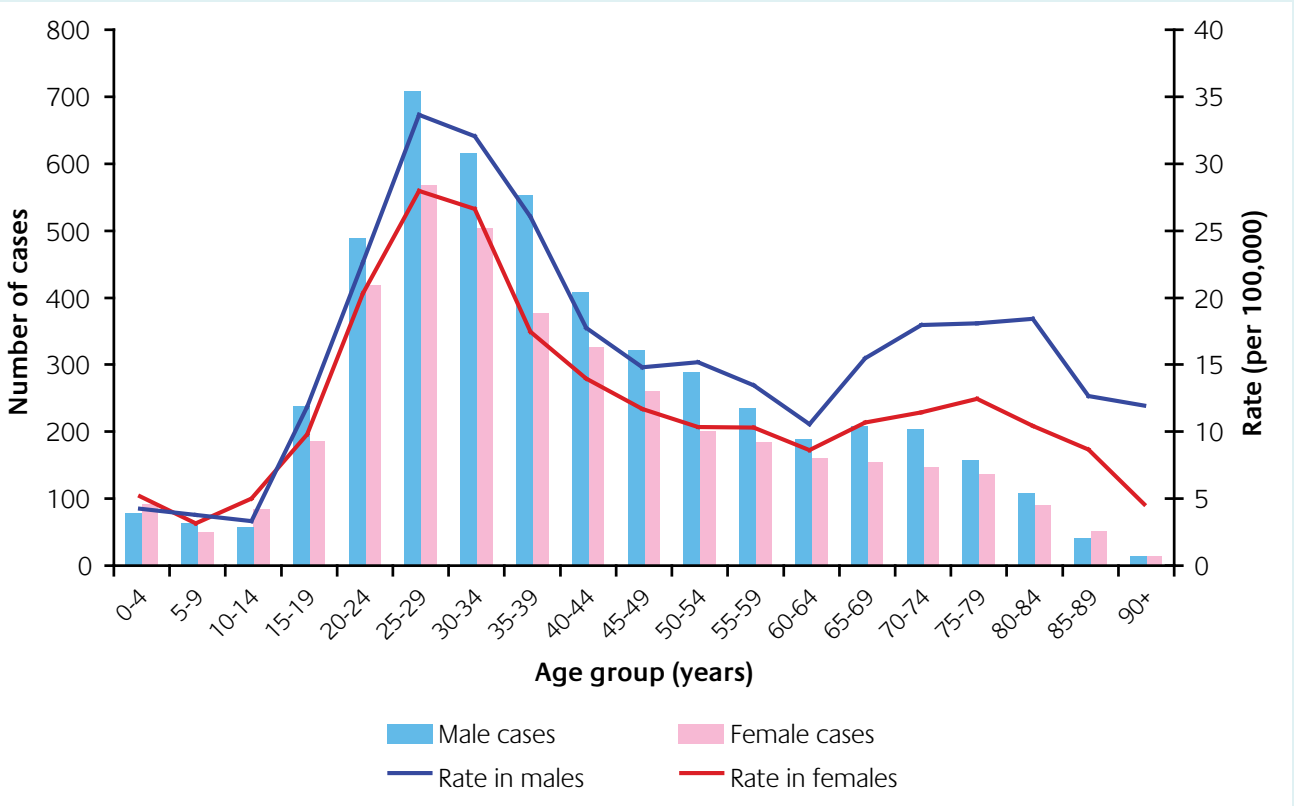
Sex and Age

Just over half of all cases in 2009 were male (55%, 4980/8987); cases under 15 years of age, however, were more likely to be female (53%, 227/427).

Individuals aged 15 to 44 years accounted for the largest proportion of cases (60%, 5425/9040); those aged 45 to 64, 65 and over, 5 to 14 and under 5 years accounted for 20%, 15%, 4% and 2% of cases respectively. In Northern Ireland and Wales, as well as the North East and South West of England, the proportion of cases occurring in young adults was lower (around 40-45%), with a greater proportion of cases found in those aged 65 years and over.

The highest rates of tuberculosis were in young adults, and rates were generally higher in males (Figure 1.4). Higher rates were also seen among the elderly. In England, the rate of tuberculosis in UK-born children under five years of age, an indicator of recent transmission, has remained stable at around 4 per 100,000 since 2000 (Appendix A xi).

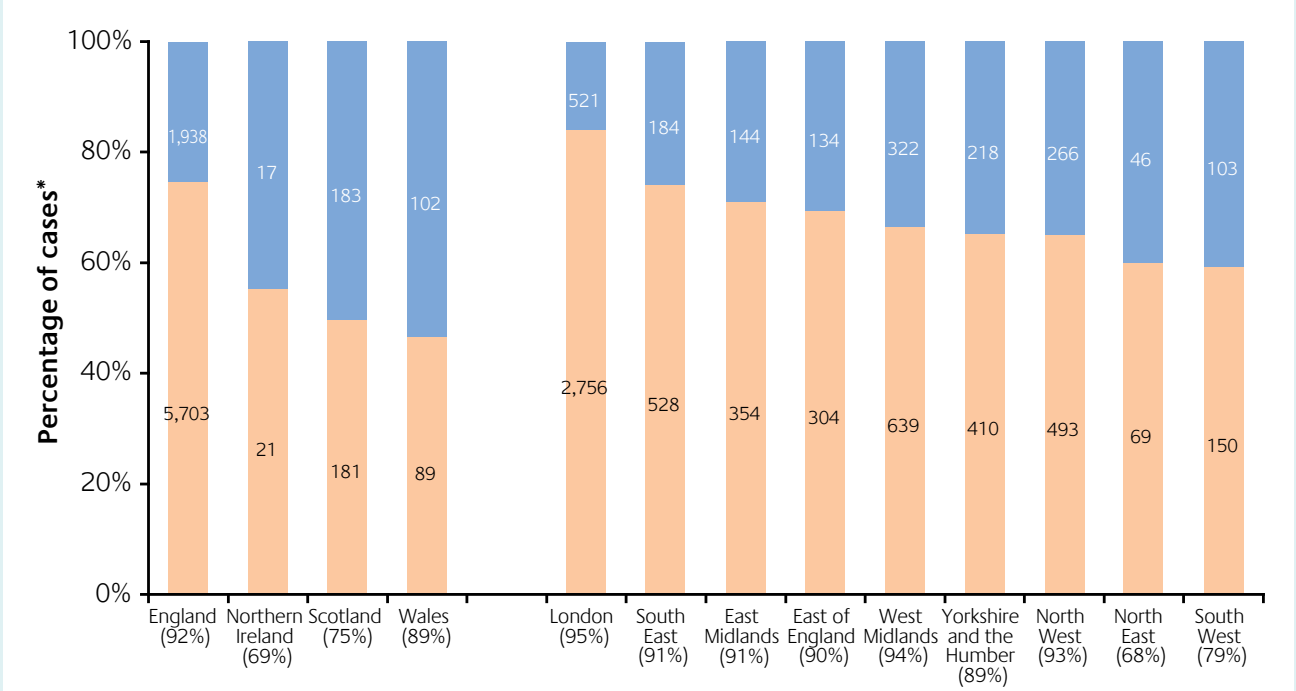
Figure 1.4. Tuberculosis case reports and rates by age group and sex, UK, 2009



Place of birth

Place of birth was known for 91% (8234/9040) of cases reported in 2009. Of these, 73% (5994/8234) were born outside the UK, an increase of one percentage point compared to 2008. The proportion of cases born outside the UK ranged from 84% in London to 47% in Wales (Figure 1.5). The rate of tuberculosis among the non-UK-born population in the UK was over 21 times the rate in the UK-born (86 per 100,000 versus 4 per 100,000).

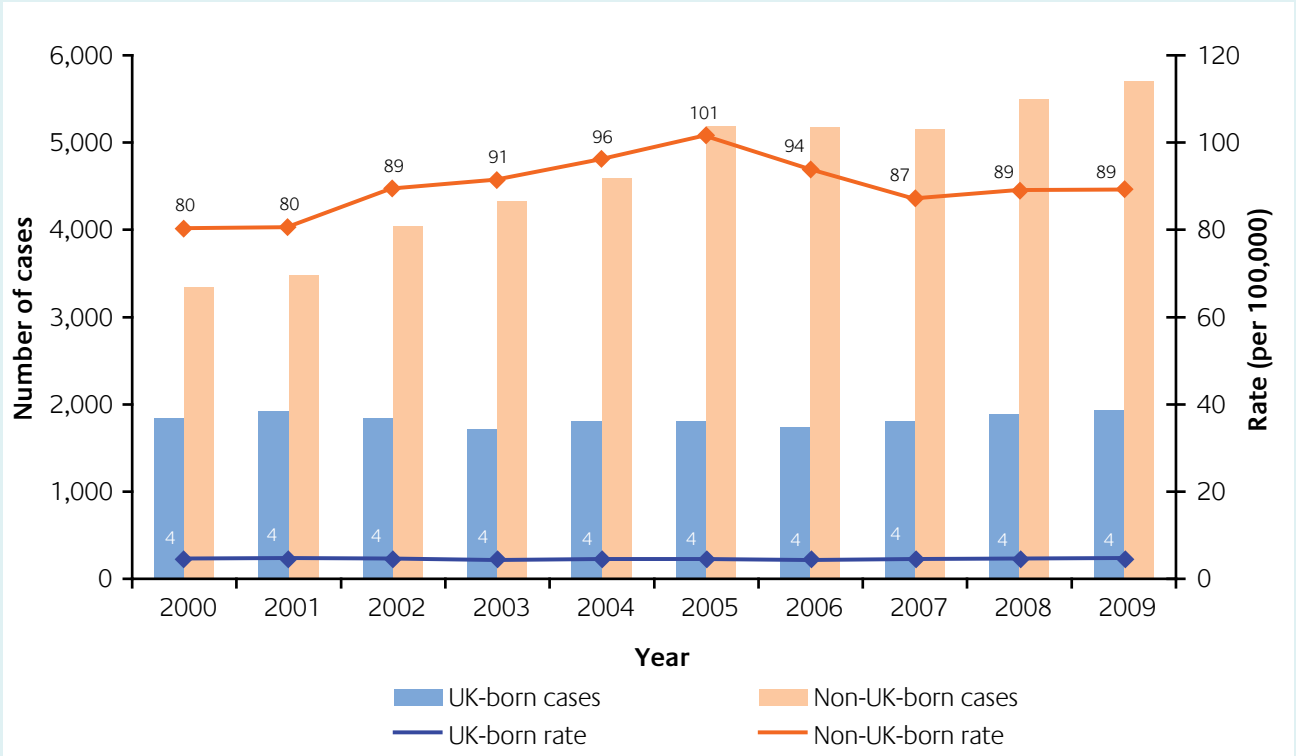
Figure 1.5. Tuberculosis case reports by place of birth and region/country, UK, 2009



* Where place of birth was known
Numbers of cases stated in bars

Within England, the rate of tuberculosis in the non-UK-born was 89 per 100,000 in 2009, maintaining the decreased rate in this group that has been seen since the peak in 2005 (Figure 1.6/Appendix A xii) (UK data not available). The rate in the UK-born has not declined and remains at around 4 per 100,000.

Figure 1.6. Tuberculosis case reports and rates by place of birth, England, 2000-2009



Numbers and rates in the UK- and non-UK-born differed by age and region. The median age in the non-UK-born was 34 years (inter-quartile range (IQR) 26-47) compared with 42 years (IQR 23-65) in the UK-born. The highest rates in the non-UK-born were in young adults (around 120 cases per 100,000); among the UK-born, the highest rates occurred in the elderly (around 7 per 100,000) (Figures 1.7.1 and 1.7.2). While rates were lower across all age groups in the UK-born, peaks were seen in young adults and the elderly irrespective of place of birth. Rates were higher in London compared to the rest of the UK in both the UK-born (10 versus 4 per 100,000) and non-UK-born (103 versus 75 per 100,000); this difference was seen in all age groups. The numbers and rates by place of birth and age were similar to 2008.

Figure 1.7.1. Non-UK-born tuberculosis case reports and rates by age, UK, 2009

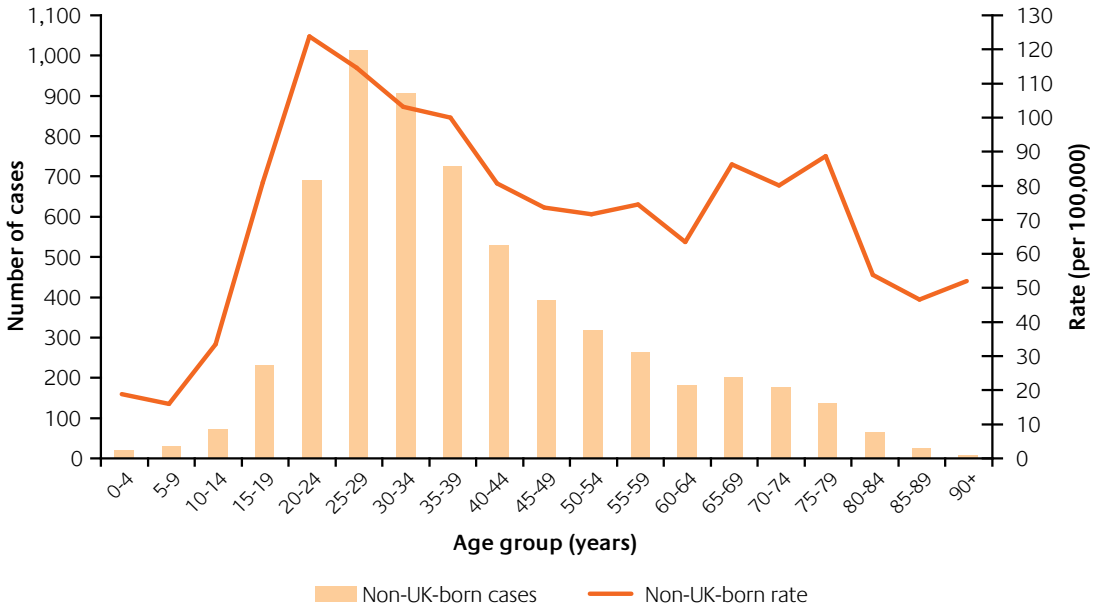
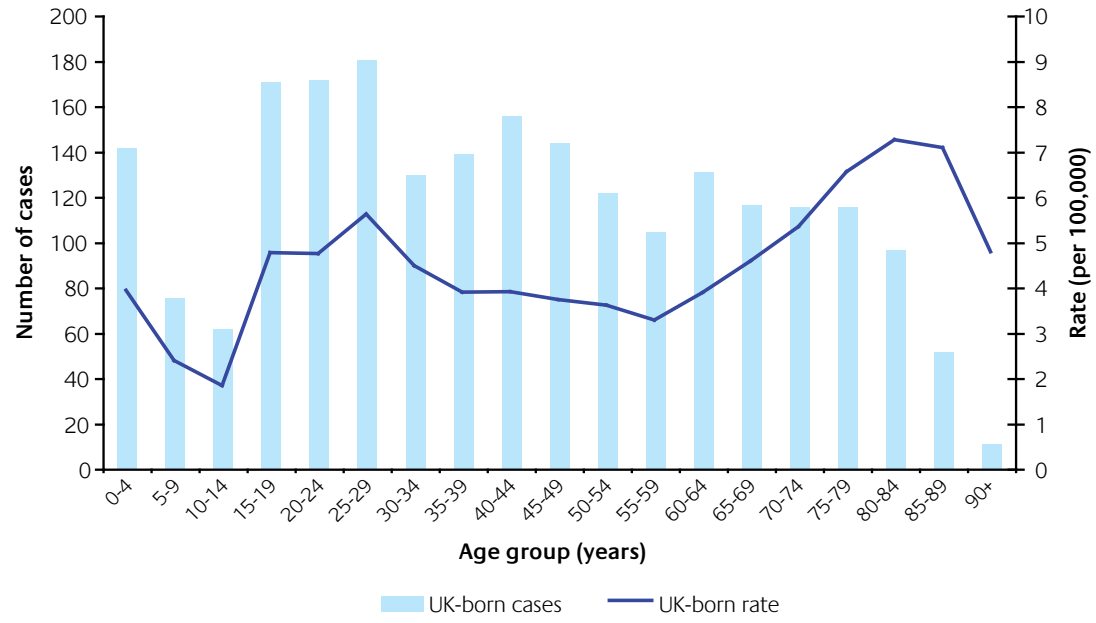


Figure 1.7.2. UK-born tuberculosis case reports and rates by age, UK, 2009



As in previous years, the majority of cases born outside of the UK originated from South Asia (55%, 3167/5782) and sub-Saharan Africa (30%, 1704).

Among non-UK-born cases, the most frequent country of birth was India (28%, 1615/5793) followed by Pakistan (17%, 982) and Somalia (10%, 551) (Table 1.1). The three most frequent countries of birth of non-UK-born cases has remained the same in England in recent years (UK data not available); the number and proportion from India, however, continues to increase whereas the figures for Pakistan and Somalia have remained relatively stable.

Table 1.1. Most frequent countries of birth for non-UK-born tuberculosis cases, UK, 2009

Country of birth	Number of cases	Percentage of cases*
India	1,615	28
Pakistan	982	17
Somalia	551	10
Bangladesh	247	4
Nigeria	186	3
Zimbabwe	168	3
Philippines	119	2
Nepal	117	2
Kenya	112	2
Eritrea	101	2
Afghanistan	98	2
Sri Lanka	94	2
Uganda	81	1
South Africa	80	1
China	60	1
Others (each <1%)	1182	20
Total	5,793	100

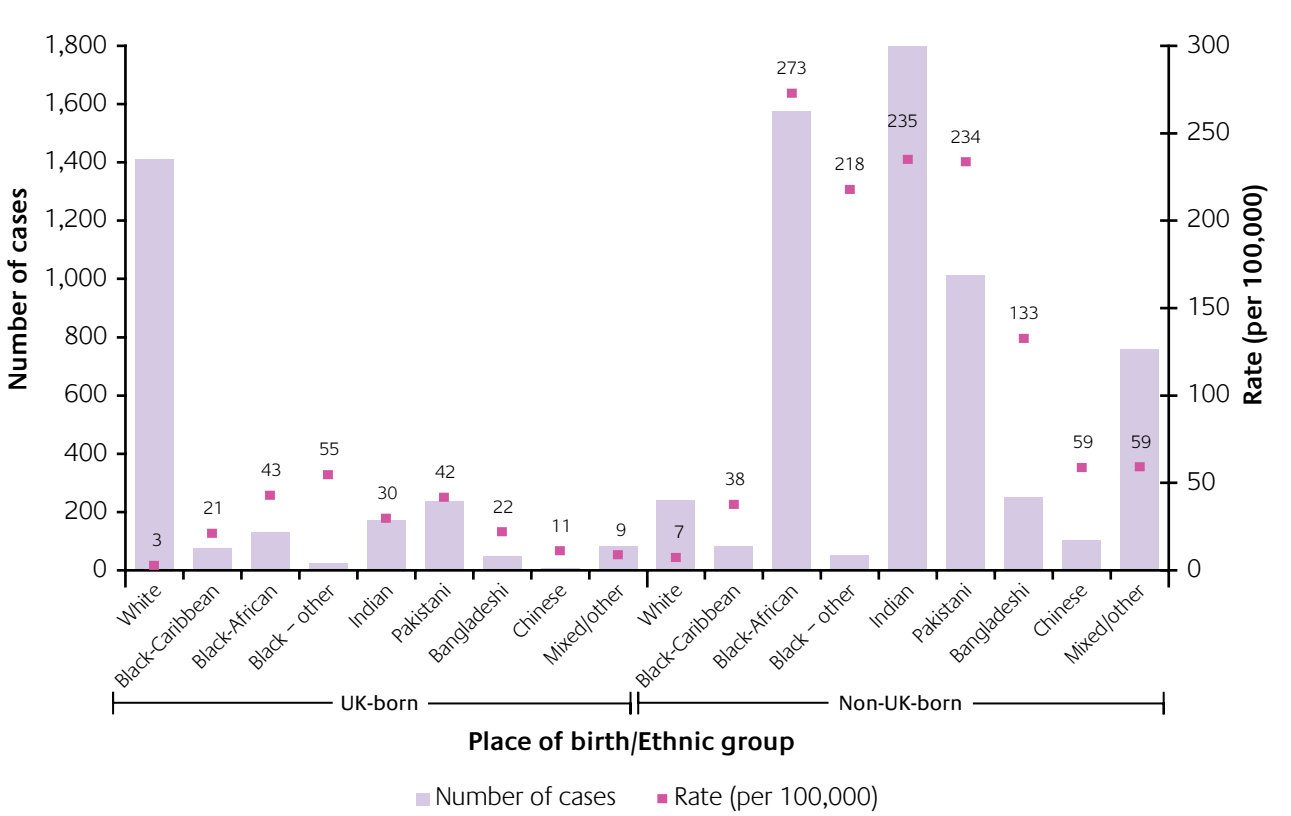
*Where country of birth was known

Ethnic group

Information was available on both ethnic group and place of birth for 89% of all cases in 2009 (8064/9040). The majority of cases born in the UK were of white ethnicity (64%, 1412/2193) but the rate in this group was low (3 per 100,000) (Figure 1.8). Higher rates among the UK-born were seen in all non-white ethnic groups (9-55 per 100,000).

Among the non-UK-born, the largest proportions of cases were from the Indian (31%, 1798/5871) and black African (27%, 1574) ethnic groups. The highest rates were in the black African, Indian, Pakistani and black other ethnic groups (218-273 per 100,000). Rates by ethnic group and place of birth were similar to those reported for 2008.

