SCREENING FOR TUBERCULOSIS AND THE IMMIGRATION CONTROL

UK BORDER AGENCY REVIEW OF CURRENT SCREENING ACTIVITY 2011 (CENTRAL POLICY UNIT).

SECTION 1

AN INTRODUCTION TO THE UK BORDER AGENCY TB SCREENING REVIEW

1.1.1 The UK currently conducts screening for tuberculosis (TB) in the immigration context through four programmes:

- Since 2005, the UK has, with the assistance of the International Organization for Migration (IOM), conducted a pilot pre-entry screening programme for TB across 15 countries where the disease is highly prevalent.
- Other migrants arriving from high risk countries may be screened on arrival (at Heathrow and Gatwick, the only ports where x-ray machines are available on site) or identified for medical referral after entry under longstanding arrangements at other ports. These functions are primarily carried out on behalf of the UK Border Agency by the Health Protection Agency (HPA) in England and their counterparts in the devolved administrations. The screening activity at Heathrow and Gatwick requires funding in the region of £2.5m per annum from the HPA.
- Refugees accepted for resettlement into the UK through the Gateway Programme are screened for TB and other medical conditions and needs.
- Newly arrived asylum seekers who are taken into UK Border Agency provided accommodation are also offered screening for TB.

1.1.2 The purpose of this paper is to focus on the first two of these programmes, to assess their effectiveness and efficiency, and provide a short briefing in order to allow policy officials and Ministers to explore options for change.

1.1.3 The TB screening programmes apply only to those who are subject to immigration control and in general terms only to those who are seeking to remain in the UK for longer than six months. Those making shorter visits to the UK are not routinely screened for TB. However, an Immigration or Entry Clearance Officer has the power in law to require a person seeking to travel to the UK to require a medical examination. The UK Border Agency does not provide any medical services or conduct any screening activity directly and the Department of Health (DH) and HPA have provided assistance in reviewing the effectiveness and cost effectiveness (or efficiency) of the currently employed TB screening programmes with a view to assessing how they may be improved and how resources can best be used.

1.1.4 The pre-entry pilot programme is now approaching its fifth year. DH has conducted analysis of the results obtained by IOM. The HPA has also conducted a separate analysis on the current on-entry screening programme.

1.1.5 This review affords an opportunity for cross-Government consideration into the strategy the UK should adopt into the future in relation to the use of screening for TB in an immigration context, and as part of the overall strategy for TB control in the UK.

RECOMMENDATIONS FROM THE REVIEW

1.2.1 The UK Border Agency and HPA cease routine on-entry screening for TB by Chest X ray. The evidence available finds that x-ray screening at our ports is expensive and makes an insignificant contribution to safeguarding public health. The financial information alone leads to the clear conclusion, that as a minimum, screening at Gatwick should be ceased (although data on arriving passengers could still be collected and transmitted to local health bodies as is done at other ports).

1.2.2 The UK Border Agency takes forward a consultation across Government and the devolved administrations on a proposal to extend pre-entry screening to all countries where there is a high incidence of TB. Currently, we screen those arriving from countries with an incidence of TB of over 40 per 100,000. With HPA and DH advice, however, we could focus our resources on certain categories of migrant or set the rate employed at a higher rate of incidence (the consequence being that fewer migrants are screened and screening is focussed on the highest risk countries). In the alternative, we could screen the 22 WHO high burden countries. Overall savings to the NHS may not be substantial when compared to overall spending on health. However, those with infectious TB would be prevented from entering the UK until treated and the burden of funding the costs of screening and any treatment then required would fall upon visa applicants and overseas health authorities and not on the UK taxpayer.

1.2.3 Maintain a Port Medical Inspector and staff in ensuring a means of detecting and managing other public health issues and in the provision of medical advice in relation to those who should be refused entry on medical or mental health grounds or where the passenger may cause a draw upon NHS resources.

1.2.4 HPA and UK Border Agency to explore the use of electronic data sharing to give HPA and the NHS more accurate information about people from high risk countries granted visas to enter the UK for more than 6 months and irregular migrants encountered. Moving to such data sharing in conjunction with recommendation 1 may allow the HPA and other bodies collecting such data manually opportunities to achieve further efficiencies and to provide a service for new migrants consistent with NICE recommendations.

1.2.5 DH, HPA and UK Border Agency to explore other opportunities for closer working, such as encouraging people from high risk countries to connect with NHS services to ensure effective monitoring of TB risk.

SECTION 2

TUBERCULOSIS (TB) IN THE UK

2.1 TB is a global public health issue with some estimates suggesting that a third of the world's population carry TB in a latent form. Few of those who carry latent TB will develop the active form of that disease and treatment using multiple antibiotics is highly effective in the majority of cases. The risk of onward transmission/infection only arises where the disease is in the active form in the lungs. Although TB normally attacks the lungs (pulmonary TB) it can affect other parts of the body. Other forms of TB (extra-pulmonary) are generally not infectious to others and for those with pulmonary TB the risk of transmission can be addressed within a few weeks of commencing drug treatment. TB strains that are resistant to antibiotics are an increasing problem and treatment in such cases is both more protracted and expensive.

2.2 An estimated 1.8 million people are killed worldwide by TB each year and in the 1990s the disease was recognised as a major global public health problem. The World Health Organization reports that some important progress has been made in stabilising the incidence of TB across the world.

2.3 Commonly referred to previously as "consumption", TB is believed to have accounted for a quarter of deaths in the UK in the nineteenth century. Significant progress was made in the last century with around 120,000 new TB cases reported in 1913 declining to around 5-6,000 cases per annum in the 1980s. Mortality rates also decreased significantly following the development of more effective treatment regimes. There has been a gradual increase in the numbers of TB cases identified across the UK over the past 20 years and the over 9,000 cases reported in 2009 represented the highest numbers reported since the late 1970s. In 2008, ONS statistics recorded 334 deaths in England and Wales where TB was the underlying cause. An action plan "Stopping Tuberculosis in England: An action plan from the Chief Medical Officer" was published in October 2004 and advocated disseminating good practice in screening new migrants (albeit this recommendation related to interventions in country).

2.4 The rate of TB across the UK in 2009 was 14.6 per 100,000 population. In some conurbations, rates were much higher with London accounting for some 38% of all cases (a rate of 44.4 per 100,000 across London with average rates of over 100 per 100,000 in Brent and Newham). The higher London figure places the city as a high risk on the accepted WHO global risk matrix and the increase in the incidence of TB in the UK has attracted adverse comments from some commentators. The UK has been labelled by some the "western capital for tuberculosis" (Lancet vol 377 January 2011 "The white plague returns to London") and TB in people born abroad is a factor commonly quoted.

2.5 Rates of TB amongst the "non-UK born" population are more than 20 times higher than rates amongst the UK born population (86 per 100,000 as opposed to 4 per 100,000). Rates are also higher among UK born ethnic minority groups (9-55 per

100,000). Only around 20% of these cases, however, are diagnosed with the active disease within two years of entry.

2.6 In understanding these figures, it is important to bear in mind that place of birth should not be confused with nationality or indeed immigration status. Of those born abroad, some will be British citizens, settled here or nationals of states within the EEA (TB being highly prevalent in some states within the EEA) and so would not be subject to health screening at the immigration control.

2.7 Non-UK born cases accounted for 73% of all cases reported in 2009 with young adults demonstrating the highest rates (around 120 per 100,000). Those originating from South Asia and sub-Saharan Africa constituted around 85% of cases detected amongst the non-UK born numbers with those from India accounting for 28% of these cases alone. The proportion of those from India continues to increase. Non-UK born sufferers from Pakistan and Somalia accounted for 17% and 10% respectively but the incidence rate amongst these communities are relatively stable. Non-UK born cases also showed higher rates of drug resistant TB with 7.4% showing first-line drug resistance and 1.4% with multi-drug resistance compared to 6.3% and 0.6% amongst UK born cases. Those born in South Asia and sub-Saharan Africa constituted the majority amongst these cases (53.3% and 28.1% respectively) with those born in Eastern Europe displaying the greater proportion of drug resistant cases at 36.7% (11 cases out of 30 detected were drug resistant).

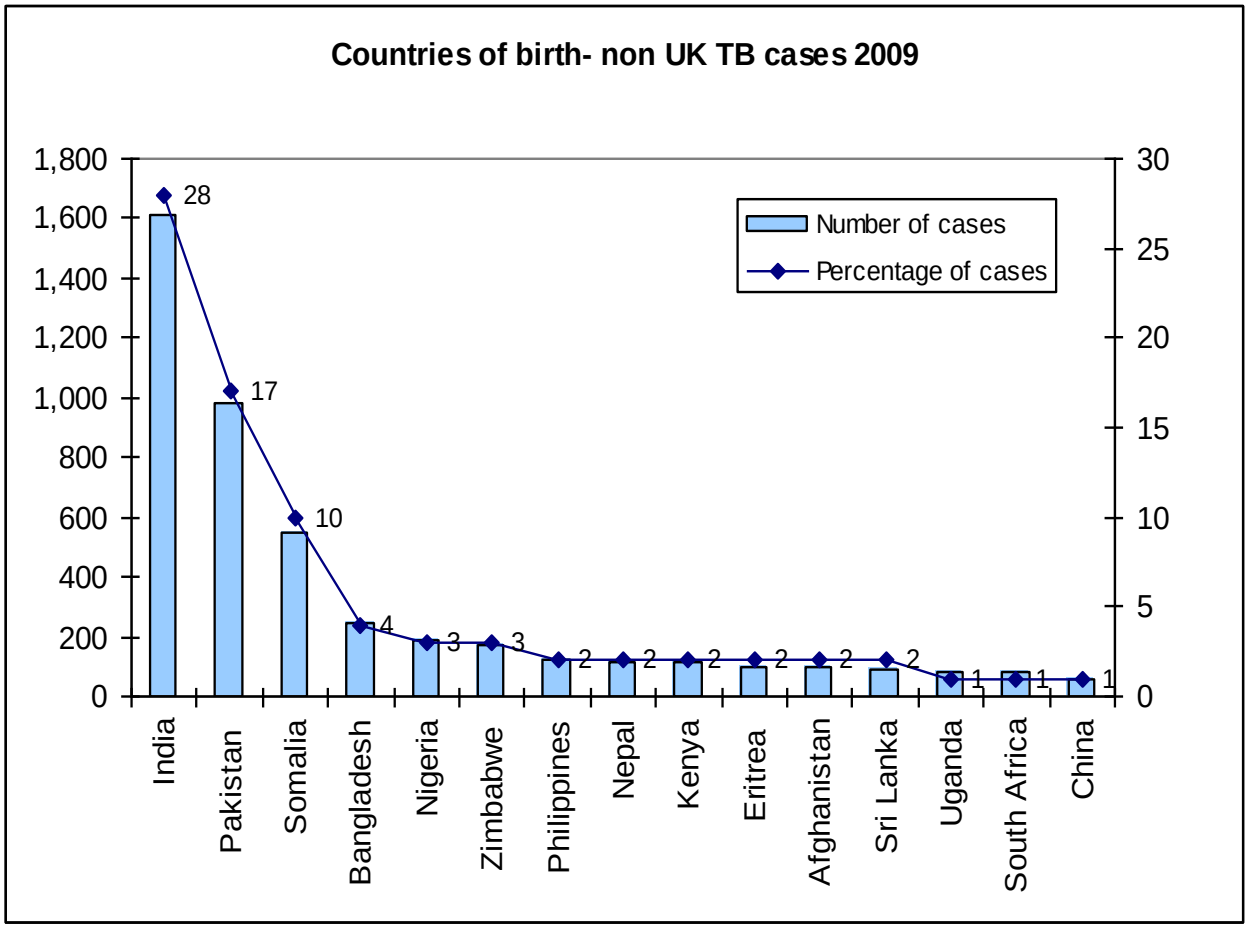
2.8 An average of 351 cases where the individual is recorded as having arrived within 12 months were detected between 2007 and 2009 (i.e. about 3.25% of the overall cases detected in 2009). Some of these individuals will, however, be British or EEA nationals and returning residents and as such not subject to immigration control. The relatively low proportion of cases attributed to new arrivals shows that in the main, TB is a chronic disease that is often reactivated in individuals at risk some years after arrival for the non-UK born. Not all will have suffered active TB at the time of arrival and with x-ray screening only a small proportion of those screened would have been identified. The evidence suggests that many of those who go on to develop the active disease in the UK do so having entered the country with latent infection. There is currently no scientifically approved method of establishing which persons with latent TB infection will develop active disease.

2.9 Whilst immigration is a factor to consider in understanding the incidence of TB in the UK and those who are themselves from migrant families are at a greater risk of developing active TB, there are other factors that need to be considered. For migrant families there may be a greater risk of infection through exposure to visitors from abroad or travel to other countries. However, equally important factors will relate to overall states of health. Poor living conditions, substance and alcohol abuse and poor or ill health (perhaps as a consequence of other health conditions such as HIV/AIDS) are factors that heighten the risk of active TB. Early detection and treatment are key to addressing the incidence and spread of TB.

2.10 Given the prevalence of latent TB and the fact that active TB may only develop in a proportion of those carrying latent TB and in the majority of those cases only many years after arrival into the UK, it is important that access to health care is readily available and that healthcare professionals are aware of the need to consider

the possibility that developing health conditions may be TB-related. There is currently little data as to onward transmission of the infection to indigenous populations by new arrivals, though that which is available suggests that the incidence is low. Transmission will normally require sustained contact and is commonly associated with overcrowding in housing.

2.11 Those suffering active TB are currently exempted from NHS charges for public health reasons. The HPA and their equivalent bodies in the devolved administrations record all new cases of TB for analytical purposes, provide assistance to front line clinical services and lead on investigations of local and national incidents and outbreaks (as part of the Chief Medical Officer's Action Plan for stopping TB in England 2004).



SECTION 3

ON ENTRY SCREENING

3.1 The Aliens Act 1905 provided for the health screening of new migrants through the appointment of a Port Medical Inspector (PMI). The health screening allowed for the exclusion of those considered to be medically unwell, suffering from mental health problems or likely to constitute a charge on public health services.

3.2 The role of the PMI remains essentially unchanged in nature and at Heathrow and Gatwick (as with all other English ports) the provision of Inspectors is the responsibility of the HPA. The Medical Inspector can recommend refusal of entry on public health grounds to the Immigration Officer or on the grounds that a migrant is unable to provide for themselves by virtue of a health condition (and as a consequence may pose a draw upon NHS and social care resources). However, their main activity over the past few decades has related to screening migrants for pulmonary TB through the use of x-rays of those arriving from countries with a high incidence of TB (over 40 per 100,000 population) and intending to remain in the UK for over six months.

3.3 Whilst there is power in law to refuse entry to and remove those detected with active TB, arriving passengers with abnormal results are normally hospitalised (released on temporary admission under immigration powers and a grant of leave delayed until treatment has been completed) or the HPA will recommend a grant of entry and forward details of the migrant to the relevant health authorities in order to ensure follow up in country.

3.4 The responsibility for monitoring new arrivals and conducting screening is split between the HPA and the NHS. These arrangements reflect the evolution of processes over the past few decades. The HPA leads on the provision of the medical inspector and TB screening at Heathrow and Gatwick, which are the only ports that have x-ray facilities available on site and the more extensive presence of medically qualified staff. Furthermore, while X-Ray screening can, in theory, detect 75% of all active pulmonary cases it is not always possible to screen all passengers given operational and physical constraints. The costs of the operations at Heathrow and Gatwick are approximately £2.5m per annum (comprising funds from the HPA and local health bodies), a significant increase over the funding that was transferred from DH when the HPA took over this remit and the bulk of these funds are directed to TB screening and the collection and transmission of data on arriving passengers to local health units.

3.5 X-rays do not provide conclusive evidence of active TB and the vast majority of abnormal results detected do not relate to TB. Relatively small numbers of cases are detected at ports as having an abnormal result, and there is a general consensus that screening in this manner is no longer considered effective on either clinical or financial grounds. HPA analysis suggests that at best, x-rays will only detect 6% of those who will develop active TB. Data from 2006/7, for instance, shows that approximately 67,000 x-rays were taken at Heathrow with around 80 people referred to hospital of which only 34 cases were subsequently identified as suffering active

TB (around 51 per 100,000). The HPA and the NHS devote significant resource to reporting new arrivals who may require follow up in the community or may not have been screened on arrival to local health units. This latter number will comprise those who should not be x-rayed (children under 11 and pregnant women) and those who were not screened on arrival.

3.6 Changes in passenger flows over the past two decades have also impacted upon the effectiveness and efficiency of on-entry screening. Many more passengers now arrive directly into other ports, and the numbers of migrants subject to immigration control arriving at Gatwick have fallen sharply over the past few years meaning that each x-ray taken now costs thousands of pounds as opposed to tens of pounds and in many cases, the screening activity may cost more than treating the disease. Across the rest of the UK, there are differing practices in collecting data on newly arriving migrants. In the main, passenger data is collected and passed to local health providers, using a variety of means (mostly manual collection of data), to facilitate some level of screening after arrival.

SECTION 4

PRE-ENTRY SCREENING

4.1 As part of the wider work on managing the incidence of TB, there was cross Government agreement in 2005 to trial the screening of migrants before their arrival in the UK. This programme of screening has been taken forward with the assistance of the IOM since late 2005. Initial set up costs were funded through the UK Border Agency and the Foreign and Commonwealth Office (FCO) with subsequent running costs defrayed to those being screened. Now covering 15 countries[1], those seeking entry clearance to the UK for more than 6 months are required to undergo TB screening through the IOM. The issue of an entry clearance (visa) is subject to confirmation that the screening has been undertaken by the IOM and active TB has not been detected (through the use of a secure certificate). Those detected with active TB are advised to seek medical care and invited to return for further screening after successful treatment.

4.2 The numbers of active cases of TB detected by the IOM is relatively low and has remained low despite a switch to combining x-ray screening with the use of laboratory-based sputum and culture testing, although detection rates have increased as a consequence. The low numbers, in many cases falling well below the recorded WHO rates for those countries, can be attributed to a number of factors. Firstly, the WHO rates relate to overall rates of TB, rates of pulmonary TB will normally account for approximately 50% of overall detection rates. Secondly, those who are able to afford to travel to the UK may often be wealthier and as a consequence healthier than the main populace within their home countries. There is some support for the second assumption in the differing rates of detection across visa categories, with those joining relatives in the UK as dependents suffering a higher incidence of TB than those, for instance, seeking to work in the UK.

4.3 The costs of the pre-entry programme to the UK have been approximately $1.8m US (£1.1m at Nov 2010 rates). These costs related to the initial set up costs of clinics and the switch to culture testing in 2009. Subsequent running costs are recouped through fees charged by the clinics (between $50-70).

4.4 The available data around the active TB cases detected by IOM does allow for a limited analysis of the financial costs and benefits of screening. IOM data shows that over 440,000 people were screened between October 2005 and August 2010. Of these, 287 were identified as suffering active TB. This translates into an overall prevalence rate of 66 per 100,000 through the course of the programme. This rate rose to around 90 per 100,000 where screening took place utilising the enhanced testing. In working on the assumptions that these 287 people would otherwise have presented at the NHS, had infected others at a rate of 0.2 per individual, did not have drug resistance and did not present with other health conditions arising from the

[1] Bangladesh, Cambodia, Ghana (which also takes applications from Burkina Faso, Cote d'Ivoire, Togo and Niger), Kenya (which also take applications from residents of Eritrea and Somalia), Pakistan, Sudan, Tanzania, and Thailand (which also takes applications from Laos).

incidence of TB, we can estimate the potential savings to the NHS at approximately £2.1m over that period (using NICE estimates of costs (1998) of around £6k per patient and taking into account the initial set up costs).

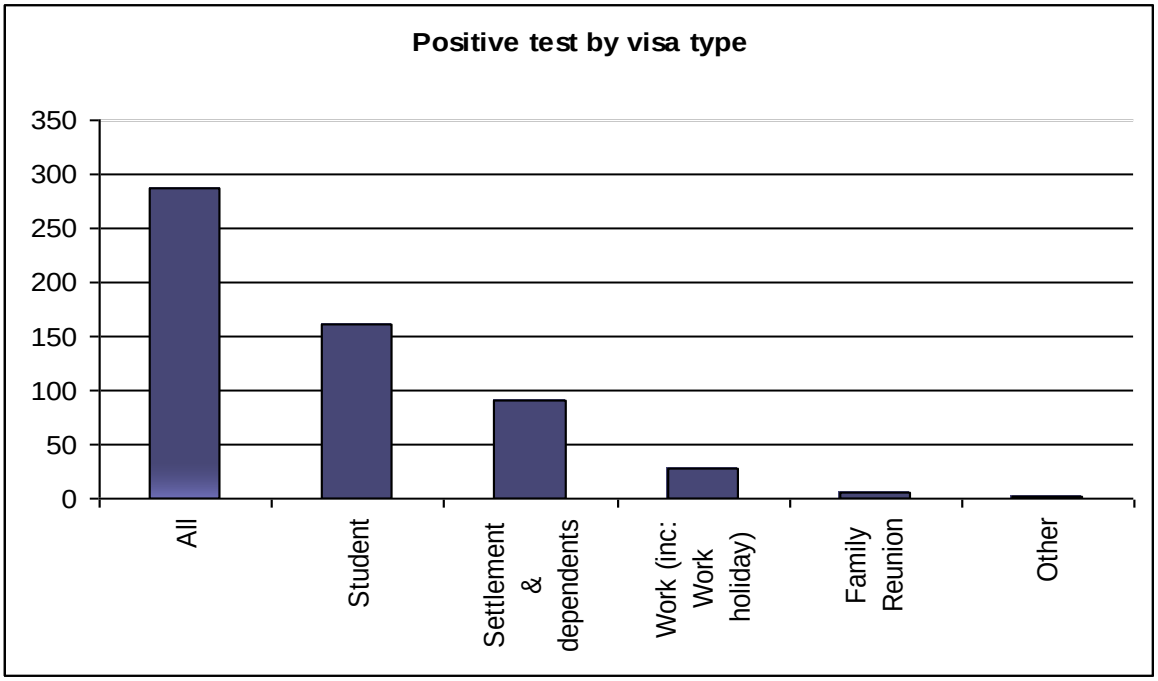
4.5 The data shows, again, some wide variations across those tested and against the WHO published rates for those countries. There is some evidence, however, that in the main the rates of active TB detected are well above 40 per 100,000 per annum (save for the year 2006 when detection rates fell to 35 per 100,000). All but one category of visa applicants also exceeded 40 per 100,000 and reached as high as 190 per 100,000 for family reunion applications (although the small numbers of those screened does not allow for conclusive findings).

4.6 It is not clear what the overall impact in terms of health benefits to the UK populace are through preventing the entry of these 287 people over the 5 year life of the programme. IOM figures suggest that over 90% of those detected completed drug treatment. This compares favourably with the reported completion of treatment within the UK (and also suggests that potential migrants have not been dissuaded from applying for entry clearance to the UK). It is perhaps not an insignificant matter in itself that those identified through screening have received clear notice that they are unwell and been encouraged to take treatment given that around a third of untreated active TB cases lead to death.

4.7 In fully understanding these figures, it is important that a number of factors are considered;

- The UK's current pre-entry screening programme covers only 15 countries. Some high risk nations, such as India and China, are not covered by the screening programme. Those born in India constitute the majority of non-UK born cases identified in 2009 (28% of those who are non-UK born). The Australian Department for Immigration and Citizenship report a rate of 147 per 100.000 in migrants screened in India. The returns of the current pilot, therefore, do not give a complete picture of potential NHS savings.

- The costs borne by the UK have arisen through the need to set up clinics abroad with the IOM. There are, however, opportunities to avoid set up costs in rolling out an expanded pre-entry screening programme. The IOM already has existing facilities in many parts of the world (including where they conduct TB screening for other states) and may be able to expand to provide TB screening for the UK without any upfront costs and may, in other circumstances, recover set up costs by spreading the burden across service users through fees. Existing commercial enterprises may also be able to provide screening in many countries abroad, again without the need for upfront set up costs. The USA, Canada, New Zealand and Australia (amongst others) screen for TB, and as well as relying upon the IOM also utilise a network of "panel doctors". They are not directly employed and in many instances (such as the panel doctors employed by our partners in screening migrants from the UK) are private service providers.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150
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50
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All
Student
Settlement & dependents
Work (inc: Work holiday)
Family Reunion
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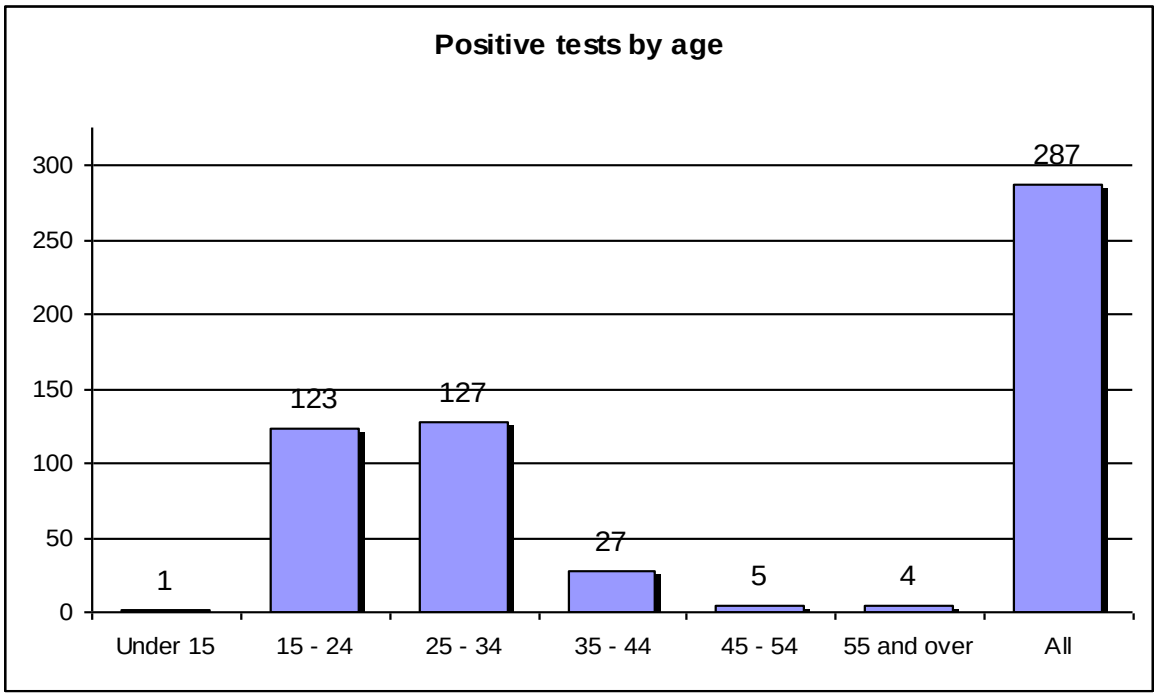
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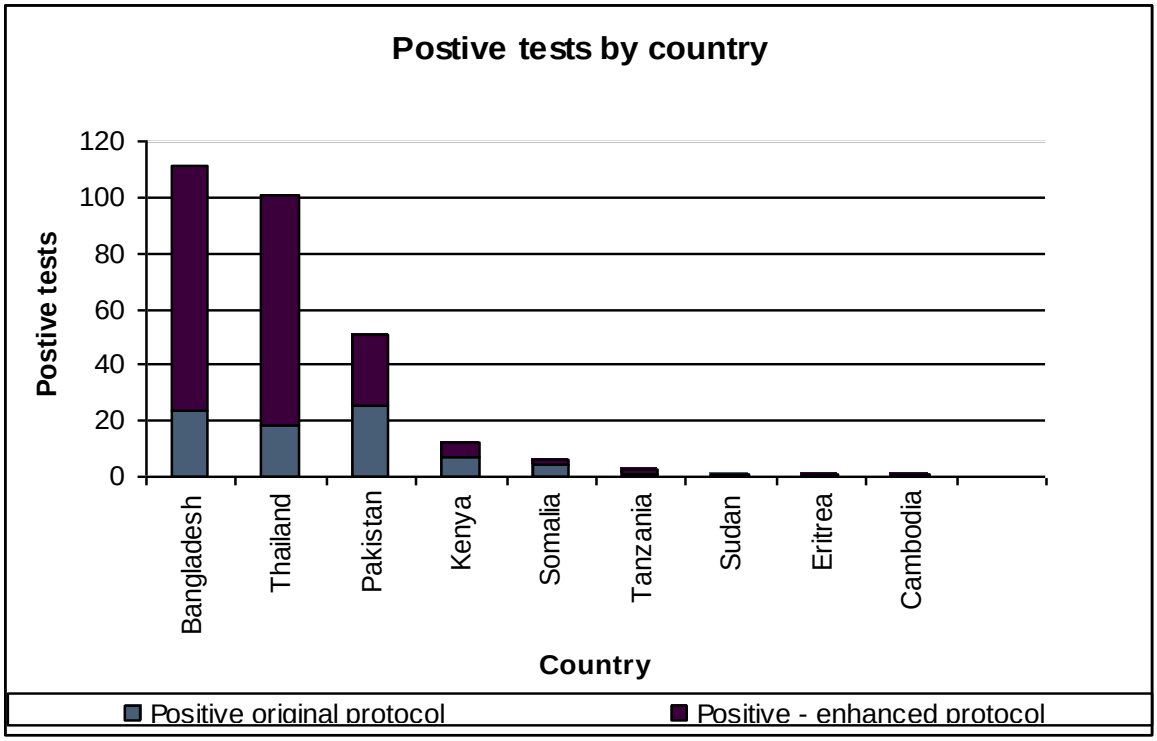
45 - 54
55 and over
All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20
0
Postive tests
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Thailand
Pakistan
Kenya
Somalia
Tanzania
Sudan
Eritrea
Cambodia
Country
Positive original protocol
Positive - enhanced protocol

SECTION 5

TB SCREENING AND IMMIGRATION IN THE INTERNATIONAL CONTEXT

5.1 There are differing practices across our EEA partners. Within Europe, the UK is unique in employing pre-entry screening for TB in relation to regular migrants (although many EEA nations employ medical screening where accepting refugees from abroad under managed resettlement programmes). Some nations do require new migrants to undergo screening after arrival and, in some countries, the extension of immigration stay is conditional upon production of evidence that this screening has taken place.

5.2 The USA, Canada, Australia and New Zealand, employ extensive global pre-entry health screening of migrants (that is those who intend to travel to and remain within their territories for periods over 3 to 6 months) and conduct specific screening for TB in countries with a high incidence of that disease.

5.3 The nations above are taking forward an ambitious programme to rationalise their existing health screening programmes. This will see the 4 nations moving towards using shared screening facilities and possibly the roll out of a shared IT infrastructure. The programme also involves shared quality auditing and a move towards establishing consistencies of approach. In the main, our partners screen migrants for a number of health conditions in order to safeguard public health and in some cases, to preclude migrants who may pose a significant draw on health and social service resources. The majority of the existing screening activity is conducted through the use of “panel doctors”, in essence private medical facilities who charge potential migrants a fee for their service.

USA.

5.4 The USA screening programmes are overseen by the Centre for Disease Control working in conjunction with the US immigration authorities. The US now conducts pre-entry testing for latent TB as part of the overall screening activity. In many cases, migrants are required to comply with follow up examinations after entry.

AUSTRALIA.

5.5 Australia has enjoyed a relatively stable TB prevalence rate of around 5 to 6 per 100,000 despite significant immigration flows from high prevalence TB countries. The incidence of TB amongst migrants accounted for over 86% of the 1,135 cases detected in 2007. The Australian National Tuberculosis Advisory Committee attributes Australia’s success in maintaining such stable rates to the use of the pre-entry screening programme combined with well resourced and targeted specialised follow-up screening in country.

5.6 All permanent and many temporary (based on a risk matrix) migrants are required to meet a health requirement (Australia’s wider health screening programme). Those from countries with a high prevalence rate of TB are required to

undergo screening for the disease, with some level of risk profiling utilised, and a few migrants will also be subject to further health checks in country after arrival. In the year from 1 July 2009, 519 active TB cases were detected from amongst 378,939 individuals screened (137 per 100,000). Of these, 4 were found to have multi-drug resistant TB (1.05 per 100,000). It is estimated that the pre-entry screening programme has prevented an increase of approximately 31% in TB cases diagnosed in country which would have led to an increase in incidence rates of around 2.5 cases per 100,000 a year or an overall incidence rate of 7.5 per 100,000.

5.7 As with the UK's experience in pre-entry screening across 15 countries, the Australian data found variation across the classes of migrants. Those joining family members exhibited high rates of TB prevalence and the number of students identified with active TB comprised some 30% of all cases. There were also variations against the WHO prevalence rates in many countries and it is interesting to note that Australia reports a TB detection rate of around 30 per 100,000 from their pre-entry health screening in the UK.

5.8 Also interesting, given that many irregular migrants in the UK will undergo no screening, the prevalence rate of 137 per 100,000 detected amongst "regular migrants" in a study in Australia is below the 157 per 100,000 cases detected during a study in 2000 of those detained at Australian immigration reception and processing centres (i.e. mostly irregular migrants). This suggests that in Australia there was some evidence of a higher level of risk amongst irregular migrants.

5.9 The savings attributed to pre-entry screening in Australia are estimated to be between $10,000 and $12,000 per case in treatment and care costs rising to $90,000 for those with multi drug resistant TB. At a conservative estimate, this equates to over $5m of savings to the Australian healthcare system per annum. Whilst the costs of testing and treatment are borne by the potential migrant, the Australian data also records a high rate of treatment completion (around 90%) suggesting that most migrants are not deterred from completing their journeys.

5.10 The markedly higher rates of detection enjoyed by Australia will reflect in part the differing migrants to that country but is more heavily attributable to the more pro-active screening regime utilised. The data from Australia suggests that the combination of sputum smear and culture testing detects active TB in 41- 44.5% of those who actually suffer the active disease. Detection rates using these techniques alone would in fact prove similar to those detected by the UK's pre-entry screening programme (at around 61 per 100,000). The other cases detected by the Australians require a clinical assessment of the evidence from the screening methodology in the round including follow up x-rays to establish whether an abnormality has progressed or remains stable. In Australia, these cases are monitored or assessed (according to the availability of expertise or adequate facilities in the countries abroad) by medical officers at DIAC's Global Health Branch.

5.11 The running costs of the Australian pre-entry health screening programme are approximately $4m, however, the bulk of these costs relate to the administration of the wider migrant health screening programme and it is estimated that overall costs in terms of TB and other health screening are closer to $1.5m. These costs will include the maintenance of IT systems and audit activity abroad as well as the costs

of providing for clinical monitoring or assessments.

SECTION 6

OPTIONS AND CONSIDERATIONS

6.1.1 Whilst it is clear that active TB cases are detected through the pre-entry and on-entry screening programmes, the overall numbers of those detected remain low compared with the numbers screened. Although the incidence of TB is higher in those who are non-UK born and those from migrant communities, not all of these people will be subject to immigration control. The current screening methodology will detect only TB that is active, in most cases a person with latent TB will not develop active TB for many years after arrival and only a small proportion of those with latent TB develop the disease in the active form.

6.1.2 The pre-entry screening programme allows for more extensive and thus more effective testing involving x-rays and, where abnormalities are detected, through the use of three consecutive sputum smear tests. X-rays will, at best detect only around 6% of those who develop active pulmonary TB. Sputum and culture testing can increase diagnosis rates by 50%. Further bacteriological testing (cultures) was rolled out across all of the IOM clinics between November 2007 and April 2009. The programme, however, has required investment from the UK in set up costs, creates a delay to the visa application process and attracts a further fee from those tested (an addition of around $50-$70 US to the visa fees).

6.1.3 At present, the pilot screens in 15 countries abroad (with some having their tests conducted at IOM clinics in other nations). These are not necessarily, however, the countries where the incidence of TB is highest or countries from where the UK issues significant numbers of visas.

6.1.4 Whilst the data available from the pilot suggests that savings have been accrued to the NHS, these are not significant in themselves. There are significant variations in active TB detected against the WHO reported incidence rates for each nation and it is not immediately clear what results could be achieved by expanding the pre-entry screening to other high risk nations. For instance, whilst Ghana is reported by WHO to have a high incidence of TB, no active cases were detected out of 25,000 screened. These variations between the WHO and actual detected rates through screening in the 15 countries may be due, in varying proportions, to the potential migrants being generally wealthier (and as a consequence healthier) than the general populace in those nation. There may be some corroboration to this assumption from within the data itself, in that the highest rates of detection have been seen amongst those applying for family reunion (in the main to join refugees and others granted humanitarian protection where the rate stands at 190 per 100,000).

6.1.5 The data suggests that pre-entry screening is the more effective manner in which to detect active TB. This significant difference is directly attributable to the exclusive reliance on x-rays in on entry screening process and their relative

ineffectiveness in detecting active TB. Pre-entry screening visa applicants would also avoid congestion at UK airports and exports screening and treatment costs.

6.1.6 On-entry screening is only conducted at Heathrow and Gatwick Airports and demand is subject to the usual peak and troughs in passenger flows. The late summer period, when we see new students arriving into the UK, poses a significant challenge to HPA and UK Border Agency resources and has in past years significantly increased congestion at Heathrow as those being screened are referred between the immigration and health controls. In 2009, the congestion experienced led to some students being detained for over two hours and arriving passengers being kept on their aircraft until the arrivals and baggage halls were safely able to cope with them. In contrast, the change to passenger flows into Gatwick now means that only one or two passengers are screened per week. This means that the cost of maintaining this facility is now equivalent to a cost per x-ray of around £6-7,000 and a cost per case detected in the region of £250,000, which in most cases will significantly exceed the costs of treating the disease. At Heathrow, the cost per case detected is in the region of £59,000 (or nearly ten times the costs of treating the disease). For the HPA, the costs of employing x-ray screening and collecting data on arriving passengers constitutes the bulk of their operating costs at our ports and limits their ability to perform the other roles of the medical inspector in identifying others who should be refused entry on medical grounds or on the grounds that the passenger is unable to afford to maintain themselves and afford the costs of treatment for any medical conditions they may suffer and thus may pose an excessive demand upon the NHS. The misuse of the NHS continues to pose a significant challenge to the UK and in this respect, short term visitors are equally likely to contribute to that problem (such as those who travel to the UK to give birth and have no intention of paying any charges arising).

6.1.7 The PMI's presence (not covered in this review) at Gatwick and Heathrow (and access to a PMI at other ports) would remain an important element in the effectiveness of border controls. Retaining resources at the control areas would allow for temporary migrants with health issues, including public health issues, to be detected and managed.

6.1.8 A significant number of people, including irregular migrants who employ deception or clandestine routes of entry, are not subject to either screening programme. Unless they are placed into immigration detention, they do not undergo any screening for TB. At present, there is no routine sharing of information on these migrants with the HPA. This data is, however, available through UK Border Agency databases and it should be possible to ensure that such data can be exchanged on a routine basis, perhaps with particular focus on identified risk areas (such as irregular migrants detected working in the catering or healthcare sectors). There may also be scope for the HPA and other agencies involved in collecting data on arriving passengers to effect savings and increase the effectiveness of the programme through a routine exchange of data relating to visa applications (in the main all non-EEA nationals travelling to the UK for over 6 months will require a visa or entry clearance). This data should prove more reliable and comprehensive than the existing largely manual arrangements at the larger ports and could afford the added advantage of providing a means to establish contact details for sponsors and thus overcoming the incidence of unreliable address data captured at ports as many

migrants will have made only tentative or interim arrangements for accommodation prior to arrival, may not be familiar with how UK addresses are constructed and will change addresses during their stay in the UK. Data sharing with HPA should be pursued irrespective of decisions on the future of pre and on-entry screening.

OPTIONS CONSIDERED

6.2.1 Make no changes

This option would require no further funding for the UK Border Agency. The 15 nations where screening already takes place, however, are not necessarily the nations where the greatest risk lies and visa applicants face additional costs and delays to their applications. The current on-entry screening programme can pose a significant challenge to the HPA's and UK Border Agency's resources and there is a general consensus that x-ray screening is both hugely expensive and largely ineffective. The cost of detecting a case of active TB at Gatwick is over 40 times the cost of treating the disease and at Heathrow nearly 10 times the cost of treatment.

6.2.2 Cease on-entry TB screening

Significant savings can be made by the HPA and resources diverted to more effective work. Removing the need for extensive blanket x-ray screening at our busy ports will also lessen the demands on the UK Border Agency's resources and alleviate the congestion suffered at our ports during peaks. A decision to move away from screening on entry using x-rays is fully justified in terms of the available evidence. However, the move may be seen as being counterintuitive at a time when the UK is suffering an increased incidence of TB, so would need a good communication programme around it.

6.2.3 Cease pre-entry screening

Although there may be some additional costs in assisting the IOM in managing the closure of some facilities, visa applicants in the nations screened will no longer be subject to additional requirements, delays or costs. In numerical terms, the yield of active TB cases remains relatively low and the potential savings to the NHS are not substantial in NHS terms. But with any decision to cease on-entry screening, ceasing such screening may be seen as counterintuitive.

6.2.4 Expand pre-entry TB screening to cover all high risk nations

Moving to screening across nations where TB is prevalent would be a more equitable approach than screening within the existing pilot nations alone. It is noteworthy, for instance, that whilst visa applicants from Bangladesh and Pakistan are subject to screening, those from India are not. This is despite the fact that there are significantly higher numbers of arrivals from India and TB is also prevalent there. There is the potential to save costs to the public purse in terms of removing the burden of conducting on entry and after entry screening and providing treatment and placing the bulk of the burden of operating costs upon the service users. Conducting screening on a universal basis will require some consideration as to funding. Whilst it

will be possible in some countries to utilise existing facilities (such as IOM or the panel doctors utilised by our partner nations) there may still be a need to fund new facilities and implement IT changes (in order to ensure data security). Using external private sector providers may require some measure of auditing in order to ensure that there is a consistent level of quality in testing and safeguarding against corruption. IOM have indicated that they would expect the costs of adopting such universal screening to be in the region of $4m US. However, they have also indicated that there may be considerable scope to avoid set up costs in many instances where facilities already exist, such as where the IOM already conducts screening for other nations and bodies.

6.2.5 Expand pre-entry TB screening to cover nations where the highest risk exists (22 hbc)

The WHO data reports that the bulk of the incidence of newly detected active TB (80%) occurs across 22 nations ("high burden countries"). Screening in these countries may produce the highest yields in detecting active TB. However, the numbers detected may not be significant if we see the same patterns as within the pilot programme and many migrants are healthier than the overall populace. As with option 4, there is the advantage of saving costs to the public purse by placing the bulk of the burden of funding any screening upon the service users. Annex A provides further details on incidence rates across the 22 high burden countries with approximations of visas issued in 2009/10. However, it should be borne in mind that the composition of the 22 may change over time.

Although options 4 and 5 may have a limited impact upon the impact of TB in the UK, pre-entry screening is more cost effective than on-entry screening.

6.2.6 Sharing of immigration data

There are limited powers for the sharing of data by the UK Border Agency in terms of current legislation (limited to sharing data on arriving passengers with HPA to share with local health bodies) and there may be a need for further legislation to facilitate this option. There are potential efficiencies to be gained by making data on visa applicants (effectively all non EEA nationals intending to stay in the UK for over 6 months) and irregular migrants detected in country available to HPA or health bodies. Savings could be accrued by replacing the largely manual collection of such data by HPA (and as a consequence to Public Health England who will subsume the HPA) and other bodies across the UK. Sharing details of visa sponsors (perhaps as a reactive process) may also overcome the significant problems of incorrect or incomplete addresses (over a third of potential in country follow ups are lost due to these issues) and would include data on arriving migrants who arrive at ports where data is not currently collected by HPA or the NHS.

6.2.7 Introduce requirements for migrants to undertake after entry medical follow up as a part of the immigration journey

A number of nations (including those in the EEA) require immigrants to undertake screening after arrival as a part of their immigration/residence requirements. There are no similar provisions within current UK immigration legislation save for the power

of a Border Force officer to require a newly arrived passenger to attend an examination on the recommendation of the Port Medical Inspector. Given that active TB may not develop for many years after arrival, there may be some benefit in imposing a requirement on migrants from high risk TB countries in producing evidence that they have registered with a GP or undertaken any examinations required of them by a competent health body when seeking an extension of stay (with an opportunity to provide information as to which NHS services migrants are entitled to for free and which are likely to attract a charge). This would, however, prove difficult to police and administer effectively and would require a change to primary legislation.