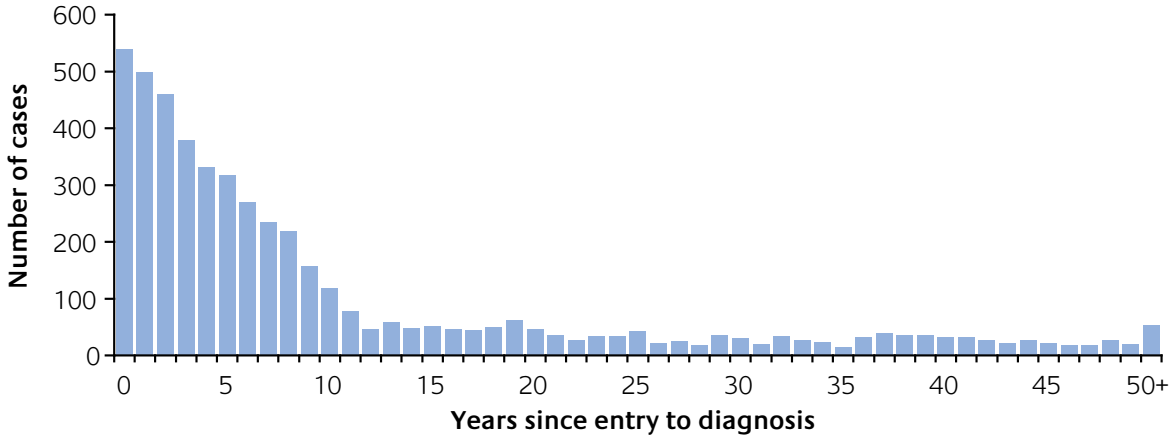
Figure 1.8. Tuberculosis case reports and rates by ethnic group and place of birth, UK, 2009



Time since entry into the UK to tuberculosis diagnosis

Time since entry into the UK to tuberculosis diagnosis was known for 82% (4929/5994) of non-UK-born cases. Of these, only 21% (1039) were diagnosed within two years of entering the UK (45%, 2209, within 5 years) (Figure 1.9); slightly lower proportions than in 2008. Twenty-four per cent (1198) were diagnosed between five and nine years after entry, and 31% (1522) had been in the UK for ten or more years before diagnosis. The median duration of stay in the UK before diagnosis of tuberculosis was four years (IQR 1-13).

Figure 1.9. Non-UK-born tuberculosis case reports by time since entry to the UK to tuberculosis diagnosis, UK, 2009



Social risk factors for tuberculosis

The collection of information on social risk factors for tuberculosis was introduced to Enhanced Tuberculosis Surveillance in England, Wales and Northern Ireland during 2009. Regions/countries began collecting these data at different points throughout the year and so completeness levels may be lower this year than may be seen in future (see Appendix D). Although social risk factor information is also collected in Scotland, data were not combined due to differences in definitions.

Information on social risk factors was known for 69-74% of cases. Among cases with known information, 3.3% (213/6369) of cases had a history of or current problem drug use and 4.6% (272/5930) of cases had a history of or current alcohol misuse/abuse; 2.6% of cases (166/6343) were currently homeless or had a history of homelessness and 2.8% (167) were currently in prison or had a history of being in prison.

Six-hundred and eight cases (9%) had at least one of the risk factors (out of 6732 cases with known information on at least one risk factor). One hundred and fifty cases (25% of those with at least one risk factor) had more than one and 16 cases were reported to have all four risk factors.

Clinical characteristics

Site of disease

Just over half of tuberculosis cases reported in 2009 had pulmonary disease, with or without any extra-pulmonary disease (54%, 4851/8968 where site of disease was known). This varied, however, by place of birth: 70% (1557/2225) of UK-born cases had pulmonary tuberculosis compared with 47% (2810/5969) of non-UK-born cases. Nine per cent (814/8963) of tuberculosis cases involved both a pulmonary and at least one extra-pulmonary site.

In England, the proportion of cases with pulmonary disease has decreased; 59% of cases presented with pulmonary disease (with or without extra- pulmonary disease) from 2000 to 2003 but this proportion has fallen to 53-54% since 2007 (UK data not available).

Of the specified extra-pulmonary sites of disease, the most commonly reported in 2009 were extra-thoracic lymph nodes (20%), intra-thoracic lymph nodes (9%) and the pleura (7%) (Table 1.2).

Table 1.2. Tuberculosis case reports by site of disease, UK, 2009

Site of disease*	Number of cases	Percentage**
Pulmonary	4,851	54.1
Extra-thoracic lymph nodes	1,831	20.4
Intra-thoracic lymph nodes	810	9.0
Other extra-pulmonary	694	7.7
Pleural	620	6.9
Gastrointestinal	367	4.1
Bone – spine	364	4.1
Cryptic/miliary	258	2.9
Bone – other	180	2.0
CNS – meningitis	179	2.0
Genitourinary	118	1.3
CNS – other	91	1.0
Laryngeal	17	0.2
Unknown extra-pulmonary	13	0.1

*With or without disease at another site **Percentage of cases with known sites of disease (8968)
CNS - Central Nervous System Total percentage exceeds 100% due to infections at more than one site

Previous diagnosis of tuberculosis

Information on previous history of tuberculosis was available for 87% (7824/9040) of cases; of these, 10% (816) had a previous diagnosis of tuberculosis more than 12 months ago.

Hospital in-patient

Whether or not a patient was a hospital in-patient was known for 87% of cases in England, Wales and Northern Ireland (7415/8555); 26% (1931/7415) were hospital in-patients at diagnosis.

Additional clinical characteristics

During 2009, the collection of information on BCG vaccination and planned course of treatment was introduced to Enhanced Tuberculosis Surveillance in England, Wales and Northern Ireland. Regions/countries began collecting these data at different points throughout the year and so completeness levels may be lower this year than may be seen in future (see Appendix D). Nevertheless, we are able to present information on these characteristics for the first time.

BCG vaccination

Data on previous BCG vaccination was available for 52% of cases in England, Wales and Northern Ireland (4473/8555); 71% (3166) had previously received BCG vaccination. Cases aged over 65 years were least likely to have received BCG vaccination (36%, 171/479), followed by the 0-14, 45-64 and 15-44 year age groups; 65%(182/279), 71% (581/819) and 77% (2232/2896) respectively.

Planned course of treatment

Data on the planned course of treatment was known for 44% of cases in England, Wales and Northern Ireland (3728/8555); 92% were due to begin a standard 6-month course of treatment.

Whether or not a patient was to begin a course of treatment under direct observation was known for 73% of cases in England, Wales and Northern Ireland (6229/8555); 8% (528) of cases were due to start directly observed therapy (DOT). Among cases known to have a previous diagnosis of tuberculosis, 17% (84/484) were due to start DOT. Among cases with any current or historical problem drug use, alcohol misuse/abuse, homelessness or imprisonment, 31% were known to be due to start DOT.

HIV co-infection

Figures on TB-HIV co-infection available for cases reported in 2008 for England, Wales and Northern Ireland show that the proportion of tuberculosis cases known to be HIV positive was 6.7% (553/8258). This was less than proportions observed between 2002-2006 (8.0-9.5%) but similar to that of 2007 (6.6%).

Bacteriological results

Sputum-smear

The result of a sputum-smear test was known for 58% of cases with pulmonary disease (2790/4851). Of these, 57% (1579) had a positive result. Among cases with at least one social risk factor, 60% of cases with pulmonary disease were sputum-smear positive (192/318).

Culture

The proportion of all UK cases that were culture-confirmed in 2009 was 56% (5075/9040); 66% (3219/4851) of pulmonary cases and 45% (1838/4117) of cases with extra-pulmonary disease only. The proportions of cases culture-confirmed were very similar to those for 2008.

The proportion of sputum-smear positive cases that were also culture-confirmed was 88% (1389/1579).

Species identification

Among culture-confirmed cases, 99% (5014/5075) were due to infection by *Mycobacterium tuberculosis*; 0.5% (25) were identified with *M. bovis* and 0.7% (36) with *M. africanum*. Within England, the number of cases attributable to *M. africanum* has increased in recent years from around three cases per year between 2000 and 2005 to 31 cases in 2009 (UK data not available); the number of cases due to *M. bovis* has remained relatively stable.

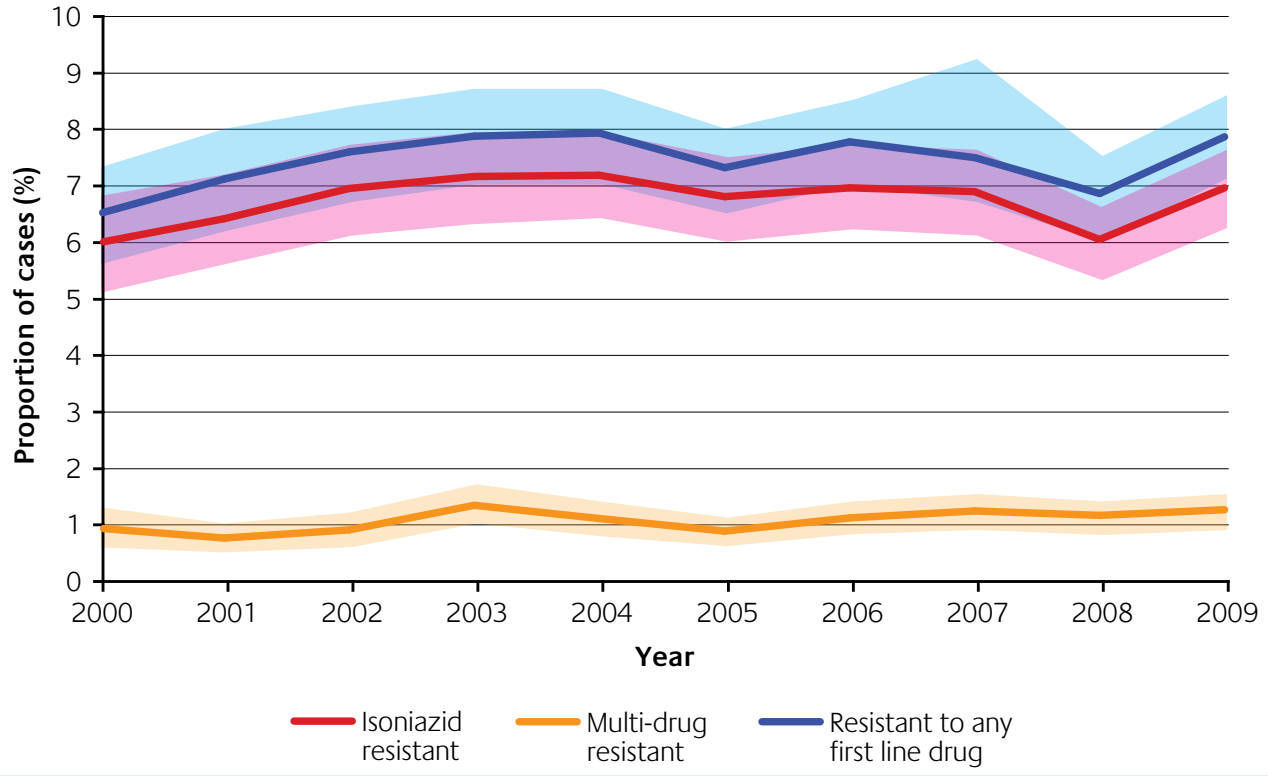
2 Tuberculosis drug resistance, UK, 2000-2009

Isoniazid, rifampicin, ethambutol and pyrazinamide are considered first-line drugs for the treatment of tuberculosis in the UK. Drug susceptibility test results, for at least isoniazid and rifampicin, were available for 4991 (98.3%) of the culture-confirmed cases in 2009. Of these, 6.9% were resistant to isoniazid, 1.4% were resistant to rifampicin, 0.6% were resistant to ethambutol, and 1.0% were resistant to pyrazinamide at the start of treatment (Appendix A xiii). Multi-drug resistance (MDR- organisms resistant to at least isoniazid and rifampicin) was seen in 1.2% of cases and 7.8% had resistance to at least one first-line antibiotic.

Trends in drug resistance

Proportions of drug resistance were similar to those observed over the last four years for multi-drug resistance, rifampicin and ethambutol (Appendix A xiii). However, following a substantial drop in isoniazid resistance to 6.0% in 2008, there was an increase to 6.9% in 2009, which is similar to the levels observed between 2002-2007. This was due to an increase in the number of isoniazid mono-resistant cases associated with the London outbreak, which occurred in the last quarter of 2009[7]. As a consequence, there was also an increase in the proportions of resistance to any first-line drug (Figure 2.1).

Figure 2.1. Proportion of tuberculosis cases with first-line drug resistance, UK, 2000-2009



The shaded areas indicate 95% confidence intervals

Pyrazinamide resistance increased from 0.7% in 2008 to 1.0% in 2009. This increase was observed in the non-UK-born population aged 15-44 and 45-64 years old, who were predominantly of mixed/other ethnicity and were longer term entrants (>5 years since entry to the UK). No single world region of birth predominated. A number of these cases (6/52) were due to infection with *Mycobacterium africanum* which is more likely to be inherently resistant to pyrazinamide compared to *M. tuberculosis*. The proportion of *M. africanum* cases resistant to pyrazinamide in 2008 and 2009 is higher compared to previous years.

Geographical region/country

Proportions of isoniazid resistance reached the CMO's limit of 7% in England and this was exceeded in two regions; London and the East Midlands. Both isoniazid and multi-drug resistance levels were higher in London in 2009 than in 2008, where MDR levels are approaching the recommended upper limit of 2% (Table 2.1). Due to low numbers, regional trends outside London should be interpreted with caution. There were no cases of drug resistant tuberculosis reported in Northern Ireland in 2009 which is not unusual considering Northern Ireland also has the lowest burden of tuberculosis of any country in the UK.

Table 2.1. Number and proportion of tuberculosis cases with drug resistance by country/region, UK, 2009

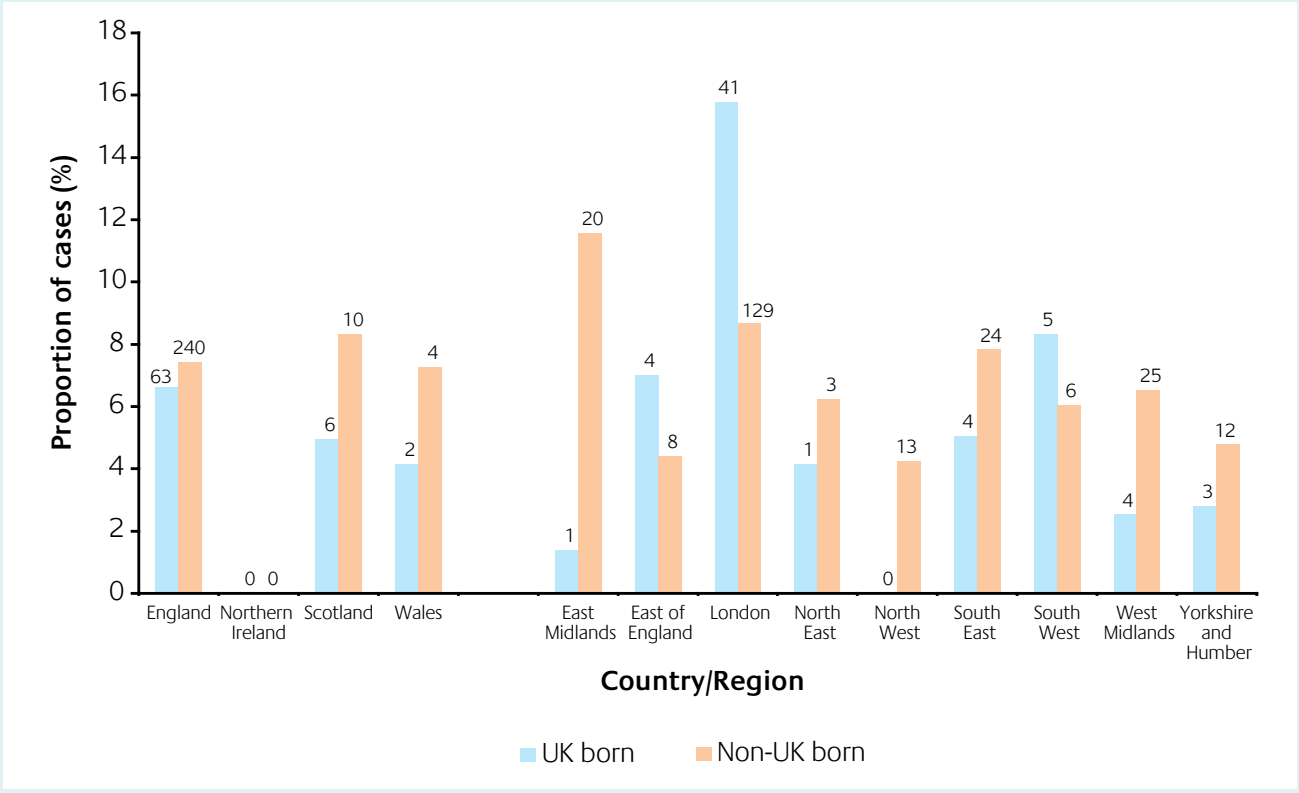
Country/region	Isoniazid resistant		Multi-drug resistant		Resistant to any first line drug		Total*
	n	%	n	%	n	%	
England	318	7.0	56	1.2	359	7.9	4,520
Northern Ireland	0	0.0	0	0.0	0	0.0	44
Scotland	20	6.4	2	0.6	22	7.1	312
Wales	6	5.2	0	0.0	8	7.0	115
East Midlands	21	7.8	2	0.7	22	8.2	269
East of England	13	4.9	4	1.5	18	6.8	266
London	172	9.4	34	1.9	192	10.5	1,826
North East	6	5.8	1	1.0	6	5.8	104
North West	17	3.6	3	0.6	21	4.5	471
South East	28	6.5	3	0.7	34	7.9	431
South West	13	6.8	2	1.1	16	8.4	190
West Midlands	31	5.5	4	0.7	33	5.8	567
Yorkshire and Humber	17	4.3	3	0.8	17	4.3	396

Variations by country and region should be interpreted with caution in view of small numbers
* Culture-confirmed cases with drug susceptibility testing results for at least isoniazid and rifampicin
It should be noted that culture confirmed laboratory cases could be notified in subsequent or preceding years

Place of birth

Among cases where place of birth was known, those born outside the UK had higher proportions of isoniazid resistance (7.4%, 254/3421 versus 6.3%, 71/1133) and multi-drug resistance (1.4%, 49/3421 versus 0.6%, 7/1133) compared to those who were born in the UK. However, in London, the South West and the East of England, isoniazid resistance was more common in the UK-born population (Figure 2.2). Although this has not been seen previously for the South West, this finding should be treated with caution due to the low numbers. The cases in the South West were not part of the isoniazid resistant outbreak which predominantly affects London.

Figure 2.2. Proportion of tuberculosis cases with isoniazid resistance by country/region, UK, 2009



Variations by region and country should be interpreted with caution in view of small numbers
Number of cases given above each bar

The majority of non-UK-born cases with any first-line drug resistance were born in South Asia (53.3%) and Sub-Saharan Africa (28.1%), which reflects the distribution by world region of birth for all tuberculosis cases. However, the proportion resistant was much higher among those born in East Europe (37%, 11/30) compared to those born in other world regions (Appendix xiv).

Age and sex

Men had higher proportions of isoniazid resistance than women (7.1%, 201/2824 versus 6.6%, 142/2143) but women had higher proportions of multi-drug resistance (1.3%, 27 versus 1.1%, 31).

Proportions of isoniazid resistance and multi-drug resistance decreased as age group increased, with highest proportions observed in the 0-14 year olds (Table 2.2). However, there was an increase in resistance to any first-line drug in the 15-44 and 45-65 year olds, compared to 2008, where highest

proportions were observed in the younger age groups. This is a result of increased proportions of pyrazinamide resistance in these age groups.

Table 2.2. Number and proportion of tuberculosis cases with drug resistance by age group, UK, 2009

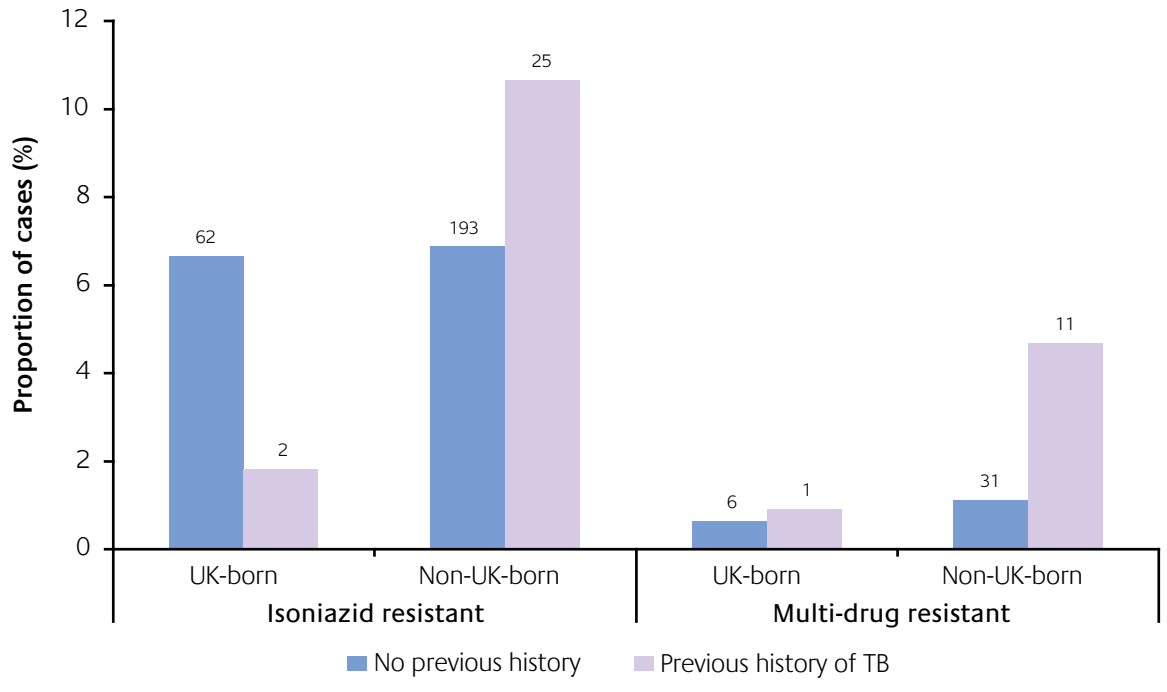
Age Group	Isoniazid resistant		Multi-drug resistant		Resistant to any first line drug		Total*
	n	%	n	%	n	%	
0-14	8	7.8	4	3.9	8	7.8	103
15-44	249	7.6	45	1.4	281	8.6	3283
45-65	67	7.2	7	0.8	76	8.1	937
65+	20	3.0	2	0.3	24	3.6	668

* Culture confirmed cases with drug susceptibility results for at least isoniazid and rifampicin

Previous history of tuberculosis

Cases with a previous history of tuberculosis had higher proportions of isoniazid resistance (7.7%, 28/364 versus 6.6%, 262/3957), multi-drug resistance (3.3%, 12/364 versus 0.9%, 37/3957) and resistance to any first-line drug (8.8%, 32/364 versus 7.4%, 292/3957) compared to cases with no previous history. For isoniazid resistance, however, this varied by place of birth; proportions were higher among UK-born cases in those with no previous history of treatment (Figure 2.3). This suggests that a higher proportion of UK-born cases may become infected with isoniazid resistant strains through direct transmission, while more non-UK-born cases acquire it as a result of poor treatment regimens and management in their countries of origin or due to patient non-compliance. Proportions of MDR were higher in those with a previous history of treatment in both the UK- and the non-UK-born.

Figure 2.4. Proportion of tuberculosis cases with isoniazid and multi-drug resistance by place of birth and previous history of tuberculosis, UK, 2009*



* Number of cases given above each bar

Site of disease

The proportion of isoniazid resistant cases was highest in those with extra-pulmonary disease compared to pulmonary disease (7.2%, 131/1812 versus 6.7, 211/3161), which was consistent with figures from 2008. For pulmonary cases where sputum result was known, the proportion of isoniazid resistance was higher in sputum-smear negative cases (7.7%, 75/981) compared with sputum-smear positive cases (6.9%, 94/1367). Despite this, 54% of all cases had pulmonary disease, and as a result the numbers of isoniazid resistant pulmonary cases was larger than the number with extra-pulmonary disease (61.7% versus 38.3%), which is important with regards to transmission. Proportions of multi-drug resistance did not vary by site of disease.

Risk factors

Data collected on social risk factors was complete for about two-thirds of isoniazid resistant cases reported in England, Wales and Northern Ireland, which is slightly lower compared with all cases of tuberculosis. For cases with risk factors recorded, proportions of isoniazid resistance were higher in the homeless (14.3%, 16/112 versus 6.6%, 222/3332), problem drug users (16.4%, 23/140 versus 6.5%, 216/3316), and prisoners (17.8%, 21/118 versus 6.5%, 205/3071). There were also slightly higher proportions in those with known alcohol misuse/abuse (7.1%, 12/168 versus 6.7%, 205/3071). Proportions of multi-drug resistant tuberculosis were higher in the homeless (3.6%, 4/56 versus 1.1%, 25/3332) but were similar for those with or without other risk factors. However, these results should be interpreted with caution due to small numbers.

Directly observed therapy

Data collected on DOT was available for 83.3% and 87.5% of isoniazid resistant and multi-drug resistant cases, respectively. Only 15.6% (42/270) of initially isoniazid resistant cases were placed on DOT at the start of treatment, a slightly higher proportion than among isoniazid sensitive cases (8.1%, 277/3382). Sixteen of 49 multi-drug resistant cases (32.6%) started treatment on DOT compared to 8.4% (303/3603) of cases that did not have multi-drug resistant tuberculosis.

Extensively-drug resistant tuberculosis (XDR TB)

The emergence of XDR TB is a serious threat to tuberculosis control. XDR TB is defined as tuberculosis resistant to any fluoroquinolone and at least one of three injectable second-line drugs (capreomycin, kanamycin and amikacin), in addition to multi-drug resistance[8]. In the UK, there were three culture-confirmed cases of XDR TB reported by tuberculosis reference laboratories in 2009 and a total of nine between 1995 and 2008.

The majority of cases were male (10/12) and non-UK-born (8). There were no patients under the age of 20 years and the majority were 20-44 years old (8). The ethnic distribution of the cases generally reflected that of all tuberculosis cases apart from two East European patients being diagnosed in the past two years. Only four cases were known to have a previous history of tuberculosis and nine had pulmonary disease. This suggests that most cases arose as a result of primary resistance (direct transmission of drug resistant organisms) as opposed to developing resistance while on treatment.

Isolates were resistant to a median of 8.5 (5-12) drugs. Six cases were resistant to ciprofloxacin, four were resistant to moxifloxacin and five were resistant to ofloxacin. However, sensitivity testing for resistance to moxifloxacin and ofloxacin only began in 2008, following changes in recommendations for treatment of XDR TB[9] and therefore resistance to these drugs could be underestimated. Drug sensitivity test results for injectable agents showed that resistance to capreomycin was most common (7) followed by amikacin (5) and all isolates tested for kanamycin resistance since 2008 (5) were resistant to this drug.

3 Tuberculosis treatment outcomes, UK, 2001-2008

Of the 8,152 cases reported in 2008, for whom information on treatment outcome was received, 6,618 (81%) completed treatment within 12 months. The proportion of cases completing treatment has generally increased over time from 78.4% in 2001 (Table 3.1).

Table 3.1. Number and proportion of tuberculosis cases completing treatment within 12 months, UK, 2001-2008

Year	Cases reported*	Completed treatment		95% confidence interval
		n	%	
2001	5,502	4,314	78.4	77.3 - 79.5
2002	6,365	4,993	78.4	77.4 - 79.4
2003	6,543	5,173	79.1	78.1 - 80.0
2004	6,903	5,464	79.2	78.2 - 80.1
2005	7,566	5,976	79.0	78.1 - 79.9
2006	7,917	6,266	79.1	78.2 - 80.0
2007	8,068	6,524	80.9	80.0 - 81.7
2008	8,152	6,618	81.2	80.3 - 82.0

*For whom information on treatment outcome was received.
(See appendix D for data on the completeness of treatment outcome reporting).

The most common reasons for not completing treatment were death (6%) still on treatment (4.9%) and lost to follow up (4.6%) (Table 3.2).

Table 3.2. Tuberculosis treatment outcomes at 12 months, UK, 2008

Treatment outcome	n	%
Treatment completed	6,618	81.2
Died	486	6.0
Still on treatment	400	4.9
Lost to follow up	379	4.6
Transferred out	90	1.1
Treatment stopped	80	1.0
Not completed (unknown reason)	15	0.2
Outcome unknown	84	1.0
Total	8,152	100

Among tuberculosis cases reported to have died, 24% (114/486) were diagnosed post mortem (Table 3.3). Tuberculosis caused or contributed to 60% (176/291) of deaths, where cause of death was known. In 40% (195) of cases, however, the cause was unknown or not reported. The Office for National Statistics recorded 334 deaths in England and Wales in 2008 where tuberculosis was the underlying cause (this may include people diagnosed before 2008). A total of 3,312 years of life were lost as a result of premature mortality from tuberculosis in 2008.

Table 3.3. Cause of death among tuberculosis cases dying before or during the first 12 months of treatment, UK, 2008

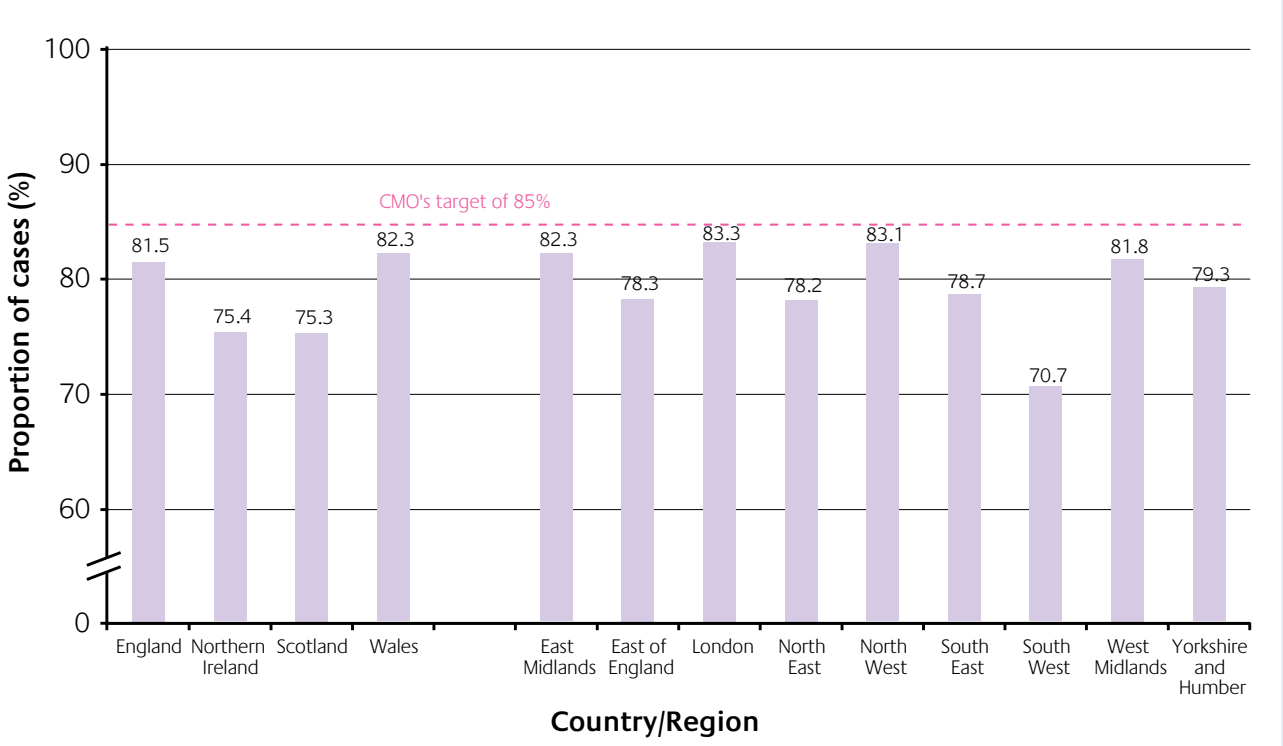
Relationship between TB and death	Post mortem diagnosis		Total (%)
	Yes	No	
TB caused death	24	39	63 (13.0)
TB contributed to death	20	93	113 (23.3)
TB incidental to death	13	102	115 (23.7)
Unknown or not reported	57	138	195 (40.1)
Total	114 (23.5)	372 (76.5)	486

The majority of cases reported to be still on treatment had a planned course of treatment exceeding 12 months (63%, 242/400), while others had their course of treatment changed (22%, 83/400), or interrupted (15%, 57/400).

Geographic variation

The highest level of treatment completion was seen in England and Wales, with 82% of cases reported from these countries completing treatment (Figure 3.1), compared to 75% in Northern Ireland and Scotland. None of the regions in England met the target of 85% set out in the CMO's Action Plan[1]. The highest proportions of cases completing treatment were in London and the North West (83% in both regions), and the lowest was in the South West (71%).

Figure 3.1. Proportion of tuberculosis cases that completed treatment within 12 months by country/region, UK, 2008



The main reason for not completing treatment for cases reported in Wales and Scotland was death, with around 9.5% dying before completing treatment (Appendix A xv). In Northern Ireland, loss to follow-up (9.8%) was seen most often. For London, non-completion was mostly due to cases still being on treatment (7.1%) and only 3.7% of cases died before completing treatment which reflects the higher levels of drug resistance, and the younger population in the capital, respectively.

Age and sex

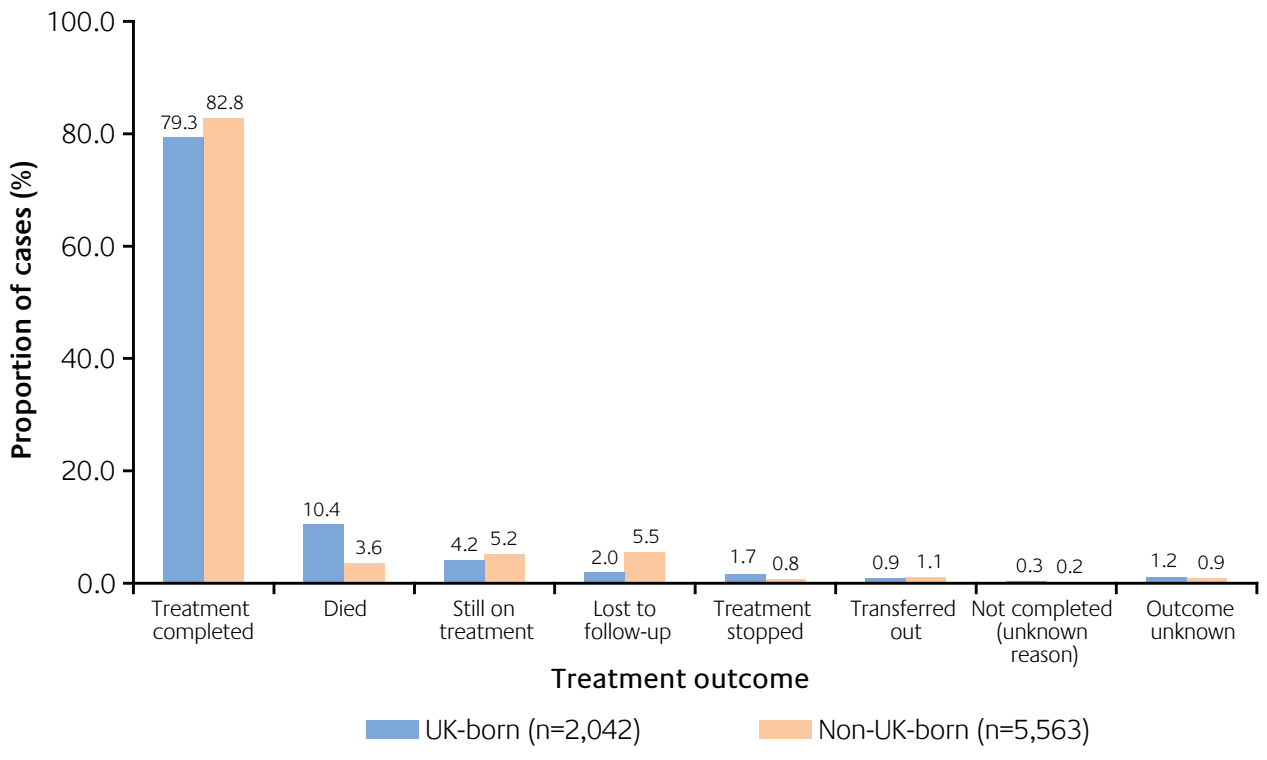
Treatment completion levels declined with age, from 91% in 0-14 year olds to 63% in patients aged 65 years and over, while the proportions reported to have died before completing treatment increased from 0.4% to 28%, respectively. The proportion of cases lost to follow-up was highest in patients aged 15-44 years old at 6%.

Treatment completion was similar in men and women (80.2%, 3532/4403 versus 82.3%, 3059/3716). However, men were more often lost to follow-up than women (5.9%, 259 versus 3%, 117).

Place of birth and ethnic group

A higher proportion of non-UK-born cases completed treatment compared to UK-born cases (83%, 4604/5563 versus 79%, 1620/2042) (Appendix A xvi). Among non-UK-born cases, the most common reasons for not completing treatment were still being on treatment (5%) and lost to follow-up (6%). Death (10%) was the main reason for treatment non-completion among UK-born cases (Figure 3.2), a larger proportion of which are older.

Figure 3.2. Treatment outcome at 12 months by place of birth, UK, 2008



Cases of white ethnicity had the lowest proportion of treatment completion (73%, 1187/1631) compared to all other ethnic groups, irrespective of place of birth. The most common reason for non-completion in this group was death (16%, 252/1631), but this was only observed in UK-born cases (17%, 201/1216, Table 3.4). In non-UK-born cases of white ethnicity, death (6%, 16/258) was a less frequent reason for not completing treatment, while still being on treatment and being lost to follow-up (each 9%, 22 cases) were both more common.

The proportion of cases completing treatment was only higher in non-UK-born compared with UK-born cases in patients of white, black Caribbean and Bangladeshi ethnic group (Appendix A xvi). In all other ethnic groups the UK-born had higher levels of treatment completion. Numbers of cases in the black Caribbean, black other, Bangladeshi and Chinese ethnic groups were small and results should be interpreted with caution.

Site of disease and sputum-smear

Completion of treatment was lower among cases with pulmonary disease (with or without extra-pulmonary disease) (80%, 3480/4372), compared to those with extra-pulmonary disease only (83%, 3708). Among sputum-smear positive pulmonary cases, the proportion completing treatment was 78% (Table 3.4). This was lower than in pulmonary cases with a negative or unknown sputum-smear (81%), and those with extra-pulmonary disease only (83%). Among pulmonary cases, the most common reason for not completing treatment was death (8.0%, 344/4372), while among extra-pulmonary cases still being on treatment was the most common reason (5.6%).

Table 3.4. Treatment outcome at 12 months by site of disease and sputum smear status, UK, 2008

Treatment outcome	Pulmonary with or without extra-pulmonary				Extra-pulmonary only	
	Sputum smear					
	Positive		Negative or unknown			
	n	%	n	%	n	%
Treatment completed	1,224	78.0	2,256	80.5	3,082	83.1
Died	119	7.6	225	8.0	134	3.6
Still on treatment	89	5.7	102	3.6	209	5.6
Lost to follow up	82	5.2	118	4.2	176	4.7
Treatment stopped	9	0.6	33	1.2	37	1.0
Transferred out	28	1.8	32	1.1	29	0.8
Not completed (unknown reason)	3	0.2	6	0.2	6	0.2
Outcome unknown	16	1.0	30	1.1	35	0.9
Total	1,570	100	2,802	100	3,708	100

Patients with miliary tuberculosis and tuberculosis meningitis, the most severe forms of extra-pulmonary disease, had the lowest levels of treatment completion at 55% and 54%, respectively (Appendix A xvii). For tuberculosis meningitis, 12 months of treatment is recommended[10] and it is, therefore, not surprising that 18% of these cases were still on treatment. The other common reason for treatment non-completion in this group was death (16%). Among cases with miliary tuberculosis, 21% had died before completing treatment, 12% were still on treatment, and 9% were lost to follow-up at 12 months. Completion of treatment at 12 months was also low among cases with tuberculosis of the bone and spine, with 70% completing treatment and 14% still on treatment at 12 months. Other types of extra-pulmonary disease had levels of treatment completion ranging from 81 to 86%.

Previous diagnosis

Treatment completion was lower among cases with a previous diagnosis of tuberculosis (74%) compared to cases who were not diagnosed with the disease before (83%) (Appendix A xviii). The most common reason for not completing treatment in those with a previous diagnosis of tuberculosis was death (10%), but numbers were small and should therefore be interpreted with caution. Among cases that did not have a previous diagnosis, the most common reasons for treatment non-completion were still being on treatment (5%), death (5%) and lost to follow-up (4%).

Drug resistance

Of the 225 isoniazid mono-resistant cases reported in 2008, 211 (94%) had a treatment outcome reported. Of these, 64% (136) had completed treatment at 12 months, 22% (47) were still on treatment, 6% (12) were lost to follow-up and 4% (8) had died.

Monitoring treatment outcomes at 24 months was introduced gradually during 2008-9 and special efforts were made to follow-up all MDR cases reported in 2007. At 24 months, 66% of MDR cases reported in 2007 had completed treatment, 11% had died, 9% were still on treatment, and 7% had had their treatment stopped (Table 3.5).

Table 3.5. Treatment outcome of MDR cases at 24 months, UK, 2007

Treatment outcome	n	%
Treatment completed	37	66.1
Died	6	10.7
Still on treatment	5	8.9
Lost to follow up	1	1.8
Treatment stopped	4	7.1
Transferred out	3	5.4
Not completed (unknown reason)	0	0.0
Outcome unknown	0	0.0
Total	56	100

4 The national strain typing service

Introduction

The need for a nationwide tuberculosis strain typing service as a key component of TB control was first identified by the CMO's TB Action Plan of 2004[1]. The recently launched national strain typing service was formed to fulfil this requirement; not only by ensuring the full provision of a standardised strain typing system, compatible with international systems, but also by enhancing the centralised database to contain both strain typing and epidemiological data. Furthermore, agreed operational guidelines on the use of molecular typing data will allow effective management of information from tuberculosis strain typing services. The combined use of epidemiological and strain typing data will be a powerful tool in the detection of recent transmission and thus the implementation of targeted public health control measures.

The service is a collaboration across the divisions of the HPA. It will run for three years, during which an Evaluation Group will assess the effectiveness and cost-effectiveness of the project. The results of this evaluation will inform the future national strain typing strategy - and whether the project is implemented as a full scale HPA service.

Elements of the service

All first isolates of *Mycobacterium tuberculosis* obtained from patients in England and Wales will be typed using the 24-loci Mycobacterium Interspersed Repetitive Units-Variable Number Tandem Repeats (MIRU-VNTR) strain typing method. This work will be carried out by the Regional Centre for Mycobacteriology (RCM)-Birmingham, RCM-Newcastle, National Mycobacterium Reference Laboratory (NMRL), London and the Wales Centre for Mycobacteria (WCM), Cardiff. Strain typing data will also be used to check for laboratory cross-contamination.

Strain typing results will be uploaded into the web-based Enhanced Tuberculosis Surveillance system, creating a combined centralised database of strain typing, laboratory and epidemiological data, which will help to identify recent transmission events between tuberculosis patients and new settings for transmission. It will allow us to investigate the demographic and clinical characteristics of cases in a cluster and their identified contacts. It will also enable us to closely monitor cluster growth, identify associated risk factors for spread of infection and provide information on the geographical distribution of strain types, thus increasing awareness of outbreaks that cross regional boundaries within the UK.

Substantial public health gains are to be expected from this project. The strain typing data will be used at both the national and local levels to facilitate early detection and subsequent epidemiological cluster investigation. This will lead to the implementation of timely targeted interventions to control and halt further transmission. The action to be taken by local, regional and national teams will be guided by the TB Strain Typing Handbook for Health Protection Units (HPUs)[11].

Current activities

Prospective typing of all first isolates of *Mycobacterium tuberculosis* is progressing well in England. By the end of August 2010, >99% of samples from all three designated specialist reference laboratories had undergone 24-loci typing, which is already greater than the 95% target set out in the project initiation document. This process is just being rolled out at the WCM in Cardiff and the Scottish Mycobacteria Reference Laboratory in Edinburgh. The NMRL and RCMs have been preparing summary monthly cluster reports for local, regional and national units.

A handbook outlining the protocols for using strain typing data to support the detection, investigation and management of tuberculosis clusters has been developed for HPUs[11]. This will be distributed along with a training package to Local and Regional Services by the end of 2010. This material will then be cascaded to other health professionals who work with the HPA to manage tuberculosis incidents. Workshops on the use of strain typing have been carried out by RCM-Birmingham with HPUs in their region.

An inter-country subgroup of the Strain Typing Project Board is currently being formed from public health and laboratory representatives of the HPA, Health Protection Scotland, Public Health Wales, the Public Health Agency for Northern Ireland and the Health Service Executive of the Republic of Ireland. It is hoped that this group will promote a mutually beneficial exchange of scientific expertise and improvement of public health activities. The NMRL has conducted joint typing workshops with colleagues in Wales, Northern Ireland and Scotland to facilitate this interaction.

Evaluation of the service

An independent Evaluation Group has been formed comprising experts from various fields relating to service evaluation, molecular typing, epidemiology, health economics, and public health and clinical tuberculosis control. The evaluation will adopt a multi-disciplinary approach to evaluate the effectiveness and cost-effectiveness of the service. The main outcomes of the evaluation are public health outcomes: the amount of transmission prevented, the cost per case prevented, and the cost of public health action avoided as a result of the strain typing service. Early stages of data collection are underway.