JULY 2011

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ANNEX A

HIGH BURDEN TB COUNTRIES (WHO ESTIMATES)

Countries (high burden shaded) (current screening pilots in red bold)	Estimated cases of TB 2009	WHO TB estimated rate per 100k of population	Active cases detected in UK 2006-2009	% of all FN cases detected in UK 2006-2009	Visas issued greater than 6 months 2010 (by nationality)
Afghanistan	53,000	189	345	1.7%	2,514
Bangladesh	360,000	225	906	4.4%	15,667
Brazil	87,000	45	47	0.2%	3,435
Cambodia	65,000	442	<5	0.0%	90
China (inc Hong Kong)	1,300,000	96	267	1.3%	54,794
Dem Rep Congo	250,000	372	32	0.2%	654
Ethiopia	300,000	359	216	1.1%	705
India	2,000,000	168	5186	25.4%	137,269
Indonesia	430,000	189	35	0.2%	2,710
Kenya	120,000	305	465	2.3%	4,027
Mozambique	94,000	409	29	0.1%	84
Myanmar (Burma)	200,000	404	66	0.3%	483
Nigeria	460,000	295	648	3.2%	65,385
Pakistan	420,000	231	3448	16.9%	56,542
Philippines	260,000	280	404	2.0%	10,534
Russian Federation	150,000	106	19	0.1%	19,340
South Africa	490,000	971	378	1.9%	22,667
Tanzania	80,000	183	111	0.5%	1,327
Thailand	93,000	137	133	0.7%	8,688
Uganda	96,000	293	313	1.5%	1,452
Vietnam	180,000	200	145	0.7%	3,297
Zimbabwe	93,000	742	807	4.0%	3,411

ANNEX B

COUNTRY LIST OF PASSENGERS LIABLE TO ON ENTRY SCREENING

Countries (high burden shaded) (current screening pilots in red bold)	Estimated cases of TB 2009	WHO TB estimated rate per 100k of population**	Active cases detected in UK 2006-2009*	% of all FN cases detected in UK 2006-2009 ##	Visas issued greater than 6 months 2010 (by nationality)***
Afghanistan	53,000	189	345	1.7%	2,514
Angola	55,000	298	97	0.5%	862
Bangladesh	360,000	225	906	4.4%	15,667
Bhutan	1,100	158		0.0%	107
Bolivia	14,000	140	22	0.1%	193
Botswana	14,000	694	33	0.2%	320
Brazil	87,000	45	47	0.2%	3,435
Burkina Faso #	34,000	215	<5	0.0%	39
Burundi	29,000	348	24	0.1%	51
Cambodia	65,000	442	<5	0.0%	90
Cameroon	35,000	182	59	0.3%	1,375
Cape Verdi	750	148		0.0%	23
Central African Rep	14,000	327		0.0%	5
Chad	32,000	283		0.0%	17
China (inc Hong Kong)	1,300,000	96	267	1.3%	54,794
Congo	14,000	382	192	0.9%	92
Cote D'Ivoire #	84,000	399	36	0.2%	366
Djibouti	5,400	620		0.0%	30
Dem Rep Congo	250,000	372	32	0.2%	654
Ecuador	9,300	68	17	0.1%	537
Equatorial Guinea	790	117		0.0%	66
Eritrea #	5,000	99	311	1.5%	745
Ethiopia	300,000	359	216	1.1%	705
Gabon	7,400	501		0.0%	42
Gambia	4,600	269	89	0.4%	125
Ghana	48,000	201	160	0.8%	7,014
Guinea	32,000	318	25	0.1%	236
Guinea-Bissau	3,700	229		0.0%	11
Haiti	24,000	238		0.0%	35
India	2,000,000	168	5186	25.4%	137,269

Indonesia	430,000	189	35	0.2%	2,710
Kazakhstan	26,000	163		0.0%	4,657
Kenya	120,000	305	465	2.3%	4,027
Kiribati	340	351		0.0%	0
Korea Dem Peoples Rep	82,000	345	14	0.1%	3
Korea Rep of	43,000	90	16	0.1%	0
Kyrgyzstan	8,700	159		0.0%	200
Laos #	5,600	89	<5	0.0%	15
Lesotho	13,000	634		0.0%	38
Liberia	11,000	288	21	0.1%	86
Madagascar	51,000	261		0.0%	51
Malawi	46,000	304	122	0.6%	461
Malaysia	23,000	83	70	0.3%	8,244
Mali	42,000	324		0.0%	92
Mauritania	11,000	330		0.0%	37
Micronesia	99	90		0.0%	0
Moldova	6,400	178		0.0%	321
Mongolia	6,000	224	28	0.1%	301
Morocco	29,000	92	52	0.3%	2,894
Mozambique	94,000	409	29	0.1%	84
Myanmar (Burma)	200,000	404	66	0.3%	483
Namibia	16,000	727	23	0.1%	90
Nepal	48,000	163	338	1.7%	9,703
Niger #	28,000	181	<5	0.0%	27
Nigeria	460,000	295	648	3.2%	65,385
Pakistan	420,000	231	3448	16.9%	56,542
Papua New Guinea	17,000	250		0.0%	18
Peru	33,000	113	10	0.0%	751
Philippines	260,000	280	404	2.0%	10,534
Russian Federation	150,000	106	19	0.1%	19,340
Rwanda	38,000	376	31	0.2%	210
Sao Tome & Prince	160	98		0.0%	0
Senegal	35,000	282	16	0.1%	400
Sierra Leone	37,000	644	111	0.5%	1,230
Solomon Islands	600	115		0.0%	0
Somalia #	26,000	285	2263	11.1%	2,118
South Africa	490,000	971	378	1.9%	22,667
Sri Lanka	13,000	66	333	1.6%	14,047
Sudan	50,000	119	119	0.6%	2,209
Suriname	700	135		0.0%	15
Swaziland	15,000	1257		0.0%	60
Tajikistan	14,000	202		0.0%	90

Tanzania	80,000	183	111	0.5%	1,327
Thailand	93,000	137	133	0.7%	8,688
Timor-Leste	5,600	498	16	0.1%	0
Togo #	30,000	446	<5	0.0%	86
Tuvalu	15	155		0.0%	0
Uganda	96,000	293	313	1.5%	1,452
Ukraine	46,000	101	11	0.1%	5,801
Uzbekistan	35,000	128		0.0%	509
Vietnam	180,000	200	145	0.7%	3,297
Zambia	56,000	433	143	0.7%	892
Zimbabwe	93,000	742	807	4.0%	3,411

Notes:

* Cases with an incidence of less than 5 cannot be released to protect medical confidentiality

**Incidence: Rates reported by WHO Nov 2010.
http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733758290

Incidence is defined by WHO as the number of new occurrences in a given year. The figure shown above is the estimated instance of TB detected per 100,000 people.

*** Excludes family visitor and other visitors. May not reflect the numbers of visas issued in country.
# Part of current screening pilot but applications dealt with in hub country.

Figures do not include 777 non-UK cases whose country of birth was not identified.

Annex C – Department of Health report

Department of health analysis of IOM data

PRE-ENTRY SCREENING OF UK VISA APPLICANTS FOR TUBERCULOSIS

Introduction

In October 2005, the Government introduced a pre-entry screening programme to detect and treat infectious cases of pulmonary tuberculosis, which currently covers applicants for visas to enter the UK for longer than six months from selected high-risk countries.

Centres have been established to carry out the screening process in Bangladesh, Cambodia, Ghana, Kenya, Pakistan, Sudan, Tanzania, and Thailand.

In addition to their own visa applicants, these centres also carry out tests on applicants from Burkina Faso, Côte d'Ivoire, Niger, Togo, Eritrea, Somalia, and Laos. Applicants from the first four of these countries are screened in Ghana, those from Eritrea and Somalia in Kenya, and those from Laos in Thailand.

The screening process, carried out by the International Organization for Migration (IOM), starts with a chest x-ray. Applicants found to have radiological abnormalities consistent with TB are also given three sputum smear tests. Since the introduction of the screening, the protocol has been enhanced so that individuals with clinical findings highly suggestive of infectious TB undergo further bacteriological (sputum culture) tests. These culture tests have been introduced at different dates between October 2007 and December 2009 across the screening centres. Applicants whose tests are TB-positive are not issued a certificate by IOM.

UK Border Agency have raised five questions:

1. What is the incidence of TB detected per 100,000 people
    a. In terms of overall detections;
    b. In terms of detections by country;
    c. Detections by sex;
    d. Detections across age ranges; and
    e. Detections across visa application categories?

2. Where do detection rates fall against the accepted WHO tables relating risk in terms of incidence per 100,000?

3. Does the data provide evidence that detection rates have improved significantly in 2009?

4. What savings have been accrued to the NHS in terms of the detected cases since the implementation of the screening programme?

5. What do any savings to the NHS (if any) show the return of the initial investment ($1.8M) to be?

This note considers the first and third of these questions in Section 3 on the results of the screening process, and the last two in Section 4 on savings to the NHS. For reasons covered in 2.1 below, we have not felt able to compare the screening results with the WHO estimates of incidence and prevalence, although we do comment on how they compare for the countries with most tests.

1. Methodology

Although the report is largely statistical, there are some matters where interpretation has been necessary. These are covered in the following section.

2.1 Country of Applicant

In the introduction, we identify fifteen countries from which visa applicants are screened for pulmonary tuberculosis. However, the database only identifies the eight countries where there are centres, and does not record the applicant's country of residence.

As a result, we are only able to identify with certainty the applicants from the five countries that have centres and only process applications from those countries (Bangladesh, Cambodia, Pakistan, Sudan and Tanzania). We are not able to differentiate reliably between, for example, applicants from Thailand from applicants from Laos.

The database does, however, identify the nationality of an applicant. Where applicants are of the nationality of one of the seven screening countries without their own centres, and are screened in the corresponding country, then they are classified according to their nationality, otherwise they are classified according to where they were screened[2].

For example, if an applicant is screened in Thailand, they are regarded as being from Laos if that is their nationality, otherwise they are regarded as coming from Thailand. This is obviously an imperfect indicator of residence.

In view of this problem, and the small numbers of checks carried out relating to some countries, we have not provided a table comparing the 2009 screening detection rates per 100,000 individuals screened with the WHO estimates of epidemiological burden for tuberculosis, although we do comment on how the detection rates under the new protocol compare with the WHO estimates for the countries with most tests.

[2] Within the database, there were 130 cases where the nationality was not identified. Of these, 115 were from Kenya, 10 from Ghana and 5 from Tanzania.

We **recommend** to IOM that the residence of an applicant is separately identified on the database to enable more detailed analysis in the future.

2.2 Definition of a Positive Test

The results of sputum smear test (SS) and sputum culture test (SC) are used to determine whether an applicant is TB-positive. The following categories are regarded as TB-positive:

- SS positive, no SC carried out;
- SS positive, SC positive;
- SS negative, SC positive;
- SS positive, SC incomplete; and
- SS positive, SC negative, and no certificate issued.

There are 65 cases where the sputum smear test was positive and the sputum culture test was negative. A certificate was issued for 56 of these applications (52 of these 56 applications were from Thailand, 2 from Pakistan, and 1 from each of Bangladesh and Kenya). We have assumed that the certificate was not issued for the remaining nine as the applicant was considered TB-positive (eight of these nine were referred for treatment).

There were 99 applicants with negative smear tests and positive culture tests. Of these, 45 were from Bangladesh, 42 from Thailand, 5 from Pakistan , 4 from Kenya, and 1 each from Cambodia, Somalia and Tanzania. (Of the 1,452 cases with both completed smear and culture tests, 793 were from Bangladesh, 409 from Thailand, 181 from Pakistan, 23 from Ghana, 14 from Tanzania, 13 from Kenya, 8 from Somalia, 3 each from Cambodia and Côte d'Ivoire, 2 from Sudan, and 1 each from Burkina Faso, Eritrea and Laos.)

As well as these applicants who were found to be TB-positive through the laboratory tests, a further 24 applicants were not issued certificates on clinical grounds. These are cases who

- were referred for treatment;
- were referred for follow-up as a family contact of someone who is TB-positive;
- are already on treatment; or
- would need to repeat their chest x-ray before being issued with a certificate.

Of these cases, 10 were from Bangladesh, 6 from Thailand, 5 from Pakistan, 2 from Somalia and 1 from Eritrea. These cases are not included in the following calculations.

2.3 Expected Detection Rate

We observe in section 3.1 that there is a marked difference between the detection rates for different countries, and in some cases between the rates for the original and enhanced protocols. We need to remember this effect when we are looking at the detection rates according to other characteristics (sex, age and visa type) in sections 3.3 to 3.5, and ensure that any differences that we see here are not caused by difference between countries.

Consider the comparison of TB detection rate in males and females. For each sex, we have looked at how many came from each country, and how many of these were tested under the original and enhanced protocols. We have then applied the corresponding screening detection rates to identify how many males and females we would expect to be positive, based purely on country and protocol. These detection rates per 100,000 tests are shown in the columns headed “Expected Detection Rate” in Tables 5, 6 and 7.

If the actual detection rates are similar to the expected detection rates, then the sex of the applicant does not have a major impact on their likelihood to be TB-positive – any apparent variation is caused by different proportions coming from each country. However, if the actual and expected detection rates do differ, then the applicant’s sex does affect their likelihood to be TB-positive.

2.4 Savings to the NHS

As a result of the screening process, we expect that number of people requiring treatment for tuberculosis has reduced. In our calculations, we consider two groups:

- Initial treatment of visa applicants; and
- Treatment of other individuals who develop TB through contact with the initial applicants.

We assume that all individuals who are tested positive will need treatment in the UK[3], but have ignored treatment for recurrence of TB amongst applicants. Applicants identified as TB-positive are invited to reapply for a visa once they have been successfully treated, and so we cannot assume any saving for treatment of any recurrence of the disease.

In considering onward transmission, we have assumed that each individual who is receiving treatment will, on average, infect 0.2 further individuals who will require treatment[4]. We have not considered any further onward transmission, or any recurrence within these secondary cases.

In costing the treatment, we have generally used the average cost of £5,130 from the NICE guidelines[5], inflated using the prices index for Hospital and Health Community Services[6] for years up to 2009/10, and then by 3% above the GDP deflator rate[7] to reach a figure of £6,106 2010/11 prices.

For set-up costs, we have assumed that half of the $1.8m was incurred in 2005/06 and the rest in 2006/7, which we have converted to pounds sterling using the average of the four corresponding quarterly average spot exchange rates[8]. These costs were then inflated to 2010/11 prices in the same way as treatment costs.

At the request of UKBA, the paper does not consider the costs to the visa applicants, or the opportunity costs to the UK economy of potential migrants being deterred from or delayed in entering the UK. We also only consider the benefits of the existing system, and do not consider the likely benefits under any alternative screening system.

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[3] This ignores a small proportion of applicants who may become sufficiently ill to enter treatment before entering the UK, but also ignores any TB-positive individuals who may have been deterred from applying by the screening process.

[4] Following discussion with HPA, based on NICE guidelines

[5] NICE Clinical Guideline 33: Tuberculosis, Appendix H, Annex 5. (March 2006)

[6] Unit Costs of Health and Social Care 2010, Page 223, Table 2 (taken 25/1/11 from http://www.pssru.ac.uk/uc/uc2010contents.htm). Years after 2009/10 were calculated in 2008/09 prices.

[7] Source: http://www.hm-treasury.gov.uk/Economic_Data_and_Tools/GDP_Deflators/data_gdp_index.cfm

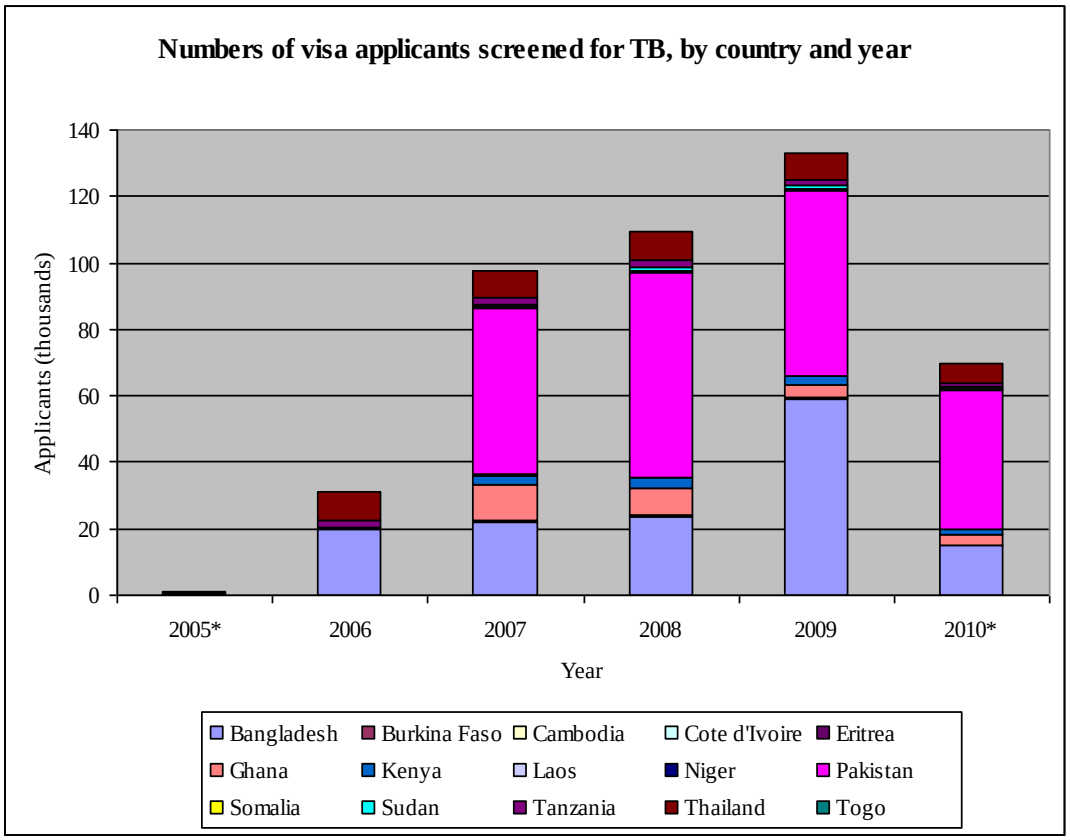
[8] Source: http://www.bankofengland.co.uk/mfsd/iadb/index.asp?Travel=NIxIRx&levels=1&XNotes=Y&XNotes2=Y&Nodes=X3952X3955X3958X3961X3965X3969X3972X3975X3978X3981X3985X3989X3992X3995X3998X4001X4004X4007X4010X4013X4016X4019X41107X41122X3790X3791&SectionRequired=I&HideNums=-1&ExtraInfo=true&A3836XBMX3790X3791.x=6&A3836XBMX3790X3791.y=7, accessed 12/1/11.

Results of the Screening Process

The analysis uses data provided by IOM on tests carried out on over 440,000 applicants between October 2005 and August 2010. Table 1 shows the distribution of these tests by country and year.

Table 1: Number of UK visa applicants screened for TB, by Year and Country

	2005*	2006	2007	2008	2009	2010*	Total
Bangladesh	0	19,711	22,185	23,457	58,996	15,024	139,373
Burkina Faso	0	0	6	32	22	6	66
Cambodia	0	64	76	80	127	83	430
Côte d'Ivoire	0	0	116	339	263	145	863
Eritrea	0	0	58	45	30	25	158
Ghana	0	0	10,896	8,446	4,065	2,809	26,216
Kenya	0	0	2,859	2,981	2,529	1,676	10,045
Laos	1	16	25	22	25	19	108
Niger	0	0	5	34	18	4	61
Pakistan	0	0	50,251	61,896	55,944	42,142	210,233
Somalia	0	0	316	458	519	429	1,722
Sudan	5	817	819	1,020	1,006	659	4,326
Tanzania	354	1,934	1,906	2,054	1,362	751	8,361
Thailand	634	8,731	8,314	8,690	7,866	6,122	40,357
Togo	0	0	17	86	55	33	191
Total	**994**	**31,273**	**97,849**	**109,640**	**132,827**	**69,927**	**442,510**



*indicates years for which less than 12 months' data available

The data include 67 cases where the tests have not been completed.

3.1 Detections by Country

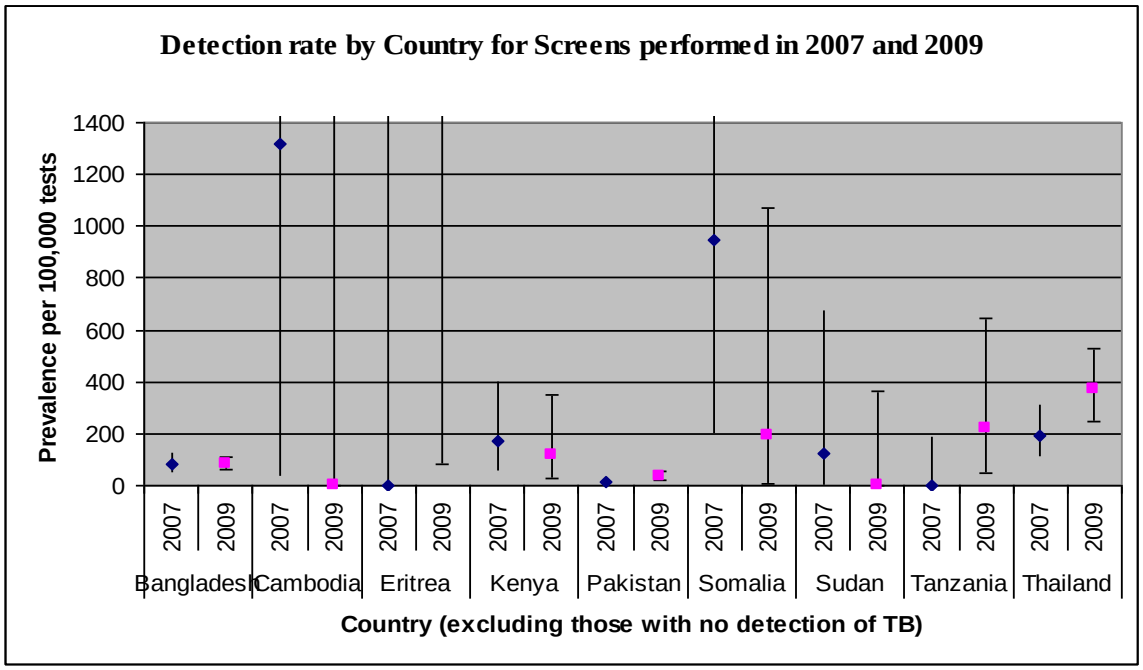
Two significant factors that affect the detection rate are the country where the applicant has applied for their visa, and whether they were screened under the original or enhanced protocol (the latter potentially involving a culture test).

As mentioned above, the following analysis uses applicants' nationality to attempt to identify applicants from Burkina Faso, Côte d'Ivoire, Eritrea, Laos, Niger, Somalia and Togo.

Table 2 shows the number of people screened from each country according to the protocol, the number of these that were found to be TB-positive, and the corresponding detection rates (confidence intervals are based on a poisson distribution).

Table 2: Results of screening by country and protocol

	Date Protocol Enhanced	**Original Protocol**				**Enhanced Protocol**			
Country		Screened	Positive	Detections per 100k tests	(95% CI)	Screened	Positive	Detections per 100k tests	(95% CI)
Bangladesh	01-Nov-07	37,465	24	64	(41-95)	101,908	87	85	(68-105)
Burkina Faso	01-Mar-09	44	0	0	(0-8384)	22	0	0	(0-16768)
Cambodia	01-Oct-07	120	0	0	(0-3074)	310	1	323	(8-1797)
Côte d'Ivoire	01-Mar-09	505	0	0	(0-730)	358	0	0	(0-1030)
Eritrea	01-Jul-08	86	0	0	(0-4289)	72	1	1389	(35-7738)
Ghana	01-Mar-09	20,001	0	0	(0-18)	6,215	0	0	(0-59)
Kenya	01-Jul-08	4,004	7	175	(70-360)	6,041	5	83	(27-193)
Laos	01-Nov-07	36	0	0	(0-10247)	72	0	0	(0-5123)
Niger	01-Mar-09	46	0	0	(0-8019)	15	0	0	(0-24593)
Pakistan	01-Apr-09	125,980	25	20	(13-29)	84,253	26	31	(20-45)
Somalia	01-Jul-08	523	4	765	(208-1958)	1,199	2	167	(20-603)
Sudan	01-Dec-09	3,573	1	28	(1-156)	753	0	0	(0-490)
Tanzania	01-May-09	6,693	1	15	(0-83)	1,668	2	120	(15-433)
Thailand	01-Nov-07	16,646	18	108	(64-171)	23,711	83	350	(279-434)
Togo	01-Mar-09	111	0	0	(0-3323)	80	0	0	(0-4611)



Although the detection rate has changed for many of the countries with the move from the original to the enhanced protocol, the change is only statistically significant for Thailand. (Other large differences, for example in Eritrea and Somalia, are not significant due to the small numbers involved.)

Under the new protocol, the detection rates for Cambodia, Eritrea and Thailand are the highest, although few tests have been carried out in these countries (the same applies to Somalia under the original protocol). However, the figure for Thailand is higher than the WHO prevalence rates whereas those for the other countries with over 5,000 tests per year are lower than the WHO rates[9].