Conclusion

It is envisaged that the national strain typing service will enhance understanding of the dynamics of tuberculosis transmission in the UK and therefore strengthen the prevention and control of tuberculosis. In the longer term the data generated by this initiative will advance future research, aiding understanding of the differing rates of transmission, virulence and molecular characteristics of particular tuberculosis strains.

Furthermore, the service will not only contribute to the local and national effort against tuberculosis, but will also feed into UK and international initiatives through collaborations with Health Protection Scotland, the European Centre for Disease Control and the World Health Organization.

5 Progress and conclusions

National trend and geographic spread

Tuberculosis incidence continues to rise in the UK with 9,040 cases reported in 2009, the highest number since the early 1970s[12]. The rate of disease in the UK in 2009 was 14.6 per 100,000, 4% higher than in 2008 and 28% higher than in 2000. The sustained levels of disease in UK-born children aged under five years and in the UK-born population shows some evidence of continued transmission within the UK.

The main burden of disease was seen in urban areas and in particular London. Rates in some parts of the London region were over 80 per 100,000 which are similar to those reported in some high incidence countries in South America, Asia and North Africa[5]. Outside London, three primary care organisations in urban areas had rates of over 40 per 100,000. The proportion of cases reported from London has declined slightly since 2003 (from 42% in 2003 to 38% in 2009) and the numbers of cases have been relatively stable since 2005. Therefore the rise in tuberculosis is now mainly occurring elsewhere in the country.

- The national effort needs to be scaled up to halt this trend by identifying communities with ongoing transmission and targeting them with interventions. This will require a coordinated and effective national programme with responsibility for strategic oversight of action.
- Specific urban control measures should be applied in any urban area with high rates of disease, using examples from London and other western cities. These include active case finding through contact tracing and cluster investigation, measures to enhance prompt detection and treatment of active and latently infected cases, and ensuring treatment completion.

Groups at risk

Rates of tuberculosis are more than 20 times higher in the non-UK-born population compared to the UK-born, and nearly three-quarters of all patients are non-UK-born. Although rates in this population have declined since 2005 they still remain high at 86 per 100,000. The decline may be due to changes in the origin of migrant populations in the UK; this requires further investigation. Case numbers have continued to rise, exerting further burden on tuberculosis services. Since only 21% of cases are diagnosed with disease within two years of arrival to the UK, port of entry checks for active tuberculosis are unlikely to have a large effect. The occurrence of tuberculosis in these risk groups is consistent with observations from other western countries[13,14].

Efforts also need to be focused on the UK-born population, where no decline has been seen in the last decade, in contrast to other western countries[13,15,16]. Transmission of disease in the population with social risk factors is thought to contribute to this[17]. Rates are also higher among UK-born ethnic minority groups, suggesting that contact with non-UK-born cases in the UK and travel to communities in high incidence countries is higher in this group.

In 2009, the collection of social risk factor information was introduced to Enhanced Tuberculosis Surveillance in England, Wales and Northern Ireland. Initial results show that almost 10% of cases fall into this group and that many had more than one risk factor. Patients with social risk factors more often presented with drug resistance than other cases.

People living with HIV are also a known risk group for tuberculosis, and those who develop tuberculosis if co-infected with HIV are more difficult to diagnose as well as treat[18,19,20]. Data for 2008 show that nearly seven percent of tuberculosis patients were co-infected with HIV. HIV co-infection status is not recorded in tuberculosis surveillance and information on the level of co-infection is obtained by matching national tuberculosis case reports to national HIV surveillance records. This means that data is less timely, and that it is not possible to distinguish between no HIV co-infection and unknown sero-status.

- To achieve control of tuberculosis in the UK, a substantial decline in tuberculosis in the non-UK-born is required. In addition to a high index of clinical suspicion to ensure prompt diagnosis of active tuberculosis cases, this will require continued support to the global control effort, to reduce incidence in other countries. Many of these individuals arrive in the UK with latent tuberculosis infection and usually no sign of active tuberculosis detectable clinically or radiologically. Some may acquire tuberculosis due to travel or transmission within the UK. The role of detection and management of latent infection should therefore be strengthened.

- Early diagnosis and effective treatment are necessary to minimise spread of disease, requiring specific targeted interventions and improving awareness of TB in those at high risk.

- Further years of data are required to study the trends in hard to reach groups and this population should be monitored carefully especially with regards to treatment outcome, the use of DOT and levels of drug resistance.

- Collecting information on HIV testing and co-infection status in tuberculosis case reports would allow us to monitor trends of co-infection and treatment outcomes. This could provide invaluable information on the success of tuberculosis treatment and management of these complex patients.

Clinical presentation

The proportion of cases confirmed by culture has not improved since 2006 and remains at 56% of all cases, and 66% of pulmonary cases. Although this meets the goal of 65% of pulmonary cases specified in the CMO Action Plan[1,21], the HPA strategic aims prescribe having at least 70% of patients with pulmonary tuberculosis confirmed by laboratory culture.

The trend of an increasing number of cases with extra-pulmonary disease has implications for diagnosis and management. Although extra-pulmonary cases are generally not infectious to others, they are more difficult to diagnose than pulmonary cases owing to a wide range of clinical manifestations with limited specificity.

- Previous reports have highlighted that the level of culture-confirmed cases should be improved and samples should be submitted for all patients whenever it is possible to obtain them.

- Extra-pulmonary disease has been documented as more common among non-UK-born cases than UK-born cases, and clinicians should have a high index of clinical suspicion for extra-pulmonary disease in this group[22].

Drug resistance

After a drop in isoniazid resistance in 2008, an increase in resistance to this drug was seen in 2009 to 6.9%, a level similar to those observed from 2002-2007. This trend reflects a rise in cases associated with the isoniazid mono-resistant outbreak in London that occurred in the last quarter of 2009[7]. In England, isoniazid resistance reached the limit of 7% recommended in the CMO's Action Plan, and this was exceeded in both London and in the East Midlands.

Resistance to pyrazinamide increased to 1.0% after fluctuating between 0.3 and 0.7% from 2000-2008. It is unlikely that the rise in cases infected with *M. africanum*, which are more likely to be resistant to pyrazinamide, has caused the observed increase since only a small proportion of resistant cases was infected with this species and this proportion was similar between 2008 and 2009.

The proportion of tuberculosis cases that are multi-drug resistant remained stable and below the CMO's stated maximum level of 2% for the UK. However, in London, the proportion of multi-drug resistant cases is approaching this level at 1.9% and overall numbers of MDR TB cases have increased, potentially stretching current resources required for treatment and management. Guidelines recommend all multi-drug resistant cases to be placed on DOT[10], but initial data show this was the case for only 33%. Three cases of extensively drug-resistant disease were identified in 2009. Although small numbers are likely to fluctuate, this was one more case than observed in 2008.

- The isoniazid resistant outbreak in London, which is mainly among UK-born cases with social risk factors, is still continuing ten years after it was first identified, with over 400 confirmed linked cases. A review of all cases to date is currently under way in the London region, specifically to consider issues around case management and contact tracing, and report back to the London TB Commissioning Board.

- The factors contributing to the increase in pyrazinamide resistance are unclear and further investigation, as well as monitoring of the trend, is indicated.

- Careful monitoring of MDR TB and XDR TB cases is required, especially in London. It is recommended that all MDR TB cases are placed on DOT to ensure treatment adherence and completion and therefore avoid further development of resistance and future relapse. The assessment of resources required in the UK for the treatment of tuberculosis should take into account the increasing number of cases of MDR TB.

Planned treatment and treatment outcomes

The proportion of cases completing treatment within 12 months was 81%. Treatment completion remains below the 85% level, recommended by the CMO, in all countries of the UK and regions of England. Not all 19% of cases that did not complete treatment failed treatment (5% of cases were still on treatment due to a planned course of treatment exceeding 12 months). However, 6% were lost to follow up and this is a disappointing outcome for a resource rich setting. A low proportion of cases, with social risk factors associated with being lost to follow-up, were placed on DOT (16%).

Although the majority of multi-drug resistant cases completed treatment within 24 months (66%), this was much lower than for all tuberculosis cases. However, of the 11% of cases that died before completing treatment, death was incidental in 39% and should not be interpreted as treatment failures.

Reported treatment completion was lower in sputum-smear positive cases compared to sputum-smear negative and extra-pulmonary cases, which is concerning as these cases pose the highest risk of transmission.

Four English regions did not meet the minimum level of 95% reporting of treatment outcome stated in the Department of Health Toolkit[2]; further effort to improve data quality in these areas should be implemented. Ideally, all cases should have their treatment outcome reported[1].

- Greater efforts are needed to minimise cases becoming lost to follow-up, especially among drug resistant cases and sputum-smear positive cases.
- Greater use of DOT should be considered, especially for all patients with a social risk factor, and the proportions with such risk factors should be considered in terms of their impact on resources.

Quality of the data

The quality of the tuberculosis surveillance data is continually monitored and results fed back through user and steering groups. Audits, matching studies and capture-recapture methods are used to assess the completeness of reporting (Appendix D). Completeness of data fields are generally high and meet the targets set. Because the newly collected information on social risk factors and initial treatment plan were gradually introduced in 2009, completeness was lower and, as with other variables, may improve with time.

Progress towards CMO and HPA aims:

Indicator	Status
A progressive decline (of at least 2% per year) in rates of tuberculosis in population groups born in England.	No decline in rate among UK-born since 2000.
A reduction in the incidence of disease among people who entered the country and became resident here within the previous five years.	Numbers of cases diagnosed within 5 years of entering the UK have declined since 2005.
No more than 7% of new cases resistant to the anti-tuberculosis drug isoniazid.	6.9% of all cases were isoniazid resistant.
No more than 2% of new cases multi-drug resistant (resistant to at least isoniazid and rifampicin).	1.2% of all cases were multi-drug resistant.
At least 70% of patients with pulmonary tuberculosis have the diagnosis confirmed by laboratory culture.	66% of pulmonary cases are culture confirmed.
At least 95% of patients diagnosed with tuberculosis have the outcome of their treatment recorded[2].	Treatment outcome was reported for 95% of cases.
At least 85% of cases successfully complete their treatment.	81% of cases completed treatment within 12 months.

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Appendix A: Additional data

i. Tuberculosis case reports, rates and annual percentage change, UK, 2000-2009

Year	Number of cases	Rate per 100,000 (95% CI)	Annual change in case numbers (%)	Annual change in rate (%)
2000	6,724	11.4 (11.1-11.7)	–	–
2001	6,865	11.6 (11.3-11.9)	2.1	1.7
2002	7,243	12.2 (11.9-12.5)	5.5	5.1
2003	7,247	12.2 (11.9-12.5)	0.1	-0.3
2004	7,639	12.8 (12.5-13.1)	5.4	4.9
2005	8,319	13.8 (13.5-14.1)	8.9	8.2
2006	8,344	13.8 (13.5-14.1)	0.3	-0.3
2007	8,305	13.6 (13.3-13.9)	-0.5	-1.1
2008	8,621	14.0 (13.7-14.3)	3.8	3.1
2009	9,040	14.6 (14.3-14.9)	4.9	4.2

CI – confidence interval

ii. Tuberculosis case reports and rates by country, UK, 2000-2009

Year	Country								Total	
	England		Northern Ireland		Scotland		Wales			
	Number of cases	Rate per 100,000 (95% CI)	Number of cases	Rate per 100,000 (95% CI)	Number of cases	Rate per 100,000 (95% CI)	Number of cases	Rate per 100,000 (95% CI)	Number of cases	Rate per 100,000 (95% CI)
2000	6,081	12.4 (12.0-12.7)	57	3.4 (2.6-4.4)	403	8.0 (7.2-8.8)	183	6.3 (5.4-7.3)	6,724	11.4 (11.1-11.7)
2001	6,270	12.7 (12.4-13.0)	57	3.4 (2.6-4.4)	351	6.9 (6.2-7.7)	187	6.4 (5.5-7.4)	6,865	11.6 (11.3-11.9)
2002	6,626	13.3 (13.0-13.7)	67	3.9 (3.1-5.0)	393	7.8 (7.0-8.6)	157	5.4 (4.6-6.3)	7,243	12.2 (11.9-12.5)
2003	6,656	13.3 (13.0-13.7)	57	3.3 (2.5-4.3)	367	7.3 (6.5-8.0)	167	5.7 (4.9-6.6)	7,247	12.2 (11.9-12.5)
2004	6,977	13.9 (13.6-14.3)	81	4.7 (3.8-5.9)	392	7.7 (7.0-8.5)	189	6.4 (5.5-7.4)	7,639	12.8 (12.5-13.1)
2005	7,691	15.2 (14.9-15.6)	75	4.3 (3.4-5.5)	365	7.2 (6.4-7.9)	188	6.4 (5.5-7.3)	8,319	13.8 (13.5-14.1)
2006	7,720	15.2 (14.9-15.6)	61	3.5 (2.7-4.5)	381	7.4 (6.7-8.2)	182	6.1 (5.3-7.1)	8,344	13.8 (13.5-14.1)
2007	7,626	14.9 (14.6-15.3)	69	3.9 (3.1-5.0)	410	8.0 (7.2-8.8)	200	6.7 (5.8-7.7)	8,305	13.6 (13.3-13.9)
2008	7,942	15.4 (15.1-15.8)	66	3.7 (2.9-4.7)	446	8.6 (7.8-9.5)	167	5.6 (4.8-6.5)	8,621	14.0 (13.7-14.3)
2009	8,286	16.0 (15.7-16.3)	55	3.1 (2.3-4.0)	485	9.3 (8.5-10.2)	214	7.1 (6.2-8.2)	9,040	14.6 (14.3-14.9)

CI - confidence interval

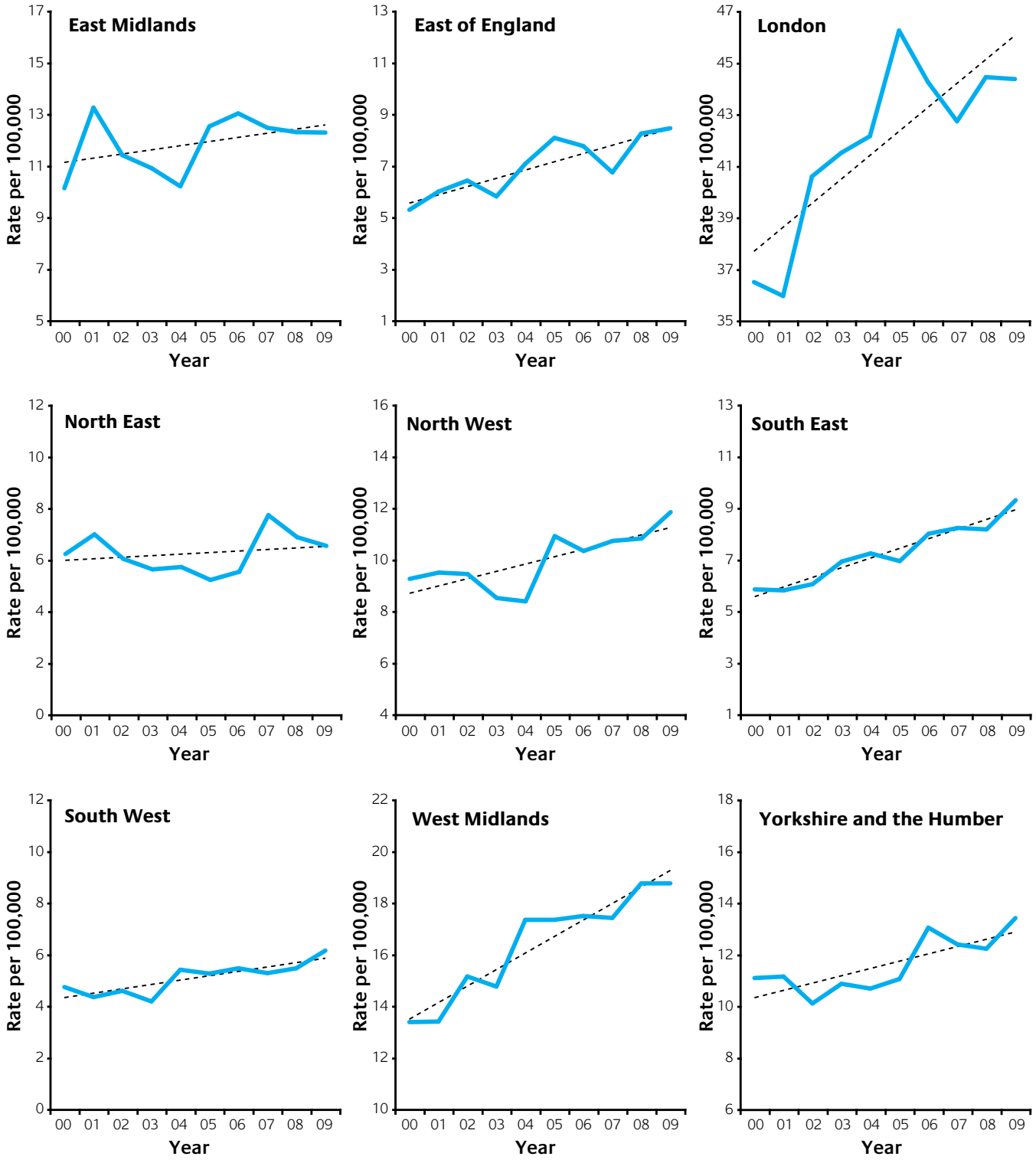
iii. Tuberculosis case reports by region, England, 2000-2009

Year	Region									Total
	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	
2000	422	284	2,640	158	626	466	232	704	549	6,081
2001	555	323	2,632	177	643	465	214	707	554	6,270
2002	481	348	2,987	153	639	491	221	801	505	6,626
2003	464	318	3,056	143	578	565	203	783	546	6,656
2004	437	389	3,114	145	571	593	265	923	540	6,977
2005	542	449	3,447	133	746	616	267	927	564	7,691
2006	568	435	3,324	141	707	658	279	938	670	7,720
2007	548	381	3,229	198	736	683	273	937	641	7,626
2008	545	472	3,386	177	743	684	284	1,014	637	7,942
2009	546	487	3,440	169	816	784	321	1,018	705	8,286

Table iv. Tuberculosis case rates by region, England, 2000-2009

Year	Region									Total
	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	
2000	10.1	5.3	36.5	6.2	9.2	5.8	4.7	13.4	11.1	12.4
2001	13.2	6.0	35.9	7.0	9.5	5.8	4.3	13.4	11.1	12.7
2002	11.4	6.4	40.6	6.0	9.4	6.0	4.6	15.1	10.1	13.3
2003	10.9	5.8	41 .5	5.6	8.5	6.9	4.2	14.7	10.9	13.3
2004	10.2	7.1	42.1	5.7	8.4	7.2	5.4	17.3	10.7	13.9
2005	12.5	8.1	46.2	5.2	10.9	6.9	5.2	17.3	11.0	15.2
2006	13.0	7.8	44.2	5.5	10.3	8.0	5.4	17.5	13.0	15.2
2007	12.5	6.7	42.7	7.7	10.7	8.2	5.3	17.4	12.4	14.9
2008	12.3	8.2	44.4	6.9	10.8	8.2	5.5	18.7	12.2	15.4
2009	12.3	8.4	44.4	6.5	11.8	9.3	6.1	18.7	13.4	16.0

v. Rates of tuberculosis case reports and linear trends by region, England, 2000-2009



vi. Three-year average tuberculosis case reports and rates by Primary Care Trust, England, 2001-2009

Primary Care Trust	Average number of cases			Average rate per 100,000 (95% CI)*		
	2001-2003	2004-2006	2007-2009	2001-2003	2004-2006	2007-2009
Ashton, Leigh and Wigan	5	11	12	2 (1-4)	4 (2-6)	4 (2-7)
Barking and Dagenham	35	51	68	21 (15-29)	31 (23-41)	40 (31-51)
Barnet	93	110	107	29 (23-36)	34 (28-41)	32 (26-39)
Barnsley	8	8	6	4 (2-7)	4 (2-7)	3 (1-6)
Bassetlaw	2	3	4	2 (0-7)	3 (1-8)	4 (1-9)
Bath and North East Somerset	11	10	8	6 (3-12)	6 (3-11)	4 (2-9)
Bedfordshire	32	34	34	8 (6-12)	9 (6-12)	8 (6-12)
Berkshire East	87	87	78	23 (19-29)	23 (18-28)	20 (16-25)
Berkshire West	53	65	77	12 (9-16)	15 (11-19)	17 (13-21)
Bexley (Care Trust)	21	23	22	10 (6-15)	10 (7-16)	10 (6-15)
Birmingham East and North	94	115	124	24 (19-29)	29 (24-35)	31 (26-37)
Blackburn with Darwen Teaching (Care Trust Plus)	46	57	54	33 (24-44)	40 (31-52)	38 (29-50)
Blackpool	12	8	13	8 (4-15)	6 (2-11)	9 (5-16)
Bolton	60	62	67	23 (17-29)	24 (18-30)	25 (20-32)
Bournemouth and Poole Teaching	22	30	23	7 (5-11)	10 (7-14)	8 (5-11)
Bradford and Airedale Teaching	135	152	184	29 (24-34)	31 (26-37)	37 (32-42)
Brent Teaching	217	251	294	81 (70-92)	93 (82-105)	109 (97-122)
Brighton and Hove City	11	16	34	4 (2-8)	6 (4-10)	13 (9-19)
Bristol	52	75	82	13 (10-17)	18 (15-23)	19 (15-24)
Bromley	24	33	28	8 (5-12)	11 (8-16)	9 (6-13)
Buckinghamshire	46	37	35	9 (7-12)	7 (5-10)	7 (5-10)
Bury	14	8	14	8 (4-13)	4 (2-9)	8 (4-13)
Calderdale	25	22	25	13 (8-19)	11 (7-17)	12 (8-18)
Cambridgeshire	22	35	39	4 (2-6)	6 (4-8)	6 (5-9)
Camden	104	92	91	50 (41-61)	41 (33-51)	39 (31-47)
Central and Eastern Cheshire	11	7	7	2 (1-4)	2 (1-3)	2 (1-3)
Central Lancashire	43	35	37	10 (7-13)	8 (5-11)	8 (6-11)
City and Hackney Teaching	143	142	127	66 (56-78)	66 (56-78)	58 (48-69)
Cornwall and Isles of Scilly	12	14	15	2 (1-4)	3 (1-5)	3 (2-5)
County Durham	16	17	22	3 (2-5)	3 (2-5)	4 (3-7)
Coventry Teaching	66	90	113	22 (17-28)	29 (24-36)	36 (30-44)
Croydon	106	111	117	32 (26-38)	33 (27-40)	34 (28-41)
Cumbria Teaching	5	5	13	1 (0-2)	1 (0-2)	3 (1-4)
Darlington	5	3	3	5 (2-12)	3 (1-9)	3 (1-9)
Derby City	50	37	50	22 (16-28)	16 (11-22)	21 (16-28)
Derbyshire County	33	32	34	5 (3-7)	4 (3-6)	5 (3-7)
Devon	18	19	24	3 (2-4)	3 (2-4)	3 (2-5)
Doncaster	17	16	13	6 (3-9)	6 (3-9)	4 (2-8)
Dorset	13	16	16	3 (2-6)	4 (2-6)	4 (2-6)
Dudley	31	34	37	10 (7-14)	11 (8-16)	12 (8-17)
Ealing	190	241	217	62 (53-71)	79 (69-89)	70 (61-80)
East Lancashire Teaching	51	61	60	13 (10-18)	16 (12-20)	16 (12-20)
East Riding of Yorkshire	9	9	7	3 (1-5)	3 (1-5)	2 (1-4)
East Sussex Downs and Weald	15	11	16	5 (3-8)	3 (2-6)	5 (3-8)
Eastern and Coastal Kent	35	37	56	5 (4-7)	5 (4-7)	8 (6-10)
Enfield	90	99	96	32 (26-39)	35 (28-43)	33 (27-41)
Gateshead	6	4	9	3 (1-7)	2 (1-5)	5 (2-9)
Gloucestershire	20	28	30	4 (2-5)	5 (3-7)	5 (3-7)
Great Yarmouth and Waveney	9	9	23	4 (2-8)	4 (2-8)	11 (7-16)
Greenwich Teaching	71	91	122	32 (25-41)	41 (33-50)	55 (45-65)
Halton and St Helens	5	6	6	2 (1-4)	2 (1-4)	2 (1-4)
Hammersmith and Fulham	71	79	70	42 (33-53)	46 (37-58)	41 (32-51)
Hampshire	38	45	55	3 (2-4)	4 (3-5)	4 (3-6)
Haringey Teaching	139	144	109	62 (52-73)	64 (54-76)	48 (40-58)
Harrow	108	118	129	51 (42-62)	55 (46-66)	60 (50-71)
Hartlepool	7	2	7	8 (3-16)	2 (0-8)	8 (3-16)

continued ...