3.2 Detection Rate by Year

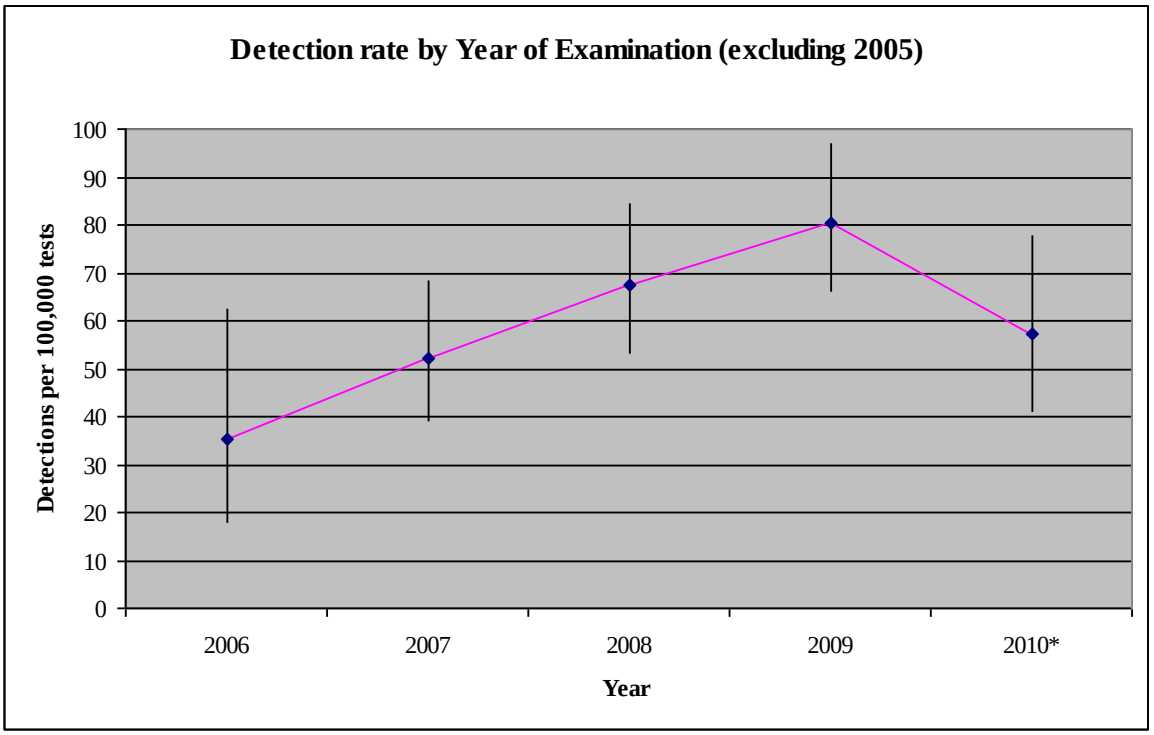
Table 3 shows how the number of people screened has grown across the years of the programme, with the corresponding detection rate.

[9] In 2009, all Bangladesh applicants and over 98% of those for Thailand were nationals of the respective country. 94% of Pakistan applicants were Pakistani nationals, and 5.8% were nationals of Afghanistan, whose prevalence estimates are lower than Pakistan's.

Table 3: Results of screening, by year of examination

Year	Number screened	% screened under enhanced protocol	Number TB+	Detections per 100k tests	(95% CI)
2005*	994	0%	4	402	(110-1030)
2006	31,273	0%	11	35	(18-63)
2007	97,849	6%	51	52	(39-69)
2008	109,640	31%	74	67	(53-85)
2009	132,827	88%	107	81	(66-97)
2010*	69,927	100%	40	57	(41-78)

*indicates years for which less than 12 months' data available



*indicates years for which less than 12 months' data available

This table shows that, after the initial year when a surprisingly large proportion of applicants were found to be TB-positive, the proportion of applicants found to be positive for TB has increased up until 2009. However, screening of applicants from nine or ten of the fifteen countries did not take place until 2007, and there was a change in the mix of applicants across the countries in 2009, with a much larger proportion from Bangladesh and smaller proportion from Pakistan (which we would

expect to increase the detection rate). The detection rate of TB appears to have fallen in 2010.

More specifically, Table 4 presents screening information for 2007 and 2009 by country.

Table 4: Results of screening in 2007 and 2009, by country

	2007				2009			
Country	Screened	Positive	Detections per 100k tests	(95% CI)	Screened	Positive	Detections per 100k tests	(95% CI)
Bangladesh	22,185	18	81	(48-128)	58,996	50	85	(63-112)
Burkina Faso	6	0	0	(0-61481)	22	0	0	(0-16768)
Cambodia	76	1	1316	(33-7331)	127	0	0	(0-2905)
Côte d'Ivoire	116	0	0	(0-3180)	263	0	0	(0-1403)
Eritrea	58	0	0	(0-6360)	30	1	3333	(84-18572)
Ghana	10,896	0	0	(0-34)	4,065	0	0	(0-91)
Kenya	2,859	5	175	(57-408)	2,529	3	119	(24-347)
Laos	25	0	0	(0-14756)	25	0	0	(0-14756)
Niger	5	0	0	(0-73778)	18	0	0	(0-20494)
Pakistan	50,251	7	14	(6-29)	55,944	20	36	(22-55)
Somalia	316	3	949	(196-2774)	519	1	193	(5-1074)
Sudan	819	1	122	(3-680)	1,006	0	0	(0-367)
Tanzania	1,906	0	0	(0-194)	1,362	3	220	(45-644)
Thailand	8,314	16	192	(110-313)	7,866	29	369	(247-529)
Togo	17	0	0	(0-21699)	55	0	0	(0-6707)

The detection rate is significantly higher in 2009 than in 2007 for Pakistan, Tanzania and Thailand. However, the 2010 detection rate is lower than 2009 for each of these countries, and is not significantly higher than the 2007 rate.

3.3 Detection Rate by Sex

Table 5 shows the number of tests carried out on male and female applicants, with the corresponding number of positive results and detection rate per 100,000 tests.

Table 5: Results of screening, by sex of applicant

Sex	**Screened**	**Positive**	**Detections per 100k tests**	**(95% CI)**	**Expected Detection Rate**
F	143,010	115	80	(66-97)	85
M	299,500	172	57	(49-67)	55

When looking at these results, we might initially infer that there is a higher prevalence among female applicants, and therefore we should pay more attention to females than to males. However, there is a significant difference in the proportion of female applicants from the different source countries, which is affecting the results. For example, 72% of the applicants from Thailand were female, whereas the corresponding proportion for Bangladesh was only 19%.

The expected detection rate column shows detection rates adjusted to allow for this difference in applicants from different countries. We see that the actual and expected detection rates are similar. This implies that an applicant's sex does not significantly influence their likelihood of being TB-positive.

3.4 Detection Rate by Age

Table 6 presents the numbers of tests carried out on applicants by age bands, with the corresponding number of positive results and detections per 100,000, and the "expected detection rate" for each age band allowing for source country and protocol.

Table 6: Results of screening, by Age Band

Age Band	Screened	Positive	Detections per 100k tests	(95% CI)	Expected Detection Rate
Under 15[1] [2]	10,930	1	9	(0-51)	72
15 - 24	229,162	123	54	(45-64)	62
25 - 34	161,951	127	78	(65-93)	66
35 - 44	29,665	27	91	(60-132)	73
45 - 54	7,094	5	70	(23-164)	70
55 and over	3,708	4	108	(29-276)	76

With the exception of the 45-54 age group, the detection rate of TB among applicants increases as we go through the age groups. This is not reflected in the expected detection rates, and the difference is significant. We would therefore infer that, broadly speaking, the likelihood of an applicant being TB-positive increases with age.

3.5 Detection Rate by Visa Type

Table 7 presents the numbers of tests carried out on applicants by type of visa, with the corresponding number of positive results and detection rate per 100,000 tests, and the "expected detection rate" for each age band allowing for source country and protocol.

Table 7: Results of screening, by Visa Type

Visa Type	Screened	Positive	Detections per 100k tests	(95% CI)	Expected Detection Rate
Family Reunion	3,166	6	190	(70-412)	135
Settlement & dependents	132,679	91	69	(55-84)	64
Student	256,905	161	63	(53-73)	67
Work	41,044	27	66	(43-96)	54
Of which…					
Work	*20,017*	*16*	*80*	*(46-130)*	*63*
Working holiday maker	*21,027*	*11*	*52*	*(26-94)*	*46*
Other	8,716	2	23	(3-83)	29

Here, we find that the three main types of visa have similar detection rates, while *Family Reunion* has a markedly higher detection level, and *Other* a lower level. However, it should be noted that only six applications for *Family Reunion* visas were found to be positive, of which five were from Somalia. Three of these five, and the remaining one from Pakistan, were examined in 2007. All were tested under the original protocol.

4. Savings to the NHS

To the end of August 2010, the screening process has identified 287 as TB positive through its laboratory tests. Assuming that, on average, these would infect a further 0.2 individuals who would require treatment, this would mean that the screening process has saved the NHS from treating 344 individuals. With an average treatment cost of £6,106, this leads to a saving to the NHS of approximately £2.1m in 2010/11 terms[10].

UKBA have indicated a cost of $1.8m to set up the screening programme. After converting this to sterling, uplifting to 2010/11 prices gives a figure of approximately £1.15m. Comparing these figures would suggest that the programme has comfortably covered its costs within the period under consideration.

Table 8 considers where the people who were treated in England for TB between 2006 and 2009 were born, and the number of UK visas issued to people with the corresponding nationality over the same period.

[10] Although cost has been saved to the NHS, the screened individuals in question have been referred for treatment in their home countries. Their treatment cost has therefore been transferred rather than saved outright.

Table 8: Cases of Tuberculosis in England by country of Birth, 2006-2009

		TB cases in England[1]		Visas issued[2]		Incidence	
	Country of Birth	**All cases**	**Pulmonary TB occurring within 1 year of entry**	**All visas**	**For stays over 6 months[3]**	**Cases per 100,000 visas over 6m**	**WHO country Estimate (2009)**
Pre-entry screening countries	Pakistan	3,448	174	477,453	131,882	132	231
	Somalia	2,263	101	11,497	9835	1,027	285
	Bangladesh	906	45	130,397	59,167	76	225
	Kenya	465	20	60,890	14,899	134	305
	Eritrea	311	40	5,477	3,160	1,266	99
	Ghana	160	10	90,871	20,521	49	201
	Thailand	133	21	169,420	38,346	55	137
	Sudan	119	6	32,098	6,274	96	119
	Tanzania	111	8	26,606	6,780	118	183
	Côte D'Ivoire	36	<5	8,781	1,831		399
	Burkina Faso	<5	<5	1,172	201		215
	Cambodia	<5	<5	1,715	453		442
	Laos	<5	<5	550	137		89
	Niger	<5	<5	787	277		181
	Togo	<5	<5	1,753	399		446
	Total from screening countries	*7,965*	*427*	*1,019,467*	*294,162*		
Other notable countries[4] / regions	India	5,186	277	1,669,531	472,977	59	168
	Zimbabwe	807	33	44,137	15,564	212	742
	Nigeria	648	52	467,063	79,986	65	295
	Philippines	404	39	196,774	109,716	36	280
	South Africa	378	46	165,264	70,218	66	971
	Afghanistan	345	39	20,511	13,894	281	189
	Nepal	338	52	61,326	41,091	127	163
	Sri Lanka	333	15	128,695	39,737	38	66
	Uganda	313	21	28,343	6,981	301	293
	Ethiopia	216	18	15,570	5,281	341	359
	Other South Asian[5]	65	5	1,003	611	818	
	Other Sub-Saharan African[6]	1,135	77	163,141	50,158	154	
	Other non-UK-born[7]	3,392	243				
	Total other non-UK born	*13,560*	*917*				
	Total non-UK born	*21,525*	*1,344*				
	United Kingdom	7,367					
	Total	**28,892**					

1[1] Source: HPA Enhanced Tuberculosis Surveillance as at July 2010. Numbers below 5 are suppressed due to disclosure risks.

1[2] Source: UKBA CRS, run dates 7 and 8 March 2011 (provisional figures, based on nationality).

1[3] Includes visas issued for non-standard lengths of stay, some of which may be less than 6 months

1[4] Countries of birth from the 15 most commonly reported not already included in the table

1[5] Other South Asian countries not stated above

1[6] Other Sub-Saharan African countries not stated above

1[7] Including those with unknown country of birth

The table shows that roughly a third of the foreign-born TB cases among were known to be born in countries that are currently part of the screening programme, although the country of birth will not always be the same as the country of application (for example, 355,000 people applied for a visa in Pakistan, but 477,000 Pakistani nationals applied worldwide). It also shows that there are a number of countries, in particular India, which are not part of the screening programme which yielded more TB cases than the majority of those that are participating.

Only a small proportion of foreign-born cases were pulmonary and occurred within a year of arrival (around 6%). This shows that the impact of any screening programme for active TB will have a limited impact on the overall number of TB cases.

The table also shows the number of visas issued between 2006 and 2009 to individuals of the corresponding nationality[11]. These individuals will not correspond to those who developed TB over the period – some sufferers will have entered the country a number of years before. Although some visitors and family visitors may develop TB while in England, the majority of cases will arise among those staying in the country for at least 6 months. We therefore show both numbers of visas.

In an attempt to derive a very broad equivalent to the detection rate at screening, we have calculated the number of cases of pulmonary TB occurring within a year of

[11] We recognise that an individual's nationality will not necessarily correspond to the country of their birth. However, the differences should be relatively small.

entry to the UK per 100,000 visas of at least 6 months duration issued (or “case rate”). This is shown alongside the WHO estimate of incidence of new cases in each country in 2009. Two countries in the screening programme, Eritrea and Somalia, both have a rate of above one case per 100 visas. None of the other four countries with rates of above 200 cases per 100,000 visas are part of the screening programme (Ethiopia, Uganda, Afghanistan and Zimbabwe). Only Eritrea and Somalia, and to a lesser extent Afghanistan, have a case rate that is markedly higher than the WHO incidence estimate.

It is worth noting that although just under a quarter of the cases of TB are among those known to be born in India, its case rate is below that of a number of other countries.

March 2011
Health Protection Analytical Team
Department of Health

Annex C: Health Protection Agency Report

Tuberculosis screening at Ports of Entry

Executive Summary

1. Recommendations

    - Chest X-Ray (CXR) screening at Gatwick should stop immediately on cost grounds; volumes are very low, are unlikely to change and no cases are being diagnosed.
    - CXR screening at Heathrow should cease on the basis of costs, a lack of effectiveness and poor cost benefits.
    - The option of extending pre-entry screening (as identified in the paper from UKBA) should be explored with the possibility of including countries with a high TB risk and significant numbers of people entering the UK – that is those from which the greatest burden of TB is coming
    - More effective ways of implementing NICE guidance on screening of new entrants should be explored between the HPA, UKBA, DH and the NHS Commissioning Board, with a particular focus on systematic ways to ensure engagement of new migrants with primary health care services.
    - There should be an assessment as to whether the practice in some countries of entry being conditional on engaging with and having further medical assessment (by local primary health care services) could be applied in England. This would facilitate more effective implementation of NICE guidance.
    - The HPA and UKBA should explore the use of electronic data sharing from visa applications to give the HPA and the NHS clearer, more accurate information about people from high risk countries granted visas to enter the UK for more than 6 months, so that they can be offered TB screening.
    - The HPA should work with local NHS organisations to actively encourage primary care health checks for new entrants as described in the HPA's Migrant Health Guide.

2. The tuberculosis (TB) rate in the UK remains at the highest since the 1980s despite a small decline in the recently reported provisional figures for 2010. The highest rates of TB are seen in migrants from high burden countries reflecting the greater risk of exposure either overseas or within migrant communities in the UK. The rates of TB in migrant groups increased over the last two decades but have been relatively stable over the last five years at levels over 20 times that in the UK born population. On average, cases present about four years after arrival in the UK with about 80% of cases diagnosed over 2 years after arrival.

3. In public health terms, the most important cases are active sputum smear positive pulmonary (open TB of the lungs) TB as these are the only ones that are infectious and can spread the disease to others. Other cases are, of course, vital to treat from the perspective of the individual affected.

4. The HPA is committed to evidence-based actions to reduce the burden of TB in the UK, and a core element of this is about tackling TB in migrant communities. The current arrangements for reducing TB in new migrants in the UK include:
    - Pre-entry screening on a pilot basis for 15 countries – this has been reviewed by the Department of Health (DH) on behalf of the UK Border Agency - and the report from DH appears to show that the cost of the programme is more than offset by the savings it generates for the NHS.
    - At entry screening by CXR at Heathrow and Gatwick airports for newly arrived migrants intending to stay for 6 months or more in the UK who come from a high risk country (TB incidence ≥ 40 per 100 000) and for whom a visa is required for entry. The X rays are read at the airport. The very small numbers with evidence of active TB are referred to a hospital locally. The other results are passed on to the NHS based on addresses provided by migrants, and follow up (particularly of abnormal X rays) is organised locally by the NHS.
    - Screening of migrants ("new entrants") from high risk countries via new registrations with primary care, entry to education and statutory and voluntary groups who work with new entrants. While this is NICE guidance, it is not clear how well this happens.
    - Routine management of cases of TB and their contacts as per normal NHS arrangements. These include arrangements for the prompt diagnosis of TB among migrants and awareness raising initiatives.
    - BCG vaccination of groups at high risk of TB who are likely to benefit from vaccination.

    This paper primarily reviews the arrangements for at entry screening and its associated follow up mechanisms, but makes recommendations in the context of the overall control of TB in the migrant population.

5. Evaluation of the effectiveness, cost effectiveness and impact of the at entry programme was undertaken by: analysis of the current service (including utilisation and outcome data and financial information); exploring how the relevant NICE guidance on controlling TB in new migrants could apply in ports; a literature review and an economic analysis. The main findings were:
    - The maximum number of cases of active pulmonary TB that could be detected by entry CXR screening is about 132 a year if all eligible individuals are screened. This is about 6% of all new cases of pulmonary TB in the non-UK born each year. This means that 94% of cases of TB arising in non-UK born individuals cannot be detected by screening at Heathrow and Gatwick even if every single eligible individual is screened. This is because of inherent limitations in CXRs as a diagnostic test for infection with TB
    - The actual numbers screened are only about half of the numbers eligible. This is because some are screened pre entry, some are pregnant or children and thus excluded and some are not referred by immigration staff
    - At both Heathrow and Gatwick there have been falls in the actual numbers screened. Overall, the service costs about £2.5m. At Gatwick only 91 individuals were screened in 2010 at a cost of about £0.5m. This is as a result of changes in routes arriving at Gatwick that are expected to be permanent. At Heathrow, 42,500 people were screened in 2009 at a cost of about £2m.
    - At Gatwick, no cases of TB were identified during 2010.
    - At Heathrow, in 2007/8, out of 68,800 X rays taken, 590 were suggestive of TB of which 511 were passed on to the NHS for follow up and 79 directly referred to hospital for investigation. The best estimate of the number of cases of TB actually identified by the current system is 34 from community follow up (51 cases of active pulmonary TB per

100,000) and 25 from hospital referrals, giving a total of 59 cases. This equates to 88 cases of active pulmonary TB per 100,000 screened.

- Data on the time between symptom onset and diagnosis in newly arrived migrants shows that on average, this interval is about 2 months. This means that the maximum average impact of the port CXR programme is to bring forward the diagnosis for these 59 cases by 2 months.
- With a set of assumptions that are generally optimistic about the cost benefits of the current programme, the cost per QALY is about £106,000. This is far higher than the £30,000 often used as an indication of what is a cost-effective intervention for the NHS.
- Other weaknesses include:
    i. CXRs are only available at Heathrow and Gatwick and some entrants who meet the current screening criteria arrive at other ports.
    ii. Not all those at high risk of TB are eligible for at entry screening e.g. EEA nationals from high TB risk countries in Eastern Europe and UK citizens who have spent long periods in high risk countries
    iii. Follow up of abnormal X rays by the NHS is compromised by inaccurate or absent addresses collected at ports. About one third of the port forms that are sent to the NHS from ports fall into this category. This information is provided by migrants at the port.

6. NICE is responsible for providing advice on evidence based care that the health sector in England should provide. It has recently published evidence-based recommendations on what should happen to all newly arrived migrants in relation to TB. These recommendations include identification and treatment of active TB, identification and treatment of latent TB to prevent progression to active TB and BCG vaccination for some groups. The recommended screening for latent infection is supported by a recent UK multi centre study which found that it is cost effective to test migrants from countries with TB incidence greater than 150,000 with interferon gamma release assays. While NICE does not specifically recommend where these recommendations should take place, it is clear that the full process cannot happen in ports as they requires complex tests and follow up. NICE argues that eligible migrants should be identified via a variety of approaches

7. Looking at the various weaknesses of the current at port arrangements, some of them can be improved but with limited impact:
    - Processes at Gatwick and Heathrow could be strengthened to ensure that a larger proportion of those eligible are screened (excluding children and pregnant women). This would increase the revenue costs of the service considerably but would still not impact on 94% of cases.
    - CXRs could be made available at other airports, but this would involve considerable capital and revenue costs, and would still only detect a small minority of cases.
    - On the highly optimistic assumption that all eligible migrants could be screened by CXR at all ports at the same annual cost as the current Heathrow service (£2m), and with other optimistic assumptions, the cost benefit analysis shows that the cost per QALY would be £32k – still higher than the £30,000 often used as an indicator of what is a cost-effective intervention.
    - CXR screening at ports could be extended to other at risk groups, but since the current arrangements take place under the Immigration Act, this would be difficult as those at risk and not currently eligible are not generally subject to immigration control. While the proportion of new cases that could be diagnosed would increase, the impact would remain small.

- Migrants could be required to give accurate addresses, or could be given some form of conditional entry to the country dependant on completing health screening. This would improve community based follow up of abnormal X rays.

8. However, some of the weaknesses cannot be solved:
    - CXRs contain inherent weaknesses as a screening tool. They will always miss some cases as even under optimal conditions, CXRs are an imprecise tool. At their best they miss over a third of cases of TB, and inaccurately identify 3% as having TB. Accurate diagnosis of TB also requires microbiology tests, skin tests and clinical examination.
    - The majority of cases of TB in migrants occur several years after they have arrived in the country. This is a simple reflection of the natural history of the disease, which can remain latent and therefore undetectable by CXR for many years. Any one off screening by CXR can only ever identify a small proportion of cases that will arise in that population.
    - While the current system does detect cases, most would be picked up by other systems. Some are so ill that they would be referred to hospital, and others would be diagnosed by the normal within country systems for diagnosing and managing TB. There is good evidence that migrants are diagnosed earlier in the course of their illness than the indigenous white population – so the extra benefits of the port system are low. The maximum impact of the programme should all eligible individuals be screened is to diagnose 132 cases per year about 2 months earlier

9. Several options for reducing the burden of TB in non-UK born migrants are explored in the full paper:
    - Keeping the current system the same. This is not recommended as it is costly with very low impact.
    - Maintaining the port system but addressing the weaknesses that can be dealt with. This is not recommended as even if operating to its greatest effectiveness, the overall impact will be low, potentially detecting less than 6% of all cases ultimately diagnosed in non-UK born migrants.
    - Stopping CXR screening at ports with and without pre entry screening, with and without enhanced primary care based screening, and with and without working with UKBA to allow better data transfer from visa information into the NHS. This is addressed in the recommendations below.

10. On the basis of the analysis in this paper the HPA recommends:
    - That CXR screening at Gatwick should stop immediately on cost grounds; volumes are very low, are unlikely to change and no cases are being diagnosed.
    - That CXR screening at Heathrow should cease on the basis of costs, a lack of effectiveness and poor cost benefits.
    - That the option of extending pre-entry screening (as identified in the accompanying paper from UKBA) should be explored with the possibility of including countries with a high TB risk and significant numbers of people entering the UK – that is those from which the greatest burden of TB is coming
    - That ways of more effectively implementing NICE guidance on screening of new entrants should be explored between the HPA, UKBA, DH and the NHS Commissioning Board, with a particular focus on systematic ways to ensure engagement of new migrants with primary health care services.
    - That there should be an assessment as to whether the practice in some countries of entry being conditional on engaging with and having further medical assessment (by local

primary health care services) could be applied in England. This would facilitate more effective implementation of NICE guidance.