Primary Care Trust	Average number of cases			Average rate per 100,000 (95% CI)*		
	2001-2003	2004-2006	2007-2009	2001-2003	2004-2006	2007-2009
Hastings and Rother	7	6	3	4 (2-8)	3 (1-7)	2 (0-5)
Havering	16	21	22	7 (4-12)	9 (6-14)	10 (6-14)
Heart of Birmingham Teaching	177	226	241	67 (58-78)	84 (73-96)	88 (77-99)
Herefordshire	3	3	6	2 (0-5)	2 (0-5)	3 (1-7)
Hertfordshire	59	89	76	6 (4-7)	8 (7-10)	7 (6-9)
Heywood, Middleton and Rochdale	18	26	47	9 (5-14)	13 (8-18)	23 (17-30)
Hillingdon	101	126	134	41 (33-50)	51 (42-61)	53 (44-63)
Hounslow	113	139	148	52 (43-63)	64 (54-76)	66 (56-78)
Hull Teaching	12	13	12	5 (2-8)	5 (3-9)	5 (2-8)
Isle of Wight National Health Service	4	1	4	3 (1-8)	1 (0-4)	3 (1-7)
Islington	95	89	92	53 (43-64)	48 (39-59)	48 (39-59)
Kensington and Chelsea	41	49	45	25 (18-34)	28 (21-37)	25 (18-33)
Kingston	18	25	30	12 (7-19)	16 (11-24)	19 (13-27)
Kirklees	84	76	98	22 (17-27)	19 (15-24)	24 (20-30)
Knowsley	5	5	2	3 (1-8)	3 (1-8)	1 (0-5)
Lambeth	148	134	116	55 (46-64)	50 (42-59)	42 (35-51)
Leeds	91	122	126	13 (10-16)	16 (14-20)	16 (14-19)
Leicester City	220	217	212	78 (68-89)	76 (66-87)	72 (63-82)
Leicestershire County and Rutland	42	46	50	6 (5-9)	7 (5-9)	7 (5-10)
Lewisham	80	86	86	32 (25-39)	34 (27-42)	33 (26-41)
Lincolnshire Teaching	11	19	21	2 (1-3)	3 (2-4)	3 (2-5)
Liverpool	34	54	47	8 (5-11)	12 (9-16)	11 (8-14)
Luton	78	76	83	42 (33-52)	41 (32-51)	43 (34-54)
Manchester Teaching	131	155	179	31 (26-37)	35 (30-41)	39 (33-45)
Medway	18	13	20	7 (4-11)	5 (3-9)	8 (5-12)
Mid Essex	10	13	9	3 (1-5)	4 (2-6)	2 (1-5)
Middlesbrough	21	18	31	15 (9-23)	13 (8-21)	22 (15-32)
Milton Keynes	16	28	38	7 (4-12)	12 (8-18)	16 (11-22)
Newcastle	36	37	43	13 (9-19)	14 (10-19)	16 (11-21)
Newham	222	254	292	88 (76-100)	102 (90-115)	117 (104-131)
Norfolk	20	33	35	3 (2-4)	5 (3-6)	5 (3-6)
North East Essex	11	8	6	4 (2-7)	3 (1-5)	2 (1-4)
North East Lincolnshire (Care Trust Plus)	6	2	6	4 (1-8)	1 (0-5)	4 (1-8)
North Lancashire Teaching	17	10	7	5 (3-9)	3 (1-6)	2 (1-4)
North Lincolnshire	4	4	19	3 (1-7)	3 (1-7)	12 (7-19)
North Somerset	5	7	10	3 (1-6)	4 (1-7)	5 (2-9)
North Staffordshire	7	7	7	3 (1-7)	3 (1-7)	3 (1-7)
North Tyneside	10	10	9	5 (2-10)	5 (2-9)	5 (2-9)
North Yorkshire and York	16	25	27	2 (1-3)	3 (2-5)	3 (2-5)
Northamptonshire Teaching	69	74	72	11 (8-14)	11 (9-14)	11 (8-13)
Northumberland (Care Trust)	9	6	10	3 (1-6)	2 (1-4)	3 (2-6)
Nottingham City	45	61	75	17 (12-22)	22 (16-28)	26 (20-32)
Nottinghamshire County Teaching	23	21	26	4 (2-5)	3 (2-5)	4 (3-6)
Oldham	42	42	44	19 (14-26)	19 (14-26)	20 (15-27)
Oxfordshire	35	60	62	6 (4-8)	10 (8-13)	10 (8-13)
Peterborough	22	36	36	14 (9-21)	22 (15-31)	22 (15-30)
Plymouth Teaching	12	11	14	5 (3-9)	4 (2-8)	6 (3-9)
Portsmouth City Teaching	15	22	33	8 (4-13)	11 (7-17)	17 (11-23)
Redbridge	97	124	149	40 (32-49)	50 (41-59)	58 (49-68)
Redcar and Cleveland	5	3	5	4 (1-8)	2 (0-6)	4 (1-8)
Richmond and Twickenham	13	17	16	7 (4-13)	10 (6-15)	9 (5-14)
Rotherham	36	24	20	14 (10-20)	9 (6-14)	8 (5-12)
Salford	17	24	31	8 (5-13)	11 (7-16)	14 (10-20)
Sandwell	86	107	108	30 (24-37)	37 (31-45)	37 (31-45)
Sefton	10	11	9	4 (2-7)	4 (2-7)	3 (1-6)
Sheffield	78	93	95	15 (12-19)	18 (14-22)	18 (14-22)
Shropshire County	8	15	9	3 (1-6)	5 (3-9)	3 (1-6)
Solihull (Care Trust)	12	15	18	6 (3-10)	7 (4-12)	9 (5-14)
Somerset	10	15	11	2 (1-4)	3 (2-5)	2 (1-4)

continued ...

Primary Care Trust	Average number of cases			Average rate per 100,000 (95% CI)*		
	2001-2003	2004-2006	2007-2009	2001-2003	2004-2006	2007-2009
South Birmingham	56	53	64	17 (13-22)	16 (12-21)	19 (15-24)
South East Essex	22	30	29	7 (4-10)	9 (6-13)	9 (6-12)
South Gloucestershire	9	10	16	4 (2-7)	4 (2-7)	6 (4-10)
South Staffordshire	13	21	24	2 (1-4)	3 (2-5)	4 (3-6)
South Tyneside	10	4	11	7 (3-12)	3 (1-7)	7 (4-13)
South West Essex	18	26	30	5 (3-7)	7 (4-10)	8 (5-11)
Southampton City	26	33	27	12 (8-17)	15 (10-20)	12 (8-17)
Southwark	101	132	105	39 (32-48)	50 (42-59)	38 (31-46)
Stockport	23	16	21	8 (5-12)	6 (3-9)	7 (5-11)
Stockton-on-Tees Teaching	11	15	13	6 (3-11)	8 (4-13)	7 (4-12)
Stoke on Trent	34	36	29	14 (10-19)	15 (10-20)	12 (8-17)
Suffolk	14	20	29	3 (1-4)	3 (2-5)	5 (3-7)
Sunderland Teaching	21	20	20	7 (5-11)	7 (4-11)	7 (4-11)
Surrey	41	70	74	4 (3-5)	7 (5-8)	7 (5-8)
Sutton and Merton	68	88	88	18 (14-23)	23 (19-29)	23 (18-28)
Swindon	10	14	20	5 (3-10)	7 (4-12)	10 (6-16)
Tameside and Glossop	26	26	33	11 (7-15)	11 (7-15)	13 (9-19)
Telford and Wrekin	4	13	12	3 (1-6)	8 (4-14)	7 (4-13)
Torbay (Care Trust)	6	10	10	5 (2-10)	8 (4-14)	7 (4-14)
Tower Hamlets	111	126	143	54 (44-65)	60 (50-72)	65 (55-76)
Trafford	27	21	27	13 (8-19)	10 (6-15)	13 (8-18)
Wakefield District	14	24	20	4 (2-7)	7 (5-11)	6 (4-10)
Walsall Teaching	58	52	55	23 (17-30)	20 (15-27)	22 (16-28)
Waltham Forest	90	112	105	41 (33-50)	51 (42-61)	47 (38-57)
Wandsworth	80	100	103	29 (23-37)	36 (29-44)	36 (30-44)
Warrington	4	4	10	2 (1-5)	2 (1-5)	5 (2-9)
Warwickshire	35	38	53	7 (5-10)	7 (5-10)	10 (7-13)
West Essex	13	14	15	5 (3-8)	5 (3-9)	5 (3-9)
West Kent	21	35	55	3 (2-5)	5 (4-7)	8 (6-11)
West Sussex	39	52	50	5 (4-7)	7 (5-9)	6 (5-8)
Western Cheshire	3	11	7	1 (0-4)	5 (2-8)	3 (1-6)
Westminster	81	89	78	38 (30-48)	39 (31-48)	33 (26-41)
Wiltshire	12	11	13	3 (1-5)	2 (1-4)	3 (2-5)
Wirral	9	11	13	3 (1-5)	4 (2-6)	4 (2-7)
Wolverhampton City	65	80	73	27 (21-35)	34 (27-42)	31 (24-39)
Worcestershire	15	24	17	3 (2-5)	4 (3-6)	3 (2-5)

*Rates calculated using middle year ONS mid-year population estimates (2002, 2005, 2008)

vii. Characteristics of tuberculosis case reports by Primary Care Trust, England, 2007-2009

Primary Care Trust	Place of birth	Site of disease	Microscopy	Culture	Drug resistance***		Treatment outcome****	
	% Non-UK-born (95% CI)	% Pulmonary* (95% CI)	% Sputum-smear positive** (95% CI)	% Culture-confirmed (95% CI)	% INH Resistant (95% CI)	% MDR (95% CI)	% Outcome reported	% Treatment completed *****
Ashton, Leigh and Wigan	57 (39-74)	59 (41-75)	71 (42-92)	74 (57-88)	0 (0-14)~	0 (0-14)~	97 (84-100)	72 (53-86)
Barking and Dagenham	79 (73-85)	49 (41-56)	62 (49-73)	56 (49-63)	9 (4-16)	2 (0-6)	100 (98-100)~	82 (76-88)
Barnet	81 (76-86)	59 (53-64)	41 (33-51)	54 (49-60)	6 (3-10)	1 (0-4)	100 (98-100)	84 (80-88)
Barnsley	36 (13-65)	76 (50-93)	25 (3-65)	53 (28-77)	0 (0-34)~	0 (0-34)~	71 (49-87)	71 (44-90)
Bassetlaw	20 (3-56)	62 (32-86)	100 (48-100)	46 (19-75)	0 (0-46)~	0 (0-46)~	44 (14-79)	100 (40-100)~
Bath and North East Somerset	39 (20-61)	57 (34-77)	67 (22-96)	50 (29-71)	9 (0-41)	0 (0-28)~	82 (57-96)	86 (57-98)
Bedfordshire	82 (74-89)	55 (45-65)	39 (22-59)	46 (36-56)	9 (2-20)	0 (0-8)~	98 (93-100)	88 (79-93)
Berkshire East	85 (79-89)	47 (41-54)	67 (53-78)	48 (42-55)	4 (1-9)	0 (0-3)~	100 (98-100)~	87 (82-91)
Berkshire West	77 (71-83)	40 (34-47)	65 (53-76)	62 (55-68)	6 (3-11)	1 (0-4)	100 (98-100)~	84 (79-89)
Bexley (Care Trust)	70 (58-81)	54 (41-66)	63 (44-80)	63 (50-74)	2 (0-13)	0 (0-8)~	100 (95-100)~	78 (67-87)
Birmingham East and North	70 (65-75)	53 (48-58)	95 (87-99)	53 (48-59)	4 (1-7)	1 (0-3)	95 (92-97)	85 (81-89)
Blackburn with Darwen Teaching (Care Trust Plus)	73 (66-80)	41 (33-49)	56 (41-71)	52 (44-59)	4 (1-10)	1 (0-7)	99 (97-100)	90 (85-95)
Blackpool	38 (22-55)	70 (53-83)	77 (55-92)	78 (62-89)	6 (1-21)	3 (0-17)	100 (90-100)~	81 (64-92)
Bolton	70 (63-76)	51 (44-58)	65 (52-76)	53 (45-60)	6 (2-12)	1 (0-5)	98 (96-100)	84 (78-89)
Bournemouth and Poole Teaching	71 (59-82)	57 (44-68)	64 (44-81)	55 (43-67)	3 (0-14)	0 (0-9)~	98 (91-100)	78 (67-87)
Bradford and Airedale Teaching	72 (68-76)	47 (43-51)	48 (39-57)	56 (52-61)	5 (3-8)	0 (0-2)	95 (93-97)	78 (74-82)
Brent Teaching	90 (88-92)	49 (45-52)	43 (38-48)	55 (52-58)	8 (6-11)	1 (0-3)	100 (99-100)	86 (84-88)
Brighton and Hove City	58 (48-68)	55 (45-65)	58 (39-75)	43 (33-53)	7 (1-19)	0 (0-8)~	78 (67-86)	79 (67-88)
Bristol	81 (75-86)	59 (52-65)	71 (60-81)	57 (51-64)	6 (3-12)	1 (0-4)	81 (75-85)	73 (66-79)
Bromley	68 (56-78)	42 (32-54)	59 (39-78)	53 (42-64)	9 (3-22)	5 (1-16)	98 (93-100)	83 (73-90)
Buckinghamshire	66 (56-76)	55 (45-65)	48 (29-67)	67 (57-76)	9 (3-18)	1 (0-8)	100 (97-100)~	91 (84-96)
Bury	61 (45-76)	70 (54-83)	76 (50-93)	70 (54-83)	7 (1-22)	7 (1-22)	84 (64-95)	67 (43-85)
Calderdale	67 (55-77)	42 (31-54)	71 (49-87)	58 (46-69)	2 (0-12)	0 (0-8)~	100 (95-100)~	83 (72-91)
Cambridgeshire	71 (62-80)	49 (39-58)	38 (18-62)	56 (46-65)	8 (3-18)	5 (1-14)	92 (86-96)	81 (72-88)
Camden	72 (66-78)	55 (49-61)	54 (44-63)	54 (48-60)	9 (5-15)	1 (0-4)	100 (99-100)~	82 (77-86)
Central and Eastern Cheshire	47 (23-72)	58 (33-80)	64 (31-89)	60 (36-81)	8 (0-38)	0 (0-26)~	75 (53-90)	83 (59-96)
Central Lancashire	71 (61-80)	55 (45-65)	45 (30-61)	44 (34-53)	2 (0-11)	2 (0-11)	92 (85-96)	91 (84-96)
City and Hackney Teaching	74 (69-78)	52 (46-57)	55 (47-63)	46 (41-51)	15 (10-22)	2 (0-5)	100 (99-100)~	81 (77-85)
Cornwall and Isles of Scilly	31 (17-48)	74 (59-86)	65 (44-83)	74 (59-86)	6 (1-20)	0 (0-11)~	98 (88-100)	67 (50-80)
County Durham	28 (15-45)	62 (49-73)	64 (43-82)	66 (53-77)	2 (0-12)	0 (0-8)~	97 (88-100)	76 (63-86)
Coventry Teaching	76 (70-81)	60 (55-66)	54 (40-67)	46 (41-51)	6 (3-11)	1 (0-5)	87 (83-90)	75 (70-80)
Croydon	86 (82-89)	45 (40-51)	61 (52-70)	65 (60-70)	7 (4-11)	2 (0-4)	100 (99-100)~	85 (80-88)
Cumbria Teaching	22 (10-39)	56 (40-72)	85 (62-97)	44 (28-60)	0 (0-21)~	0 (0-21)~	73 (54-87)	79 (58-93)
Darlington	40 (5-85)	50 (16-84)	100 (16-100)	63 (24-91)	20 (1-72)	0 (0-52)~	100 (66-100)~	89 (52-100)
Derby City	71 (63-78)	53 (45-61)	53 (39-66)	53 (44-61)	12 (6-21)	1 (0-7)	79 (71-85)	78 (70-86)
Derbyshire County	26 (17-37)	69 (59-77)	62 (46-76)	44 (34-54)	9 (3-22)	0 (0-8)~	86 (77-92)	80 (70-88)
Devon	37 (25-50)	77 (66-86)	81 (64-92)	65 (53-76)	7 (1-18)	2 (0-12)	98 (91-100)	76 (63-86)
Doncaster	69 (50-84)	56 (40-72)	54 (25-81)	48 (32-64)	5 (0-26)	5 (0-26)	85 (71-94)	69 (52-83)
Dorset	48 (31-66)	62 (46-75)	88 (62-98)	55 (40-70)	8 (1-25)	0 (0-13)~	100 (92-100)~	81 (66-91)
Dudley	56 (46-65)	57 (47-66)	39 (24-55)	49 (39-58)	4 (0-13)	2 (0-10)	100 (97-100)~	84 (77-91)
Ealing	89 (86-91)	45 (41-49)	38 (32-45)	54 (50-58)	8 (6-12)	1 (0-2)	100 (99-100)	79 (76-82)
East Lancashire Teaching	57 (50-65)	59 (51-66)	65 (54-76)	62 (54-69)	2 (0-6)	1 (0-5)	91 (86-95)	88 (82-93)
East Riding of Yorkshire	41 (21-64)	67 (43-85)	75 (35-97)	73 (50-89)	6 (0-30)	0 (0-21)~	96 (82-100)	74 (54-89)
East Sussex Downs and Weald	62 (45-77)	60 (44-74)	79 (49-95)	50 (35-65)	4 (0-21)	0 (0-14)~	64 (46-79)	78 (56-93)
Eastern and Coastal Kent	66 (58-74)	70 (63-77)	65 (52-76)	59 (51-66)	5 (2-11)	0 (0-4)~	95 (91-98)	70 (62-77)
Enfield	79 (74-84)	56 (50-61)	45 (36-54)	53 (47-58)	8 (4-13)	2 (0-6)	100 (99-100)~	85 (80-89)
Gateshead	55 (32-77)	69 (48-86)	67 (35-90)	69 (48-86)	6 (0-27)	0 (0-19)~	95 (74-100)	78 (52-94)
Gloucestershire	55 (43-66)	67 (57-77)	78 (63-89)	71 (61-80)	0 (0-6)~	0 (0-6)~	94 (88-98)	76 (66-84)
Great Yarmouth and Waveney	46 (34-59)	83 (72-91)	72 (51-88)	61 (49-73)	2 (0-13)	0 (0-8)~	94 (85-99)	75 (60-86)
Greenwich Teaching	78 (74-83)	56 (51-61)	57 (49-64)	57 (51-62)	7 (4-11)	1 (0-4)	100 (99-100)~	83 (78-87)
Halton and St Helens	33 (10-65)	59 (33-82)	56 (21-86)	71 (44-90)	8 (0-38)	0 (0-26)~	72 (47-90)	62 (32-86)
Hammersmith and Fulham	79 (73-85)	57 (50-64)	53 (42-64)	62 (55-69)	10 (5-16)	1 (0-4)	100 (97-100)	86 (80-90)
Hampshire	72 (65-79)	60 (52-68)	69 (56-80)	56 (48-64)	9 (4-16)	1 (0-6)	93 (88-97)	70 (62-78)