- That the HPA and UKBA should explore the use of electronic data sharing from visa applications to give the HPA and the NHS clearer, more accurate information about people from high risk countries granted visas to enter the UK for more than 6 months, so that they can be offered TB screening.
- That the HPA should work with local NHS organisations to actively encourage primary care health checks for new entrants as described in the HPA's Migrant Health Guide.

1 Introduction

1.1. The Health Protection Agency (HPA) is responsible for ensuring an appropriate Medical Inspection service at ports in England. The major part of this service is screening migrants from high risk countries who plan to stay for more than 6 months for TB by Chest X-ray (CXR) at Heathrow and Gatwick airports.

1.2. The HPA and British Thoracic Society have expressed are concerns about the cost effectiveness and appropriateness of CXR screening for tuberculosis (TB) at ports of entry.

1.3. The HPA has examined the rationale for CXR screening for tuberculosis (TB) at ports of entry, in conjunction with UK Border Agency (UKBA) and DH officials by undertaking further analyses of the available evidence and data. This follows a request from Home Office Ministers and supported by the Public Health Minister. Both HPA and UKBA recognise that this programme has been run with the objective of contributing to reducing the spread of TB across the UK. What is not clear is how successful this programme has been in achieving that objective.

1.4. Screening for tuberculosis in migrants can (and does) take place in a variety of different locations:

- In the country of origin prior to departure to the UK
- At the port of entry to the UK
- In the community after entry into the UK

1.5. While this paper focuses on the HPA's position with respect to the current arrangements for screening at ports – it recognises that the overall context includes pre and post entry screening. The purpose of this paper is to describe and assess port of entry screening arrangements and explore options for the future, so as to rationalise TB screening of migrants in the context of the overall control of TB in the UK.

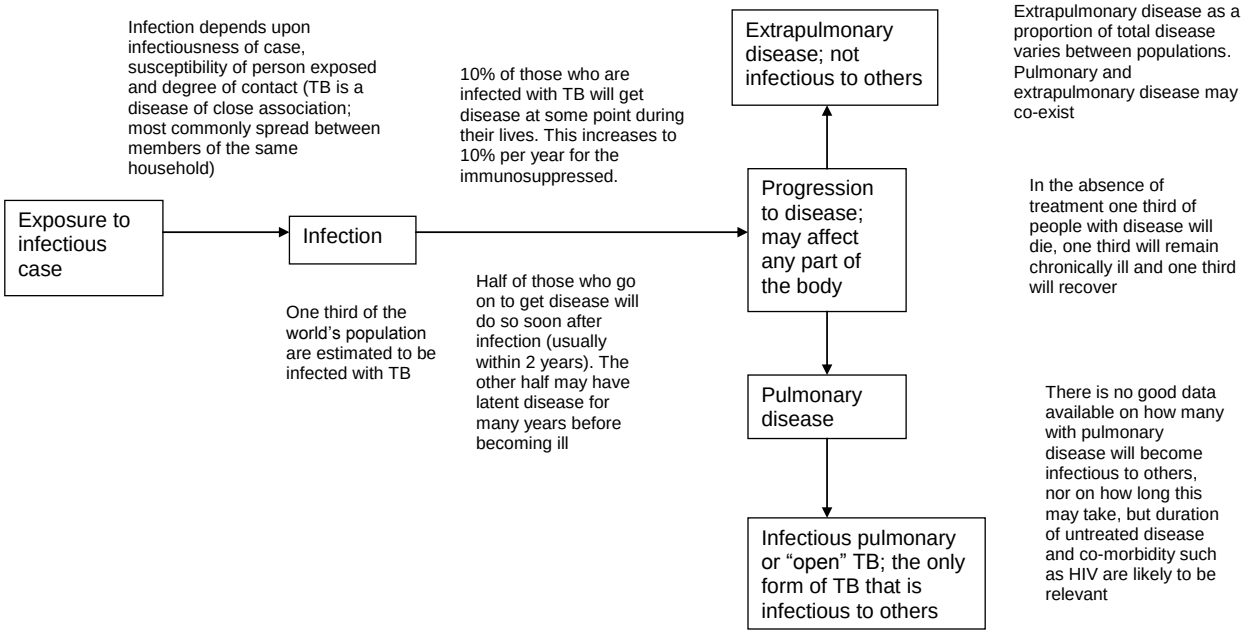
2 Tuberculosis in the UK

2.1 Natural History of Tuberculosis

Figure 1 shows the natural history of TB. The key points are:

- Infection results in active disease in only one in 10 individuals.
- In those who go on to get an active disease, this is most likely to occur in the first few years after infection, but may occur many years later. This is termed reactivation of latent disease.
- Only pulmonary disease has the potential to become infectious to others.
- In general, only a proportion of those with pulmonary disease who have 'open' TB[12] are infectious to others.
- Transmission of infection requires close prolonged contact with a case of 'open' TB.
- From a public health perspective the cases of most concern are infectious cases of 'open' pulmonary TB.

Figure 1: Outline of natural history of tuberculosis



Note that this diagram represents the natural history of the disease in the absence of treatment. With modern treatment TB is curable and infectious cases are rapidly rendered non-infectious. It is vital that patients are supported to complete their treatment course since incomplete treatment can lead to the development of drug resistant disease.

2.2 Epidemiology of TB in the UK

The key features of the epidemiology of TB in the UK are:

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

2.2.2. In 2009, 73% of all TB cases reported in UK were in people not born in the UK, though these represent only 13%[i] of the UK population. This disproportionate burden has increased over the last decade. The non-UK born experience more extra-pulmonary (non-infectious) disease than the UK born, and are therefore also slightly less likely than the UK born to have infectious TB at

[12] "open TB" refers to disease affecting the lungs where it has been possible to observe the organism causing TB in a sample of sputum examined under a microscope following special staining in a laboratory

diagnosis.

2.2.3. The biggest proportions of non-UK born cases reported in 2009 were those born in the Indian subcontinent (55%) and sub Saharan Africa (30%). The rate of TB among the non-UK-born population in the UK was over 21 times the rate of that in the UK-born (86 per 100,000 versus 4 per 100,000). Compared to the white indigenous population, the rate is also higher in UK born ethnic communities with links to migrant communities/endemic countries. This probably reflects the fact that people tend to live in households with other members of the same ethnic group as well as receive visitors from, and make visits to, high TB burden countries.

2.2.4. The proportion of all cases of TB, reported in the non-UK born, that have active pulmonary disease at the time of arrival is small. Modelling data shows that of all pulmonary cases in the non-UK born reported each year; perhaps 176 may have been symptomatic with active lung disease at the time of arrival, of whom 132 were possibly detectable (Appendix 1). This represents around two percent of all TB cases in the non-UK born, around six percent of pulmonary cases in this group and 1.5% of the total number of cases.

2.2.5. Nearly 80% of all non-UK born cases of TB reported in 2009 arrived more than two years before they developed disease, and 31% ten years or more. The median time between arrival and diagnosis of disease is four years.

2.2.6. Most of the cases of TB reported in the non-UK born probably acquired their infection prior to arrival in the UK, with disease developing at variable times after infection according to the natural history of the disease. An unknown proportion may, however, have been infected after arrival. This may either be as a result of travel back to their country of origin, or as a result of exposure within the UK. What causes progression to disease is not well understood, but factors such as HIV co-infection and other conditions associated with relative immuno-suppression (including malnutrition) are likely to be important. The impact of migration itself on disease progression is unknown. TB has always been a disease associated with overcrowding and deprivation, and so socio-economic conditions experienced by the non-UK born in the UK may also contribute to disease rates.

2.2.7. Analysis of national epidemiological data suggests no significant transmission from the non UK born population to the majority white UK born population. This is supported by the published literature which shows no evidence that imported tuberculosis has increased the incidence in the indigenous population[ii]. By contrast, UK born ethnic minority populations have higher rates of TB, suggesting acquisition of TB in households or through travel.

2.3 How is TB controlled in England - and what are the current guidelines on screening of new entrants?

2.3.1. The national policies and guidance on TB control are described in the previous Chief Medical Officer's Action Plan for Tuberculosis[iii] and the NICE clinical guidelines on TB diagnosis, management, prevention and control[iv]. The Department of Health commissioning toolkit[v] sets out a quality framework that local NHS health organisations are expected to meet.

2.3.2. Broadly speaking, the key interventions recommended to control TB are early diagnosis and treatment, complemented by active case finding through contact tracing, treatment of individuals with recently acquired latent infection, and appropriate use of BCG vaccination.

What are the UK guidelines on screening of new entrants?

2.3.3. The best evidence based guidelines on TB are produced by NICE[4]. They do not explicitly cover immigration related screening, but do make recommendations for screening new entrants from high-risk countries after entry in the NHS context, with the aims of:

- detecting cases with active disease, particularly respiratory, to enable treatment to be given and to prevent secondary cases
- detecting those with tuberculosis infection, particularly children, for whom treatment for latent TB infection is appropriate
- identifying those with no evidence of TB infection, who if previously unvaccinated might benefit from BCG immunisation

2.3.4. These guidelines apply to all new entrants to England and Wales in these categories (irrespective of whether they are subject to immigration control or not) as well as to people returning to England and Wales after a prolonged period in high incidence countries irrespective of where they were born.

2.4 How many cases of TB are detected from Chest X ray screening at Heathrow and Gatwick?

Appendices 2-6 give an overview of the system of screening for TB at the port of arrival, including activity data for Heathrow and Gatwick Health Control Units.
This section focuses on activity data to calculate the number of cases of TB detected in each Health Control Unit.

Summary of findings from Heathrow Health Control unit (Appendices 2, 4 and 5).

2.4.1. A trend of a fall in the number of individuals referred to the HCU for screening over recent years (Appendix 2).
2.4.2. In 2009, visas for >6 months were issued to 488 265 individuals from high incidence countries[13]. Using 2008/9 data, only 162 739 people were referred at Heathrow (33%). It is unlikely that more than another 2-3% of those eligible were seen at other airports. Even accounting for those that may have been screened pre-entry, this represents a shortfall of at least 40% of those eligible.
2.4.3. Of those who were referred to the HCU in 2008/9, 52% had a valid reason not to have an X-ray.
2.4.4. Of those who were eligible for an X-ray, in 2008/9, 44% did not have an X-ray
2.4.5. In 2008/9, of those that needed reports to be sent to the local Consultant in Communicable Disease Control (CCDC) from the HCU, 31% did not have a valid address, hence a report could not be sent initially.
2.4.6. Only 4% of individuals with reports sent to CCDCs of abnormal X-ray suggestive of TB had the results of their community investigations fed back to the Heathrow HCU in 2006/7.
2.4.7. Many cases of pulmonary TB detected at Heathrow are in people who are unwell, and referred directly to hospital. Based on 2006/7 data, there were an estimated 24 active pulmonary TB cases detected in those referred to hospital directly from Heathrow (based on an estimate that 30% of the 79 cases referred to hospital with an abnormal CXR suggestive of TB actually had TB). This is compared to 34 cases that were picked up through Port referrals to CCDCs of suspicious X-rays. It is likely that even without CXR screening, people who are unwell would continue to be picked up through other Port Health procedures.
2.4.8. Using 2006/7 data, the yield for active pulmonary TB from Heathrow was 88 cases per 100 000 Chest X-rays. The yield for active pulmonary TB for those cases detected from Port health referrals to the community only (ie excluding the hospital estimates) is 51 per 100 000.
2.4.9. Excluding those who were directly referred to hospital, the cost per case of active pulmonary TB detected by Port Health screening of those referred to the community is £59,000. (The estimated cost of the CXR service at Heathrow is £2m per annum)

[13] UKBA data

Summary of findings from Gatwick Health Control Unit (Appendix 6).

2.4.10. Like Heathrow, the trend is of a fall in the number of individuals referred to the HCU for screening over recent years due to changes in the pattern of traffic – this is however more marked in Gatwick. Only 91 individuals were screened in 2010.

2.4.11. Based on 2006/7 data, there was a yield of 47 active pulmonary TB cases detected per 100 000 X-rays at a cost per case of £250 000. (Assuming the yield of chest X ray from port referrals to the community to be similar to Heathrow (Appendix 5) at 12%). (The estimated cost of the CXR service at Gatwick is £0.5m per annum)

2.4.12. Only 91 individuals were screened in 2010 as a result of changes in flight patterns that are not expected to change, and no cases of TB were detected.

Conclusion: Chest X-ray screening at Gatwick is extremely expensive for no impact, and at Heathrow, expensive for little impact

2.5 Are the CXR yields at Heathrow and Gatwick comparable to what would be expected from the literature?

2.5.1. There is only one systematic review of active screening at entry for TB among new entrants. It reviewed 22 studies and was conducted in 2010 by Arshad et al[vi](Table 1).The host countries were in Europe or the US, Canada, New Zealand, Australia and Kuwait.

2.5.2. The prevalence yield of cases of pulmonary TB was 350 per 100 000 (range from 100 and to 3800) but this systematic review included many studies in different settings. Some of these settings, for example clinics for asylum seekers or refugees are not comparable to entry screening at Heathrow or Gatwick because the populations involved are known to have very high rates of TB - hence the prevalence yields are higher than found in Heathrow. There was no cost analysis or a review of the effectiveness of screening.

Table 1: Results from systematic review

	Active Pulmonary Tuberculosis: Prevalence Yield: (per 100 000 screened)	95 % Confidence Interval	Range
Total	350	290-410	100-3500 3800??
Refugees	1190	670-1720	
Immigrants	280	200-360	
Asylum seekers	270	200-340	

2.5.3. Prevalence yields also depend on the type of migrants screened (refugees had a four fold higher rate than other groups) and the incidence in the country of origin. Immigrants from Asia and Africa were found to be five and three times more likely than European immigrants to have pulmonary tuberculosis, but this may be because approximately 51% of those from Asia were refugees and all the African migrants were asylum seekers.

What are the results of studies from the UK on port health screening yields?

2.5.4. The yields from community studies of migrants screened at ports of entry all show low yields (Appendix 8). One study looked at individuals sent to hospital directly from Heathrow. Markey et al[vii] found that of 96,638 individuals screened at Heathrow in 1980-83, 203 (0.2%) were sent to

hospital for suspected TB; 51 (0.05% of total screened and 27% of those referred to hospital) were confirmed by culture to have tuberculosis.

2.6 Detection thresholds for TB in other countries

2.6.1. There are differing screening practices across European Economic Area (EEA) countries (Table 2). There were little data on how screening was organised

Table 2: Screening for new entrants (Bothamley et al[viii])

Screening arrangements	Number of countries
None	21
Screen migrants from countries with rates greater than 40 per 100 000	7 (including UK)
Screen Asylum seekers only	3
Screen migrants at rates greater than 50 per 100 000	3
Screen all new entrants	8
Screen non EU or non western EU only	3
Other or combination	5

2.6.2. The four other 5 Country Conference (5CC) nations (USA, Canada, Australia and New Zealand) employ global pre-entry health screening of migrants - that is those who intend to travel to and remain within their territories for periods over 3 to 6 months - and conduct specific screening for TB of potential migrants in countries with a high incidence of that disease.

2.6.3. Conclusion: Only 6 other countries in the EEA screen migrants with the same criteria as the UK. Other comparable countries (within the 5CC) use pre-entry screening of those who arrive from high TB incidence countries.

3 Effectiveness of entry screening for tuberculosis

This section critically evaluates the effectiveness of the current CXR screening system

3.1 What proportion of the total burden of TB in new entrants in the UK can be detected through screening at Port of Entry? (Appendix 1)

Even if the system at ports managed to screen all new entrants, no more than 2% of all TB cases ultimately diagnosed in the non-UK born, 1.5% of all cases or 6% of all pulmonary TB cases in the non-UK born, could be detected by chest X-ray at the time of entry.

3.2 Can the NICE guidelines be delivered in ports?

This section considers whether and what elements of the three aims described by NICE (section 2.3) can actually be delivered in ports[3].

AIM 1: Prevention of onward transmission of disease from infectious cases

3.2.1. Identification of infectious cases requires examination of a minimum of three sputum smear samples taken at different times. Infectiousness cannot be determined by chest X-ray alone. In the context of patients presenting to health services with symptoms suggestive of pulmonary TB, both chest X-ray and sputum smear examination are a routine part of investigation and the sputum smear result will inform contact tracing activities.

3.2.2. Population screening of all new entrants by sputum smear examination would be impossible in the port of entry setting and would have an extremely low detection rate. The efficiency of case detection could be increased by only performing sputum smear examination on those with chest X-ray abnormalities consistent with TB. This is the basis of the Government's pre-entry 'screening' programme but is also impractical in the port of entry setting.

3.2.3. Chest X rays used alone are of limited value in identifying infectious cases. As a screening tool for TB the chest X ray is furthermore limited by its sensitivity and specificity. Not every individual with a positive X-ray will actually have TB (false positives) and some of those who have TB will not be detected by chest X-ray as CXRs can only detect pulmonary disease. Appendix 7 gives an indication of the best numbers that could be detected, given different underlying prevalences of TB in the population to be screened.

3.2.4. From Appendix 1, each year a maximum of 176 pulmonary cases in the non-UK born are estimated to have been symptomatic at the time of arrival. Given the limitations of the screening tool, a maximum of 75% might have been detected by chest X-ray i.e. 132 cases. This represents only a small percentage of total pulmonary cases reported in the UK annually and it can therefore be seen that the contribution of at entry chest X ray (when used alone) to prevention of onward transmission of disease can only ever be small.

AIM 2: Prevention of development of active disease in those who are infected

3.2.5. In many cases a person with latent TB at entry may not develop active TB at all or if so, only many years after arrival. It is important to note here that detecting latent infection per se contributes little to overall disease prevention and control if preventive treatment is not offered

appropriately and the treatment adhered to. An integral component of testing is therefore the clinical follow up, which should also include consideration of possible HIV co-infection since this can affect interpretation of the results.

3.2.6. This means that the setting of the screening is important as it has to allow and support follow up. Ports of entry are completely inappropriate for this because of the time taken for the testing procedure and the fact that clinical follow up is required one to three days later to read and give test results. Patients also require ongoing support to adhere to preventive treatment.

3.2.7. As recommended by NICE guidelines, screening should ideally therefore be done in the context of an integrated preventative strategy including improved case finding and case management.

AIM 3: Identifying those with no evidence of TB infection, who if previously unvaccinated might benefit from BCG immunisation

3.2.8. In order to do this the total population at risk must be identified. Screening at port of entry does not aim to identify this population - only those that have active pulmonary TB.

Conclusion

3.2.9. Screening at ports of entry can only detect a small minority of cases and the few that are detected entail a disproportionately high cost that could be better expended at a more cost-effective intervention in-country. The in-country programme would involve the prompt evaluation of most at risk immigrants for latent and active TB according to risk. Hence it would fit the NICE criteria and would be more cost effective.

3.3 What are the health risks for mass X-ray screening?

The additional radiation induced cancer risk per chest x-ray is about 1 in a million, but since many migrants with suspicious X-rays cannot be followed up at the address given at the airport, even this low risk cannot be justified [ix].

3.4 Does Port of Entry screening integrate successfully with the wider framework for TB control?

3.4.1. Port Entry screening does not and cannot do this for several reasons. In particular, only 30 to 40% of all new entrants identified in the community had contact with Port Heath[22-29]. While some improvements could be made to the current system, these are impractical and expensive, and would not improve it sufficiently to make it viable.. Appendix 8 summarises some of the relevant literature.

A) Not all those at risk are screened

3.4.2. Several groups at high risk of TB are not screened by the current mechanisms and it is not possible to screen them under the current system:

- Undocumented migrants. These may be those who enter in a clandestine manner or through the use of false documents, or those who overstay short term visas.
- Temporary migrants such as visitors
- EEA citizens from parts of Europe where TB rates are high.
- UK citizens who have been in high risk countries for long periods

B) Eligible individuals are not screened at entry

3.4.3. Many of those who fit the entry criteria are not screened because they do not enter the UK through Heathrow or Gatwick. The trend in both airports is of a drop in the numbers being referred for screening; probably due to the expansion of regional airports. Of those who are eligible, it is estimated that there is a shortfall of approximately 40% between those eligible and those actually referred for screening.

3.4.4. Only 91 X-rays were taken at Gatwick in 2010, partly due to lack of referral from Immigration officers but mainly because of a decrease in flights from areas of high incidence.

3.4.5. Only 54 % of those referred for screening were actually screened at Heathrow for several reasons (Appendix 5). If all referred individuals were X-rayed then this would require an 80% increase in the number of X-rays performed with an attendant increase in revenue (and possibly) capital costs.

3.4.6. Demand for screening is subject to the usual peaks and troughs in passenger flows. The late summer period, with new students arriving into the UK, poses a significant challenge to HPA and UK Border Agency resources. Last year, the congestion experienced led to some students being detained for over two hours and the need to keep arriving passengers on aircraft until the arrivals and baggage halls were safely able to cope with other passengers.

C) Incomplete data on addresses supplied to Port Health means that notifications cannot be sent on to local health protection teams.

3.4.7. Approximately 31% of notifications were not sent out (Appendix 5) because of incomplete data (50, 000 individuals). There is no system in ports for verifying the validity of the address of the migrant.

D) Incorrect addresses for new entrants are supplied which leads to loss to follow up

3.4.8. Migrants may move frequently so there are difficulties in ensuring that addresses are current. Data from 2006/2007 from three of the four London Health Protection Units showed that a third of referrals from Port Health were lost to follow up (internal HPA data).

E) Lack of follow up of notifications other than Port 103s/Ref 3s

3.4.9. Pareek et al[x] surveyed Primary Care Organisations (PCO) in the UK on follow up of port health forms. All responding PCOs (177/177) reported that they followed up new-entrants issued with an abnormal CXR form. Fewer PCOs followed up new-entrants issued with inconclusive CXRs/CXRs not undertaken (134/177 - 75.7%), normal CXRs (96/177 – 54.2%) and those identified through new-patient registrations in primary-care (62/177 – 35.0%).

3.4.10. High-burden PCOs were significantly less likely to follow up new-entrants where the CXR was inconclusive/not undertaken (61.9% vs. 80.0%; OR 0.41, 95% CI 0.19-0.86, p=0.019) and where

the CXR was normal(28.6% vs. 62.2%; OR 0.24, 95% CI 0.11-0.52, p<0.0001). There was a trend towards high-burden PCOs being less likely to follow-up new-entrants identified through primary care, (23.8% vs. 38.5%; OR 0.50, 95% CI 0.23-1.1, p=0.08).

G) Many of the individuals identified through screening might be detected by other means anyway

3.4.11. As described earlier, some are so unwell at arrival that they are referred to hospital where TB is diagnosed. After arrival in the UK, there is no evidence to suggest that the non-UK born delay seeking healthcare longer than the UK born population.[xi] In fact, a recent analysis of surveillance data showed that the delay between onset of symptoms and diagnosis was significantly less in recent entrants into the UK of whatever ethnic group, than in those born in the UK. Furthermore, non-UK born patients are slightly more likely to complete treatment than UK born cases.[xii]

3.4.12. Analysis of surveillance data suggests that for those diagnosed via CXRs at ports, the effect was to bring their diagnosis forwards by an average of about 2 months

Conclusions

3.4.13. Current screening has many weaknesses: Some of these cannot be improved:

- Failure to identify all individuals that are at most risk
- Approximately 31 % of reports could not be sent to CCDCs because of incomplete addresses
- Approximately a third of all reports that are sent to CCDCs are lost to follow up, usually because of incorrect addresses given

3.4.14. Some weaknesses could be improved, such as follow up of those identified at Heathrow, and increasing the proportion actually being screened. Both of these are possible, but the latter would incur significant costs.

4 Options appraisal for screening

The options for screening new migrants are:

1) Continue with current system of screening at port of entry
2) Maintain the current system, but address the weaknesses that can be dealt with
3) Stop CXR screening at ports, but with or without each of:
   - pre entry screening
   - enhanced primary care based post entry screening
   - working with UKBA to allow better data transfer from visa information into the NHS)

4.1 Continue with current system of screening at port of entry

4.1.1. The literature quotes a prevalence yield of between 100-3800 cases of active pulmonary TB per 100 000 individuals screened, depending on the underlying prevalence in the population being screened and the type of individuals screened.
4.1.2. At Heathrow HCU, for 2006/7 the yield was 88 per 100 000, and at Gatwick the numbers screened are now very small with no cases detected.
4.1.3. Overall, the current service costs about £2.5m pa and detects about 59 cases – giving a cost per case detected of about £40k. Since 25 of these are as a result of referral to hospital because they are ill, the total extra cases detected by the current CXR system are about 34. This increases the estimate of the cost per case detected to about £70k. Of those that are not obviously symptomatic, there is evidence that new entrants more promptly seek care in comparison to the rest of the population, and would be detected by normal in country NHS services anyway[2]. On average, they would be diagnosed about 2 months later. So the net total extra effect of the current CXR system is to diagnose 34 cases per year 2 months earlier, and presumably to stop a small number of onward transmissions from these case - at a cost of £2.5m
4.1.4. At face value this is an ineffective use of resources. HPA has undertaken an economic analysis of the system (Appendix 9). With a set of assumptions that are generally optimistic about the cost benefits of the current programme, the cost per QALY comes out at £106,000. This is far higher than the £30,000 often used as an indicator of what is a cost-effective intervention. The case for specifically stopping CXRs at Gatwick is even stronger as the current system cost £0.5m pa and does not diagnose any cases.

4.2 Continue the current system but address its weaknesses

Changes in passenger flows have impacted upon the effectiveness of on-entry screening. The number of individuals screened at Heathrow and Gatwick have fallen; the latter to an unsustainable level as many passengers now arrive directly into other ports. This means, for instance that where the cost per x-ray at Heathrow remains in the tens of pounds, costs per x-ray are significantly higher at Gatwick where far fewer passengers are screened.

4.2.1 What would need to be improved?
Since most of those who should be screened under the current policy arrive at Heathrow, there would need to be about an 80% increase in the number of X-rays undertaken to capture all of those individuals fitting the criteria for screening. To achieve this, UKBA rates of eligible entrant referral would need to rise significantly and terminal capacity would need to be improved. This would incur substantial costs. To capture most of those arriving at other airports, there would need to be substantial additional

investment required at several other regional airports. This would still only detect a small proportion of cases in migrants.

These changes would need to be supported by a systematic strengthening of the mechanisms to transfer reports to the community from ports such as an electronic data transfer. As many migrants settle at different addresses than the ones given at entry and many do not have a valid address, it is difficult to see how this can be tackled, other than by generally strengthening community and outreach services and supporting migrants to engage with local community and primary care services.

4.2.2 Would this be worthwhile?

As described in 4.2.1, the current system detects about 59 cases per year. Modelling data suggests that the maximum number of cases that could be detected if all those eligible were screened would be about 132 (assuming 75% sensitivity for CXR screening). If 25 cases per year continue to be diagnosed because they are unwell at arrival, the number of extra cases detected by such a system would be 107. On the highly optimistic assumption that this could be done at the same annual cost as the Heathrow service (£2m), the cost per case detected falls to about £19k, but as described above, the true extra benefit is likely to be that 107 cases are diagnosed 2 months earlier at a cost of £2m. The cost benefit analysis (Appendix 9) suggests that if all these cases were detected at the same costs, the cost per QALY would at best be £32k - higher than the £30,000 often used as an indicator for what is a cost-effective intervention

This would be a more efficient position than the current system, but:

- Is probably unachievable as there are many reasons why migrants do not have CXRs at ports that would be almost impossible to resolve (pregnancy, children, excessive queues)
- Would require considerable investment to expand CXR capacity at Heathrow and elsewhere
- Could not realistically be delivered for £2m pa
- Is unlikely to create any meaningful savings for the NHS
- And would still not reach the normal threshold for economic analysis of NHS interventions
- would at its best only identify 6% of new pulmonary cases of TB

4.2.3 Conclusion

Although this option is superficially attractive, it would require considerable investment, even with highly optimistic assumptions would cost £19k per case diagnosed, cost at least £32k per QALY, the cases would only be diagnosed 2 months earlier and the system would only diagnose 6% of new pulmonary UK cases (Appendix 1). Overall, this is not a viable option.

4.3 Discontinue current system of CXRs at ports, with and without each of

- pre entry screening
- enhanced primary care based post entry screening
- working with UKBA to allow better data transfer from visa information into the NHS)

4.3.1 Pre entry screening

Evidence from the literature

Some nations require new migrants to undergo screening prior to arrival. In some countries, the extension of immigration stay is conditional upon production of evidence that this screening has taken place.

There is other limited evidence from the literature. Based on a study in Vietnam, Maloney et al found a 7% yield, but this is not generalisable to other countries[xiii]. Mor et al[xiv] examined the effect of pre-entry screening on the long term follow up of new entrants from Ethiopia into Israel and found that those screened pre-entry (compared to the standard screening performed within a month of entry) had lower rates of tuberculosis after entry. However the two groups were chronologically distinct and there was a shorter time of follow up of the pre-entry group.

Experience of the UK pre entry screening pilot

As part of the wider work on managing the incidence of TB, the Home Office sought and gained cross Government agreement to trial the screening of migrants before their arrival in the UK. This programme of screening has been taken forward with the assistance of the International Organisation for Migration (IOM) since late 2005. Now covering 15 countries, the issue of an entry clearance is subject to confirmation that the screening has been undertaken (through the use of a secure certificate). Those detected with active TB are advised to seek medical care and invited to return for screening after successful treatment.

The number of active cases of TB detected is relatively low and has remained low despite a switch to combining x-ray screening and sputum smear examination with the use of culture testing (rolled out between November 2009 and April 2009). The low numbers (in many cases falling well below the recorded WHO rates for those countries) can, however, be attributed to a number of factors such as that those who are able to afford to migrate to the UK may often be wealthier and as a consequence healthier than the main populace within their home countries[xv].

For instance, whilst Ghana is reported by the WHO to have a high incidence of TB, no active cases were detected out of 25,000 or so screened. The highest rates of detection have been seen amongst those applying for family reunion (mainly to join refugees and others granted humanitarian protection where the rate stands at 211 per 100,000) and settlement and dependent visas (70 per 100,000). Prospective students and workers fall below the overall rate of 66 per 100,000 but only marginally so at 64 per 100,000 apiece.

The Department of Health, on behalf of the UK Border Agency, has conducted further analysis of the data provided by the IOM; however, an interim report by the IOM earlier this year showed that just over 400,000 people were screened between October 2005 and March 2010. Of these, 265 were identified as suffering from active pulmonary TB. This translates into a cumulative prevalence rate of 66 per 100,000. Working on the assumptions that these 265 people would otherwise have presented to the NHS, had not infected others, did not have drug resistance and did not present with other health conditions arising from the incidence of TB, we can estimate the potential savings to the NHS at £1.59m over that period (using NICE estimates of costs (1998) at £6k per patient).

The costs of the pre-entry programme to the UK have been approximately $1.8m (£1.1m at Nov 2010 rates). These costs related to the initial set up costs of clinics and the switch to culture testing in 2009. These figures suggest that the pre-entry screening has recouped the costs of set up to the UK within 5 years. For the purpose of this exercise, the costs to the visa applicants and lost opportunity costs (in terms of the potential loss to the UK of economy by migrants deterred from travelling) have not been included.

It is not clear what the overall impact in terms of health benefits to the UK populace are through preventing the entry of these 265 people. IOM figures suggest, however, that over 90% of those detected completed drug treatment. This compares favourably with the reported completion of treatment within the UK and may suggest that very few visa applicants have been deterred from

pursuing their visa application. It is perhaps not an insignificant matter in itself that those identified have received clear notice that they are unwell and been encouraged to take treatment.

Conclusions
To fully understand these data, it is important to recognise that the UK's current pre-entry screening programme covers only 15 countries. Some high risk nations, such as India and China are not covered by the screening programme. Those born in India constitute the majority of non-UK born cases identified in 2009 (28% of those who are non-UK born). The Australian Department for Immigration and Citizenship report a rate of 147 per 100.000 in migrants screened in India. The returns here, therefore, do not give a complete picture of potential savings to the NHS.

The costs borne by the UK have arisen through the need to set up clinics abroad with the IOM. There are, however, existing commercial enterprises that may be able to provide screening in many countries abroad without the significant set up costs involved with the IOM. Other 5CC partners utilise a network of "panel doctors". They are not directly employed and in many instances (such as the panel doctors employed by our partners across the UK) are private service providers.

Overall, pre – entry screening cannot have a large impact on TB in the UK because of the natural history of TB (cases presenting years after arrival), but the savings to the NHS are probably greater than the costs of the programme. Expanding it to countries with high TB rates and from which large numbers of migrants come to the UK (India and China) would increase its impact.

4.3.2 post entry screening

Current position and advice
There is no nationally co-ordinated screening programme for TB in new entrants after entry. There are examples of programmes in some areas (see below). However, the NICE guidance is clear as to what local NHS organisations should offer to new entrants from high-risk countries. NICE guidelines outline the groups that should be screened for latent and active tuberculosis with eligible migrants identified via a variety of approaches. The recommended screening for latent infection is supported by a recent UK multi centre study which found that it is cost effective to test migrants from countries with TB incidence rate greater than 150 cases per 100,000 with interferon gamma release assays.

A report on migration, public health and compulsory screening for TB and HIV by the Institute of Public Policy Research (IPPR) published in 2003[xvi] examined the medical, legal and ethical issues surrounding at-entry and pre-entry screening and recommended that the government introduce instead a 'welcome health check' to all migrants after entry to the UK. Similarly, the Chief Medical Officer's Action plan for tuberculosis called for targeted screening of new entrants, by a "one-stop shop"[iii].

A recommendation for an extended new patient check in primary care was also made in the HPA's Migrant Health Guide[xvii]. The HPA has recently made a free to use resource available on its website. The Migrant Health Guide provides a wide range of information and resources to primary care practitioners who look after migrant patients. Country specific guidance is given which includes advice about TB detection and management. www.hpa.org.uk/migranthealthguide

What could be done?
Since at entry screening could never cover 100% of the eligible population, and is severely limited in what it can achieve, and pre entry screening only addresses active TB, the only way to systematically implement the NICE guidance is via a structured post entry programme. ONS data on first GP

registration of people who have arrived from abroad (Flag 4 status)[14] shows that over the last few years the number registering has been roughly equivalent to the Home Office statistics on number of people entering the country. This may imply that most people who are eligible for NHS services do in fact register with GPs.

Screening for tuberculosis within the NHS has been demonstrated to be acceptable to migrants and to be seen as a socially responsible activity.[xviii] Furthermore a recent study of a programme promoting TB screening in people registering in primary care in London showed a 31% increase in diagnosis of active TB, a 100% increase in diagnosing latent TB and a 7-fold increase in BCG immunisation. [xix]

At present only 35% of PCOs reported routinely screening new-entrants identified through primary-care registrations[12]. However many studies on screening migrants for TB indicate that community screening would be more effective and acceptable than entry screening (Appendix 8)[22-27]. This is because migrants that are not being screened or are currently lost to the system because of invalid addresses are picked up by post entry screening systems. All this suggests that structured primary care based programmes are acceptable and could have a significant impact on TB in migrants

What would be required to make primary-care based screening work?
This could involve:

- Generally promoting registration with GPs
- Giving information to migrants about how to access primary care services
- Introducing requirements for primary care services to improve access, and/or appropriate financial incentives such as the QOF
- Working with community groups and third sector organisations to promote screening within migrant communities
- Developing a structured NHS programme for health care checks for new migrants (www.hpa.org.uk/migranthealthguide)
- Developing a programme for encouraging registration of undocumented migrants

4.3.3 Data transfer from UKBA to NHS

At the moment, the information that is transferred to the NHS (via the HPA) from ports is a manual system using address information given by migrants. As described earlier this is inefficient and frequently inaccurate. However, better data sharing between UKBA and the HPA and NHS could be used to create a central database for providing information about who would need to undergo post entry screening. This could be based on visa applications to UKBA, and as this would be electronic and centralised, would be far more efficient than the current manual and fragmented system.

Irregular/undocumented migrants do not undergo any screening for TB. At present, there is no routine sharing of information on these migrants with the HPA. These data are, however, available through UK Border Agency databases and it should be possible to ensure that such data can be exchanged on a routine basis, perhaps with particular focus on identified risk areas (such as irregular migrants detected working in the catering or healthcare sectors).

[14] http://www.statistics.gov.uk/StatBase/Product.asp?vlnk=15283&More=Y

5 Summary and Recommendations

5.1 Summary of at entry screening

5.1.1. The prevalence yield from Heathrow HCU for pulmonary TB is 59 per 100 000 for those who were referred to the community via Port 103s. Approximately 40% of those who are eligible for screening do not appear to be detected by the system. Of those referred for screening at Heathrow, only 54% were actually screened. 31% of all notifications could not be sent out by the HCU as they did not have a valid address. A third of all individuals whose reports were sent to local districts were lost to follow up.

5.1.2. The annual cost of running the service at Gatwick and Heathrow is estimated to be £2.5 million, and the current effect of the programme is to detect 34 cases 2 months earlier each year. As currently run, the programme is not cost-effective and the best estimate is that it costs £106k per QALY. This concurs with the literature that screening on entry in low incidence countries has little impact and is not cost effective[ii]. There is a separate and clear value for money consideration at Gatwick Airport.

5.1.3. It is possible to make improvements to at entry CXR screening, but even with highly optimistic assumptions; the best that can be achieved is to diagnose 107 cases per year 2 months earlier than they would have been. Even this would require considerable investment, would cost £19k per case diagnosed, the cost per QALY would be at least £32k and the system would only diagnose 6% of new pulmonary UK cases (Appendix 1). This is not a viable option.

5.1.4. Conclusion: Entry screening as currently run is not cost effective and many migrants are not detected or lost to the system eg due to lack of valid addresses. While the system can be strengthened, this would cost, and would still fail to have to have any meaningful impact on TB control.

5.2 Summary of post entry screening

5.2.1. Far preferable is better implementation of the more comprehensive TB screening recommended by NICE in the community, within services that allow for continuity of care, and which apply to everyone at risk, including British residents returning from prolonged stays in endemic countries and others not subject to immigration control. The evidence from the literature would suggest concentrating resources in improving screening and detection of TB in all groups at risk would be preferable to entry screening.

5.2.2. Conclusion: There are many studies to suggest this would be a more effective for TB control. In designing services, one would need to draw on a range of diverse approaches to maximise access to and uptake of screening. Critically, this should include electronic transfer of UKBA visa information to the NHS.

5.3 Summary of pre-entry screening

5.3.1. The pre-entry screening programme allows for more extensive and definitive testing involving both x-rays and, where abnormalities are detected, three consecutive sputum smear tests and/or sputum culture.

5.3.2. The programme, however, has required investment from the UK in set up costs, creates a delay to the visa application process and attracts a fee from those tested. At present, the pilot screens in 15 countries abroad (with some having their tests conducted at IOM clinics in other nations).

5.3.3. The evidence is that pre-entry screening can make savings to the NHS that are greater than the costs of the programme.

5.3.4. Expanding pre-entry screening for TB could allow for further opportunities to institute a wider health screening regime. Other 5CC nations employ universal screening programmes to detect a range of infectious diseases.

5.3.5. The numbers of active TB cases detected through entry screening are significantly lower than the rate of detection seen at the pre-entry programme. This may be due to the difference in population screened in the pilot compared to the population on entry but the observation is in line with the findings in the literature.

5.3.6. Conclusion: Pre-entry screening may be effective but if it is to achieve a greater impact, India and China would need to be part of the programme

5.4 Recommendations.

5.4.1. That CXR screening at Gatwick should stop immediately on cost grounds; volumes are very low, are unlikely to change and no cases are being diagnosed.
5.4.2. That CXR screening at Heathrow should cease on the basis of costs and a lack of effectiveness.
5.4.3. That the option of extending pre-entry screening (as identified in the accompanying paper from DH) should be explored with the possibility of including countries with a high TB risk and significant numbers of people entering the UK – that is those from which the greatest burden of TB is coming
5.4.4. That ways of implementing NICE guidance more effectively should be explored between the HPA, UKBA, DH and the NHS Commissioning Board, with a particular focus on systematic ways to ensure engagement of new migrants with primary health care services.
5.4.5. That there should be an assessment as to whether the practice in some countries of entry being conditional on engaging with and having further medical assessment (by local primary health care services) could be applied in England. This would enable the implementation of NICE guidance.
5.4.6. That the HPA and UKBA should explore the use of electronic data sharing from visa applications to give the HPA and the NHS clearer, more accurate information about people from high risk countries granted visas to enter the UK for more than 6 months.
5.4.7. That the HPA should work with local NHS organisations to actively encourage them to introduce primary care health checks for new entrants as described in the HPA's Migrant Health Guide.

5.5 If entry screening for TB was stopped at Gatwick and Heathrow - what considerations would need to be addressed?

What border health security would be needed at Ports?
5.5.1. The HPA is already responsible for the delivery of expert health protection at ports and this should continue.
5.5.2. Retaining medical resources at the control areas in Heathrow would allow for new entrants/visitors with health issues (including public health issues) to be detected and managed. Unwell individuals with TB may thus continue to be detected and assessed by clinicians even in the absence of routine X-ray screening.

Improved data sharing

5.5.3. Better data sharing between UKBA and the HPA and NHS could be used to create a central database for providing information about who would need to undergo post entry screening. This could be based on visa applications to UKBA, and as this would be electronic and centralised, would be far more efficient than the current manual and fragmented system.

5.5.4. Irregular/undocumented migrants do not undergo any screening for TB. At present, there is no routine sharing of information on these migrants with the HPA. These data are, however, available through UK Border Agency databases and it should be possible to ensure that such data can be exchanged on a routine basis, perhaps with particular focus on identified risk areas (such as irregular migrants detected working in the catering or healthcare sectors).

Appendices:

Appendix 1: Estimation of the proportion of TB cases in the non-UK born that might have been detectable by screening around the time of entry

Notes;

- Within Enhanced Tuberculosis Surveillance (ETS), 91% of cases have known place of birth and 82% of non-UK born cases have a known year of entry.
- The year of entry is recorded in ETS but not the actual date; therefore estimates of time in the UK before diagnosis were made assuming entry in the middle of the year.
- Only pulmonary cases are considered in the following analysis since CXR may only detect such cases. Data from ETS 2009 show that 54% of all TB cases reported in the non-UK born are pulmonary, though this varies by country of origin and is known to differ also by HIV status.

Assumptions;

- Anyone presenting with TB more than a year after entry to the UK is very unlikely to have been symptomatic around the time of entry. [This is supported by the median and 75th centile of duration of symptoms using ETS data.][15]
- Only those with signs of pulmonary TB might be detected by CXR. [In practice CXR may detect some pulmonary disease before the patient becomes symptomatic. However, most individuals rapidly progress to symptomatic disease after the appearance of radiological changes.[21] This formed part of the rationale behind stopping mass population screening with CXR in many countries].

1. The average number of non-UK born pulmonary cases reported to ETS in each year between 2007 and 2009, who were diagnosed *within a year of entering* the country, was 351.

2. The total number of cases of TB reported to the ETS between 2007-2009 was an average of 8655.

3. Based on a median duration of symptoms of 3 months before diagnosis of pulmonary disease, 25% of those reported within a year of entry might be expected to have been symptomatic around the time of entry. Allowing an optimistic estimate of 50% because of possible variation in the duration and detection sometimes being possible shortly before the symptomatic phase, 176 (50% of 351) might be detected.

3. The sensitivity of CXR for detection of pulmonary TB has been quoted in the literature as 75%[xx]. This may be an optimistic figure but even if this level of sensitivity is achieved, of 176 pulmonary cases in the non-UK born that were reported within a year of arrival and may have been symptomatic at the time of arrival the number that might have been detected by CXR would be expected to be 132.

4. Thus, of pulmonary TB cases reported in any one year in the non-UK born who arrived within the previous year, the percentage that might have been detected by CXR at the time of arrival can be estimated to be 38% (132/351).

5. Between 2007 and 2009 an average of 2263 cases of pulmonary TB in non-UK born people were reported to ETS each year with a known year of arrival. Thus of all pulmonary cases reported in

[15] Median duration of symptoms prior to diagnosis = 89 days; (75th percentile, 160 days).

the non-UK born over this time period 6% (132/2263) might have been detectable by CXR around the time of arrival.

6. The total number of non-UK born cases reported to ETS each year, including those with extra pulmonary manifestations which cannot be detected by CXR, was on average 5754 between 2007 and 2009. Hence, out of all non-UK born cases occurring in the UK each year only 2% (132/5754) might have been detectable if screened at port of entry.

Conclusion; Overall 6% of all pulmonary cases reported in the non UK born, may have been detectable by CXR around the time of arrival.
Since less than half of all TB cases reported in the non-UK born are pulmonary, the proportion of all TB cases in the non-UK born that may have been detectable by CXR screening at the time of entry would be 2%.

Appendix 2: Port of arrival system for migrants

In the past, every alien landing in Britain was liable under the 1953 Aliens Order to be medically examined at the port of entry, but this had proved to be impracticable[14]. As a result, after much debate, the current port of arrival system was set up in 1965. Chest X- rays were introduced, on a partial and experimental basis, at Heathrow Airport. Initially, these were a minor part of the medical examinations as a whole but in the 1990s the proportion of migrants X-rayed rose substantially.

Also, the principle of conditional entry was established, whereby a migrant could be admitted on condition that they reported to the Medical Officer of Health (MOH) of the local authority and attended there for tests or examinations as required. This condition could be imposed by the Immigration Officer, on the advice of a Medical Inspector, if "*it appeared to him necessary to do so in the interests of public health*"[15]. This was reaffirmed in the 1971 Immigration Act. The port medical officers forwarded addresses of migrants to the MOH.

The Department of Health issued *Instructions to Medical Inspectors* in 1992. The instructions specify the duties of the Medical Inspector, which are "*to advise the Immigration Officer on those aspects of the subject's health that are relevant to his ability to meet the rules for entry to the UK*" (para.2.6). The purpose of the referral for medical inspection by the Immigration Officer is "*to bring to notice any person who, if admitted, might endanger the health of others, or be unable for medical reasons to support himself or his dependants or require major medical treatment*" (para.3.1). Additionally, Immigration Officers are encouraged to refer migrants from areas of the world that have a high prevalence of tuberculosis as "*referral for medical inspection can serve an important function even if there is no power to refuse a passenger*" (para3.2). Chest X-ray screening is not mandatory, though it should be done if there are facilities on-site (section 4.6).

In practice, at Heathrow over 99% of referrals from Immigration Officers are related to TB screening, though referrals for other infectious disease, severe mental illness or to establish the cost of medical intervention (including pregnancy) occurs at low levels.