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Primary Care Trust	Place of birth	Site of disease	Microscopy	Culture	Drug resistance***		Treatment outcome****	
	% Non-UK-born (95% CI)	% Pulmonary* (95% CI)	% Sputum-smear positive** (95% CI)	% Culture-confirmed (95% CI)	% INH Resistant (95% CI)	% MDR (95% CI)	% Outcome reported	% Treatment completed *****
Haringey Teaching	80 (75-84)	63 (57-68)	45 (37-53)	53 (48-59)	13 (8-19)	1 (0-4)	100 (99-100)~	82 (78-86)
Harrow	89 (85-92)	46 (41-51)	32 (24-40)	56 (51-61)	7 (4-11)	0 (0-2)ˇ	100 (99-100)~	88 (85-92)
Hartlepool	53 (29-76)	41 (21-64)	43 (10-82)	41 (21-64)	22 (3-60)	11 (0-48)	100 (74-100)~	100 (74-100)~
Hastings and Rother	88 (47-100)	63 (24-91)	100 (16-100)	88 (47-100)	14 (0-58)	0 (0-41)ˇ	100 (69-100)~	70 (35-93)
Havering	70 (58-81)	42 (30-55)	67 (41-87)	53 (40-65)	6 (1-20)	3 (0-16)	100 (94-100)~	73 (60-84)
Heart of Birmingham Teaching	70 (66-73)	54 (51-58)	95 (90-98)	57 (53-61)	4 (2-6)	1 (0-2)	94 (93-96)	83 (80-86)
Herefordshire	40 (12-74)	67 (38-88)	60 (15-95)	47 (23-72)	0 (0-37)~	0 (0-37)ˇ	33 (12-62)	80 (28-99)
Hertfordshire	68 (61-74)	63 (56-69)	62 (47-76)	47 (40-53)	10 (5-18)	2 (0-7)	96 (92-98)	78 (72-83)
Heywood, Middleton and Rochdale	66 (57-74)	51 (42-59)	67 (48-82)	48 (39-56)	9 (3-18)	1 (0-8)	79 (71-86)	86 (78-92)
Hillingdon	87 (83-90)	53 (48-58)	46 (38-53)	56 (51-61)	4 (2-8)	0 (0-3)	100 (99-100)~	80 (76-84)
Hounslow	90 (87-93)	39 (34-44)	50 (40-60)	52 (47-57)	7 (4-11)	2 (0-4)	100 (98-100)	67 (62-72)
Hull Teaching	64 (46-79)	71 (54-85)	77 (46-95)	73 (56-86)	7 (1-24)	0 (0-13)ˇ	98 (88-100)	70 (54-83)
Isle of Wight National Health Service	80 (44-97)	38 (14-68)	50 (7-93)	54 (25-81)	29 (4-71)	0 (0-41)ˇ	88 (47-100)	71 (29-96)
Islington	71 (65-77)	65 (59-70)	50 (41-59)	51 (44-57)	17 (11-24)	4 (1-8)	100 (99-100)~	82 (77-86)
Kensington and Chelsea	80 (72-87)	63 (55-72)	38 (26-52)	46 (38-55)	8 (3-18)	2 (0-9)	100 (97-100)~	83 (75-89)
Kingston	84 (74-91)	63 (52-73)	54 (39-69)	56 (45-67)	6 (1-18)	0 (0-8)ˇ	100 (96-100)~	70 (58-79)
Kirklees	59 (53-65)	54 (48-60)	58 (47-68)	48 (42-54)	3 (1-7)	0 (0-3)ˇ	99 (97-100)	86 (81-90)
Knowsley	25 (1-81)	60 (15-95)	67 (9-99)	67 (22-96)	0 (0-60)~	0 (0-60)ˇ	67 (35-90)	63 (24-91)
Lambeth	80 (75-84)	52 (47-58)	49 (40-58)	62 (57-67)	10 (7-15)	2 (1-5)	100 (99-100)~	82 (78-86)
Leeds	81 (76-85)	53 (48-58)	41 (32-50)	62 (57-67)	7 (4-11)	2 (0-4)	95 (92-97)	81 (77-85)
Leicester City	89 (86-92)	48 (45-52)	45 (37-52)	46 (42-50)	8 (5-11)	2 (1-4)	94 (92-96)	87 (84-89)
Leicestershire County and Rutland	61 (51-71)	65 (57-73)	55 (43-67)	48 (40-56)	3 (0-10)	0 (0-5)ˇ	92 (86-96)	78 (70-84)
Lewisham	81 (76-86)	55 (49-62)	64 (55-72)	61 (55-67)	13 (8-19)	1 (0-4)	100 (98-100)	85 (80-89)
Lincolnshire Teaching	46 (33-60)	69 (56-80)	77 (59-90)	56 (42-68)	3 (0-15)	3 (0-15)	81 (69-90)	71 (56-83)
Liverpool	69 (61-77)	55 (46-63)	61 (48-73)	57 (48-65)	3 (0-9)	0 (0-5)ˇ	94 (89-97)	74 (66-81)
Luton	76 (70-81)	50 (43-56)	41 (22-61)	53 (46-59)	5 (2-11)	0 (0-3)ˇ	98 (96-100)	90 (85-93)
Manchester Teaching	78 (75-82)	49 (45-53)	67 (58-75)	61 (57-65)	7 (4-10)	1 (0-2)	94 (92-96)	84 (80-87)
Medway	81 (68-91)	55 (42-68)	50 (21-79)	77 (64-87)	5 (1-15)	2 (0-12)	91 (80-97)	63 (48-76)
Mid Essex	59 (39-78)	74 (54-89)	67 (38-88)	56 (35-75)	7 (0-32)	0 (0-22)ˇ	97 (84-100)	77 (59-90)
Middlesbrough	60 (48-71)	57 (46-67)	58 (41-73)	62 (51-72)	5 (1-15)	2 (0-10)	99 (93-100)	81 (70-89)
Milton Keynes	85 (77-91)	37 (28-47)	65 (43-84)	57 (48-67)	6 (2-15)	3 (0-11)	100 (97-100)~	80 (72-87)
Newcastle	74 (65-82)	44 (35-53)	65 (50-78)	73 (64-80)	12 (6-20)	4 (1-11)	98 (95-100)	78 (70-85)
Newham	92 (90-94)	44 (41-48)	62 (55-68)	56 (52-59)	7 (5-10)	1 (1-3)	100 (99-100)	82 (79-84)
Norfolk	67 (55-78)	63 (53-73)	45 (27-64)	56 (46-66)	16 (7-27)	5 (1-14)	93 (86-97)	71 (61-79)
North East Essex	81 (54-96)	78 (52-94)	70 (35-93)	78 (52-94)	8 (0-38)	0 (0-26)ˇ	86 (65-97)	74 (49-91)
North East Lincolnshire (Care Trust Plus)	44 (22-69)	61 (36-83)	100 (54-100)	72 (47-90)	8 (0-36)	0 (0-25)ˇ	100 (82-100)~	63 (38-84)
North Lancashire Teaching	22 (6-48)	75 (51-91)	67 (35-90)	60 (36-81)	0 (0-26)~	0 (0-26)ˇ	100 (81-100)~	78 (52-94)
North Lincolnshire	33 (21-47)	79 (66-89)	50 (23-77)	54 (41-68)	10 (2-27)	0 (0-12)ˇ	100 (88-100)~	90 (73-98)
North Somerset	35 (17-56)	65 (44-83)	88 (47-100)	70 (51-85)	10 (1-30)	0 (0-16)ˇ	71 (48-89)	73 (45-92)
North Staffordshire	50 (26-74)	52 (30-74)	50 (12-88)	52 (30-74)	0 (0-31)~	0 (0-31)ˇ	96 (79-100)	74 (52-90)
North Tyneside	55 (32-77)	50 (30-70)	55 (23-83)	73 (52-88)	11 (1-33)	0 (0-18)ˇ	100 (86-100)~	80 (59-93)
North Yorkshire and York	48 (36-60)	66 (55-76)	55 (32-77)	66 (55-76)	2 (0-10)	2 (0-10)	100 (95-100)~	73 (61-82)
Northamptonshire Teaching	66 (59-72)	63 (56-69)	62 (51-72)	54 (48-61)	5 (2-11)	1 (0-5)	97 (93-99)	78 (72-84)
Northumberland (Care Trust)	38 (19-59)	63 (44-80)	71 (42-92)	57 (37-75)	0 (0-21)~	0 (0-21)ˇ	96 (82-100)	78 (58-91)
Nottingham City	72 (66-78)	54 (47-61)	43 (32-56)	63 (56-69)	5 (2-10)	1 (0-4)	100 (98-100)	82 (76-86)
Nottinghamshire County Teaching	61 (48-73)	62 (50-72)	55 (36-73)	63 (51-74)	2 (0-11)	2 (0-11)	89 (80-95)	78 (67-88)
Oldham	69 (60-77)	43 (34-52)	83 (69-92)	63 (54-71)	5 (1-12)	0 (0-4)ˇ	89 (82-93)	86 (79-92)
Oxfordshire	77 (70-83)	55 (47-62)	49 (37-62)	60 (53-67)	7 (3-14)	1 (0-5)	100 (98-100)~	86 (80-91)
Peterborough	69 (58-78)	50 (41-60)	56 (35-76)	63 (54-72)	1 (0-8)	0 (0-5)ˇ	96 (91-99)	67 (58-76)
Plymouth Teaching	62 (45-78)	56 (40-72)	63 (35-85)	59 (42-74)	13 (3-32)	0 (0-14)ˇ	98 (87-100)	63 (47-78)
Portsmouth City Teaching	71 (61-80)	64 (54-73)	50 (32-68)	41 (31-51)	12 (4-26)	0 (0-9)ˇ	96 (88-99)	75 (63-85)
Redbridge	86 (82-89)	44 (40-49)	54 (45-63)	50 (46-55)	8 (5-12)	2 (1-5)	100 (99-100)~	83 (79-86)
Redcar and Cleveland	20 (3-56)	67 (38-88)	83 (36-100)	33 (12-62)	0 (0-52)~	0 (0-52)ˇ	100 (75-100)~	77 (46-95)

continued ...

Primary Care Trust	Place of birth	Site of disease	Microscopy	Culture	Drug resistance***		Treatment outcome****	
	% Non-UK-born (95% CI)	% Pulmonary* (95% CI)	% Sputum-smear positive** (95% CI)	% Culture-confirmed (95% CI)	% INH Resistant (95% CI)	% MDR (95% CI)	% Outcome reported	% Treatment completed *****
Richmond and Twickenham	52 (37-67)	53 (38-68)	69 (41-89)	66 (51-79)	0 (0-11)~	0 (0-11)~	100 (92-100)~	67 (51-80)
Rotherham	42 (28-57)	67 (53-78)	43 (22-66)	48 (35-62)	4 (0-18)	0 (0-12)~	94 (84-99)	73 (58-85)
Salford	63 (53-73)	53 (42-63)	68 (51-82)	63 (53-73)	2 (0-9)	0 (0-6)~	88 (79-94)	72 (61-82)
Sandwell	66 (60-71)	54 (49-60)	55 (45-64)	52 (46-57)	5 (2-9)	1 (0-3)	100 (99-100)~	77 (72-81)
Sefton	61 (39-80)	57 (37-76)	86 (57-98)	68 (48-84)	5 (0-26)	0 (0-18)~	82 (63-94)	74 (52-90)
Sheffield	77 (71-82)	62 (56-68)	51 (41-61)	57 (51-63)	2 (0-5)	1 (0-3)	89 (85-92)	76 (70-81)
Shropshire County	37 (16-62)	44 (25-65)	67 (9-99)	37 (19-58)	10 (0-45)	0 (0-31)~	76 (58-89)	60 (39-79)
Solihull (Care Trust)	59 (44-72)	45 (31-60)	100 (69-100)	36 (23-50)	0 (0-18)~	0 (0-18)~	96 (87-100)	82 (69-92)
Somerset	42 (22-63)	74 (56-87)	75 (48-93)	68 (49-83)	0 (0-15)~	0 (0-15)~	82 (65-93)	46 (28-66)
South Birmingham	62 (55-69)	52 (45-59)	97 (82-100)	59 (52-66)	5 (2-11)	2 (0-6)	94 (89-97)	75 (68-82)
South East Essex	68 (57-78)	58 (47-69)	68 (49-83)	69 (58-78)	8 (3-19)	2 (0-9)	100 (96-100)~	80 (70-88)
South Gloucestershire	55 (39-70)	56 (40-70)	36 (11-69)	46 (31-61)	9 (1-29)	5 (0-23)	56 (38-73)	63 (38-84)
South Staffordshire	50 (37-63)	62 (50-74)	64 (44-81)	63 (51-75)	4 (1-15)	0 (0-8)~	62 (47-75)	75 (57-89)
South Tyneside	54 (33-74)	65 (46-80)	63 (35-85)	59 (41-75)	5 (0-25)	0 (0-17)~	100 (87-100)~	74 (54-89)
South West Essex	68 (57-78)	59 (48-69)	72 (51-88)	64 (53-74)	3 (0-12)	0 (0-6)~	100 (96-100)~	83 (73-90)
Southampton City	78 (67-87)	56 (45-67)	66 (47-81)	65 (53-75)	0 (0-7)~	0 (0-7)~	93 (85-97)	71 (60-81)
Southwark	81 (76-85)	46 (40-51)	58 (49-68)	65 (60-70)	7 (4-11)	0 (0-3)	100 (98-100)	86 (82-89)
Stockport	64 (50-76)	61 (47-73)	67 (46-83)	53 (40-66)	6 (1-20)	0 (0-11)~	80 (68-89)	76 (63-87)
Stockton-on-Tees Teaching	50 (32-68)	66 (49-80)	75 (48-93)	45 (29-62)	6 (0-29)	0 (0-20)~	98 (89-100)	82 (68-91)
Stoke on Trent	73 (63-83)	53 (42-64)	54 (33-73)	75 (64-83)	8 (3-17)	6 (2-15)	94 (87-98)	78 (68-86)
Suffolk	53 (41-64)	63 (52-73)	31 (11-59)	57 (46-67)	4 (0-14)	0 (0-7)~	81 (69-90)	72 (58-84)
Sunderland Teaching	45 (29-62)	77 (64-87)	55 (38-71)	67 (53-78)	5 (1-17)	0 (0-9)~	99 (92-100)	78 (66-87)
Surrey	70 (63-77)	58 (51-65)	63 (49-76)	61 (54-67)	2 (0-7)	1 (0-4)	93 (88-96)	64 (57-71)
Sutton and Merton	80 (75-85)	61 (55-67)	43 (33-53)	48 (41-54)	7 (3-13)	1 (0-4)	100 (98-100)	87 (82-91)
Swindon	89 (74-97)	55 (39-70)	64 (31-89)	53 (39-66)	10 (2-26)	3 (0-17)	44 (31-58)	58 (37-77)
Tameside and Glossop	43 (33-54)	61 (51-71)	59 (33-82)	46 (36-56)	2 (0-12)	0 (0-8)~	89 (80-95)	76 (65-86)
Telford and Wrekin	52 (31-73)	75 (58-88)	100 (59-100)	78 (61-90)	4 (0-19)	0 (0-13)~	86 (70-95)	80 (61-92)
Torbay (Care Trust)	14 (4-33)	83 (64-94)	68 (43-87)	59 (39-76)	12 (1-36)	0 (0-20)~	100 (86-100)~	71 (49-87)
Tower Hamlets	84 (80-87)	46 (41-50)	36 (29-44)	54 (50-59)	10 (6-15)	3 (1-6)	100 (99-100)	85 (81-88)
Trafford	60 (49-71)	54 (42-65)	52 (31-72)	44 (33-55)	17 (6-33)	0 (0-10)~	78 (67-88)	86 (74-94)
Wakefield District	56 (41-71)	59 (46-72)	58 (37-77)	61 (47-73)	12 (3-27)	0 (0-10)~	96 (88-100)	72 (58-84)
Walsall Teaching	64 (56-72)	53 (45-61)	60 (46-73)	63 (55-70)	5 (2-11)	1 (0-5)	99 (97-100)	89 (83-93)
Waltham Forest	86 (82-90)	46 (41-52)	48 (39-58)	60 (55-66)	12 (7-17)	2 (1-5)	100 (99-100)~	88 (84-91)
Wandsworth	82 (77-86)	53 (48-59)	43 (34-52)	51 (45-57)	5 (2-10)	1 (0-5)	100 (99-100)~	85 (80-89)
Warrington	72 (53-87)	62 (42-79)	92 (62-100)	70 (51-85)	0 (0-16)~	0 (0-16)~	86 (65-97)	79 (54-94)
Warwickshire	49 (39-58)	66 (58-73)	52 (38-66)	46 (38-54)	7 (2-15)	1 (0-7)	95 (90-98)	74 (66-81)
West Essex	63 (46-78)	54 (39-69)	30 (7-65)	63 (48-77)	4 (0-18)	0 (0-12)~	100 (92-100)~	64 (49-78)
West Kent	70 (62-78)	64 (56-71)	69 (55-82)	49 (42-57)	9 (4-17)	3 (0-9)	95 (90-98)	63 (54-71)
West Sussex	75 (67-82)	57 (49-66)	77 (64-87)	62 (54-70)	3 (1-9)	0 (0-4)~	89 (84-93)	60 (51-68)
Western Cheshire	35 (15-59)	45 (24-68)	60 (15-95)	36 (17-59)	13 (0-53)	13 (0-53)	100 (88-100)~	67 (47-83)
Westminster	83 (77-87)	55 (48-61)	46 (35-58)	51 (44-58)	7 (3-13)	0 (0-3)~	100 (98-100)	82 (77-87)
Wiltshire	63 (42-81)	77 (60-90)	79 (49-95)	65 (48-79)	8 (1-25)	8 (1-25)	74 (58-87)	76 (56-90)
Wirral	28 (14-45)	73 (56-86)	81 (58-95)	61 (43-76)	0 (0-15)~	0 (0-15)~	76 (61-88)	81 (64-93)
Wolverhampton City	57 (50-64)	53 (46-60)	65 (52-76)	60 (53-67)	2 (0-7)	0 (0-3)~	98 (95-99)	84 (78-88)
Worcestershire	50 (32-68)	72 (58-84)	95 (74-100)	71 (57-83)	6 (1-19)	0 (0-10)~	77 (62-88)	83 (67-94)

continued ...

CI - Confidence interval. INH - Isonazid, MDR - Multi-drug resistant
*With or without extra-pulmonary disease
** Pulmonary cases only with known results
***Among culture-confirmed cases with drug sensitivity results for at least isoniazid and rifampicin
****Cases reported between 2006 and 2008
*****Out of cases with an outcome reported
~One-sided, 97.5% confidence interval

viii. Three-year average tuberculosis case reports and rates by Health and Social Services Board, Northern Ireland, 2001-2009

Health and Social Services Board	Year range					
	2001-2003		2004-2006		2007-2009	
	Average number of cases per year	Rate (per 100,000)*	Average number of cases per year	Rate (per 100,000)*	Average number of cases per year	Rate (per 100,000)*
Eastern	25	4	33	5	27	4
Northern	16	4	14	3	12	3
Southern	12	4	17	5	15	4
Western	7	3	9	3	9	3

*Rates calculated using middle year ONS mid-year population estimates (2002, 2005, 2008)

ix. Three-year average tuberculosis case reports and rates by NHS Board, Scotland, 2001-2009

NHS Board	Year range					
	2001-2003		2004-2006		2007-2009	
	Average number of cases per year	Rate (per 100,000)*	Average number of cases per year	Rate (per 100,000)*	Average number of cases per year	Rate (per 100,000)*
Argyll and Clyde**	31	7.4	19	4.5	-	-
Ayrshire & Arran	11	3.0	8	2.3	10	3
Borders	2	2.2	4	3.3	5	4
Dumfries & Galloway	2	1.4	5	3.4	6	4
Fife	14	4.1	14	3.9	10	3
Forth Valley	7	2.5	4	1.5	13	4
Grampian	27	5.2	27	5.1	44	8
Greater Glasgow**	172	19.9	124	14.3	-	-
Greater Glasgow & Clyde	0	0.0	44	3.7	212	18
Highland	8	3.8	9	3.8	12	4
Lanarkshire	31	5.6	37	6.6	34	6
Lothian	51	6.5	71	9.0	78	10
Orkney	0	0.0	0	0.0	0	0
Shetland	1	3.0	1	3.0	0	0
Tayside	11	2.8	11	2.9	22	6
Western Isles	2	6.4	1	2.5	1	5

*Rates calculated using middle year ONS mid-year population estimates (2002, 2005, 2008)
**1st April 2006 saw the dissolution of NHS Argyll and Clyde into NHS Greater Glasgow to become Greater Glasgow and Clyde NHS Board

x. Three-year average tuberculosis case reports and rates by Local Health Board, Wales, 2001-2009

Local Health Board	Year range					
	2001-2003		2004-2006		2007-2009	
	Average number of cases per year	Rate (per 100,000)*	Average number of cases per year	Rate (per 100,000)*	Average number of cases per year	Rate (per 100,000)*
Abertawe Bro Morgannwg University	28	6	32	7	36	7
Aneurin Bevan	32	6	28	5	31	5
Betsi Cadwaladr University	23	3	38	6	31	5
Cardiff and Vale University	45	10	47	11	63	14
Cwm Taf	22	8	13	4	19	7
Hywel Dda	15	4	20	5	9	2
Powys Teaching	3	2	5	4	5	4

*Rates calculated using middle year ONS mid-year population estimates (2002, 2005, 2008)

xi. Tuberculosis case reports and rates in under-5 year olds by place of birth, England, 2000-2009

Year	UK-born		Non-UK-born		Total*	
	Number of cases	Rate (per 100,000)	Number of cases	Rate (per 100,000)	Number of cases	Rate (per 100,000)
2000	78	2.7	28	48.6	123	4.1
2001	114	4.0	18	32.9	141	4.8
2002	102	3.6	31	55.2	141	4.9
2003	76	2.7	21	33.1	105	3.7
2004	113	4.0	23	39.3	144	5.0
2005	108	3.8	35	59.1	152	5.3
2006	88	3.1	14	16.9	114	3.9
2007	130	4.4	14	16.1	152	5.0
2008	144	4.8	19	20.9	168	5.4
2009	127	4.1	22	20.7	155	4.8

*Including where place of birth unknown

xii. Tuberculosis case reports and rates by place of birth, England, 2000-2009

Year	Place of birth						Total*	
	UK-born			Non-UK-born				
	Number of cases	Rate per 100,000	Annual change in rate (%)	Number of cases	Rate per 100,000	Annual change in rate (%)	Number of cases	Rate per 100,000
2000	1,843	4.2	–	3,343	80.0	–	6,081	12.4
2001	1,918	4.3	4	3,476	80.2	0	6,270	12.7
2002	1,845	4.2	-4	4,041	89.0	11	6,626	13.3
2003	1,712	3.9	-7	4,333	91.1	2	6,656	13.3
2004	1,805	4.0	5	4,585	95.8	5	6,977	13.9
2005	1,812	4.1	0	5,180	101.1	6	7,691	15.2
2006	1,738	3.9	-4	5,176	93.6	-7	7,720	15.2
2007	1,802	4.1	4	5,148	86.7	-7	7,626	14.9
2008	1,889	4.2	5	5,498	88.6	2	7,942	15.4
2009	1,938	4.3	2	5,703	88.8	0	8,286	16.0

*Including where place of birth unknown
Rates by place of birth calculated using Labour Force Survey population estimates; total rates calculated using mid-year population estimates

xiii. Number and proportion of tuberculosis cases with first-line drug resistance, UK, 2000-2009