Appendix 3: Electronic referral forms

Prior to June 2009, Port reporting forms to CCDCs were paper. Electronic forms were phased in and replaced the old notifications. The electronic referral forms are as follows:

Ref 0. The above entrant from a low risk country for TB has been referred to the Health Control Unit and the relevant details are given above. You may want to encourage the entrant to register with a local GP.

This notification replaced Port form 101.

Ref 1. The above entrant is from a 'high risk country' for TB. They have been referred to the Health Control Unit and the relevant details are given above. This category includes those with a normal x-ray or x-ray report and those with minor findings not suggestive of TB. You may want to arrange follow up and encourage the entrant to register with a local GP.

This notification replaced Port form 101.

Ref 2. The above entrant has been referred to the Health Control Unit and their x-ray gives an appearance which is suggestive of prior TB. Assessment of activity cannot be made on this single x-ray and therefore further assessment for TB is required. You may want to arrange follow up at a local chest clinic and encourage the entrant to register with a local GP.

This notification replaced Port form 102.

Ref 3. This is an urgent notification that the above entrant from a 'high risk country' for TB has been referred to the Health Control Unit and their x-ray gives an appearance typically associated with and SUGGESTIVE OF ACTIVE TB. The entrant is required to be in contact with the local authority to arrange chest clinic follow-up and urgent chest clinic follow up is advised.

This notification is linked to Port Form 103.

Ref 4. The above entrant is from a 'high risk country' for TB. They have been referred to the Health Control Unit and the relevant details are given above. Their x-ray gives an appearance of a non TB abnormality which may require evaluation and follow up. You may therefore want to arrange follow up and encourage the entrant to register with a local GP.

This notification replaced Port form 101.

Ref 5. The above entrant is a contact of a person who has been referred for follow up with an x-ray SUGGESTIVE OF ACTIVE TB. You may want to arrange Chest Clinic follow up and encourage the entrant to register with a local GP.

This notification replaced Port form 102.

Ref 6. The above entrant is from a 'high risk country' for TB. They have been referred to the Health Control Unit and the relevant details are given above. Chest x-ray however was NOT performed. You may want to arrange follow up and encourage the entrant to register with a local GP.

This notification replaced Port form 102.

Appendix 4: Screening for TB at English Ports of Entry

This section describes how the current port systems operate

TB screening and the immigration process

UKBA is the agency with responsibility for applying the immigration rules to people entering the country who do not have right of abode in the UK. If there are grounds for suspecting health reasons why the person may not meet these rules, the Immigration Officer may refer the person to a Medical Inspector appointed under the Immigration Act 1971. Following on from the 2006 Port Health Review, the HPA is responsible for ensuring the provision of appropriate Medical Inspector services in England. At Heathrow, where there are Health Control Units at three terminals, there is an HPA employed Medical Inspector on duty during core hours. At Gatwick, there are also Health Control Units with a Medical Inspector on duty. At other major ports and airports in England, where the needs are lower, Medical Inspectors are available as required. In practice, most referrals to the Medical inspector take place at Heathrow, with only a small number at Gatwick and very few anywhere else.

In addition to this statutory function, it has been national policy for many years to refer selected immigrants for screening for TB. Heathrow and Gatwick have modern X-ray facilities on-site and carry out chest X-rays (CXR) on eligible immigrants; elsewhere they are referred to the NHS.

To be screened for pulmonary TB, arrivals to the UK have to meet the following criteria;

1) subject to immigration control
2) intend to stay for 6 months or more
3) come from a country with an incidence of TB of 40 per 100,000 or greater (as defined by WHO).

X-ray screening at Heathrow

The majority of immigrants arrive at Heathrow. Immigrants who meet the above criteria are identified by the UKBA Immigration Officer and referred to an HCU. There, the personal identifiers of the immigrant, including the intended destination in the UK (if known), are logged onto the Passenger Administration System (PAS) by administrative staff (Health Control Officers employed by the Local Authority). They are then sent for a CXR, unless there is a reason to exempt them. The CXR is read by the Medical Inspector in the HCU, usually at Terminal 3. Exemption from CXR includes having evidence of being screened for TB satisfactorily pre-departure, children (aged less than 16) and women who might be pregnant. Those who have been screened pre-departure are asked to show their CXR to check the validity of the exemption. The Medical Inspector reads the CXRs in the HCU and, if satisfactory, the immigrant returns to the Immigration Officer to complete their entry procedure. The results of the X-ray screening are sent routinely to the Consultant in Communicable Disease Control (CCDC) in the Health Protection Unit (HPU) in the district of the address which the immigrant has given, for onward transmission to the NHS chest clinic if there are radiological changes which merit further investigation. If there appears to be active/infectious pulmonary TB the immigrant may be admitted directly to hospital (Northwick Park) at the Medical Inspector's discretion.

X-ray screening at other airports and ports in England

Gatwick is the only other port with on-site radiological facilities, but it has a very much smaller number of eligible immigrants than Heathrow. The process is essentially the same as at Heathrow. At the larger regional airports (Birmingham and Manchester), arriving eligible immigrants are identified and their details forwarded to the appropriate district CCDC. At the smaller airports and all ferry-ports, the number of eligible immigrants arriving is too small to have systems in place to identify them.

Appendix 5: Activity at Heathrow Health Control Unit (HCU).

1 There are 4 medical staff, one part-time radiologist and 1 radiographer. Their role is to examine travellers referred by Immigration Officers and to interpret their chest X-rays.

2 There are 28 Health Control Officers (HCO) with 6 supervisors and 1 clerical assistant. The backgrounds of the HCOs are varied, but all are now operating in an administrative/clerical capacity. Their role is to establish the address of long-term migrants into the UK and to take chest x-rays under supervision.

3 Feed back from the community referrals of possible Pulmonary TB has continued to be very low and was only 4% in 2006/7.

4 The cost of providing radiological screening is approximately £2 million.

The table lists the activity at Heathrow HCU over recent years.

Table 3: Heathrow Health Control Unit activity

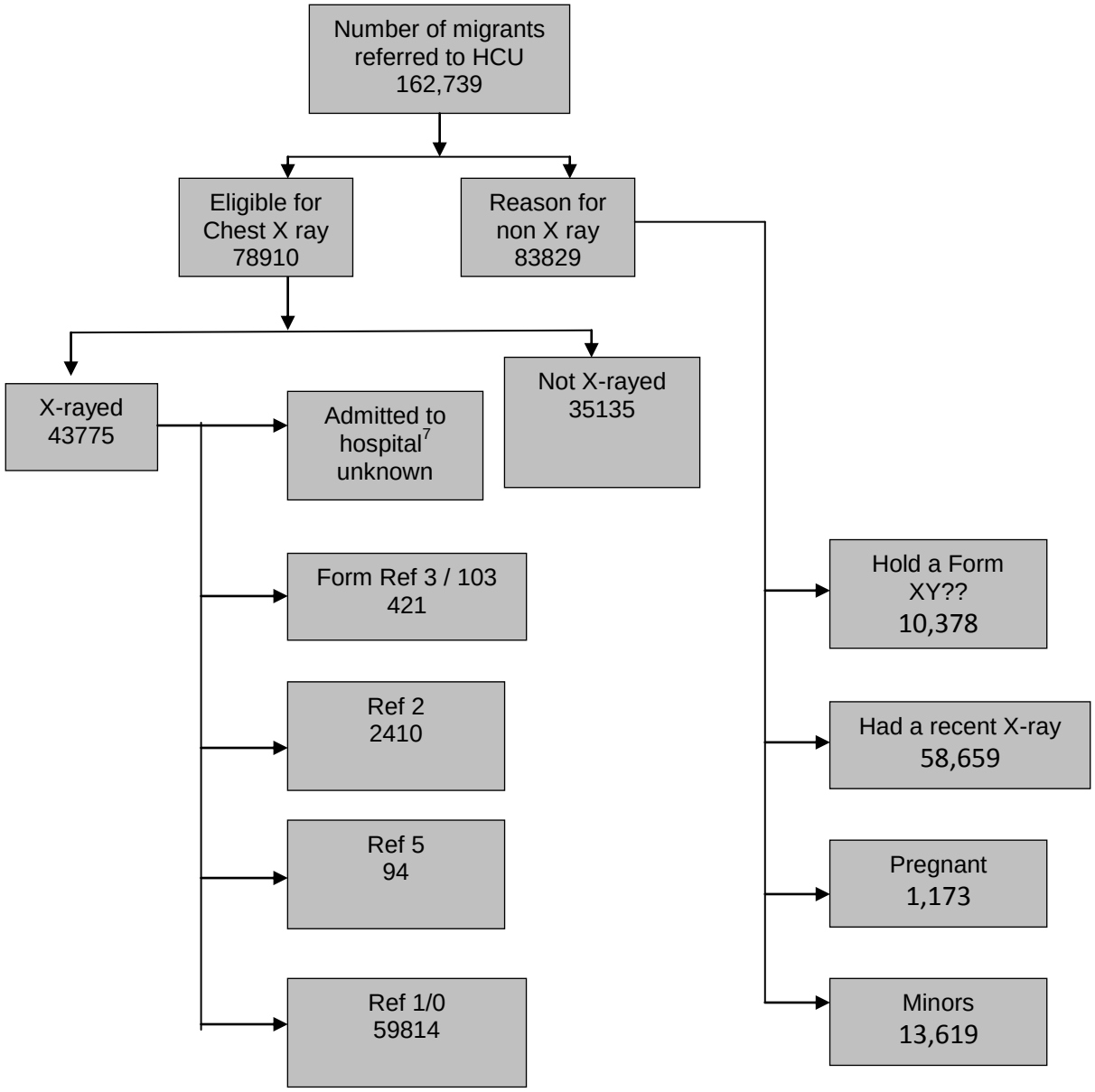
Source: Heathrow HCU (annual report 2009)

Year	2005/6	2006/7	2007/8	2008/9	2009/10[2]
1) Total Referrals to HCU from immigration officers	190,685	187,760	180,248	162,739	??
2) Total number of chest x-rays performed by the HCU	74,060	66,812	53,850	43,775	42,544
3) Total possible active TB cases referred ("Ref 3" i.e. people sent urgently to hospital and reports sent to CCDCs – "port 103 forms")	587	590	475	421	521
4) Total community referrals for abnormal x-rays ("Ref 2")[1]	1,506	2,347	2,250	2,410	
5) Total number of x-rays referred for further investigation ("Ref" 3+4)	2,093	2,937	2,725	2,831	
6) Yield of "Ref 3" forms per 1000 Chest X-rays performed	7.9	8.8	8.8	9.6	12.2
7) Reports not sent immediately by HCU to CCDCs due to lack of address at time of entry	52,823	52,392	50,687	*50,117*	
8) Approx total of reports sent out by HCU to CCDCs	164,274	161,348	154,052	*137,731*	

[1] this includes CXRs interpreted as probable active TB and other pulmonary TB

[2] Data on complete months unavailable from April 2009-June 2009, hence data taken from July 2009-June 2010. Additionally transfer to a new x-ray system meant significant downtime in this year (09/10).

Flow diagram of processes at Heathrow HCU, using activity data from 2008/9.

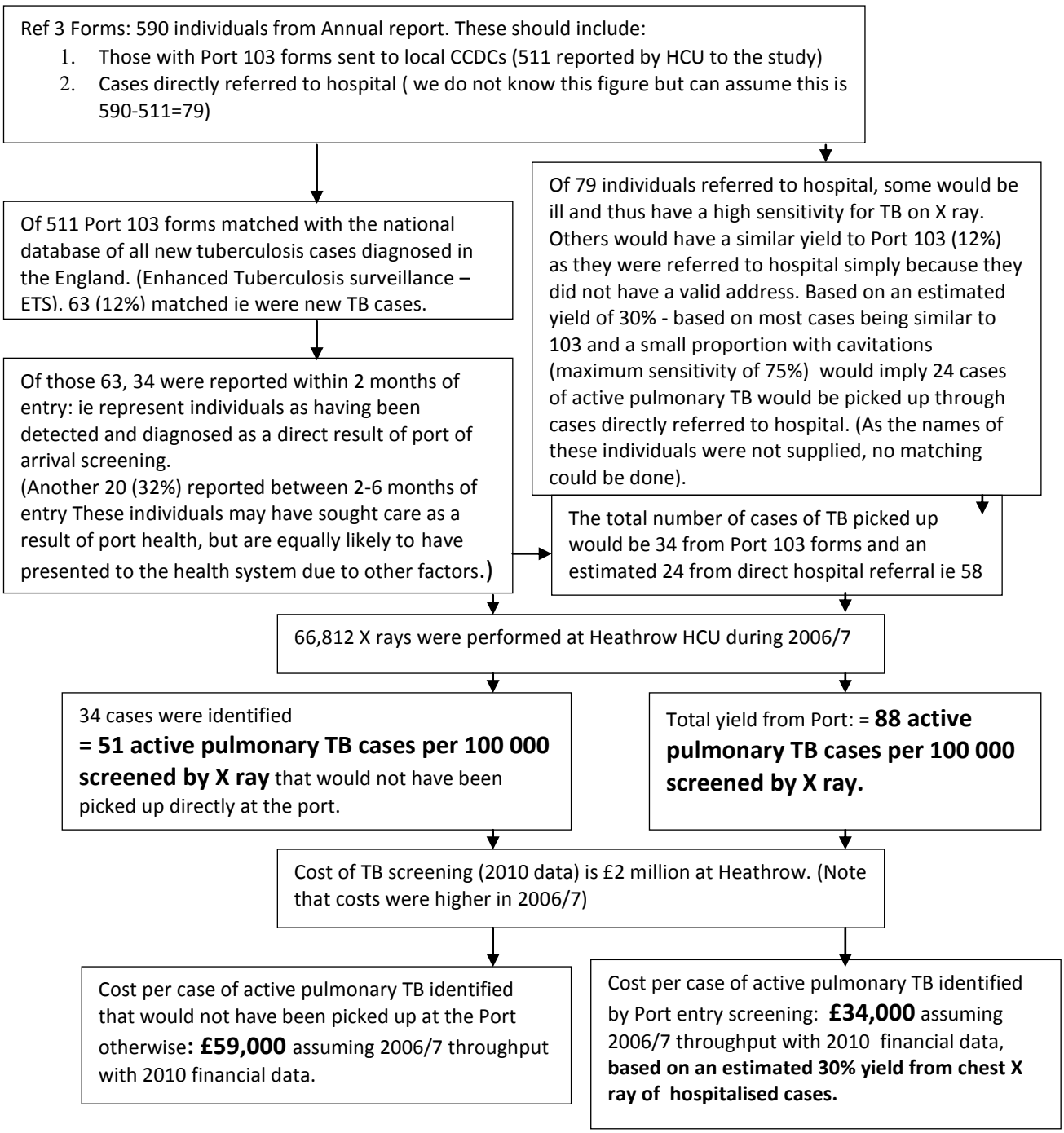


Summary of findings from activity data and the annual report 2009:

The trend is a fall in the number of individuals referred to the HCU for screening. However, 2008/9 in comparison with previous years, some of the fall in activity was due to changes at Heathrow. Terminal 5 HCU was late opening and was not fully functional for most of the first year of the terminal's operation. This included the lack of the facility to x-ray for most of the year. Terminal 2 HCU was closed while Terminal 2 was still open and Terminal 1 HCU had a restricted service due to staff shortages.

Of those who were referred to the HCU, 52% (83829/162739) had a valid reason not to have an X-ray.
Of those who were eligible for an X-ray, 44% (35135/78910) did not have an X-ray.
Of those who had an X-ray, the yield of Xrays suggestive of TB range from 7.9 to 12.2 per 1000 Chest X-rays in the last 5 years.
Of those that needed reports sent to the local Consultant in Communicable Disease Control (CCDC), 31% did not have a valid address, hence a report could not be sent initially.

Evaluation of outcome of Port of Entry screening at Heathrow, using 2006/7 data.


Ref 3 Forms: 590 individuals from Annual report. These should include:
1. Those with Port 103 forms sent to local CCDCs (511 reported by HCU to the study)
2. Cases directly referred to hospital (we do not know this figure but can assume this is 590-511=79)
Of 511 Port 103 forms matched with the national database of all new tuberculosis cases diagnosed in the England. (Enhanced Tuberculosis surveillance – ETS). 63 (12%) matched ie were new TB cases.
Of those 63, 34 were reported within 2 months of entry: ie represent individuals as having been detected and diagnosed as a direct result of port of arrival screening.
(Another 20 (32%) reported between 2-6 months of entry These individuals may have sought care as a result of port health, but are equally likely to have presented to the health system due to other factors.)
Of 79 individuals referred to hospital, some would be ill and thus have a high sensitivity for TB on X ray. Others would have a similar yield to Port 103 (12%) as they were referred to hospital simply because they did not have a valid address. Based on an estimated yield of 30% - based on most cases being similar to 103 and a small proportion with cavitations (maximum sensitivity of 75%) would imply 24 cases of active pulmonary TB would be picked up through cases directly referred to hospital. (As the names of these individuals were not supplied, no matching could be done).
The total number of cases of TB picked up would be 34 from Port 103 forms and an estimated 24 from direct hospital referral ie 58
66,812 X rays were performed at Heathrow HCU during 2006/7
34 cases were identified
= 51 active pulmonary TB cases per 100 000 screened by X ray that would not have been picked up directly at the port.
Total yield from Port: = 88 active pulmonary TB cases per 100 000 screened by X ray.
Cost of TB screening (2010 data) is £2 million at Heathrow. (Note that costs were higher in 2006/7)
Cost per case of active pulmonary TB identified that would not have been picked up at the Port otherwise: £59,000 assuming 2006/7 throughput with 2010 financial data.
Cost per case of active pulmonary TB identified by Port entry screening: £34,000 assuming 2006/7 throughput with 2010 financial data, based on an estimated 30% yield from chest X ray of hospitalised cases.

Appendix 6: Activity data at Gatwick Health control unit

Activity data show a significant decline in activity in recent years. One reason for this as suggested by UKBA is a change in the traffic pattern (Table 2). Another reason may be that referral to the HCU has also been erratic. Only an estimated 71 X-rays (extrapolated from data up to September 2010) will be done in 2010.

There is a service at both terminals. Only the office in the North terminal has X-ray equipment. One terminal has a Medical Inspector during the day with on-call cover overnight. Both offices are leased from the airport operator.
There are 2 medical staff (and 3 who provide out-of-hours service), and one radiographer. Their role is to examine travellers referred by the Immigration Officer and to interpret their chest X-rays.
There are 13 Health Control Officers (HCO) with 1 manager and a clerical assistant. The backgrounds of the HCOs are varied, but all are now operating in an administrative / clerical capacity. Their role is to record the addresses given by long-term migrants into the UK and to take chest x-rays under supervision.
The total number of long-term migrants (>6 months) arriving at Gatwick is not known.

Table 4: Output of Gatwick Health care Unit

	2004/5	2005/6	2006/7	2010[2]
Total Referrals to HCU from immigration officers	9777	13,576	15,127	3705
Individuals with an X-ray done overseas		2026	1956	
No X-ray done		7727	9475	
Total number of chest x-rays done at HCU	2178	3384	2935	91
Total possible active TB cases referred (Ref 3 / Port 103)	4	11	16	0
Other community referrals for abnormal x-rays (Ref 2) [1]		11	74	
Total number of x-rays referred for further investigation (Ref 3 + Ref 2)		22	90	
Yield of Ref 3 Forms per 1000 Xrays	1.8	3.3	5.4	0

[1]extrapolated from data January-September2010

For Gatwick, combining the data from 2005/6 and 2006/7: 27 Ref 3 Chest X-rays were detected. Assuming a 12% yield of Chest X-ray in detecting pulmonary TB, (ie as in the Heathrow) the detection of TB from Ref 3 X-rays could be approximately 3 cases.
This gives an active pulmonary tuberculosis prevalence yield of 47 cases of TB per 100 000 X-rays and a cost per case notified via Ref 3s of 250 000 per case of TB. (TB screening in Gatwick costs annually £500, 000 / 2010 figures). However, given the dramatic fall in X-rays taken at Gatwick in 2010, there is now a revenue cost per X-ray in Gatwick of £5500, clearly unsustainable.

Appendix 7: Chest X-ray as a screening tool

Table 1 illustrates the limitations of chest X-ray as a screening tool[16]. The number of people that have to be screened to detect one case of pulmonary disease and the number of false positives varies by population prevalence of disease.

Table 5: Theoretical yield from Chest X-ray

For 100,000 people screened by CXR for TB	**For population prevalence of all forms of TB 500/100,000**	**For population prevalence of all forms of TB 40/100,000**
Expected number of cases of all forms of TB	500	40
Expected number of cases of pulmonary TB[17]	250	20
Number of actual cases of pulmonary disease detected through screening (if sensitivity of CXR is 75%*)	188	15
Yield of screening (i.e. the % of cases detected in those screened)	0.2%	0.02%
Number of cases of pulmonary TB missed through CXR	62	5
Number of cases of all forms of TB missed through CXR	312	25
Number of people without pulmonary TB but classified as possibly having pulmonary TB from CXR – false positives (based on specificity of CXR of 99%*)	1000	1000
Proportion of people identified as possibly having pulmonary TB who actually have it	16%	1.5%
Number needed to screen to detect one case of pulmonary TB	531	6,666
Cost to detect one case of pulmonary TB (based on £38 per X-ray, which is the cost at Heathrow)	£20,178	£253,308

*These figures have been quoted in the literature but may be optimistic. Their use in this table therefore represents the best possible scenario

The numbers used for prevalence in different groups of new entrants are usually based on overall country population data. The population choosing to migrate to the UK may, however, not be typical of the general population in the country (in general the more affluent members of a population have more opportunity to voluntarily migrate[xv] and more affluent people are likely to be at lower risk of TB).

[16] Note that prevalence is the proportion of the population that are cases at any given point in time. Incidence is generally measured as the number of new cases per 100,000 population over a given time period. The UK Government has a policy of at entry TB screening by CXR for people from countries with a TB incidence (all forms) of >40/100,000 per year. Previous (2006) NICE guidelines had recommend further screening for people from countries with an incidence (all forms) of >500/100,000. Hence for the table prevalences of 40/100,000 and 500/100,000 have been chosen as examples because when a group of people are screened for the first time, both prevalent and newly incident cases may be picked up..It should be remembered that for chronic diseases such as TB prevalence may be higher than incidence.

Thus the numbers that need to be screened to detect one case among the migrating population from countries may be higher than those shown in the table, but even using this the theoretical cost associated with case detection varies enormously with the prevalence of disease in the population.