Year	Isoniazid resistant		Rifampicin resistant		Ethambutol resistant		Pyrazinamide resistant*		Multi-drug resistant		Resistant to any first line drug		Total**
	n	%	n	%	n	%	n	%	n	%	n	%	
2000	190	5.9	41	1.3	11	0.3	14	0.4	28	0.9	206	6.4	3205
2001	225	6.4	38	1.1	18	0.5	18	0.5	25	0.7	250	7.1	3539
2002	278	6.9	45	1.1	23	0.6	29	0.7	34	0.8	304	7.5	4033
2003	294	7.1	73	1.8	24	0.6	22	0.5	53	1.3	324	7.8	4142
2004	318	7.1	62	1.4	19	0.4	31	0.7	47	1.1	351	7.9	4462
2005	325	6.7	55	1.1	17	0.4	15	0.3	40	0.8	350	7.3	4820
2006	339	6.9	72	1.5	30	0.6	27	0.6	52	1.1	379	7.7	4906
2007	322	6.8	69	1.5	28	0.6	32	0.7	56	1.2	351	7.4	4715
2008	285	6.0	71	1.5	35	0.7	34	0.7	53	1.1	324	6.8	4787
2009	344	6.9	69	1.4	29	0.6	52	1.0	58	1.2	389	7.8	4991

* Excludes *M. bovis* cases
** Culture confirmed cases with drug susceptibility results for at least isoniazid and rifampicin
It should be noted that culture confirmed laboratory cases could be notified in subsequent or preceding years

xiv. Number and proportion of non-UK born tuberculosis cases with resistance to any first-line drug by world region of birth, UK, 2009

World region of birth	n	%	(95% CI)	Total
East Europe	11	36.7	(16.8-19.4)	30
South East Asia	17	11.4	(4.6-6.2)	149
East Asia	7	10.9	(6.4-10.4)	64
South Asia	146	8.5	(1.3-1.4)	1718
South and Central America and the Caribbean	6	8.5	(5.3-9.0)	71
Sub-Saharan Africa	77	7.5	(1.5-1.8)	1021
West Europe	80	6.6	(3.4-6.8)	86
North Africa	2	6.5	(5.7-14.9)	31
Central Europe	4	4.6	(3.5-6.8)	86
East Mediterranean	0	0	(0.0-12.7)	27
North America and Oceania	0	0	(0.0-45.9)	6

Variations by world region should be interpreted with caution in view of small numbers

xv. Treatment outcome of tuberculosis cases at 12 months by region/country, UK 2008

Final outcome	Treatment completed		Died		Lost to follow-up		Still on treatment		Treatment stopped		Transferred out		Not completed (reason unknown)		Unknown outcome		Eligible cases
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
England	6,158	81.5	432	5.7	348	4.6	366	4.8	73	1.0	90	1.2	15	0.2	74	1.0	7,556
Northern	46	75.4	4	6.6	6	9.8	4	6.6	1	1.6	0	0.0	0	0.0	0	0.0	61
Scotland	284	75.3	35	9.3	21	5.6	23	6.1	5	1.3	0	0.0	0	0.0	9	2.4	377
Wales	130	82.3	15	9.5	4	2.5	7	4.4	1	0.6	0	0.0	0	0.0	1	0.6	158
East Midlands	385	82.3	35	7.5	17	3.6	10	2.1	6	1.3	10	2.1	0	0.0	5	1.1	468
East of England	342	78.3	28	6.4	36	8.2	15	3.4	2	0.5	8	1.8	0	0.0	6	1.4	437
London	2,820	83.3	125	3.7	136	4.0	241	7.1	35	1.0	20	0.6	0	0.0	9	0.3	3,386
North East	133	78.2	13	7.6	8	4.7	5	2.9	3	1.8	7	4.1	0	0.0	1	0.6	170
North West	507	83.1	35	5.7	30	4.9	13	2.1	8	1.3	10	1.6	0	0.0	7	1.1	610
South East	506	78.7	47	7.3	28	4.4	26	4.0	7	1.1	6	0.9	4	0.6	19	3.0	643
South West	169	70.7	27	11.3	17	7.1	14	5.9	2	0.8	4	1.7	4	1.7	2	0.8	239
West Midlands	818	81.8	85	8.5	33	3.3	14	1.4	8	0.8	14	1.4	7	0.7	21	2.1	1,000
Yorkshire and the Humber	478	79.3	37	6.1	43	7.1	28	4.6	2	0.3	11	1.8	0	0.0	4	0.7	603
UK total	6,618	81.2	486	6.0	379	4.6	400	4.9	80	1.0	90	1.1	15	0.2	84	1.0	8,152

xvi. Tuberculosis treatment outcomes at 12 months by ethnic group and place of birth, UK 2008

	Final outcome	Treatment completed		Died		Lost to follow-up		Still on treatment		Treatment stopped		Transferred out		Not completed (reason unknown)		Unknown outcome		Eligible cases
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
UK-born	All UK-born cases	1,620	79.3	213	10.4	86	4.2	40	2.0	34	1.7	19	0.9	6	0.3	24	1.2	2,042
	White	888	73.0	201	16.5	47	3.9	24	2.0	25	2.1	12	1.0	3	0.3	16	1.3	1,216
	Black-Caribbean	74	84.1	2	2.3	2	2.3	4	4.6	4	4.6	0	0.0	0	0.0	2	2.3	88
	Black-African	125	93.3	0	0.0	6	4.5	1	0.8	0	0.0	1	0.8	1	0.8	0	0.0	134
	Black-other	17	89.5	1	5.3	0	0.0	0	0.0	1	5.3	0	0.0	0	0.0	0	0.0	19
	Indian	175	86.6	4	2.0	13	6.4	4	2.0	1	0.5	2	1.0	0	0.0	3	1.5	202
	Pakistani	223	91.4	1	0.4	8	3.3	6	2.5	0	0.0	3	1.2	1	0.4	2	0.8	244
	Bangladeshi	29	82.9	2	5.7	2	5.7	0	0.0	2	5.7	0	0.0	0	0.0	0	0.0	35
	Chinese	8	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8
	Mixed/other	64	86.5	1	1.4	8	10.8	0	0.0	0	0.0	1	1.4	0	0.0	0	0.0	74
	Ethnicity not reported	17	77.3	1	4.6	0	0.0	1	4.6	1	4.6	0	0.0	1	4.6	1	4.6	22
non-UK-born	All non-UK-born cases	4,604	82.8	199	3.6	289	5.5	308	5.2	43	0.8	62	1.1	9	0.2	49	0.9	5,563
	White	189	73.3	16	6.2	22	8.5	22	8.5	1	0.4	3	1.2	2	0.8	3	1.2	258
	Black-Caribbean	60	88.2	3	4.4	3	4.4	2	2.9	0	0.0	0	0.0	0	0.0	0	0.0	68
	Black-African	1,366	84.8	29	1.8	81	5.0	82	5.1	16	1.0	23	1.4	1	0.1	13	0.8	1,611
	Black-other	34	82.9	2	4.9	2	4.9	3	7.3	0	0.0	0	0.0	0	0.0	0	0.0	41
	Indian	1,267	80.8	83	5.3	67	4.3	113	7.2	5	0.3	14	0.9	3	0.2	17	1.1	1,569
	Pakistani	780	84.9	38	4.1	37	4.0	37	4.0	9	1.0	7	0.8	0	0.0	11	1.2	919
	Bangladeshi	203	84.6	5	2.1	20	8.3	7	2.9	1	0.4	2	0.8	1	0.4	1	0.4	240
	Chinese	62	81.6	6	7.9	2	2.6	4	5.3	1	1.3	1	1.3	0	0.0	0	0.0	76
	Mixed/other	579	83.2	13	1.9	49	7.0	32	4.6	9	1.3	10	1.4	1	0.1	3	0.4	696
	Ethnicity not reported	64	75.3	4	4.7	6	7.1	6	7.1	1	1.2	2	2.4	1	1.2	1	1.2	85

xvii. Treatment outcome (proportion) at 12 months by site of disease, UK, 2008

Site of disease	Treatment completed	Died	Still on treatment	Lost to follow-up	Treatment stopped	Transfer out	Not completed (reason unknown)	Outcome unknown	Number of cases
Pulmonary, with or without EP	79.6	7.9	4.4	4.6	1.0	1.4	0.2	1.1	4,372
Any form of EP disease	81.6	4.4	5.7	5.1	0.9	1.0	0.2	1.1	4,516
Extra-thoracic lymph nodes	86.2	1.7	4.3	4.9	0.7	0.6	0.1	1.3	1,737
Intra-thoracic lymph nodes	85.5	2.9	3.9	4.1	0.8	1.3	0.0	1.4	760
Pleural	81.7	8.3	3.2	4.7	0.7	0.8	0.3	0.3	602
Bone*	69.5	3.8	13.9	6.8	1.5	2.8	0.9	0.9	469
CNS Meningitis	54.2	16.3	17.5	6.6	0.6	1.2	1.8	1.8	166
Miliary	54.5	20.5	12.0	8.5	0.0	1.5	0.5	2.5	200
All other EP sites**	80.9	5.2	5.5	5.2	1.1	0.7	0.3	1.1	1,150
Unknown site	66.7	18.2	3.0	3.0	0.0	3.0	0.0	6.1	33

EP – extra-pulmonary, CNS – central nervous system.
* Bone - includes spinal tuberculosis
** All other EP sites - includes gastrointestinal, genitourinary, laryngeal, cryptic disseminated, CNS other, and other and unknown extra-pulmonary disease

xviii. Treatment outcome at 12 months by previous diagnosis of tuberculosis, UK, 2008

Final outcome	Previous diagnosis					
	No		Yes		Unknown	
	No	%	No	%	No	%
Treatment completed	5,107	82.9	370	74.0	1,141	76.6
Died	285	4.6	48	9.6	153	10.3
Still on treatment	316	5.1	36	7.2	48	3.2
Lost to follow up	271	4.4	25	5.0	83	5.6
Treatment stopped	65	1.1	4	0.8	11	0.7
Transferred out	59	1.0	14	2.8	17	1.1
Not completed (unknown reason)	8	0.1	0	0.0	7	0.5
Outcome unknown	51	0.8	3	0.6	30	2.0
Total	6,162		500		1,490	

Appendix B: Data sources and methods

Enhanced surveillance of tuberculosis

Enhanced Tuberculosis Surveillance (ETS) was introduced on 1 January 1999 in England and Wales and the following year in Northern Ireland. The equivalent scheme in Scotland, Enhanced Surveillance of Mycobacterial Infections (ESMI), was introduced in 2000. Data from the two systems are compiled for the purpose of UK reporting.

Enhanced Tuberculosis Surveillance (ETS) - England, Wales and Northern Ireland

Clinical teams are asked to provide information on tuberculosis cases, either directly through the new web-based ETS (see below) by local users, or on a case report form to be entered onto the system at Health Protection Unit (HPU) level. Data include notification details, demographic information, clinical and microbiological information.

In response to the requirement for high quality surveillance outlined in the CMO's Action Plan[1], development of the new web-based ETS system began in September 2006. Following a pilot scheme in 2008, the system was delivered sequentially in 2009 for England (with the exception of London), Wales and Northern Ireland. Benefits of the system include real-time case reporting, instant access to case data (at clinic, HPU, regional and national levels) and quicker access to laboratory data. The system continues to expand as a reporting, surveillance and case management tool in response to user requirements. The London region currently reports via the London TB Register, data from which is uploaded to ETS.

Implications of moving to the new web-based ETS system

Data analysed for this annual report are a combination of data collected through both the original ETS system and the web-based ETS system, in addition to data from ESMI. Previously, data from ETS have been collated annually at the national level, undergoing a process of cleaning and de-duplication to produce a 'closed', finalised dataset for each calendar year. Any subsequent notifications and de-notifications, for example, of duplicates or cases found not to be tuberculosis, were not included. With the implementation of the new web-based system, ETS has moved to a dynamic, more timely and accurate system with an 'open' dataset which is constantly subject to change. Any changes to the data which occurred following the previous 'closures' of the data each year have now been taken into account and hence the numbers presented in this reported differ to those published previously. It should also be noted that, unlike in previous years, cases reported as 'not TB' through treatment outcome monitoring that incorrectly remained notified have been excluded from our figures. The ESMI system also operates dynamically. All figures in this report are current as at July 2010.

Enhanced Surveillance of Mycobacterial Infections (ESMI) - Scotland

The ESMI scheme provides the clinical surveillance system for tuberculosis in Scotland and is co-ordinated by Health Protection Scotland (HPS). Information collected on each case includes notification details, demographic information, clinical characteristics, and microbiological investigations. Each NHS Board Public Health Team notifies HPS of a case via a completed questionnaire. HPS continuously collates and updates the information at the national level and reports findings annually.

UK Mycobacterial Surveillance Network (MycobNet)

Information on *Mycobacterium tuberculosis* complex isolates in the UK is obtained from seven mycobacterial reference laboratories as part of the MycobNet collaboration (Box 1). Data collected includes species (*Mycobacterium tuberculosis, Mycobacterium bovis* or *Mycobacterium africanum*), drug susceptibility and some minimal demographic and clinical data.

For the purpose of matching to case report data from ETS, data received from the reference laboratories are cleaned to remove duplicate records and further reports of isolates from the same individual within a 12-month period. The cleaned data are then matched to the ETS dataset through a computerised matching process based on patient identifiers common to both systems, thus improving the completeness and validity of microbiological information in ETS. The new web-based ETS features data uploaded from MycobNet and, in future, it is intended that matching of isolate reports and case reports will be largely carried out at local level. However, for 2008 cases, and until this is fully established, computerised matching will be utilised at national level. The linkage of reference laboratory data to cases reported via ESMI is managed by HPS.

Box 1. UK mycobacterial reference laboratories

- Health Protection Agency (HPA) National Mycobacterium Reference Laboratory (NMRL), London.
- HPA Regional Centre for Mycobacteriology, Birmingham.
- HPA Regional Centre for Mycobacteriology, Newcastle.
- Royal Brompton Hospital Microbiology Department, London.
- Wales Centre for Mycobacteria, Penarth.
- Northern Ireland Public Health Laboratory, Belfast.
- Scottish Mycobacteria Reference Laboratory (SMRL), Edinburgh.

Treatment outcome monitoring

Since 2002, treatment outcome information has been collected for cases reported to ETS/ESMI in the previous year. Clinicians and/or nurses are asked to complete a short form detailing the patient's status 12 months after starting treatment or being notified, including patients who were diagnosed post-mortem. The definitions for treatment outcome are based on World Health Organization (WHO) and European definitions, but adapted to the UK context[23]. Treatment outcome information can now be reported either directly to the web-based ETS or via a form.

The number of years lost due to premature mortality were calculated using standard expected years of life lost derived from the standard West Level 26 life-table and the numbers of deaths with tuberculosis as the underlying cause of death (ICD10-codes A15:A19) in 2008 obtained from the Office for National Statistics (ONS).

Tuberculosis rates

Overall tuberculosis rates per 100,000 population, as well as those by age, sex and region of reporting, are calculated using the mid-year estimates provided by the ONS, incorporating data from the General Register Office for Scotland and Northern Ireland Statistics and Research Agency.

Rates by place of birth and by ethnic group have been calculated using population estimates from the Labour Force Survey (LFS). The LFS is based on a population sample, so estimates are liable to sampling

errors, particularly for small population subgroups. In 2001/2, the ethnic group classifications used in the LFS changed; rates by ethnic group presented in this report are therefore from 2002 only. In 2006, the LFS moved from producing data for seasonal quarters to calendar quarters and, in both 2007 and 2009, LFS estimates were reweighted in line with revised Census data. Rates by ethnic group and place of birth should be interpreted with caution and may not be comparable to those previously reported.

Proportions

All proportions in this report are calculated among cases with known information or a known result, except where otherwise stated.

The proportion of cases that were culture-confirmed has been calculated differently for this annual report and so figures are not directly comparable to those published earlier. Previously, a case was classified as culture-confirmed if it was either matched to a positive reference laboratory culture or if the clinical case report to ETS indicated culture confirmation. The accuracy of culture confirmation information from ETS case reports, where there was no match to a reference laboratory culture, has since been found to be uncertain and so, for this report, only cases matching to a reference laboratory culture were considered culture-confirmed. The change in method of calculation has resulted in approximately a 3% drop in the proportions of cases considered culture-confirmed. The calculation of proportions by species also now relies on information only from matched laboratory cultures due to a lack of accuracy in species information reported via clinical case reports.

Drug resistance is reported as the proportion of tuberculosis case reports resistant at the start of treatment, using cases with available drug susceptibility results for at least isoniazid and rifampicin as the denominator. *M. bovis* is usually resistant to pyrazinamide, so cases with disease due to this species are excluded when calculating resistance to this drug.

The proportion of cases completing treatment is calculated using, as the denominator, all cases with an outcome reported (including post-mortem cases), minus cases whose treatment was stopped because they were subsequently recognised not to have tuberculosis.

Decimal places and rounding

Whole numbers presented in the text may not correspond to figures in tables, where decimals are included, due to rounding errors. Rates calculated using Labour Force Survey population estimates are usually presented as whole numbers only, since the effect of sampling variability requires caution, especially when the estimated numbers are small.

Confidence Intervals

A 95% confidence interval for incidence was obtained using the relevant procedure in Stata, assuming a Poisson distribution. For prevalence data (proportions) a binomial distribution was assumed.

Matching of tuberculosis and HIV data

The ETS system does not collect information on HIV status, therefore, this information was obtained by record linkage between tuberculosis surveillance and HIV/AIDS surveillance systems (New HIV Diagnoses and SOPHID (Survey of prevalent HIV infections diagnosed) which includes data from England, Wales and Northern Ireland). ETS case reports (for 2000-2008) and culture positive lab samples reported to MycobNet (2000-2008) without an equivalent ETS case report were matched with the national HIV/AIDS

databases (for 1979-2008/9) using probabilistic matching based on surname Soundex code, forename initial, date of birth, sex, ethnic group, country of birth and hospital. AIDS diagnoses reported with tuberculosis as an AIDS defining illness that were not found in the tuberculosis surveillance system were also counted. Matching was not carried out on cases aged below 15 years as HIV in children is reported separately. Cases with a tuberculosis notification date or specimen date later than the date of death in the HIV database were excluded. Tuberculosis cases that were not matched to HIV/AIDS reports were described as 'not known to be HIV-positive', because the absence of a match does not provide evidence of negative HIV status, and it is unknown whether patients were tested for HIV.

Appendix C: Definitions

Case definition

The following cases are reported through ETS/ESMI:

- Confirmed cases: Culture-confirmed case, due to *M. tuberculosis* complex infection (including *M. tuberculosis, M. bovis* and *M. africanum*).
- Other than culture-confirmed case: In the absence of culture confirmation, a case that meets the following criteria:
  - A clinician's judgement that the patient's clinical and/or radiological signs and/or symptoms are compatible with tuberculosis, and
  - A clinician's decision to treat the patient with a full course of anti-tuberculosis treatment.

Persons receiving preventive chemoprophylaxis are not reported through ETS/ESMI.
Cases subsequently found not to be tuberculosis should be denotified.

Social risk factor definitions

Problem drug use

Injecting drug use or long duration/regular use of opiates, cocaine and or amphetamines.

Alcohol misuse/abuse

Based on clinical judgement, alcohol misuse or abuse considered likely to affect the patient's ability to adhere to the prescribed tuberculosis treatment regimen in the absence of DOT.

Homelessness

Homelessness and insecure housing tenure are defined as not having permanent or secure accommodation. This includes people who are sleeping rough, living in temporary accommodation such as bed and breakfast, hostels, hotels and squats and people who are involuntarily dependant on friends.

In prison

Incarceration in a prison and/or remand centre at time of diagnosis or had a history of being in prison.

Planned course of treatment definitions

Standard short course of treatment

A standard short-course treatment of two months of isoniazid, rifampicin, ethambutol and pyrazinamide plus four months of isoniazid and rifampicin [2(RHZE)4(RH)].

Directly observed therapy

Treatment under Directly Observed Therapy (DOT). This entails someone supervising the intake of drugs by the patient to ensure adherence to treatment and that the drugs are taken in the right combination and for the correct duration.

Treatment outcome definitions

Treatment completion

A patient is defined as having completed treatment if a) the case was reported, b) the patient completed a full course of treatment and c) was officially discharged by the attending physician.

Death

The outcome 'death' is used for patients who died before or during treatment, and includes cases diagnosed post-mortem. Death does not have to be related to tuberculosis. Four subcategories are used to provide information on the nature of the link between death and tuberculosis:

1. tuberculosis caused death.
2. tuberculosis contributed to death.
3. tuberculosis incidental to death (tuberculosis was not related to death).
4. relationship between tuberculosis and death unknown.

Still on treatment

This category is used for patients still on treatment at one year after starting treatment. Subcategories are used to provide reasons for still being on treatment:

1. still on initially planned treatment (regimen longer than initial 12 months planned).
2. treatment interrupted (non-completion of initially planned treatment regimen for 12 months or less).
3. treatment changed as a result of any of the following: intolerance or side effects, initial drug resistance, development of new drug resistance, failure to culture convert and poor clinical response to treatment.

Treatment stopped

A patient is classified in this category when he or she did not complete treatment for reasons other than death or still being on treatment.

Transferred out

The patient is classified as 'transferred out' if responsibility for his/her care was transferred to another clinical team.

Lost to follow-up

The patient is classified in this category if he/she was lost to follow-up before the end of treatment.

Unknown

When no treatment details (including outcome) are available (for example, lost patient notes) or when treatment is not completed for unknown reasons, the patient is classified as having an unknown outcome.

Other definitions and classifications

Pulmonary tuberculosis

A pulmonary case is defined as a case with tuberculosis involving the lungs and/or tracheo-bronchial tree, with or without extra-pulmonary tuberculosis diagnosis.

Sputum-smear result

A sputum-smear positive tuberculosis case is defined as a tuberculosis case with a positive microscopy result on spontaneously produced or induced sputum.

Multi-drug resistance

Multi-drug resistance (MDR) is defined as resistance to at least isoniazid and rifampicin, with or without resistance to other drugs.

New case versus previously diagnosed case

Information on previous tuberculosis diagnosis is collected. A case with no previous tuberculosis diagnosis is referred to as a 'new tuberculosis case' in this report.

Ethnic group

The classification of ethnic group is based on the definitions used by the ONS.

Place of reporting

The data are presented according to the nine HPA regions in England (as from April 2002), plus Scotland, Wales and Northern Ireland, as well as by Primary Care Trust in England, Health and Social Services Board in Northern Ireland, NHS Board in Scotland and Local Health Board in Wales. Recent changes to primary care organisations in England and Wales are incorporated, however, it was not possible to present data according to the new Health and Social Care Trusts in Northern Ireland in this report. Information on place of reporting is based on the residence of the patient, where available, or the reporting clinic.

World regions

Information on the country of birth of tuberculosis cases is collected. Countries were grouped into world regions based on the United Nations (UN) classifications, adjusted to take into account the global epidemiology of tuberculosis and migration patterns to the UK. For example, the five African regions defined by the UN were grouped into two regions (North Africa and sub-Saharan Africa). North America and Oceania were grouped together based on the similar epidemiology of tuberculosis in these areas.