Appendix 8: Studies in the literature

Table 6: Studies on the efficiency of port entry TB screening in the UK

Author	Study findings
Hogan et al[xxi]	Survey of CCDCs regarding Port 101 and 102 forms; felt detracted from contact tracing of true cases and follow-up of those at highest risk, Port entry screening had low yield - most new entrants with TB had no earlier contact with port health; prefer community-based approach.
Lavender et al[xxii]	In Newcastle upon Tyne in 1993, 1/3 of new migrants from Indian sub-continent had port of arrival form; of all immigrants identified by port health, only 39% had evidence of screening (most unable to reach at given address); active follow-up of hospital and GP records indicate 1 case of active TB identified through screening.
Hardie et al[xxiii]	Only about 1/3 of migrants referred to port health; many lost to follow-up at district level. Six districts reported finding 0-100 additional migrants more than those referred from port of arrival (50-200 a year). Screening was done in the migrant's home (31), in chest clinics (36) and in clinic for new migrants (6). Difficulties due to incorrect addresses, ambiguity over guidelines on follow up of migrants from low prevalent countries, and lack of resources to ensure follow-up of those at increased risk of TB. Districts would prefer notification of all migrants and require methods to locate those who could not be contacted.
Underwood et al[xxiv]	Contact tracing vs. new entrant screening in Tower Hamlets; 644 contact of active cases and 322 new entrants screened; 18 (3%) of contacts had active TB; no new entrants had active TB.
Van den Bosch, Roberts[xxv]	Port health screening only identifies 10-40% of new entrants known to the Home Office or registering with GPs; 14-50% of those invited attend screening.
Ormerod[xxvi]	Prospective data on new immigrant screening 1990-94 in Blackburn, Hyndburn and Ribble Valley; 2242 new immigrants screened, 898 found via port of arrival system, 10 cases of active TB found.
Millership and Cummins[xxvii]	Port screening system performed poorly in terms of identifying cases with TB. 35 cases of active TB in new entrant health care workers, only one of whom had been screened on arrival.
Bothamley et al[xxviii]	Port screening vs. GP vs. homeless screening in Hackney; of 1262 new entrants 235 (19%) attended screening when invited, 3 (1.2% of those screened) diagnosed with TB; 2 of these had already registered with a GP; 63% of those with port notification had already registered with GP.
Griffiths et al[xix].	Intervention in primary care setting in Hackney; 13,478 screened and 66 (0.5%) cases identified.

Studies of pre-entry screening

Table 7: Studies of pre-entry screening

Author	Type of screening	Result	Yield
Overseas screening in Vietnam Maloney[xiii] 2006	CXR- smear and culture	of 14098 screened, 183 AFB culture positive	1298 Active Pulmonary prevalence yield per 100 000 screened. 8362 active pulmonary TB cases per 1000 000 positive CXR
Pre-immigration screening process and pulmonary TB (PTB) among Ethiopian migrants in Israel, Mor et al[xiv] 2008	Follow up of cases screened: Comparison of those screened at preentry and those screened after arrival Pre-screening by: sputum and CXR. Anyone symptomatic asked to provide sputum	Pre-immigration screening reduced PTB incidence in subsequent years, TB was diagnosed earlier193 vs 487 days after entry, and process found to be cost-effective and cost-beneficial	Incidence density 325 patients per 100,000 person-yrs Incidence post entry in those screened before departure 711/100,000 vs 1746/100,000 in comparison group
Overseas screening for TB in U.S - bound immigrants and refugees; Liu et al[xxix] 2009.	Follow up evaluation of individuals screened overseas - 1999-2005/2.714,223 U.S bound immigrants screened overseas		Yield from pre-entry screening prevalence of 1036 per 100 0000 (95% CI 1004 to 1068) for smear negative pulmonary TB and 2838 per 100 000 (2785 to 2891).

Appendix 9: Cost-effectiveness analysis

Objective

To estimate the cost-effectiveness (in terms of cost per QALY gained) of tuberculosis screening at ports of entry.

Methods

Mortality due to untreated active TB

1. The risk of mortality among individuals with untreated active TB was estimated using data from a study linking TB case reports to mortality information in the NHS central register and ONS death registrations (Crofts et al, 2008)

2. Kaplan-Meier survival analysis was conducted on individual-level data from this study. Individuals who were still alive on 1 January 2010 were censored. Individuals were not censored at the date of initiating (or indeed completing) treatment because such dates were inadequately recorded. Hence the risk of death in untreated individuals (and the cost-effectiveness of screening) may be underestimated.

3. A Kaplan-Meier survival curve is shown in the figure below, together with best fitting normal, gamma and uniform cdfs to these data (see Figure below). A normal distribution appears to fit the data best, particularly the near-linear decline in survival probability between days 500 and 1500. However, a normal cdf does not have the value of zero (i.e. no risk of mortality) at day 0. To correct this, the entire curve was uplifted so that survival at day 0 was assumed to be 1.

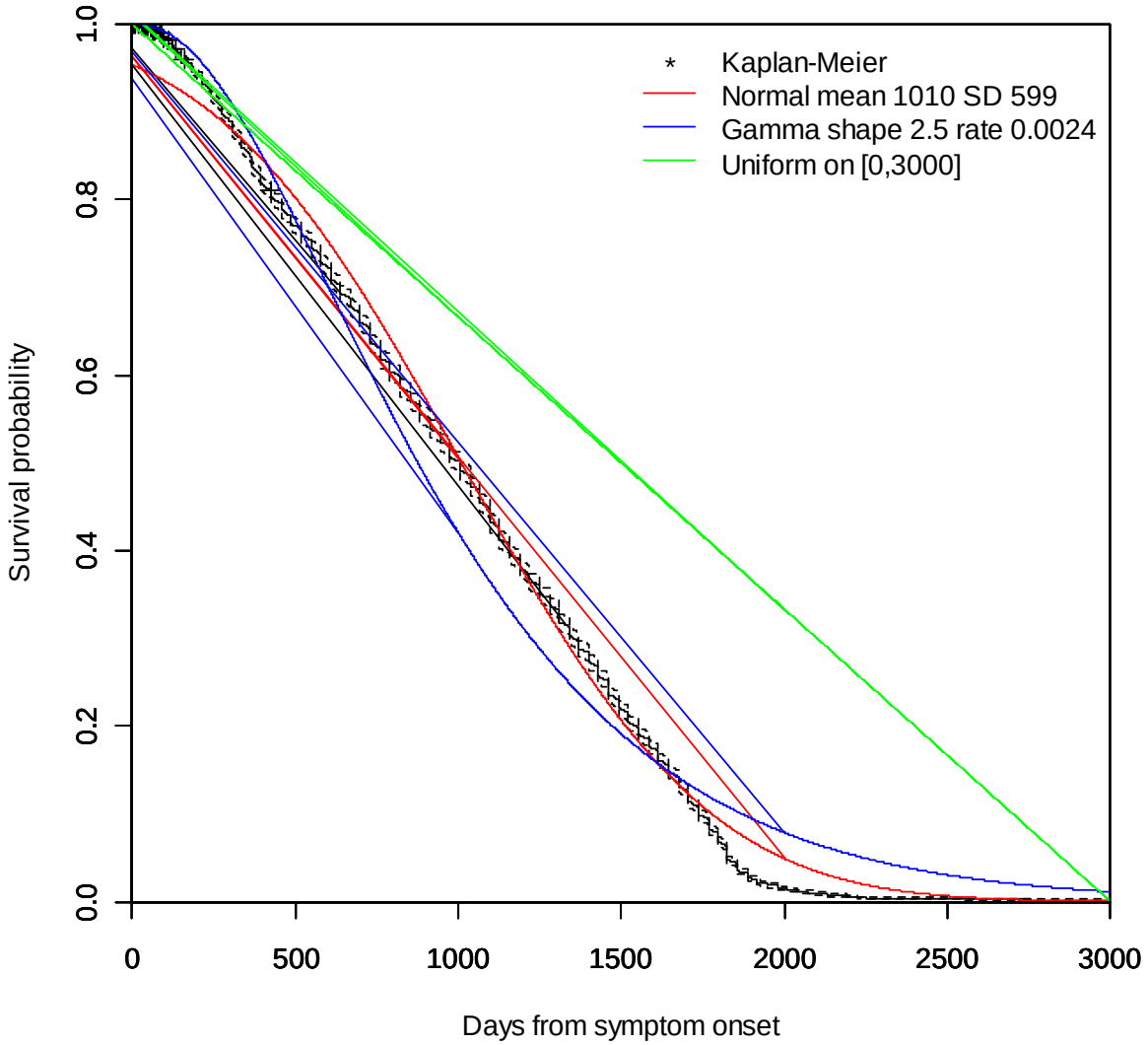


Figure. Kaplan-Meier survival curve for a cohort of individuals with active TB, together with best fitting normal, gamma and uniform cdfs.

Delay before presenting for treatment

1. The median and upper quartile for the duration of symptoms before presenting with TB for health care among cases in ETS is 89 and 160 days respectively. It may be reasonable to assume that the time between symptom onset and presentation for health care is gamma distributed (with a rapid initial increase in the probability of presentation during the first few days of symptom onset, followed by a gradual decrease and a long tail). If so, then these data are consistent with over 99% of individuals in ETS having presented for health care within a year of symptom onset.

2. However, not all individuals with TB upon entry to the UK may eventually have presented to health care and hence appear in the ETS database. Individuals with active TB on UK entry may die or leave the UK before presenting to the health service. Here we ignore the group of individuals who leave the UK before either dying or presenting for health care, but consider those who die before presenting for health care.

Modelling

1. A compartmental model was constructed in order to represent individuals with tuberculosis entering the UK, moving between compartments representing active untreated TB, treatment for TB and death (see Figure below). The risk of death was assumed to be normally distributed over the time since the onset of symptoms, while the risk of seeking treatment was assumed to be exponentially distributed.

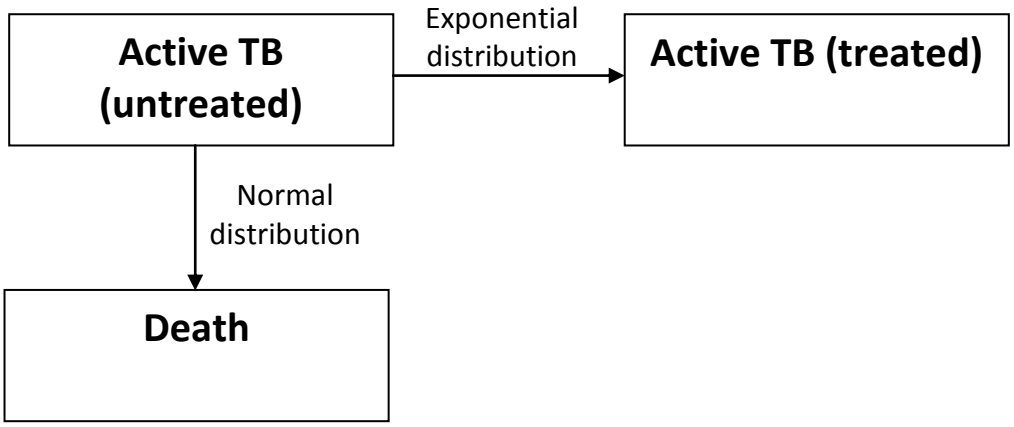


Figure. Flow diagram of the model showing movement of individuals with active TB between untreated, treated and dead compartments.

2. The model has a daily step size, and the exponential rate of moving to being treated was fitted so that of the cohort of individuals who survive to day 365, 50% are under treatment by day 89 and 75% are under treatment by day 160. Date of entry was used as a proxy for date of symptom onset – this is probably justified since the mortality rate due to TB is extremely slow.

3. Individuals with active TB not receiving treatment are assumed to have a quality of life weight of 0.68 (Kruijshaar et al., 2010). This was deducted from the UK population norm of 0.87 for 20-39 year olds (Kind et al, 1998).

4. Any deaths due to untreated TB are assumed to occur at age 38.7 years (the mean age of non-UK born cases in the ETS database). Life years lost as a consequence are estimated at 17.5 years, based on adjusting for average UK population health norms (Kind et al, 1998), and discounting at a rate of 3.5% per year as used in the reference case by the National Institute for Health and Clinical Excellence (NICE). If benefits are instead discounted at a rate of 1.5% per year as used by the Department of Health, then life years lost per death are estimated at 25.3 years.

Secondary transmission

1. A further benefit of diagnosing and treating TB patients is reducing the duration of active symptoms and hence the risk of secondary transmission to susceptible individuals.

2. A realistic estimate of the magnitude of this benefit would require a transmission dynamic model as well as robust data on TB prevalence and transmission among the migrant population.

3. As a simplification, the benefit of preventing some secondary transmission was estimated using the assumptions in a static model used to inform clinical guidelines on TB from the National Institute for Health and Clinical Excellence (NICE, 2011). This model assumed that each primary case of TB would transmit infection to an average of 0.2 secondary cases, and that each secondary case would lead to a loss of 0.493 QALYs. In addition, early diagnosis of TB would prevent 50% of these secondary cases from occuring. However, this reduction in secondary cases was estimated in the context of testing contacts of active TB cases, rather than port-of-entry screening. Hence it may overestimate the benefit of port-of-entry screening, since port-of-entry screening may expedite diagnosis by a smaller time period.

Results

1. The figure below shows the probability that an individual with active TB will not be under treatment, be under treatment or be dead at a given number of days after symptom onset.

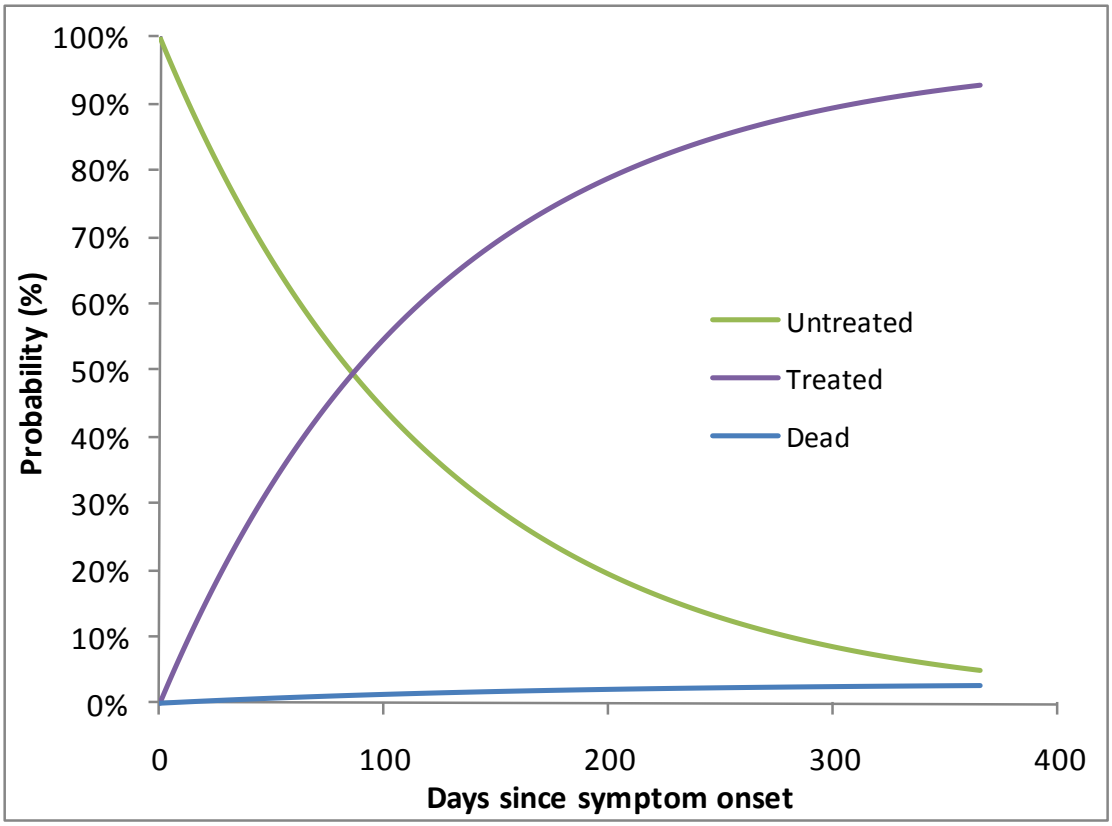


Figure. Model estimate of the probability that an individual with active TB at entry has untreated TB, treated TB or is dead.

2. The number of QALYs lost per person during the time between symptom onset and treatment presentation is estimated to be 0.54, of which 0.06 are due to having untreated TB, 0.44 due to premature death due to TB, and 0.05 due to secondary transmission.

3. In 2006/7, 34 cases of active pulmonary TB were identified (and hence presumably put on treatment earlier than they would otherwise have been). If the cost of screening is £2.5 million, then

the incremental cost-effectiveness ratio (ICER) for this intervention is estimated to be £135,000 (assuming a discount rate of 3.5% per year).

4. However, one estimate is that a maximum of 107 cases of active pulmonary TB may be identified through entry screening if the system works as well as it possible can. If this is the case, and the cost of screening is unchanged, then the then the ICER for this intervention would drop to £43,000 per QALY gained (assuming a discount rate of 3.5% per year).

5. If benefits are discounted at 1.5% per year instead of 3.5% per year, then the number of QALYs lost per person increases to 0.74 (of which 0.63 are due to premature death due to TB), and the ICER for the intervention drops to £106,000 per QALY gained (34 cases identified) or £32,000 per QALY gained (107 cases identified).

6. Hence under most of these assumptions, entry screening would not be regarded as cost-effective under the usual criteria for cost-effectiveness used by NICE. Only under the most favourable assumptions and discount rates does the ICER for entry screening approach £30,000 per QALY gained, which is the upper threshold for an intervention to be regarded as cost-effective by NICE.

7. The NICE (2008, p. 59) guidelines for assessment state that "above a most plausible ICER of £30,000 per QALY gained, the Committee will need to identify an increasingly stronger case for supporting the technology as an effective use of NHS resources" (with respect to factors such as certainty of analysis and robustness of the assessment of changes in health). Hence, the current evidence appears not to support entry screening on cost-effectiveness grounds, and would at best suggest further work is needed to develop a more robust economic model.

Limitations and biases

Limitation	Implication for conclusions
A full sensitivity analysis on parameter values has not been conducted. However, this table explores the general implications of the most important assumptions in the model.	General caution, but main conclusions remain robust
The model assumes that all individuals with active TB identified at port of entry are successfully delivered to health services for treatment. This may require improving management of TB patients in the health service, a step that may impose costs that are greater the £2.5 million estimated here.	The models are optimistic as regards the value of the ICER
The secondary transmission parameter used is likely to over estimate the true amount of infection averted from additional exposure to cases due to a delay in diagnosis	The models are optimistic as regards the value of the ICER

that will be associated with the discontinuation of a port of entry screening programme. A more robust estimate will require a transmission dynamic model that will require more time and resources to construct.	
The models assume that (at Heathrow) it would be possible to screen all those who are currently not screened (for a variety of reasons) at the same cost. This would require an 80% increase in the numbers of X rays taken	The models are highly optimistic as regards the value of the ICER
The models assume that a sensitivity of 75% for CXRs for active TB can be achieved. This is a best case assumption	The models are optimistic as regards the value of the ICER
The models assume that all the 107 theoretically detectable cases either come through Heathrow (which they do not) or can be detected at other ports. Achieving this would require extra capital and revenue costs	The models are optimistic as regards the value of the ICER
The models use both a 3.5% discount rate (as per normal NICE methodologies) and a 1.5% rate as per DH guidance.	Even at the more optimistic DH 1.5% rate, the ICER is above £32k per QALY

Sources

Crofts JP, Pebody R, Grant A, Watson JM, Abubakar I. Estimating tuberculosis case mortality in England and Wales, 2001-2002. Int J Tuberc Lung Dis 2008; 12(3):308-313.

Kind P, Dolan P, Gudex C, Williams A. Variations in population health status: results from a United Kingdom national questionnaire survey. BMJ 1998; 316:736-741.

Kruijshaar ME, Lipman M, Essink-Bot ML et al. Health status of UK patients with active tuberculosis. Int J Tuberc Lung Dis 2010; 14(3):296-302.

National Institute for Health and Clinical Excellence. Clinical diagnosis and management of tuberculosis, and measures for its prevention and control. March 2011.

National Institute for Health and Clinical Excellence. Guide to the methods of technology appraisal. June 2008.

MJ/6-05-20

References:

[i] Labour Force Survey

[ii] K. Dasgupta D. Menzies Cost-effectiveness of tuberculosis control strategies among immigrants and refugees .Eur Resp J 2005 25:1107-1116

[iii] Department of Health Stopping tuberculosis in England; an action plan from the Chief Medical Officer. October 2004

[iv] National Institute for Health and Clinical Excellence. Clinical diagnosis and management of tuberculosis, and measures for its prevention and control. March 2011

[v] Department of Health. Tuberculosis prevention and treatment: a toolkit for planning, commissioning and delivering high-quality services in England. June 2007

[vi] Arshad S. et al Active screening at entry for tuberculosis among new immigrants: a systematic review and meta-analysis Eur Resp J 2010 35:1336-1345

[vii] Markey et al Suspected cases of pulmonary tuberculosis referred from port of entry into Great Britain, 1980-3 BMJ 1986 292:398

[viii] Bothamley GH et al Active case finding of tuberculosis in Europe: a Tuberculosis Network European Trials Group (TBNET) survey. European Respiratory Journal. 32(4):1023-30, 2008

[ix] Report from Radiation Protection Division, HPA, 2006

[x] Pareek M, Abubakar I, White PJ, et al. TB screening of migrants to low TB burden nations: insights from evaluation of UK practice. Eur Respir J 2010 Nov .

[xi] French CE, Kruijshaar MK, Jones J, Abubakar I. The influence of socio-economic deprivation on tuberculosis treatment delays in England, 2000-2005. Epidemiology and Infection. 137(4):591-6; 2008.

[xii] Health Protection Agency. Tuberculosis in the UK. 2010.

[xiii] Maloney SA et al. Assessing the performance of overseas tuberculosis screening programs: a study among US-bound immigrants in Vietnam. Archives of Internal Medicine. 166(2):234-40, 2006 Jan 23.

[xiv] Mor Z. Lerman Y. Leventhal A. Pre-immigration screening process and pulmonary tuberculosis among Ethiopian migrants in Israel. European Respiratory Journal. 32(2):413-8, 2008 Aug.

[xv] International Organisation for Migration

[xvi] Coker R. Compulsory screening of immigrants for tuberculosis and HIV. BMJ 2004 328, p298-300 February

[xvii] www.hpa.org.uk/migranthealthguide

[xviii] Brewin et al. Is screening for tuberculosis acceptable to immigrants? A qualitative study. Journal of Public Health 2006 28, 3, p253-260

[xix]Griffiths C et al Screening for tuberculosis in primary care; a cluster randomised controlled trial. Eur Respir J, 2005

[xx] Toman, K (1979) Tuberculosis case finding and chemotherapy: Questions and answers. WHO: Genev

[xxi] Hogan H, Coker R, Gordon A, Meltzer M, Pickles H. Screening of new entrants for tuberculosis: responses to port notifications. J Public Health (Oxf) 2005; 27: 192-5

[xxii] Lavender M Screening immigrants for tuberculosis in Newcastle upon Tyne. J Public Health Med 1997;19:320-323

[xxiii] Hardie, R. M.; Witson, J. M. Screening Migrants at risk of Tuberculosis. British Medical Journal 1993. Volume 307, 1539-1540

[xxiv] Underwood BR, White VLC, Baker T, Law MR, Moore-Gillon J.Contact tracing and population screening for tuberculosis – who should be assessed? *J Publ Hlth Med* 2003; **25**: 59–61.

[xxv] Van Den Bosch C. Roberts J. Tuberculosis screening of new entrants; how can it be made more effective? J Public Health (2000) 22 (2): 220-223.

[xxvi] Ormerod LP. Is new immigrant screening for tuberculosis still worthwhile? *J Infect* 1998; **37**: 39–40.

[xxvii] Millership S, Cummins A. Identification of tuberculosis cases by port health screening in Essex 1997-2003. Journal of Public Health J Public Health (2005 27 (2): 196-198.

[xxviii] G H Bothamley et al. Screening for tuberculosis: the port of arrival and the homeless scheme compared with screening in general practice *Thorax* 2002;57;45-49

[xxix] Liu Y. et al. Overseas screening for tuberculosis in U.S.-bound immigrants and refugees. New England Journal of Medicine. 360(23):2406-15, 2009

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