Appendix D: Data quality of UK tuberculosis surveillance

Surveillance systems

The UK has a long history of surveillance of tuberculosis. In the late 1800s, statutory recording of deaths was instituted in England leading to one of the oldest reliable sources of tuberculosis trends. A clinical diagnosis of tuberculosis became statutorily notifiable in 1913 in England. Data on cases of tuberculosis have therefore been available for nearly a hundred years.

In 1994, a UK-wide network of reference laboratories and the national tuberculosis surveillance team initiated a national system for monitoring all laboratory confirmed cases of tuberculosis in a central database. This collaboration, known as the UK Mycobacterial Network (MycobNet), now holds over 15 years of data on culture confirmed cases of *Mycobacterium tuberculosis* complex with information recorded on species and drug susceptibility results.

Statutory notification only collected minimal information necessary to monitor overall trends and inform public health action. With the aim of improving the ability to monitor the changing epidemiology of tuberculosis and provide more detailed and accurate information, ETS started in 1999. This system collects detailed clinical and demographic data. Data are matched to the national laboratory *M. tuberculosis* (MycobNet) database annually. Since 2002, the outcome of treatment of tuberculosis cases reported to ETS has been monitored through the voluntary reports of forms by clinicians.

Following the publication of the national tuberculosis Action Plan in 2004 by the CMO[1], which forms the basis of the national policy to control tuberculosis, a decision was taken to replace the paper-based enhanced surveillance system with a national web-based enhanced surveillance system. This system also allows integration of the laboratory and clinical surveillance systems and has been rolled out successfully across the country. In London, a web-based register has been in existence since 2002.

Quality systems

HPA audits and surveillance evaluation

Tuberculosis surveillance, similar to other aspects of national surveillance, is subject to periodic audit at the national level by the Health Protection Agency Internal Audit department, the last of which was undertaken in 2009. In addition, all HPA surveillance systems were evaluated in 2008.

The HPA surveillance evaluation found that the Enhanced Tuberculosis Surveillance system was fit for purpose and has been running successfully since 1999. It was recommended that the web-based ETS should become the gold standard in tuberculosis surveillance and that DOTS should be collected as additional surveillance information and this has since been implemented.

The processes for running national surveillance are governed through a system of standard operating procedures that are periodically reviewed and updated accordingly.

Other quality systems

Other elements of quality that are continually monitored include the completeness, accuracy, timeliness and validity of data. Systems are continually improved and the effects of such changes monitored.

Data quality is monitored with the help of the regional tuberculosis surveillance co-ordinators who provide an important liaison with health protection units and clinics across the country. This group meets twice per year to discuss data quality, planning of annual reporting and development of the ETS system.

The processes for national tuberculosis surveillance and monitoring of tuberculosis treatment outcome are based on European recommendations and have been agreed following a broadly representative consultation exercise and pilot studies. A user governance group was set up in 2009 with the remit of providing overall guidance and supervision on the developments of the Enhanced Tuberculosis Surveillance System. The membership of the committee includes representatives from a number of institutions such as the British Thoracic Society, the Royal College of Nursing, the British Infection Society, HPA Local and Regional Services and the NHS. The steering group is accountable, and reports to, the HPA Tuberculosis Programme Board and it is chaired by the Head of the TB Section. User feedback is also received following the publication of surveillance reports and through a feedback form available on the system (please see Appendix F).

Case reporting

Measuring completeness (under-reporting)

The tuberculosis section currently utilises two approaches to assess whether all cases of tuberculosis are reported. The first category relies on inventory methods based on matching with other data sources including the laboratory (MycobNet) database, national HIV surveillance and bespoke surveys. These comparisons generally show between 5 to 17% under-notification to the enhanced surveillance system. A detailed audit of unmatched laboratory *M. tuberculosis* isolates recorded in the MycobNet database which was carried out in 2006, however, revealed that the proportion is closer to 5% than 17%, as several cases reported as 'failing to match' are either present in the enhanced surveillance system with few identifiers or may relate to organisms that should not have been reported, such as those from non-human cases. The matching systems have been continually improved and now rely on a probabilistic program. Validation of the probabilistic matching program was done using the NHS number, where available, as the gold standard for a correct match between the ETS and MycobNet datasets. Automatic matches only were evaluated, without the usual complementary human review. This validation showed high levels of accuracy, with an error rate of about 0.5% for false negatives (matches that were not found), and about 1.5% for false positives (matches that were not correct). Any matching program is, however, only as good as the quality of identifiers reported by local clinical teams.

The second approach relies on capture-recapture-based assessment of completeness using hospitalisation records (health care administration data), laboratory (MycobNet) records and death registrations. This allows the estimation of records that are not notified to any surveillance system. Previous studies using this approach have suggested under-notification to the surveillance systems of about 15.9% between 1999-2002[24]. This approach is, however, not without significant limitations due to the inherent dependencies between the data sources and quality of the matching as outlined above. A further capture-recapture study is currently being planned.

Using linkage and subsequent capture-recapture analysis also allows an assessment of outcome data through comparison of reported deaths with death registration data from the Office of National Statistics and the NHS Central Registrar[25].

The use of laboratory data in ensuring reporting of tuberculosis cases

It is essential that notifications are received for all culture confirmed drug resistant cases to prevent the underestimation of resistance in the population. A retrospective follow-up exercise was carried out for 2009 to determine the number of culture confirmed MDR TB cases without case reports. Four cases were identified and although this number appears small, it is vital that all MDR TB cases are notified to ensure the early detection of any increase in the number of cases. Regional co-ordinators were informed and carried out further investigation with the clinics. Since this review, all unmatched isolates are now listed on web-ETS as an alert to case managers to encourage notification. In Northern Ireland and Scotland all laboratory cases are followed up for notification. In addition to highlighting unreported culture confirmed cases on the web-based system to clinical teams, we now plan to prospectively follow up all MDR TB, isoniazid resistant and rifampicin resistant culture confirmed cases on a monthly basis to ensure notification

In 2009 a review was also undertaken to identify cases that had been incorrectly denotified. Denotified cases with culture confirmed results were investigated for possible laboratory contamination and for incorrect denotification at the clinic or HPU. Six cases were found to be wrongly denotified and 3 cases were denotified as a result of laboratory contamination.

Preventing overestimation of case numbers

Tuberculosis cases reported to ETS are either confirmed by mycobacterial culture of *M. tuberculosis* complex (*M. tuberculosis, M. bovis* and *M. africanum*) or clinically diagnosed, requiring a clinician's judgment that the patient's clinical and/or radiological signs and/or symptoms are compatible with tuberculosis as well as a clinician's decision to treat the patient with a full course of anti-tuberculosis therapy. It can be more difficult to obtain a culture result from samples taken from some sites of the body and therefore is important that the latter category is included. The proportion of all UK cases that were culture confirmed in 2009 was 56% (5075/9040).

Sometimes tuberculosis cases reported to ETS are later found not to have tuberculosis, when they were based on a clinical diagnosis. When this happens the case should be denotified. Any cases that are not denotified within 12 months of diagnosis will be picked up in treatment outcome monitoring, as their treatment will have been stopped for this reason. The web-based system reminds users to denotify cases with a treatment outcome 'stopped - patient later found not to have TB', and any cases that remain notified are not counted in national figures.

In addition to this, the same case may be reported by several clinics, for example if they have disengaged service with one and gone to another, or moved to a different part of the country. Duplicate records are identified using a probabilistic matching algorithm. Also, when a new case is reported, the web-based system searches the database to determine whether a case with similar details has already been reported to prevent unnecessary duplicate reporting.

Data fields

Checks for the validity of fields are built into the web-based system. For example, NHS number is checked for validity and dates of diagnosis, symptom onset and reporting have to follow a logical order. In addition, the system derives a number of administrative variables from postcodes reducing data entry errors.

The introduction of a national web-based surveillance system has contributed to the completeness of data reported. Either "age" or "date of birth", "postcode" and "site of disease" are mandatory fields in the system and "date of notification" is completed automatically when a new case is reported.

Information on drug resistance, species and culture confirmation is obtained by matching to laboratory reports from MycobNet, rather than relying on data entry by clinicians.

Information on treatment outcome is based on the assessment of the physician/team in charge for the management of that specific patient. For patients with pulmonary tuberculosis, information on culture conversion can be reported with the treatment outcome. However, the proportion of patients for whom this is provided is small, because follow-up samples are not often taken for various reasons as highlighted in our previous annual reports and publications on this issue[26,27].

Monitoring of key data fields

Audits of records are undertaken annually based on the criteria suggested in the 2007 Department of Health TB Toolkit for commissioners which outlines the minimum quality standards for surveillance[2].

In addition to the data targets included in the 2007 TB Toolkit, an additional field –"previous TB diagnosis"- was also included because it is present in international reports by the European Centre for Disease Prevention and Control and the World Health Organization (Table i).

Table i. Completeness of key data fields—2009 data

Region/Country	Data Field - Proportion Completed												
	Postcode	Name	Sex	Ethnic group	Date of notification	Date of birth	Born/not born in UK	Previous treatment	Start of treatment	Previous TB diagnosis	Treatment outcome reported	Sputum smear status*	Site of disease§
East Midlands	99	100	99	93	100	99	90	80	84	83	86	55	98
East of England	100	100	97	94	100	100	90	83	91	86	93	28	99
London	100	100	100	98	100	100	94	88	93	91	100	75	100
North East	100	100	98	99	100	100	67	82	86	86	96	59	100
North West	100	100	99	99	100	100	92	88	91	90	82	49	99
Northern Ireland	91	100	100	93	100	100	68	84	77	87	92	79	99
Scotland	NA	NA	100	86	100	NA	75	80	NA	82	85	74	100
South East	99	100	99	92	100	100	91	85	92	86	94	44	99
South West	98	100	98	83	100	100	79	75	77	77	84	50	91
Wales	97	100	97	92	100	100	88	76	83	80	95	33	100
West Midlands	98	100	100	97	100	100	93	53	90	75	99	43	99
Yorkshire and The Humber	98	100	99	94	100	100	89	88	87	91	95	45	99
England, Wales and Northern Ireland	99	100	-	-	-	99	-	-	89	-	-	-	-
Whole of UK	-	-	99	95	100	-	91	83	-	87	95	58	99
Target for completeness	95	95	95	95	95	95	95	95	95	-	95	95	95

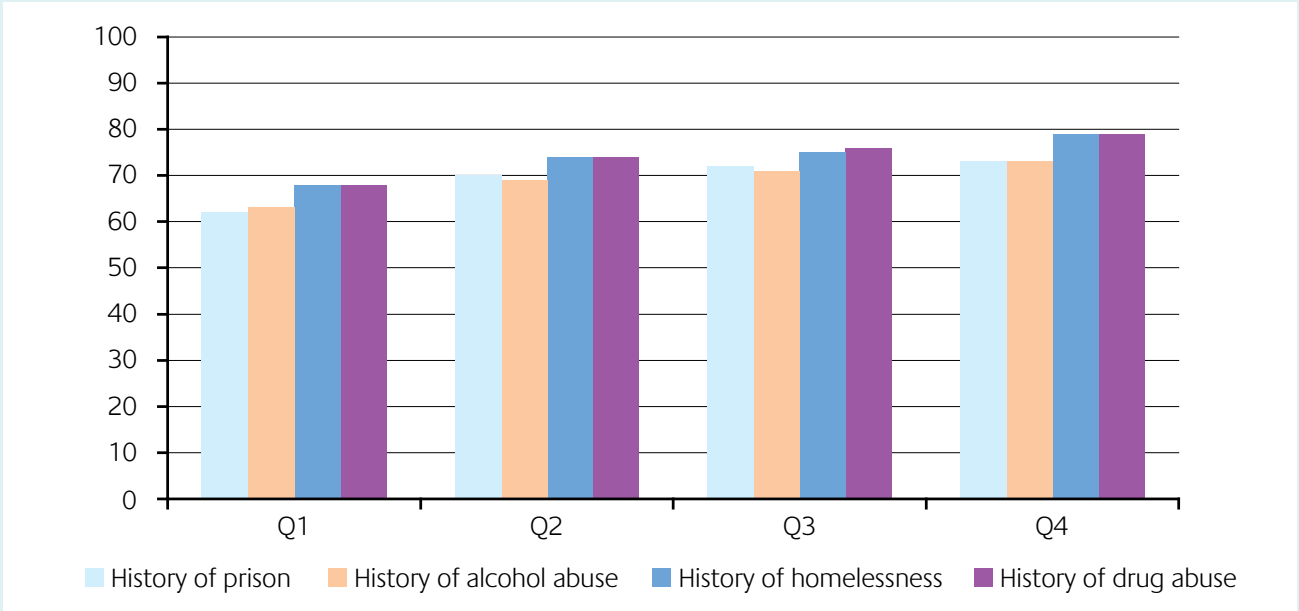
*Pulmonary cases only
§ Pulmonary or extra-pulmonary
NA= not applicable

Table ii shows the level of completion of the new ETS fields ("history of drug abuse, alcohol abuse, homelessness, incarceration and previous BCG vaccination") that were added to the revised notification form rolled out in 2009. Completeness of these fields is therefore expected to be lower compared to key data fields. This is particularly evident for those regions where ETS was rolled out in mid and late 2009. However, overall data show an increase in the level of completeness during 2009 (Figure Di).

Table ii. 2009 data: completeness of new ETS fields - England, Wales and Northern Ireland

Region/country	Data field - proportion completed				
	Previous BCG	History of Drug Abuse	History of Alcohol Abuse	Homelessness	Prison
East Midlands	48	72	70	72	65
East of England	52	81	79	83	74
London	61	81	72	80	81
North East	43	79	79	77	63
North West	41	66	68	68	58
Northern Ireland	43	22	11	14	7
South East	59	80	75	79	74
South West	38	70	70	69	58
Wales	48	74	72	77	60
West Midlands	32	45	42	44	41
Yorkshire and The Humber	58	86	83	84	76
England, Wales and Northern Ireland	52	74	69	74	69

Figure i. Level of completion of all risk factors by quarter (2009)* - England, Wales & Northern Ireland



*Previous BCG is not included

Data shown for the completeness of new fields do not include data from Scotland as different information is collected by the Scottish Enhanced Surveillance of Mycobacterial Infections (ESMI) and data received from Health Protection Scotland still need to be collated with the information collected by ETS.

Table Diii shows the completeness of reporting of treatment outcome data. Information on treatment outcome at 12 months was received for 8152/8621 (95%) cases reported in 2008. This is slightly lower than the completeness of reporting in 2007 (97%). At the time of last year's annual report, outcomes were received for 96% of the cases reported in 2007 and therefore completeness for 2008 cases may still improve further.

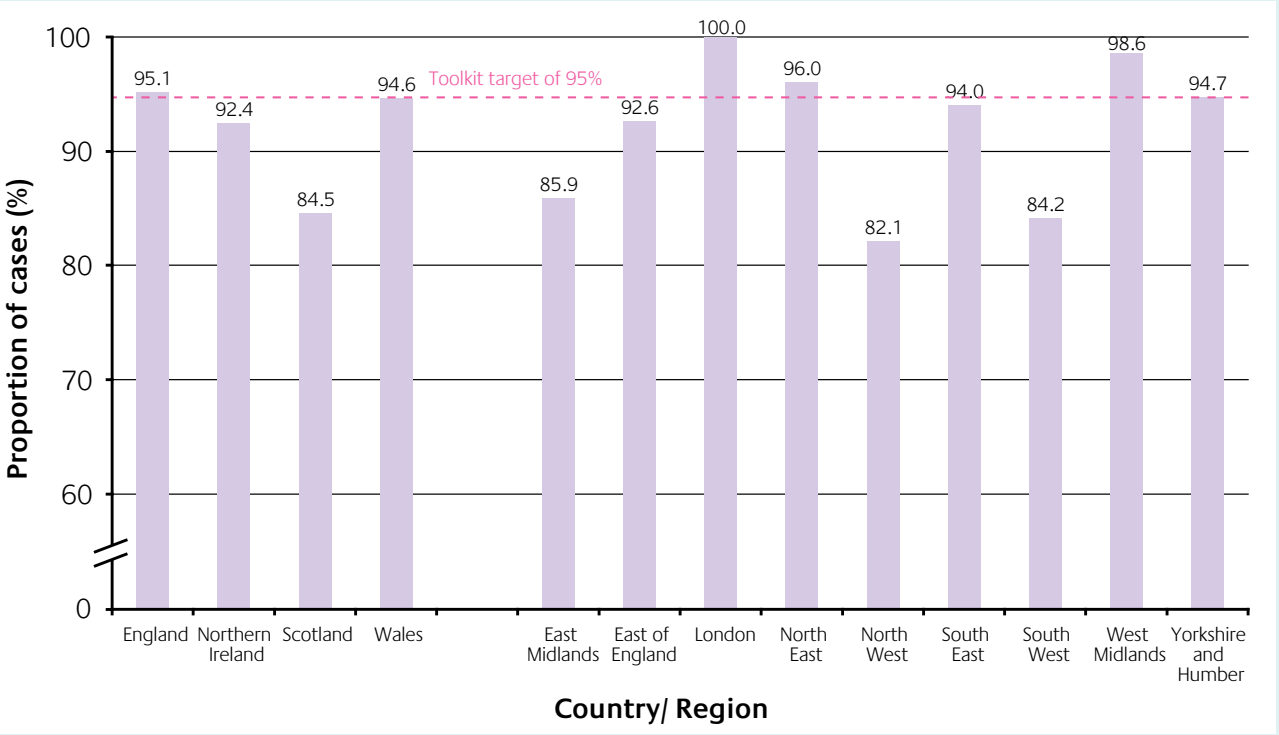
Table iii. Number and proportion of tuberculosis cases with treatment outcome reported at 12 months, UK, 2001-2008

Year	Number of cases	Reported outcomes	
		n	%
2001	6,865	5,502	80
2002	7,243	6,365	88
2003	7,247	6,543	90
2004	7,639	6,903	90
2005	8,319	7,566	91
2006	8,344	7,917	95
2007	8,305	8,068	97
2008	8,621	8,152	95

* Cases reported to enhanced surveillance who were later identified as not having tuberculosis but not denotified

The completeness of treatment outcome reporting varied by country and more widely by region in England, ranging from 82% in the North West to 100% in London (Figure ii). Five of the nine English regions reported outcomes for at least 95% of the reported cases, as recommended by the Department of Health Toolkit[2].

Figure ii. Proportion of tuberculosis cases with treatment outcome reported at 12 months by country/ region, UK, 2008



Timeliness

Previous audits of timeliness suggested that nearly all regions are able to provide data by the agreed deadline for the national collation of figures, February for provisional data and July for finalised data.

The implementation of the web-based surveillance system now means instantaneous availability of these data to all levels. However, the finalisation of national datasets still requires significant work at the national level to improve final data quality.

Validity

The programme of audit by the HPA internal audit department described earlier is designed to ensure that a random selection of regions is assessed, with records at all levels compared to ensure that data recorded at the national level are valid. The matching audit also provides a means of monitoring the validity of data.

Further measures to improve validity include a data dictionary for the web-based system, training events provided for new users and a webcast recorded to help new users.

Appendix E: Data contributors

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Appendix F: Surveillance feedback form

Enhanced TB Surveillance System - User Feedback Form

FEEDBACK FORM ID [___]-[___]

ENHANCED TUBERCULOSIS SURVEILLANCE SYSTEM

USER FEEDBACK FORM

1.1 Date DD-MM-YYYY: [__]-[__]-[____]
1.2 Your name *(optional)*[_____]
1.3 Current Position [_____]
1.4 Place of work Clinic [_____]
PCT [_____]
HPU [_____]
Region [_____]
1.5 Please provide your comments in the space below:

Enhanced TB Surveillance System - User Feedback Form

Some more questions

Thank you for taking the time to answer the following additional questions.
Please tell us if you "strongly agree", "slightly agree", "slightly disagree" or "strongly disagree" with these statements.

Web-based ETS has	*Strongly agree*	*Slightly agree*	*Slightly disagree*	*Strongly disagree*
improved timelines of inputting outcome data	4	3	2	1
made it easier to generate surveillance reports	4	3	2	1
allowed the use of additional risk factor fields	4	3	2	1
improved timeliness of access to data during outbreak/incident investigation	4	3	2	1
made it easier to transfer a case to another project manager	4	3	2	1
made it easier to produce the NOIDs form without duplicate entry	4	3	2	1
made it easier access to case manager details for cases reported out of area	4	3	2	1
made it possible to search for cases in other areas	4	3	2	1

THANK YOU for your comments!

Please e-mail your feedback form to: tbsection@hpa.org.uk

Or via fax: 020 8327 6112

Appendix G: Bibliography

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- Health Protection Agency / National Knowledge Service – TB www.hpa.org.uk/HPA/ProductsServices/InfectiousDiseases/ServicesActivities/1200055718370/
- Department of Health – Tuberculosis www.dh.gov.uk/en/Publichealth/Communicablediseases/Tuberculosis/index.htm
- Public Health Agency for Northern Ireland – Tuberculosis www.cdscni.org.uk/surveillance/Tuberculosis/
- Health Protection Scotland – Tuberculosis http://www.hps.scot.nhs.uk/resp/tuberculosis.aspx
- Public Health Wales – Tuberculosis http://www.wales.nhs.uk/sitesplus/888/page/43877

International Organisations

- The European Centre for Disease Prevention and Control http://www.ecdc.europa.eu/
- EuroTB www.euroTB.org
- Centers for Disease Control and Prevention – Division of Tuberculosis Elimination www.cdc.gov/tb/
- The International Union Against Tuberculosis and Lung Disease www.theunion.org/
- World Health Organization – Stop TB Department www.who.int/tb/about/en/
- World Health Organization – Health Topics: Tuberculosis www.who.int/topics/tuberculosis/en/
- Stop TB Partnership www.stoptb.org

Clinical Guidance

- National Institute for Health and Clinical Excellence - Tuberculosis http://www.nice.org.uk/nicemedia/pdf/CG033FullGuideline.pdf
- British Thoracic Society – Tuberculosis guidelines - http://www.brit-thoracic.org.uk/Tuberculosis/TuberculosisGuidelines/tabid/386/Default.aspx

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UK Statistics

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- Northern Ireland Statistics and Research Agency www.nisra.gov.uk
- General Register Office for Scotland www.gro-scotland.gov.uk

Other Relevant Websites

- All-Party Parliamentary Group on Global Tuberculosis www.appg-tb.org.uk/
- The British Lung Foundation http://www.lunguk.org/
- Target Tuberculosis www.targettuberculosis.org.uk
- TB Alert www.tbalert.org
- The Truth About TB www.thetruthabouttb.org
- TB Alliance www.tballiance.org
- Adfam www.adfam.org.uk
- The National Treatment Agency www.nta.nhs.uk

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